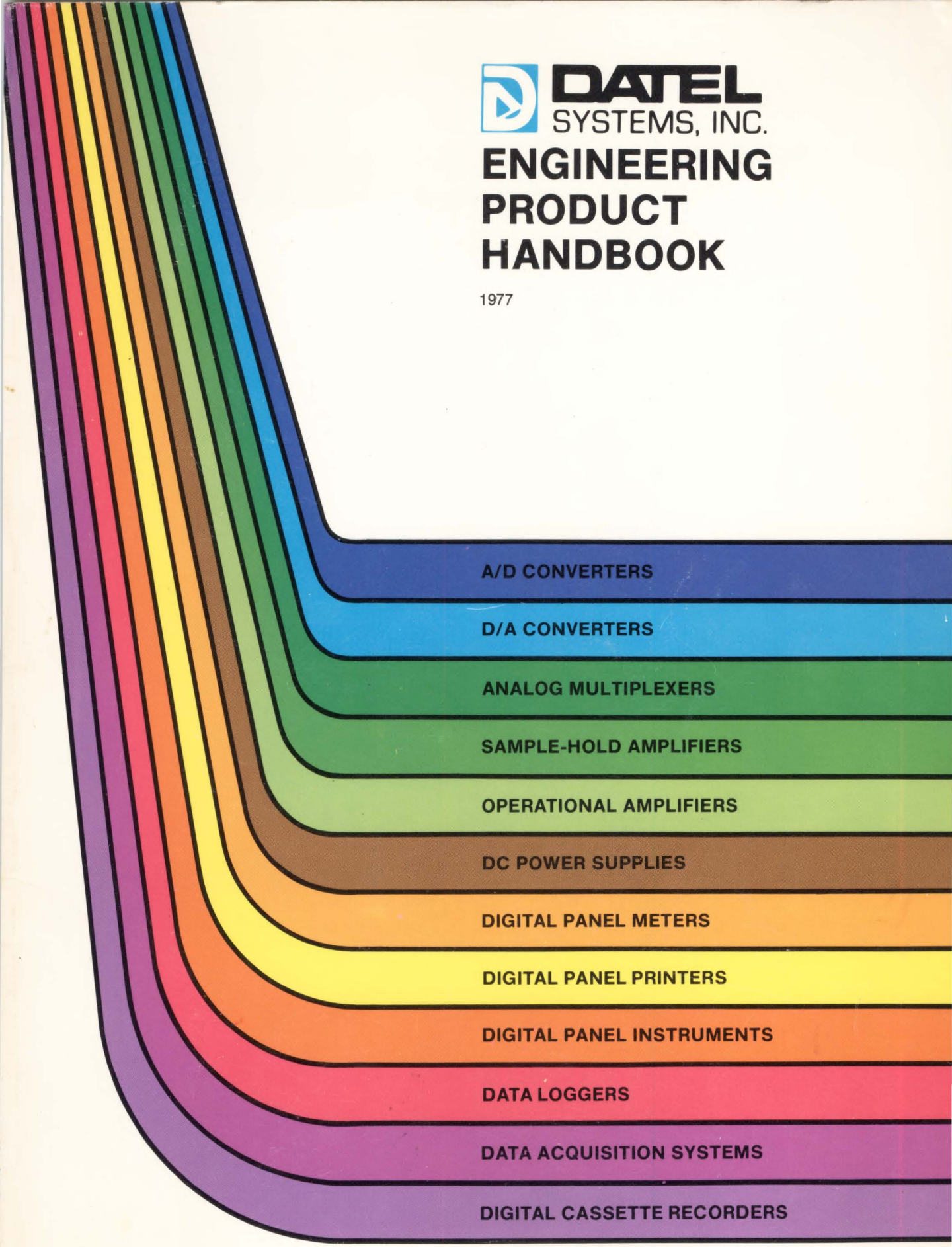


MOST PRODUCTS IN THIS BROCHURE ARE COVERED BY GSA CONTRACT

# Contents

**Most Datel Systems products are covered by GSA contracts.**




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# Introduction

Datel Systems Inc. was founded in February, 1970, and began production of a basic line of A/D converters, D/A converters, miniature power supply modules, and other circuit modules. Since then these basic lines have expanded considerably and many new product lines have been developed. Now in its seventh operating year, Datel Systems holds a leadership position in the areas of data converters, data acquisition systems, digital panel meters, digital panel printers, data logging systems, and power supplies. Although still a young company compared with others in these product areas, Datel has grown rapidly and achieved significant diversification of its product lines. This diversification is significant in assuring the future growth of the company.

A recently added hybrid microelectronics division is dedicated to the production of new lines of high performance hybrid data converters. Datel Systems' modern plant of 75,000 square feet is located on Route 138 in Canton, Massachusetts, just 15 miles southwest of Boston. It is easily accessible from Logan International Airport.

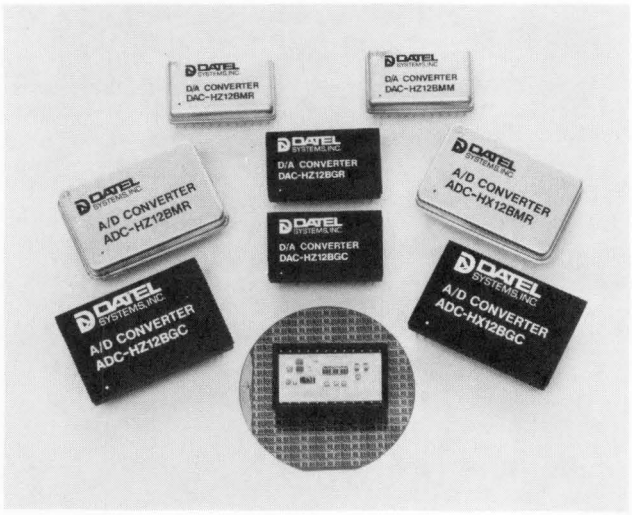
## DATEL SYSTEMS' PRODUCTS

Datel Systems' product lines now include the following:

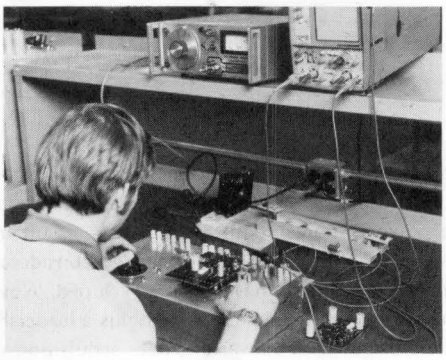
- A/D Converters
- D/A Converters
- Sample Holds
- Analog Multiplexers
- Operational Amplifiers
- Instrumentation Amplifiers
- Active Filters
- Computer Analog Peripheral Systems
- Digital Panel Meters
- Data Acquisition Systems
- Data Logging Systems
- Power Supplies
- V/F Converters
- Digital Control Instruments
- Digital Panel Printers
- Digital Cassette Transports and Systems

Datel Systems' reputation in these product areas has been established by the tens of thousands of products presently in use throughout the world. These products are used in a wide variety of applications from military and government systems to industrial, scientific, medical, environmental, and oceanographic systems.

Product reliability is an important part of any company's reputation. Reliability at Datel Systems begins with conservative engineering design, use of quality pre-tested components, manufacturing methods with built-in checking procedures, and sufficient product electrical tests at the proper stages of the manufacturing cycle. These procedures in conjunction with a fully implemented Quality Assurance Program have resulted in an extremely low return rate for delivered products.




# About this Product Handbook



## NEW PRODUCTS

Over the past year Datel Systems has introduced a significant number of new products. Some of these products are:

- A line of high performance hybrid 12 bit A/D and D/A converters (DAC-HZ, ADC-HZ, and ADC-HX series)
- A new portable data logging instrument for field use (DL-2)
- Industry's fastest 12 bit A/D converter with a 2 $\mu$sec. conversion time (ADC-EH12B3)
- A new low cost 3-1/2 digit DPM selling for $59.00 in quantities of 100 (DM-350)
- A new ultra low-power incremental digital cassette transport (ICT Series)
- A new line of digital control instruments for industrial timing and control applications (8000 Series)
- A new high resolution, isolated, ratiometric dual slope converter series (ADC-EP Series)
- A low-cost modular data acquisition system featuring 16 channels, 12 bit resolution and 50 kHz throughput rate.

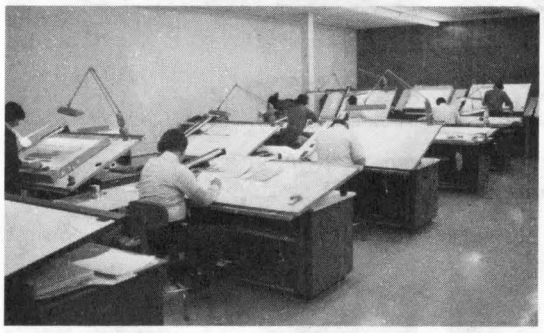
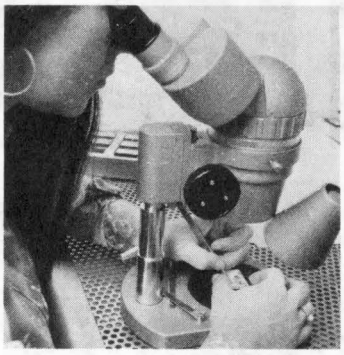
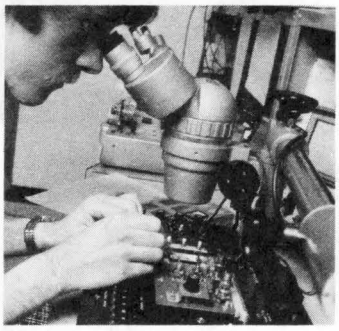
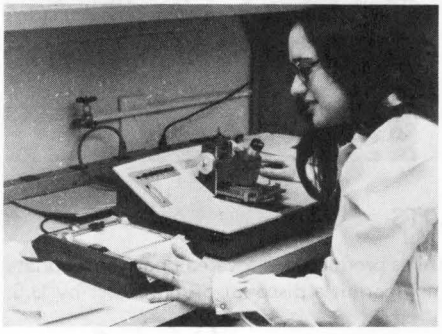
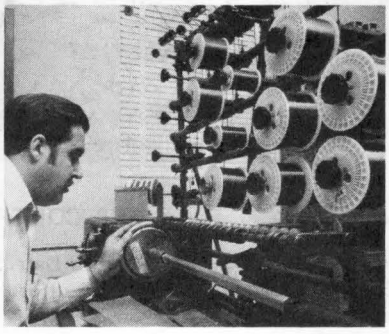
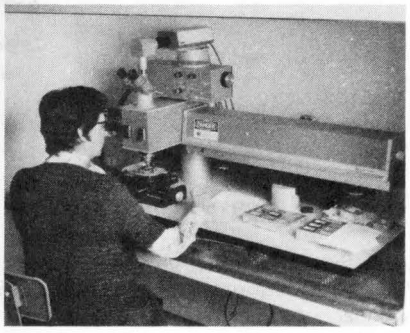
Watch for future new products from Datel Systems announced and advertised in the electronics trade journals. New products are also discussed in detail in the periodical, "Datel Digest".

## ABOUT THIS PRODUCT HANDBOOK

This new edition of Datel's Engineering Product Handbook is written primarily for the systems and circuit design engineer who requires a substantial amount of technical information about products in order to select and apply the right product in his specific requirement. The goal of this product handbook, therefore, has been to present detailed technical data in an easily readable form in order to simplify the product evaluation and selection process.

This edition, however, is a departure in format from previous editions. We have here, for the first time, combined product data in tabular form with product data sheets. Not all Datel Systems' product data sheets are included here, but our most significant products are included. Other data sheets may be obtained by contacting the factory or Datel's nearest sales office.

The product evaluation and selection process in most cases can be shortened by referring first to the specification tables in order to compare performance and pricing, and then going to the appropriate data sheet section of the catalog. In all cases the data sheets of a particular product category immediately follow the specification tables.

Also included in this product handbook is a 13 page section entitled "Principles of Data Acquisition and Conversion" which is basic background material about the operation and application of the products described in this catalog. This material will serve as both a quick review of basics for those already experienced in the application of data converters and as tutorial material for those who are not familiar with data conversion systems.

## ORGANIZATION OF THIS PRODUCT HANDBOOK

This product handbook is divided into the following major sections: Data Conversion Devices, Converter Accessory Circuits, Modular Data Acquisition Systems, Power Supplies, Digital Panel Instruments, Data Loggers, and Digital Cassette Recording Systems. Most of these sections include product specification tables in addition to product data sheets.

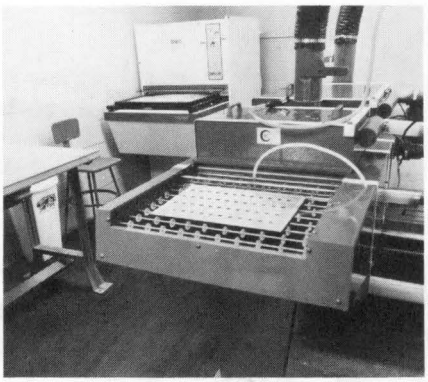
Also included in this catalog are sections on extended performance modules, accessory products (sockets, trimming potentiometers, etc.) and an ordering guide.

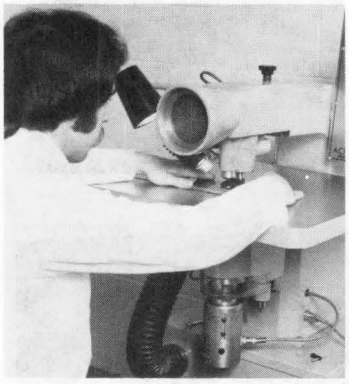
## PRODUCT SUPPORT

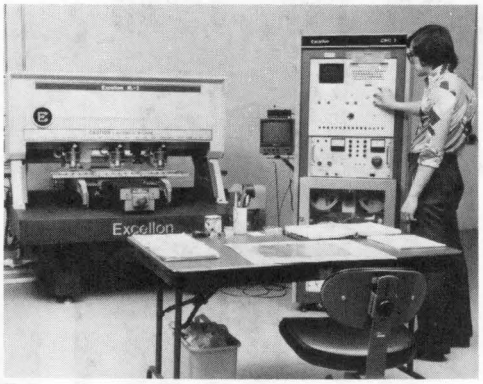
All Datel Systems' products are backed up by a detailed technical data sheet. In many cases there is also an instruction manual available. The appropriate literature may be obtained by contacting the factory. In all cases the appropriate technical data is shipped with each product ordered. There is also a number of technical application notes available from the factory.

While the available literature gives all the information normally required to use any of our products, we also maintain an applications engineering department to answer any additional questions you may have regarding the application of these products.

Our qualified team of field sales engineers is available to service our customers throughout the United States, Canada, Western Europe, and the Far East. Datel Systems has direct sales offices in Santa Ana, California; Sunnyvale, California; and Gaithersburg, Maryland. There are Datel sales subsidiaries in London, England; Paris, France; Munich, West Germany; Tokyo, Japan; and Osaka, Japan.








## QUALITY ASSURANCE

Datel Systems has a fully implemented Quality Assurance Program in conformance with MIL-STD-9858A. This program is under a full-time Quality Assurance Manager who reports directly to the President of Datel Systems, Inc. The quality assurance responsibility is superimposed over procurement, material control, manufacturing, and shipping activities. The Quality Assurance Manager is responsible for the following areas: quality assurance engineering, systems test, in-process inspection, purchased material inspection, and calibration. The quality assurance program encompasses receiving inspection of all components, in-process inspection of all assemblies, burn-in or shock testing where required, calibration of all instruments and maintenance of calibration records, component vendor records and vendor rating systems, and implementation and control of a material review board. The Q.A. Manager also submits monthly, to management, in-house quality performance reports on all departments.

## GSA CONTRACTS

Most of Datel Systems products are covered under appropriate GSA contracts which permit a discount on purchases by U.S. Government.

Eugene L. Zuch
Product Marketing Manager

PRODUCTION MODULAR PRODUCTS

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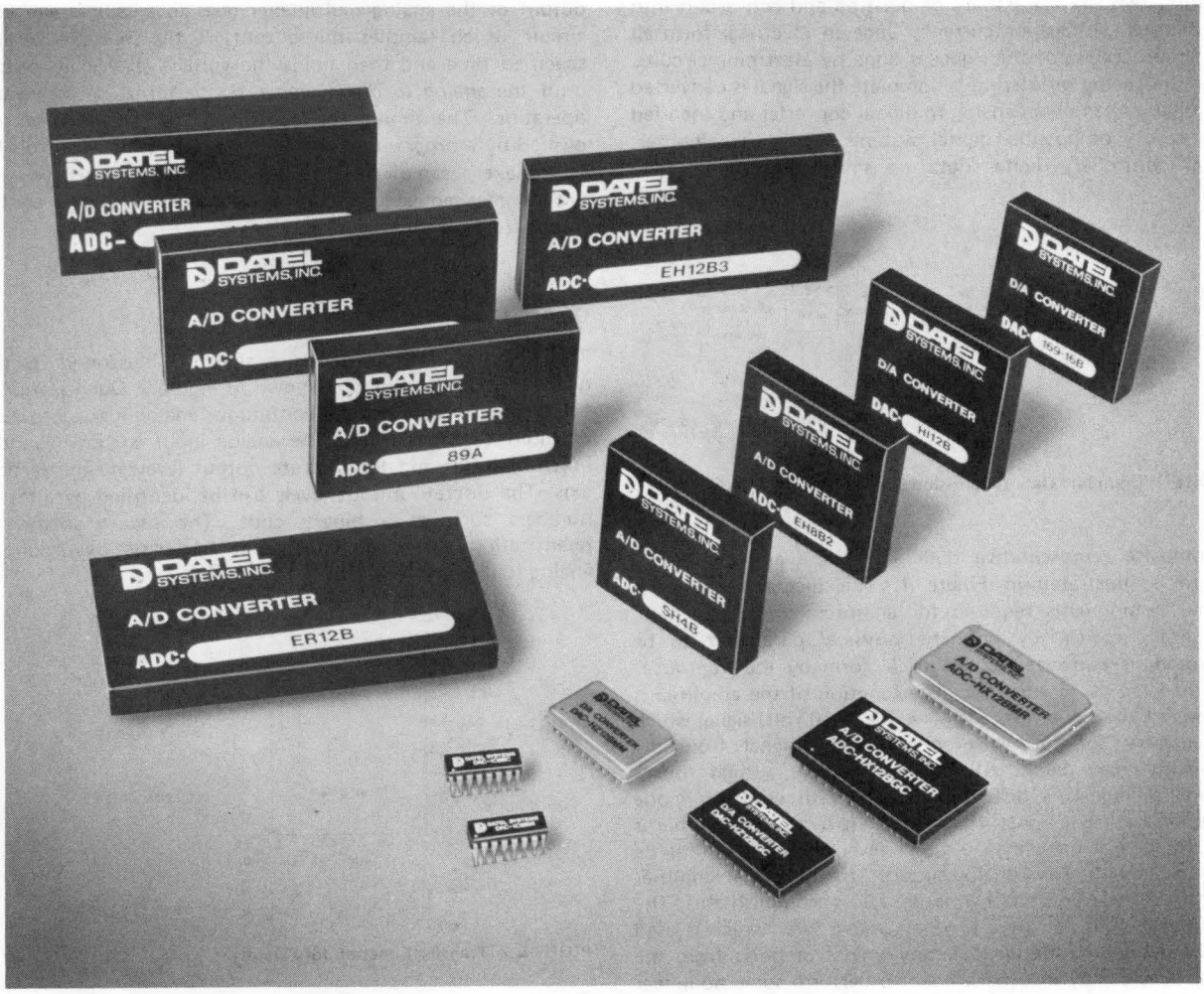
# A/D and D/A Converters



# Principles of Data Acquistion and Conversion

Data acquisition and conversion systems are used to process analog signals and convert them into digital form for subsequent processing or analysis by computer or for data transmission. In general a transducer takes a physical parameter such as pressure, temperature, strain, or position and converts it into an electrical voltage or current. Once in electrical form all further processing of the signal is done by electronic circuits. After the analog processing is complete the signal is converted into digital form by an analog to digital converter and then fed to a variety of possible digital systems such as a computer, digital controller, digital data transmitter, or digital data logger.

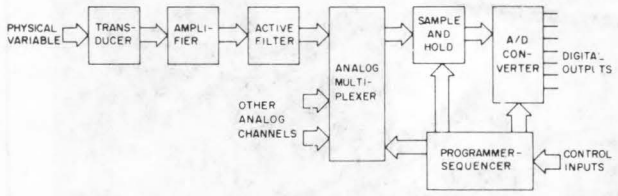



**FIGURE 1. Complete Data Acquisition and Conversion System.**

A complete representative data acquisition and conversion system is illustrated in Figure 1. This diagram shows the various components required for an interconnected system. The input to the system, the *physical parameter* to be measured, is converted to electrical form by the *transducer* and then fed to an *amplifier.* The function of the amplifier is to convert the signal to a high level (1 to 10 volt) signal which is necessary for further processing. The signal from the transducer may be a millivolt level signal, a high source impedance signal, a differential signal with common mode noise, or a current signal. In any of these cases the amplifier is used to convert the signal to a high level voltage which can be used to drive the next analog circuit. An operational amplifier or instrumentation amplifier is used to accomplish this. The amplifier is followed by a low pass *active filter* which is used to eliminate high frequency components or noise from the signal. There may also be a need to perform some nonlinear operation on the signal such as squaring, linearizing, or multiplication by another function. Such operations, which may be performed by an analog multiplier or other nonlinear circuit, also require high level signals to maintain good accuracy and may be performed either before or after the active filter.

The signal then goes to an *analog multiplexer* which performs a time division multiplexing operation between a number of different signal inputs. Each input channel is sequentially connected to the output of the multiplexer for some specified period of time. The circuits which follow the multiplexer are thus time shared between a number of analog signals. The output of the analog multiplexer goes to a *sample and hold* circuit which samples the output of the multiplexer at a specified time and then holds the voltage level at its output until the *analog to digital converter* performs its conversion operation. The timing and control of this system is accomplished by a *programmer-sequencer* circuit which controls the multiplexer, sample and hold, and A/D converter. The programmer-sequencer in turn is controlled by digital control inputs from a data processor.

## QUANTIZING THEORY

The operation of quantizing a signal is illustrated by the quantizer transfer function shown in Figure 2. Quantization is the process of converting a continuous analog input into a set of discrete output levels. The analog input is shown on the horizontal axis and the discrete output levels on the vertical axis. The discrete output levels can be identified by a set of numbers such as a binary code. The two processes of quantization and coding represent the basic operation of analog to digital conversion.

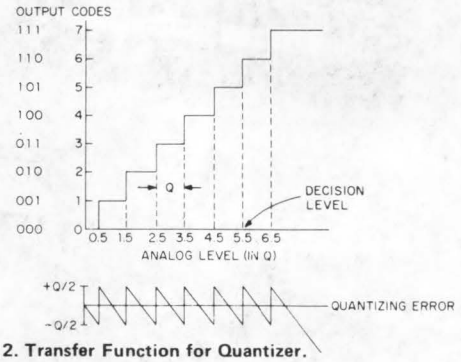



**FIGURE 2. Transfer Function for Quantizer.**

The quantizer transfer function has a number of important characteristics. The function shown is ideal with analog decision levels at values of 0.5, 1.5, 2.5, etc. The decision levels are set at values which bracket the true levels. In other words, an analog input value of 1 should correspond with a binary output level of 001. The analog 1 value is halfway between the decision levels 0.5 and 1.5. Thus an analog value of 1 ±0.5 is read out as a digital 001. The distance between decision levels is Q, the quantization size or bit size. A

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quantizer with a binary output code has $2^n$ discrete output levels with $2^n-1$ analog decision levels. The decision levels in an actual quantizer would not be precise but would have a finite uncertainty band around them. For an analog value within this uncertainty band the output could be at either of two discrete output levels. In addition, in an actual quantizer the decision levels would not necessarily be at precisely the correct analog values, but would miss these values due to nonlinearity, offset, and gain errors.

If the input to the quantizer is moved through its full range of values and subtracted from the discrete output levels an error signal will result. This error is called "quantizing error" and is an irreducible error due to the quantizing process and dependent on the number of quantization levels, or resolution, of the quantizer. When the quantizing error is plotted, as shown in the illustration, it has the form of a sawtooth waveform with a peak to peak value of Q. The output of the quantizer can be thought of as the input analog signal with quantization noise added to it. Thus the output, which is restricted to a finite number of discrete values, jumps from one value to the next as the input moves through its full range. The quantization error is zero only midway between the decision levels. The peak value of quantization noise is Q/2 and the RMS value can be computed from the triangular shape and found to be $Q/2\sqrt{3}$. Although the quantization noise can be reduced by increasing the resolution of the quantizer, there always remains a quantization uncertainty of at least ±Q/2 for any quantizer.

An A/D converter performs the operations of quantizing and coding a signal in some finite amount of time. The time required to do this depends both on the resolution of the converter and the particular conversion method used. The speed of conversion required in a particular situation depends on the time variation of the signal to be converted and the amount of resolution required. The time required to make a measurement or conversion is generally called the "aperture time."

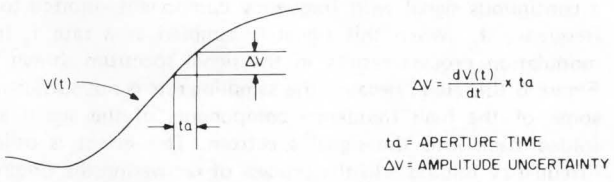


**FIGURE 3. Aperture Time and Amplitude Uncertainty.**

Aperture time can be considered to be a time uncertainty or amplitude uncertainty. As shown in Figure 3 the aperture time and amplitude uncertainty are related by the time rate of change of the signal. For the particular case of a sinusoidal signal to be converted, the maximum rate of change occurs at the zero crossing of the waveform and the amplitude change is:

$$\Delta V = \frac{d}{dt}(V\sin\omega t)_{t=0} \times t_a = V\omega t_a$$

giving

$$\frac{\Delta V}{V} = \omega t_a = 2\pi f t_a$$

From the result we can determine, for example, the aperture time (or conversion time) required to digitize a 1 kilohertz signal to 10 bits resolution. This is a resolution of 1 part in $2^{10}$ or 0.1%, and using the above equation:

$$t_a = \frac{\Delta V}{V} \times \frac{1}{2\pi f} = \frac{.001}{6.28 \times 10^3} = 160 \times 10^{-9}$$

The result is a required aperture time of only 160 nanoseconds to remain within 1 bit (0.1%) of resolution due to the rate of change of the signal. It can be seen from this result that to convert even a slowly varying signal to moderate resolution levels requires an extremely fast and, therefore, expensive analog to digital converter. Fortunately there is a simple and inexpensive way around this problem by the use of the sample and hold circuit which can reduce the aperture time considerably by taking a rapid sample of the signal and then holding its value for the required conversion time. The aperture time required for sinusoids of other frequencies and different resolutions is summarized by the graph shown in Figure 4.

## SAMPLING THEORY

The operation of sampling is illustrated in Figure 5 which shows an analog signal and a train of periodic sampling pulses. The pulses represent a fast acting switch which connects to the analog signal for a very short time and then opens for the remainder of the period. Sampling pulses thus have a very short ON time compared to the total period. The result of the sampling process is identical with multiplying the analog signal with a train of pulses of unity amplitude. The resultant modulated signal is shown in Figure 5 (c) where the amplitude of the analog signal is preserved in the modulation envelope of the pulses. If the switch-type sampler is replaced by a switch and a capacitor, then the analog signal is sampled and stored until the next sample pulse with the result shown in Figure 5 (d). This type of sampler is called a sample and hold.

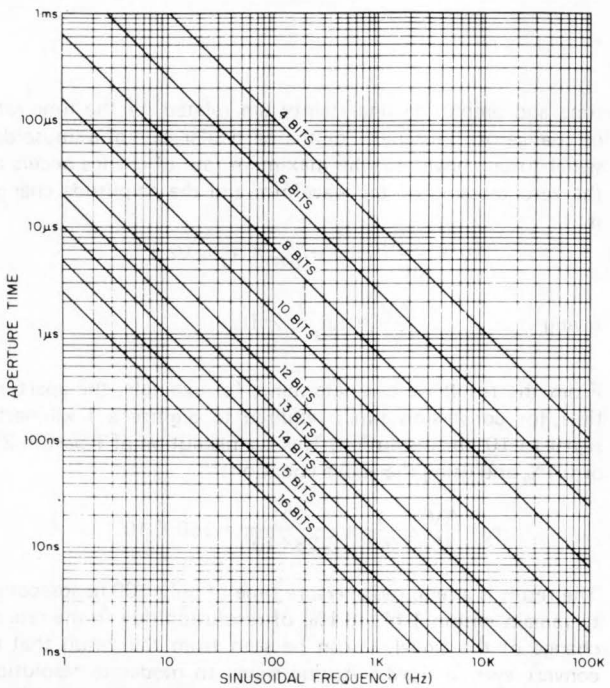


**FIGURE 4. Aperture Time Required for a Given Frequency and Resolution.**

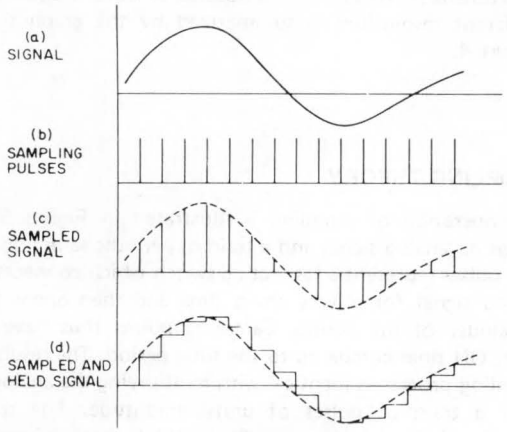


**FIGURE 5. Signal Sampling Process.**

The purpose of signal sampling is the efficient use of data processing equipment or data transmission facilities. A single data transmission link can be used to transmit many channels of information by simply sampling each channel periodically. Likewise, for the efficient use of data processing equipment to monitor and control a process, for example, it may only be necessary to sample the state of a process once every 5 minutes, perform a computation and correction, and then free the computer the remaining time for other tasks. Continuous monitoring of a single information channel by a computer would be very expensive indeed. In data conversion systems it is also more economical to use a single A/D converter, which may be the most expensive component in the system, for a number of information channels by using sampling.

An important and fundamental question to ask about sampled-data channels is "how often must I sample a given signal in order not to loose information from the signal?" It seems obvious that all useful Information can be extracted by sampling a slowly changing signal at a much faster rate than any change which occurs, and likewise that if a signal is significantly changing value between samples, information is being lost. The answer is contained in the well known Sampling Theorem which can be stated as follows: *If a continuous bandwidth limited signal contains no frequency components higher than $f_c$ then the original signal can be completely recovered without distortion if it is sampled at the rate of at least $2f_c$ samples per second.*

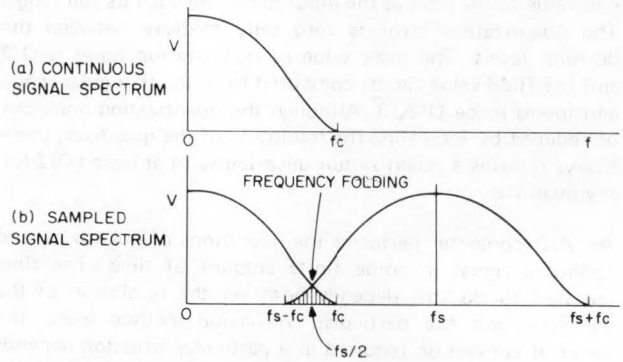


**FIGURE 6. Spectra Showing Frequency Folding.**

The sampling theorem can be illustrated by the frequency spectra shown in Figure 6. Figure 6 (a) shows the spectrum of a continuous signal with frequency components limited to a frequency $f_c$. When this signal is sampled at a rate $f_s$ the modulation process results in the signal spectrum shown in Figure 6 (b). Here, because the sampling rate is not sufficient, some of the high frequency components of the signal are folded back into the signal spectrum. This effect is called "frequency folding." In the process of recovering the original signal, the folded frequency components cause distortion and cannot be separated or distinguished from the original signal. It can be seen from the figure that by changing the sampling rate such that $f_s - f_c > f_c$, we obtain the result that $f_s > 2f_c$ which demonstrates the sampling theorem. Frequency folding is eliminated by either using a high enough sampling frequency or filtering the original signal to eliminate any frequency

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components above one half the sampling rate. It should be noted, however, that in practice there is always some frequency folding due to wideband noise and non-ideal filters and that one must attempt to reduce the effect to negligible proportions.

Another effect which is the result of frequency folding is known as an "alias." Figure 7 illustrates this by showing a periodic signal which is sampled at a rate less than twice per cycle. The sample amplitudes are shown connected by a dotted line which obviously has a period quite different from the original signal and is an alias. From this figure it can be readily seen that if the waveform is sampled at least twice per period as required by the sampling theorem, its original frequency is preserved.

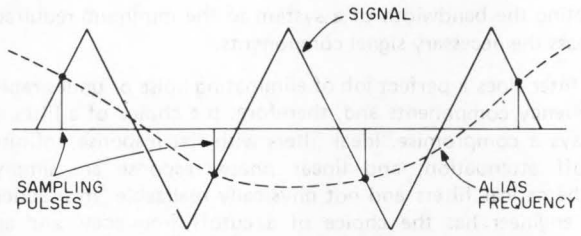


**FIGURE 7. Alias Frequency Caused by Inadequate Sampling Rate.**

The sample and hold device, which is so commonly used in data conversion systems and also analog multiplexed data systems, has some important characteristics which should be briefly discussed. An ideal sample and hold, or zero order hold as it is also known, takes a sample in zero time and then holds the value of the sample indefinitely with perfect accuracy. In practical units, a sample is taken in a time period which is short compared to the holding time. During the holding time there is some change in the output which is small compared to the system accuracy. The effect of this process on a continuous analog input signal can be determined by finding the transfer function of a sample and hold. By use of the impulse response of this device and using the Laplace transform the transfer function is found to be:

$$G(j\omega) = \frac{1 - e^{-j\omega T}}{j\omega} = \frac{2\pi}{\omega_s} \frac{\sin \pi \omega/\omega_s}{\pi \omega/\omega_s} e^{-j\pi\left(\frac{\omega}{\omega_s}\right)}$$

where T is the sampling period and $\omega_s$ is the sampling radian frequency. The magnitude and phase of this function are plotted in Figure 8 which shows that a sample and hold device acts like a low pass filter with a cutoff frequency of approximately $f_s/2$ and a phase delay of T/2, or one half the sampling period. Circuit characteristics of the sample and hold will be discussed in a following section.

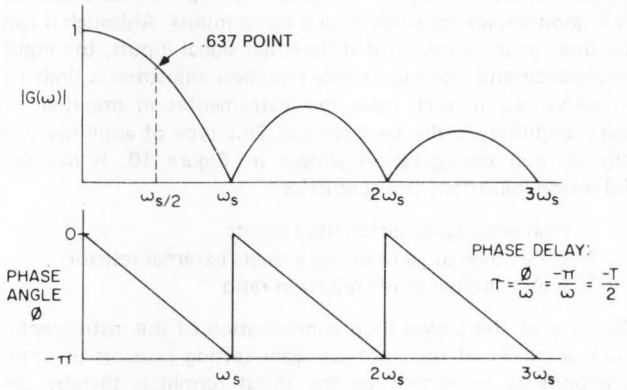


**FIGURE 8. Sample and Hold Transfer Function.**

## AMPLIFIERS AND FILTERS

The first part of a data acquisition and conversion system is concerned with extracting the signal which is to be measured. The initial processing of the signal is done with an amplifier, filter, and possibly a nonlinear operator. The purpose of the amplifier is to perform one or more of the following functions: boost the amplitude of the signal, buffer the signal, convert a signal current into a voltage, or separate a differential signal from common mode noise. For most data conversion systems the desired voltage level out of the amplifier is 5 or 10 volts full scale. This is the level accepted by most analog multiplexers, sample and holds, and A/D converters to give the best accuracy.

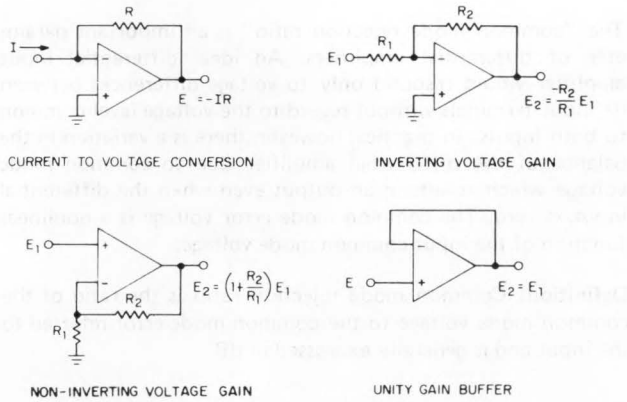


**FIGURE 9. Operational Amplifier Configurations.**

Operational or instrumentation amplifiers are used to perform the above listed signal translations. Some of the operational amplifier configurations used are shown in Figure 9 with their

output relationships given. In general an operational amplifier is a good choice for single ended signal inputs. Although it can be used in some cases for differential signal inputs, the input impedance and common mode rejection adjustments limit its effectiveness. In such cases the instrumentation amplifier, or data amplifier, is the best choice. This type of amplifier is a closed loop configuration shown in Figure 10. It has the following important characteristics.

1. high impedance differential inputs
2. wide range of gains set by a single external resistor
3. high common mode rejection ratio

Because of the closed loop configuration of the instrumentation amplifier, it does not use gain setting resistors or other components connected to the input terminals thereby degrading the input impedance. Thus the high impedance inputs maintain the high common mode rejection characteristic even with moderate source impedances.

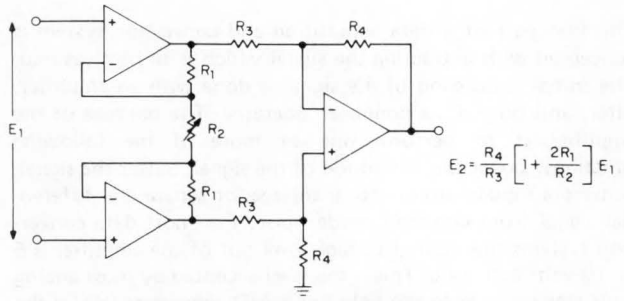


**FIGURE 10. Instrumentation Amplifier Configuration.**

The "common mode rejection ratio" is an important parameter of differential amplifiers. An ideal differential input amplifier would respond only to voltage differences between its input terminals without regard to the voltage level common to both inputs. In practice, however, there is a variation in the balance of the differential amplifier due to common mode voltage which results in an output even when the differential input is zero. The common mode error voltage is a nonlinear function of the input common mode voltage.

**Definition:** Common mode rejection ratio is the ratio of the common mode voltage to the common mode error referred to the input and is generally expressed in dB.

$$CMRR = 20 \log_{10}\left[\frac{V_{cm}}{e_{cm}}\right]$$

where $V_{cm}$ is the common mode voltage and $e_{cm}$ is the common mode error referred to the input. CMRR is a function of both common mode voltage and frequency. At even moderate frequencies a high CMRR can be significantly degraded by small unbalances in source impedance and input capacitances.

Following the amplifier in our system, it may be necessary to use a low pass filter. Filtering is used in a data acquisition system for two reasons: to limit the bandwidth of the processed signal to less than half the sampling frequency in order to eliminate frequency folding, and to reduce either man-made or electrically generated noise in the system. Man-made noise usually has some identifiable characteristic such as periodicity and regular shape and can be eliminated by some specific technique such as a notch filter. Thermal, or Johnson noise, on the other hand is random noise with a noise power proportional to bandwidth. It is minimized by restricting the bandwidth of a system to the minimum required to pass the necessary signal components.

No filter does a perfect job of eliminating noise or undesirable frequency components and, therefore, the choice of a filter is always a compromise. Ideal filters with flat response, infinite cutoff attenuation, and linear phase response are simply mathematical filters and not physically realizable. In practice the engineer has the choice of a cutoff frequency, and an attenuation rate and phase response based on the number of poles and filter characteristic chosen. The effect of overshoot and non-uniform phase delay must also be considered.

Active filters are very popular due to a number of excellent features they have over older RLC type passive filters. They eliminate inductors and associated saturation and temperature stability problems. The response of an active filter can be accurately set by temperature stable capacitors and resistors. In addition, they overcome the problems of insertion loss and loading effects by their use of operational amplifiers.

## SETTLING TIME

A parameter that occurs very often in data acquisition and conversion systems is "settling time." Settling time is defined as *the time elapsed from the application of a full scale step input to an amplifier to when the output has entered and remained within a specified error band around its final value.* Although this definition is stated in the terms of an amplifier response, settling time is also used in the specification of other components such as D/A converters, analog multiplexers, and sample holds. It has essentially the same meaning in these other cases although in some of them the input step is actually applied by turning on a switch and, therefore, a switching time is included in the settling time. In the case of sample and holds, the equivalent of settling time is the acquisition time and includes both the turn-on time of the sampling switch and the charging time of the holding capacitor to its final value.

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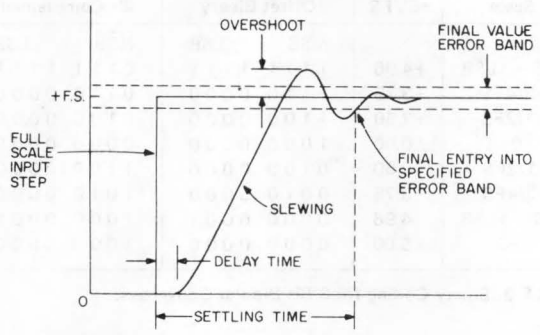


**FIGURE 11. Amplifier Settling Time.**

The settling time of a fast amplifier is illustrated in Figure 11. After the application of the input step, there is a small delay time after which the amplifier begins to slew or change its output at the maximum possible rate. During this time the amplifier is in a non-linear or saturated state. The output then overshoots its final value, recovers from saturation, and then settles into its specified error band after a small amount of ringing. The definition distinguishes that the amplifier must enter and remain in the error band rather than just enter it the first time.

Settling time, unfortunately, is not readily predictable from other amplifier parameters such as bandwidth, slew rate, or overload recovery time although it depends on all of these. It is also dependent on the amplifier open loop response characteristic, dielectric absorption by internal capacitors, output load capacitance, and input capacitance. An amplifier must be designed and optimized for settling time, and settling time is a parameter which must be evaluated by testing.

One of the important requirements of a fast settling amplifier in addition to wide bandwidth, fast slew rate, and fast overload recovery is that it have a true single pole open loop response characteristic. This means a smooth 6dB per octave frequency roll-off characteristic. Such an amplifier can never settle to its final value in less time than that derived from the number of time constants required to reach this accuracy. Figure 12 shows a plot of the output error as a function of the number of time constants. The settling time may actually be quite a bit larger due to slew rate limitation and other problems. An amplifier with a closed loop bandwidth of 1MHz has a time constant of 160 nanoseconds and to settle within .01% of final value requires at least 9 time constants or 1.44 microseconds.

If an amplifier does not have a single pole response and, therefore, an uneven gain roll-off characteristic, its output response may get to the vicinity of the error band quickly but then require a very long time to actually enter it. Likewise, it may overshoot the error band and take a long time to enter it a remain inside it. This is the case for amplifiers with pole-zero mismatches in their response characteristic.

Modern fast settling amplifiers are generally specified to 0.1% or .01% settling for small closed loop gains and have settling times of less than 1 $\mu$sec. In data acquisition systems these

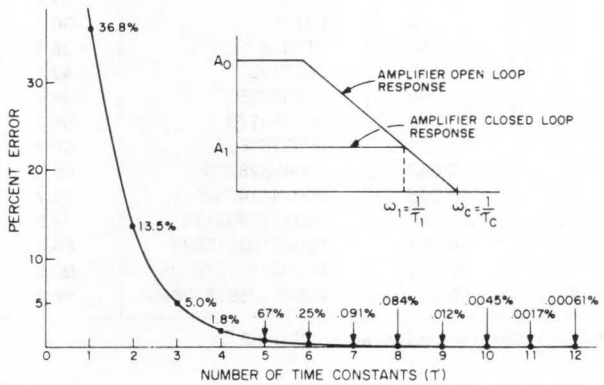


**FIGURE 12. Error as a Function of the Number of Time Constants for a Single Pole Response.**

amplifiers are useful in the design of sample and hold circuits, buffer amplifiers for analog multiplexers or A/D converters, and output amplifiers for fast D/A converters. In many cases fast settling amplifiers are required even though slowly changing signals are being processed. This is because of the high data switching rate through the analog multiplexer.

## DIGITAL CODING

A/D and D/A converters relate analog and digital values by means of an appropriate digital code. The codes used are various binary related codes, the most common of which is natural binary. A binary number is represented as

$$N = a_n 2^n + a_{n-1} 2^{n-1} + \ldots + a_2 2^2 + a_1 2^1 + a_0 2^0$$

where the coefficients $a_n$ assume the values of "0" or "1". Table 1 shows the decimal equivalents of $2^n$ and $2^{-n}$ for values of n up to 16.

In an A/D or D/A converter the first bit is called the most significant bit or MSB and has a weight of ½ of full scale of the converter; the second bit has a weight of ¼ FS and so on down to the last bit which is called the least significant bit or LSB and has a weight of $1/2^n$ FS. The resolution of the converter is determined by the number of bits, and the size of the LSB is $FS/2^n$. It should be noted that the digital code used in general does not correspond to its decimal equivalent in analog voltage. The coding used is the set of coefficients of $2^{-n}$ representing a fractional part of full scale. The MSB is always positioned on the left and the LSB on the right of the digital code. The binary code 10110 thus represents (1 X 1/2) + (0 X 1/4) + (1 X 1/8) + (1 X 1/16) + (0 X 1/32) or 11/16 of full scale of the converter. The full scale analog value for a

| n | $2^n$ | $2^{-n}$ | dB |
|---|---|---|---|
| 0 | 1 | 1 | 0 |
| 1 | 2 | .5 | −6 |
| 2 | 4 | .25 | −12 |
| 3 | 8 | .125 | −18.1 |
| 4 | 16 | .0625 | −24.1 |
| 5 | 32 | .03125 | −30.1 |
| 6 | 64 | .015625 | −36.1 |
| 7 | 128 | .0078125 | −42.1 |
| 8 | 256 | .00390625 | −48.2 |
| 9 | 512 | .001953125 | −54.2 |
| 10 | 1 024 | .0009765625 | −60.2 |
| 11 | 2 048 | .00048828125 | −66.2 |
| 12 | 4 096 | .000244140625 | −72.2 |
| 13 | 8 192 | .0001220703125 | −78.3 |
| 14 | 16 384 | .00006103515625 | −84.3 |
| 15 | 32 768 | .000030517578125 | −90.3 |
| 16 | 65 536 | .0000152587890625 | −96.3 |

**TABLE 1. Decimal Equivalents of $2^n$ and $2^{-n}$**

converter can be any convenient voltage, but voltages such as 0 to +5, 0 to +10, ±2.5, ±5, and ±10 are most commonly used. A 12 bit converter, for example, has a resolution of 1 part in 4096. If the full scale analog voltage is 10 volts then the LSB size is 10V/4096 or 2.44 millivolts. The resolution of a converter can be conveniently related to dynamic range in dB since a factor of 2 corresponds to 6.02dB. Therefore, the number of bits × 6.02 gives the dynamic range in dB. A 12 bit converter has a dynamic range of 72.2dB.

| Scale | +10VFS | Straight Binary | Complementary Binary |
|---|---|---|---|
| | | MSB LSB | MSB LSB |
| +FS − 1LSB | +9.96 | 1111 1111 | 0000 0000 |
| +3/4FS | +7.50 | 1100 0000 | 0011 1111 |
| +1/2FS | +5.00 | 1000 0000 | 0111 1111 |
| +1/4FS | +2.50 | 0100 0000 | 1011 1111 |
| +1/8FS | +1.25 | 0010 0000 | 1101 1111 |
| +1LSB | +0.04 | 0000 0001 | 1111 1110 |
| 0 | 0.00 | 0000 0000 | 1111 1111 |

**TABLE 2. Binary Coding for 8 Bit Unipolar Converters.**

Converters have both unipolar and bipolar analog values and use a number of different binary related codes. Table 2 shows binary coding for a unipolar 8 bit converter with a 10 volt full scale. Notice that all one's in the digital code does not correspond to full scale but $(1-2^{-n})$FS. In some converters it is convenient to use reverse sense binary coding, or complementary binary, where the most negative analog value corresponds to full scale digital value. This code is just the binary code with all 1's made 0's and vice versa. For bipolar analog values the most common codes are offset binary and 2's complement which are shown for an 8 bit converter in Table 3.

| Scale | ±5VFS | Offset Binary | 2's Complement |
|---|---|---|---|
| | | MSB LSB | $\overline{\text{MSB}}$ LSB |
| +FS − 1LSB | +4.96 | 1111 1111 | 0111 1111 |
| +3/4FS | +3.75 | 1110 0000 | 0110 0000 |
| +1/2FS | +2.50 | 1100 0000 | 0100 0000 |
| 0 | 0.00 | 1000 0000 | 0000 0000 |
| −1/2FS | −2.50 | 0100 0000 | 1100 0000 |
| −3/4FS | −3.75 | 0010 0000 | 1010 0000 |
| −FS + 1LSB | −4.96 | 0000 0001 | 1000 0001 |
| −FS | −5.00 | 0000 0000 | 1000 0000 |

**TABLE 3. Binary Coding for 8 Bit Bipolar Converters.**

Offset binary is simply a shifted binary code where ½ FS binary corresponds to analog zero. 2's complement coding is the same as offset binary except that the MSB is complemented, resulting in a digital code of all 0's corresponding to analog zero. Binary coded decimal or BCD coding is also commonly used in converters and is illustrated by the 8 bit coding shown in Table 4. In BCD, 4 binary digits are used to code each decimal digit. This code can also be used for bipolar analog values if a separate sign bit is used. Other codes such as gray code, sign-magnitude binary, and 1's complement are sometimes used but are not as common as the codes just described.

| Scale | +10VFS | BCD |
|---|---|---|
| | | MSD LSD |
| +FS − 1LSD | +9.9 | 1001 1001 |
| +3/4FS | +7.5 | 0111 0101 |
| +1/2FS | +5.0 | 0101 0000 |
| +1/4FS | +2.5 | 0010 0101 |
| +1LSD | +0.1 | 0000 0001 |
| 0 | 0.0 | 0000 0000 |

**TABLE 4. BCD Coding for 2 Digit Unipolar Converter.**

## D/A CONVERTERS

In addition to being used as a basis for a large fraction of all A/D converters that are manufactured, D/A converters have a large number of important uses in their own right. Among these uses are computer driven CRT displays, digitally controlled power supplies for automatic test equipment, digital generation of analog waveforms, and digital control of automatic process control systems.

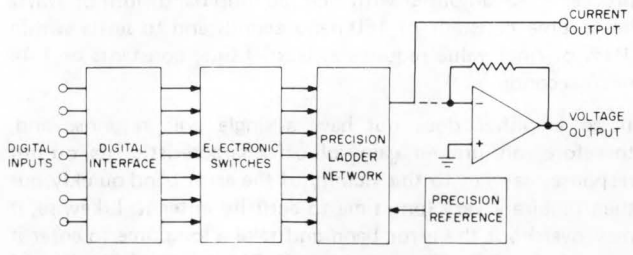


**FIGURE 13. Diagram of a D/A Converter.**

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Although there exists a large array of techniques for accomplishing digital to analog conversion, the methods discussed here will be limited to the most commonly used parallel conversion methods. The basic configuration of a D/A converter, or DAC, is shown in Figure 13. A digital interfacing circuit converts the logic inputs to the control levels of a set of switches. These operate in conjunction with a precision resistor ladder network to give binary weighted currents or voltages; the ladder network is referenced to a stable precision voltage source. The output of the ladder network is the sum of all the binary weights in the form of a voltage or current. In the figure a current output ladder is shown. The two types of D/A converters are current output DAC's and voltage output DAC's. For current output types, the current output of the ladder is brought out as the output of the converter; for voltage output types the current goes to an operational amplifier current-to-voltage converter circuit. In most high speed applications a current output DAC is used since there is always some loss of speed due to current-to-voltage conversion.

A frequently used method of achieving a binary weighted set of currents is the circuit shown in Figure 14. A series of transistor current sources has its collector currents set by emitter resistors with values of R, 2R, 4R, 8R, etc. A stable reference voltage, compensated for the base to emitter voltage variation with temperature, is used to bias the bases of all of the transistors and thus set up constant emitter currents. The current source transistors are switched on or off by logic inputs connected through diodes to the emitters. Depending

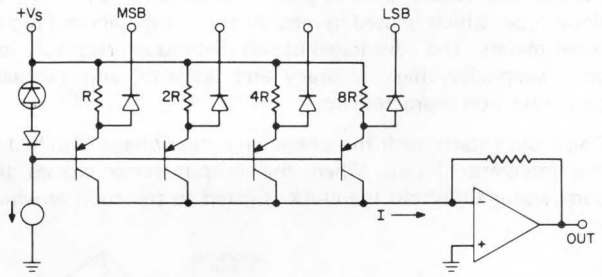


**FIGURE 14. Weighted Current Source D/A Converter.**

on the logic level at each diode input, the current will flow either through the diode or through the transistor. The weighted currents are summed at the collectors of all the transistors and become either the current output of the converter or the current input to an operational amplifier as shown in the diagram. Alternatively, to preserve the high speed of the current output, a resistor can be connected to this output to convert the current directly to a voltage. This is an excellent way of maintaining the speed of the converter but is restricted to relatively small full scale voltages of a volt or so, due to the limited positive voltage swing of the transistor collectors.

The weighted current source method has the advantage of simplicity and high speed. Current output DAC's of this type can also be used in configurations where one or more units are used to sum their output currents together directly. The disadvantage of this method is the wide range of resistance values required for a high resolution converter and the resultant effect on both temperature tracking and speed. Nevertheless, high resolution converters with high speed can be made by using several groups, with 4 or 5 current sources each, and dividing down the current output of each group. This is illustrated in Figure 15 which shows 3 groups of current sources with resistive current dividers following groups 2 and 3. If each group has 4 binary current sources, then the dividers would have to reduce the current outputs of groups 2 and 3 to 1/16 of their original value.

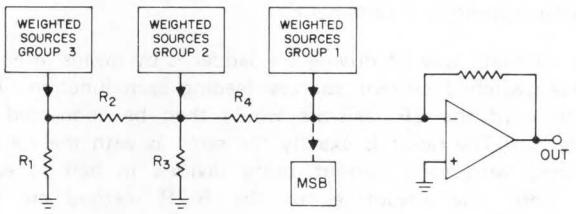


**FIGURE 15. Groups of Identical Binary Weighted Current Sources to Achieve High Resolution.**

Figure 15 also shows the method of achieving a bipolar output for a D/A converter. A current source with a current equal to the MSB weight is connected to the output of all the other weighted sources. This offsets the output of the converter by one half the full scale value, thus setting analog zero at one half digital full scale. This gives offset binary coding as discussed previously.

A second popular method for D/A conversion is the R-2R ladder technique. As shown in Figure 16 this consists of a network of series values of R and shunt values of 2R. The bottoms of the shunt resistors are switched between a voltage reference source and common. The operation of the ladder

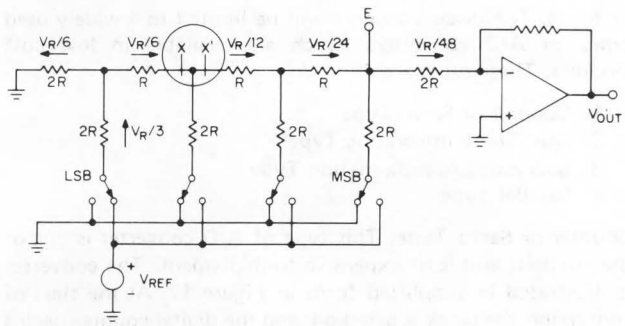


**FIGURE 16. R–2R Network D/A Converter.**

network is based on the binary division of a current as it flows down the ladder. This can be seen by examination of the

points X and X′ in the network. The following conclusions are valid: from point X looking to the right a resistance R is seen and looking to the left a resistance of 2R is seen; from point X′ looking to the right a resistance of 2R is seen and looking to the left a resistance of R is seen. These properties hold for any of the junctions along the ladder. If a 2R resistor is switched to the voltage reference source, the source sees a resistance of 2R plus 2R in parallel with 2R, or 3R total, and a current of $V_{REF}/3R$ flows into the junction. At the junction this current divides equally, with half flowing to the left and half to the right. The right-hand current flows to the next junction where it is again divided in half, and so on to the right end of the ladder where it becomes part of the total output current. The total output current is the sum of all the currents from the shunt resistors which are weighted binarily with the LSB at the leftmost switch and MSB at the rightmost switch. The output of the ladder can be a current, as shown going into the operational amplifier input, or it can be a voltage appearing at terminal E.

An alternate way of driving the ladder is by means of equal value switched current sources feeding each junction. The bottom of the 2R resistors would then be connected to common. The result is exactly the same as with the voltage source, with each current being divided in half at each junction. The advantages of the R-2R method are the following:

1. All resistors are values of either R or 2R resulting in easy matching and temperature tracking.
2. Resistor values can be kept low to insure high speed.
3. The output amplifier always sees a constant resistance value at its input terminal.

Compared to the weighted current source method the R-2R ladder requires two resistors per bit whereas the former requires one resistor per bit.

## A/D CONVERTERS

In analog to digital conversion there is an even larger number of methods commonly used than in D/A conversion. This is so because A/D conversion, except in the very fastest requirements, lends itself to many serial methods and indirect methods. The discussion here will be limited to 4 widely used types of A/D converters which are available in low cost modules. These types are:

1. Counter or Servo Type
2. Dual Slope Integrating Type
3. Successive Approximation Type
4. Parallel Type

**Counter or Servo Type**: This type of A/D converter is one of the simplest and least expensive to implement. The converter is illustrated in simplified form in Figure 17. At the start of conversion the clock is gated on, and the digital counter begins to count clock pulses. As it counts it changes the output of the D/A converter which is compared to the analog input voltage. When the DAC output is equal to the input, the comparator changes state and inhibits the clock pulses. At this time conversion is complete and the output digital number is contained in the output register of the counter.

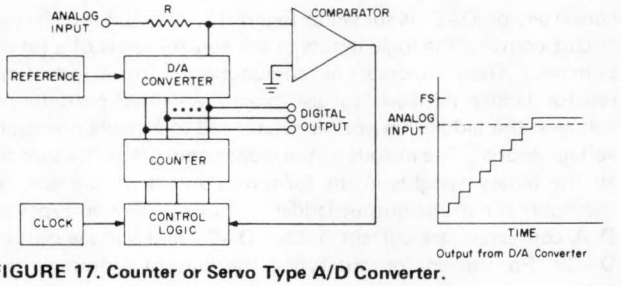


**FIGURE 17. Counter or Servo Type A/D Converter.**

This converter features simplicity, low cost, and good accuracy but has the disadvantage of slow speed. Conversion time is proportional to input voltage and is longest for a full scale input. In some applications the speed is improved if an up-down counter is used, and the converter counts either up or down from its previous value rather than resetting to zero. In this way the counting converter can follow slowly varying inputs. This converter is also called a servo type because of the feedback method of controlling the counter.

**Dual Slope Integrating Type**: Integrating A/D converters operate by the indirect method of converting a voltage to a time period which is then measured by a counter. There are several different types of converters using the integrating, or ramp principle including single ramp, dual ramp, and triple ramp which are all variations on the basic principle. The most popular and widely used at present is the dual ramp, or dual slope type, which is used in most digital voltmeters and digital panel meters. The advantages of this method are relatively low cost, simplicity, high accuracy and linearity, and excellent noise rejection characteristics.

Conversion starts with the unknown input voltage switched to the integrator input. When the output ramp crosses the comparator threshold the clock is gated to the counter which

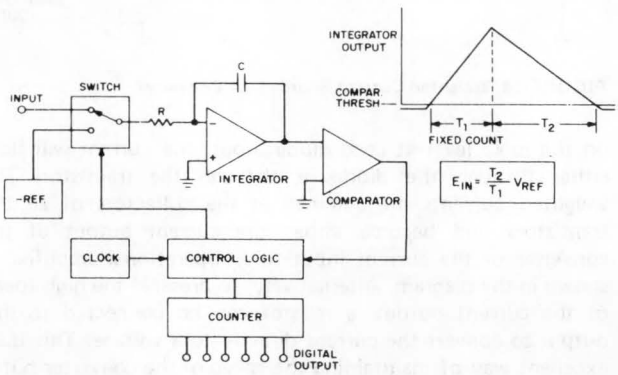


**FIGURE 18. Dual Slope Type A/D Converter.**

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counts up to a predetermined number. At this time the input of the integrator is switched to the reference and the counter is reset to zero. The integrator then integrates the reference back down to the comparator threshold at which time the count is stopped. The input voltage is then the ratio of $T_2$ counts to $T_1$ counts times the reference voltage, and can be read directly from the counter register.

The dual slope method has a number of important features. Conversion accuracy is independent of the clock frequency and integrating capacitor value as long as they are stable within a conversion period, and depends only on the accuracy and stability of the reference. Resolution is basically only limited by the analog resolution of the converter. In addition, this converter gives excellent noise rejection because of the integration operation; in particular, normal mode noise rejection is infinite for $T_1$ equal to a multiple of the period of the interfering noise. The main drawback of this method is the relatively long conversion time.

**Successive Approximation Type**: This conversion method is the most widely used in general practice due to its combination of high resolution and high speed. The successive approximation converter operates with a fixed conversion time per bit, independent of the value of the analog input. The method is illustrated in Figure 19 and operates by comparing the input voltage with the D/A converter output, one bit at a time.

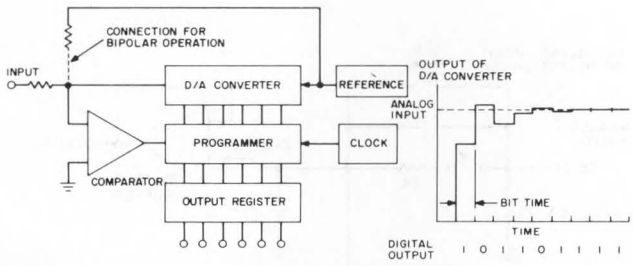


**FIGURE 19. Successive Approximation Type A/D Converter.**

At the start of the conversion cycle, the D/A converter's MSB output, which is ½ full scale, is compared with the input. If it is smaller than the input, the MSB is left on and the next bit is tried. If the MSB is larger than the input, it is turned off when the next bit is turned on. This process of comparison is continued down to the LSB after which the output register contains the complete output digital number. Both serial and parallel output data can be brought out of this converter and, in addition, the conversion can be synchronized to an external clock on some units. Speeds as high as 100 nanoseconds per bit can be achieved by this method. Successive approximation converters can also be quite accurate, but the accuracy depends on the stability of the reference, the switches, the ladder network, and the comparator. In the figure it is also shown how bipolar operation is accomplished using a precision resistor connected from the reference source to the comparator input, thus subtracting a ½ full scale current from the input. Many converters have this resistor built in so that bipolar operation can be achieved by external pin connection.

**Parallel Type**: While the successive approximation converter is capable of speeds as high as 100 nsec. per bit, giving conversion rates of 1 MHz for 10 bits, significantly faster conversion must be achieved using the parallel technique. This method is sometimes referred to as the simultaneous, or flash technique, and is capable of 25MHz conversion rates for 4 bits. As shown in Figure 20, the method employs an input quantizer comprised of $2^n-1$ comparators biased 1 LSB apart by a reference voltage. For a given analog input voltage to the comparators, all comparators below the input level turn on while all comparators above it are off. The quantization process is accomplished in the switching time of a single comparator.

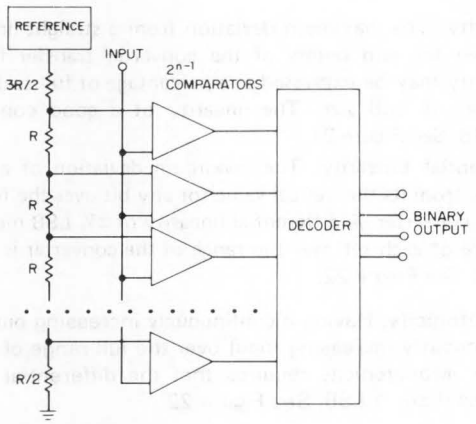


**FIGURE 20. Parallel Type A/D Converter.**

The comparator outputs, however, are not in the binary code and must, therefore, go through a decoder. The parallel method has the advantage of the fastest speed but is limited to a relatively few bits, usually about 4, due to the large number of comparators required. To convert a large number of bits it is necessary to employ a hybrid technique whereby a parallel conversion stage is followed by a fast D/A converter, the output of which is subtracted from the input voltage, the difference amplified and then converted using another parallel stage. This results in a speed compromise but higher resolution.

There are a number of important parameters used to characterize the accuracy of A/D and D/A converters. Since they have specific meanings as applied to converters, these parameters are defined here.

**Resolution**: The smallest analog change that can be distinguished by an A/D converter or produced by a D/A converter. Resolution is the analog value of the LSB, which is $FS/2^n$ for an n bit binary converter and $FS/10^d$ for a d digit BCD converter. Resolution is often specified in percentage of full scale, as in a 10 bit converter which has a resolution of 0.1%.

In many cases the useful resolution of a converter may be less than its specified resolution.

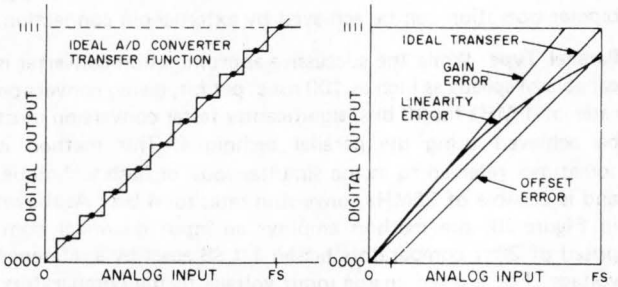


**FIGURE 21. Gain, Offset, & Linearity Errors.**

**Linearity**: The maximum deviation from a straight line drawn between the end points of the converter transfer function. Linearity may be expressed as a percentage of full scale or as a fraction of LSB size. The linearity of a good converter is ±½ LSB. See Figure 21.

**Differential Linearity**: The maximum deviation of an actual bit size from its theoretical value for any bit over the full range of the converter. A differential linearity of ±½ LSB means that the size of each bit over the range of the converter is 1 LSB ± ½ LSB. See Figure 22.

**Monotonicity**: Having a continuously increasing output for a continuously increasing input over the full range of the converter. Monotonicity requires that the differential linearity be less than 1 LSB. See Figure 22.

**Missing Code**: In an A/D converter this occurs when the output code skips a digit. This happens when the differential linearity is greater than 1 LSB for some bit.

**Quantizing Error**: The basic uncertainty associated with digitizing an analog signal due to the finite resolution of an A/D converter. An ideal converter has a maximum quantizing error of ½ LSB. See Figure 2.

**Relative Accuracy**: The input to output error as a fraction of full scale, with gain and offset errors adjusted to zero. Relative accuracy is a function of linearity.

**Absolute Accuracy**: The full scale analog error referenced to the NBS standard volt.

**Offset Error**: The error by which the transfer function fails to pass through the origin, referred tc the analog axis. This is adjustable to zero in available converters. See Figure 21.

**Gain Error or Scale Factor Error**: The difference in slope between the actual transfer function and the ideal function in percent. This error is also adjustable to zero in available converters. See Figure 21.

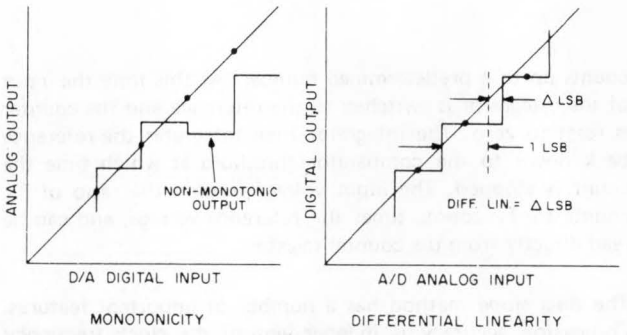


**FIGURE 22. Monotonicity and Differential Linearity.**

## ANALOG MULTIPLEXERS

Analog multiplexer circuits are used for time sharing of analog to digital converters between a number of different analog information channels. An analog multiplexer consists of a group of analog switches arranged with inputs connected to the individual analog channels and outputs connected in common, as shown in Figure 23. The switches can be addressed by a digital input code. MOSFET switches are generally used and may be connected directly to an output load if it is a high enough impedance, or to an output buffer amplifier which provides a very high impedance to the switches. Using a fast bipolar transistor follower amplifier as a buffer, an input impedance of $10^9$ ohms is achieved resulting in a negligible transfer error due to the switch resistance of typically 2K ohms.

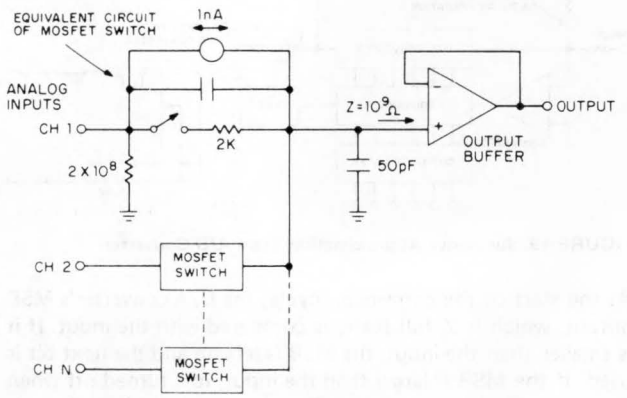


**FIGURE 23. Analog Multiplexer Circuit.**

Figure 23 shows the equivalent circuit of one of the MOSFET switches which is characterized by series and shunt resistance, shunt capacitance and a leakage current. Differential analog multiplexing can also be accomplished by using two MOSFET switches for each input channel.

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There are several important parameters used to characterize analog multiplexers which are defined below.

**Transfer Accuracy**: The input to output error as a percentage of the input. Transfer accuracy depends on the source impedance, switch resistance, load impedance if the multiplexer is not buffered, and the signal frequency.

**Settling Time**: Same definition as discussed earlier. Here it includes the switching time of the switches.

**Throughput Rate**: The highest rate at which the multiplexer can switch from channel to channel at its specified accuracy. This rate is determined by the settling time.

**Crosstalk**: The amount of signal coupled to the output as a percentage of input signal applied to all OFF channels together. The inverse of the above is expressed as an attenuation in dB.

**Input Leakage Current**: The highest current that flows into or out of an OFF channel input terminal due to switch leakage.

## SAMPLE AND HOLD CIRCUITS

Some of the properties of sample and hold circuits were discussed in the section on sampling theory. Here the circuit configurations and operating parameters will be discussed. Sample and hold circuits are used in conjunction with both A/D converters and D/A converters. With A/D converters they are used to shorten the aperture time for the converter by rapidly sampling the input signal and then holding its value until the conversion is completed. In the case of D/A converters they are used in display applications to remove "glitches" which appear at the output of all DAC's as they change from one analog level to another.

As described before, a sample and hold in its basic form consists of a switch and a capacitor. When the switch is closed the unit is in the sampling or tracking mode and will follow a changing input signal. When the switch is opened the unit is in the hold mode and retains a voltage on the capacitor for some period of time depending on capacitor and switch leakage.

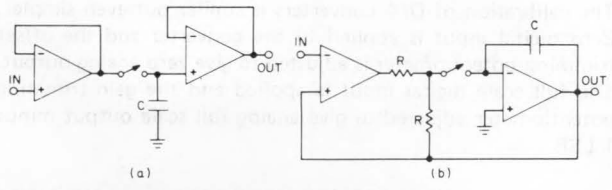


**FIGURE 24. Sample and Hold Circuit Configurations.**

Practical sample and hold circuits also use input and output buffer amplifiers and sophisticated switching techniques. The output buffer amplifier must be a low input current FET amplifier in order to have as small an effect as possible on the leakage of the capacitor. Likewise, the electronic switch used must be a low leakage type such as an FET switch. Figure 24 illustrates two sample and hold circuit configurations which are commonly used. Circuit (a) is used for fast sample and holds and is an open loop configuration using fast voltage follower amplifiers. For very fast circuits a diode bridge type sampling switch is used. Circuit (b) is a closed loop configuration with an operational integrator in the feedback path of the input buffer amplifier. This circuit results in extremely good accuracy and linearity.

Sample and holds are characterized by a number of important parameters, each with a specific meaning for these circuits. These are defined below.

**Acquisition Time**: The time from when the sample command is given to the point when the output enters and remains within a specified error band around the input value. At the end of the acquisition time the output is tracking the input. Note similarity to definition of settling time.

**Aperture Time**: The time elapsed between the hold command and the point at which the sampling switch is completely open. Aperture time is also referred to as turn-off time.

**Aperture Uncertainty Time**: The variation in aperture time for a sample and hold. The difference between maximum and minimum aperture time.

**Decay Rate**: The maximum change in output voltage with time in the hold mode.

**Feedthrough**: The amount of input signal appearing at the output when the unit is in the hold mode. Feedthrough varies with signal frequency and may be expressed as an attenuation in dB.

## A/D AND D/A CONVERTER ADJUSTMENTS

A timing diagram for a typical successive approximation A/D converter is shown in Figure 25. The start of conversion is initiated by a start convert pulse of 30 nsec. minimum duration. The EOC (end of conversion) or status output then goes high indicating that conversion is in process. The MSB output of the D/A converter is turned on to be compared with the input voltage, registering a logic "1" at the Bit 1 parallel data output. If the MSB is smaller than the input voltage it stays on and the logic "1" remains on the Bit 1 output. If it is larger than the input, it turns off after the first clock pulse and the Bit 1 output goes to logic "0". After the first clock pulse the serial output for Bit 1 appears on the serial output pin. After the first clock pulse, Bit 2 is compared with the input remainder, after the second clock pulse Bit 3 is compared, and so on down to Bit 10 in this case. Thus each succeeding bit is compared to the remaining input during one clock interval, and the true output for that bit appears at the next clock interval. At the end of the 10th clock pulse, all parallel bit outputs are true and the serial LSB output appears. Also, the EOC output returns to logic "0" indicating that conversion is complete. The EOC or status output may be used to control the sample and hold preceding the A/D converter, since when

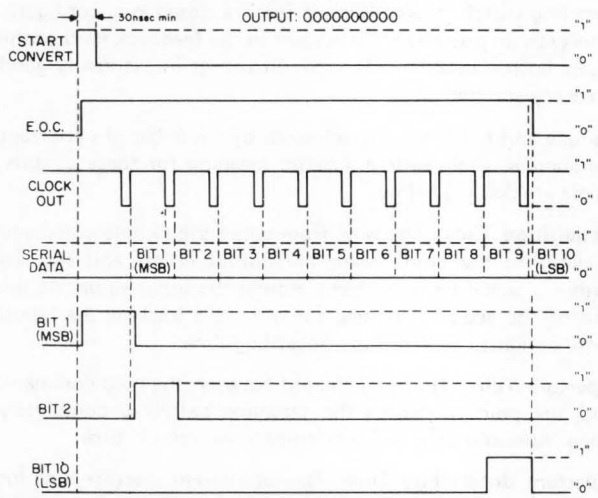


**FIGURE 25. Timing Diagram for 10 Bit A/D Converter.**

it is low the sample and hold is put in the tracking mode, and when it is high, during conversion, the sample and hold is put in the hold mode.

Most Datel A/D and D/A converters are capable of both unipolar and bipolar operation with several analog ranges selected by external pin connection. The commonly used ranges are 0 to +5V, 0 to +10V, ±2.5V, ±5V, and ±10V. The digital coding used is binary or BCD for unipolar operation and offset binary or two's complement for bipolar operation. All Datel A/D and D/A converters have provision for user adjustment of full scale and offset in order to obtain optimum accuracy in a given application. Figure 26 shows the circuit connection necessary to perform the calibration adjustments on an A/D converter. Calibration is accomplished as follows for a unipolar A/D converter:

1. Connect a precision pulse generator to the "Start Convert" input terminal. The generator should be set to give a pulse width and amplitude as specified in the converter data sheet. The repetition rate should be set for the conversion time of the converter.

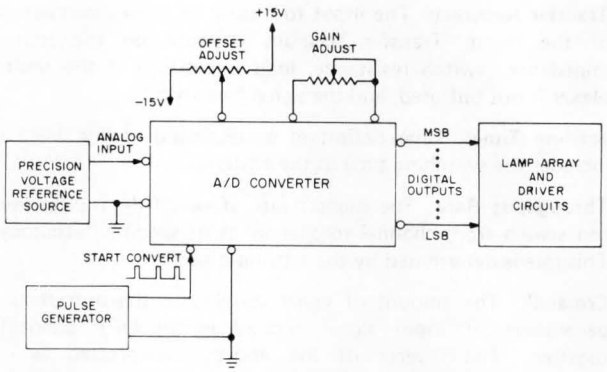


**FIGURE 26. Connections for Calibration of A/D Converter.**

2. Connect a precision voltage reference source to the analog input terminal.

3. Adjust the output of the voltage reference source to zero plus ½ LSB. This voltage is found by multiplying the converter full scale voltage range by one half the value of $2^{-n}$ for an n bit converter. Adjust the zero offset trimming potentiometer until the LSB output flickers between logic "0" and logic "1".

4. Adjust the output from the voltage reference source to full scale minus 1½ LSB. Adjust the gain trimming potentiometer until the LSB output flickers between logic "0" and logic "1".

In the case of a bipolar A/D converter the calibration is identical except that the first part of step three is modified as follows:

3. Adjust the output from the voltage reference source to minus full scale plus ½ LSB.

The calibration of D/A converters is similar but even simpler. Zero digital input is applied to the converter and the offset trimming potentiometer is adjusted to give zero analog output. The full scale digital input is applied and the gain trimming potentiometer adjusted to give analog full scale output minus 1 LSB.

# A/D Converter Rapid Selection Guide

The Rapid Selection Guide presented below is a capsule summary of all of Datel Systems' A/D converter lines. Because we manufacture the broadest line of A/D converters in the industry, this table is a useful guide for quickly locating the converters, by price range and performance, that are best suited for your particular application.

After locating the desired converter series, turn to the following pages which present more detailed specifications of the various models in tabular form.

| Converter Type | Series | Resolution | Conversion Method | Conversion Time | Tempco | Price Range | See Page |
|---|---|---|---|---|---|---|---|
| Low Cost General Purpose | ADC-Econo | 6 Bits | Count Up | 50 μsec. | 100 ppm/°C | $29.95 | 20 |
| | ADC-89A | 8 Bits | Count Up | 100-200 μsec. | 50 ppm/°C | $69.00 | 20 |
| | ADC-D, K | 8, 10, 12 Bits | Succ. Approx. | 50 μsec. | 30-50 ppm/°C | $ 79 - $139 | 20 |
| | ADC-MA | 10, 12 Bits | Succ. Approx. | 20-40 μsec. | 30 ppm/°C | $ 95 - $145 | 20 |
| High Performance | ADC-149 | 14 Bits | Succ. Approx. | 50 μsec. | 15 ppm/°C | $239.00 | 22 |
| | ADC-CM | 8, 10, 12 Bits | Succ. Approx. | 250-350 μsec. | 30 ppm/°C | $149 - $169 | 22 |
| | ADC-L, M | 8, 10, 12 Bits | Succ. Approx. | 4-20 μsec. | 10 ppm/°C | $135 - $349 | 22 |
| Dual Slope | ADC-E | 8, 10, 12 Bits | Dual Slope | 312 μsec. - 5 msec. | 50 ppm/°C | $ 79 - $ 99 | 24 |
| | ADC-ER | 8, 10, 12 Bits | Dual Slope | 43.3-76.7 msec. | 35 ppm/°C | $ 79 - $ 99 | 24 |
| | ADC-EP | 14 Bits | Dual Slope | 230 msec. | 13 ppm/°C | $179.00 | 24 |
| Fast | ADC-EH | 8, 10, 12 Bits | Succ. Approx. | 2.0-8.0 μsec. | 30-50 ppm/°C | $ 85 - $209 | 26 |
| | ADC-N, P | 8, 10, 12 Bits | Succ. Approx. | 2.0-4.0 μsec. | 20 ppm/°C | $275 - $325 | 26 |
| | ADC-SH4B | 4 Bits | Succ. Approx. | 500 nsec. | 200 ppm/°C | $ 79.00 | 26 |
| Ultra-Fast | ADC-EH12B3 | 12 Bits | Succ. Approx. | 2.0 μsec. | 30 ppm/°C | $249.00 | 28 |
| | ADC-G, H | 4, 6, 8, 10 Bits | Succ. Approx. | 400 nsec.-1.0 μsec. | 20-50 ppm/°C | $239 - $349 | 28 |
| | ADC-UH, VH | 4, 6, 8 Bits | Parallel (Flash) | 40-200 nsec. | 50 ppm/°C | $695 - $895 | 28 |
| | ADC-TV | 8 Bits | Parallel (Flash) | 60 nsec. | 100 ppm/°C | * | 28 |
| Monolithic | ADC-EK | 8, 10, 12 Bits | Volt. to Freq. | 1.25-20 msec. | 40 ppm/°C | $ 13.50 - $36 | 30 |
| Hybrid | ADC-HX | 12 Bits | Succ. Approx. | 20 μsec. | 20 ppm/°C | $ 85 - $155 | 30 |
| | ADC-HZ, HS | 12 Bits | Succ. Approx. | 8 μsec. | 20 ppm/°C | $119 - $195 | 30 |
| | ADC-HC | 12 Bits | Succ. Approx. | 300 μsec. | 20 ppm/°C | * | 30 |
| | ADC-HF | 12 Bits | Succ. Approx. | 2 μsec. | 20 ppm/°C | * | 30 |
| | ADC-HU | 3 Bits | Parallel | 20 nsec. | 5 ppm/°C | * | 30 |

*To be announced

# Low Cost, General Purpose A/D Converters

| | Model | Resolution | Accuracy (% FS) | Conversion Time | Output Coding (2) | Input Ranges |
|---|---|---|---|---|---|---|
| Lowest Cost | ADC-Econo. | 6 Bits | 0.8% | 50 μsec. | Bin | +5, +10, ±2.5, ±5V |
| | ADC-89A8B | 8 Bits | 0.2% | 200 μsec. | Bin | 0 to +10V, ±5V |
| | ADC-89A8D | 2 Digits | 0.5% | 100 μsec. | BCD | 0 to +10V |
| Low Cost Successive Approximation | ADC-D8B | 8 Bits | 0.2% | 50 μsec. | Bin, 2C | 0 to +10V, ±5V |
| | ADC-D10B | 10 Bits | .05% | | | |
| | ADC-D12B | 12 Bits | .01% | | | |
| Low Cost Successive Approximation | ADC-K8B | 8 Bits | 0.2% | 50 μsec. | Bin, 2C | 0 to +10V, ±5V |
| | ADC-K10B | 10 Bits | .05% | | | |
| | ADC-K12B | 12 Bits | .01% | | | |
| ADC-12QZ Equivalent → | ADC-MA10B2A | 10 Bits | .05% | 40 μsec. | Bin, 2C | 0 to +5, +10V ±2.5, ±5, ±10V |
| | ADC-MA10B2B | 10 Bits | .05% | 20 μsec. | | |
| | ADC-MA12B2A | 12 Bits | .01% | 40 μsec. | | |
| | ADC-MA12B2B | 12 Bits | .01% | 20 μsec. | | |

**NOTES:** 1. An optional high impedance buffer amplifier is available on special order to give 1000 megohms input impedance. Add $20.00 to price.

2. Coding: Bin = Straight binary or offset binary
BCD = Binary coded decimal
2C = Two's complement

**ADC-ECONOVERTER:** This lowest cost model is a counting type converter with 6 bit resolution and 50 μsec. conversion time for a full scale conversion.

**ADC-89A SERIES:** These low cost models are 8 bit binary or 2 digit BCD counting type converters with 200 and 100 μsec. conversion times respectively.

**ADC-D SERIES:** This series uses successive approximation for 8, 10, and 12 bit resolutions with conversion time of 50 μsec.

**ADC-K SERIES:** These models are also low cost successive approximation types with 8, 10, and 12 bit resolutions and 30 ppm/°C tempco.

**ADC-MA SERIES:** These versatile 10 and 12 bit models feature pin programmable operating features with conversion times of 40 and 20 μsec. The ADC-MA12B2A is a pin and performance equivalent of the popular ADC-12QZ model.

**ALL MODELS:** have operating temperature range of 0°C to 70°C; have DTL/TTL compatible outputs; use DILS-1 or DILS-2 dual-in-line strips for sockets.

*See pages 283 and 284 for information on Extended Performance versions.*


| Linearity | Input Impedance | Gain Tempco | Power Requirement | Case Size (inches) | Price (1-9) | See Page |
|---|---|---|---|---|---|---|
| 1/2 LSB | 4.2 K | 100 ppm/°C | ±15V, +5V | 2 x 2 x 0.375 | $29.95 | |
| 1/2 LSB | 5 K | 50 ppm/°C | ±15V, +5V | 3 x 2 x 0.375 | $69.00 | * |
| | | | | | $69.00 | |
| 1/2 LSB | 10 K | 50 ppm/°C | ±15V, +5V | 4 x 2 x 0.4 | $ 79.00 | |
| | | | | | $105.00 | * |
| | | | | | $129.00 | |
| 1/2 LSB | 10 K | 30 ppm/°C | ±15V, +5V | 4 x 2 x 0.4 | $109.00 | |
| | | | | | $129.00 | * |
| | | | | | $139.00 | |
| 1/2 LSB | 2.5, 5, 10 K (1) | 30 ppm/°C | ±15V, +5V | 4 x 2 x 0.4 | $95.00 | |
| | | | | | $125.00 | 51 |
| | | | | | $125.00 | |
| | | | | | $145.00 | |

**THESE CONVERTERS ARE COVERED BY GSA CONTRACT**

***Contact nearest Datel sales office for data sheet.**

# High Performance A/D Converters

| | Model | Resolution | Accuracy (% FS) | Conversion Time | Output Coding (2) | Input Ranges |
|---|---|---|---|---|---|---|
| 14 Bits | ADC-149-14B | 14 Bits | .005% | 50 μsec. | Bin, 2C | −10, −20, ±5, ±10V |
| Low Power CMOS | ADC-CM8B | 8 Bits | 0.2% | 250 μsec. | Bin | −5, −10, ±5, ±10V |
| | ADC-CM10B | 10 Bits | .05% | 300 μsec. | | |
| | ADC-CM12B | 12 Bits | .01% | 350 μsec. | | |
| High Performance Successive Approximation | ADC-L8B | 8 Bits | 0.2% | 12 μsec. | Bin, 2C | +5, +10, ±5, ±10V |
| | ADC-L10B | 10 Bits | .05% | 16 μsec. | | |
| | ADC-L12B | 12 Bits | .01% | 20 μsec. | | |
| | ADC-L8D | 2 Digits | 0.5% | 12 μsec. | BCD | 0 to +5, +10V |
| | ADC-L12D | 3 Digits | .05% | 20 μsec. | | |
| High Performance Successive Approximation | ADC-M8B | 8 Bits | 0.2% | 4.0 μsec. | Bin, 2C | +5, +10, ±5, ±10V |
| | ADC-M10B | 10 Bits | .05% | 11.5 μsec; | | |
| | ADC-M12B | 12 Bits | .01% | 13.0 μsec. | | |
| | ADC-M8D | 2 Digits | 0.5% | 4.0 μsec. | BCD | 0 to +5, +10V |
| | ADC-M12D | 3 Digits | .05% | 13.0 μsec. | | |

**NOTES:** 1. An optional high impedance buffer amplifier is available on special order to give 10 megohms input impedance. Add $20.00 to price.

2. Coding: Bin = Straight binary on offset binary
BCD = Binary coded decimal
2C = Two's complement

**ADC-149-14B:** This low cost, high resolution converter uses the successive approximation method to achieve 14 bit resolution with a 15 ppm/°C tempco. Conversion time is 50 μsec.

**ADC-CM SERIES:** These 8, 10, and 12 bit converters use CMOS circuitry to achieve a low power consumption of 140mW for portable and remote instrumentation applications. These units can operate from either a single +12 to +15V supply or from dual ±12 to ±15V supplies.

**ADC-L SERIES:** These high performance successive approximation converters feature 8, 10, and 12 bit conversions in less than 20 μsec. and a low tempco of 10 ppm/°C. Specific input voltage ranges must be ordered by model number.

**ADC-M SERIES:** These models are also fast, high performance successive approximation converters with less than 13 μsec. conversion time. Tempco is 10 ppm/°C and input voltage ranges must be ordered by model number.

**ALL MODELS:** have operating temperature range of 0°C to 70°C; have DTL/TTL or CMOS compatible outputs; use DILS-1 or DILS-2 dual-in-line strips for sockets.

*See pages 284 and 285 for information on Extended Performance versions.*


| Linearity | Input Impedance | Gain Tempco | Power Requirement | Case Size (inches) | Price (1-9) | See Page |
|---|---|---|---|---|---|---|
| 1 LSB | 5, 10 K | 15 ppm/°C | ±15V, +5V | 4 x 2 x 0.8 | $239.00 | 55 |
| 1/2 LSB | 25, 50 100 K | 30 ppm/°C | +12 to +15V | 3 x 2 x 0.8 | $149.00<br>$159.00<br>$169.00 | 57 |
| 1/2 LSB | 10 K (1) | 10 ppm/°C | ±15V, +5V | 3 x 2 x 0.375<br>4 x 2 x 0.4 | $135.00<br>$155.00<br>$175.00<br>$135.00<br>$175.00 | * |
| 1/2 LSB | 10 K (1) | 10 ppm/°C | ±15V, +5V | 3 x 2 x 0.375<br>4 x 2 x 0.4 | $229.00<br>$295.00<br>$349.00<br>$229.00<br>$349.00 | * |

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# Dual Slope Integrating A/D Converters

| | Model | Resolution | Accuracy (% FS) | Conversion Time | Output Coding (2) | Input Ranges |
|---|---|---|---|---|---|---|
| Low Cost Fast Integrating | ADC-E8B | 8 Bits | 0.2% | 312 μsec. | S.M. Bin | ±1, ±5, ±10V |
| | ADC-E10B | 10 Bits | .05% | 1.25 msec. | | |
| | ADC-E12B | 12 Bits | .01% | 5.0 msec. | | |
| | ADC-E8D | 2 Digits | 0.5% | 500 μsec. | S.M. BCD | ±2, ±5, ±10V |
| | ADC-E12D | 3 Digits | .05% | 5.0 msec. | | |
| High Resolution | ADC-EP14B | 14 Bits | .01% | 230 msec. | S.M. Bin | ±2V (1) |
| | ADC-EP16D | 4 Digits | .01% | 230 msec. | S.M. BCD | ±2V (1) |
| 4 Wire Ratiometric | ADC-ER8B | 8 Bits | 0.2% | 43.3 msec. | S.M. Bin | ±1V (1) |
| | ADC-ER10B | 10 Bits | .05% | 43.3 msec. | | |
| | ADC-ER12B | 12 Bits | .01% | 43.3 msec. | | |
| | ADC-ER8D | 2 Digits | 0.5% | 76.7 msec. | S.M. BCD | ±2V (1) |
| | ADC-ER12D | 3 Digits | .05% | 76.7 msec. | | |

**NOTES:** 1. Has four wire ratiometric inputs

2. Coding: S.M. Bin = Sign-magnitude binary
S.M. BCD = Sign-magnitude BCD

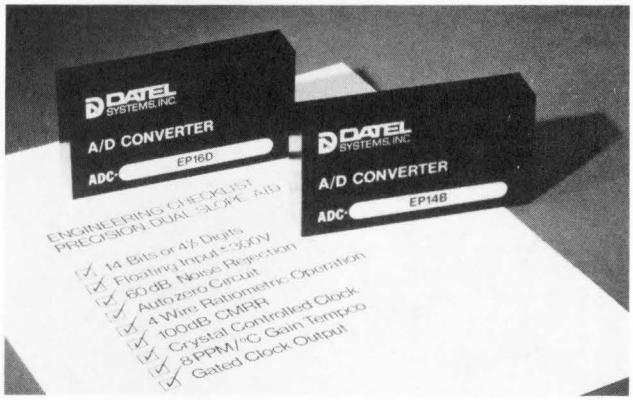
**ADC-E SERIES:** These models feature 8, 10, and 12 bit resolution with both binary and BCD coding. Conversion time is from 312 μsec. to 5 msec. depending on the resolution. Coding is sign-magnitude binary or sign-magnitude BCD.

**ADC-EP SERIES:** These high resolution models feature 14 binary bits or 4 BCD digits with a conversion time of 230 msec. Temperature coefficient is 13ppm/°C. The analog front end of this converter is electrically floated from digital ground to give ±300V common mode input range with greater than 100 dB CMR. The input is 4 wire ratiometric with a flying capacitor reference input. An auto zeroing circuit stabilizes zero drift to less than 1μV/°C. A crystal controlled clock results in better than 60 dB normal mode rejection to input frequency noise.

**ADC-ER SERIES:** This series also features 4 wire ratiometric input along with operation from a single +5V supply. The analog input is differential with 70 dB of common mode rejection. The internal clock can be adjusted for synchronism with the power line frequency to give 40 dB of normal mode rejection to this noise. Resolution is 8, 10, and 12 bits with both binary and BCD models.

**ALL MODELS:** have operating temperature range of 0°C to 70°C: have DTL/TTL compatible outputs; use DILS-1 or DILS-2 dual-in-line strips for sockets.

*See pages 284 and 285 for information on Extended Performance versions.*




| Linearity | Input Impedance | Gain Tempco | Power Requirement | Case Size (inches) | Price (1-9) | See Page |
|---|---|---|---|---|---|---|
| | | | | | $ 79.00 | |
| | | | | | $ 89.00 | |
| .01% | 100 Meg, 10K | 50 ppm/°C | ±15V, 5V | 4 x 2 x 0.4 | $ 99.00 | * |
| | | | | | $ 79.00 | |
| | | | | | $ 99.00 | |
| .01% | 100 Meg. | 13 ppm/°C | ±15V, +5V | 4 x 2 x 0.8 | $179.00 | 65 |
| | | | | | $179.00 | |
| | | | | | $ 79.00 | |
| | | | | | $ 89.00 | |
| .05% | 100 Meg. | 35 ppm/°C | +5V | 4 x 2 x 0.4 | $ 99.00 | 61 |
| | | | | | $ 79.00 | |
| | | | | | $ 99.00 | |

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# Fast A/D Converters

| | Model | Resolution | Accuracy | Conversion Time | Output Coding (1) | Input Ranges |
|---|---|---|---|---|---|---|
| Fast 8 Bit | ADC-EH8B1 | 8 Bits | 0.2% | 4.0 μsec. | Bin, 2C | 0 to +10V, ±5V |
| | ADC-EH8B2 | 8 Bits | 0.2% | 2.0 μsec. | | |
| Fast 10 Bit | ADC-EH10B1 | 10 Bits | .05% | 4.0 μsec. | Bin, 2C | 0 to +10V, ±5V |
| | ADC-EH10B2 | 10 Bits | .05% | 2.0 μsec. | | |
| | ADC-EH12B1 | 12 Bits | .01% | 8.0 μsec. | Bin, 2C | 0 to +10V, ±5V |
| | ADC-EH12B2 | 12 Bits | .01% | 4.0 μsec. | | |
| Fast 10 & 12 Bit | ADC-N10B | 10 Bits | .05% | 4.0 μsec. | Bin | 0 to −5, −10V |
| | ADC-N12B | 12 Bits | .01% | 4.0 μsec. | | ±5, ±10V |
| Fast 8 & 10 Bit | ADC-P8B | 8 Bits | 0.2% | 2.0 μsec. | Bin | 0 to −5, −10V |
| | ADC-P10B | 10 Bits | .05% | 2.0 μsec. | | ±5, ±10V |
| 4 Bit w. S/H | ADC-SH4B | 4 Bits | 3.0% | 500 nsec. | Bin | 0 to +1V |

**OTES:** 1. Coding: Bin = Straight binary or offset binary
2C = Two's complement

**ADC-EH8B SERIES:** These 8 bit successive approximation converters feature 4 and 2 μsec. conversion times at low cost. Temperature coefficient is 50ppm/°C.

**ADC-EH10B SERIES:** This series of 10 bit converters uses the successive approximation method with 4 and 2 μsec. conversion times and 30ppm/°C tempco.

**ADC-EH12B SERIES:** These 12 bit models are also successive approximation types with 8 and 4 μsec. conversion times. Tempco is 30ppm/°C.

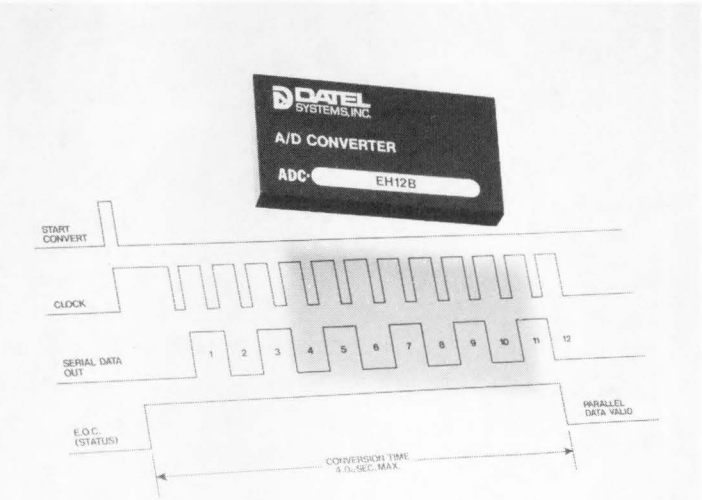
**ADC-N SERIES:** This series features 10 and 12 bit models both with 4 μsec. conversion times and 20ppm/°C tempco. Successive approximation is used.

**ADC-P SERIES:** These 8 and 10 bit models are successive approximation converters both with 2 μsec. conversion time and 20ppm/°C tempco.

**ADC-SH4B:** This model is a 4 bit A/D converter with a self-contained sample-hold circuit. Time for both acquisition and conversion is 500 nsec. This device is designed for optical scanning and fast pulse code modulation applications.

**ALL MODELS:** have operating temperature range of 0°C to 70°C; have DTL/TTL compatible outputs; use DILS-1 or DILS-2 dual-in-line strips for sockets.

*See pages 284 and 285 for information on Extended Performance versions.*




| Linearity | Input Impedance | Gain Tempco | Power Requirement | Case Size (inches) | Price (1-9) | See Page |
|---|---|---|---|---|---|---|
| 1/2 LSB | 4.45 K | 50 ppm/°C | ±15V, +5V | 2 x 2 x 0.375 | $ 85.00<br>$129.00 | 37 |
| 1/2 LSB | 2.3 K | 30 ppm/°C | ±15V, +5V | 3 x 2 x 0.375 | $149.00<br>$189.00 | 39 |
| 1/2 LSB | 2.3 K | 30 ppm/°C | ±15V, +5V | 4 x 2 x 0.375 | $169.00<br>$209.00 | 41 |
| 1/2 LSB | 500, 1K, 2K | 20 ppm/°C | ±15V, +5V | 4 x 2 x 0.8 | $275.00<br>$295.00 | * |
| 1/2 LSB | 500, 1K, 2K | 20 ppm/°C | ±15V, +5V | 4 x 2 x 0.4<br>4 x 2 x 0.8 | $305.00<br>$325.00 | * |
| 2% | 50 ohms | 200 ppm/°C | ±15V, +5V | 2 x 2 x 0.375 | $ 79.00 | * |

**THESE CONVERTERS ARE COVERED BY GSA CONTRACT**

***Contact nearest Datel sales office for data sheet.**

# Ultra-Fast A/D Converters

| | Model | Resolution | Accuracy | Conversion Time | Output Coding | Input Ranges |
|---|---|---|---|---|---|---|
| 12 Bit, 2 μsec. | ADC-EH12B3 | 12 Bits | .01% | 2.0 μsec. | Bin, 2C | 0 to +10V, ±5V |
| 100 nsec./Bit | ADC-G8B | 8 Bits | 0.2% | 800 nsec. | Bin, 2C | -5, – 10, ±5, ±10V |
| | ADC-G10B | 10 Bits | .05% | 1.0 μsec. | | |
| 100 nsec./Bit | ADC-H4B | 4 Bits | 3.0% | 400 nsec. | Bin, 2C | 0 to – 5, – 10V ±5V, ±10V |
| | ADC-H6B | 6 Bits | 0.8% | 600 nsec. | | |
| | ADC-H8B | 8 Bits | 0.2% | 800 nsec. | | |
| | ADC-H10B | 10 Bits | .05% | 1.0 μsec. | | |
| Parallel Type | ADC-VH4B | 4 Bits | 3.0% | 100 nsec. | Bin | 0 to -2.56 (1) |
| | ADC-VH6B | 6 Bits | 0.8% | 200 nsec. | | |
| | ADC-VH8B | 8 Bits | 0.4% | 200 nsec. | | |
| Parallel Type | ADC-UH4B | 4 Bits | 3.0% | 40 nsec. | Bin | 0 to -2.56 (1) |
| | ADC-UH6B | 6 Bits | 0.8% | 100 nsec. | | |
| | ADC-UH8B | 8 Bits | 0.4% | 100 nsec. | | |
| 8 Bit Video | ADC-TV8B | 8 Bits | 0.2% | 50 nsec. | Bin | ±0.25 to ±10V (2) |

NOTES: 1. Bipolar versions are also available with ±1.28V input. Add $50.00 to price.

2. Input can be configured for unipolar operation by user. Input impedance is 50 ohms for ±0.25V input.

3. Coding: Bin= Straight binary or offset binary
2C = Two's complement

**ADC-EH12B3:** This 12 bit converter with 2 μsec. conversion time is the fastest 12 bit modular converter in the industry. Unipolar or bipolar operation is achieved by pin connection.

**ADC-G SERIES:** These converters feature conversions of 100 nsec. per bit for 8 and 10 bit conversions with a tempco of 50 ppm/°C.

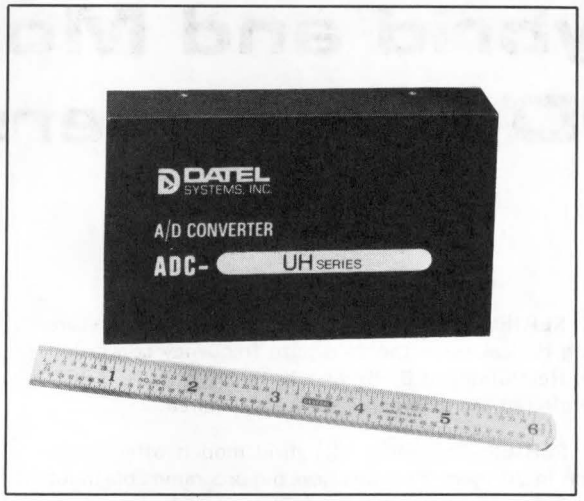
**ADC-H SERIES:** This series also features 100 nsec. per bit for 4 through 10 bit conversions. Tempco is 20 ppm/°C.

**ADC-VH SERIES:** These models use the parallel (or flash) conversion technique to realize a 4 bit conversion in 100 nsec. and 6 or 8 bit conversions in 200 nsec.

**ADC-UH SERIES:** This series is identical with the VH series except for faster conversion speed of 40 nsec. for 4 bits and 100 nsec. for 6 or 8 bits.

**ADC-TV8B:** This soon to be available model is a small circuit card made up of hybrid and monolithic components. It performs 8 bit conversions at better than 15 MHz rate.

**ALL MODELS:** Have operating temperature range of 0°C to 70°C; have DTL/TTL compatible outputs (ADC-TV8B has ECL compatible outputs); use DILS-1 or DILS-2 dual-in-line strips for sockets (ADC-TV8B uses a standard edge connector).




**See pages 284 and 285 for information on Extended Performance versions.**

| Linearity | Input Impedance | Gain Tempco | Power Requirement | Case Size (inches) | Price (1-9) | See Page |
|---|---|---|---|---|---|---|
| 1/2 LSB | 1.15 K | 30 ppm/°C | ±15V, +5V | 4 x 2 x 0.4 | $249.00 | 43 |
| 1/2 LSB | 500, 1K, 2K | 50 ppm/°C | ±15V, +5V | 4 x 2 x 0.4 | $239.00 | |
| | | | | 4 x 2 x 0.8 | $279.00 | 45 |
| 1/2 LSB | 500, 1K, 2K | 20 ppm/°C | ±15V, +5V | 4 x 2 x 0.4 | $279.00 | |
| | | | | 4 x 2 x 0.4 | $299.00 | ** |
| | | | | 4 x 2 x 0.4 | $319.00 | |
| | | | | 4 x 2 x 0.8 | $349.00 | |
| 1/2 LSB | | | | | $695.00 | |
| 1/2 LSB | 100 ohms | 50 ppm/°C | ±15V, ±5V | 5 x 3 x 1.15 | $745.00 | ** |
| 1 LSB | | | | | $795.00 | |
| 1/2 LSB | | | | | $795.00 | |
| 1/2 LSB | 100 ohms | 50 ppm/°C | ±15V, ±5V | 5 x 3 x 1.15 | $845.00 | 47 |
| 1 LSB | | | | | $895.00 | |
| 1/2 LSB | 50 ohms (2) | 60 ppm/°C | ±15V, ±5V | 7.5 x 4.25 x 0.875 | * | ** |

**THESE CONVERTERS ARE COVERED BY GSA CONTRACT**

*To be announced

**Contact nearest Datel sales office for data sheet and availability.

# Hybrid and Monolithic A/D Converters

**ADC-EK SERIES:** This series of monolithic converters are integrating devices using the voltage to frequency conversion principle. Resolutions of 8, 10, and 12 binary bits and 3 BCD digits are offered. An external reference is required.

**ADC-HX SERIES:** This series of hybrid models offer 12 bit conversion in 20 μsec. The units have pin-programmable input ranges and short cycling capability. Three temperature range versions are available.

**ADC-HZ SERIES:** These hybrid converters give 12 bit resolution in only 8 μsec. conversion time. Pin-programmable input ranges and short cycle capability are featured. Short cycling results in 10 bit conversion in 6 μsec. and 8 bit conversion in 4 μsec. Three temperature range versions are available.

| | Model | Resolution | Accuracy | Conversion Time | Output Coding | Input Ranges |
|---|---|---|---|---|---|---|
| New! Monolithic Series | ADC-EK8B | 8 Bits | 0.2% | 1.25 msec. | Bin | 0 to +10, ±5V |
| | ADC-EK10B | 10 Bits | .05% | 5 msec. | Bin | |
| | ADC-EK12B | 12 Bits | .01% | 20 msec. | Bin | |
| | ADC-EK12D | 3 Digits | .05% | 10 msec. | BCD | |
| New! Hybrid 12 Bit, 20 μsec. | ADC-HX12BGC | 12 Bits | .01% | 20 μsec. | C Bin, C 2C | 0 to +5, +10V ±2.5, ±5, ±10V |
| | ADC-HX12BMR | | | | | |
| | ADC-HX12BMM | | | | | |
| New! Hybrid 12 Bit, 8 μsec. | ADC-HZ12BGC | 12 Bits | .01% | 8 μsec. | C Bin, C 2C | 0 to +5, +10V ±2.5, ±5, ±10V |
| | ADC-HZ12BMR | | | | | |
| | ADC-HZ12BMM | | | | | |
| Coming! Hybrid | ADC-HS12B (1) | 12 Bits | .01% | 8 μsec. | C Bin, C 2C | +5, +10, ±2.5, ±5, ±10V |
| Coming! 12 Bit | ADC-HC12B | 12 Bits | .01% | 300 μsec. | Bin, 2C | +5, +10, ±2.5, ±5, ±10V |
| Hybird CMOS | ADC-HC12D | 3 Digits | .05% | 300 μsec. | BCD | 0 to +5, +10V |
| Coming! Hybrid | ADC-HF12B | 12 Bits | .01% | 2 μsec. | Bin, 2C | +5, +10, ±2.5, ±5, ±10V |
| Coming! Hybrid | ADC-HU3B | 3 Bits | 6% | 20 nsec. | Bin | ±2.5V |

**NOTES:** 1. The ADC-HS12B has an internal sample hold circuit ahead of the A/D converter.

2. Coding: Bin = Straight binary or offset binary
2C = Two's complement
BCD = Binary coded decimal
C Bin = Complementary binary or comp. offset Bin
C 2C = Complementary two's complement

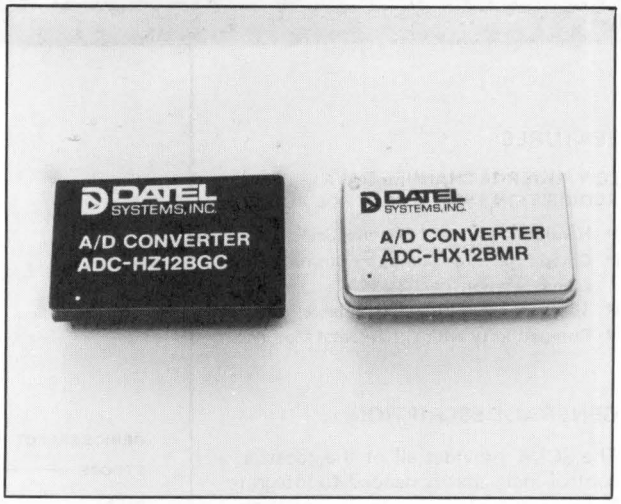
**ADC-HS12B:** This model combines a 12 bit 8 μsec. converter and a sample-hold circuit into a single hybrid package. Coming soon.

**ADC-HC SERIES:** These models are 12 bit hybrid CMOS devices for low power applications. Coming soon.

**ADC-HF12B:** This ultra speed hybrid converter provides 12 bit conversion in just 2 μsec. Coming soon.

**ADC-HU3B:** This hybrid model is a 3 bit parallel (flash) type. A 3 bit conversion is performed in 20 nsec. Several units may be used together to make an ultra fast 8 bit A/D converter. Coming soon.

**ALL MODELS:** Have operating temperature range of 0°C to 70°C except for those models specified otherwise; have DTL/TTL compatible outputs except for ADC-HC which has CMOS compatible outputs; use DILS-1 or DILS-2 dual-in-line strips for sockets except for ADC-IC and ADC-EK.




| Linearity | Temp. Range | Gain Tempco | Power Requirement | Case Size (inches) | Price (1-9) | See Page |
|---|---|---|---|---|---|---|
| 1/2 LSB | 0 to 70C | 40 ppm/°C | ±5V | 24 Pin DIP | $13.50<br>$26.00<br>$36.00<br>$29.00 | ** |
| 1/2 LSB | 0 to 70C<br>-25 to +85C<br>-55 to +100C | 20 ppm/°C | ±15V, +5V | 32 Pin DIP | $ 85.00<br>**$125.00**<br>**$155.00** | 33 |
| 1/2 LSB | 0 to 70C<br>-25 to +85C<br>-55 to +100C | 20 ppm/°C | ±15V, +5V | 32 Pin DIP | $119.00<br>**$169.00**<br>$195.00 | 33 |
| 1/2 LSB | 0 to 70C | 20 ppm/°C | ±15V, +5V | 32 Pin DIP | * | ** |
| 1/2 LSB<br>1/2 LSB | 0 to 70C | 20 ppm/°C | ±15V, +5V | 32 Pin DIP | *<br>* | ** |
| 1/2 LSB | 0 to 70C | 20 ppm/°C | ±15V, +5V | 32 Pin DIP | * | ** |
| 0.2% | 0 to 70C | 5 ppm/°C | ±5V | 32 Pin DIP | * | |

**THESE CONVERTERS ARE COVERED BY GSA CONTRACT**

***To be announced**

**** Contact nearest Datel sales office for data sheet and availability.**

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

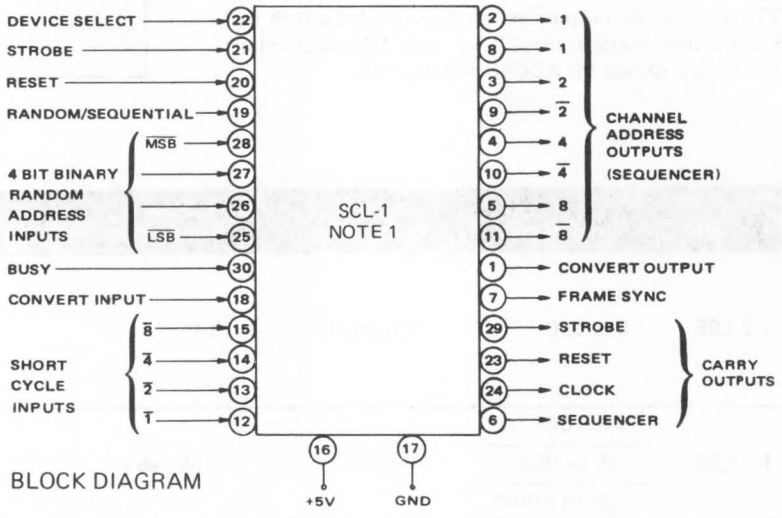
# DATA ACQUISITION SYSTEM PROGRAMMER SEQUENCER

# MODEL SCL-1

## FEATURES

**LOW POWER 16 CHANNEL DATA ACQUISITION SYSTEM CONTROL LOGIC**

- **Random/Sequential Channel Selection**
- **Gated Inputs for Computer Bus or Party Line Operation**
- **16 Channel Capacity-Expandable**
- **Compatibility with Other Datel Modules**


BLOCK DIAGRAM

## GENERAL DESCRIPTION

The SCL-1 provides all of the necessary control logic that is needed to integrate Datel's multiplexer, sample and hold, and A/D converters into a working 16 channel data acquisition system, all at substantial cost savings over prepackaged systems and with the additional choice of speed and performance specs of the components.

The SCL-1 reduces the basic external control functions to a simple ready/busy - strobe technique while providing both random or sequential channel selection modes. Other features include all the necessary controls for easy computer interfacing such as device select and strobe inputs for party line operations. All significant inputs are carried through the SCL-1 for system variations.

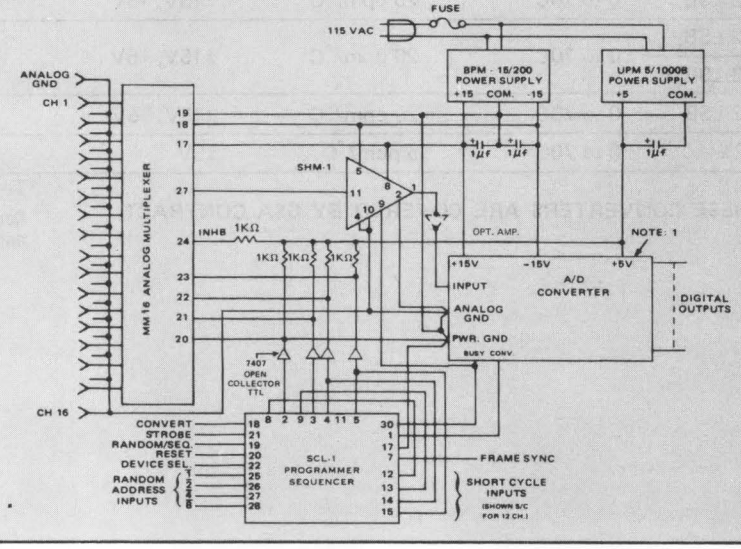
The SCL-1 also has provisions for short cycle (less than 16 channel operation) and provides a frame sync output at channel 1 for system expansion.

A single SCL-1 is capable of handling one Model MM-16 analog multiplexer for a 16 channel single ended system or an MMD-8 analog multiplexer for an 8 channel differential system. Channel capacity can be expanded, in the increments mentioned above, by simply adding MM-16's and SCL-1's. By employing the AM-201 instrumentation amplifier, a low level differential system can be configured for transducer monitoring and digital processing. With the exception of the SHM-2, all of Datel Systems' sample and hold circuits can be connected directly to the SCL-1. Datel's selection of A/D converters will allow for high conversion speeds with 8 bit to 14 bit resolution.

**Price** (1–9) $69.00

**NOTE:**
For low power applications contact Datel for information on Model SCL-CM

TYPICAL 16 Channel
DATA ACQUISITION SYSTEM
USING THE SCL-1



DATEL SYSTEMS, INC.
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# LOW COST, 12 BIT HYBRID ANALOG TO DIGITAL CONVERTERS

# ADC-HX, ADC-HZ SERIES

## FEATURES

- ▶ 12 Bit Resolution
- ▶ 8 or 20μSec. Conversion
- ▶ Programmable Ranges
- ▶ Internal Buffer Amp.
- ▶ Short Cycle Capability
- ▶ Glass or Metal Package

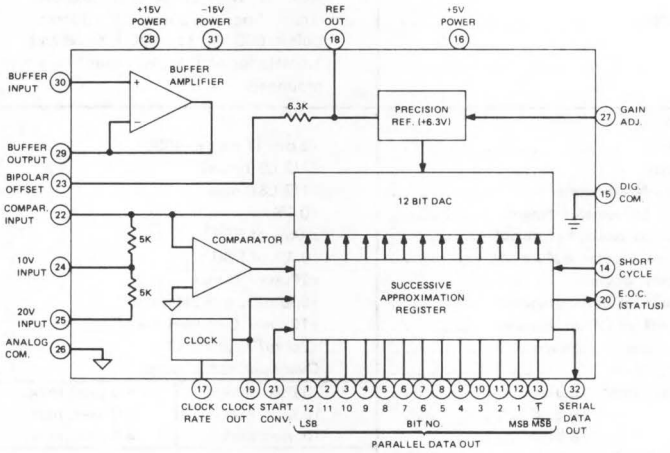
## GENERAL DESCRIPTION

The ADC-HX12B and ADC-HZ12B are self-contained, high performance, 12 bit A/D converters manufactured with thin-film hybrid technology. They use the successive approximation conversion technique to achieve a 12 bit conversion in 20 and 8 microseconds respectively. Five input voltage ranges are programmable by external pin connection: 0 to +5V, 0 to +10V, ±2.5V, ±5V, and ±10V. An internal buffer amplifier is also provided for applications where 100 megohm input impedance is required.

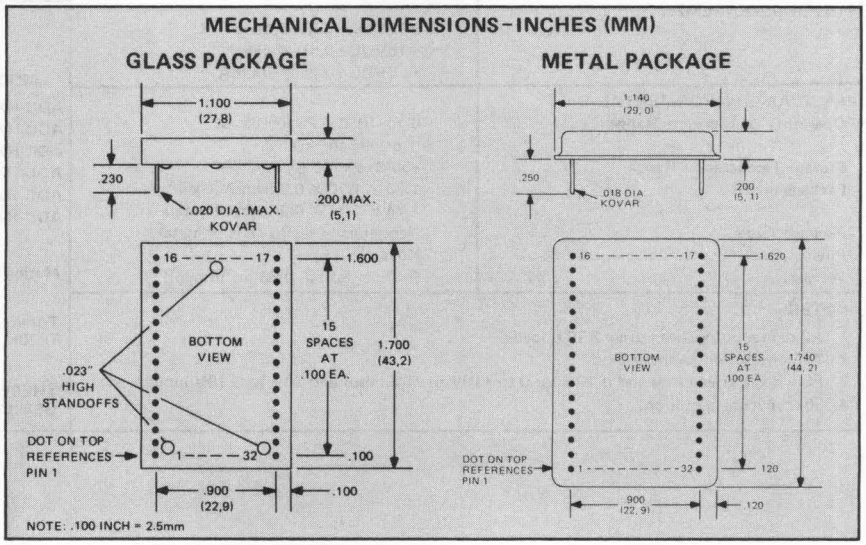
These converters utilize a fast 12 bit DAC consisting of tightly matched monolithic quad current switches, a stable nichrome thin-film resistor network, and a precision zener reference source. The circuit also contains a fast monolithic comparator, a monolithic 12 bit successive approximation register, a clock, and a monolithic buffer amplifier. The thin-film resistor network is functionally trimmed by a laser to precisely set the 8-4-2-1 current weighting in the quad current switches. The close tracking of the thin-film resistor and quad current switches result in a differential nonlinearity tempco of only ±2ppm/°C. Gain tempco is ±20ppm/°C maximum.

Both models have identical operation except for conversion speed. They can be short-cycled to give faster conversion in lower resolution applications. Use of the internal buffer amplifier increases conversion time by 3μsec., the settling time of the amplifier. Output coding is complementary binary, complementary offset binary, or complementary 2's complement. Serial data is also brought out. The package is a 32 pin hermetically sealed glass or metal case. Six different models are offered covering the operating temperature ranges of 0 to 70°C, -25 to +85°C, and -55 to +100°C.


(ACTUAL SIZE)




## MECHANICAL DIMENSIONS-INCHES (MM)



## SPECIFICATIONS, (Typical at 25°C, ±15V and +5V supplies unless otherwise noted)

| | ADC-HX12B | ADC-HZ12B |
|---|---|---|
| **INPUTS** | | |
| Analog Input Ranges, unipolar | 0 to +5V, 0 to +10V FS | |
| Analog Input Ranges, bipolar | ±2.5V, ±5V, ±10V FS | |
| Input Impedance | 2.5K (0 to +5V, ±2.5V)<br>5K (0 to +10V, ±5V)<br>10K (±10V) | |
| Input Impedance with Buffer | 100 Megohms | |
| Input Bias Current of Buffer | 125nA typ., 250nA max. | |
| Input Overvoltage | ±15V | |
| Start Conversion | 2V min. to 5.5V max. positive pulse with duration of 100nsec. min. Rise and fall times <30nsec.<br>Logic "1" resets converter<br>Logic "0" initiates conversion.<br>Loading: 1 TTL load | |
| **OUTPUTS**[1] | | |
| Parallel Output Data | 12 parallel lines of data held until next conversion command.<br>$V_{OUT}$ ("0") ≤ +0.4V<br>$V_{OUT}$ ("1") ≥ +2.4V | |
| Coding, unipolar | Complementary Binary | |
| Coding, bipolar | Complementary Offset Binary<br>Complementary Two's Complement | |
| Serial Output Data | NRZ successive decision pulses out, MSB first. Compl. Binary or Compl. Offset Binary Coding | |
| End of Conversion (Status) | Conversion status signal. Output is logic "1" during reset and conversion and logic "0" when conversion complete. | |
| Clock Output | Train of positive going +5V 100nsec. pulses. 600 kHz for ADC-HX12B and 1.5MHz for ADC-HZ12B (pin 17 grounded). | |
| **PERFORMANCE** | | |
| Resolution | 12 bits (1 part in 4096) | |
| Nonlinearity | ±1/2 LSB max. | |
| Differential Nonlinearity | ±1/2 LSB max. | |
| Gain Error, before adjustment | ±0.1% | |
| Zero Error, unipolar, before adj. | ±.05% of FSR[3] | |
| Offset Error, bipolar, before adj. | ±0.1% of FSR[3] | |
| Temp. Coeff. of Gain | ±20ppm/°C max. | |
| Temp. Coeff. of Zero, unipolar | ±5ppm/°C of FSR max.[3] | |
| Temp. Coeff. of Offset, bipolar | ±10ppm/°C of FSR max.[3] | |
| Diff. Nonlinearity Tempco | ±2ppm/°C of FSR[3] | |
| No Missing Codes | Over oper. temp. range | |
| Conversion Time[2], 12 bits | 20 µsec. max. | 8.0 µsec. max. |
| 10 bits[4] | 15 µsec. max. | 6.0 µsec. max. |
| 8 bits[4] | 10 µsec. max. | 4.0 µsec. max. |
| Buffer Settling Time, 10V step | 3.0 µsec. to .01% | |
| Power Supply Rejection | .002% / % Supply max. | |
| **POWER REQUIREMENT** | +15VDC ±0.5V @ 55mA<br>−15VDC ±0.5V @ 45mA<br>+ 5VDC ±0.25 @ 100mA | |
| **PHYSICAL-ENVIRONMENTAL** | | |
| Operating Temperature Range | 0 to 70°C, −25 to +85°C, or −55 to +100°C | |
| Storage Temperature Range | −55°C to +100°C | |
| Package Size | 1.70 X 1.10 X 0.2 inches (Glass)<br>1.74 X 1.14 X 0.2 inches (Metal) | |
| Package Type | Hermetically sealed glass or metal | |
| Pins | Kovar | |
| Weight | 0.42 oz. (glass), 0.53 oz. (metal) | |

**NOTES:**

1. All digital outputs can drive 2 TTL loads.
2. Without buffer amplifier used.
3. FSR is full scale range and is 10V for 0 to +10V or ±5V input and 20V for ±10V input.
4. Short cycled operation.

## TECHNICAL NOTES

1. It is recommended that the ±15V power input pins both be bypassed to ground with a .01µF ceramic capacitor in parallel with a 1µF electrolytic capacitor and the +5V power input pin be bypassed to ground with a 10µF electrolytic capacitor as shown in the connection diagrams. In addition, pin 27 should be bypassed to ground with a .01µF ceramic capacitor. These precautions will assure noise free operation of the converter.
2. Digital Common (pin 15) and Analog Common (pin 26) are not connected together internally, and therefore must be connected as directly as possible externally. It is recommended that a ground plane be run underneath the case between the two commons. Analog ground and ±15V power ground should be run to pin 26 whereas digital ground and +5V ground should be run to pin 15.
3. External adjustment of zero or offset and gain are provided for by trimming potentiometers connected as shown in the connection diagrams. The potentiometer values can be between 10K and 100K ohms and should be 100ppm/°C cermet types (such as Datel Systems TP series). The adjustment range is ±0.2% of FSR for zero or offset and ±0.3% for gain. The trimming pots should be located as close as possible to the converter to avoid noise pickup. In some cases, for example 8 bit short-cycled operation, external adjustment may not be necessary.
4. Short cycled operation results in shorter conversion times where the conversion can be truncated to less than 12 bits. This is done by connecting pin 14 to the output bit following the last bit desired. For example for an 8 bit conversion, pin 14 is connected to bit 9 output. Maximum conversion times are given for short-cycled conversions of 8 or 10 bits. In these two cases the clock rate is also speeded up by connecting the clock rate adjust (pin 17) to +5V (10 bits) or +15V (8 bits). The clock rate should not be arbitrarily speeded up to exceed the maximum conversion rate at a given resolution, however, or missing codes will result.
5. Note that output coding is complementary coding. For unipolar operation it is complementary binary and for bipolar operation it is complementary offset binary or complementary 2's complement. In cases where bipolar coding of offset binary or 2's complement is required, this can be achieved by inverting the analog input to the converter (using an op amp connected for gain of −1.0000). The converter is then calibrated so that −FS analog input gives an output code of 0000 0000 0000, and +FS−1LSB gives 1111 1111 1111.
6. These converters dissipate approximately 2 watts of power. The case to ambient thermal resistance is approximately 25°C per watt. For ambient temperatures above 50°C, care should be taken not to restrict air circulation in the vicinity of the converter.

## ORDERING INFORMATION

| MODEL | TEMP. RANGE | CASE | PRICE(1-9) |
|---|---|---|---|
| ADC-HX12BGC | 0 to 70C | GLASS | $ 85.00 |
| ADC-HX12BMR | −25 to +85C | METAL | $125.00 |
| ADC-HX12BMM | −55 to +100C | METAL | $155.00 |
| ADC-HZ12BGC | 0 to 70C | GLASS | $119.00 |
| ADC-HZ12BMR | −25 to +85C | METAL | $169.00 |
| ADC-HZ12BMM | −55 to +100C | METAL | $195.00 |

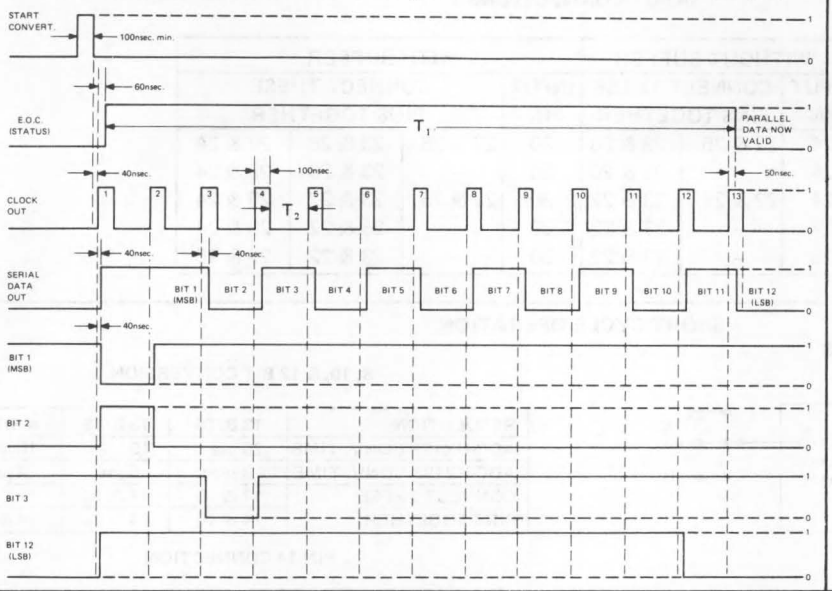
**Mating Socket:** DILS-2 (2/converter) at $5.00 /pair

Trimming Potentiometers: TP2K, TP5K, TP10K, TP20K, TP50K or TP100K at $3.00 each

**THESE CONVERTERS ARE COVERED UNDER GSA CONTRACT**

## TIMING AND CONNECTION DIAGRAMS

### TIMING DIAGRAM FOR ADC-HX12B, ADC-HZ12B OUTPUT: 101010101010

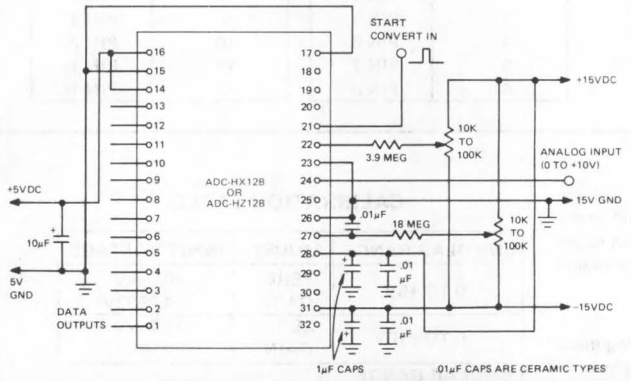



### INPUT/OUTPUT CONNECTIONS

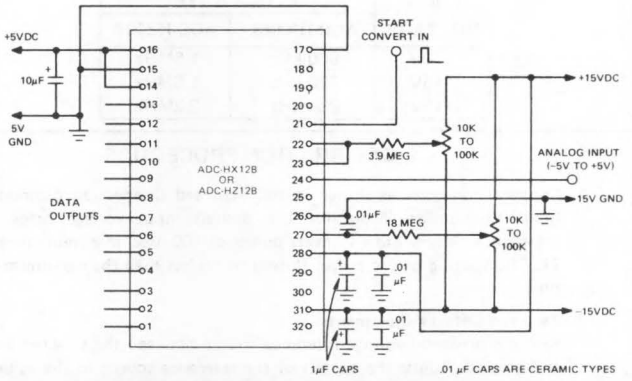
| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | BIT 12 OUT (LSB) | 17 | CLOCK RATE |
| 2 | BIT 11 OUT | 18 | REF. OUT |
| 3 | BIT 10 OUT | 19 | CLOCK OUT |
| 4 | BIT 9 OUT | 20 | E.O.C. (STATUS) |
| 5 | BIT 8 OUT | 21 | START CONVERT |
| 6 | BIT 7 OUT | 22 | COMPAR. INPUT |
| 7 | BIT 6 out | 23 | BIPOLAR OFFSET |
| 8 | BIT 5 OUT | 24 | 10V INPUT |
| 9 | BIT 4 OUT | 25 | 20V INPUT |
| 10 | BIT 3 OUT | 26 | ANALOG COM. |
| 11 | BIT 2 OUT | 27 | GAIN ADJUST |
| 12 | BIT 1 OUT (MSB) | 28 | +15V POWER |
| 13 | BIT 1 OUT ($\overline{\text{MSB}}$) | 29 | BUFFER OUTPUT |
| 14 | SHORT CYCLE | 30 | BUFFER INPUT |
| 15 | DIGITAL COM. | 31 | –15V POWER |
| 16 | +5V POWER | 32 | SERIAL OUTPUT |

| | ADC-HX12B | ADC-HZ12B |
|---|---|---|
| $T_1$ | 20 μsec. | 8.0 μsec. |
| $T_2$ | 1.56 μsec. | 0.56 μsec. |

### UNIPOLAR OPERATION, 0 TO +10V




### BIPOLAR OPERATION, -5V TO +5V




## CODING TABLES

### UNIPOLAR OPERATION

| INPUT RANGE | | COMP. BINARY CODING | | |
|---|---|---|---|---|
| 0 TO +10V | 0 TO +5V | MSB | | LSB |
| +9.9976V | +4.9988V | 0000 | 0000 | 0000 |
| +8.7500 | +4.3750 | 0001 | 1111 | 1111 |
| +7.5000 | +3.7500 | 0011 | 1111 | 1111 |
| +5.0000 | +2.5000 | 0111 | 1111 | 1111 |
| +2.5000 | +1.2500 | 1011 | 1111 | 1111 |
| +1.2500 | +0.6250 | 1101 | 1111 | 1111 |
| +0.0024 | +0.0012 | 1111 | 1111 | 1110 |
| 0.0000 | 0.0000 | 1111 | 1111 | 1111 |

### BIPOLAR OPERATION

| INPUT VOLTAGE RANGE | | | COMP. OFFSET BINARY | | | COMP. TWO'S COMPLEMENT | | |
|---|---|---|---|---|---|---|---|---|
| ±10V | ±5V | ±2.5V | MSB | | LSB | MSB | | LSB |
| +9.9951V | +4.9976V | +2.4988V | 0000 | 0000 | 0000 | 1000 | 0000 | 0000 |
| +7.5000 | +3.7500 | +1.8750 | 0001 | 1111 | 1111 | 1001 | 1111 | 1111 |
| +5.0000 | +2.5000 | +1.2500 | 0011 | 1111 | 1111 | 1011 | 1111 | 1111 |
| 0.0000 | 0.0000 | 0.0000 | 0111 | 1111 | 1111 | 1111 | 1111 | 1111 |
| –5.0000 | –2.5000 | –1.2500 | 1011 | 1111 | 1111 | 0011 | 1111 | 1111 |
| –7.5000 | –3.7500 | –1.8750 | 1101 | 1111 | 1111 | 0101 | 1111 | 1111 |
| –9.9951 | –4.9976 | –2.4988 | 1111 | 1111 | 1110 | 0111 | 1111 | 1110 |
| –10.0000 | –5.0000 | –2.5000 | 1111 | 1111 | 1111 | 0111 | 1111 | 1111 |

## CONNECTIONS AND CALIBRATION

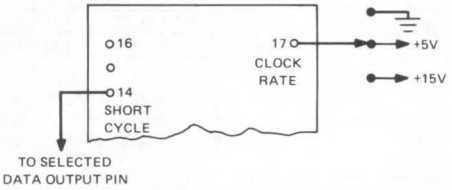
DATEL

### INPUT CONNECTIONS

| INPUT VOLT. RANGE | WITHOUT BUFFER | | | WITH BUFFER | | | |
|---|---|---|---|---|---|---|---|
| | INPUT PIN | CONNECT THESE PINS TOGETHER | | INPUT PIN | CONNECT THESE PINS TOGETHER | | |
| 0 TO +5V | 24 | 22 & 25 | 23 & 26 | 30 | 22 & 25 | 23 & 26 | 29 & 24 |
| 0 TO +10V | 24 | — | 23 & 26 | 30 | — | 23 & 26 | 29 & 24 |
| ±2.5V | 24 | 22 & 25 | 23 & 22 | 30 | 22 & 25 | 23 & 22 | 29 & 24 |
| ±5V | 24 | — | 23 & 22 | 30 | — | 23 & 22 | 29 & 24 |
| ±10V | 25 | — | 23 & 22 | 30 | — | 23 & 22 | 29 & 25 |

### SHORT CYCLE OPERATION

#### CONNECTIONS




#### 8, 10, & 12 BIT CONVERSION

| RESOLUTION | 12 BITS | 10 BITS | 8 BITS |
|---|---|---|---|
| ADC-HX12B CONV. TIME | 20 µsec. | 15 µsec. | 10 µsec. |
| ADC-HZ12B CONV. TIME | 8 µsec. | 6 µsec. | 4 µsec. |
| CONNECT THESE | 17 & 15 | 17 & 16 | 17 & 28 |
| PINS TOGETHER | 14 & 16 | 14 & 2 | 14 & 4 |

#### CLOCK RATE VS. VOLTAGE

| PIN 17 VOLTAGE | CLOCK RATE | |
|---|---|---|
| | ADC-HX12B | ADC-HZ12B |
| 0V | 600 kHz | 1.5MHz |
| +5V | 720 kHz | 1.8MHz |
| +15V | 880 kHz | 2.2MHz |

#### PIN 14 CONNECTION

| RES. (BITS) | PIN 14 TO |
|---|---|
| 1 | PIN 11 |
| 2 | PIN 10 |
| 3 | PIN 9 |
| 4 | PIN 8 |
| 5 | PIN 7 |
| 6 | PIN 6 |

| RES. (BITS) | PIN 14 TO |
|---|---|
| 7 | PIN 5 |
| 8 | PIN 4 |
| 9 | PIN 3 |
| 10 | PIN 2 |
| 11 | PIN 1 |
| 12 | PIN 16 |

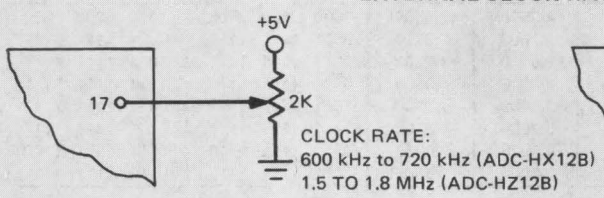
### CALIBRATION PROCEDURE

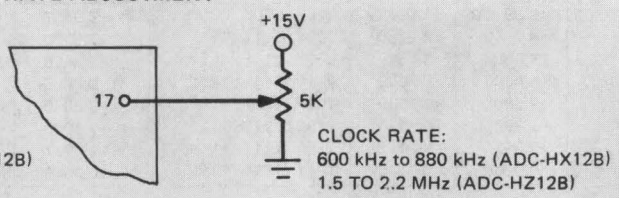
1. Connect converter as shown in the Standard Connection diagrams. Use the Input Connection Table for the desired input voltage range and input impedance. Apply Start Convert pulses of 100 nsec. minimum duration to pin 21. The spacing of the pulses should be no less than the maximum conversion time.
2. **Zero and Offset Adjustments**
   Apply a precision voltage reference source between the selected analog input and ground. Adjust the output of the reference source to the value shown in the Calibration Table for the unipolar zero adjustment (zero +½ LSB) or the bipolar offset adjustment (–FS+½ LSB). Adjust the trimming potentiometer so that the output code flickers equally between 1111 1111 1111 and 1111 1111 1110.
3. **Full Scale Adjustment**
   Change the output of the precision voltage reference source to the value shown in the Calibration Table for the unipolar or bipolar gain adjustment (+FS–1½ LSB). Adjust the gain trimming potentiometer so that the output code flickers equally between 0000 0000 0001 and 0000 0000 0000.

### CALIBRATION TABLE

| UNIPOLAR RANGE | ADJUST. | INPUT VOLTAGE |
|---|---|---|
| 0 TO +5V | ZERO | +0.6 mV |
| | GAIN | +4.9982V |
| 0 TO +10V | ZERO | +1.2 mV |
| | GAIN | +9.9963V |
| **BIPOLAR RANGE** | | |
| ±2.5V | OFFSET | –2.4994V |
| | GAIN | +2.4982V |
| ±5V | OFFSET | –4.9988V |
| | GAIN | +4.9963V |
| ±10V | OFFSET | –9.9976V |
| | GAIN | +9.9927V |

### EXTERNAL CLOCK RATE ADJUSTMENT



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# FAST, 8 BIT ANALOG TO DIGITAL CONVERTER

# MODEL ADC-EH8B

## FEATURES

- 8 Bit Resolution
- 4.0 & 2.0 μsec. Conversion Time
- Unipolar or Bipolar Operation
- Parallel & Serial Outputs
- Low Cost

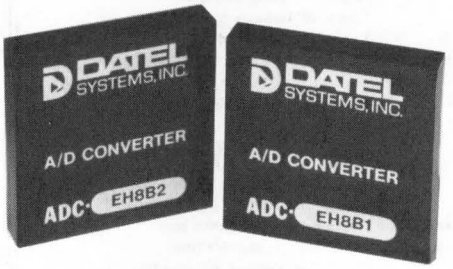
## GENERAL DESCRIPTION

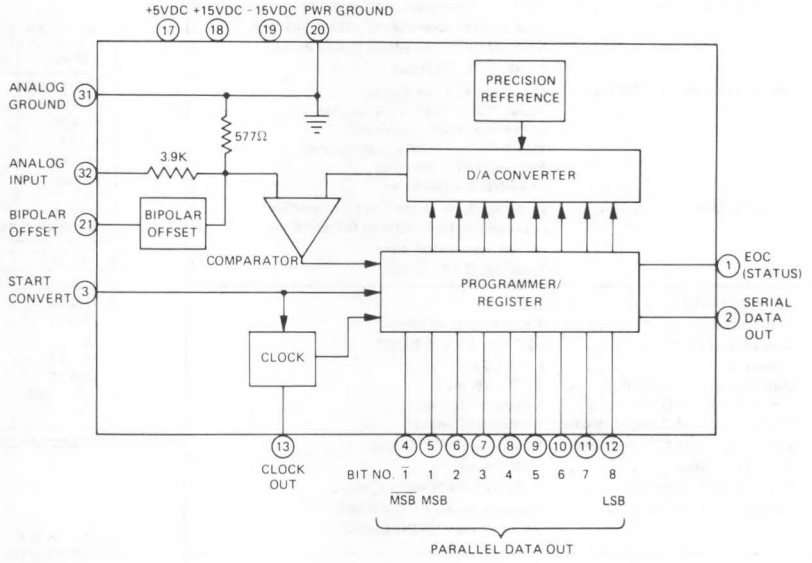
The model ADC-EH8B is a fast, 8 bit successive approximation type analog to digital converter in a compact 2 x 2 x .375 inch module. These converters are low cost devices with application in pulse code modulation systems and instrumentation and control systems requiring fast data conversion rates up to 400,000 per second. There are two models to choose from based on conversion speed: ADC-EH8B1 with a conversion time of 4.0 μsec. (250 kHz rate), and ADC-EH8B2 with a conversion time of 2.0 μsec. (416 kHz rate).

The high speed in a small size is made possible by the use of an MSI integrated circuit which provides all the necessary successive approximation logic, along with other new integrated circuit components. The analog input range is either unipolar 0 to +10V or bipolar -5V to +5V, determined by external pin connection. For unipolar operation no external adjustments are necessary; for bipolar operation only a bipolar offset adjustment must be made externally. Parallel output coding is straight binary for unipolar operation and offset binary or two's complement for bipolar operation. A serial output gives successive decision pulses in NRZ format with straight or offset binary coding. Other outputs are clock output for synchronization with serial data, and $\overline{\text{MSB}}$ output for two's complement coding.

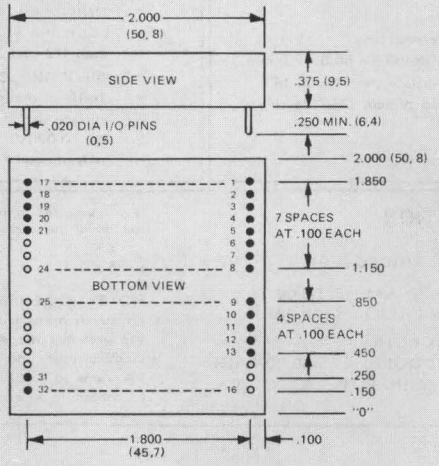
Other specifications include full scale temperature coefficient of 50 ppm/°C max., long term stability of .05%/year, and linearity of ±1/2 LSB. Power requirement is ±15VDC and +5VDC.

The ADC-EH8B1 & 2 are improved versions of Datel's former models ADC-EH1 & 2, and are identical in all specifications and pin positions except for a small change in input impedance and three added output pins for Clock Out, $\overline{\text{MSB}}$ Out, and Serial Data Out.




## MECHANICAL DIMENSIONS INCHES (MM)




NOTES
1. Open dots designate omitted pins.
2. 0.100 inch = 2.5 mm, 0.150 inch = 3.8 mm.

## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | E.O.C. (STATUS) |
| 2 | SERIAL DATA OUTPUT |
| 3 | START CONVERT |
| 4 | BIT 1 OUT ($\overline{\text{MSB}}$) |
| 5 | BIT 1 OUT (MSB) |
| 6 | BIT 2 OUT |
| 7 | BIT 3 OUT |
| 8 | BIT 4 OUT |
| 9 | BIT 5 OUT |
| 10 | BIT 6 OUT |
| 11 | BIT 7 OUT |
| 12 | BIT 8 OUT (LSB) |
| 13 | CLOCK OUT |
| 17 | +5V POWER IN |
| 18 | +15V POWER IN |
| 19 | -15V POWER IN |
| 20 | POWER GROUND |
| 21 | BIPOLAR OFFSET |
| 31 | ANALOG GROUND |
| 32 | ANALOG INPUT |

## SPECIFICATIONS, ADC-EH8B
**(Typical at 25°C, ±15V & +5V Supplies, unless otherwise indicated)**

### INPUTS

| | |
|---|---|
| **Analog Input Range** | 0V to +10V FS or ±5V FS |
| **Input Impedance** | 4.45K ohms ±50 ohms |
| **Input Overvoltage** | ±20V (no damage) |
| **Start Conversion** | 2V min. to 5.5V max. positive pulse with duration of 100 nsec. min. Rise and fall times <50 nsec.<br>Logic "1" resets converter<br>Logic "0" initiates conversion<br>Loading: 1 TTL load |

### OUTPUTS

| | |
|---|---|
| **Parallel Output Data** | 8 parallel lines of data held until next conversion command.<br>V out ("0") ⩽ +0.4V<br>V out ("1") ⩾ +2.4V<br>Each output capable of driving up to 4 TTL loads. |
| **Coding, Unipolar Operation** | Straight Binary, positive true |
| **Bipolar Operation** | Offset Binary, positive true.<br>Two's Complement, positive true. |
| **Serial Output Data** | NRZ successive decision pulse output generated during conversion, with MSB first.<br>Straight binary or offset binary coding.<br>Loading: 4 TTL loads |
| **End of Conversion (EOC)** | Conversion Status Signal.<br>V out ("0") ⩽ +0.4V indicates conversion time completed.<br>V out ("1") ⩾ +2.4V during reset and conversion periods.<br>Loading: 4 TTL loads. |
| **Clock Output** | Internal clock pulse train of negative going pulses from +5V to 0V gated on during conversion time.<br>Loading: 6 TTL loads |

### PERFORMANCE

| | |
|---|---|
| **Resolution** | 8 Bits (1 part in 256) |
| **Accuracy at 25°C** | ±0.2% of FS ± 1/2 LSB |
| **Linearity** | ± 1/2 LSB |
| **Differential Nonlinearity** | ±1/2 LSB max. |
| **Temp. Coeff. of Gain** | ± 50ppm/°C max. |
| **Temp. Coeff. of Zero, Unipolar** | ± 100μV/°C max. |
| **Temp. Coeff. of Offset, Bipolar** | ± 35 ppm of FS/°C max. |
| **Long Term Stability** | ± .05%/year |
| **Power Supply Rejection** | ± .02% of FS/% supply, max. |
| **Conversion Time** | 4.0 μsec. max., ADC-EH8B1<br>2.0 μsec. max., ADC-EH8B2 |

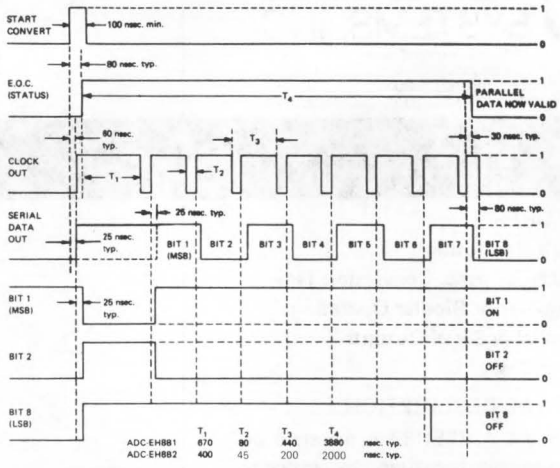
### POWER REQUIREMENT

± 15VDC ±0.5V @ 25mA max.
+5VDC ± 0.25V @ 125mA max.

### PHYSICAL-ENVIRONMENTAL

| | |
|---|---|
| **Operating Temp. Range** | 0°C to 70°C |
| **Storage Temp. Range** | −55°C to +85°C |
| **Relative Humidity** | Up to 100% non-condensing |
| **Case Size** | 2 x 2 x 0.375 inches (50,8 x 50,8 x 9,5 mm) |
| **Case Material** | Black diallyl phthalate per MIL-M-14 |
| **Pins** | .020" round, gold plated, .250" lg. min. |
| **Weight** | 2 oz. max. (57g.) |

## TIMING DIAGRAM FOR ADC-EH8B Output: 10101010




## OUTPUT CODING

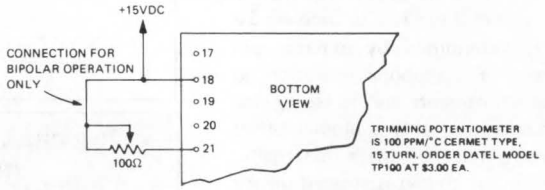
UNIPOLAR (0 TO +10V)

| SCALE | INPUT VOLTAGE | STRAIGHT BINARY |
|---|---|---|
| +FS−1 LSB | +9.96V | 1111 1111 |
| +7/8 FS | +8.75V | 1110 0000 |
| +3/4 FS | +7.50V | 1100 0000 |
| +1/2 FS | +5.00V | 1000 0000 |
| +1/4 FS | +2.50V | 0100 0000 |
| +1 LSB | +0.04V | 0000 0001 |
| 0 | 0.00V | 0000 0000 |

BIPOLAR (−5V TO +5V)

| SCALE | INPUT VOLTAGE | OFFSET BIN | 2'S COMPLEMENT |
|---|---|---|---|
| +FS−1 LSB | +4.96V | 1111 1111 | 0111 1111 |
| +3/4 FS | +3.75V | 1110 0000 | 0110 0000 |
| +1/2 FS | +2.50V | 1100 0000 | 0100 0000 |
| 0 | 0.00V | 1000 0000 | 0000 0000 |
| −1/2 FS | −2.50V | 0100 0000 | 1100 0000 |
| −3/4 FS | −3.75V | 0010 0000 | 1010 0000 |
| −FS+1 LSB | −4.96V | 0000 0001 | 1000 0001 |
| −FS | −5.00V | 0000 0000 | 1000 0000 |

## ADC-EH8B CALIBRATION




1. UNIPOLAR – No adjustments are necessary and 100Ω trimming pot is not used. Full scale and zero are internally set to better than 1/2 LSB. Pin 21 is left open.
2. BIPOLAR – Connect pin 18 (+15VDC) to pin 21 through a 100Ω trimming potentiometer as shown. Connect a precision voltage source to pin 32 and set the input voltage to + 1/2 LSB or +0.020V. Adjust the trimming potentiometer so that the output code flickers equally between 1000 0000 and 1000 0001.

## ORDERING INFORMATION

ADC-EH8B ——

| CONVERSION TIME |
|---|
| 1 = 4.0 μSEC. |
| 2 = 2.4 μSEC. |

PRICES (1-9)

| | |
|---|---|
| ADC-EH8B1 | $ 85.00 |
| ADC-EH8B2 | $129.00 |

MATING SOCKETS:

| | |
|---|---|
| DILS-2 (2/MODULE) | $5.00/PAIR |
| TP100 TRIMMING POT. | $3.00 EA. |

For extended temperature range operation, the following suffixes are added to the model number. Consult factory for pricing.

| | |
|---|---|
| −EX | −25°C to +85°C operation |
| −EXX−HS | −55°C to +85°C operation with hermetically sealed semiconductor components. |

**NOTE:** ADC-EH8B1 & 2 replace former models ADC-EH1 & 2 and are improved models of these units respectively. The only difference from the previous models is the 3 additional output pins for serial output, clock output, and $\overline{\text{MSB}}$ output, and a change in input impedance from 5K ohms to 4.45K ohms. If the newly used pins (nos. 2, 4, and 13) cause a problem in an existing application, they should be clipped off.

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# 10 BIT, 2.0 AND 4.0μSEC. ANALOG TO DIGITAL CONVERTERS

# MODEL ADC-EH10B

## FEATURES

- **2.0 μsec. Conversion – $189.**
- **4.0 μsec. Conversion – $149.**
- **10 Bit Resolution**
- **Compact 3" x 2" x .375" Module**
- **±30ppm/°C max. Tempco**

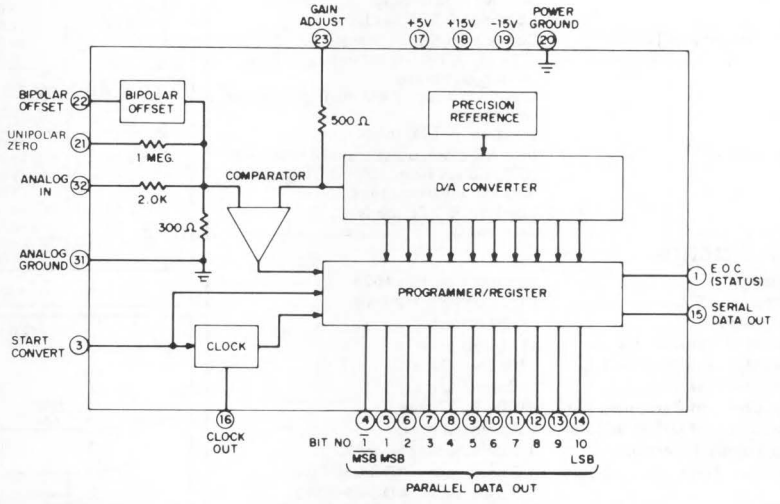
## GENERAL DESCRIPTION

Model ADC-EH10B is a very fast 10 bit successive approximation type A/D converter in a compact low profile package. Low pricing makes this converter an ideal choice for many applications including fast scanning data acquisition systems, PCM systems, and fast pulse analysis. This converter is available in two versions based on conversion speed: ADC-EH10B1 with 4.0 μsec. (250kHz rate) and ADC-EH10B2 with 2.0 μsec. (500kHz rate).

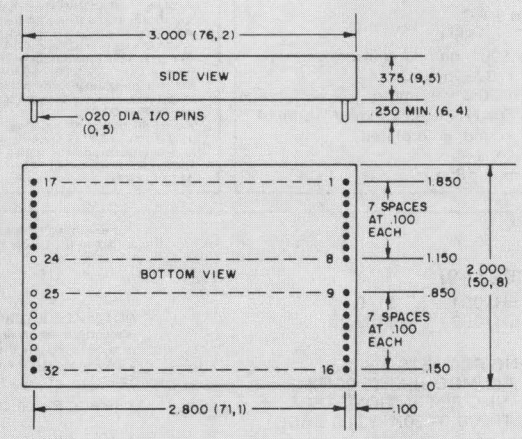
High speed and moderate power consumption (1.7 watts) in a compact size (3" x 2" x .375") are made possible by use of an MSI integrated circuit successive approximation programmer/register used with 10 fast switching current sources driving a low impedance R-2R ladder network. A fast precision comparator and precision voltage reference circuit are also used.

Operating features include unipolar (0 to +10V) or bipolar (±5V) operation by external pin connection. The converter has a maximum full scale temperature coefficient of ±30ppm/°C and is monotonic over the full operating temperature range of 0°C to 70°C. External offset and gain adjustments are provided for precise calibration of zero and full scale. Parallel output coding is straight binary for unipolar operation and offset binary or two's complement for bipolar operation. A serial output gives successive decision pulses in NRZ format with straight binary or offset binary coding. Other outputs include clock output for synchronizing serial data, MSB output for two's complement coding, and end of conversion (status) signal. All outputs are DTL/TTL compatible. Power requirement is ±15VDC and +5VDC. The ADC-EH10B is also available in extended temperature range versions.

The ADC-EH10B1 is an improved version of Datel's former ADC-EH10B converter. The ADC-EH10B1 is identical in all specifications and pin positions with the former model except for a change in input impedance and reduction in +5V supply current.


## MECHANICAL DIMENSIONS INCHES (MM)




NOTES:
1. OPEN DOTS DESIGNATE OMITTED PINS
2. 0.100 INCH = 2.5mm

## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | E.O.C. (STATUS) |
| 2 | NO CONNECTION |
| 3 | START CONVERT |
| 4 | BIT 1 OUT (MSB) |
| 5 | BIT 1 OUT (MSB) |
| 6 | BIT 2 OUT |
| 7 | BIT 3 OUT |
| 8 | BIT 4 OUT |
| 9 | BIT 5 OUT |
| 10 | BIT 6 OUT |
| 11 | BIT 7 OUT |
| 12 | BIT 8 OUT |
| 13 | BIT 9 OUT |
| 14 | BIT 10 OUT (LSB) |
| 15 | SERIAL DATA OUT |
| 16 | CLOCK OUT |
| 17 | +5VDC POWER IN |
| 18 | +15VDC POWER IN |
| 19 | -15VDC POWER IN |
| 20 | POWER GROUND |
| 21 | UNIPOLAR ZERO |
| 22 | BIPOLAR OFFSET. |
| 23 | GAIN ADJUST. |
| 31 | ANALOG GROUND |
| 32 | ANALOG IN |

## SPECIFICATIONS, ADC-EH10B
**(Typical at 25°C, ±15V & +5V Supplies, unless otherwise indicated)**

### INPUTS

| | |
|---|---|
| **Analog Input Range** | 0V to +10V FS or ±5V FS |
| **Input Impedance** | 2.3K ±0.1% |
| **Input Overvoltage** | ±20V, no damage |
| **Start Conversion** | 2V min. to 5.5V max. positive pulse with duration of 100 nsec. min. Rise and fall times <500 nsec. Logic "1" resets converter Logic "0" initiates conversion Loading: 1 TTL load |

### OUTPUTS

| | |
|---|---|
| **Parallel Output Data** | 10 parallel lines of data held until next conversion command. V out ("0") ≤ +0.4V V out ("1") ≥ +2.4V Each output capable of driving up to 4 TTL loads. |
| **Coding, Unipolar operation** | Straight Binary, positive true |
| **Bipolar operation** | Offset Binary, positive true Two's complement, positive true |
| **Serial Output Data** | NRZ successive decision pulse output generated during conversion with MSB first. Straight binary or offset binary, positive true coding. Loading: 4 TTL loads |
| **End of Conversion (EOC)** | Conversion Status Signal. V out ("0") ≤ +0.4V indicates conversion completed. V out ("1") ≥ +2.4V during reset and conversion. Loading: 4 TTL loads |
| **Clock Output** | Internal clock pulse train of negative going pulses from +5V to 0V gated on during conversion time. Loading: 6 TTL loads |

### PERFORMANCE

| | |
|---|---|
| **Resolution** | 10 Bits (1 part in 1024) |
| **Accuracy at 25°C** | ±.05% of FS ±1/2 LSB. |
| **Nonlinearity** | ±1/2 LSB max. |
| **Differential Nonlinearity** | ±1/2 LSB max. |
| **Differential Nonlinearity T.C.** | ±10ppm/°C max. |
| **Temp. Coeff. of Gain** | ±30ppm/°C max. |
| **Temp. Coeff. of Zero, unipolar** | ±100 μV/°C max. |
| **Temp. Coeff. of Offset, bipolar** | ±20ppm/°C max. |
| **Power Supply Rejection** | .01% FS/% supply, max. |
| **Conversion Time** | 4.0 μsec. max., ADC-EH10B1 2.0 μsec. max., ADC-EH10B2 |

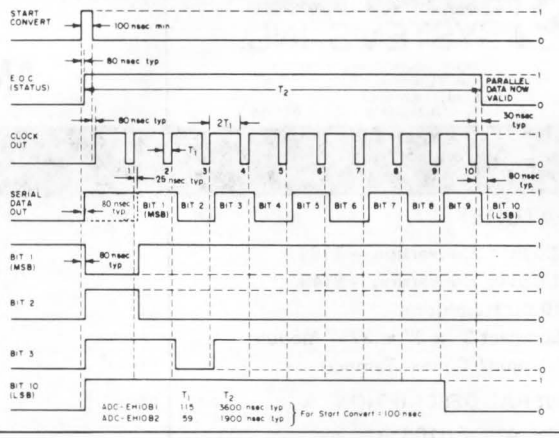
### POWER REQUIREMENT

+15VDC ±0.5VDC @ 45mA max.
-15VDC ±0.5VDC @ 20mA max.
+5VDC ±0.25VDC @ 150mA max.

### PHYSICAL-ENVIRONMENTAL

| | |
|---|---|
| **Operating Temp. Range** | 0°C to 70°C |
| **Storage Temp. Range** | -25°C to +85°C |
| **Relative Humidity** | Up to 100% non-condensing |
| **Case Size** | 3 x 2 x .375 inches (76,2 x 30,8 x 9,5mm) |
| **Case Material** | Black Diallyl Phthalate per MIL-M-14 |
| **Pins** | .020" round, gold plated, .250" long min. |
| **Weight** | 3 oz. max. (85g.) |

## TIMING DIAGRAM FOR ADC-EH10B Output: 1010101010




## OUTPUT CODING

UNIPOLAR (0V TO +10V)

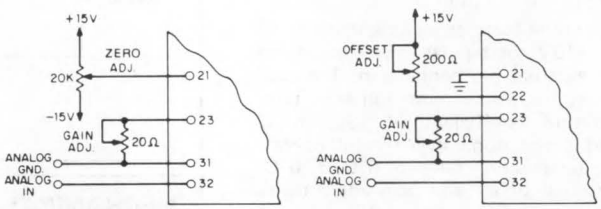
| SCALE | INPUT VOLTAGE | STRAIGHT BINARY |
|---|---|---|
| +FS - 1 LSB | +9.9902V | 1111 1111 11 |
| +7/8 FS | +8.7500V | 1110 0000 00 |
| +3/4 FS | +7.5000V | 1100 0000 00 |
| +1/2 FS | +5.0000V | 1000 0000 00 |
| +1/4 FS | +2.5000V | 0100 0000 00 |
| + 1 LSB | +0.0098V | 0000 0000 01 |
| 0 | 0.0000V | 0000 0000 00 |

BIPOLAR (–5V TO +5V)

| SCALE | INPUT VOLTAGE | OFFSET BINARY | TWO'S COMPLEMENT* |
|---|---|---|---|
| +FS -1 LSB | +4.9902V | 1111 1111 11 | 0111 1111 11 |
| +3/4 FS | +3.7500V | 1110 0000 00 | 0110 0000 00 |
| +1/2 FS | +2.5000V | 1100 0000 00 | 0100 0000 00 |
| 0 | 0.0000V | 1000 0000 00 | 0000 0000 00 |
| -1/2 FS | -2.5000V | 0100 0000 00 | 1100 0000 00 |
| -3/4 FS | -3.7500V | 0010 0000 00 | 1010 0000 00 |
| -FS + 1 LSB | -4.9902V | 0000 0000 01 | 1000 0000 01 |
| -FS | -5.0000V | 0000 0000 00 | 1000 0000 00 |

*Using $\overline{\text{MSB}}$ output for Bit 1

## GAIN & OFFSET ADJUSTMENTS




### UNIPOLAR OPERATION

1. Apply START CONVERT pulses to pin 3 (see specifications and timing diagram).
2. Apply a precision reference voltage source to ANALOG IN (pin 32) and ANALOG GROUND (pin 31). Adjust the output of the voltage reference to Zero +1/2 LSB (+4.9mV). Adjust the zero trimming potentiometer so that the output code flickers equally between 0000 0000 00 and 0000 0000 01.
3. Adjust the output of the voltage reference to +FS – 1 1/2 LSB (+9.9854V). Adjust the GAIN trimming potentiometer so that the output code flickers equally between 1111 1111 10 and 1111 1111 11.

### BIPOLAR OPERATION

1. Apply START CONVERT pulses to pin 3 (see specifications and timing diagram).
2. Apply a precision reference voltage source to ANALOG IN (pin 32) and ANALOG GROUND (pin 31). Adjust the output of the voltage reference to –FS +1/2 LSB (–4.9951V). Adjust the offset trimming potentiometer so that the output code flickers equally between 0000 0000 00 and 0000 0000 01.
3. Adjust the output of the voltage reference to +FS – 1 1/2 LSB (+4.9854V). Adjust the GAIN trimming potentiometer so that the output code flickers equally between 1111 1111 10 and 1111 1111 11.

## ORDERING INFORMATION

ADC-EH10B ——

| CONVERSION TIME |
|---|
| 1 = 4.0 μsec. |
| 2 = 2.0 μsec. |

**PRICES (1-9)**

| | |
|---|---|
| ADC-EH10B1 | $149.00 |
| ADC-EH10B2 | $189.00 |

MATING SOCKETS:
DILS-2 (2/MODULE) $5.00/PAIR
TRIMMING POTENTIOMETERS:
TP20, TP200, TP20K $3.00 EACH

For extended temperature range operation, the following suffixes are added to the model number. Consult factory for pricing.

| | |
|---|---|
| –EX | –25°C to +85°C operation |
| –EXX–HS | –55°C to +85°C operation with hermetically sealed semiconductor components |

NOTE: ADC-EH10B1 replaces former Datel model ADC-EH10B and is an improved version of the model. The only differences from the previous model is the change in input impedance from 10K ohms to 2.3K ohms, and the reduction in 5V supply current from 280mA to 150mA.

THE ADC-EH10B CONVERTERS ARE COVERED BY GSA CONTRACT

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# 12 BIT, 4.0 AND 8.0μSEC. ANALOG TO DIGITAL CONVERTERS

# MODEL ADC-EH12B1, ADC-EH12B2

## FEATURES

- **4.0 μsec. Conversion – $209.**
- **8.0 μsec. Conversion – $169.**
- **12 Bit Resolution**
- **30PPM/°C Tempco**
- **Low Profile – 0.4" High**

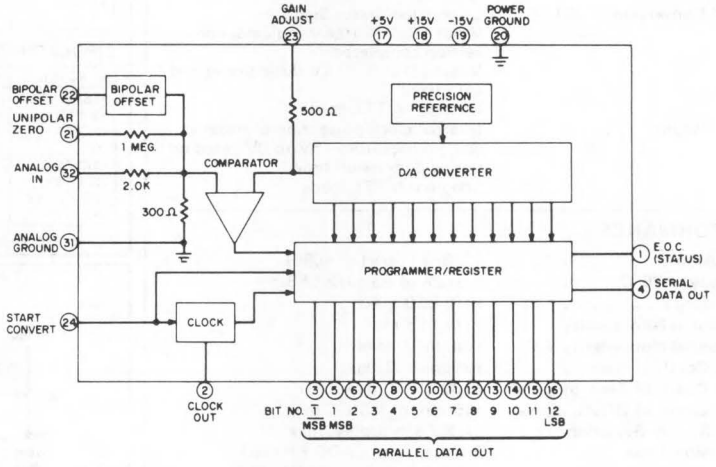
## GENERAL DESCRIPTION

Model ADC-EH12B is a 4 microsecond, 12 bit successive approximation type A/D converter in a low profile 4 x 2 x 0.4 inch module. This high performance converter is priced at about half that of other competing models; in addition, it consumes only 2.0 watts of power, much less than competing devices. It is ideal for application in PCM systems, data acquisition systems, and other instrumentation and control systems requiring very fast data conversion rates up to 250,000 per second. The ADC-EH12B is also available in an even lower cost 8.0 μsec. version.

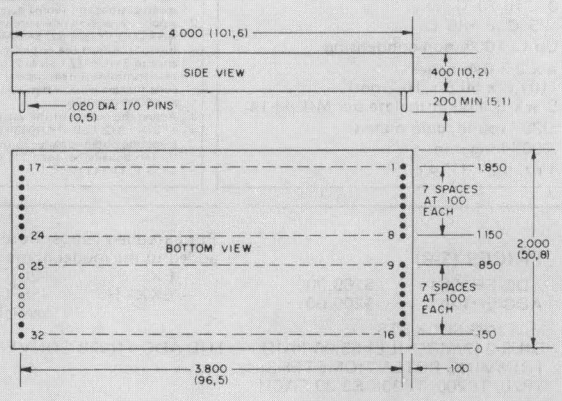
The ADC-EH12B design utilizes an MSI integrated circuit successive approximation programmer/register, 12 fast switching current sources, a low impedance R-2R resistor network, a precision voltage reference circuit, and a fast precision comparator to achieve its very fast conversion rate.

Operating features include unipolar (0 to +10V) or bipolar (±5V) operation by external pin connection. Full scale temperature coefficient is 30ppm/°C maximum and the converter is monotonic over its full operating temperature range of 0°C to 70°C. External offset and gain adjustments are provided for precise calibration of zero and full scale. Parallel output coding is straight binary for unipolar operation and offset binary or two's complement for bipolar operation. A serial output gives successive decision pulses in NRZ format with straight binary or offset binary coding. Other outputs include clock output for synchronization with serial data, $\overline{\text{MSB}}$ output for use in two's complement coding, and end of conversion (status) signal. All outputs are DTL/TTL compatible.

Power requirement is ±15VDC and +5VDC. Extended temperature range versions are also available.


## MECHANICAL DIMENSIONS INCHES (MM)




NOTES:
1. OPEN DOTS DESIGNATE OMITTED PINS
2. 0.100 INCH = 2.5mm

## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | E.O.C. (STATUS) |
| 2 | CLOCK OUT |
| 3 | BIT 1 OUT (MSB) |
| 4 | SERIAL DATA OUT |
| 5 | BIT 1 OUT (MSB) |
| 6 | BIT 2 OUT |
| 7 | BIT 3 OUT |
| 8 | BIT 4 OUT |
| 9 | BIT 5 OUT |
| 10 | BIT 6 OUT |
| 11 | BIT 7 OUT |
| 12 | BIT 8 OUT |
| 13 | BIT 9 OUT |
| 14 | BIT 10 OUT |
| 15 | BIT 11 OUT |
| 16 | BIT 12 OUT (LSB) |
| 17 | +5V POWER IN |
| 18 | +15V POWER IN |
| 19 | -15V POWER IN |
| 20 | POWER GROUND |
| 21 | UNIPOLAR ZERO |
| 22 | BIPOLAR OFFSET |
| 23 | GAIN ADJUST |
| 24 | START CONVERT IN |
| 31 | ANALOG GROUND |
| 32 | ANALOG IN |

## SPECIFICATIONS, ADC-EH12B
**(Typical at 25°C, ±15V & +5V Supplies, unless otherwise indicated)**

### INPUTS

| | |
|---|---|
| **Analog Input Range** | 0V to +10V FS or ±5V FS |
| **Input Impedance** | 2.3K ohms ±0.1% |
| **Input Overvoltage** | ±20V, no damage |
| **Start Conversion** | 2V min. to 5.5V max. positive pulse with duration of 100 nsec. min. Rise and fall times <500 nsec.<br>Logic "1" resets converter<br>Logic "0" initiates conversion<br>Loading: 1 TTL load |

### OUTPUTS

| | |
|---|---|
| **Parallel Output Data** | 12 parallel lines of data held until next conversion command.<br>V out ("0") ⩽ +0.4V<br>V out ("1") ⩾ +2.4V<br>Each output capable of driving up to 4 TTL loads. |
| **Coding, Unipolar operation** | Straight Binary, positive true |
| **Bipolar operation** | Offset Binary, positive true<br>Two's complement, positive true |
| **Serial Output Data** | NRZ successive decision pulse output generated during conversion with MSB first.<br>Straight binary or offset binary, positive true coding.<br>Loading: 4 TTL loads |
| **End of Conversion (EOC)** | Conversion Status Signal.<br>V out ("0") ⩽ +0.4V indicates conversion completed.<br>V out ("1") ⩾ +2.4V during reset and conversion.<br>Loading: 4 TTL loads |
| **Clock Output** | Internal clock pulse train of negative going pulses from +5V to 0V gated on during conversion time.<br>Loading: 6 TTL loads |

### PERFORMANCE

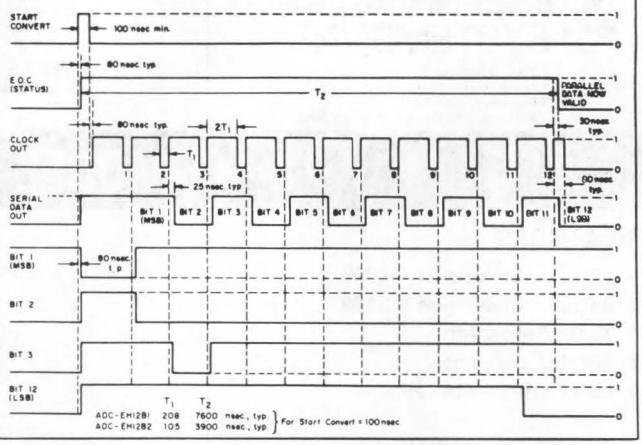
| | |
|---|---|
| **Resolution** | 12 Bits (1 part in 4096) |
| **Accuracy at 25°C** | ±.012% of FS ±1/2 LSB. |
| **Nonlinearity** | ±1/2 LSB max. |
| **Differential Nonlinearity** | ±1/2 LSB max. |
| **Differential Nonlinearity T.C.** | ±3ppm/°C max. |
| **Temp. Coeff. of Gain** | ±30ppm/°C max. |
| **Temp. Coeff. of Zero, unipolar** | ±100 μV/°C max. |
| **Temp. Coeff. of Offset, bipolar** | ±15ppm of F.S./°C max. |
| **Power Supply Rejection** | .01% FS/% supply, max. |
| **Conversion Time** | 8.0 μsec. max., ADC-EH12B1<br>4.0 μsec. max., ADC-EH12B2 |

### POWER REQUIREMENT
±15VDC ±0.5VDC @ 40mA max.
+5VDC ±0.25VDC @ 150mA max.

### PHYSICAL-ENVIRONMENTAL

| | |
|---|---|
| **Operating Temp. Range** | 0°C to 70°C |
| **Storage Temp. Range** | -25°C to +85°C |
| **Relative Humidity** | Up to 100% non-condensing |
| **Case Size** | 4 x 2 x 0.4 inches<br>(101,6 x 50,8 x 10,2mm) |
| **Case Material** | Black Diallyl Phthalate per MIL-M-14 |
| **Pins** | .020" round, gold plated,<br>.200" long min. |
| **Weight** | 4 oz. max. (114 g.) |

## TIMING DIAGRAM FOR ADC-EH12B Output: 101010101010




## OUTPUT CODING

UNIPOLAR (0V TO +10V)

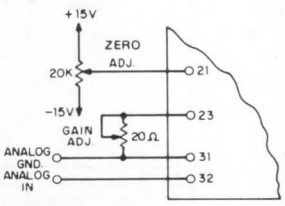
| SCALE | INPUT VOLTAGE | STRAIGHT BINARY |
|---|---|---|
| +FS - 1 LSB | +9.9976V | 1111 1111 1111 |
| +7/8 FS | +8.7500V | 1110 0000 0000 |
| +3/4 FS | +7.5000V | 1100 0000 0000 |
| +1/2 FS | +5.0000V | 1000 0000 0000 |
| +1/4 | +2.5000V | 0100 0000 0000 |
| +1 LSB | +0.0024V | 0000 0000 0001 |
| 0 | 0.0000V | 0000 0000 0000 |

BIPOLAR (–5V TO +5V)

| SCALE | INPUT VOLTAGE | OFFSET BINARY | TWO'S COMPLEMENT* |
|---|---|---|---|
| +FS - 1 LSB | +4.9976V | 1111 1111 1111 | 0111 1111 1111 |
| +3/4 FS | +3.7500V | 1110 0000 0000 | 0110 0000 0000 |
| +1/2 FS | +2.5000V | 1100 0000 0000 | 0100 0000 0000 |
| 0 | 0.0000V | 1000 0000 0000 | 0000 0000 0000 |
| -1/2 FS | -2.5000V | 0100 0000 0000 | 1100 0000 0000 |
| -3/4 FS | -3.7500V | 0010 0000 0000 | 1010 0000 0000 |
| -FS + 1 LSB | -4.9976V | 0000 0000 0001 | 1000 0000 0001 |
| -FS | -5.0000V | 0000 0000 0000 | 1000 0000 0000 |

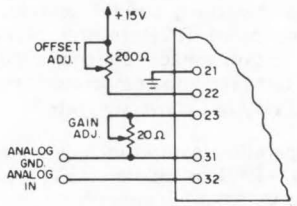
*Using MSB output for Bit 1

## GAIN & OFFSET ADJUSTMENTS




UNIPOLAR OPERATION

1. Apply START CONVERT pulses to pin 24 (see specifications and timing diagram).
2. Apply a precision reference voltage source to ANALOG IN (pin 32) and ANALOG GROUND (pin 31). Adjust the output of the voltage reference to Zero +1/2 LSB (+1.2mV). Adjust the zero trimming potentiometer so that the output code flickers equally between 0000 0000 0000 and 0000 0000 0001.
3. Adjust the output of the voltage reference to +FS – 1 1/2 LSB (+9.9963V). Adjust the GAIN trimming potentiometer so that the output code flickers equally between 1111 1111 1110 and 1111 1111 1111.




BIPOLAR OPERATION

1. Apply START CONVERT pulses to pin 24 (see specifications and timing diagram).
2. Apply a precision reference voltage source to ANALOG IN (pin 32) and ANALOG GROUND (pin 31). Adjust the output of the voltage reference to –FS +1/2 LSB (–4.9988V). Adjust the offset trimming potentiometer so that the output code flickers equally between 0000 0000 0000 and 0000 0000 0001.
3. Adjust the output of the voltage reference to +FS – 1 1/2 LSB (+4.9854V). Adjust the GAIN trimming potentiometer so that the output code flickers equally between 1111 1111 1110 and 1111 1111 1111.

## ORDERING INFORMATION

ADC-EH12B–

| CONVERSION TIME |
|---|
| 1= 8.0 μsec. |
| 2= 4.0 μsec. |

### PRICES (1-9)

| | |
|---|---|
| ADC-EH12B1 | $169.00 |
| ADC-EH12B2 | $209.00 |

MATING SOCKETS:
DILS-2 (2/MODULE) $5.00/PAIR
TRIMMING POTENTIOMETERS:
TP20, TP200, TP20K $3.00 EACH

For extended temperature range operation, the following suffixes are added to the model number. Consult factory for pricing.

| | |
|---|---|
| –EX | -25°C to +85°C operation |
| –EXX–HS | -55°C to +85°C operation with hermetically sealed semiconductor components |

THE ADC-EH12B CONVERTERS ARE COVERED BY GSA CONTRACT.

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# ULTRA FAST 12 BIT ANALOG TO DIGITAL CONVERTER

# MODEL ADC-EH12B3

## FEATURES

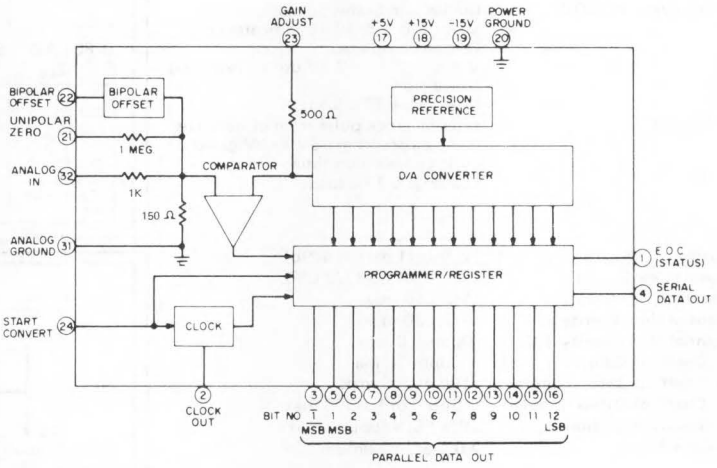
- ▸ 2.0 μsec. Conversion Time
- ▸ 12 Bit Resolution
- ▸ Low Power Consumption – 2.25W
- ▸ Low Profile Case – 0.4" High
- ▸ Economy Price – $249.00

## GENERAL DESCRIPTION

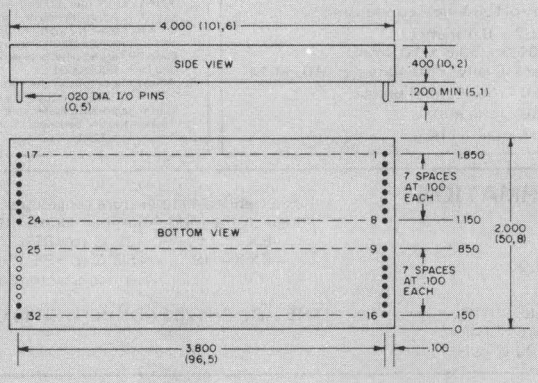
Model ADC-EH12B3 is a new, ultra fast, 12 bit successive approximation A/D converter with a 2.0 microsecond maximum conversion time. This converter utilizes 12 very fast switched current sources with a low impedance R-2R ladder network, a fast precision comparator, a precision zener reference source, and an MSI integrated circuit successive approximation register to achieve its state of the art performance. It is encapsulated in a low profile 2 x 4 x 0.4 inch module and consumes only 2.25 watts of power. The ADC-EH12B3 opens up a broad range of fast data conversion applications where conversion rates up to 500,000 per second are required.

Input voltage ranges are 0 to +10V unipolar or ±5V bipolar by external pin connection; input impedance is 1.15K ohms. The parallel output is in straight binary, offset binary, or two's complement coding. Serial output data is also brought out in the form of an NRZ format MSB first pulse train. Full scale temperature coefficient is ±30ppm/°C maximum and zero temperature coefficient is ±100 μV/°C maximum. Due to its low differential linearity temperature coefficient there are no missing codes over the 0°C to 70°C operating temperature range. Provision is made for precise alignment in a given application.

Other DTL/TTL compatible outputs include clock, $\overline{MSB}$ output (for two's complement coding), and end of conversion (status) output. Power supply requirement is ±15VDC and +5VDC.


## MECHANICAL DIMENSIONS INCHES (MM)




NOTES:
1. OPEN DOTS DESIGNATE OMITTED PINS
2. 0.100 INCH = 2.5mm

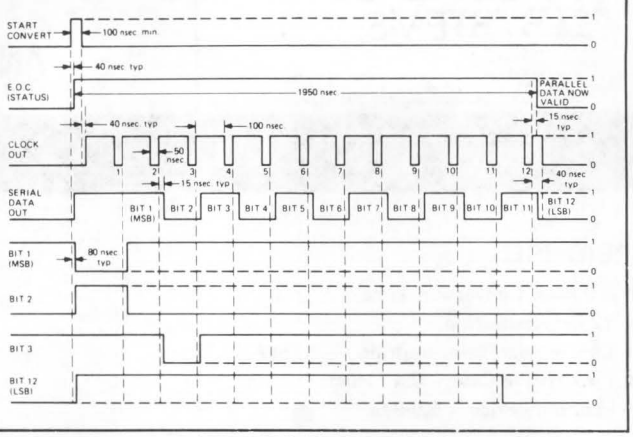
## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | E.O.C. (STATUS) |
| 2 | CLOCK OUT |
| 3 | BIT 1 OUT (MSB) |
| 4 | SERIAL DATA OUT |
| 5 | BIT 1 OUT (MSB) |
| 6 | BIT 2 OUT |
| 7 | BIT 3 OUT |
| 8 | BIT 4 OUT |
| 9 | BIT 5 OUT |
| 10 | BIT 6 OUT |
| 11 | BIT 7 OUT |
| 12 | BIT 8 OUT |
| 13 | BIT 9 OUT |
| 14 | BIT 10 OUT |
| 15 | BIT 11 OUT |
| 16 | BIT 12 OUT (LSB) |
| 17 | +5V POWER IN |
| 18 | +15V POWER IN |
| 19 | -15V POWER IN |
| 20 | POWER GROUND |
| 21 | UNIPOLAR ZERO |
| 22 | BIPOLAR OFFSET |
| 23 | GAIN ADJUST |
| 24 | START CONVERT IN |
| 31 | ANALOG GROUND |
| 32 | ANALOG IN |

## SPECIFICATIONS, ADC-EH12B3
**(Typical at 25°C, ±15V & +5V Supplies, unless otherwise indicated)**

| | |
|---|---|
| **Analog Input Range** | 0V to +10V FS or ±5V FS |
| **Input Impedance** | 1.15K ohms ±0.1% |
| **Input Overvoltage** | ±20V, no damage |
| **Start Conversion** | 2V min. to 5.5V max. positive pulse with duration of 100 nsec. min. Rise and fall times <500 nsec.<br>Logic "1" resets converter<br>Logic "0" initiates conversion<br>Loading: 1 TTL load |
| **Parallel Output Data** | 12 parallel lines of data held until next conversion command.<br>V out ("0") ≤ +0.4V<br>V out ("1") ≥ +2.4V<br>Each output capable of driving up to 4 TTL loads. |
| **Coding, Unipolar operation** | Straight Binary, positive true |
| **Bipolar operation** | Offset Binary, positive true<br>Two's complement, positive true |
| **Serial Output Data** | NRZ successive decision pulse output generated during conversion with MSB first.<br>Straight binary or offset binary, positive true coding.<br>Loading: 4 TTL loads |
| **End of Conversion (EOC)** | Conversion Status Signal.<br>V out ("0") ≤ +0.4V indicates conversion completed.<br>V out ("1") ≥ +2.4V during reset and conversion.<br>Loading: 4 TTL loads |
| **Clock Output** | Internal clock pulse train of negative going pulses from +5V to 0V gated on during conversion time.<br>Loading: 6 TTL loads |
| **Resolution** | 12 Bits (1 part in 4096) |
| **Accuracy at 25°C** | ±.012% of FS ±1/2 LSB. |
| **Nonlinearity** | ±1/2 LSB max. |
| **Differential Nonlinearity** | ±1/2 LSB max. |
| **Differential Nonlinearity T.C.** | ±3ppm/°C max. |
| **Temp. Coeff. of Gain** | ±30ppm/°C max. |
| **Temp. Coeff. of Zero, unipolar** | ±100 µV/°C max. |
| **Temp. Coeff. of Offset, bipolar** | ±15ppm of F.S./°C max. |
| **Power Supply Rejection** | .01% FS/% supply, max. |
| **Conversion Time** | 2.0 µsec. maximum |
| | +15VDC ±0.5V @ 80mA max.<br>−15VDC ±0.5V @ 20mA max.<br>+5VDC ±0.25V @ 150mA max. |
| **Operating Temp. Range** | 0°C to 70°C |
| **Storage Temp. Range** | -25°C to +85°C |
| **Relative Humidity** | Up to 100% non-condensing |
| **Case Size** | 4 x 2 x 0.4 inches<br>(101,6 x 50,8 x 10,2mm) |
| **Case Material** | Black Diallyl Phthalate per MIL-M-14 |
| **Pins** | .020" round, gold plated,<br>.200" long min. |
| **Weight** | 4 oz. max. (114 g.) |

## TIMING DIAGRAM FOR ADC-EH12B3 Output 101010101010




## OUTPUT CODING

UNIPOLAR (0V TO +10V)

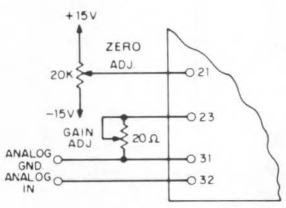
| SCALE | INPUT VOLTAGE | STRAIGHT BINARY |
|---|---|---|
| +FS - 1 LSB | +9.9976V | 1111 1111 1111 |
| +7/8 FS | +8.7500V | 1110 0000 0000 |
| +3/4 FS | +7.5000V | 1100 0000 0000 |
| +1/2 FS | +5.0000V | 1000 0000 0000 |
| +1/4 | +2.5000V | 0100 0000 0000 |
| +1 LSB | +0.0024V | 0000 0000 0001 |
| 0 | 0.0000V | 0000 0000 0000 |

BIPOLAR (−5V TO +5V)

| SCALE | INPUT VOLTAGE | OFFSET BINARY | TWO'S COMPLEMENT* |
|---|---|---|---|
| +FS - 1 LSB | +4.9976V | 1111 1111 1111 | 0111 1111 1111 |
| +3/4 FS | +3.7500V | 1110 0000 0000 | 0110 0000 0000 |
| +1/2 FS | +2.5000V | 1100 0000 0000 | 0100 0000 0000 |
| 0 | 0.0000V | 1000 0000 0000 | 0000 0000 0000 |
| -1/2 FS | -2.5000V | 0100 0000 0000 | 1100 0000 0000 |
| -3/4 FS | -3.7500V | 0010 0000 0000 | 1010 0000 0000 |
| -FS + 1 LSB | -4.9976V | 0000 0000 0001 | 1000 0000 0001 |
| -FS | -5.0000V | 0000 0000 0000 | 1000 0000 0000 |

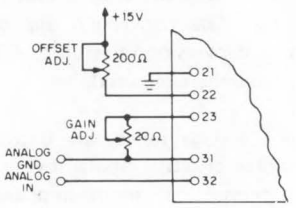
*Using MSB output for Bit 1

## GAIN & OFFSET ADJUSTMENTS




UNIPOLAR OPERATION

1. Apply START CONVERT pulses to pin 24 (see specifications and timing diagram).
2. Apply a precision reference voltage source to ANALOG IN (pin 32) and ANALOG GROUND (pin 31). Adjust the output of the voltage reference to Zero +1/2 LSB (+1.2mV). Adjust the zero trimming potentiometer so that the output code flickers equally between 0000 0000 0000 and 0000 0000 0001.
3. Adjust the output of the voltage reference to +FS − 1 1/2 LSB (+9.9963V). Adjust the GAIN trimming potentiometer so that the output code flickers equally between 1111 1111 1110 and 1111 1111 1111.




BIPOLAR OPERATION

1. Apply START CONVERT pulses to pin 24 (see specifications and timing diagram).
2. Apply a precision reference voltage source to ANALOG IN (pin 32) and ANALOG GROUND (pin 31). Adjust the output of the voltage reference to −FS +1/2 LSB (−4.9988V). Adjust the offset trimming potentiometer so that the output code flickers equally between 0000 0000 0000 and 0000 0000 0001.
3. Adjust the output of the voltage reference to +FS − 1 1/2 LSB (+4.9854V). Adjust the GAIN trimming potentiometer so that the output code flickers equally between 1111 1111 1110 and 1111 1111 1111.

## ORDERING INFORMATION

**PRICES (1-9)**

ADC-EH12B3 $249.00

MATING SOCKETS:
DILS-2 (2/MODULE) $5.00/PAIR
TRIMMING POTENTIOMETERS:
TP20, TP200, TP20K $3.00 EACH

For extended temperature range operation, the following suffixes are added to the model number. Consult factory for pricing.

| | |
|---|---|
| −EX | -25°C to +85°C operation |
| −EXX−HS | -55°C to +85°C operation with hermetically sealed semiconductor components |

THE ADC-EH12B3 CONVERTER IS COVERED UNDER GSA CONTRACT.

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# 1 µSEC TOTAL CONVERSION TIME

# ADC-G SERIES

## FEATURES

- 8 and 10 Binary Bit Versions
- 100 nsec/bit Conversion Time
- ±1/2 LSB Linearity
- Four Input Ranges To Choose From

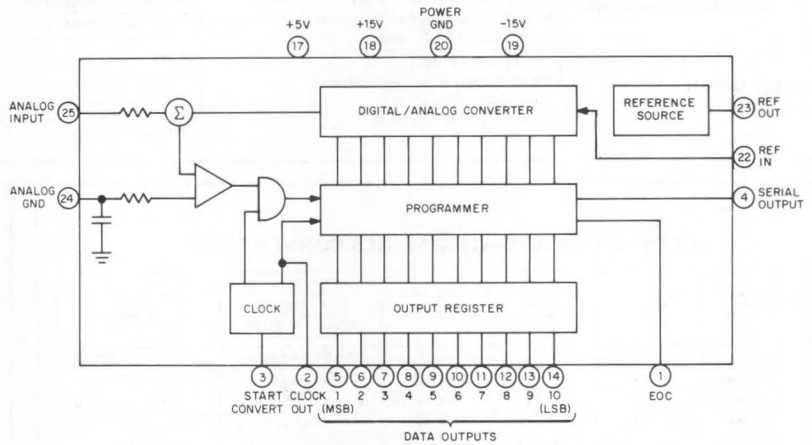

## GENERAL DESCRIPTION

The ADC-G Series are 8 or 10 binary bit, analog to digital converters offering another price breakthrough by Datel Systems. The ADC-G Series provide the user with a combination of high speed, moderate high resolution, and compact size, all for a cost well below competing units. All this is made possible by the use of a proprietary modified successive approximation conversion technique, unique packaging methods and volume production.

Both models use the inherently accurate successive approximation conversion method to compare an unknown analog input signal against the output of a precision digital-to-analog converter in a high gain feedback loop. This method guarantees a full monotonic conversion and excellent linearity over the full scale input range.

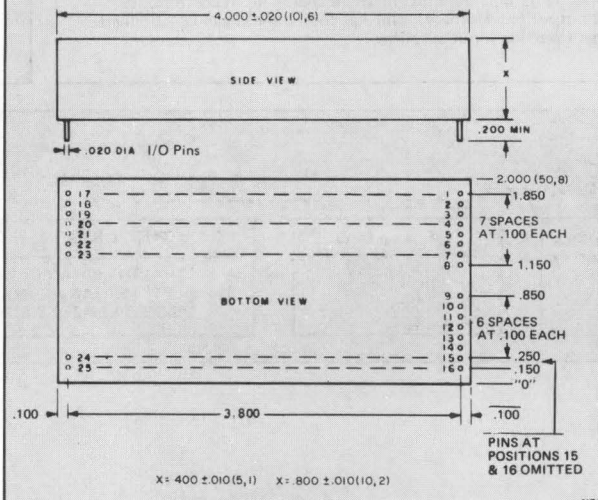
The ADC-G Series is completely self contained, consisting of an operational temperature compensated voltage reference source, successive approximation logic circuitry, output storage register/programmer, an ultra-high speed low noise voltage comparator and a precision digital-to-analog converter. All units provide adjustment free operation over a temperature range of 0°C to +70°C, requiring only D.C. power and a start convert command, which will interface with DTL or TTL logic levels.

Numerous other modules are available at little cost; these include a narrow aperture sample and hold, an eight channel multiplexer, ultra-miniature D.C. power supplies and system programmer. These modules are all compatible and can be easily integrated into a complete multi-channel data acquisition system.




**BLOCK DIAGRAM**

**MECHANICAL DIMENSIONS – INCHES (MM)**




**ADC-G8B ADC-G10B**

**INPUT/OUTPUT CONNECTIONS**

| PINS | FUNCTION |
|---|---|
| 1 | E.O.C. (STATUS) |
| 2 | INTERNAL CLOCK OUT |
| 3 | START CONVERT |
| 4 | SERIAL OUTPUT |
| 5 | BIT 1 OUT (MSB) |
| 6 | BIT 2 OUT |
| 7 | BIT 3 OUT |
| 8 | BIT 4 OUT |
| 9 | BIT 5 OUT |
| 10 | BIT 6 OUT |
| 11 | BIT 7 OUT |
| 12 | BIT 8 OUT |
| 13 | BIT 9 OUT |
| 14 | BIT 10 OUT |
| 15 | NO CONNECTION |
| 16 | NO CONNECTION |
| 17 | + 5V POWER INPUT |
| 18 | +15V POWER INPUT |
| 19 | −15V POWER INPUT |
| 20 | POWER GROUND |
| 21 | OFFSET |
| 22 | REFERENCE IN |
| 23 | REFERENCE OUT |
| 24 | ANALOG GROUND |
| 25 | ANALOG INPUT |

NOTE FOR 8 BIT UNITS PIN 12 IS LSB
FOR 10 BIT UNITS PIN 14 IS LSB

## SPECIFICATIONS (typical @ 25°C unless otherwise noted)

| | ADC–G SERIES |
|---|---|
| **INPUTS** | |
| INPUT VOLTAGE RANGE AND INPUT IMPEDANCE | 0V to −5V FS Range 1 500 Ω<br>0V to −10V FS Range 2 1K Ω<br>±5V FS Range 3 1K Ω<br>±10V FS Range 4 2K Ω |
| INPUT OVERVOLTAGE | ±15VDC |
| INPUT IMPEDANCE | 2K Ohms typical |
| SOURCE CURRENT | 5 ma Max. |
| START CONVERSION (Trigger Command) | 2V min. to 7V max. positive pulse<br>30 nanoseconds min. width<br>Loading, 3 TTL Loads 500 nSec<br>"1" Resets max. rise<br>"0" Starts Conversion time. |
| **DIGITAL OUTPUTS** | |
| PARALLEL OUTPUT DATA | 8 or 10 parallel lines of data, held until next conversion command<br>V out ("0") ≤ +0.4V<br>V out ("1") ≥ +2.4V<br>Each output capable of driving up to 6 TTL loads |
| OUTPUT DIGITAL CODING INVERTED OUTPUTS (2) | Straight Binary (Unipolar Input)<br>Offset Binary (Bipolar Input)<br>Two's Complement (Bipolar Input) |
| END OF CONVERSION OUTPUT | Conversion Status Signal<br>Conversion Complete – V out ("0") ≤ +0.4V<br>Reset & Conversion Period – V out ("1") ≥ +2.4V<br>Loading up to 5 TTL loads |
| CLOCK OUTPUT | Internal clock output<br>Negative going pulse from +5V max.<br>Pulse width 30 nsec<br>Loading up to 6 TTL loads |

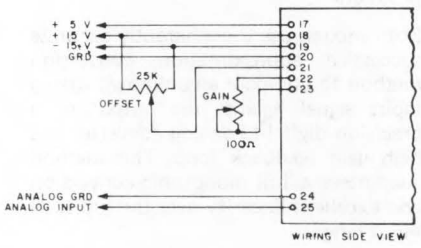
| | ADC–G SERIES |
|---|---|
| SERIAL OUTPUT | NRZ successive decision pulse output generated during conversion, with MSB first<br>V out ("0") ≤ +0.4V<br>V out ("1") ≤ +2.4V<br>Loading up to 5 TTL loads |
| **PERFORMANCE** | |
| RESOLUTION | One part in $2^n$ (max. resolution 10 bits)<br>n = number of binary bits |
| ACCURACY (@ 25°C) | Adj. to ±0.1% ±1/2 LSB – all models |
| LINEARITY | ±1/2 LSB |
| LONG TERM STABILITY | ±0.1%/6 month period |
| TEMPERATURE COEFFICIENT | ±50 ppm/°C |
| ENCODING TIME | 100 nsec/bit for all models |
| WORD RATE | 1.25 MHz – 8 binary bits<br>1.0 MHz – 10 binary bits |
| INPUT POWER REQUIREMENTS | + 5 VDC, ±0.25VDC @ 380 ma max.<br>+15 VDC, ±0.5 VDC @ 50 ma max.<br>−15 VDC, ±0.5 VDC @ 30 ma max. |
| **PHYSICAL ENVIRONMENTAL** | |
| OPERATING TEMPERATURE RANGE | 0° to +70°C |
| STORAGE TEMPERATURE RANGE | −55°C to +85°C |
| RELATIVE HUMIDITY | Up to 100% non-condensing |
| CASE MATERIAL (1) | Black Diallyl Phthalate, per MIL–M–14 |
| PINS | 0.020" round gold plated<br>0.250" long min. |
| SIZE | 2"W x 4"L x 0.4"H (8 bits)<br>2"W x 4"L x 0.8"H (10 bits) |
| WEIGHT | 8 oz. max.<br>Note (1): Converters are fully repairable |

### CODING FOR ADC–G10B SERIES CONVERTERS

| ANALOG INPUT RANGE 1 0 TO −5V, FS | ANALOG INPUT RANGE 2 0 TO −10V, FS | ANALOG INPUT RANGE 3 ±5V, FS | ANALOG INPUT RANGE 4 ±10V, FS | DIGITAL OUTPUTS NOTE (2) OFFSET BINARY FOR RANGES 3 AND 4 STRAIGHT BINARY FOR RANGES 1 AND 2 | DIGITAL OUTPUTS NOTE (2) 2'S COMPLEMENT FOR RANGES 3 AND 4 |
|---|---|---|---|---|---|
| 0V | 0V | +5V | +10V | 0000000000000 | 1000000000000 |
| −0.625V | −1.25V | +3.75V | +7.5V | 0010000000000 | 1010000000000 |
| −1.25V | −2.5V | +2.5V | +5.0V | 0100000000000 | 1100000000000 |
| −1.875V | −3.75V | +1.25V | +2.5V | 0110000000000 | 1110000000000 |
| −2.5V+1 LSB | −5V+1 LSB | 0V+1 LSB | 0V+1 LSB | 0111111111111 | 1111111111111 |
| −2.5V | −5V | 0V | 0V | 1000000000000 | 0000000000000 |
| −2.5V−1 LSB | −5V−1 LSB | 0V−1 LSB | 0V−1 LSB | 1000000000001 | 0000000000001 |
| −3.125V | −6.25V | −1.25V | −2.5V | 1010000000000 | 0010000000000 |
| −3.75V | −7.5V | −2.5V | −5.0V | 1100000000000 | 0100000000000 |
| −4.375V | −8.75V | −3.75V | −7.5V | 1110000000000 | 0110000000000 |
| −5V+1 LSB | −10V+1 LSB | −5V+1 LSB | −10V+1 LSB | 1111111111111 | 0111111111111 |

**Note 2:** *Reverse coding sense:* Note that the most negative analog input corresponds to full scale digital output (11-1 binary). Normal coding sense can be obtained by using an external inverting input amplifier.

### GAIN & OFFSET EXTERNAL ADJUSTMENT CONNECTIONS FOR ADC-G SERIES




ALL TRIM POTS ARE ≤ 100 PPM/°C

Connections shown here must be made to insure proper operation of converter.

**Adjustment Ranges:**

Offset: ± 0.5% of FS
Gain: ± 2% of FS

### ORDERING INFORMATION

**ADC–G** ___ ___ ___

| Number of Bits and Coding | FS Analog Input | OUTPUT FORMAT |
|---|---|---|
| 8B = 8 binary bits<br>10B = 10 binary bits | 1 = 0V to −5V<br>2 = 0V to −10V<br>3 = ±5V<br>4 = ±10V | A = STRAIGHT BINARY (UNIPOLAR)<br>B = OFFSET BINARY (BIPOLAR)<br>C = 2'S COMPLEMENT (BIPOLAR) |

**PRICE (SINGLE QUANTITY)**
ADC–G8B . . . . $239.00
ADC–G10B . . . $279.00

**MATING SOCKET**
DILS–2 . . . . . $5.00/pr.
2 req'd per module

**TRIMPOTS** . . . . . $3.00 each
TP100 (100Ω)
TP25K (25 KΩ)

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# 8 BINARY BITS-10 MILLION CONV'S/SEC ANALOG TO DIGITAL CONVERTER

# ADC-UH SERIES

## FEATURES

- Smallest Size . . . 3"W x 5"L x 1.150"H
- Fast Encoding Time . . . . . to 40nsec
- Excellent Temperature
- Coefficient . . . . . ±0.005%/°C

## GENERAL DESCRIPTION

The ADC-UH series are state-of-the-art ultra high speed analog to digital converters consisting of three models; six and eight binary bits operating at word repetition rates of up to 10 MHz and a four bit version capable of making a conversion every forty nanoseconds.

In addition to the cost and performance advantages of all three models, close attention to circuit detail has resulted in a highly reliable converter with relatively low power consumption.

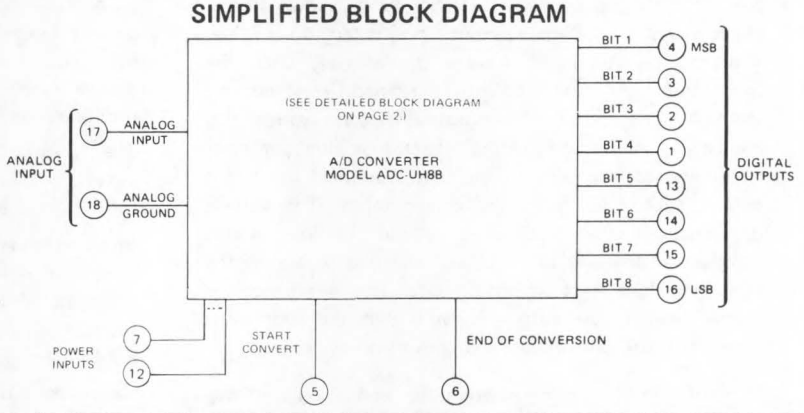
The entire converter is packaged in a black anodized aluminum module to provide electrostatic shielding. Overall physical size is 3"Wx5"Lx1.150"H, or one fifth the size of the nearest rival. Power drain has been reduced to eight watts, which is a fraction of competing units and a good measure of the ADC-UH series reliability.

Other features relating to the integrity of the circuit design, are its low temperature coefficient of 50ppm/°C and long term stability of ±.25%/year.

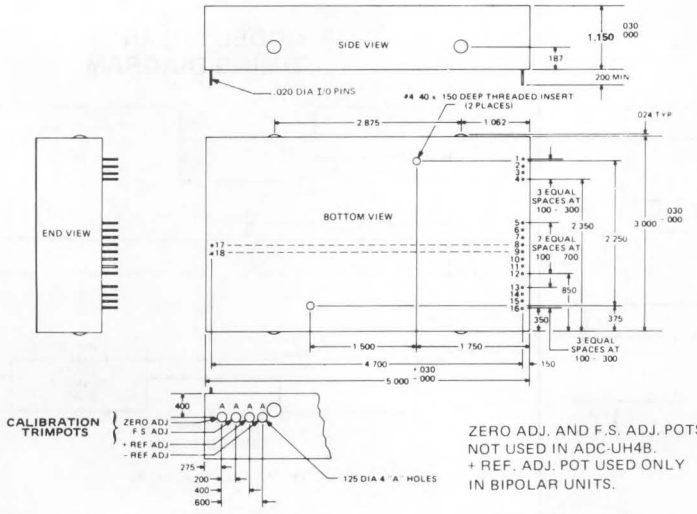
Input power requirements are ±15VDC and ±5VDC.

Output digital coding is straight binary for a unipolar input and inverted offset binary for the optional bipolar input.


## SIMPLIFIED BLOCK DIAGRAM




## MECHANICAL DIMENSIONS (INCHES)




ZERO ADJ. AND F.S. ADJ. POTS NOT USED IN ADC-UH4B.
+ REF. ADJ. POT USED ONLY IN BIPOLAR UNITS.

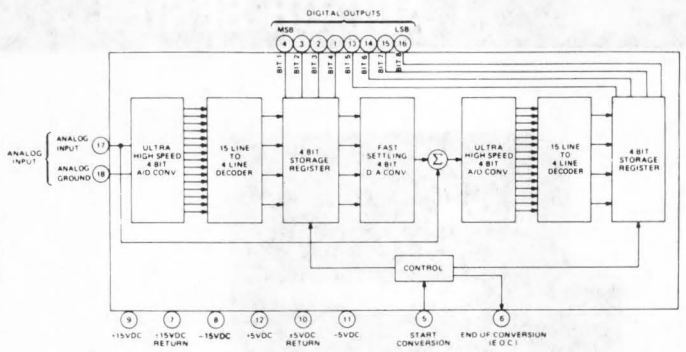
## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | BIT 4 (LSB) MODEL ADC-UH4B |
| 2 | BIT 3 |
| 3 | BIT 2 |
| 4 | BIT 1 (MSB) |
| 5 | START CONVERT |
| 6 | E.O.C. (STATUS) |
| 7 | ±15V RETURN (1) |
| 8 | −15VDC |
| 9 | +15VDC |
| 10 | ±5V RETURN (1) |
| 11 | −5VDC |
| 12 | +5VDC |
| 13 | BIT 5 |
| 14 | BIT 6 (LSB) MODEL ADC-UH6B |
| 15 | BIT 7 |
| 16 | BIT 8 (LSB) MODEL ADC-UH8B |
| 17 | ANALOG INPUT |
| 18 | ANALOG GROUND (1) |

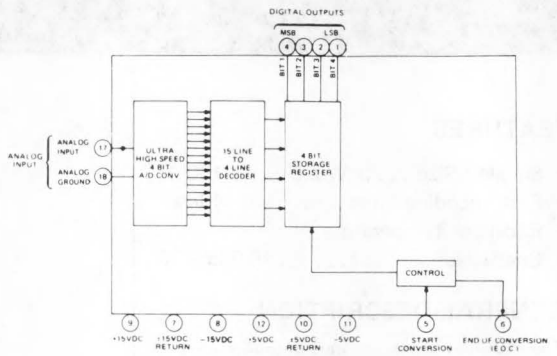
NOTES
1. PINS #7, 10 AND 18 INTERNALLY CONNECTED
2. CASE ALUMINUM, BLACK ANODIZED

DATEL

## MODEL ADC-UH8B BLOCK DIAGRAM




## MODEL ADC – UH4B BLOCK DIAGRAM




### TECHNICAL DESCRIPTION

The model ADC-UH8B analog to digital converter employs a two step conversion technique as shown in the block diagram. The analog input signal is fed to a 15 line, 4 bit comparator array (4 bit A/D converter) where the four most significant bits are determined. This four bit word is then stored in an output register which also controls a 4 bit subtracting digital-to-analog converter where the analog value of the first four most significant bits is subtracted from the analog input. The voltage difference is then fed to a second 15 line, 4 bit comparator array (4 bit A/D converter) to determine the remaining four least significant bits. This 4 bit word is then stored in an output register with the four most significant bits to complete the conversion cycle.

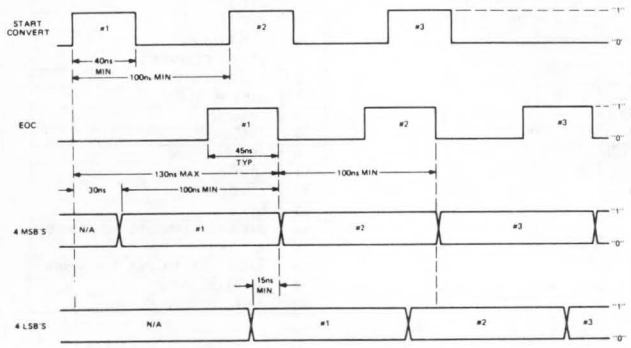
As shown in the timing diagram the leading edge of the start convert pulse initiates a conversion cycle by activating the first stage A/D converter. One hundred and thirty nanoseconds later the End of Conversion pulse will go negative indicating the conversion is complete and the data is ready at the output. Although the throughput delay is 130 nanoseconds a new start convert input pulse can be issued at a minimum interval of 100 nanoseconds resulting in a maximum word rate of 10 MHz.

The 10 MHz word rate is made possible by the two stage conversion technique which allows a new conversion cycle to be started before the prior cycle is completed.

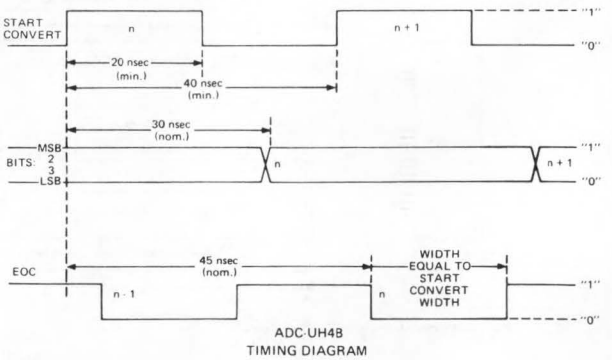
In transferring an output word, it should be noted that a minimum of 15 nanoseconds is allowed for transfer set-up while no time is allowed for holding the word after transfer. Transfer can be implemented by using a zero hold time register such as a SN 74H106.

The model ADC-UH4B block diagram shows that the 4-bit converter employs a single step conversion method and does not use the analog difference summing junction.

## MODEL ADC-UH8B TIMING DIAGRAM




## MODEL ADC-UH4B TIMING DIAGRAM




ADC-UH4B TIMING DIAGRAM

NOTE: NO SAMPLE & HOLD MODULE IS NEEDED FOR ADC-UH4B

## SPECIFICATIONS (typical @ 25°C, 5 minute warm-up, unless otherwise noted)

| MODEL | ADC-UH4B | ADC-UH6B | ADC-UH8B |
|---|---|---|---|
| **INPUTS:** | | | |
| Analog Input Range | 0V to −2.560V FS (1) | | |
| Input Overvoltage | ±5VDC | | |
| Input Impedance | 100 Ohms | | |
| Source Current | 25.6 mA | | |
| Start Conversion (Trigger Command) | 2V min. to 5V max. positive pulse, 40nsec min. width positive excursion initiates a conversion<br>LOADING: 1 TTL LOAD<br>MAXIMUM REPETITION RATE −10MHz (2) | | |
| **DIGITAL OUTPUTS:** | | | |
| Parallel Output Data (See coding chart) | 4 parallel lines<br>(4 Binary Bits)<br>V out ("0") ≤ +0.4V<br>V out ("1") ≥ +2.4V<br>LOADING: 4 TTL LOADS | 6 parallel lines<br>(6 Binary Bits)<br>V out ("0") ≤ +0.4V<br>V out ("1") ≥ +2.4V<br>LOADING: 4 TTL LOADS | 8 parallel lines<br>(8 Binary Bits)<br>V out ("0") ≤ +0.4V<br>V out ("1") ≥ +2.4V<br>LOADING: 4 TTL LOADS |
| End of Conversion | Positive Pulse,<br>Trailing edge (negative transition) indicates conversion complete<br>LOADING: 12 TTL LOADS | | |
| **PERFORMANCE:** | | | |
| Accuracy @ 25°C | ±3% of FS | ±0.8% of FS | ±0.4% of FS |
| Long Term Stability | ±0.25%/year | | |
| Resolution | 1LSB (160 mV) | 1LSB (40 mV) | 1LSB (10 mV) |
| Linearity | ±1/2LSB | ±1/2LSB | ±1LSB |
| Temperature Coefficient | ±50ppm/°C | | |
| Encoding Time | 40 nsec | 100 nsec (2) | 100 nsec (2) |
| Word Repetition Rate (MAX.) | 25 MHz | 10 MHz (2) | 10 MHz (2) |
| Input Power Requirements (See Datel Systems Ultraminiature DC Power Supplies - Bulletin PSC-3-73-1) | +15VDC, ±0.2VDC @ 80 mA<br>−15VDC, ±0.2VDC @ 9 mA<br>+5VDC, ±0.1VDC @ 650 mA<br>−5VDC, ±0.1VDC @ 150 mA | +15VDC, ±0.2VDC @ 80 mA<br>−15VDC, ±0.2VDC @ 9 mA<br>+5VDC, ±0.1VDC @ 780 mA<br>−5VDC, ±0.1VDC @ 170 mA | +15VDC, ±0.2VDC @ 80 mA<br>−15VDC, ±0.2VDC @ 9 mA<br>+5VDC, ±0.1VDC @ 1300 mA<br>−5VDC, ±0.1VDC @ 250 mA |
| **PHYSICAL-ENVIRONMENTAL:** | | | |
| Operating Temperature Range | 0°C to +70°C | | |
| Storage Temperature Range | −55°C to +85°C | | |
| Relative Humidity | Up to 100% NON-CONDENSING | | |
| Case Pins | 0.020" round gold plated<br>0.250" long minimum | PC Board is covered with an aluminum electrostatic shield and encapsulated. All converters are fully repairable. | |
| Size | 3"Wx5"Lx1.150"H | | |
| Weight | 15 oz. | | |

NOTES: (1) A Bipolar input (±1.280V) is also available. Output data coding will be "reverse coding sense" (See below). When ordering a Bipolar input add the number 2 to the model number.

(2) Models ADC-UH6B and ADC-UH8B have a throughput delay of 130 nsec. because of the two stage conversion technique employed. Although the throughput delay is 130 nsec both models can start a new conversion every 100 nsec, for a word rate of 10 MHz. See timing diagram for more details.

### OUTPUT DATA CODING

| ADC-UH8B2 Offset Binary (1) (8-Bit Shown. 4 & 6-Bit available) | |
|---|---|
| Analog Input | Digital Output |
| −1.270V | 11111111 |
| −0.640V | 11000000 |
| 0.000V | 10000000 |
| +1.270V | 00000001 |
| +1.280V | 00000000 |

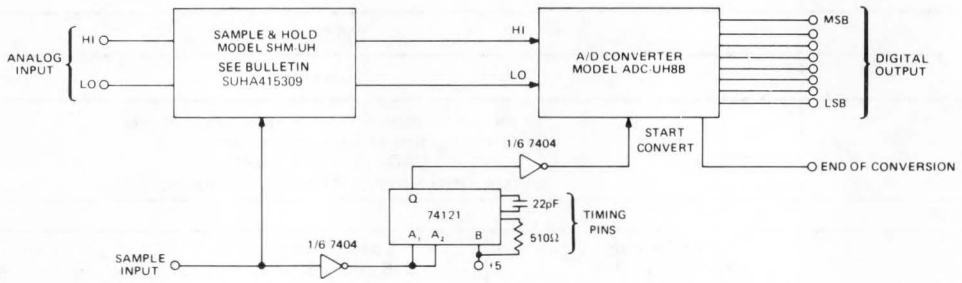
**Reverse coding sense:** Note that the most negative analog input corresponds to full scale output (11 ... 1, binary)

| ADC-UH4B Straight Binary | | ADC-UH6B Straight Binary | | ADC-UH8B Straight Binary | |
|---|---|---|---|---|---|
| Analog Input | Digital Output | Analog Input | Digital Output | Analog Input | Digital Output |
| −2.400V | 1111 | −2.520V | 111111 | −2.550V | 11111111 |
| −1.920V | 1100 | −1.920V | 110000 | −1.920V | 11000000 |
| −1.280V | 1000 | −1.280V | 100000 | −1.280V | 10000000 |
| −0.160V | 0001 | −0.040V | 000001 | −0.010V | 00000001 |
| 0.000V | 0000 | 0.000V | 000000 | 0.000V | 00000000 |

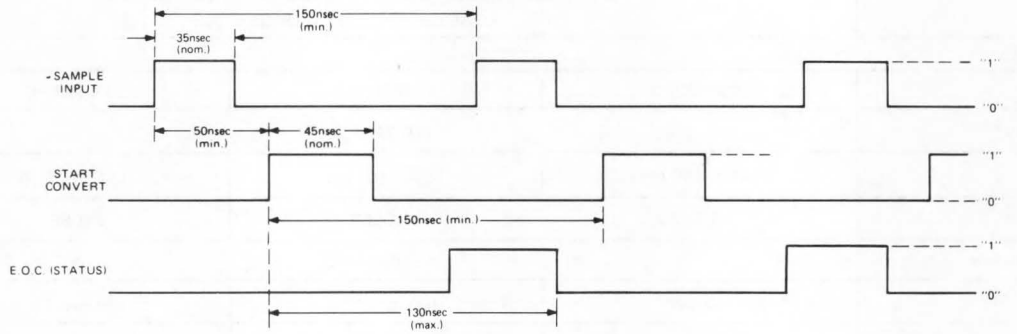
DATEL

# TYPICAL 8-BIT SYSTEM CONFIGURATION FOR OBTAINING A TOTAL SYSTEM APERTURE TIME OF 200psec. FOR MODEL ADC-UH8B ONLY

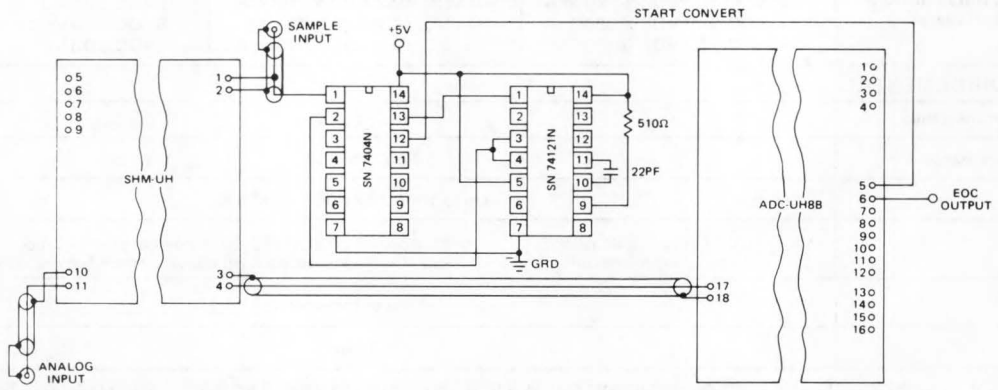
## BLOCK DIAGRAM




## 6 OR 8-BIT SYSTEM TIMING DIAGRAM




## ADC-UH8B AND SHM-UH INTERCONNECTIONS




**ORDERING INFORMATION**

ADC-UH

Add suffix number 2 for bipolar input

| NUMBER OF BITS AND CODING |
|---|
| 4B = 4 BINARY BITS |
| 6B = 6 BINARY BITS |
| 8B = 8 BINARY BITS |

**PRICES (SINGLE QUANTITY)**

| | |
|---|---|
| ADC-UH4B | $795. |
| ADC-UH6B | $845. |
| ADC-UH8B | $895. |
| SAMPLE & HOLD MODEL SHM-UH | $ 229 |

For -2 Version (Bipolar) Add $50. to Price

DATEL SYSTEMS, INC.

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

1020 TURNPIKE STREET, CANTON, MASS. 02021 TEL. (617) 828-8000 TWX: 710-348-0135 TELEX: 924461



Bulletin AUHCT15312

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# GENERAL PURPOSE, ANALOG-TO-DIGITAL CONVERTERS

# ADC-MA SERIES

## FEATURES

- ▶ 10 & 12 Bit Resolution
- ▶ Selectable Input Ranges
- ▶ 20 & 40 μsec. Conversion Times
- ▶ Unipolar or Bipolar Operation
- ▶ Input Buffer Option
- ▶ Parallel & Serial Outputs
- ▶ ADC-MA12B1A & ADC-MA12B2A Are Equivalents to ADC-12QZ

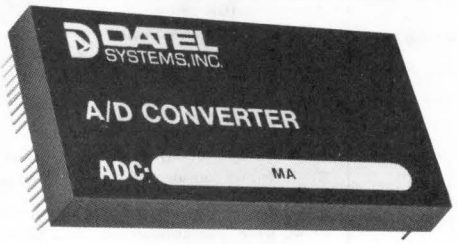
## GENERAL DESCRIPTION

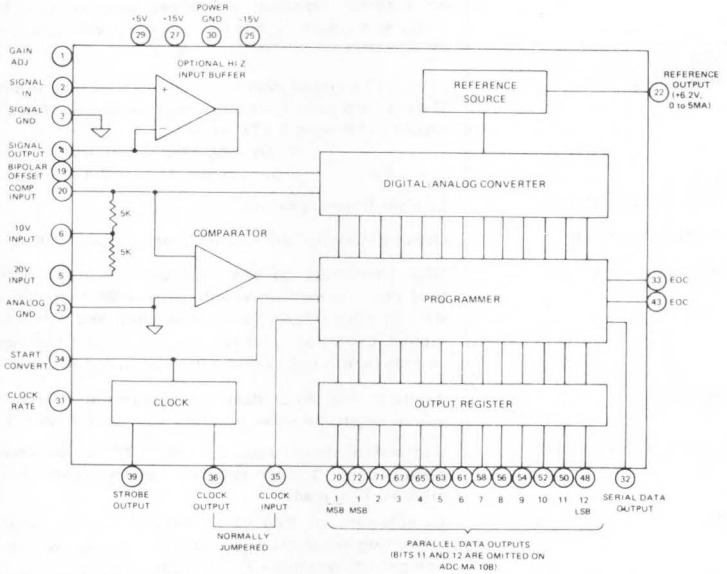
The ADC-MA series A/D converters consist of 10 and 12 bit resolution models with 20 or 40 microsecond conversion times. These units feature high performance and versatility at a low price.

The exceptional versatility of the ADC-MA series is seen in the following features. Single-ended input voltage ranges of 0 to +5V, 0 to +10V, ±5V, and ±10V are pin selectable by the user. In addition, an internal high input impedance buffer amplifier is available as an option. This amplifier gives an input impedance of 1000 megohms on all voltage ranges. Without the amplifier the input impedances are 2.5K, 5K, and 10K ohms on 5V, 10V, and 20V full scale ranges respectively. Digital output data is available in either parallel form or serial NRZ format with synchronizing strobe pulses. Serial data is straight binary for unipolar operation and offset binary for bipolar operation. Parallel data is straight binary for unipolar operation and offset binary or two's complement for bipolar operation. The ADC-MA units can operate either internally or externally clocked. In addition, the internal clock rate can be decreased by use of an external capacitor.

The ADC-MA series uses the successive approximation technique to achieve excellent linearity, speed, and stability. Temperature coefficient is held to ±30ppm/°C for gain and ±5ppm/°C for offset in unipolar operation. Tight temperature tracking of the weighted current sources results in monotonic operation with no missing codes over the 0°C to 70°C temperature operating range.

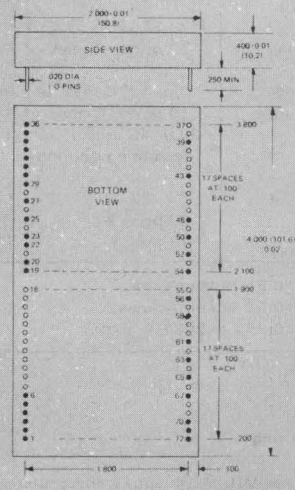
These converters are encapsulated in a 4 X 2 X 0.4 inch module with DIP compatible .100" pin spacing. Input power requirements are ±15VDC and +5VDC and are available from Datel's line of modular power supplies. All digital inputs and outputs are DTL/TTL compatible.




NOTE: Pins 3 & 23 are connected internally. Pin 30 must be externally connected to either pin 3 or 23.

## MECHANICAL DIMENSIONS INCHES (MM)




NOTE: Open dots designate omitted pins. Pins 48 and 50 are omitted on 10 bit versions and pin 52 is the LSB. Pin position tolerance is ±0.005" from datum, non-accumulative.

## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | Gain Adjust | 35 | Clock Input |
| 2 | Signal Input | 36 | Clock Output |
| 3 | Signal Gnd. | 39 | Strobe Output |
| 4 | Signal Output | 43 | E.O.C. (Status) |
| 5 | 20 V. Input | 48 | Bit 12 Out (LSB) |
| 6 | 10 V. Input | 50 | Bit 11 Out |
| 19 | Bipolar Offset | 52 | Bit 10 Out |
| 20 | Comparator In. | 54 | Bit 9 Out |
| 22 | Reference Out | 56 | Bit 8 Out |
| 23 | Analog Gnd | 58 | Bit 7 Out |
| 25 | -15V Pwr In | 61 | Bit 6 Out |
| 27 | +15V Pwr In | 63 | Bit 5 Out |
| 29 | +5V Pwr In | 65 | Bit 4 Out |
| 30 | Power Gnd | 67 | Bit 3 Out |
| 31 | Clock Rate | 70 | Bit 1 Out (MSB) |
| 32 | Serial Output | 71 | Bit 2 Out |
| 33 | E.O.C. (Status) | 72 | Bit 1 Out (MSB) |
| 34 | Start Convert | | |

## SPECIFICATIONS (typical @ 25°C unless otherwise noted)

| | ADC-MA10B | ADC-MA12B |
|---|---|---|
| **INPUTS** | | |
| Analog Input Range | 0 to +5V FS, 0 to +10V FS, ±5V FS, ±10V FS | |
| Input Overvoltage | ±15V without damage to unit | |
| Input Impedance | | |
| 0 to +5V FS Range | 2.5K ohms | 2.5K ohms |
| ±5V and 0 to +10V FS Range | 5K ohms | 5K ohms |
| ±10V FS Range | 10K ohms | 10K ohms |
| With Optional Input Buffer | 1000 Megohms | 1000 Megohms |
| Start of Conversion | +2V min. to +5.5V max. positive pulse, DC coupled, with duration of 100 nsec. min. Rise and fall times 500 nsec. max. Three TTL loads. Logic "1" resets converter. Transition to logic "0" initiates conversion. | |
| Clock Input | Must be connected to Clock Output to use internal clock. Clock Input can also be used with an external clock. | |
| Clock Rate | Rate is internally set to give maximum conversion rate of 20 or 40 μsec. per conversion. This time may be increased with an external capacitor connected between pin 31 (Clock Rate) and pin 36 (Clock Out). See conversion time formulas. | |
| **OUTPUTS** | | |
| Parallel Output Data | 10 Lines of data | 12 Lines of data |
| | Data is held until next conversion command. Each output is capable of driving 5 TTL loads. | |
| | V out (Logic "0") ≤ +0.4V | |
| | V out (Logic "1") ≥ +2.4V | |
| Coding | | |
| Unipolar Operation | Straight Binary, positive true. | |
| Bipolar Operation | Offset Binary or Two's Complement, positive true. | |
| Serial Output Data | NRZ (nonreturn to zero) successive decision pulse output generated during conversion with MSB first. Serial data is straight binary for unipolar operation and offset binary for bipolar operation. Output will drive 10 TTL loads. Two's complement is not available with serial output. | |
| Strobe Output | Available for serial data synchronization. Serial output is usable on strobe pulse leading edges. Will drive 9 TTL loads. | |
| EOC (End of Conversion) | Conversion status output. Logic "0" for conversion complete, Logic "1" during reset and conversion period. Will drive 10 TTL loads. | |
| $\overline{EOC}$ | Complement of End of Conversion output. Logic "1" for conversion complete and Logic "0" during reset and conversion period. Will drive 7 TTL loads. | |
| Clock Output | Internal clock pulse train output gated on during conversion time. | |
| Signal Output | Output of optional internal buffer amplifier. | |
| **PERFORMANCE** | | |
| Resolution | 10 Bits (one part in 1024) | 12 Bits (one part in 4096) |
| Accuracy | ±.05% FS ±½LSB | ±.012%FS ±½LSB |
| Linearity | ±½LSB | ±½LSB |
| Temp. Coefficient of Gain | ±30 ppm/°C max. of Reading | ±30 ppm/°C max. of Reading |
| Temp. Coefficient of Zero | | |
| Unipolar | ±5 ppm/°C max. of Range | ±5 ppm/°C max. of Range |
| Bipolar | ±10 ppm/°C max. of Range | ±10 ppm/°C max. of Range |
| Conversion Time, max. | 20 or 40 μsec. (depending on model) | 20 or 40 μsec. (depending on model) |
| Power Supply Sensitivity (tracking ±15V supplies) | | |
| Gain | ±20 ppm/% | ±20 ppm/% |
| Zero | ±10 ppm/% | ±10 ppm/% |
| **POWER REQUIREMENT** (with input buffer amplifier) | +15VDC ±0.5V @ 40mA, max.<br>−15VDC ±0.5V @ 45mA, max.<br>+ 5VDC ±0.25V @ 200mA, max. | |
| **PHYSICAL-ENVIRONMENTAL** | | |
| Operating Temperature Range | 0°C to 70°C | |
| Storage Temperature Range | −55°C to +85°C | |
| Relative Humidity | Up to 100% non-condensing | |
| Case Size | 4" x 2" x 0.4" | |
| Case Material | Black Diallyl Phthalate per MIL-M-14, epoxy encapsulated. | |
| Pins | .020" round, gold plated, .250" long min. | |
| Weight | 8 oz. (227 grams) | |
| Mating Sockets (optional) | DILS-2, 4 required. | |

### TECHNICAL NOTES

The ADC-MA series contains an internal clock which is set to the maximum conversion rate. This rate may be decreased by connecting an external capacitor between pins 31 and 36. The approximate capacitor value to achieve the desired conversion time is shown in the table at the bottom of the next page. The longer conversion time obtained in this manner does not improve accuracy but it does permit compatibility or synchronization with interfacing equipment for many applications. To use the internal clock a jumper must be connected between pins 35 and 36. For external clocking, which may be desirable in some applications, the jumper is removed and the external clock applied to pin 35. Use a symmetrical 0 to +5V square wave with a minimum 3.0 μsec. period for the 40 μsec. converters and a minimum 1.6 μsec. period for the 20 μsec. converters. The Start Convert pulse should have a minimum 100 nsec. width and should not be made too long since clocking begins on the falling edge of this pulse and, therefore, its width is part of the total conversion time.

Analog inputs are connected to pin 6 for 10V ranges and pin 5 for the 20V range when the input buffer amplifier is not used. The input impedances in these cases are 5K ohms and 10K ohms respectively. For the 0 to 5V range, pin 5 is connected to pin 20, thus paralleling the two internal 5K resistors to give a 2.5K ohm input impedance at pin 6.

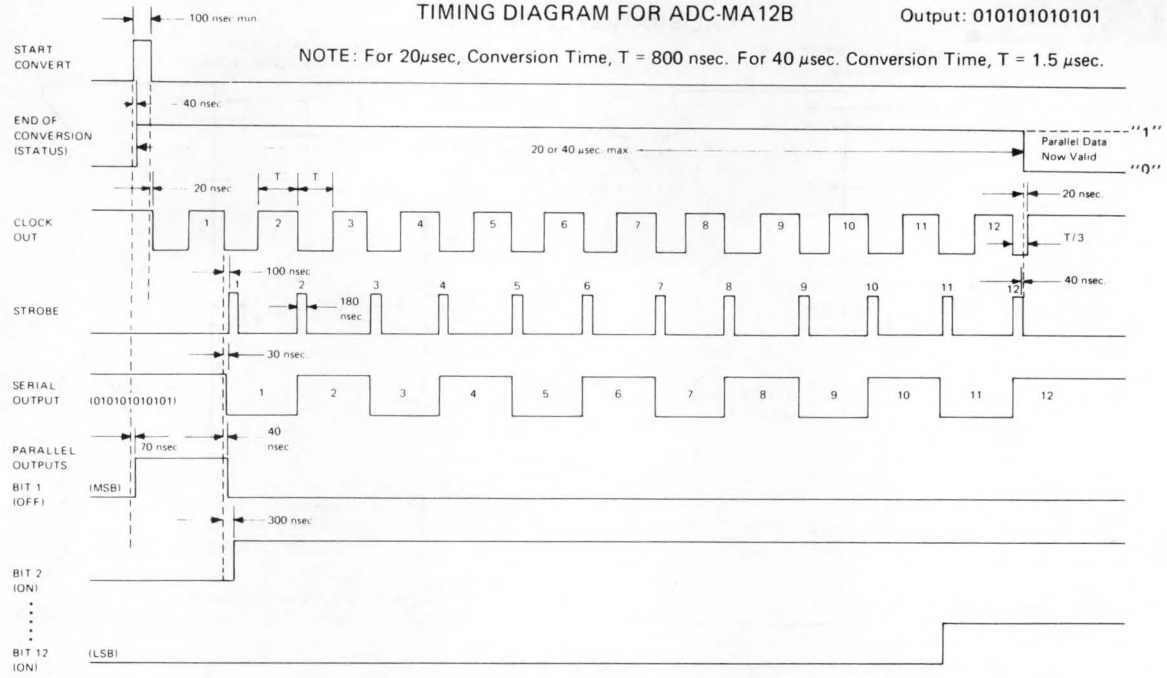
The end of conversion or status pulse is available at pin 33 and its complement $\overline{EOC}$ is available at pin 43. Normally the EOC output is used to control the mode of the input sample and hold. Serial output data is available at pin 32 in straight binary code for unipolar operation or offset binary for bipolar operation. Nonreturn to zero (NRZ) format is used and the data is valid at the leading edge of the strobe pulse. Parallel data output is straight binary for unipolar operation and offset binary or two's complement for bipolar operation. Two's complement is obtained by using the complemented MSB output at pin 70.

DATEL

## TIMING DIAGRAM FOR ADC-MA12B

Output: 010101010101

NOTE: For 20μsec, Conversion Time, T = 800 nsec. For 40 μsec. Conversion Time, T = 1.5 μsec.




## OUTPUT DIGITAL CODING, ADC-MA SERIES

### ADC-MA12B (12 BITS)

| UNIPOLAR INPUT RANGE | | STRAIGHT BINARY | BIPOLAR INPUT RANGE | | OFFSET BINARY | TWO'S COMPLEMENT |
|---|---|---|---|---|---|---|
| 0 TO +10V FS | 0 TO +5V FS | MSB LSB | ±10V FS | ±5V FS | MSB LSB | $\overline{\text{MSB}}$ LSB |
| +9.9976 | +4.9988 | 111111111111 | +9.9951 | +4.9976 | 111111111111 | 011111111111 |
| +8.7500 | +4.3750 | 111000000000 | +7.5000 | +3.7500 | 111000000000 | 011000000000 |
| +7.5000 | +3.7500 | 110000000000 | +5.0000 | +2.5000 | 110000000000 | 010000000000 |
| +5.0000 | +2.5000 | 100000000000 | 0.0000 | 0.0000 | 100000000000 | 000000000000 |
| +2.5000 | +1.2500 | 010000000000 | -5.0000 | -2.5000 | 010000000000 | 110000000000 |
| +1.2500 | +0.6250 | 001000000000 | -7.5000 | -3.7500 | 001000000000 | 101000000000 |
| +0.0024 | +0.0012 | 000000000001 | -9.9951 | -4.9976 | 000000000001 | 100000000001 |
| 0.0000 | 0.0000 | 000000000000 | -10.0000 | -5.0000 | 000000000000 | 100000000000 |

### ADC-MA10B (10 BITS)

| | | | | | | |
|---|---|---|---|---|---|---|
| +9.9902 | +4.9951 | 1111111111 | +9.9805 | +4.9902 | 1111111111 | 0111111111 |
| +8.7500 | +4.3750 | 1110000000 | +7.5000 | +3.7500 | 1110000000 | 0110000000 |
| +7.5000 | +3.7500 | 1100000000 | +5.0000 | +2.5000 | 1100000000 | 0100000000 |
| +5.0000 | +2.5000 | 1000000000 | 0.0000 | 0.0000 | 1000000000 | 0000000000 |
| +2.5000 | +1.2500 | 0100000000 | -5.0000 | -2.5000 | 0100000000 | 1100000000 |
| +1.2500 | +0.6250 | 0001000000 | -7.5000 | -3.7500 | 0010000000 | 1010000000 |
| +0.0098 | +0.0049 | 0000000001 | -9.9805 | -4.9902 | 0000000001 | 1000000001 |
| 0.0000 | 0.0000 | 0000000000 | -10.0000 | -5.0000 | 0000000000 | 1000000000 |

## EXTERNAL PIN CONNECTIONS

| INPUT RANGE (FS) | BUFFER OPTION | INPUT TO PIN | JUMPER PIN 4 TO | JUMPER PIN 20 TO | JUMPER PIN 19 TO |
|---|---|---|---|---|---|
| 0 TO +10V | WITHOUT | 6 | – | – | 23 |
| | WITH | 2 | 6 | – | 23 |
| ±5V | WITHOUT | 6 | – | – | 20 |
| | WITH | 2 | 6 | – | 20 |
| ±10V | WITHOUT | 5 | – | – | 20 |
| | WITH | 2 | 5 | – | 20 |
| 0 TO +5V | WITHOUT | 6 | – | 5 | 23 |
| | WITH | 2 | 6 | 5 | 23 |

## CONVERSION TIME USING EXTERNAL CAPACITOR

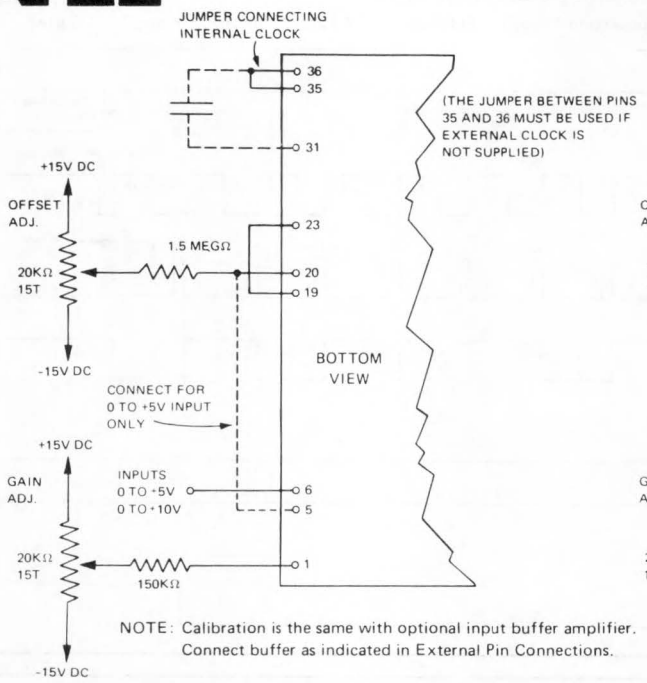
The external capacitor is connected between pins 31 and 36. Conversion time in the table is in microseconds and capacitor value is in picofarads.

| Conversion Time Formula (approx.) | | |
|---|---|---|
| Conv. Time* | ADC-MA10B | ADC-MA12B |
| 20 μsec. | C = 60(T-20μsec.) | C = 50 (T-20μsec.) |
| 40 μsec. | C = 65(T-40μsec.) | C = 55(T-40μsec.) |

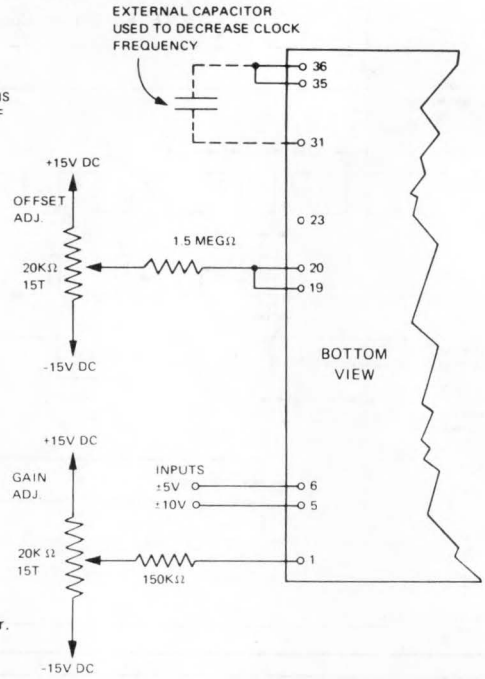
*Maximum internal conversion rate when no external capacitor is used.

DATEL

## CALIBRATION CONNECTIONS




**UNIPOLAR OPERATION (WITHOUT BUFFER)**




**BIPOLAR OPERATION (WITHOUT BUFFER)**

NOTE: Calibration is the same with optional input buffer amplifier. Connect buffer as indicated in External Pin Connections.

### CALIBRATION PROCEDURE

Gain and offset adjustments are accomplished as shown in the above diagram using the Calibration Table. The trimming potentiometers used should be 15 turn 100ppm/°C temperature coefficient cermet type units and are available from Datel Systems at $3.00 each. A pulse generator should be adjusted to give +5 volt pulses with 100 nsec. minimum duration and a spacing equal to or larger than the specified maximum conversion time (20 or 40 usec.). This generator should be connected to the "Start Convert" input. A precision voltage reference source should be connected to the selected analog input terminal.

**Offset Adjustment:** For unipolar operation set the output of the voltage reference source to zero plus 1/2 LSB. The value is shown in the Calibration Table. Adjust the offset trimming potentiometer until the LSB output flickers equally between logic "0" and logic "1". (Output between 000 . . . 000 and 000 . . . 001). For bipolar operation set the voltage reference source to minus full scale plus 1/2 LSB and make the same adjustment.

**Gain Adjustment:** Adjust the output of the voltage reference source to full scale minus 1 1/2 LSB. This value is also shown in the Calibration Table. Adjust gain trimming potentiometer until LSB output flickers equally between logic "0" and logic "1". (Output between 111 . . . 110 and 111 . . . 111).

### CALIBRATION TABLE ADC-MA SERIES

| | INPUT RANGE | ADJUSTMENT | INPUT VOLTAGE 10 BIT | INPUT VOLTAGE 12 BIT |
|---|---|---|---|---|
| UNIPOLAR | 0 TO +5V | OFFSET | 2.4 mV | 0.61 mV |
| | | GAIN | +4.9927V | +4.9982V |
| | 0 TO +10V | OFFSET | 4.9 mV | 1.2 mV |
| | | GAIN | +9.9854V | +9.9963V |
| BIPOLAR | ±5V | OFFSET | -4.9951V | -4.9988V |
| | | GAIN | +4.9854V | +4.9963V |
| | ±10V | OFFSET | -9.9902V | -9.9976V |
| | | GAIN | +9.9707V | +9.9927V |

### ORDERING INFORMATION

ADC-MA

| NUMBER OF BITS AND CODING | WITH OR W/O HIGH Z BUFFER | CONVERSION TIME |
|---|---|---|
| 10B = 10 BINARY BITS<br>12B = 12 BINARY BITS | 1 = WITH<br>2 = WITHOUT | A = 40μSEC<br>B = 20μSEC |

### PRICES (1-9)

| | | | |
|---|---|---|---|
| ADC-MA10B2A | $ 95.00 | ADC-MA12B2A | $125.00 |
| ADC-MA10B2B | $125.00 | ADC-MA12B2B | $145.00 |

For optional internal high impedance buffer amplifier add $20.00 to price.

Mating Socket: DILS-2, 4 required @ $5.00 per pair
Trimming Potentiometers: TP20K $3.00 each (1-9)

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# HIGH RESOLUTION ANALOG-TO-DIGITAL CONVERTER

# MODEL ADC-149

## FEATURES

- **14 Bit Resolution**
- **50 μsec. Conversion Time**
- **Low Price—$279**
- **Unipolar or Bipolar Inputs**
- **15ppm/°C Gain Temp. Coeff.**

## GENERAL DESCRIPTION

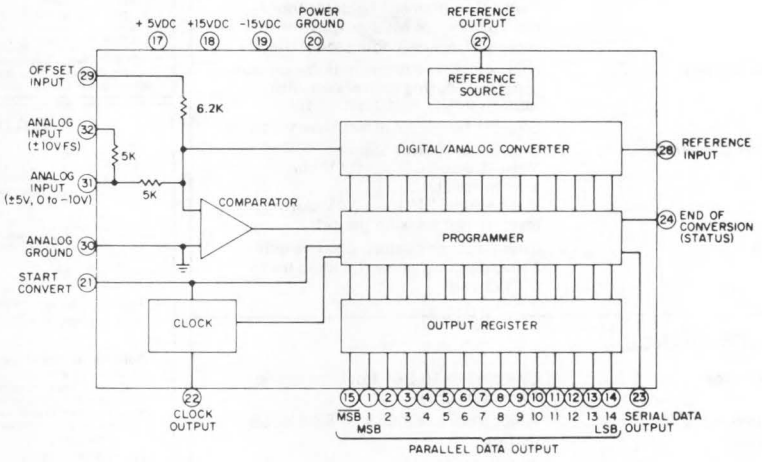
The ADC-149 is a 14 bit successive approximation type analog to digital converter for OEM use. It was specifically designed to give high resolution and accuracy at moderate cost for incorporation into precision instruments for process control systems and test and measurement systems.

This converter accepts either unipolar or bipolar input voltages of 0 to −10V, 0 to −20V, ±5V, or ±10V full scale by external pin connection and performs a 14 bit conversion in 50 μsec. Several output codes are available including straight binary for unipolar inputs and either offset binary or two's complement for bipolar inputs. Two's complement is obtained by using the $\overline{\text{MSB}}$ output pin. Reverse coding sense is used with the most negative analog input corresponding to full scale digital output. A serial data output is also provided and has a nonreturn-to-zero (NRZ) format. Logic outputs ate DTL/TTL compatible and will drive 6 standard TTL loads.

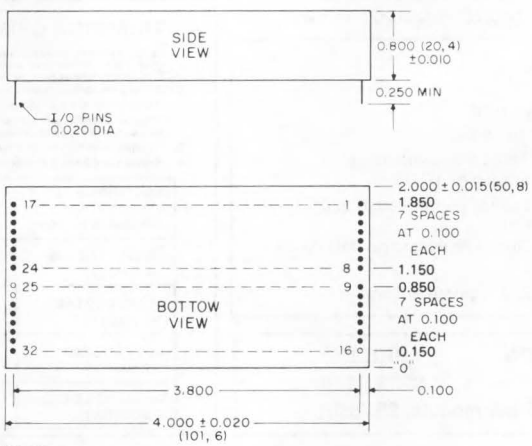
The ADC-149 can resolve 1 part in 16,384 giving an operating dynamic range of 84.3dB. On the 10 volt full scale range it can detect an input change of less than 1 millivolt. Accuracy is adjustable to ±.005% of full scale ±½LSB. The temperature coefficient is held to a low ±15ppm/°C over the 0° to 70°C operating temperature range.

This converter is encapsulated in a compact 2×4×0.8 inch module with DIP compatible pin spacing for PC board mounting. It can be stored from −55°C to +85°C. Power supplies required are standard ±15VDC and +5VDC. (Available from Datel's line of modular power supplies.)

The high resolution and accuracy of the ADC-149 make it particularly valuable in applications such as moderate speed data reduction, and computer arithmetic processing of analog inputs. Digitizing inputs from sensors and transducers allows data transmission or storage with drastically reduced degradation of accuracy compared to analog methods. This is also vital for automatic process and alarm limit computer control, and digital linearization of logarithmic or special function analog inputs. The ADC-149 offers at least a $100. price advantage over competitive converters in these applications.


## MECHANICAL DIMENSIONS INCHES (MM)




NOTES:
1. OPEN HOLES DESIGNATE WHERE PINS ARE OMITTED

## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | BIT 1 (MSB) |
| 2 | BIT 2 |
| 3 | BIT 3 |
| 4 | BIT 4 |
| 5 | BIT 5 |
| 6 | BIT 6 |
| 7 | BIT 7 |
| 8 | BIT 8 |
| 9 | BIT 9 |
| 10 | BIT 10 |
| 11 | BIT 11 |
| 12 | BIT 12 |
| 13 | BIT 13 |
| 14 | BIT 14 (LSB) |
| 15 | BIT 1 (MSB) |
| 16 | NOT USED |
| 17 | +5V POWER |
| 18 | +15V POWER |
| 19 | −15V POWER |
| 20 | POWER GROUND |
| 21 | START CONVERT |
| 22 | CLOCK OUTPUT |
| 23 | SERIAL OUTPUT |
| 24 | END OF CONVERT (STATUS) |
| 25 | NOT USED |
| 26 | NOT USED |
| 27 | REFERENCE OUTPUT |
| 28 | REFERENCE INPUT |
| 29 | OFFSET INPUT |
| 30 | ANALOG GROUND |
| 31 | ANALOG IN (0 to +10, ±5V) |
| 32 | ANALOG IN (±10V) |

## SPECIFICATIONS (Typical @ +25°C unless noted)

### INPUTS

**Analog Input Range (single-ended input referenced to ground)** ..... ±5V FS, ±10V FS
0 to -10V FS, 0 to -20V FS

**Input Overvoltage** ..... ±15VDC without damage to unit.

**Input Impedance** ..... 5K Ohms (±5V and 0 to -10V FS range)
10K Ohms (±10V and 0 to −20V FS range)

**Start of Conversion** ..... +2.5V min. to +5.5V max. positive pulse with 150 nsec. min. duration.
Loading: 1mA
Logic "1" resets converter
Logic "0" initiates conversion

### OUTPUTS

**Parallel Output Data** ..... 14 parallel lines of data held until the next conversion command.
Vout (Logic "0") ⩽ +0.4V
Vout (Logic "1") ⩾ +2.4V
Each output capable of driving up to 6 TTL loads.

**Coding** ..... Straight Binary (Unipolar Input)
Offset Binary (Bipolar Input)
Two's Complement (Bipolar Input)
Pin 15 provides MSB output for this coding. (Reverse coding sense used).

**Serial Output** ..... NRZ successive decision pulse output generated during conversion with MSB first. LO = "1", HI = "0"
Straight binary or offset binary coding

**End of Conversion** ..... Conversion Status Signal
Vout (Logic "0") ⩽ +0.4V conversion complete
Vout (Logic "1") ⩾ +2.4V during reset and conversion period.

**Clock** ..... Internal clock output, positive going 3 microsecond pulse. Loading up to 6 TTL loads.

### PERFORMANCE

**Resolution** ..... One part in 16,384 (max. resolution 14 binary bits)

**Accuracy (25°C)** ..... Adjustable to ±.005% of FS ±½LSB.

**Linearity** ..... ±½LSB

**Temperature Coefficient of Full Scale** ..... ±15ppm/°C

**Temperature Coefficient of Zero, Unipolar** ..... ±10ppm/°C
**Bipolar** ..... ±10ppm/°C

**Conversion Time** ..... 50 μsec.

**Throughput Rate** ..... 20kHz

**Power Requirements** ..... ±15VDC ±0.5VDC @ 80mA max.
+5VDC ±0.25 VDC @ 200mA max.

### PHYSICAL-ENVIRONMENTAL

**Operating Temperature Range** ..... 0°C to +70°C

**Storage Temperature Range** -55°C to +85°C

**Relative Humidity** ..... Up to 100% non-condensing

**Size** ..... 2"W×4"L×0.8" H

**Pins** ..... .020" round, gold plated, 0.250" long min.

**Case Material** ..... Black Diallyl Phthalate per MIL-M-14

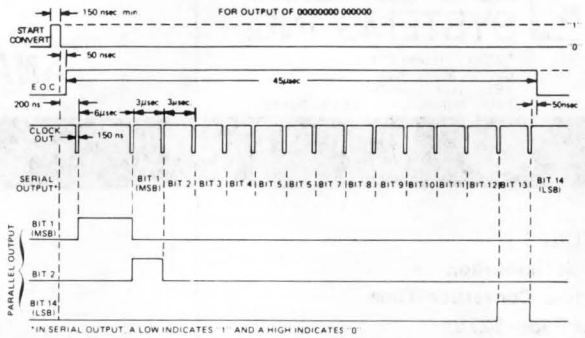
**Weight** ..... 8 oz.

**Mating Sockets** ..... DILS-2, 2 required @ $5/pair.

### ORDERING INFORMATION — PRICE

Model ADC-149-14B — $239. (1-9)
Mating Socket DILS-2 (2 per module, $5./pair)

## TIMING FOR ADC-149-14B

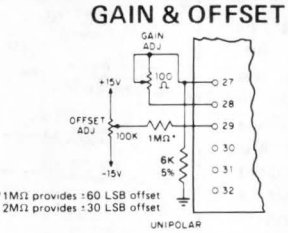



## OUTPUT DIGITAL CODING

| BIPOLAR | | | | UNIPOLAR | |
|---|---|---|---|---|---|
| Analog Input Range | | Offset Binary | 2's Complement (MSB Output) | Analog Input Range 0 to | Straight Binary |
| ±5V FS | ±10V FS | MSB LSB | MSB LSB | 10V FS | MSB LSB |
| +5.0000 | +10.0000 | 0 0000000000000 | 1 0000000000000 | 0.0000 | 0 0000000000000 |
| +2.5000 | +5.0000 | 0 1000000000000 | 1 1000000000000 | 0.0006 | 0 0000000000001 |
| +0.0006 | +0.0012 | 0 1111111111111 | 1 1111111111111 | 2.5000 | 0 1000000000000 |
| 0.0000 | 0.0000 | 1 0000000000000 | 0 0000000000000 | 5.0000 | 1 0000000000000 |
| -2.5000 | -5.0000 | 1 1000000000000 | 0 1000000000000 | 7.5000 | 1 1000000000000 |
| -4.9994 | -9.9988 | 1 1111111111111 | 0 1111111111111 | 9.9994 | 1 1111111111111 |

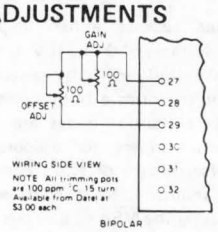
NOTE: *Reverse coding sense is used with the most negative analog input corresponding to full scale digital output. Normal coding sense can be obtained by using an external inverting amplifier. Or complementary binary can be used by adjusting for a 1 LSB offset.

## GAIN & OFFSET ADJUSTMENTS




*1MΩ provides ±60 LSB offset
2MΩ provides ±30 LSB offset

UNIPOLAR




BIPOLAR

**Adjustment Procedure – Unipolar Input**

A. Connect a precision pulse generator to the "Start Convert" input terminal. See specifications for pulse width and amplitude.
B. Connect a precision voltage reference source to the appropriate analog input terminals. See I/O Connections.

**Zero Offset Control**

Adjust the voltage output from the reference to minus ½ LSB. Rotate the zero offset control until the LSB output (Least Significant Bit) flickers between logic "zero" and logic "one".

**Full Scale Gain Control**

Adjust the output from the reference source to full scale minus 1½ LSB. Rotate the gain control until the LSB output (Least Significant Bit) flickers between logic "zero" and logic "one".

**Adjustment Procedure – Bipolar Input**

A. Connect a precision pulse generator to the "Start Convert" input terminals. See specifications for pulse width and amplitude.
B. Connect a precision voltage reference source to the appropriate analog input terminals. See I/O connections.

**Zero Offset Control**

Adjust the voltage output from the reference source to plus full scale minus ½ LSB.
Rotate the offset control until the LSB output (Least Significant Bit) flickers between logic "zero" and logic "one".

**Gain Control**

Adjust the output from the reference source to minus full scale minus 1½ LSB.
Rotate the gain control until LSB output (Least Significant Bit) flickers between logic "zero" and logic "one".

## TRIMMING OF 3 MOST SIGNIFICANT BITS (INTERNAL)

The three trimming potentiometers on the side of the module are for periodic adjustment of the three most significant bits. Normally no adjustment of these trims is necessary since they are calibrated at the factory at 25°C. Should readjustment be required for optimum accuracy at a different temperature or to compensate periodically for long term drift, the following procedure should be carefully followed:

1. Adjust external offset and gain as above.
2. Readjust external gain trim and then bits 3, 2, and 1 in accordance with the table below. Adjust so that the output flickers equally between the two codes shown.
3. Readjust external zero or offset and gain.
4. Repeat steps 2 and 3 as necessary.

| Input Voltage | | Output Code | Adjustment |
|---|---|---|---|
| Unipolar (0 to -10V) | Bipolar (±5V) | | |
| -0.625V -1/2 LSB (-0.62531V) | +4.375V -1/2 LSB (+4.37469V) | 00010 . . . 01<br>00010 . . . 00 | Gain Trim |
| -1.25V -1/2 LSB (-1.25031V) | +3.75V -1/2 LSB (+3.74969V) | 00100 . . . 01<br>00100 . . . 00 | Trim #3 (Bit 3) |
| -2.5V -1/2 LSB (-2.50031V) | +2.50V -1/2 LSB (+2.49969V) | 01000 . . . 01<br>01000 . . . 00 | Trim #2 (Bit 2) |
| -5.0V -1/2 LSB (-5.00031V) | 0V -1/2 LSB (-0.00031V) | 10000 . . . 01<br>10000 . . . 00 | Trim #1 (Bit 1) |

DATEL SYSTEMS, INC.
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Canton, Massachusetts 02021 U.S.A.
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TWX: 710-348-0135 TELEX: 924461

# 50 MILLIWATTS TOTAL POWER CONSUMPTION WILL OPERATE FROM 12 VOLT BATTERY ANALOG TO DIGITAL CONVERTER

# ADC-CM SERIES

## FEATURES

- AUTOMATIC SHUTDOWN BETWEEN CONVERSIONS
- CHOICE OF C/MOS OR TTL OUTPUTS
- UP TO 3000 CONVERSIONS PER SECOND
- ±0.025% ACCURACY
- FOUR INPUT RANGES

## GENERAL DESCRIPTION

The most unique feature of the ADC-CM series analog-to-digital converters is their low power consumption, approximately two orders of magnitude lower than those attainable with conventional A/D converters.

ADC-CM series are well adapted for applications in remote areas with limited power. Ideally suited for operation from battery power, they will find wide use in oceanography, pollution monitoring, meterology and seismology. They are also ideal for other scientific uses both in the laboratory and in the field.

Power consumption is a function of the conversion rate. For 100, 500 and 1000 conversions per second, the average power drain is approximately 5, 25, and 50 milliwatts, respectively.

Model ADC-CM converters have the capability of operating from either a single +12VDC to +15VDC power source (interrupt power mode) or from a ±12VDC to ±15VDC power supply (continuous power mode) at a maximum conversion rate of 3KHz.

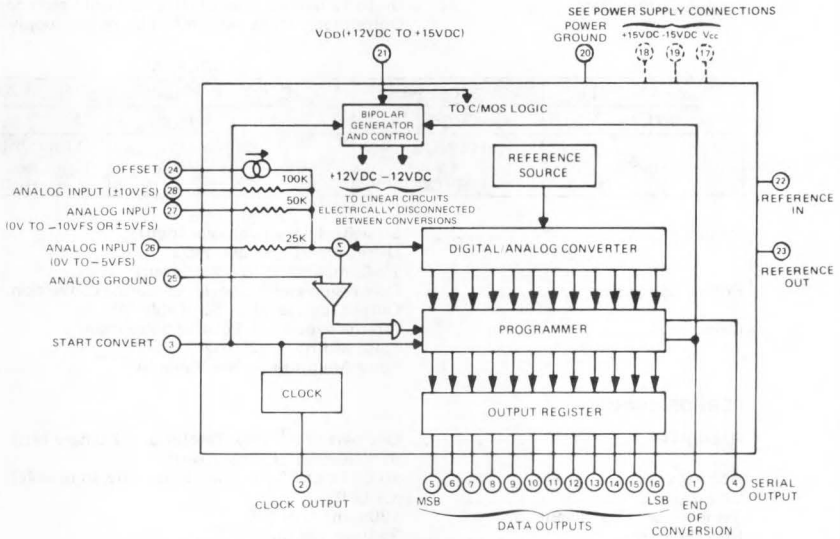
Another key feature of the ADC-CM series when operating in the interrupt power mode is its ability to normally reset in a standby state (power turned off to the analog section) and upon receipt of a convert command signal the converter will turn on, stabilize in 50 microseconds, make a complete conversion and automatically return to standby status.

All input/output control signals and output data are C/MOS compatible plus a separate logic power supply connection (+VDC-Pin 17) is provided to allow the user the convenience of TTL compatibility when required.

The ADC-CM series converters utilize C/MOS logic throughput and employ the inherently accurate successive approximation conversion method to compare an unknown analog input signal against the output of a precision digital-to-analog converter in a high gain feedback loop. This method insures a full monotonic conversion and excellent linearity over the full scale input voltage range.

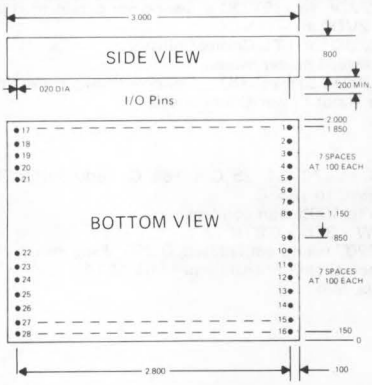
Full scale input can be unipolar (0 to −5V or 0 to −10V) or bipolar (±5V or ±10V) by simply making the appropriate pin connections.

The entire converter is contained in a 2"W x 3"L x 0.8"H plastic encapsulated module, yet fully repairable — a very significant consideration. Full scale accuracy is specified at ±0.025% with a temperature coefficient of ±30ppm/°C.


BLOCK DIAGRAM — INTERRUPT POWER MODE
ADC CM SERIES — 12 BINARY BITS SHOWN

## MECHANICAL DIMENSIONS (INCHES)




## INPUT/OUT CONNECTIONS

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | E.O.C. (STATUS) | 15 | BIT 11 OUT |
| 2 | CLOCK OUT | 16 | BIT 12 OUT (LSB) |
| 3 | START CONVERT | 17 | Vcc (+5VDC) |
| 4 | SERIAL OUTPUT | 18 | +15VDC |
| 5 | BIT 1 OUT (MSB) | 19 | −15VDC |
| 6 | BIT 2 OUT | 20 | POWER GROUND |
| 7 | BIT 3 OUT | 21 | VDD (+12VDC TO +15VDC) |
| 8 | BIT 4 OUT | 22 | REFERENCE IN |
| 9 | BIT 5 OUT | 23 | REFERENCE OUT |
| 10 | BIT 6 OUT | 24 | OFFSET SELECT |
| 11 | BIT 7 OUT | 25 | ANALOG GROUND |
| 12 | BIT 8 OUT | 26 | INPUT 3 (0V TO −5V) |
| 13 | BIT 9 OUT | 27 | INPUT 2 (0V TO −10V OR ±5V) |
| 14 | BIT 10 OUT | 28 | INPUT 1 (±10V) |

DATEL

## SPECIFICATIONS (Typical @ 25°C unless noted)

### ELECTRICAL

**Inputs:**

Analog Input Voltage Range ..... 0V to − 5V FS − PIN 26
0V to −10V FS − PIN 27
±5V FS − PIN 27
±10V FS − PIN 28

Input Overvoltage ..... ±30VDC without damage to unit

Input Impedance ..... 25K Ohms, −5V Range
50K Ohms, −10V Range
50K Ohms, ±5V Range
100K Ohms, ±10V Range

Start of Conversion ..... **Interrupt Power Mode**
Positive Pusle With Duration of 50 μsec, ±10 μsec.
**Continuous Power Mode**
Positive Pulse With Duration of 10 μsec.
Note: For either mode, the leading edge resets the converter and the trailing edge initiates a conversion. Pulse amplitude is determined by power supply used as shown below.

| | PIN 17 | | | |
|---|---|---|---|---|
| COMPATIBILITY | POWER SUPPLY | LOGIC "0" | LOGIC "1" | LOAD |
| TTL | +5VDC | ⩽+0.4V | ⩾+2.4V | 1 TTL Load. Terminate Pin 3 to Pin 17 with 4.7K |
| C/MOS | +12VDC to +15VDC | 0V | VDD | Input Impedance 20K to Ground |

**Outputs:**

Parallel Output Data. ..... Up to 12 parallel lines of data held until next conversion command.
Output logic levels determined by power supply used, as per Table 'A'.

TABLE 'A'

| COMPATIBILITY | POWER SUPPLY | LOGIC "0" | LOGIC "1" | FAN OUT |
|---|---|---|---|---|
| TTL | +5VDC | ⩽+0.4V | ⩾+2.4V | 2 TTL Loads |
| C/MOS | +12 VDC to +15VDC | 0V | VDD | Output Impedance<br>V out Low − 100 Ohms<br>V out High − 1.5K |

Coding ..... Straight Binary (Unipolar Input)
Offset Binary (Bipolar Input
2's Complement (Bipolar Input)

End of Conversion ..... Conversion status signal high during conversion.
Output logic levels − See Table 'A'

Clock ..... Internal clock out. Positive pulse train.
Pulse width: 20 μsec.
Pulse Amplitude − See Table 'A'

### PERFORMANCE:

Resolution ..... One part in $2^n$ (max. resolution 12 binary bits)
(n = Number of Binary Bits)

Accuracy ..... ±0.025% of FS ±½ LSB (Externally adjustable)

Linearity ..... ±½ LSB

Temperature Coefficient ..... ±30ppm/°C of F.S.

Encoding Time ..... 25 μsec. per bit

Input Settling Time ..... 10 μsec for a full scale step at the input.

Throughput Time ..... 310 μsec − continuous power mode
350 μsec − interrupt power mode

Word Rate ..... Up to 3.2KHz − continuous power mode (12-bit)
Up to 2.8KHz − interrupt power mode (12-bit)

Input Power Requirements ..... **Continuous power mode:**
+12VDC to +15VDC − See power curves next page
−12VDC to −15VDC
+5VDC for TTL Compatibility
**Interrupt power mode:**
+12VDC to +15VDC − See power curves next page
See Input Power Connections

### PHYSICAL–ENVIRONMENTAL

Operating Temperature Range ..... 0°C to +70°C (−25°C to +85°C − add Suffix "EX" to Part Number)

Storage Temperature Range ..... −55°C to +85°C

Relative Humidity ..... Up to 100% non-condensing

Size ..... 2"W x 3"L x 0.8"H

Pins ..... 0.020" round gold plated, 0.250" long min.

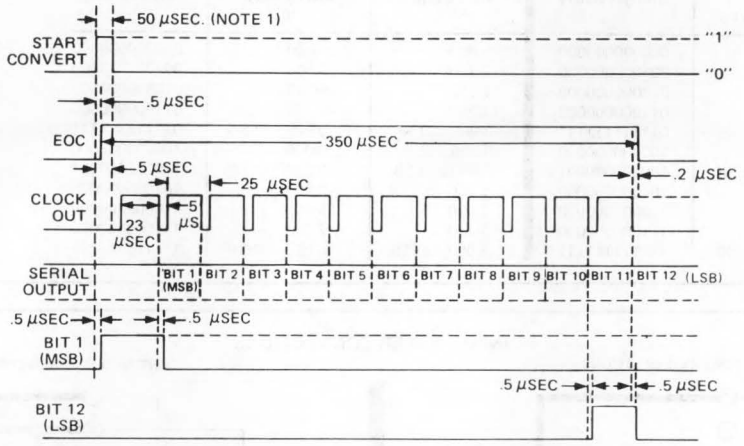
Case Material ..... Black Diallyl Phthalate per MIL-M-14

Weight ..... 8 oz. Max.

DATEL

## TIMING – INTERRUPT POWER MODE

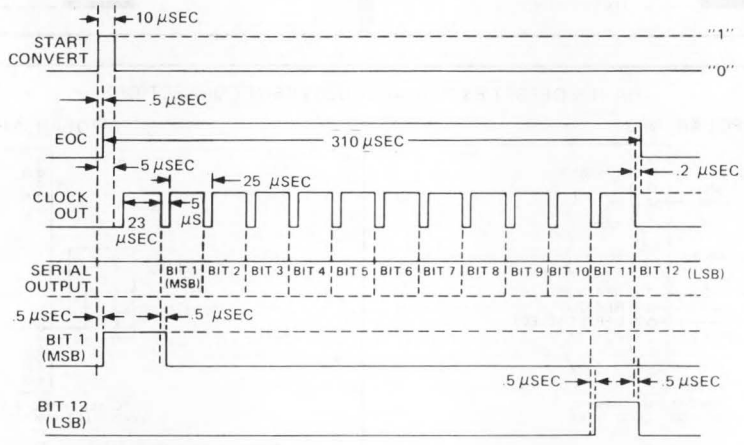
OUTPUT: 000000000000 – 12 BINARY BITS
POWER INPUT +12VDC TO +15VDC



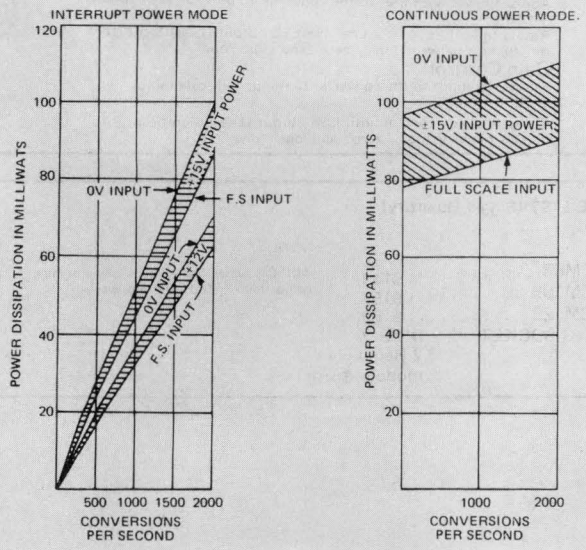

NOTE (1) Start Convert Input must have a minimum width of 50 μSec. This time is required to internally generate ±12VDC for the linear circuits.

## TIMING – CONTINUOUS POWER MODE

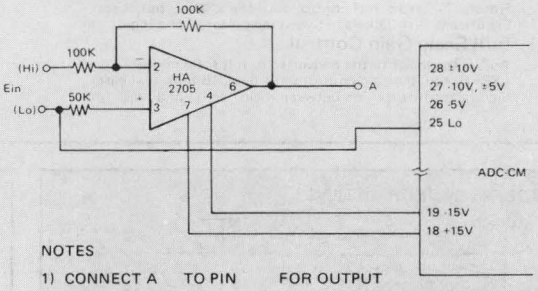
OUTPUT: 000000000000 – 12 BINARY BITS
POWER INPUT ±12VDC TO ±15VDC




## POWER DISSIPATION VERSUS CONVERSION SPEED




## SUGGESTED LOW POWER EXTERNAL INPUT AMPLIFIER FOR NON-INVERTED CODING (See coding pg. 4)




NOTES

1) CONNECT A TO PIN FOR OUTPUT

| | | |
|---|---|---|
| 26 | 0 to +5V | conventional dig. output code. |
| 27 | 0 to +10V, ±5V | |
| 28 | ±10V | |

2) The inverting amplifier does not affect the connections for the ZERO, GAIN & OFFSET Adjustments.
3) The inverting amplifier requires a maximum of 5.5 mw of extra power for the continuous mode of operation.
4) The inverting amplifier will cause a zero drift of 1.4 mv for a 0°C to 70°C temperature change. For a 0 to +10V, 12 bit ADC-CM this is about ½ LSB.

## OUTPUT DIGITAL CODING *

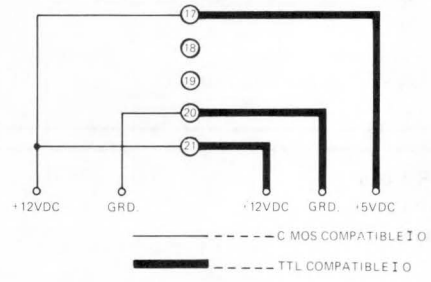
| Analog Input 0V to −5VFS | Analog Input 0V to −10VFS | Straight Binary | Analog Input ±5VFS | Analog Input ±10V | Offset Binary |
|---|---|---|---|---|---|
| 0.000 | 0.000 | 000000000000 | +5.000 | +10.000 | 000000000000 |
| −0.625 | −1.250 | 001000000000 | +3.750 | +7.500 | 001000000000 |
| −1.250 | −2.500 | 010000000000 | +2.500 | +5.000 | 010000000000 |
| −1.875 | −3.750 | 011000000000 | +1.250 | +2.500 | 011000000000 |
| −2.500 + 1LSB | −5.000 + 1LSB | 011111111111 | 0.000 + 1LSB | 0.000 + 1LSB | 011111111111 |
| −2.500 | −5.000 | 100000000000 | 0.000 | 0.000 | 100000000000 |
| −2.500 − 1LSB | −5.000 − 1LSB | 100000000001 | 0.000 − 1LSB | 0.000 − 1LSB | 100000000001 |
| −3.125 | −6.250 | 101000000000 | −1.250 | −2.500 | 101000000000 |
| −3.750 | −7.500 | 110000000000 | −2.500 | −5.000 | 110000000000 |
| −4.375 | −8.750 | 111000000000 | −3.750 | −7.500 | 111000000000 |
| −5.000 + 1LSB | −10.000 + 1LSB | 111111111111 | −5.000 + 1LSB | −10.000 + 1LSB | 111111111111 |

DATEL

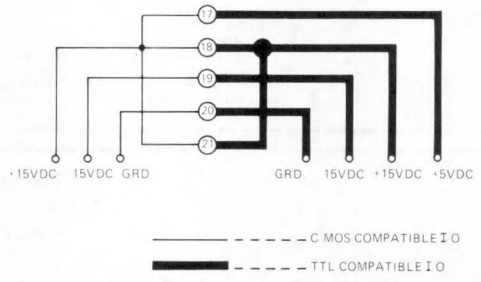
** Reverse coding sense:* Note that the most negative analog input corresponds to full scale digital output (11 - 1 binary). Normal coding sense can be obtained by using an external inverting input amplifier. See page 3 for a suggested circuit.

## INPUT POWER CONNECTIONS

INTERRUPT POWER CONNECTIONS

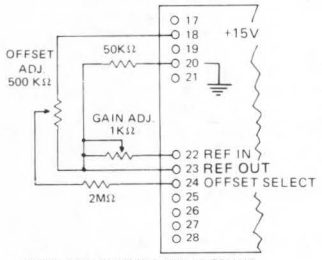



CONTINUOUS POWER CONNECTIONS




## GAIN & OFFSET EXTERNAL ADJUSTMENT CONNECTIONS

UNIPOLAR INPUT




NOTE: ALL TRIMPOTS ARE 100PPM/ C
AVAILABLE FROM DATEL – $3.00 each

### Adjustment Procedure – Unipolar Input

A. Connect a precision pulse generator to the "Start Convert" input terminal. See specifications for pulse width and amplitude.
B. Connect a precision voltage reference source to the appropriate analog input terminals. See I/O Connections.

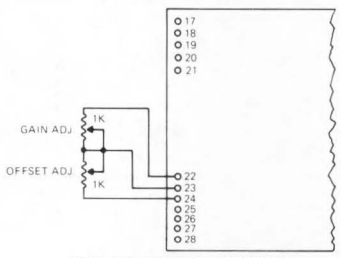
### Zero Offset Control

Adjust the voltage input to the converter to minus ½ LSB
Rotate the zero offset control until the LSB output (Least Significant Bit) flickers between logic "zero" and logic "one".

### Full Scale Gain Control

Adjust the input to the converter to full scale minus 1½ LSB. Rotate the gain control until the LSB output (Least Significant Bit) flickers between logic ' zero" and logic "one".

BIPOLAR INPUT




NOTE: ALL TRIMPOTS ARE 100PPM/
AVAILABLE FROM DATEL – $3.00 EACH

### Adjustment Procedure – Bipolar Input

A. Connect a precision pulse generator to the "Start Convert" input terminals. See specifications for pulse width and amplitude.
B. Connect a precision voltage reference sourse to the appropriate analog input terminals. See I/O Connections.

### Zero Offset Control

Adjust the voltage input to the converter to plus full scale minus ½ LSB.
Rotate the offset control until the LSB output (Least Significant Bit) flickers between logic "zero" and logic "one".

### Gain Control

Adjust the input to the converter to minus full scale minus 1½ LSB.
Rotate the gain control until LSB output (Least Significant Bit) flickers between logic "zero" and logic "one".

## ORDERING INFORMATION

ADC-CM

| NUMBER OF BITS AND CODING | ADD SUFFIX 2 FOR 2'S COMPLEMENT OUTPUT CODING |
|---|---|
| 8B = 8 BINARY BITS<br>10B = 10 BINARY BITS<br>12B = 12 BINARY BITS | |

## PRICE LIST (Single Quantity)

| | |
|---|---|
| ADC-CM8B | $149. |
| ADC-CM10B | $159. |
| ADC-CM12B | $169. |
| MATING SOCKET | DILS-2 2 Req'd per module, $5/pr |

NOTE:
ADC-CM Series feature dual in-line pinning compatibility, .100" grid pin spacing.

DATEL SYSTEMS, INC.
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TWX: 710-348-0135 TELEX: 924461

# RATIOMETRIC DUAL SLOPE ANALOG TO DIGITAL CONVERTERS

# ADC-ER SERIES

## FEATURES

- ▶ 4 Wire Ratiometric Operation
- ▶ Single +5V Power Requirement
- ▶ Differential Inputs
- ▶ 40 dB Normal Mode Noise Rejection
- ▶ 70 dB Common Mode Rejection
- ▶ Binary or BCD Coding

## GENERAL DESCRIPTION

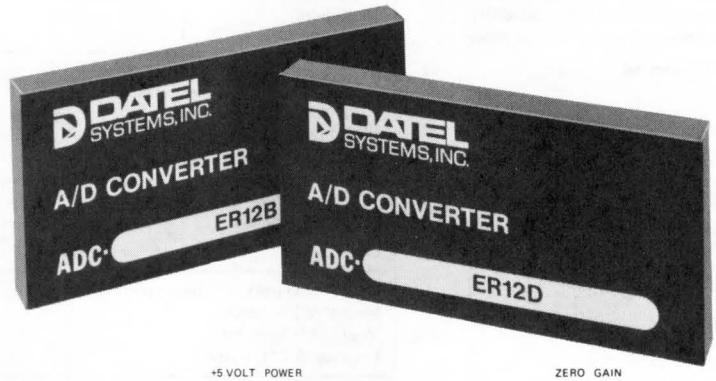
The ADC-ER series dual slope A/D converters feature ratiometric operation powered by a single +5 volt logic supply. Four-wire differential inputs give high common mode rejection with the useful capability of operating with input signal and external reference at different common mode levels; the external reference voltage can be varied over ±50% of nominal reference value. In addition, the conversion time can be externally adjusted to a 50 or 60 Hz period to give 40 dB minimum normal mode rejection of AC power line noise.

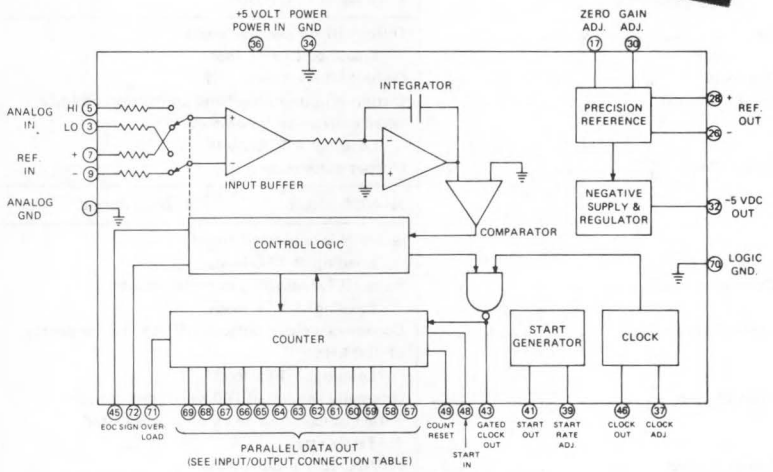
This series is available in 5 different models with resolutions of 8, 10, or 12 binary bits and sign and 2-1/2 or 3-1/2 BCD digits and sign. Important applications for these converters include test and instrumentation systems and signal conversion at transducer locations. Other operating features include: a gated clock output with a counter reset pulse for transmitting data to an external counter; an internal start pulse generator with externally adjustable rate; and a −5VDC power output supplying up to 5mA for externally powering a transducer bridge or auxiliary amplifier.

This combination of features makes the ADC-ER an extremely versatile A/D converter for systems applications. It contains an internal precision reference of 1V for binary models and 2V for BCD models which is used for normal, non-ratiometric operation. In ratiometric operation the input switches between input signal and external reference during the conversion cycle. Full scale input signal is ±1V for binary and ±2V for BCD; the input common mode voltage range is ±3V.

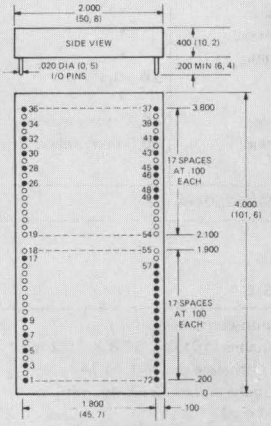
The external reference voltage range is 0.5 to 1.5V for binary models and 1 to 3V for BCD models. Common mode rejection for both signal and reference inputs is 70 dB minimum. Optimum normal mode AC line noise rejection is achieved by external adjustment of the clock frequency to synchronize the signal integration time to either 50 Hz or 60 Hz line period. Sign-magnitude coding is used in all models.

Input power requirement is +5VDC at 250mA maximum and the module size is a low profile 4 x 2 x 0.4 inches.




## MECHANICAL DIMENSIONS INCHES (MM)




## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION | PIN | DIGITAL OUTPUTS | | | | |
|---|---|---|---|---|---|---|---|
| | | | BINARY BIT | | | BCD DIGIT | |
| | | | 8B | 10B | 12B | 8D | 12D |
| 1 | ANALOG GROUND | | | | | | |
| 3 | ANALOG IN, LO | | | | | | |
| 5 | ANALOG IN, HI | 57 | X | X | X | X | 1 |
| 7 | + REFERENCE IN | 58 | X | X | 12 | X | 2 |
| 9 | - REFERENCE IN | 59 | X | X | 11 | X | 4 |
| 17 | ZERO ADJUST | 60 | X | 10 | 10 | X | 8 |
| 26 | - REFERENCE OUT | 61 | X | 9 | 9 | 1 | 10 |
| 28 | +REFERENCE OUT | 62 | 8 | 8 | 8 | 2 | 20 |
| 30 | GAIN ADJ. | 63 | 7 | 7 | 7 | 4 | 40 |
| 32 | -5VDC OUT | 64 | 6 | 6 | 6 | 8 | 80 |
| 34 | POWER GROUND | 65 | 5 | 5 | 5 | 10 | 100 |
| 36 | +5V POWER IN | 66 | 4 | 4 | 4 | 20 | 200 |
| 37 | CLOCK ADJUST | 67 | 3 | 3 | 3 | 40 | 400 |
| 39 | START RATE ADJ. | 68 | 2 | 2 | 2 | 80 | 800 |
| 41 | START OUT | 69 | 1 | 1 | 1 | 100 | 1000 |
| 43 | GATED CLOCK OUT | | | | | | |
| 45 | E.O.C. (STATUS) | | | | | | |
| 46 | CLOCK OUT | | | | | | |
| 48 | START CONVERT | | | | | | |
| 49 | COUNTER RESET | | | | | | |
| 70 | LOGIC GROUND | | | | | | |
| 71 | OVERLOAD | | | | | | |
| 72 | SIGN | | | | | | |

X INDICATES NO PIN

Notes:
1. Open dots designate omitted pins
2. 0.100 inch = 2.5mm
3. Pin position tolerance is ±0.005" from datum, non-accumulative
4. Analog Ground, Power Ground, and Logic Ground are all connected together internally.

## SPECIFICATIONS, ADC-ER SERIES

Typical at 25° C and +5V Supply unless otherwise noted

| | ADC-ER8B/10B/12B (BINARY) | ADC-ER8D/12D (BCD) |
|---|---|---|
| **INPUTS** | | |
| Analog Input Range | ±1V | ±2V |
| Reference Input Range | +0.5 to +1.5V | +1 to +3V |
| Input Overvoltage, no damage | ±20V | * |
| Input Impedance, both inputs | 100 Meg. min. | * |
| Input Bias Current, both inputs | 45nA typ., 500 nA max. | * |
| Common Mode Input Range | ±3V min. | * |
| Common Mode Rejection, DC-60Hz. | 70 dB min. | * |
| Normal Mode Rejection, 50 or 60Hz | 40 dB min. | * |
| Start Conversion | 2V min. to 5.5V max. positive pulse with duration of 100 μsec. min.<br>Logic "1" resets converter<br>Logic "0" initiates conversion<br>Loading: 1 TTL load | |
| **OUTPUTS** | | |
| Parallel Output Data | 8/10/12 parallel lines | 8/12 parallel lines and overrange |
| | Output data held until next start convert pulse.<br>Vout ("0") ⩽ +0.4V<br>Vout ("1") ⩾ +2.4V<br>Loading: 6 TTL loads | |
| Sign | Output HI for positive input<br>Loading: 10 TTL loads | |
| Overload | Output HI for ± input > FS | |
| E.O.C. (Status) | Output HI during reset and conversion and LO when conversion is complete<br>Loading: 4 TTL loads | |
| Gated Clock | Output pulse train giving: | |
| | N+4096 pulses | N+2000 pulses |
| | where N is converted count<br>Loading: 8 TTL loads | |
| Counter Reset | Pulse HI for resetting external counters<br>Loading: 4 TTL loads | |
| Clock Output | Continuous clock pulses with nominal frequency of 100 kHz<br>Loading: 1 TTL load | |
| Start Output | Internally generated 100 nsec. start convert pulse at 2/sec. Can be externally adjusted for faster rate. | |
| Power Output | −5VDC ±5% @ 5mA max. | |
| **PERFORMANCE** | | |
| Error, max. | .05% Reading ±1 count | * |
| Resolution | 8/10/12 Bits | 2½/3½ Digits |
| Coding | Sign-Mag. Binary | Sign-Mag. BCD |
| Temp. Coeff. of Gain, converter | ±5ppm/°C max. | * |
| Temp. Coeff. of Gain, reference | ±30ppm/°C max. | * |
| Temp. Coeff. of Zero | ±30 μV/°C max. | * |
| Internal Reference | 1V ±0.1% | 2V ±0.1% |
| Power Supply Rejection | .01%/% max. | * |
| Conversion Time, 60Hz period | 76.6 msec. max. | 43.3 msec. max. |
| 50Hz period | 90.0 msec. max. | 50.0 msec. max. |
| Warm Up Time | 5 minutes | * |
| **POWER REQUIREMENT** | +5.0VDC ±5% @ 250mA max. | |
| **PHYSICAL-ENVIRONMENTAL** | | |
| Operating Temperature Range | 0°C to 70°C | * |
| Storage Temperature Range | −55°C to +85°C | * |
| Relative Humidity | Up to 100% non-condensing | |
| Case Size | 4 X 2 X 0.4 inches (101,6 X 50,8 X 10,2 mm) | |
| Case Material | Black diallyl phthalate per MIL-M-14 | |
| Pins | .020" round, gold plated, .200" lg. min. | |
| Weight | 4 oz. max. (114 g.) | |

## TECHNICAL NOTES

1. Both analog input signal and external reference look into identical differential inputs with an electronic switch switching between the two during the conversion cycle. A bias current of typically 45nA flows out of the input terminals and must be returned to ground. For single-ended operation Analog LO and either reference input should be connected to Analog Ground. Only one reference is required for either polarity of analog input.
2. Zero adjustment is required for either ratiometric or normal operation, but the gain adjustment is required only for normal operation (using internal reference) or applications where the internally trimmed accuracy of 0.1% is insufficient.
3. Optimum normal mode noise rejection for AC line frequencies is obtained by externally adjusting the clock frequency to give a signal integration time equal to the line frequency period of 50 or 60 Hz. This is most easily done by using a digital counter connected to the Clock Output (pin 46). If normal mode noise is negligible or of high frequency, the adjustment is not necessary. For short term measurements an adjustment to within 0.1% of line period can be achieved, resulting in 60 dB of rejection. For longer term measurements, both line frequency and clock frequency drift slightly and a more reasonable match to within 1% results in 40 dB rejection.
4. The start rate adjustment allows operating at an internally set rate of 2 conversions/sec. or at faster rates up to 23/sec.

### ORDERING INFORMATION

ADC-ER—

| NO. OF BITS & CODING |
|---|
| 8B = 8 Binary Bits |
| 10B = 10 Binary Bits |
| 12B = 12 Binary Bits |
| 8D = 2½ BCD Digits |
| 12D = 3½ BCD Digits |

**PRICES (1-9)**

**ADC-ER8B . . . . . $79.00**
**ADC-ER10B . . . . . $89.00**
**ADC-ER12B . . . . . $99.00**
**ADC-ER8D . . . . . $79.00**
**ADC-ER12D . . . . . $99.00**

**Mating Sockets: DILS-2 (4/module) $5.00/pair**
**Trimming Potentiometers:**
**TP100K, TP10K at $3.00 each**

For extended temperature range operation, the following suffixes are added to the model number. Consult factory for pricing and delivery.

-EX −25° to +85°C operation
-EXX-HS −55°C to +85°C operation with hermetically sealed semiconductor components.

**The ADC-ER Series Converters are covered by GSA Contract**

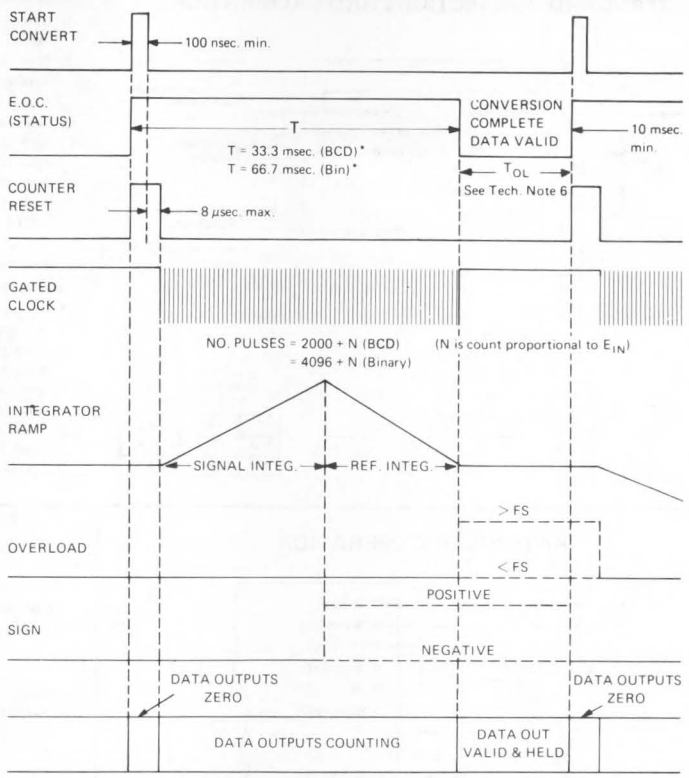
## TECHNICAL NOTES (Cont'd)

(BCD) or 13/sec. (Binary) by external adjustment. To operate with the internal start convert, pin 41 must be connected to pin 48. The converter may also be started externally by means of a 100 nsec. min. start convert pulse applied directly to pin 48.

5. The −5V power output from the converter may be used to power a transducer bridge or an auxiliary input amplifier such as μA776, LM308, or 4250 in conjunction with the +5V input power. The 5mA maximum output should not be exceeded or it will affect the operation of the converter. *This output is short circuit protected to ground but should not under any circumstance be connected to +5V or any other power supply output voltage since damage to the converter will result.* The −5V output is regulated to give a constant 10V difference with respect to the +5V power input with a typical tempco of ±100ppm/°C.

6. Analog inputs exceeding the ±5V supply voltage, although they will not cause any damage up to ±20V, will cause the input switch to malfunction. This will cause the overload output to remain high and the sign output may be invalid. If inputs exceeding ±5V are to be encountered in an application, it is recommended that clamping diodes be used from the inputs to ±5V. Overload recovery time, $T_{OL}$, after a ±5V input overload is 30 msec. for all BCD models and 50 msec. for all binary models. See timing diagram.

## TIMING DIAGRAM




*When synchronized to 60 Hz period. For 50 Hz period: T = 40.0 msec. (BCD)
T = 80.0 msec. (Bin)

## CODING TABLES

**BCD CODING**

| SCALE | 2 1/2 DIGIT | | 3 1/2 DIGIT | |
|---|---|---|---|---|
| | INPUT (±) | OUTPUT CODE | INPUT (±) | OUTPUT CODE |
| FS-1 LSD | 1.99V | 1 1001 1001 | 1.999V | 1 1001 1001 1001 |
| 3/4 FS | 1.50V | 1 0101 0000 | 1.500V | 1 0101 0000 0000 |
| 1/2 FS | 1.00V | 1 0000 0000 | 1.000V | 1 0000 0000 0000 |
| 1/2 FS-1 LSD | 0.99V | 0 1001 1001 | 0.999V | 0 1001 1001 1001 |
| 1/4 FS | 0.50V | 0 0101 0000 | 0.500V | 0 0101 0000 0000 |
| 1 LSD | 0.01V | 0 0000 0001 | 0.001V | 0 0000 0000 0001 |
| 0 | 0.00V | 0 0000 0000 | 0.000V | 0 0000 0000 0000 |

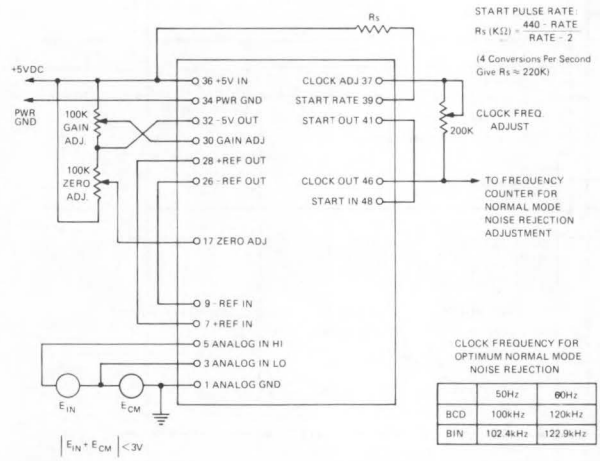
**BINARY CODING**

| SCALE | 8 BIT | | 10 BIT | | 12 BIT | |
|---|---|---|---|---|---|---|
| | INPUT (±) | CODE | INPUT (±) | CODE | INPUT (±) | CODE |
| FS-1 LSB | .996V | 1111 1111 | .9990V | 1111 1111 11 | .99976V | 1111 1111 1111 |
| 7/8 FS | .875V | 1110 0000 | .8750V | 1110 0000 00 | .87500V | 1110 0000 0000 |
| 3/4 FS | .750V | 1100 0000 | .7500V | 1100 0000 00 | .75000V | 1100 0000 0000 |
| 1/2 FS | .500V | 1000 0000 | .5000V | 1000 0000 00 | .50000V | 1000 0000 0000 |
| 1/4 FS | .250V | 0100 0000 | .2500V | 0100 0000 00 | .25000V | 0100 0000 0000 |
| 1/8 FS | .125V | 0010 0000 | .1250V | 0010 0000 00 | .12500V | 0010 0000 0000 |
| 1 LSB | .004V | 0000 0001 | .0010V | 0000 0000 01 | .00024V | 0000 0000 0001 |
| 0 | .000V | 0000 0000 | .0000V | 0000 0000 00 | .00000V | 0000 0000 0000 |

DATEL

# CALIBRATION & APPLICATION

## STANDARD CONNECTIONS AND CALIBRATION




CLOCK FREQUENCY FOR OPTIMUM NORMAL MODE NOISE REJECTION

| | 50Hz | 60Hz |
|---|---|---|
| BCD | 100kHz | 120kHz |
| BIN | 102.4kHz | 122.9kHz |

### CALIBRATION

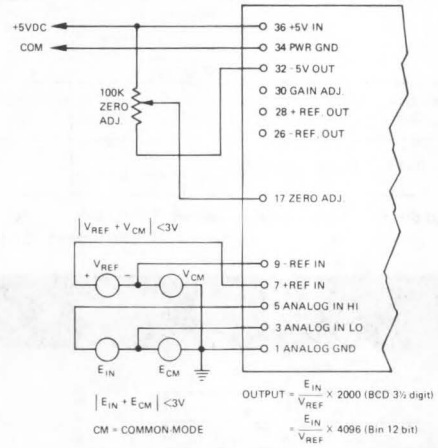
1. Connect the converter as shown in the diagram. Allow a 5 minute warm-up before making final adjustments.
2. **Zero Adjustment.** Short together Analog In HI (pin 5), Analog In LO (pin 3), and Analog Ground (pin 1). Adjust zero trimming potentiometer to obtain a flickering Sign (pin 72) and logic zero on all parallel data output lines.
3. **Gain Adjustment.** Apply a precision reference input voltage between Analog In HI (pin 5) and Analog In LO (pin 3) with the latter connected to Analog Ground (pin 1). Set the precision reference to a voltage near full scale (see coding tables) and adjust the gain trimming potentiometer to give the correct digital output code.

   **NOTE:** The gain adjustment is internally trimmed to within ±0.1% accuracy. If this accuracy is sufficient, then pin 30 should be left open. The gain adjustment is not necessary for ratiometric operation.

### ADJUSTMENT OF CLOCK FREQUENCY AND START RATE

1. To obtain optimum normal mode noise rejection at either 50 or 60 Hz, the Clock Frequency Adjust potentiometer should be adjusted to give the appropriate clock frequency shown in the table. This is most easily done using a frequency counter connected to the Clock Out (pin 46). Although a 200K adjustment potentiometer gives a full range of adjustment, most accurate adjustment is achieved by a 10K trimming potentiometer in series with an appropriate fixed resistor value.
2. The internal start pulse generator operates at a nominal rate of 2 pulses/second with no connection to pin 39. To increase the conversion rate a resistor may be connected as shown from pin 39 to +5V as illustrated in the calibration diagram.

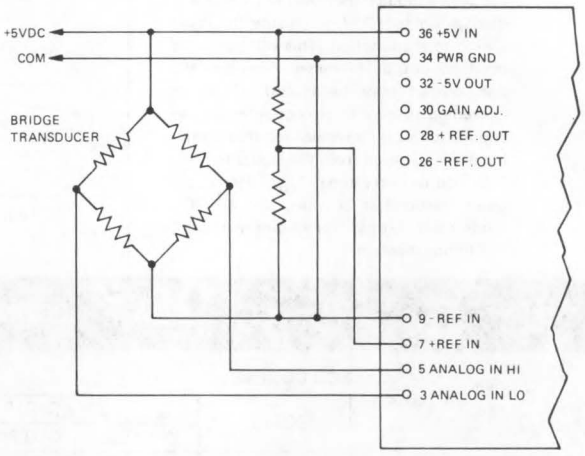
## RATIOMETRIC OPERATION



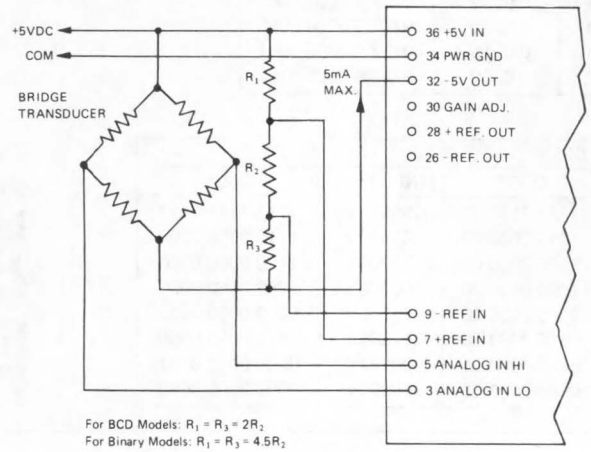

OUTPUT = $\frac{E_{IN}}{V_{REF}}$ X 2000 (BCD 3½ digit)

= $\frac{E_{IN}}{V_{REF}}$ X 4096 (Bin 12 bit)

## USING WITH BRIDGE TRANSDUCER EXCITED BY 5V SUPPLY

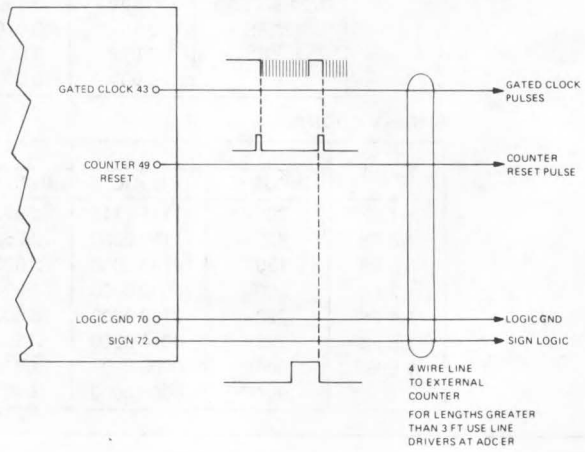



## USING WITH BRIDGE TRANSDUCER AND -5V OUTPUT TO MINIMIZE INPUT COMMON-MODE VOLTAGE




For BCD Models: $R_1 = R_3 = 2R_2$
For Binary Models: $R_1 = R_3 = 4.5R_2$

## DRIVING AN EXTERNAL COUNTER WITH THE GATED CLOCK & COUNTER RESET



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1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
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# PRECISION RATIOMETRIC DUAL SLOPE ANALOG TO DIGITAL CONVERTERS

# ADC-EP SERIES

## FEATURES

- 4½ Digit BCD or 14 Bit Binary
- 4 Wire Ratiometric Operation
- Auto-Zero Drift Correction
- Quartz Crystal Controlled Clock
- Floated Input, ±300V Range
- 60dB AC Line Noise Rejection

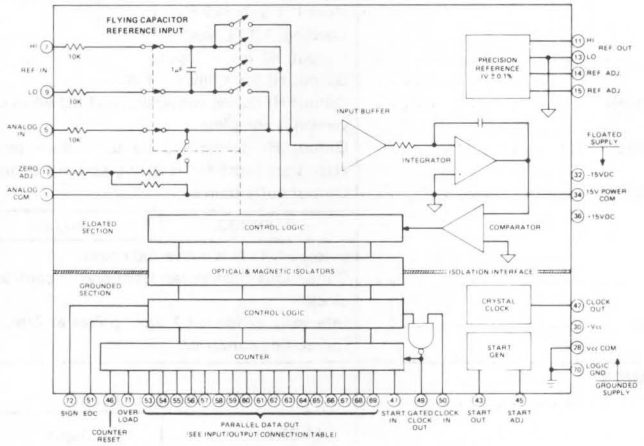
## GENERAL DESCRIPTION

The ADC-EP series are high resolution, ratiometric A/D converters using the dual slope conversion principle. The analog input is electrically floated from digital ground by means of optical and magnetic coupling of digital signals, to permit a ±300V common mode input voltage range with greater than 100dB common mode rejection. A four-wire ratiometric input permits separate connection to input signal and reference; the reference input is a flying capacitor circuit which allows the reference to operate at a different common mode level from the input signal, with greater than 70dB common mode rejection. The external reference may vary ±50% from the nominal value of 1.0 volt for ratiometric measurements; a stable internal reference of 1.00V ±0.1% is also provided for fixed reference operation.

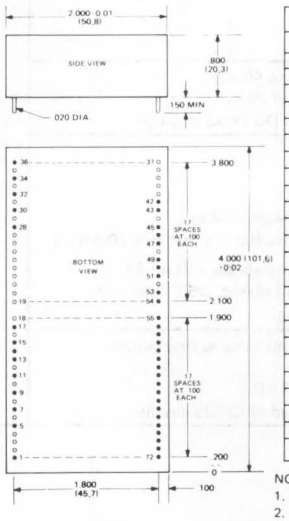
These converters are available in two basic models: a binary coded version with 14 bit resolution, and a BCD coded version with 4½ digit resolution. Both models use sign-magnitude coding. An internal quartz crystal controlled clock sets the signal integration time to a precise multiple of the AC line frequency to achieve greater than 60dB noise rejection of AC line noise. The converters can be ordered with clock frequency synchronized to either 50 or 60 Hz. An auto-zeroing circuit stabilizes the zero drift of the converters to less than ±1μV/°C. The conversion time, which includes an 80 msec. period for auto-zeroing, is 230 msec. for a 60Hz synchronized model and 260 msec. for a 50Hz synchronized model. Conversion can be initiated by either an external start pulse or by an internally generated pulse. Accuracy of both converters is .01% of reading ±1 count.

All digital outputs are from a CD4050 buffer, which will drive 1 TTL load or numerous CMOS loads. Other digital outputs include overrange on the BCD model, overload, sign, clock out, start out, and end of conversion (status). Two additional outputs, a gated clock and counter reset, permit serial transmission of output data to an external counter.

The unique features of these converters make them useful in a wide range of instrumentation and measurement applications. Power requirements are ±15VDC and +5V to +15VDC. Package size is 4 X 2 X 0.8 inches and operating temperature range is 0°C to 70°C.


## MECHANICAL DIMENSIONS INCHES (MM)




## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | ANALOG COMMON |
| 5 | ANALOG INPUT |
| 7 | REFERENCE HI INPUT |
| 9 | REFERENCE LO INPUT |
| 11 | REFERENCE HI OUTPUT |
| 13 | REFERENCE LO OUTPUT |
| 14 | REFERENCE ADJUST |
| 15 | REFERENCE ADJUST |
| 17 | ZERO ADJUST |
| 28 | Vcc POWER COMMON |
| 30 | +Vcc POWER IN |
| 32 | -15VDC POWER IN |
| 34 | 15V POWER COMMON |
| 36 | +15VDC POWER IN |
| 42 | CLOCK OUT |
| 43 | START OUT |
| 45 | START ADJUST |
| 46 | COUNTER RESET |
| 47 | START IN |
| 49 | GATED CLOCK OUT |
| 50 | CLOCK IN |
| 51 | E.O.C. (STATUS) |
| 70 | LOGIC GROUND |
| 71 | OVERLOAD |
| 72 | SIGN |

| PIN | DIGITAL OUTPUTS | |
|---|---|---|
| | BINARY BIT ADC-EP14B | BCD DIGIT ADC-EP16D |
| 53 | BIT 14 (LSB) | BIT 17 (1) |
| 54 | 13 | 16 (2) |
| 55 | 12 | 15 (4) |
| 56 | 11 | 14 (8) |
| 57 | 10 | 13 (10) |
| 58 | 9 | 12 (20) |
| 59 | 8 | 11 (40) |
| 60 | 7 | 10 (80) |
| 61 | 6 | 9 (100) |
| 62 | 5 | 8 (200) |
| 63 | 4 | 7 (400) |
| 64 | 3 | 6 (800) |
| 65 | 2 | 5 (1000) |
| 66 | X | 4 (2000) |
| 67 | X | 3 (4000) |
| 68 | X | 2 (8000) |
| 69 | BIT 1 (MSB) | BIT 1 (10,000) |

X INDICATES NO PIN

NOTES:
1. Open dots designate omitted pins
2. 0.100 inch = 2.5 MM
3. Pins 66, 67, 68 are omitted on Binary models
4. Pin position tolerance is ±0.005" from datum, non-accumulative

## SPECIFICATIONS, ADC-EP SERIES

Typical at 25°C, ±15V and +5V supplies unless otherwise noted

| | ADC-EP14B (Binary) | ADC-EP16D (BCD) |
|---|---|---|
| **INPUTS** | | |
| Analog Input Range | ±2V | * |
| Reference Input Range | 0.5 to 2.0V | * |
| Input Overvoltage, no damage[1] | ±25V | * |
| Input Impedance[1] | 100 Meg. min. | * |
| Input Bias Current[1] | 100pA max. | * |
| Common Mode Voltage Range[2] | ±300V max. | * |
| Common Mode Rej., DC-60Hz, 1K unbal.[2] | 100dB min. | * |
| Common Mode Range, ref. to analog com. | ±5V | * |
| Common Mode Rej. of Reference, DC-60Hz. | 70dB min. | * |
| Normal Mode Rej., 50 or 60 Hz | 60dB min. | * |
| Start Conversion | CMOS input, positive 0 to +Vcc pulse with 1 μsec min. duration. 100K input impedance. Logic "1" resets converter. Logic "0" initiates conversion. | |
| Clock In | CMOS input, positive 0 to +Vcc pulse with approx. 50% duty cycle. | |
| **OUTPUTS[3]** | | |
| Parallel Output Data | 14 parallel lines | 16 parallel lines and overrange |
| | Output data held until next start convert pulse. Positive true buffered CMOS outputs Vout ("0") ≤ +0.4V, Vout ("1") ≥ +2.5V } for Vcc = +5V. Loading: 1 TTL load. | |
| Sign | Output HI for + inputs | |
| Overload | Output HI for ± input > F.S. | |
| E.O.C. (Status) | Output HI during conversion and LO when conversion is complete. | |
| Counter Reset | Output HI during and up to 1 clock period after start pulse for resetting external counter. | |
| Gated Clock | Output pulse train of | |
| | N+8,192 | N+10,000 |
| | pulses where N is converted count. | |
| Clock | Continuous clock pulses from crystal controlled clock. | |
| Start Output | Internally generated 1 μsec. pulses at 2/second for starting converter. | |
| **PERFORMANCE** | | |
| Error, max. | .01% Reading ±1 count | |
| Resolution | 14 Bits | 4½ Digits |
| Coding | Sign-Mag. Binary | Sign-Mag. BCD |
| Temp. Coeff. of Gain, Converter | ±5ppm/°C max. | * |
| Temp. Coeff. of Gain, Reference | ±8 ppm/°C max. | * |
| Temp. Coeff. of Zero | ±1 μV/°C max. | * |
| Internal Reference Voltage | 1.00V ±0.1% | * |
| Conversion Time, 60Hz period | 230 msec. | * |
| Conversion Time, 50Hz period | 260 msec. | * |
| Warm-Up Time | 15 minutes | * |
| **POWER REQUIREMENT** | +15VDC ±0.5V at 45 mA<br>−15VDC ±0.5V at 20 mA<br>+5VDC to +15VDC (Vcc) at 6 mA | |
| **PHYSICAL-ENVIRONMENTAL** | | |
| Operating Temperature Range | 0°C to 70°C | |
| Storage Temperature Range | −55°C to +85°C | |
| Relative Humidity | Up to 100% non-condensing | |
| Case Size | 2 X 4 X 0.8 inches (50,8 X 101,6 X 20,3 mm) | |
| Case Material | Black diallyl phthalate per MIL-M-14 | |
| Pins | .020" round, gold plated, .150" long min. | |
| Weight | 8 oz. max. (227 g) | |

*Specifications same as first column.

1. Between ANALOG IN and ANALOG COM Terminals.
2. Between either ANALOG IN or ANALOG COM and DIGITAL GND.
3. All outputs are from a CD4050 buffer which can drive 1 TTL load or CMOS circuits.

## TECHNICAL NOTES

1. In order to make use of the floated analog input capability of the ADC-EP series, the ±15VDC analog power supply must be floated with respect to the digital logic supply (Vcc). If floated analog input is not required, then analog and digital grounds may be connected together. The analog input is single-ended with 100 megohm input impedance. The input bias current between ANALOG IN and ANALOG COMMON is 100 pA max. and this value doubles every 10°C.
2. The reference input is a flying capacitor circuit which permits the external reference to operate at a ±5V common mode voltage with respect to analog common with greater than 70dB CMR. The 1μF flying capacitor is charged from two 10K resistors which give a time constant of 20 msec. (not counting reference source impedance). This means that if the external reference changes value, 9 time constants or 180 msec. should be allowed before a correct conversion can be initiated. Or, more simply, after the reference changes to a new value approximately one full conversion period should be allowed before the next correct conversion. It should be noted that only one reference is required

## ORDERING INFORMATION

ADC-EP – ____ ____

| NO. OF BITS & CODING | NOISE REJ. FREQ. |
|---|---|
| 14B = 14 Binary Bits | 5 = 50Hz |
| 16D = 4½ BCD Digits | 6 = 60Hz |

### PRICES (1-9)

**ADC-EP16D-5 . . . . . $179.00**
**ADC-EP16D-6 . . . . . $179.00**
**ADC-EP14B-5 . . . . . $179.00**
**ADC-EP14B-6 . . . . . $179.00**

Mating Sockets: DILS-2 (4/module) $5.00/pair
Trimming Potentiometers:
TP200, TP100K at $3.00 each

For extended temperature range operation, the following suffixes are added to the model number. Consult factory for pricing and delivery.

-EX −25° to +85°C operation
-EXX-HS −55°C to +85°C operation with hermetically seaied semiconductor components.

The ADC-EP Series Converters are covered by GSA Contract

## TECHNICAL NOTES (cont'd)

for either polarity of analog input. The polarity of the analog input is automatically sensed by the converter.

3. Both ADC-EP models are internally calibrated to within ±2 LSB's at zero and ±0.1% at full scale. If this accuracy is sufficient in an application, no external adjustments are required. The internal 1.0 volt reference may also be used as a reference for other A/D converters or other circuits provided that its output is buffered with a voltage follower op amp of sufficient stability. Temperature coefficient of this reference is only ±8 ppm/°C and output impedance is 1.3K ohms.

4. For both models 80 milliseconds of the total conversion time is devoted to drift correction (auto-zeroing) before the next conversion cycle begins. A full scale input will be converted with parallel data ready in either 150 msec. (60Hz synchr.) or 180 msec. (50Hz synchr.). The E.O.C. (status) output changes state at this time, indicating that data is ready. The next conversion, however, should not be initiated until the 80 msec. auto-zero is completed. For inputs less than full scale, the output data is ready even sooner than 150 or 180 msec.

5. The converters can be operated with the internal start generator at 2 conversions/second or they can be started with an external start pulse at 3.8 conversions/sec. (50 Hz models) or 4.3 conversions/sec. (60 Hz models). The internal start pulse generator can also be slowed to less than 2 pulses/sec. by means of an external capacitor as shown in the application diagram.

6. The GATED CLOCK OUT and COUNTER RESET are convenient outputs for use with an external or remote counter in applications where serial data transmission is required.

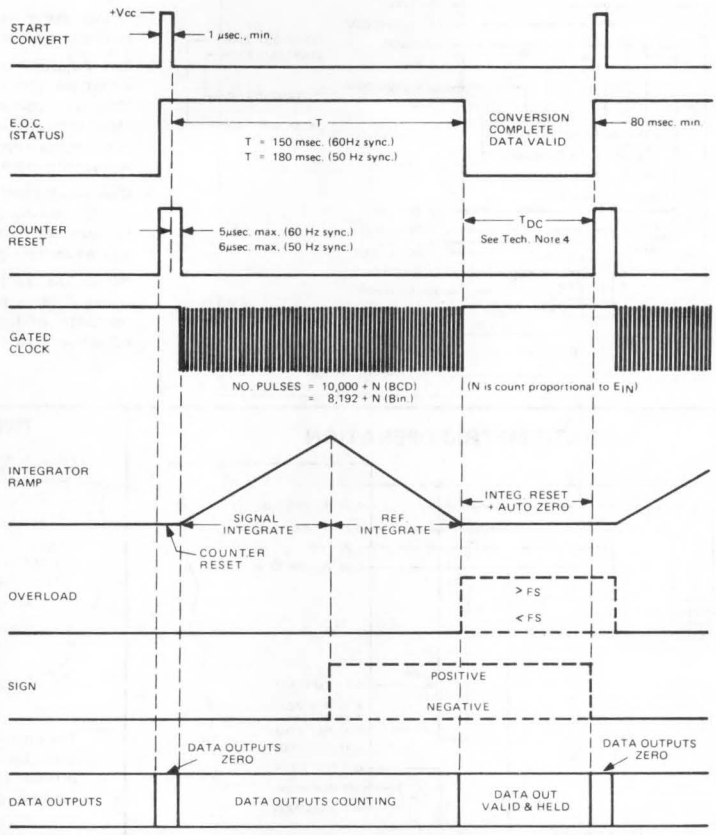
7. An external clock may also be used with the ADC-EP converters by providing an input pulse train from OV to +Vcc at approximately 50% duty cycle. For proper operation, the external clock frequency should be within ±10% of the internal crystal clock frequencies which are given here:

| | 50 Hz Sync. | 60 Hz Sync. |
|---|---|---|
| BCD | 166.66kHz | 200.00kHz |
| Bin | 136.53kHz | 163.84kHz |

8. The excellent normal mode rejection of AC power line frequency noise of the converters is due to the accurate and stable synchronization of the signal integration part of the conversion cycle with the line frequency. This synchronization is held to within 0.1% by the quartz crystal controlled clock. The correct model should be specified for operation with the appropriate AC line frequency.

## PERFORMANCE DATA

### TIMING DIAGRAM




## CODING TABLES

**BCD CODING**

| SCALE | 4½ DIGIT | |
|---|---|---|
| | INPUT (±) | OUTPUT CODE |
| FS-1LSB | 1.9999V | 1 1001 1001 1001 1001 |
| 3/4 FS | 1.5000V | 1 0101 0000 0000 0000 |
| 1/2 FS | 1.0000V | 1 0000 0000 0000 0000 |
| 1/2 FS-1LSB | 0.9999V | 0 1001 1001 1001 1001 |
| 1/4 FS | 0.5000V | 0 0101 0000 0000 0000 |
| 1 LSB | 0.0001V | 0 0000 0000 0000 0001 |
| 0 | 0.0000V | 0 0000 0000 0000 0000 |

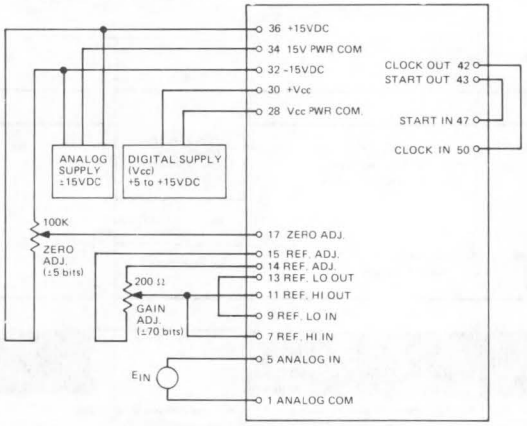
**BINARY CODING**

| SCALE | 14 BIT | |
|---|---|---|
| | INPUT (±) | OUTPUT CODE |
| FS-1LSB | 1.99988V | 1111 1111 1111 11 |
| 7/8 FS | 1.75000V | 1110 0000 0000 00 |
| 3/4 FS | 1.50000V | 1100 0000 0000 00 |
| 1/2 FS | 1.00000V | 1000 0000 0000 00 |
| 1/4 FS | 0.50000V | 0100 0000 0000 00 |
| 1/8 FS | 0.25000V | 0010 0000 0000 00 |
| 1 LSB | 0.00012V | 0000 0000 0000 01 |
| 0 | 0.00000V | 0000 0000 0000 00 |

DATEL

# CALIBRATION & APPLICATION

## STANDARD CONNECTIONS & CALIBRATION

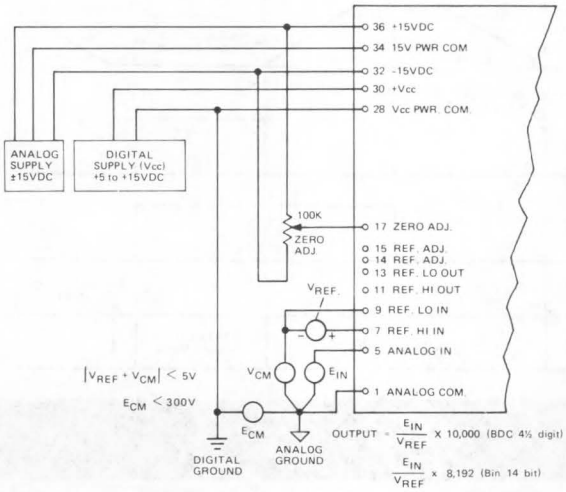



## CALIBRATION INSTRUCTIONS

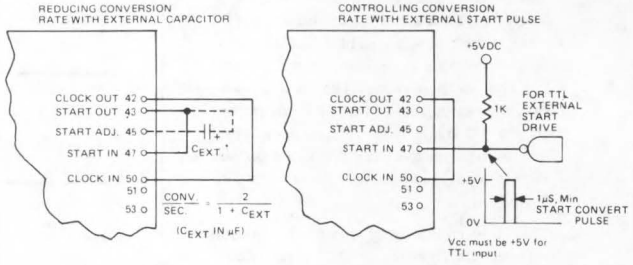
1. Connect the converter as shown in the diagram. Allow a 15 minute warm-up time before making final adjustments.
2. **Zero Adjustments.** Short together ANALOG IN (pin 5) and ANALOG COM (pin 1). Adjust the ZERO ADJ. potentiometer to obtain a flickering SIGN bit output (pin 72) along with logic zeros on all parallel data output lines. **NOTE:** The autozeroed initial offset is factory calibrated to within ±2 LSB's of zero (for either binary or BCD versions). If this is accurate enough for the required application, then no zeroing adjustment is required and pin 17 should be left open.
3. **Gain Adjustment.** Apply an external precision reference voltage between ANALOG IN (pin 5) and ANALOG COM (pin 1). Set the precision reference voltage to a voltage near full scale, say FS-1LSB (see coding tables), and adjust the GAIN ADJ. potentiometer to give the correct digital output code.

   **NOTE:** The gain (set by internal reference) is factory calibrated to within ±0.1%. If this is accurate enough for the required application, then no gain adjustment is required and the GAIN ADJ. potentiometer should be omitted. For ratiometric operation, a gain adjustment is not required.

## RATIOMETRIC OPERATION



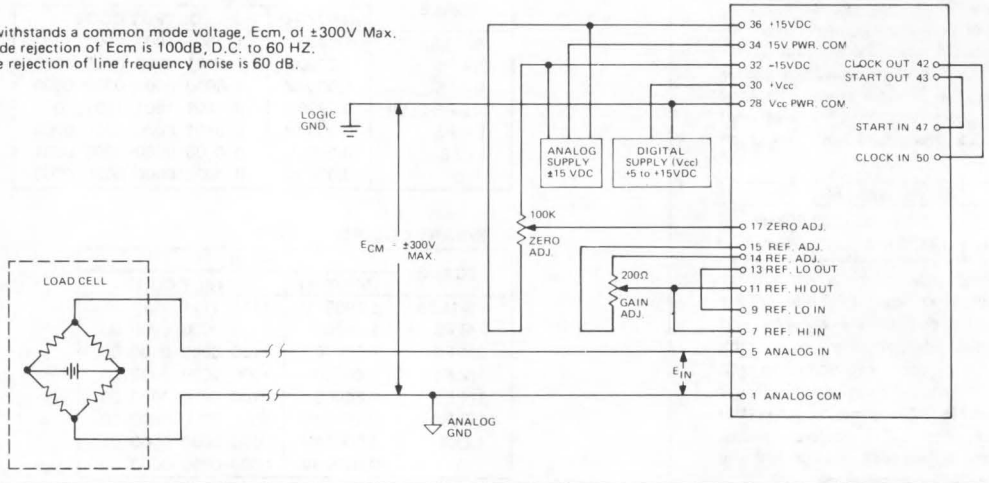

## TWO WAYS TO ALTER CONVERSION RATE




The internal start pulse generator operates at a nominal rate of 2 pulses/second. This rate may be decreased, however, by means of an external capacitor between START OUT (pin 43) and START ADJ. (pin 45). A tantalum capacitor may be used to give a conversion time as shown in the formula. Since the conversion time of the ADC-EP is either 230 or 260 msec., depending on the model, a conversion rate as fast as 4.3 conversions per second may be achieved using an external start convert pulse as shown in the second diagram. If the pulse is from a TTL logic source, a 1K pull-up resistor must be used along with Vcc voltage of +5VDC for the converter. The external start pulse may also be derived from CMOS logic in which case the same supply voltage must be used for the external logic and Vcc of the converter.

## MEASUREMENT OF LOAD CELL OUTPUT OVER LONG WIRES & HIGH COMMON MODE VOLTAGE

1. This circuit withstands a common mode voltage, Ecm, of ±300V Max.
2. Common mode rejection of Ecm is 100dB, D.C. to 60 HZ.
3. Normal mode rejection of line frequency noise is 60 dB.




DATEL

# D/A Converters Rapid Selection Guide

The Rapid Selection Guide presented below is a capsule summary of all of Datel Systems' D/A converter series. Because we manufacture the broadest line of DAC's in the industry, this table is a useful guide for quickly locating the converters, by price range and performance, that are most suitable for your application.

After locating the desired converter series, turn to the following pages which present more detailed specifications of the various models in tabular form.

| Converter Type | Series | Resolution | Output | Settling Time | Tempco | Price Range | See Page |
|---|---|---|---|---|---|---|---|
| Low Cost General Purpose | DAC-9, 19, 29 | 8 Bits | Current, Voltage | 300-500 nsec, 5-20μsec. | 50-100 ppm/°C | $14.95 - $39 | 70 |
| | DAC-49 | 10 Bits | Current, Voltage | 300 nsec, 5 μsec. | 50 ppm/°C | $49.00 | 70 |
| | DAC-69 | 12 Bits | Current, Voltage | 300 nsec, 20 μsec. | 50 ppm/°C | $59.00 | 70 |
| High Performance Moderate Cost | DAC-HB | 8, 10, 12 Bits | Voltage | 5 μsec. | 30 ppm/°C | $65 - $89 | 72 |
| | DAC-I | 8, 10, 12 Bits | Current | 150 nsec. | 15 ppm/°C | $69 - $89 | 72 |
| | DAC-R | 8, 10, 12 Bits | Voltage | 5 μsec. | 30 ppm/°C | $69 - $79 | 72 |
| | DAC-V | 8, 10, 12 Bits | Voltage | 2 μsec. | 20 ppm/°C | $79 - $119 | 72 |
| High Speed | DAC-FI-GI, HI | 8, 10, 12 Bits | Current | 25-100 nsec. | 15-30 ppm/°C | $79 - $129 | 74 |
| | DAC-HV-100 | 6, 8, 10 Bits | Voltage | 50-100 nsec. | 60 ppm/°C | $169 - $189 | 74 |
| Low Drift and High Resolution | DAC-169 | 16 Bits | Current, Voltage | 750 nsec, 30 μsec. | 10 ppm/°C | $109.00 | 76 |
| | DAC-HR | 13, 14, 15, 16 Bits | Current | 1 μsec. | 1.5 ppm/°C | $249 - $299 | 76 |
| | DAC-TR | 8, 10, 12 Bits | Voltage | 5 μsec. | 7 ppm/°C | $129 - $179 | 76 |
| Special Purpose | DAC-CM | 8, 10, 12 Bits | Voltage | 25 μsec. | 30 ppm/°C | $119 - $139 | 78 |
| | DAC-DG | 12 Bits | Voltage | 600 nsec. | 35 ppm/°C | $249.00 | 78 |
| | DAC-MI, MV | 8, 10, 12 Bits | Current, Voltage | 150 nsec, 4 μsec. | 30 ppm/°C | $119 - $159 | 78 |
| | DAC-VR | 8, 10, 12 Bits | Voltage | 2 μsec. | 20 ppm/°C | $ 89 - $129 | 78 |
| Hybrid and Monolithic | DAC-IG | 8, 10 Bits | Current | 250-300 nsec. | 20 ppm/°C | $ 8.95 | 80 |
| | DAC-HZ, HK | 12 Bits | Voltage | 3 μsec. | 10-20 ppm/°C | $ 39 - $139 | 80 |
| | DAC-HF | 8, 10, 12 Bits | Current | 50 nsec. | 30 ppm/°C | * | 80 |
| | DAC-HA | 12 Bits | Current | 500 nsec. | 3 ppm/°C | * | 80 |
| | DAC-HC | 12 Bits | Voltage | 10 μsec. | 20 ppm/°C | * | 80 |
| | DAC-HU | 4 Bits | Current | 20 nsec. | 40 ppm/°C | * | 80 |

*To be announced.

# Low Cost, General Purpose D/A Converters

| | Model | Resolution | Accuracy (% FS) | Output | Settling Time | Linearity |
|---|---|---|---|---|---|---|
| Lowest Cost Current Output | DAC-98BI (1) | 8 Bits | 0.2% | Current | 500 nsec. | 1/2 LSB |
| | DAC-98DI (1) | 2 Digits | 0.5% | | | |
| | DAC-98BIR | 8 Bits | 0.2% | | | |
| | DAC-98DIR | 2 Digits | 0.5% | | | |
| 8 Bit Voltage & Current Output | DAC-198B | 8 Bits | 0.2% | Voltage | 20 μsec. | 1/2 LSB |
| | DAC-198D | 2 Digits | 0.5% | Voltage | 20 μsec. | |
| | DAC-198BI | 8 Bits | 0.2% | Current | 300 nsec. | |
| | DAC-198DI | 2 Digits | 0.5% | Current | 300 nsec. | |
| 5 μsec. Settling Time | DAC-298B | 8 Bits | 0.2% | Voltage | 5 μsec. | 1/2 LSB |
| | DAC-298D | 2 Digits | 0.5% | | | |
| 10 Bit Voltage & Current Output | DAC-4910B | 10 Bits | .05% | Voltage | 5 μsec. | 1/2 LSB |
| | DAC-4910BI | 10 Bits | .05% | Current | 300 nsec. | |
| | DAC4912D | 3 Digits | .05% | Voltage | 5 μsec. | |
| | DAC-4912DI | 3 Digits | .05% | Current | 300 nsec. | |
| 12 Bit Voltage & Current Output | DAC-6912B | 12 Bits | .01% | Voltage | 20 μsec. | 1/2 LSB |
| | DAC-6912BI | 12 Bits | .01% | Current | 300 nsec. | |

NOTES: 1. These models derive their reference from the +15V supply.

2. Coding: Bin = Straight binary or offset binary
BCD = Binary coded decimal
2C = Two's complement

**DAC-9 SERIES:** These low cost modular DAC's feature an excellent choice of both current and voltage output models with 8 to 12 bit resolutions. All units have internal voltage references except for DAC-98BI and DAC-98DI which derive their reference voltage from the +15 volt supply. Output settling times vary from 300 to 500 nsec. for current outputs and from 5 μsec. to 20 μsec. for voltage outputs.

**ALL MODELS:** have operating temperature range of 0°C to 70°C; have DTL/TTL compatible inputs; use DIL-1 or DILS-2 dual-in-line strips for sockets.

*See pages 284 and 285 for information on Extended Performance versions.*


| Input Coding (2) | Output Ranges | Gain Tempco | Power Requirement | Case Size (inches) | Price (1-9) | See Page |
|---|---|---|---|---|---|---|
| Bin | 0 to +2.6 mA | 100 ppm/°C | +15V | 2 x 1 x 0.375 | $14.95 | * |
| BCD | 0 to +1.6 mA | | | | $14.95 | |
| Bin | 0 to +2.6 mA | | | | $16.95 | |
| BCD | 0 to +1.6 mA | | | | $16.95 | |
| Bin, 2C | 0 to +10V, ±5V | 50 ppm/°C | ±15V | 2 x 2 x 0.375 | $29.00 | * |
| BCD | 0 to +10V | | | | $29.00 | |
| Bin | 0 to +2.5 mA | | | | $29.00 | |
| BCD | 0 to +1.54 mA | | | | $29.00 | |
| Bin, 2C | 0 to +10V, ±5V | 50 ppm/°C | ±15V | 2 x 2 x 0.375 | $39.00 | * |
| BCD | 0 to +10V | | | | $39.00 | |
| Bin, 2C | 0 to +10V, ±5V | 50 ppm/°C | ±15V | 2 x 2 x 0.375 | $49.00 | * |
| Bin | 0 to +2.5 mA | | | 2 x 2 x 0.375 | $49.00 | |
| BCD | 0 to +10V | | | 2 x 2 x 0.375 | $49.00 | |
| BCD | 0 to +1.54 mA | | | | $49.00 | |
| Bin, 2C | 0 to +10V, ±5V | 50 ppm/°C | ±15V | 2 x 2 x 0.375 | $59.00 | * |
| Bin | 0 to +2.5 mA | | | | $59.00 | |

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# High Performance, Moderate Cost D/A Converters

| | Model | Resolution | Accuracy (% FS) | Output | Settling Time | Linearity |
|---|---|---|---|---|---|---|
| Voltage Output, 5 μsec. Settling | DAC-HB8B | 8 Bits | 0.2% | Voltage | 5 μsec | 1/2 LSB |
| | DAC-HB10B | 10 Bits | .05% | | | |
| | DAC-HB12B | 12 Bits | .01% | | | |
| | DAC-HB12D | 3 Digits | .05% | | | |
| Current Output, 150 nsec. Settling | DAC-I8B | 8 Bits | 0.2% | Current | 150 nsec. | 1/2 LSB |
| | DAC-I10B | 10 Bits | .05% | | | |
| | DAC-I12B | 12 Bits | .01% | | | |
| | DAC-I8D | 2 Digits | 0.5% | | | |
| | DAC-I12D | 3 Digits | .05% | | | |
| DAC-12QZ Equivalent → | DAC-R8B | 8 Bits | 0.2% | Voltage | 5 μsec. | 1/2 LSB |
| | DAC-R10B | 10 Bits | .05% | | | |
| | DAC-R12B | 12 Bits | .01% | | | |
| | DAC-R8D | 2 Digits | 0.5% | | | |
| | DAC-R12D | 3 Digits | .05% | | | |
| Fast, Voltage Output 2 μsec. Settling | DAC-V8B | 8 Bits | 0.2% | Voltage | 2 μsec. | 1/2 LSB |
| | DAC-V10B | 10 Bits | .05% | | | |
| | DAC-V12B | 12 Bits | .01% | | | |
| | DAC-V8D | 2 Digits | 0.5% | | | |
| | DAC-V12D | 3 Digits | .05% | | | |

NOTE: 1. Coding: Bin = Straight binary or offset binary
BCD = Binary coded decimal
C Bin = Complementary binary
C BCD= Complementary BCD

**DAC-HB SERIES:** These models feature voltage outputs with settling time of 5 μsec. Resolution is 8-12 bits with a 3 digit BCD model. Unipolar or bipolar operation is obtained by pin connection.

**DAC-I SERIES:** This series features low drift (15ppm/°C) current outputs with 150 nsec. settling time. Resolution is 8 through 12 bits with 2 BCD models.

**DAC-R SERIES:** This general purpose series features 8 through 12 bit performance with complementary input coding. Voltage output settling time is 5 μsec. The DAC-R12B is a pin and performance equivalent of the popular DAC-12QZ converter.

**DAC-V SERIES:** These models are fast settling (2 μsec.) voltage output devices with 8, 10, and 12 bit resolutions.

**ALL MODELS:** have operating temperature range of 0°C to 70°C; have DTL/TTL compatible inputs; use DILS-1 or DILS-2 dual-in-line strips for sockets.

*See pages 284 and 285 for information on Extended Performance versions.*


| Input Coding (1) | Output Ranges | Gain Tempco | Power Requirement | Case Size (inches) | Price (1-9) | See Page |
|---|---|---|---|---|---|---|
| | | | | | $ 65.00 | |
| Bin | 0 to +10V, ±5V | 30 ppm/°C | ±15V | 2 x 1.5 x 0.375 | $ 79.00 | * |
| | | | | | $ 89.00 | |
| BCD | 0 to +10V | | | | $ 89.00 | |
| | | | | | $ 69.00 | |
| Bin | 0 to +2, ±1 mA | | | | $ 79.00 | |
| | | 15 ppm/°C | ±15V | 2 x 1 x 0.375 | $ 89.00 | * |
| BCD | 0 to +1.25 mA | | | | $ 69.00 | |
| | | | | | $ 89.00 | |
| | ±2.5, ±5, ±10V | | | | $ 69.00 | |
| C Bin | 0 to +5, +10V | | | | $ 75.00 | |
| | | 30 ppm/°C | ±15V, +5V | 2 x 2 x 0.375 | $ 79.00 | 99 |
| C BCD | 0 to +5, +10V | | | | $ 69.00 | |
| | | | | | $ 79.00 | |
| | ±5, ±10V | | | | $ 79.00 | |
| Bin | 0 to +5, +10V | | | | $ 99.00 | |
| | | 20 ppm/°C | ±15V | 2 x 2 x 0.375 | $119.00 | * |
| BCD | 0 to +5, +10V | | | | $ 79.00 | |
| | | | | | $119.00 | |

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# High Speed D/A Converters

**DAC-FI, GI, HI SERIES:** These fast current output models feature settling times from 100 nsec. down to 25 nsec. Resolution is from 8 bits to 12 bits with temperature coefficients from 30ppm/°C down to 15ppm/°C. This series is designed to drive a small value load resistor directly or the summing junction of a fast operational amplifier.

**DAC-HV-100 SERIES:** These ultra fast voltage output models have settling times from 100 nsec. to 50 nsec. with an output drive capability up to 100mA. These devices are ideal for fast applications where it is necessary to drive a 50 ohm cable directly.

**ALL MODELS:** have operating temperature range of 0°C to 70°C; have DTL/TTL compatible inputs; use DILS-1 or DILS-2 dual-in-line strips for sockets.

*See pages 284 and 285 for information on Extended Performance versions.*

| | Model | Resolution | Accuracy (% FS) | Output | Settling Time | Linearity |
|---|---|---|---|---|---|---|
| 100 nsec. Current Out | DAC-FI8B | 8 Bits | 0.2% | Current | 100 nsec. | 1/2 LSB |
| | DAC-FI10B | 10 Bits | .05% | | | |
| 50 nsec. Current Out | DAC-GI8B | 8 Bits | 0.2% | Current | 50 nsec. | 1/2 LSB |
| | DAC-GI10B | 10 Bits | .05% | | | |
| 25 & 50 nsec. Current Out | DAC-HI8B | 8 Bits | 0.2% | Current | 25 nsec. | 1/2 LSB |
| | DAC-HI10B | 10 Bits | .05% | | 25 nsec. | |
| | DAC-HI12B | 12 Bits | .01% | | 50 nsec. | |
| 50 & 100 nsec. Voltage Out | DAC-HV6B-100 | 6 Bits | 0.8% | Voltage (1) | 50 nsec. | 1/2 LSB |
| | DAC-HV8B-100 | 8 Bits | 0.2% | | 50 nsec. | |
| | DAC-HV10B-100 | 10 Bits | .05% | | 100 nsec. | |

NOTES: 1. Has 100 mA output current drive capability.
2. Coding: Bin = Straight binary or offset binary


| Input Coding (2) | Output Ranges | Gain Tempco | Power Requirement | Case Size (inches) | Price (1-9) | See Page |
|---|---|---|---|---|---|---|
| Bin | ±2.5, +5 mA | 30 ppm/°C | ±15V | 2 x 2 x 0.375 | $ 79.00 | 91 |
| | | | | | $ 99.00 | |
| Bin | ±2.5, +5 mA | 30 ppm/°C | ±15V | 2 x 2 x 0.375 | $ 89.00 | 91 |
| | | | | | $109.00 | |
| Bin | ±2.5, +5 mA | 15ppm/°C | ±15V | 2 x 2 x 0.375 | $ 99.00 | 91 |
| | | 15 ppm/°C | | | $119.00 | |
| | | 20 ppm/°C | | | $129.00 | 95 |
| Bin | 0 to +5V | 60 ppm/°C | ±15V | 3 x 2 x 0.375 | $169.00 | 97 |
| | | | | | $179.00 | |
| | | | | | $189.00 | |

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# Low Drift and High Resolution D/A Converters

| | Model | Resolution | Accuracy (% FS) | Output | Settling Time | Linearity |
|---|---|---|---|---|---|---|
| Low Cost 16 Bits | DAC-169-16B | 16 Bits | .005% | Voltage (1) | 30 μsec. | 4 LSB |
| | DAC-169-16D | 4 Digits | | | | 1/2 LSB |
| Ultra Low Drift, 1.5 ppm/°C | DAC-HR13B | 13 Bits | .006% | Current | 1 μsec. | 1/2 LSB |
| | DAC-HR14B | 14 Bits | .003% | | | 1/2 LSB |
| | DAC-HR15B | 15 Bits | .0015% | | | 1/2 LSB |
| | DAC-HR16B | 16 Bits | .0015% | | | 1 LSB |
| Low Drift, 7 ppm/°C | DAC-TR8B | 8 Bits | 0.2% | Voltage | 5 μsec. | |
| | DAC-TR10B | 10 Bits | .05% | | | |
| | DAC-TR-12B | 12 Bits | .01% | | | 1/2 LSB |
| | DAC-TR-8D | 2 Digits | 0.5% | | | |
| | DAC-TR-12D | 3 Digits | .05% | | | |

NOTES: 1. Can also be connected for current output. Current output is 0 to + 2mA or ±1 mA for binary version and 0 to + 1.25 mA for BCD version.

2. Coding: Bin = Straight binary or offset binary
BCD = Binary coded decimal
C Bin = Complementary binary
C BCD = Complementary BCD

**DAC-169 SERIES:** These low cost, high resolution DAC's feature 16 bit or 4 BCD digit resolution with .005% linearity and 10ppm/°C temperature coefficient. By pin connection the output can be configured for either voltage or current output.

**DAC-HR SERIES:** This series features 13 through 16 bit resolutions with an ultra-low tempco of only 1.5ppm/°C. This is achieved by a low T.C. resistor network and an oven controlled zener reference. Linearity is .0015% and these models have current outputs.

**DAC-TR SERIES:** These models feature low tempco (7ppm/°C) voltage outputs with 5μsec. settling time. Input coding is complementary binary or complementary BCD.

**ALL MODELS:** have operating temperature range of 0°C to 70°C; have DTL/TTL compatible inputs; use DILS-1 or DILS-2 dual-in-line strips for sockets.

*See pages 284 and 285 for information on Extended Performance versions.*


| Input Coding (2) | Output Ranges | Gain Tempco | Power Requirement | Case Size (inches) | Price (1-9) | See Page |
|---|---|---|---|---|---|---|
| Bin | +10V, −10V, ±5V | 10 ppm/°C | ±15V | 2 x 2 x 0.375 | $109.00 | 101 |
| BCD | +10V, −10V | | | | $109.00 | |
| C Bin | 0 to +2mA, ±1mA | 1.5 ppm/°C | ±15V | 4 x 2 x 0.4 | $249.00 | 103 |
| | | | | | $263.00 | |
| | | | | | $276.00 | |
| | | | | | $299.00 | |
| C Bin | ±2.5, ±5, ±10V<br>0 to +5, +10V | 7 ppm/°C | ±15V, +5V | 2 x 2 x 0.375 | $129.00 | 99 |
| | | | | | $159.00 | |
| | | | | | $179.00 | |
| C BCD | 0 to +5, +10V | | | | $129.00 | |
| | | | | | $179.00 | |

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# Special Purpose D/A Converters

| | Model | Resolution | Accuracy (% FS) | Output | Settling Time | Linearity |
|---|---|---|---|---|---|---|
| Low Power CMOS | DAC-CM8B | 8 Bits | 0.2% | Voltage | 25 μsec. | 1/2 LSB |
| | DAC-CM10B | 10 Bits | .05% | | | |
| | DAC-CM12B | 12 Bits | .01% | | | |
| Deglitched DAC | DAC-DG12B1 | 12 Bits | .01% | Voltage (1) | 600 nsec. | 1/2 LSB |
| | DAC-DG12B2 | 12 Bits | .01% | | | |
| Multiplying DAC, Two Quadrant | DAC-MI8B | 8 Bits | 0.2% | Current | 150 nsec. | 1/2 LSB |
| | DAC-MI10B | 10 Bits | .05% | | | |
| | DAC-MI12B | 12 Bits | .01% | | | |
| | DAC-MI8D | 2 Digits | 0.5% | | | |
| | DAC-MI12D | 3 Digits | .05% | | | |
| Multiplying DAC, Four Quadrant | DAC-MV8B | 8 Bits | 0.2% | Voltage | 4 μsec. | 1/2 LSB |
| | DAC-MV10B | 10 Bits | .05% | | | |
| | DAC-MV12B | 12 Bits | .01% | | | |
| | DAC-MV8D | 2 Digits | 0.5% | | | |
| | DAC-MV12D | 3 Digits | .05% | | | |
| Digital Input Register | DAC-VR8B | 8 Bits | 0.2% | Voltage | 2 μsec. | 1/2 LSB |
| | DAC-VR10B | 10 Bits | .05% | | | |
| | DAC-VR12B | 12 Bits | .01% | | | |
| | DAC-VR8D | 2 Digits | 0.5% | | | |
| | DAC-VR12D | 3 Digits | .05% | | | |

**NOTES:** 1. Glitch amplitude is ±2 LSB's maximum.

2. Coding: Bin = Straight binary or offset binary
BCD = Binary coded decimal
2C = Two's complement

**DAC-CM SERIES:** These 8, 10, and 12 bit models are low power CMOS devices consuming only 40 milliwatts of power. They are ideal for portable and remote instrumentation systems.

**DAC-DG SERIES:** These devices are 12 bit self-contained deglitched DAC's in a compact 4 x 2 x 0.4 inch module. Output settling is a fast 600 nsec. and glitch amplitude is less than 2 LSB's.

**DAV-MI, MV SERIES:** These 8, 10, and 12 bit DAC's feature 2 and 4 quadrant multiplying capability with voltage or current outputs and excellent bandwidth.

**DAC-VR SERIES:** These 8, 10, and 12 bit models have a fast (2 μsec.) voltage output with a 20ppm/°C tempco. They feature a digital input storage register for maximum flexibility in transferring input data.

**ALL MODELS:** Have operating temperature range of 0°C to 70°C; have DTL/TTL compatible inputs, except for DAC-CM, which is CMOS; use DILS-1 or DILS-2 dual-in-line strips for sockets.

*See pages 284 and 285 for information on Extended Performance versions.*


| Input Coding (2) | Output Ranges | Gain Tempco | Power Requirement | Case Size (inches) | Price (1-9) | See Page |
|---|---|---|---|---|---|---|
| Bin | | 30 ppm/°C | ±15V | 2 x 2 x 0.375 | $119.00<br>$129.00<br>$139.00 | * |
| Bin | −10V; ±5, ±10V | 35 ppm/°C | ±15V, +5V | 4 x 2 x 0.4 | $249.00 | * |
| 2C | ±5V, ±10V | | | | $249.00 | |
| Bin | ± 1mA | 30 ppm/°C | ±15V | 3 x 2 x 0.375 | $119.00<br>$129.00<br>$159.00 | * |
| BCD | 0 to −1.25 mA | | | | $119.00<br>$159.00 | |
| Bin | ±5V, ±10V | 30 ppm/°C | ±15V | 3 x 2 x 0.375 | $119.00<br>$129.00<br>$159.00 | * |
| BCD | 0 to +5, +10V | | | | $119.00<br>$159.00 | |
| Bin | ±5V, ±10V<br>0 to +5, +10V | 20 ppm/°C | ±15V, +5V | 2 x 2 x 0.375 | $ 89.00<br>$109.00<br>$129.00 | * |
| BCD | 0 to +5, +10V | | | | $ 89.00<br>$129.00 | |

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# Hybrid and Monolithic D/A Converters

**DAC-IC SERIES:** These 8 and 10 bit DAC's are low cost current output models. They are monolithic devices in 16 pin DIP packages. The 10 bit models are coming soon.

**DAC-HA SERIES:** These models are new 12 bit multiplying CMOS DAC's with current output. Coming soon.

**DAC-HC SERIES:** These new models are high performance, low power CMOS units with internal reference and output amplifier Unipolar or bipolar operation is achieved by external pin connection. Coming soon.

**DAC-HP SERIES:** This series consists of a 16 bit binary and a 4 digit BCD model. The two models have voltage outputs and are housed in a metal case. Coming soon

**DAC-HZ SERIES:** These high performance 12 bit DAC's have pin-programmable outputs and a 20 ppm/°C tempco Models are available with either complementary binary or complementary BCD coding. A low drift version has a 10 ppm/°C max tempco. The different models in this series operate over 3 different temperature ranges and are in glass or metal cases.

| | Model | Resolution | Accuracy (% FS) | Output | Settling Time | Linearity |
|---|---|---|---|---|---|---|
| 8 Bit Monolithic | DAC-IC8BC | 8 Bits | 0.2% | Current | 300 nsec. | 1/2 LSB |
| | DAC-IC8BM | 8 Bits | 0.2% | | | |
| Coming! 10 Bit Monolithic | DAC-IC10BC | 10 Bits | .05% | Current | 250 nsec. | 1/2 LSB |
| | DAC-IC10BM | 10 Bits | .05% | | | |
| Coming! 12 Bit Hybrid CMOS | DAC-HA12B | 12 Bits | .01% | Current | 500 nsec. | 1/2 LSB |
| | DAC-HA12D | 3 Digits | .05% | | | |
| Coming! 12 Bit Hybrid CMOS | DAC-HC12B | 12 Bits | .01% | Voltage | 5 μsec. | 1/2 LSB |
| | DAC-HC12D | 3 Digits | .01% | | | |
| Coming! 16 Bit Hybrid | DAC-HP16BM | 16 Bits | .005% | Voltage | 10 μsec. | 4 LSB |
| | DAC-HP16DM | 4 Digits | .005% | | | 1/2 LSB |
| High Performance 12 Bit Hybrids | DAC-HZ12BGC | 12 Bits | .01% | Voltage | 3 μsec. | 1/2 LSB |
| | DAC-HZ12BGR | 12 Bits | .01% | | | |
| | DAC-HZ12BMC | 12 Bits | .01% | | | |
| | DAC-HZ12BMR | 12 Bits | .01% | | | |
| | DAC-HZ12BMR-1 | 12 Bits | .01% | | | |
| | DAC-HZ12BMM | 12 Bits | .01% | | | |
| Coming! Hybrid w. Input Register | DAC-HK12B | 12 Bits | .01% | Voltage | 3 μsec. | 1/2 LSB |
| | DAC-HK12D | 3 Digits | .05% | | | |
| Coming! Fast, Current Output Hybrids | DAC-HF8B | 8 Bits | 0.2% | Current | 50 nsec. | 1/2 LSB |
| | DAC-HF10B | 10 Bits | .05% | | | |
| | DAC-HF12B | 12 Bits | .01% | | | |
| Coming! Ultra-Fast | DAC-HU4B | 4 Bits | 3.0% | Current | 20 nsec. | 1/4 LSB |

NOTES: 1. All models in this series are also available with 3 digit BCD coding. Prices are same as binary. For correct model designation, change "B" to "D" in model number.

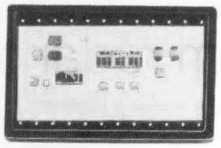
2. Coding: Bin = Straight binary or offset binary
BCD = Binary coded decimal
C Bin = Complementary binary or comp. offset Bin
C BCD = Complementary binary coded decimal
15 line = 8 bit input, no coding

**DAC-HK SERIES:** These models are identical in performance with the DAC-HZ series except that they have an input digital register. Coming soon.

**DAC-HF SERIES:** This series of 8, 10, and 12 bit current output models feature a 10 mA full scale output current which settles in 50 nsec. for high speed applications. Coming soon.

**DAC-HU4B:** This model is a 4 bit, 15 line ECL input DAC for very fast applications. The 15 mA full scale output current settles in 20 nsec. Coming soon.

**ALL MODELS:** Have operating temperature range of 0°C to 70°C except for those models specified otherwise; have DTL/TTL compatible inputs except for DAC-HU4B which is ECL compatible; use DILS-3 24 pin socket except for DAC-IC series, DAC-HA series and DAC-HU4B.





| Input Coding | Output Ranges | Gain Tempco | Temp. Range | Power Requirement | Case | Price (1-9) | See Page |
|---|---|---|---|---|---|---|---|
| Bin | 0 to -2 mA | 20 ppm/°C | 0 to 70C | +5V, -15V | 16 Pin DIP | $8.95 | 83 |
| | | | -55 to +125C | | | $12.45 | |
| Bin | 0 to -4 mA | 20 ppm/°C | 0 to 70C | +5V, -15V | 16 Pin DIP | $14.90 | ** |
| | | | -55 to +125C | | | * | |
| Bin | ±1 mA | 3 ppm/°C | 0 to 70C | +5V | 18 Pin DIP | * | ** |
| BCD | | | | | | * | |
| Bin | +5, +10, ±2.5, ±5, ±10V | 20 ppm/°C | 0 to 70C | ±15V | 24 Pin DIP | * | ** |
| BCD | 0 to +5, +10V | | | | | * | |
| C Bin | 0 to +10, ±5V | 20 ppm/°C | 0 to 70C | ±15V | 24 Pin DIP (Metal) | * | ** |
| C BCD | 0 to +10V | | | | | * | |
| C Bin (1) | ±2.5, ±5, ±10V 0 to +5, +10V | 20 ppm/°C | 0 to 70C | ±15V | 24 Pin DIP | $39.00 | 87 |
| | | 20 ppm/°C | -25 to +85C | | | $55.00 | |
| | | 20 ppm/°C | 0 to 70C | | 24 Pin DIP (Metal) | $49.00 | |
| | | 20 ppm/°C | -25 to +85C | | | $69.00 | |
| | | 10 ppm/°C | -25 to +85C | | | $139.00 | |
| | | 20 ppm/°C | -55 to +125C | | | $119.00 | |
| Binary | 0 to +10, ±5, ±10V | 20 ppm/°C | 0 to 70C | ±15V, +5V | 24 Pin DIP | * | ** |
| BCD | 0 to +5, +10V | | | | | * | |
| Bin | 0 to +10 mA | 20 ppm/°C | 0 to 70C | ±15V | 24 Pin DIP (Metal) | * | ** |
| | | | | | | * | |
| | | | | | | * | |
| | | | | | | * | |
| 15 Line | 0 to -15 mA | 40 ppm/°C | 0 to 70C | -4.4V | 32 Pin DIP | * | ** |

**THESE CONVERTERS ARE COVERED BY GSA CONTRACT**

***To be announced**

****Contact nearest Datel sales office for data sheet and availability.**

# From radar to computer...


## the DATEL* CONNECTION

The Datel ADC-UH series gives you a choice of three state-of-the-art ultra-high-speed analog to digital converters. Available are four, six and eight binary bits operating at word repetition rates of up to 25 MHz and a four bit version capable of making a conversion every forty nanoseconds.

They measure a mere 3"x5"x1.15" or about one fifth the size of their nearest rival. Power drain has been reduced to eight watts, temperature coefficient is 50ppm/ C and long term stability ±.25%/ year.

Output digital coding is straight binary for a unipolar input and inverted offset binary for the optional bipolar input. All control inputs, outputs and data output lines are compatible with standard TTL logic levels. A companion to the ADC-UH series is our SHM-UH Sample/Hold amplifier unit, which features a tracking capability of 35 nanoseconds with an aperture time of less than 200 picoseconds. For complete details on both devices, call or write

* DATEL SYSTEMS, INC.

1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
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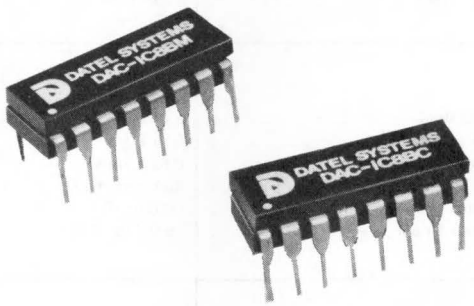
# LOW COST, 8 BIT MONOLITHIC DIGITAL TO ANALOG CONVERTERS

# MODELS DAC-IC8BC, DAC-IC8BM

**$5.95 IN 100's**




## FEATURES

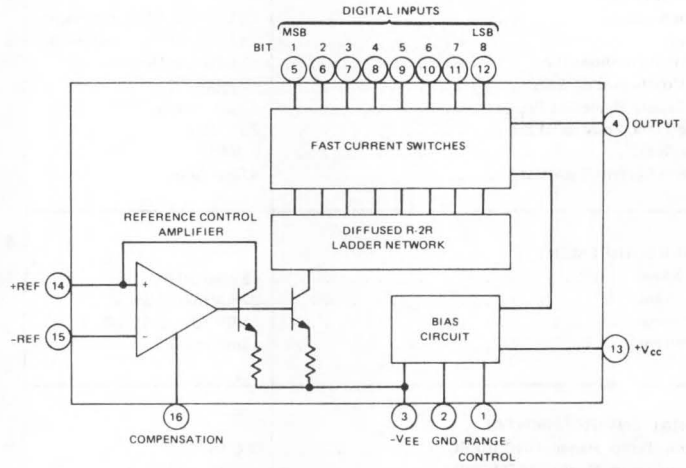
- **Low Cost—$5.95 in 100's**
- **8 Bit Resolution**
- **Fast Settling—300 nsec.**
- **1 or 2 Quadrant Multiplication**
- **±½LSB Linearity**
- **DTL/TTL Compatible Inputs**

The DAC-IC8BC and DAC-IC8BM are 8 bit monolithic DAC's with fast settling current outputs. The units are housed in a 16 pin ceramic DIP and require only an external reference and output amplifier for fast voltage output operation. A full scale output change settles in only 300 nanoseconds for current output operation and 600 nanoseconds for voltage output operation using a fast monolithic output amplifier (Datel Systems AM-452). Digital input coding is straight binary for unipolar operation and offset binary for bipolar operation and is compatible with standard DTL/TTL logic.

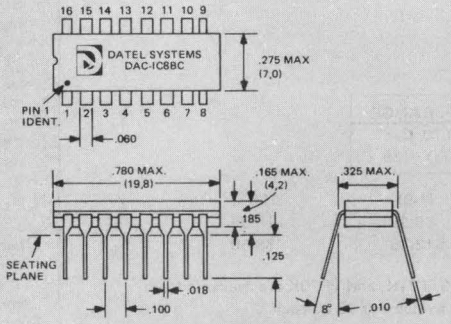
The DAC-IC8B converters consist of 8 fast-switching current sources, a diffused R-2R resistor ladder network, a bias circuit, and a reference control amplifier. The diffused resistor ladder gives excellent temperature tracking resulting in a gain temperature coefficient of –20ppm/°C. The monolithic fabrication results in excellent linearity and tempco, fast output settling, and low cost. Linearity is ±½LSB.

An external reference current of 2mA nominal programs the scale factor for the DAC; this is done by means of an external voltage reference source (such as a Zener diode) and a resistor. This reference current can also be varied, resulting in one or two quadrant multiplying operation. The output voltage can be unipolar or bipolar depending on whether an external offsetting current (derived from the reference) is used. Output voltage compliance of the DAC is –0.6V to +0.5V; this can be made as large as –5V to +0.5V by external pin connection for cases where direct voltage output from a load resistor is desired.

Power supply requirement is +5VDC and –5V to –15VDC. Model DAC-IC8BC has an operating temperature range of 0°C to 70°C while DAC-IC8BM operates over –55°C to +125°C. The two models are pin compatible with Motorola devices MC1408L-8 and MC1508L-8 respectively.




## MECHANICAL DIMENSIONS INCHES (MM)




## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | RANGE CONTROL |
| 2 | GROUND |
| 3 | $V_{EE}$ |
| 4 | OUTPUT |
| 5 | BIT 1 IN (MSB) |
| 6 | BIT 2 IN |
| 7 | BIT 3 IN |
| 8 | BIT 4 IN |
| 9 | BIT 5 IN |
| 10 | BIT 6 IN |
| 11 | BIT 7 IN |
| 12 | BIT 8 IN (LSB) |
| 13 | $V_{CC}$ |
| 14 | + REFERENCE |
| 15 | – REFERENCE |
| 16 | COMPENSATION |

## SPECIFICATIONS, DAC-IC8BC & DAC-IC8BM (Typical at 25°C, $V_{CC}$ = +5V, $V_{EE}$ = −15V, and $I_{REF}$ = 2mA unless otherwise specified)

| | |
|---|---|
| **INPUTS** | |
| Resolution | 8 bits |
| Coding, unipolar output | Straight Binary |
| Coding, bipolar output | Offset Binary |
| Input Logic Level, bit ON ("1") | +2.0V to +5.5V @ 40μA |
| Input Logic Level, bit OFF ("0") | 0V to +0.8V @ −0.8mA |
| Logic Loading | 1 TTL load |
| Nominal Reference Current (+ Ref.) | 2.0mA |
| Reference Current Range (+ Ref.) | 0 to 4.2mA |
| Reference Bias Current (− Ref.) | −3μA max. |
| **OUTPUTS** | |
| Output Current, $I_{REF}$ = 2.0mA | 2.0mA ±0.1mA |
| Output Current Range, $V_{EE}$ = −5V | 0 to 2.1mA |
| Output Current Range, $V_{EE}$ = −6 to −15V | 0 to 4.2mA |
| Output Current, all bits OFF | 4μA maximum |
| Output Voltage Compliance, pin 1 gnded | −0.6 to +0.5V |
| Output Voltage Comp., pin 1 open, $V_{EE} < -10V$ | −5.0V to +0.5V |
| **PERFORMANCE** | |
| Relative Accuracy[1] | ±½LSB (±0.19%) maximum |
| Nonlinearity | ±½LSB (±0.19%) maximum |
| Differential Nonlinearity | ±½LSB (±0.19%) |
| Temp. Coefficient of Gain | −20ppm/°C |
| Power Supply Rejection ($V_{EE}$) | 2.7μA/V max. |
| Settling Time, 2mA to ½LSB | 300 nsec. |
| Update Rate | 3.3MHz |
| Reference Current Slew Rate | 4.0mA/μsec |
| **POWER REQUIREMENT** | |
| $V_{CC}$ Voltage | +5VDC ±0.5V |
| $V_{CC}$ Current | 22mA maximum |
| $V_{EE}$ Voltage | −4.5V to −16.5VDC |
| $V_{EE}$ Current | 13mA maximum |
| **PHYSICAL-ENVIRONMENTAL** | |
| Operating Temp. Range, DAC-IC8BC | 0°C to 70°C |
| Operating Temp. Range, DAC-IC8BM | −55°C to +125°C |
| Storage Temp. Range, either model | −65°C to +150°C |
| Package | 16 pin ceramic DIP |

[1] With zero and full scale adjustments made.

### ORDERING INFORMATION

DAC-IC8B —

| OPER. TEMP. RANGE |
|---|
| C = 0°C TO 70°C |
| M = −55°C TO +125°C |

| PRICES | (1-9) | (100's) |
|---|---|---|
| DAC-IC8BC | $8.95 | $5.95 |
| DAC-IC8BM | $12.75 | $8.50 |

Trimming Potentiometers: TP500, TP1K, and TP20K are available from Datel Systems at $3.00 each.

**The DAC-IC8BC and DAC-IC8BM converters are covered under GSA contract.**

## TECHNICAL NOTES

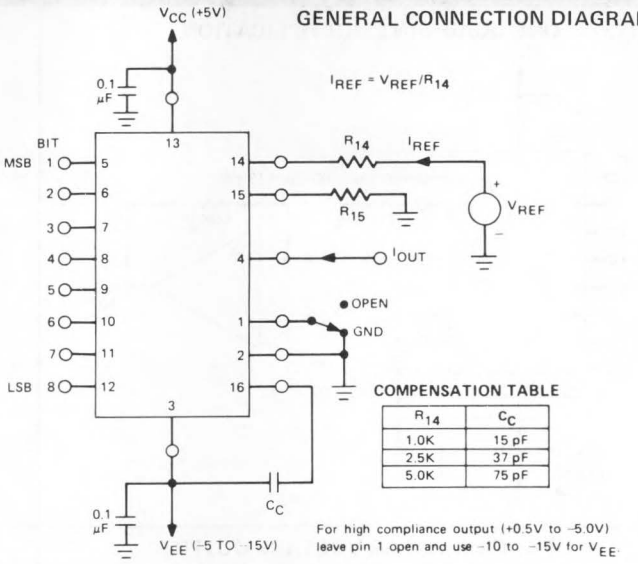
1. The *General Connection Diagram* shows the basic connections for the DAC-IC8B converter. The scale factor is set by a reference current injected into pin 14. Pins 14 and 15 are the input terminals to the reference control amplifier. When connected as shown, pin 15 is grounded through $R_{15}$ and pin 14 is at virtual ground. Therefore, the reference current is determined by the external voltage reference and $R_{14}$: $I_{REF} = V_{REF}/R_{14}$. $R_{14}$ should be a stable metal film resistor. $R_{15}$ is used only to compensate for the input bias current into pin 15 (1 μA typical) and can be shorted out with negligible effect. $R_{15}$, if used, should be equal to $R_{14}$ and may be a carbon composition type. An $I_{REF}$ of 2.0mA is recommended for most applications.
2. There is a second method of connecting the reference shown in *Two Ways to Connect Reference*. A negative reference can be applied to pin 15. In this case only the bias current must be supplied from the reference since pin 15 is a high impedance input. Pin 14 is at the negative voltage and $I_{REF}$ still flows into pin 14. Again, $R_{15}$ is used only to compensate for bias current and may be omitted. There is an important requirement for this connection: *the negative reference voltage must always be 3 volts above $V_{EE}$.*
3. The reference amplifier must be externally compensated, and this is done by capacitor $C_C$, connected from pin 16 to pin 3 ($V_{EE}$). $C_C$ may also be connected from pin 16 to ground, but connection to pin 3 improves the negative supply rejection. The value of $C_C$ depends on $R_{14}$, and typical values are given in the compensation table. Compensation is particularly important when the DAC-IC8B is used as a multiplying D/A converter. Proper compensation assures that output peaking does not occur when the reference voltage steps to a new value. If pin 14 is driven from a high impedance current source such as a transistor collector, then much larger values of $C_C$ must be used and the bandwidth of the reference amplifier is significantly reduced.
4. The *Alternative Compensation Diagram* shows another way of achieving the desired compensation. Here a 1.0K resistor is always used at pin 14, but it is in series with another R to the reference voltage. The junction of the two resistors is bypassed to ground by a 0.1μF capacitor. For high frequencies pin 14 always "sees" a 1K resistance, thus allowing a 15pF capacitor for $C_C$. $R_{15}$, if used, should be the sum of 1.0K and R. This compensation scheme is useful with voltage references such as 6.2 or 6.4 volt Zener diodes.
5. It is recommended that pin 13 ($V_{CC}$) and pin 3 ($V_{EE}$) always be bypassed to ground with at least 0.1μF capacitors located close to the pins.
6. As shown in the *General Connection Diagram*, pin 1 may be either connected to ground or left open. This connection determines the voltage compliance at pin 4 ($I_{OUT}$). For pin 1 grounded, the output compliance is −0.6 to +0.5 volt. This is satisfactory when pin 4 is used to drive a current to voltage converter and pin 4 is held at virtual ground. It is also satisfactory for low values of $R_L$ connected to pin 4 to directly convert the output current to a voltage. The voltage compliance may be extended to −5.0 volts by leaving pin 1 open and using a $V_{EE}$ more negative than −10 volts. In this way a 2.5K load resistor may be used at pin 14 to give an output voltage range of 0 to −5 volts (with reference current of 2mA). As shown in the table of *Settling Time vs $R_L$*, the output settling time is constant (300 nsec.) for $R_L$ values from 0 to 500 ohms; thereafter it increases to 1.2μsec for $R_L$ = 2.5K.
7. The accuracy of the DAC-IC8B is specified for a reference current of 2.0mA; the accuracy, however, is essentially constant for reference currents from 1.5mA to 2.5mA. Typically, this device is monotonic for all values of reference current above 0.5mA. Reference currents up to 4.2mA may be used. *When using a 4mA reference current, $V_{EE}$ must be more negative than −6 volts.*

## TECHNICAL NOTES (Cont'd)

8. For fastest voltage output settling times in either unipolar or bipolar modes, two circuits using Datel Systems AM-452 monolithic operational amplifiers are recommended. These circuits, with the compensation shown, result in output settling times of typically 600 nsec. for a 10 volt change to 1 LSB. This is the worst case settling time which occurs when all bits are turned on. For current output and $R_L$ less than 500 ohms, this time is 300 nsec.; when all bits are turned off the time is shorter, typically 100 nsec. The two circuits shown also illustrate a simple method of deriving both reference current and offset current from a precision 6.4 volt Zener reference diode.
9. Both one and two quadrant multiplication are also possible with the DAC-IC8B as shown in the two diagrams. $V_{IN}$ is shown operating into pin 14; this results in an input impedance of 2.5K. Alternatively, $V_{IN}$ can be applied to pin 15 for a high impedance input as explained previously. The range of $V_{IN}$ is then 0 to −10V. For two quadrant multiplication $V_{IN}$ is unipolar and the digital input is bipolar with offset binary coding. $V_{OUT}$ then varies over the bipolar range of ±5 volts. In multiplication applications, it is recommended that full scale $I_{REF}$ be set to 4.0mA; the output is then monotonic as the reference current varies over 0.5mA to 4.0mA.

## CONNECTION DIAGRAMS

### GENERAL CONNECTION DIAGRAM

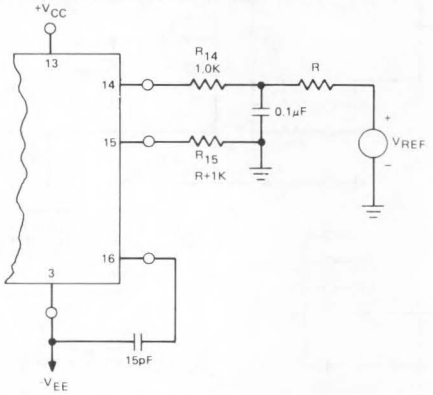



**COMPENSATION TABLE**

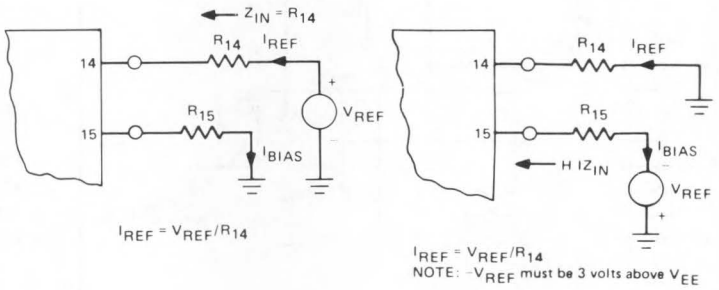
| $R_{14}$ | $C_C$ |
|---|---|
| 1.0K | 15 pF |
| 2.5K | 37 pF |
| 5.0K | 75 pF |

For high compliance output (+0.5V to −5.0V) leave pin 1 open and use −10 to −15V for $V_{EE}$.

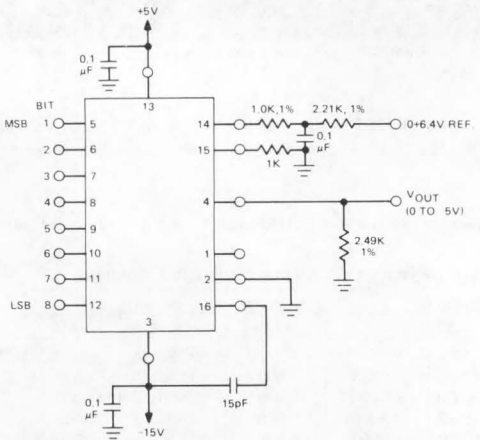
### ALTERNATIVE COMPENSATION



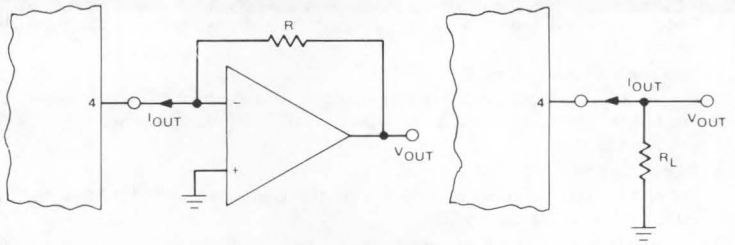

### TWO WAYS TO CONNECT REFERENCE




### HIGH COMPLIANCE OUTPUT




### OUTPUT CONNECTIONS



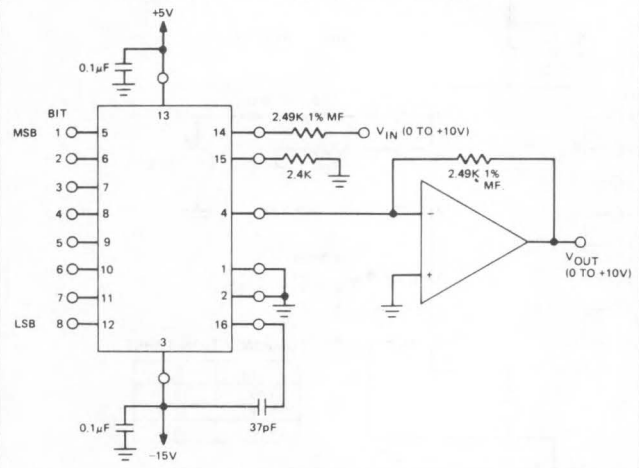

**SETTLING TIME VS. $R_L$**

| $R_L$ | S.T. |
|---|---|
| 0 | 300 nsec. |
| 500 | 300 nsec. |
| 1 K | 400 nsec. |
| 2.5 K | 1.2 μsec. |

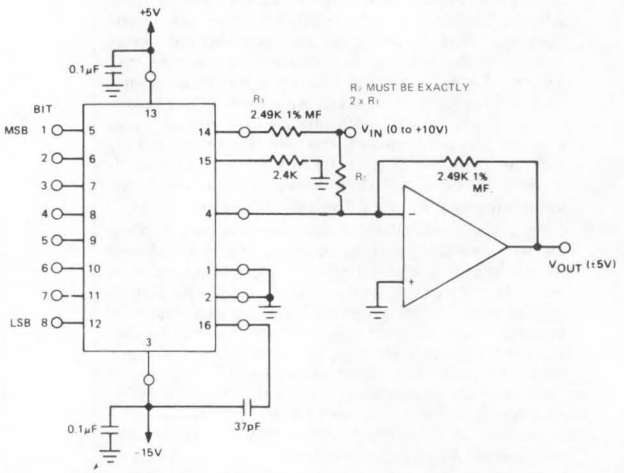
DATEL

## APPLICATION DIAGRAMS

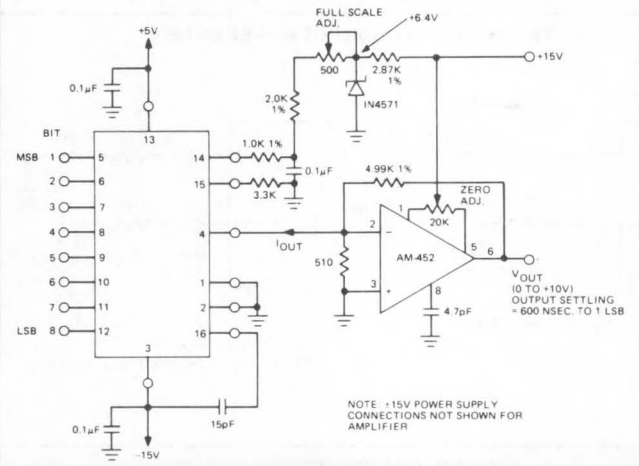
### ONE QUADRANT MULTIPLICATION



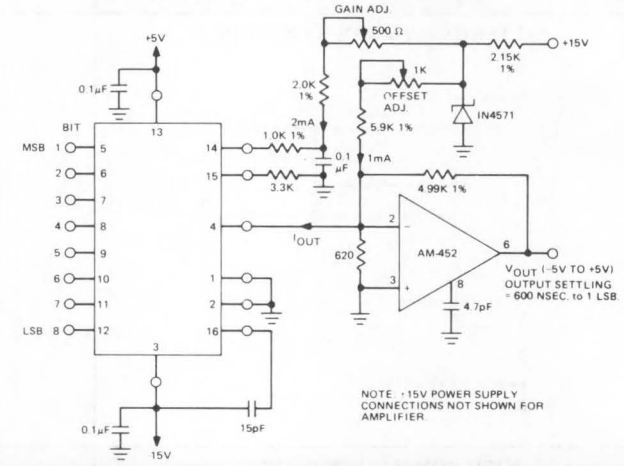

### TWO QUADRANT MULTIPLICATION




### FAST, UNIPOLAR VOLTAGE OUTPUT




### FAST, BIPOLAR VOLTAGE OUTPUT




## CALIBRATION AND CODING TABLES

1. Select the desired output range by means of the feedback resistor of the external operational amplifier and the externally programmed reference current.
2. *Zero and Offset Adjustments*
   For unipolar operation, set all digital inputs to "0" (0V to +0.8V) and adjust the output amplifier ZERO ADJUSTMENT for zero output voltage. For bipolar operation, set all digital inputs to "0" (0 to +0.8V) and adjust the OFFSET ADJUSTMENT for the negative full scale voltage shown in the Coding Table.
3. *Gain Adjustment*
   For either unipolar or bipolar operation, set all digital inputs to "1" (+2.0 to +5.5V) and adjust the GAIN ADJUSTMENT for the positive full scale voltage shown in the Coding Table.

**UNIPOLAR OPERATION–STRAIGHT BINARY CODING**

| INPUT CODE | UNIPOLAR OUTPUT RANGES | | | |
|---|---|---|---|---|
| MSB LSB | 0 TO +5V | 0 TO +10V | 0 TO -2MA | 0 TO -4MA |
| 1111 1111 | +4.980 | +9.961V | -1.992MA | -3.984MA |
| 1110 0000 | +4.375 | +8.750 | -1.750 | -3.500 |
| 1100 0000 | +3.750 | +7.500 | -1.500 | -3.000 |
| 1000 0000 | +2.500 | +5.000 | -1.000 | -2.000 |
| 0100 0000 | +1.250 | +2.500 | -0.500 | -1.000 |
| 0000 0001 | +0.020 | +0.039 | -0.008 | -0.016 |
| 0000 0000 | 0.000 | 0.000 | 0.000 | 0.000 |

**BIPOLAR OPERATION–OFFSET BINARY CODING**

| INPUT CODE | BIPOLAR OUTPUT RANGES | | | |
|---|---|---|---|---|
| MSB LSB | ±5V | ±10V | ±1MA | ±2MA |
| 1111 1111 | +4.961V | +9.922V | -0.992MA | -1.984MA |
| 1110 0000 | +3.750 | +7.500 | -0.750 | -1.500 |
| 1100 0000 | +2.500 | +5.000 | -0.500 | -1.000 |
| 1000 0000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 0100 0000 | -2.500 | -5.000 | +0.500 | +1.000 |
| 0000 0001 | -4.961 | -9.922 | +0.992 | +1.984 |
| 0000 0000 | -5.000 | -10.000 | +1.000 | +2.000 |

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TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# LOW COST, 12 BIT HYBRID DIGITAL TO ANALOG CONVERTERS

# DAC-HZ SERIES

## FEATURES

- ▶ 12 Bit Binary or 3 Digit BCD
- ▶ Pin-Programmable Outputs
- ▶ Internal Reference & Output Amp.
- ▶ Glass or Metal Package
- ▶ ±15VDC Supply Only
- ▶ Fast Settling Time
- ▶ 12 Different Models

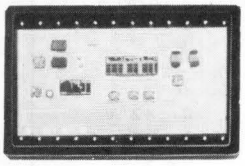
## GENERAL DESCRIPTION

The DAC-HZ series are high performance, hybrid 12 bit binary and 3 digit BCD digital-to-analog converters. These converters are manufactured in volume in Datel Systems' modern in-house thin film hybrid facility. They are complete and self-contained with a precision internal reference and fast output operational amplifier. Pin programmable output voltage ranges are provided for a high degree of application flexibility; the output voltage ranges are 0 to +5V, 0 to +10V, ±2.5V, ±5V, and ±10V with only unipolar ranges available on the BCD models. Current output is also provided.

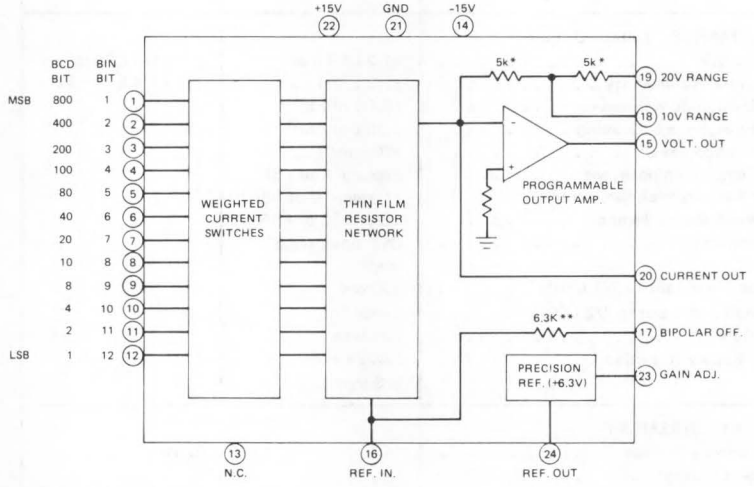
The internal design utilizes three quad current switches, two thin film resistor networks, a precision zener reference circuit, reference control circuit and output amplifier. The thin film resistor networks are functionally trimmed with a laser to precisely set the binary weights of the current switches. The excellent tracking of the thin film resistors in conjunction with the tightly matched current switches results in a differential nonlinearity tempco of only 2ppm/°C. Temperature coefficient of gain is ±20ppm/°C max. and tempco of zero is ±5ppm/°C of FS max. There are also two low drift models in the series with maximum gain tempco of ±10ppm/°C.

The DAC-HZ series consists of 12 different models covering the operating temperature ranges of 0°C to 70°C, −25°C to +85°C, and −55°C to +125°C. The models are available in miniature glass or metal hermetically sealed cases. Power requirement is ±15VDC at 35mA with no 5V logic supply required. Input coding is complementary binary or complementary BCD. Voltage output settling time is 3 μsec. to 1/2 LSB.

(ACTUAL SIZE)

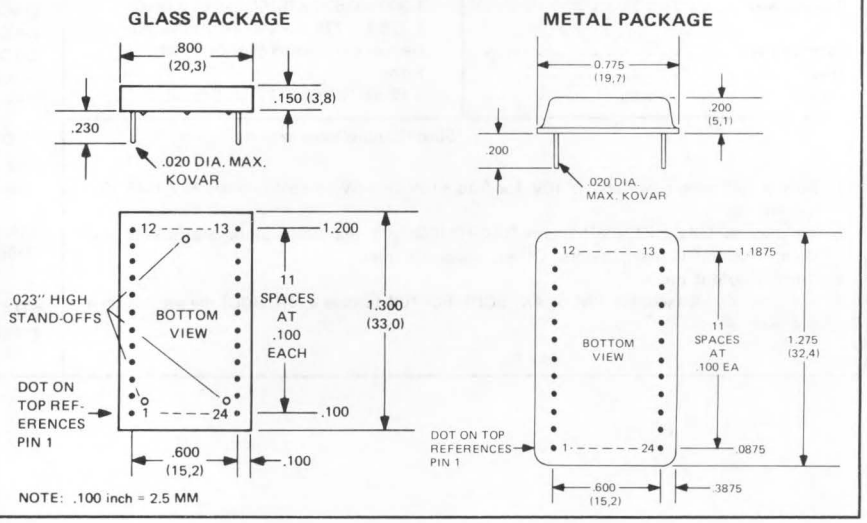







* For BCD model these resistors are 4KΩ.
** For BCD model this resistor is open circuit.

## MECHANICAL DIMENSIONS - INCHES (MM)




NOTE: .100 inch = 2.5 MM

## SPECIFICATIONS, DAC-HZ SERIES
(Typical at 25°C and ±15V supplies unless otherwise noted)

| | DAC-HZ12B (Binary) | DAC-HZ12D (BCD) |
|---|---|---|
| **INPUTS** | | |
| Resolution | 12 Binary bits | 3 BCD digits |
| Coding, unipolar output | Complementary Binary | Complementary BCD |
| Coding, bipolar output | Comp. Offset Bin. | — |
| Input Logic Level, bit ON ("0") | 0V to +0.8V @ -1mA | |
| Input Logic Level, bit OFF ("1") | +2.0V to +5.5V @ +40μA | |
| Logic Loading | 1 TTL load | |
| **OUTPUTS** | | |
| Output Current, unipolar | 0 to −2mA, ±10% | 0 to −1.25mA, ±10% |
| Output Current, bipolar | ±1mA, ±10% | — |
| Voltage Compliance, Iout | ±2.5V | * |
| Output Impedance, Iout, unipolar | 5K ohms | * |
| Output Impedance, Iout, bipolar | 2.8K ohms | — |
| Output Voltage Ranges, unipolar | 0V to +5V | 0 to +2.5V |
| | 0V to +10V | 0 to +5V |
| | | 0 to +10V |
| Output Voltage Ranges, bipolar | ±2.5V | — |
| | ±5V | — |
| | ±10V | — |
| Output Current, Vout | ±5mA min. | * |
| Output Impedance, Vout | .05 ohm | * |
| **PERFORMANCE, Voltage Output** | | |
| Nonlinearity | ±1/2 LSB max. | ±1/4 LSB max. |
| Differential Nonlinearity | ±1/2 LSB max. | ±1/4 LSB max. |
| Gain Error, before trimming | ±0.1% of FSR[1] | * |
| Zero Error, before trimming | ±.05% of FSR[1] | * |
| Gain Tempco, max.[2] | ±20ppm/°C | * |
| Zero Tempco, unipolar, max. | ±5ppm/°C of FSR[1] | * |
| Offset Tempco, biopolar, max.[2] | ±10ppm/°C of FSR[1] | * |
| Diff. Nonlinearity Tempco | ±2ppm/°C of FSR[1] | * |
| Monotonicity | Over oper. temp. range | * |
| Settling Time, Iout to 1/2 LSB[3] | 300nsec. | * |
| Settling Time, Vout to 1/2 LSB | 3 μsec.[4] | * |
| Slew Rate | 20V/μsec. | * |
| Power Supply Rejection | ±.002% FSR/% Supply[1] | * |
| **POWER REQUIREMENT** | | |
| Power Supply Voltage | ±15VDC ±0.5V | |
| Quiescent Current | 35mA | |
| **PHYSICAL-ENVIRONMENTAL** | | |
| Operating Temperature Ranges | 0°C to 70°C, −25°C to +85°C, and −55°C to +125°C | |
| Storage Temperature Range | −55°C to +125°C | |
| Package Size | 1.300 x 0.800 x 0.150 inches (Glass) | |
| | 1.275 x 0.775 x 0.200 inches (Metal) | |
| Package Type | Hermetically sealed glass or metal | |
| Pins | Kovar | |
| Weight | 0.15 oz. (Glass), 0.27 oz. (Metal) | |

*Specifications same as first column

1. FSR is full scale range and is 10V for 0 to +10V or −5V to +5V output; 20V for ±10V output, etc.
2. For models DAC-HZ12BMR-1 and DAC-HZ12DMR-1 the temperature coefficients are: Gain, ±10ppm/°C max.; Bipolar Offset, ±5ppm/°C max.
3. Current output mode.
4. For 2.5K or 5K feedback (2K or 4K, BCD). For 10K feedback (8K, BCD) the settling time is 4 μsec.

## TECHNICAL NOTES

1. The DAC-HZ12 series converters are designed and factory calibrated to give ±½LSB linearity (binary version) and ±¼LSB linearity (BCD version) with respect to a straight line between end points. This means that if zero and full scale are exactly adjusted externally, the relative accuracy will be ±1/2 LSB (±1/4 LSB, BCD) everywhere over the full output range without any additional adjustments to achieve a best straight line fit. The linearity specification is therefore a conservative one since the user does not have to make more complicated adjustments for a best straight line fit.
2. The external zero or offset adjustment for the converters has a range of ±0.2% of full scale and the external gain adjustment has a range of ±0.3% of full scale.
3. These converters must be operated with local supply by-pass capacitors from +15V to ground and −15V to ground. Tantalum type capacitors of 1μF are recommended and should be mounted as close as possible to the converter. If the converters are used in a high frequency noise environment a .01μF ceramic capacitor should be used across each tantalum capacitor.
4. When operating in the current output mode the equivalent internal current source of 2mA (1.25mA, BCD) must drive both the internal source resistances and the external load resistor. A 300 nsec. output settling time is achieved for the voltage across a 100 ohm load resistor; for higher value resistors the settling time becomes longer due to the output capacitance of the converter. For fastest possible voltage output for a large transition, an external fast settling amplifier such as Datel Systems AM-100 should be used in the inverting mode. Settling time of less than 1 μsec. can be achieved. See application diagram.

## ORDERING INFORMATION

| Model | Temp. Range | Case | Price (1–9) |
|---|---|---|---|
| DAC-HZ12BGC | 0 to 70C | Glass | $ 39.00 |
| DAC-HZ12BMC | 0 to 70C | Metal | $ 49.00 |
| DAC-HZ12BGR | −25 to +85C | Glass | $ 55.00 |
| DAC-HZ12BMR | −25 to +85C | Metal | $ 69.00 |
| *DAC-HZ12BMR-1 | −25 to +85C | Metal | $139.00 |
| DAC-HZ12BMM | −55 to +125C | Metal | $119.00 |
| DAC-HZ12DGC | 0 to 70C | Glass | $ 39.00 |
| DAC-HZ12DMC | 0 to 70C | Metal | $ 49.00 |
| DAC-HZ12DGR | −25 to +85C | Glass | $ 55.00 |
| DAC-HZ12DMR | −25 to +85C | Metal | $ 69.00 |
| DAC-HZ12DMR-1 | −25 to +85C | Metal | $139.00 |
| DAC-HZ12DMM | −55 to +125C | Metal | $119.00 |

*NOTE: Models DAC-HZ12BMR-1 and DAC-HZ12DMR-1 are low drift models with gain tempco's of ±10ppm/°C max.

**Mating Socket:** DILS-3 (24 pin socket) $1.95 ea.
**Trimming Potentiometers:**
TP10K OR TP100K at $3.00 each.

**THE DAC-HZ12 SERIES CONVERTERS ARE COVERED BY GSA CONTRACT.**

# INTERCONNECTIONS AND CALIBRATION

## CALIBRATION PROCEDURE

1. Select the desired output range and connect the converter up as shown in the Output Range Selection table and the Standard Connection diagrams below.
2. To calibrate refer to the Coding Tables below. Note that complementary coding is used.
3. **Zero and Offset Adjustments**
   For unipolar operation set all digital inputs to "1" (+2.0 to +5.5V) and adjust the ZERO ADJ. potentiometer for zero output voltage or current. For bipolar operation (binary model only) set all digital inputs to "1" and adjust the OFFSET ADJ. potentiometer for the negative full scale (for voltage out) or positive full scale (for current out) output value shown in the Coding Table.
4. **Gain Adjustment**
   For the binary model set all digital inputs to "0" (0V to +0.8V) and adjust the GAIN ADJ. potentiometer for the positive full scale (for voltage out) or negative full scale (for current out) output value shown in the Coding Table.
   For the BCD model (unipolar only) set each BCD digit to 0110 and adjust the GAIN ADJ. potentiometer for the positive full scale (for voltage out) or negative full scale (for current out) output value shown in the Coding Table.

## OUTPUT RANGE SELECTION

| BIN.RANGE | CONNECT THESE PINS TOGETHER | | | |
|---|---|---|---|---|
| ±10V | 15 & 19 | 17 & 20 | | 16 & 24 |
| ±5V | 15 & 18 | 17 & 20 | | 16 & 24 |
| ±2.5V | 15 & 18 | 17 & 20 | 19 & 20 | 16 & 24 |
| +10V | 15 & 18 | 17 & 21 | | 16 & 24 |
| +5V | 15 & 18 | 17 & 21 | 19 & 20 | 16 & 24 |
| ±1mA | | 17 & 20 | | 16 & 24 |
| −2mA | | 17 & 21 | | 16 & 24 |
| **BCD RANGE** | **CONNECT THESE PINS TOGETHER** | | | |
| +10V | 15 & 19 | | | 16 & 24 |
| +5V | 15 & 18 | | | 16 & 24 |
| +2.5V | 15 & 18 | | 19 & 20 | 16 & 24 |
| −1.25MA | | | | 16 & 24 |

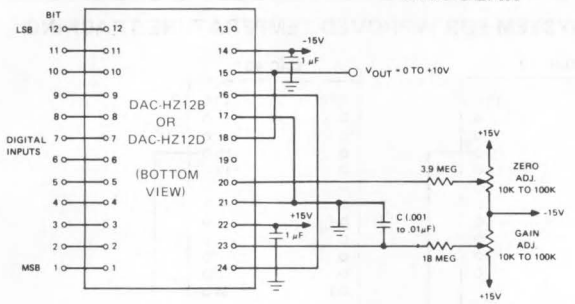
VOLTAGE OUTPUT IS AT PIN 15.
CURRENT OUTPUT IS AT PIN 20.

# STANDARD CONNECTIONS

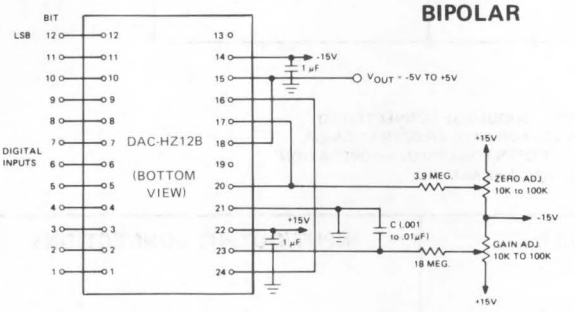
## VOLTAGE OUTPUT CONNECTIONS

(FOR DIFFERENT OUTPUT SCALING REFER TO OUTPUT RANGE SELECTION TABLE)

### UNIPOLAR

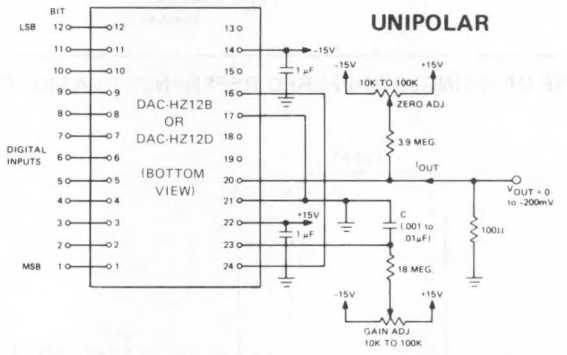



### BIPOLAR

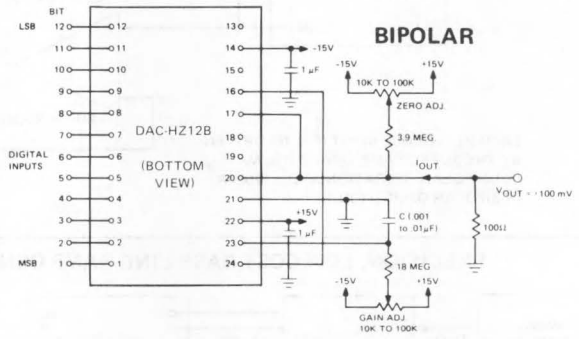



## CURRENT OUTPUT CONNECTIONS

### UNIPOLAR




### BIPOLAR




## CODING TABLES

### UNIPOLAR OUTPUT – COMPLEMENTARY BINARY

| BINARY INPUT CODE | | UNIPOLAR OUTPUT RANGES | | |
|---|---|---|---|---|
| MSB | LSB | 0 TO +10V | 0 TO +5V | 0 TO -2MA |
| 0000 | 0000 0000 | +9.9976V | +4.9988V | -1.9995MA |
| 0011 | 1111 1111 | +7.5000 | +3.7500 | -1.5000 |
| 0111 | 1111 1111 | +5.0000 | +2.5000 | -1.0000 |
| 1011 | 1111 1111 | +2.5000 | +1.2500 | -0.5000 |
| 1111 | 1111 1110 | +0.0024 | +0.0012 | -0.0005 |
| 1111 | 1111 1111 | 0.0000 | 0.0000 | 0.0000 |

### UNIPOLAR OUTPUT – COMPLEMENTARY BCD

| BCD INPUT CODE | | UNIPOLAR OUTPUT RANGES | | | |
|---|---|---|---|---|---|
| MSD | LSD | 0 TO +10V | 0 TO +5V | 0 TO +2.5V | 0 TO -1.25MA |
| 0110 | 0110 0110 | +9.990V | +4.995V | +2.498V | -1.2488MA |
| 0111 | 1010 1111 | +7.500 | +3.750 | +1.875 | -0.9375 |
| 1010 | 1111 1111 | +5.000 | +2.500 | +1.250 | -0.6250 |
| 1101 | 1010 1111 | +2.5000 | +1.250 | +0.625 | -0.3125 |
| 1111 | 1111 1110 | +0.0100 | +0.005 | +0.003 | -0.0013 |
| 1111 | 1111 1111 | 0.0000 | 0.000 | 0.000 | 0.0000 |

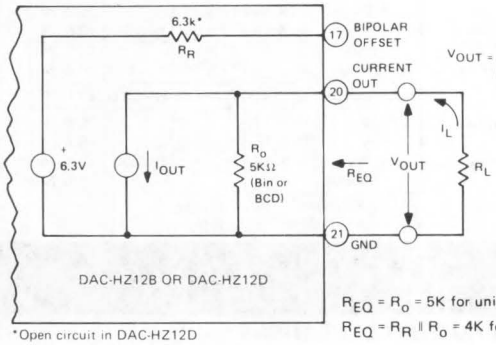
### BIPOLAR OUTPUT – COMPLEMENTARY OFFSET BINARY

| INPUT CODE | | BIPOLAR OUTPUT RANGES | | | |
|---|---|---|---|---|---|
| MSB | LSB | ±10V | ±5V | ±2.5V | ±1MA |
| 0000 | 0000 0000 | +9.9951V | +4.9976V | +2.4988V | -0.9995MA |
| 0011 | 1111 1111 | +5.0000 | +2.5000 | +1.2500 | -0.5000 |
| 0111 | 1111 1111 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1011 | 1111 1111 | -5.0000 | -2.5000 | -1.2500 | +0.5000 |
| 1111 | 1111 1110 | -9.9951 | -4.9976 | -2.4988 | +0.9995 |
| 1111 | 1111 1111 | -10.0000 | -5.0000 | -2.5000 | +1.0000 |

DATEL

# EQUIVALENT CIRCUITS & APPLICATIONS

## EQUIVALENT CURRENT MODE OUTPUT CIRCUIT



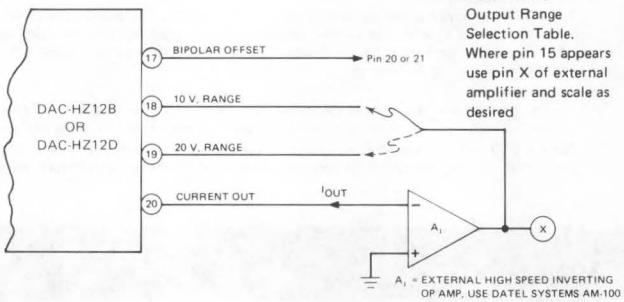

*Open circuit in DAC-HZ12D

$R_{EQ} = R_O$ = 5K for unipolar operation

$R_{EQ} = R_R \parallel R_O$ = 4K for bipolar operation

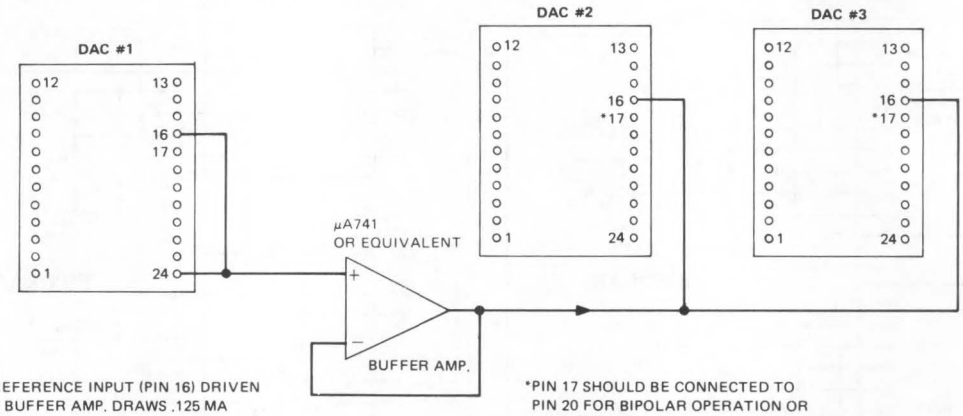
$I_{OUT}$ = 2mA binary
= 1.25mA BCD

## USE OF HIGH SPEED EXTERNAL OP AMP FOR FASTER SETTLING




$A_1$ = EXTERNAL HIGH SPEED INVERTING OP AMP, USE DATEL SYSTEMS AM-100 FOR LESS THAN 1.0 μSEC. OUTPUT SETTLING.

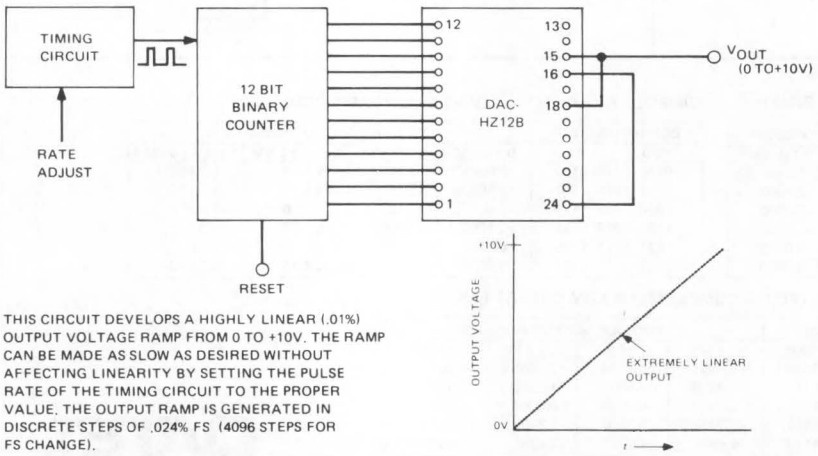
## USE OF A SINGLE BUFFERED REFERENCE IN A MULTI-DAC SYSTEM FOR IMPROVED TEMPERATURE TRACKING




EACH REFERENCE INPUT (PIN 16) DRIVEN BY THE BUFFER AMP. DRAWS .125 MA IN UNIPOLAR OPERATION AND 1.125 MA IN BIPOLAR OPERATION.

*PIN 17 SHOULD BE CONNECTED TO PIN 20 FOR BIPOLAR OPERATION OR LEFT OPEN FOR UNIPOLAR OPERATION OF DAC'S #2 AND #3.

## PRECISION, LOW COST BASE LINE RAMP GENERATOR




THIS CIRCUIT DEVELOPS A HIGHLY LINEAR (.01%) OUTPUT VOLTAGE RAMP FROM 0 TO +10V. THE RAMP CAN BE MADE AS SLOW AS DESIRED WITHOUT AFFECTING LINEARITY BY SETTING THE PULSE RATE OF THE TIMING CIRCUIT TO THE PROPER VALUE. THE OUTPUT RAMP IS GENERATED IN DISCRETE STEPS OF .024% FS (4096 STEPS FOR FS CHANGE).

## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | BIT 1 IN | 13 | NO CONN. |
| 2 | BIT 2 IN | 14 | -15VDC |
| 3 | BIT 3 IN | 15 | VOLT. OUT |
| 4 | BIT 4 IN | 16 | REF. IN |
| 5 | BIT 5 IN | 17 | BIPOLAR OFF |
| 6 | BIT 6 IN | 18 | 10V RANGE |
| 7 | BIT 7 IN | 19 | 20V RANGE |
| 8 | BIT 8 IN | 20 | CURRENT OUT |
| 9 | BIT 9 IN | 21 | GROUND |
| 10 | BIT 10 IN | 22 | +15VDC |
| 11 | BIT 11 IN | 23 | GAIN ADJ. |
| 12 | BIT 12 IN | 24 | REF. OUT |

DATEL

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# FOR ULTRA-HIGH SPEED APPLICATIONS 25 NANOSEC. OUTPUT SETTLING TIME DIGITAL TO ANALOG CONVERTERS

# DAC-FI-GI-HI SERIES

## FEATURES

- Fastest settling time available
- High Resolution
- Small Size
- Low Temperature coefficient
- Ultra linear
- Adjustment-Free operation

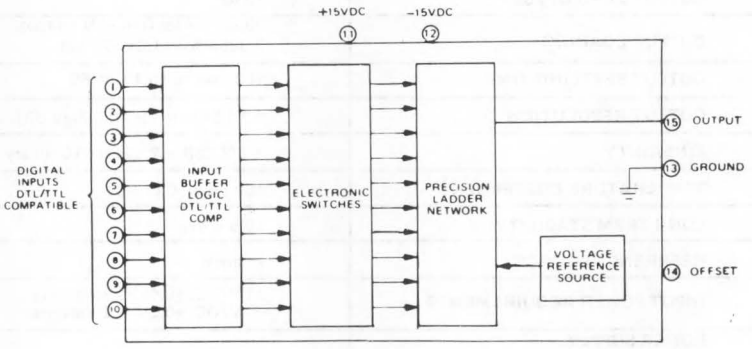
## GENERAL DESCRIPTION

This series of D/A converters are miniature ultra high speed devices offering the user state-of-the-art output settling time. Twenty-five nanoseconds for DAC-HI, fifty nanoseconds for DAC-GI and one hundred nanoseconds for DAC-FI series. Standard versions are available with either eight bit or ten bit resolution. Accuracy specifications include ±1/2 LSB linearity, ±15ppm/°C temperature coefficient, and ±0.05% full scale accuracy.

Bipolar operation is achieved by externally connecting the built-in offsetting reference. Input coding can be straight binary for unipolar output or a choice of offset binary or two's complement for bipolar output.

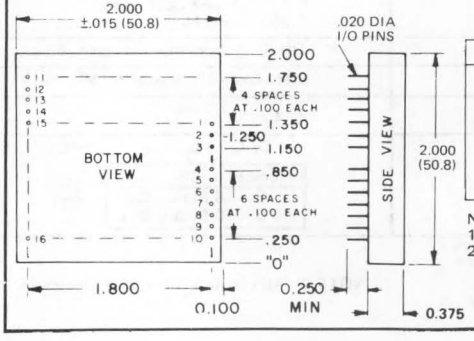
Each D/A is completely self-contained requiring only ±15 volts D.C. power. Packaged in 2" x 2" x 0.375", low profile modules, they are readily soldered or plugged directly into P.C. cards or other mother board hardware. Included in each module is digital interface logic, a precision resistor ladder network, high speed electronic switches, and a temperature compensated precision voltage reference source.

One of the many prime features is the output flexibility – 5 ma current output can be fed directly into an external resistor to develop a 1.2V maximum output or by external pin strapping a bipolar output of ±1.2V maximum can be generated across the output load resistor. The output current can also be fed into an operational amplifier for those who require sign inversion, scaling, etc. This amplifier can be selected to suit a particular application.


BLOCK DIAGRAM MODEL DAC-FI, GI, HI

## MECHANICAL DIMENSIONS INCHES – (MM)




## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | Bit 1 input (MSB) | 9 | Bit 9 input |
| 2 | Bit 2 input | 10 | Bit 10 input (LSB) |
| 3 | Bit 3 input | 11 | +15V Power input |
| 4 | Bit 4 input | 12 | -15V Power input |
| 5 | Bit 5 input | 13 | Common ground |
| 6 | Bit 6 input | 14 | Offset |
| 7 | Bit 7 input | 15 | Analog output |
| 8 | Bit 8 input | 16 | No connection |

NOTES:
1. Pins 9 and 10 omitted on 8 bit models
2. Pin position tolerance ±.005" from datum, non-accumulative

## SPECIFICATIONS (TYPICAL @ 25°C UNLESS OTHERWISE NOTED) DAC-FI – DAC-GI – DAC-HI

| PARAMETERS | DAC-FI SERIES (100nsec settling) | DAC-GI SERIES (50nsec settling) |
|---|---|---|
| **DIGITAL INPUTS** | | |
| **RESOLUTION** | Optional<br>8 or 10 Binary Bits | Optional<br>8 or 10 Binary Bits |
| **CODING**<br>(Parallel Data in the following Formats) | Straight Binary (Unipolar Output)<br>Offset Binary (Bipolar Output)<br>Two's Complement (Bipolar Output)<br>with $\overline{MSB}$ (1) | Straight Binary (Unipolar Output)<br>Offset Binary (Bipolar Output)<br>Two's Complement (Bipolar Output)<br>with $\overline{MSB}$ (1) |
| **DATA INPUTS**<br>INPUT CODE / V INPUT MIN. / V INPUT MAX. / BIT STATUS<br>"0" 0V +0.8V OFF<br>"1" +2.0V +5.5V ON | DTL or TTL Compatible<br>Positive Logic<br>Loading: 2 standard TTL loads | DTL or TTL Compatible<br>Positive Logic<br>Loading: 2 standard TTL loads |
| **ANALOG OUTPUT (@ 25°C)** | | |
| **ACCURACY** | Adj. to ±0.05% | Adj. to ±0.05% |
| **TYPE OF OUTPUT** | Current | Current |
| **FULL SCALE OUTPUT** | 5 ma @ +1.2V max. (Unipolar)<br>±2.5 ma @ ±1.2V max. (Bipolar) (1) | 5 ma @ +1.2V max. (Unipolar)<br>±2.5 ma @ ±1.2V max. (Bipolar) (1) |
| **OUTPUT IMPEDANCE** | 600 Ohms ±1% | 600 Ohms ±1% |
| **OUTPUT ZERO OFFSET** | 15 na | 15 na |
| **OUTPUT LOADING** | 300 ohms for 0 to +1V Output<br>2.325K for ±1.0V Output | 300 ohms for 0 to +1V Output<br>2.325K for ± 1.0V Output |
| **OUTPUT SETTLING TIME** | 100 nsec to ±0.1% of FS | 50 nsec to ±0.1% of FS |
| **OUTPUT RESOLUTION** | ± 1 LSB(5μa for 10 Binary Bits) | ± 1 LSB(5μa for 10 Binary Bits) |
| **LINEARITY** | ± 1/2 LSB(± 2.5μa for 10 Binary Bits) | ± 1/2 LSB(± 2.5μa for 10 Binary Bits) |
| **TEMPERATURE COEFFICIENT** | ±50 ppm/°C of FS | ±30 ppm/°C of FS |
| **LONG TERM STABILITY** | ±0.5%/Yr. | ±0.5%/Yr. |
| **REFERENCE SOURCE** | Internal | Internal |
| **INPUT POWER REQUIREMENTS** | +15VDC, ±0.5V @ 75mA max<br>−15VDC, ±0.5V @ 20mA max | +15VDC, ±0.5V @ 75mA max<br>−15VDC, ±0.5V @ 20mA max |
| **POWER SUPPLY REJECTION RATIO** | 0.05%/V | 0.05%/V |
| **PHYSICAL – ENVIRONMENTAL** | | |
| **OPERATING TEMPERATURE RANGE** | 0° to +70°C | 0° to +70°C |
| **STORAGE TEMPERATURE RANGE** | −55°C to +85°C | −55°C to +85°C |
| **RELATIVE HUMIDITY** | Up to 100% Non-Condensing | Up to 100% Non-Condensing |
| **SIZE** | 2"L x 2"W x 0.375"H<br>Plug-in Module | 2"L x 2"W x 0.375"H<br>Plug-in Module |
| **PINS** | 0.020" Round Gold Plated<br>0.250" Long Min. | 0.020" Round Gold Plated<br>0.250" Long Min. |
| **MATING SOCKET** | DILS–2, 2 per module req'd, $5/pr. | DILS–2, 2 per module req'd, $5/pr. |
| **CASE MATERIAL (2)** | Black Diallyl Phthalate Per MIL-M-14 | Black Diallyl Phthalate Per MIL-M-14 |
| **WEIGHT** | 2 oz. | 2 oz. |
| **ORDERING INFORMATION** | DAC-FI — Number of Bits: 8 B = 8 Binary Bits; 10 B = 10 Binary Bits — PRICE (1-9): $79. $99. | DAC-GI — Number of Bits: 8 B = 8 Binary Bits; 10 B = 10 Binary Bits — PRICE (1-9): $ 89. $109. |

**NOTE 1:** The converter does not directly accept 2's complement coding without first externally complementing the 2's comp MSB by using an external inverter or FF $\overline{Q}$ output. After this bit is complemented the code appears as normal offset binary which the converter can process.

**NOTE 2:** All converters are fully repairable.

DATEL

# DATEL

**DAC-HI SERIES** (25nsec settling)

Optional
8 or 10 Binary Bits

Straight Binary (Unipolar Output)
Offset Binary (Bipolar Output)
Two's Complement (Bipolar Output)
with MSB (1)

DTL or TTL Compatible
Positive Logic
Loading: 2 standard TTL loads

Adj. to ±0.05%

Current

5 ma @ +1.2V max. (Unipolar)
±2.5 ma @ ±1.2V max. (Bipolar) (1)

600 Ohms ±1%

15 na

300 ohms for 0 to +1V Output
2.325K for ± 1.0V Output

25 nsec to ±0.1% of FS

± 1 LSB(5μa for 10 Binary Bits)

± 1/2 LSB(± 2.5μa for 10 Binary Bits)

±15 ppm/°C of FS

±0.5%/Yr.

Internal

+15VDC, ±0.5V @ 75mA max
−15VDC, ±0.5V @ 20mA max

0.05%/V

0° to +70°C

−55°C to +85°C

Up to 100% Non-Condensing

2"L x 2"W x 0.375"H
Plug-in Module

0.020" Round Gold Plated
0.250" Long Min.

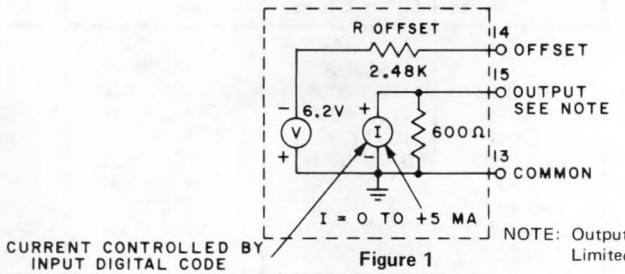
DILS−2, 2 per module req'd, $5/pr.

Black Diallyl Phthalate Per MIL-M-14

2 oz.

| DAC-HI — Number of Bits | PRICE (1-9) |
|---|---|
| 8 B = 8 Binary Bits | $ 99 |
| 10 B = 10 Binary Bits | $119 |

## APPLICATION NOTES




NOTE: Output Voltage Limited to ±1.2V max.

Figure 1

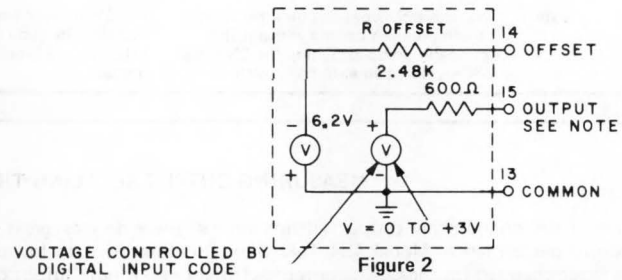



Figure 2

### UNIPOLAR CURRENT OUTPUT

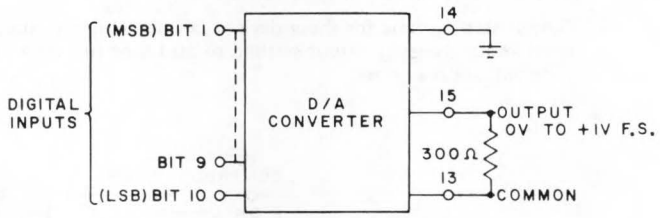



Figure 3

### BIPOLAR CURRENT OUTPUT

Connect external load resistor of 2.32K Ohms across pins 13 & 15.

Connect a 500 Ohm potentiometer* between pins 14 & 15 and with input code of 1000000000. adjust for zero volts output.

*Available from Datel, $3/each

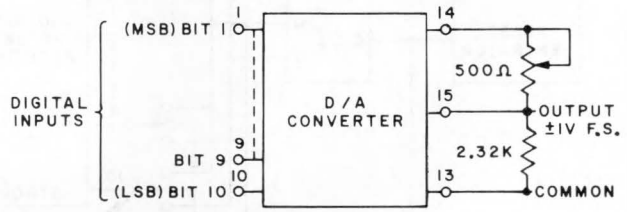



FIGURE FOUR

### UNIPOLAR OR BIPOLAR VOLTAGE OUTPUT

For Unipolar voltage output connect jumper between pins 13 & 14.
For Bipolar voltage output connect a 500 Ohm potentiometer* between pins 14 & 15.

*Available from Datel, $3/each

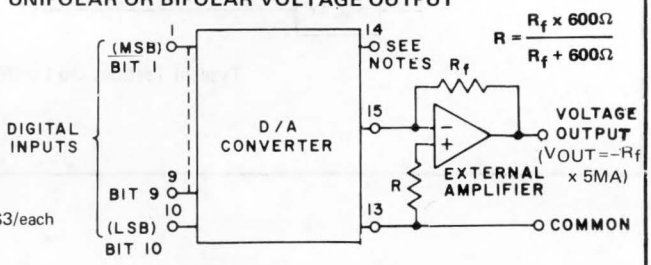



FIGURE FIVE

**Input Coding for DAC-FI, DAC-GI and DAC-HI Series (10 Bits shown)**

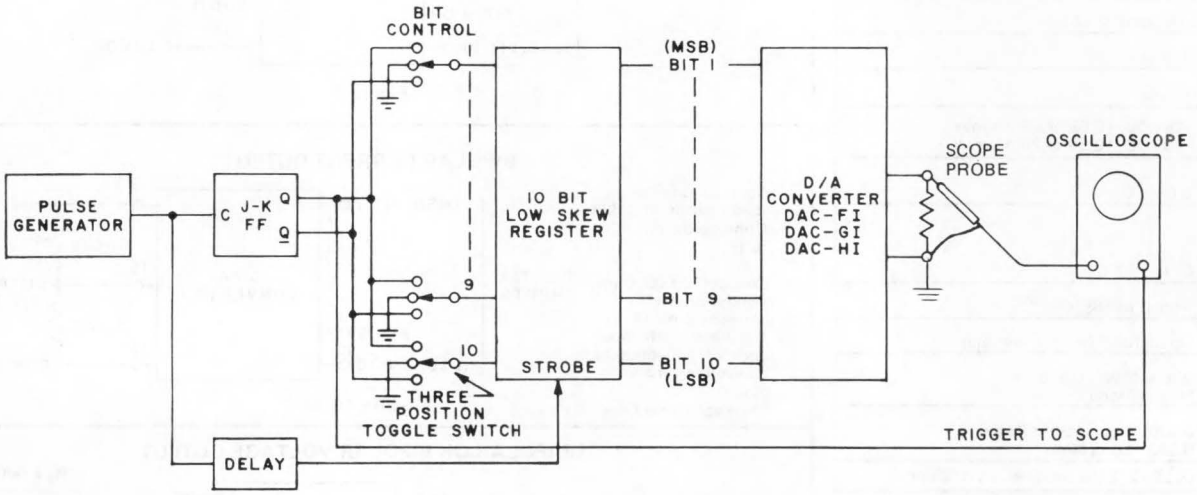
| Analog Output Range (±2.5 ma FS) | Offset Binary | 2's Complement (See Note) | Analog Output Range (0 to +5ma FS) | Straight Binary |
|---|---|---|---|---|
| +2.495 | 1111111111 | 0111111111 | +4.995 | 1111111111 |
| +2.187 | 1111000000 | 0111000000 | +4.375 | 1110000000 |
| +1.875 | 1110000000 | 0110000000 | +3.750 | 1100000000 |
| +1.250 | 1100000000 | 0100000000 | +2.500 | 1000000000 |
| 0.000 | 1000000000 | 0000000000 | +1.250 | 0100000000 |
| −1.250 | 0100000000 | 1100000000 | +0.625 | 0010000000 |
| −1.875 | 0010000000 | 1010000000 | 0.000 | 0000000000 |
| −2.187 | 0001000000 | 1001000000 | | |
| −2.495 | 0000000001 | 1000000001 | | |
| −2.500 | 0000000000 | 1000000000 | | |

**Note 1:** The converter does not directly accept 2's complement coding without first externally complementing the 2's comp MSB by using an external inverter or FF $\overline{Q}$ output. After this bit is complemented, the code appears as normal offset binary which the converter can process.

## MEASURING OUTPUT SETTLING TIME

Because of the phenomenal output settling time of these devices, great care must be taken when measuring the output performance. Model 454 Tektronix Oscilloscope with low capacitance probe and probe ground lead is recommended for measuring output settling time. Input/Output connections should be made as close as possible to the "DAC" pins. Best results occur when the digital input source has a time skew of less than 5 nanoseconds.

Output settling time for these devices can be defined as that time between application of an input digital word and the analog output settling to ±0.1% of full scale, it includes switch delay, slewing time and final exponential decay time.




Typical Test Set Up For Measuring Output Settling Time.

DATEL

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# 12 BINARY BIT RESOLUTION
# 25 NSEC OUTPUT SETTLING TIME
# DIGITAL TO ANALOG CONVERTER
# MODEL DAC-HI 12B

## FEATURES

- ULTRA FAST SETTLING
- HIGH RESOLUTION
- SMALL SIZE

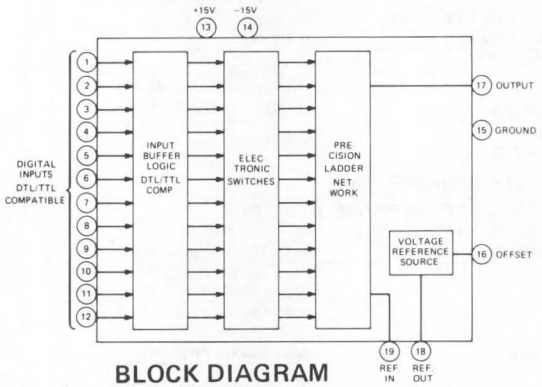
## GENERAL DESCRIPTION

The DAC-HI12B is a 12 bit Digital to Analog converter featuring a state-of-the-art output settling time of 25 nanoseconds combined with a ±1/2LSB linearity and a temperature coefficient of ±20ppm/°C.

Bipolar operation is achieved by externally pin strapping a built-in offsetting reference. Input coding can be straight binary for unipolar output, or a choice of offset binary or two's complement for bipolar output.

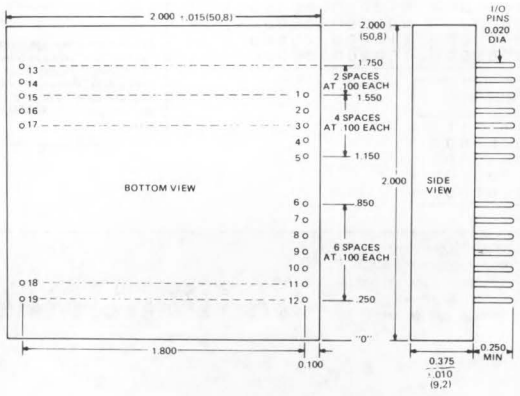
The DAC-HI12B is completely self-contained, requiring only ±15 volts D.C. power. Packaged in a 2"x2"x0.375", low profile module, it is readily soldered or plugged directly into P.C. cards or other mother board hardware. Included in each module is digital interface logic, a precision resistor ladder network, high speed electronic switches, and a temperature compensated precision voltage reference source.

One of the prime features is the unit's output flexibility with a 5 ma current output which can be fed directly into an external resistor to develop a 1.2V maximum output or, by external pin strapping, a bipolar output of ±1.2V maximum can be generated across the output load resistor. The output current can also be fed into an operational amplifier for those who require sign inversion, scaling etc. This amplifier can be selected to suit a particular application.


BLOCK DIAGRAM
MODEL DAC–HI12B

## MECHANICAL DIMENSIONS–INCHES (MM)




## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | BIT 1 INPUT (MSB) |
| 2 | BIT 2 INPUT |
| 3 | BIT 3 INPUT |
| 4 | BIT 4 INPUT |
| 5 | BIT 5 INPUT |
| 6 | BIT 6 INPUT |
| 7 | BIT 7 INPUT |
| 8 | BIT 8 INPUT |
| 9 | BIT 9 INPUT |
| 10 | BIT 10 INPUT |
| 11 | BIT 11 INPUT |
| 12 | BIT 12 INPUT (LSB) |
| 13 | +15V POWER INPUT |
| 14 | –15V POWER INPUT |
| 15 | COMMON GROUND |
| 16 | OFFSET |
| 17 | ANALOG OUTPUT |
| 18 | REFERENCE OUTPUT |
| 19 | REFERENCE INPUT |

## SPECIFICATIONS (typical @ 25° C unless otherwise noted)

| | |
|---|---|
| **MODEL NUMBER** | **DAC-HI 12B** |
| **DIGITAL INPUTS** | |
| **RESOLUTION** | 12 Binary Bits |
| **CODING** (Parallel Data in the following Formats) | Straight Binary (Unipolar Output)<br>Offset Binary (Bipolar Output)<br>Two's Complement (Note 1) (Bipolar Output) |
| **DATA INPUTS** | |

| INPUT CODE | VINPUT MIN. | VINPUT MAX. | BIT STATUS |
|---|---|---|---|
| "0" | 0V | +0.8V | OFF |
| "1" | +2.0V | +5.5V | ON |

DTL or TTL Compatible
Positive Logic
Loading: 2 standard TTL loads

| | |
|---|---|
| **ANALOG OUTPUT (@25°C)** | |
| **ACCURACY** | Adj. to ±0.01% |
| **TYPE OF OUTPUT** | Current |
| **FULL SCALE OUTPUT** | 5 ma @ +1.2V max. (Unipolar)<br>±2.5 ma @ ±1.2V max. (Bipolar) |
| **OUTPUT IMPEDANCE** | 600 Ohms ±1% |
| **OUTPUT ZERO OFFSET** | 15 na |
| **OUTPUT LOADING** | 300 ohms for 0 to +1V Output<br>2.325K for ±1.0V Output |
| **OUTPUT SETTLING TIME** | 50 nsec to ±0.025% of FS |
| **OUTPUT RESOLUTION** | 1 LSB (1.25μa for 12 Binary Bits) |
| **LINEARITY** | ±.625μA (1/2 LSB) |
| **TEMPERATURE COEFFICIENT** | ±20 ppm/°C of FS |
| **LONG TERM STABILITY** | ±0.5%/Yr. |
| **REFERENCE SOURCE** | Internal |
| **INPUT POWER REQUIREMENTS** | +15VDC, ±0.5V @ 40 ma<br>−15VDC, ±0.5V @ 20 ma |
| **POWER SUPPLY REJECTION RATIO** | .0085%/V |
| **PHYSICAL – ENVIRONMENTAL** | |
| **OPERATING TEMPERATURE RANGE** | 0° to +70°C |
| **STORAGE TEMPERATURE RANGE** | −55°C to +85°C |
| **RELATIVE HUMIDITY** | Up to 100% Non-Condensing |
| **SIZE** | 2"L x 2"W x 0.375"H Plug-in Module, fully repairable |
| **PINS** | 0.020" Round Gold Plated 0.250" Long Min. |
| **CASE MATERIAL** | Black Diallyl Phthalate |
| **WEIGHT** | 2 oz. |
| **MATING CONNECTOR** | DILS-2 2 per module required $5.00 per pair |
| **PRICE (1-9)** | $129 ea. |

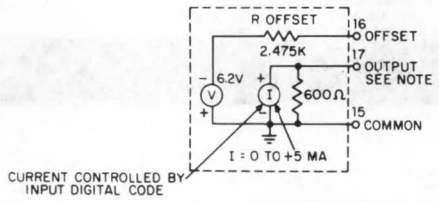
## INPUT CODING

| ANALOG OUTPUT (± 2.5mA FS) | OFFSET BINARY | 2'S COMPLEMENT (1) |
|---|---|---|
| +2.49875mA | 1 1 1 1 1 1 1 1 1 1 1 1 | 0 1 1 1 1 1 1 1 1 1 1 1 |
| +1.25000mA | 1 1 0 0 0 0 0 0 0 0 0 0 | 0 1 0 0 0 0 0 0 0 0 0 0 |
| 0mA | 1 0 0 0 0 0 0 0 0 0 0 0 | 0 0 0 0 0 0 0 0 0 0 0 0 |
| −1.25000mA | 0 1 0 0 0 0 0 0 0 0 0 0 | 1 1 0 0 0 0 0 0 0 0 0 0 |
| −2.50000mA | 0 0 0 0 0 0 0 0 0 0 0 0 | 1 0 0 0 0 0 0 0 0 0 0 0 |

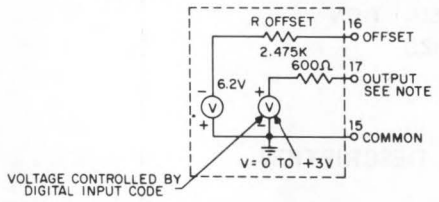
| ANALOG OUTPUT (0 to +5mA FS) | STRAIGHT BINARY |
|---|---|
| +4.99875mA | 1 1 1 1 1 1 1 1 1 1 1 1 |
| +3.75000mA | 1 1 0 0 0 0 0 0 0 0 0 0 |
| +2.50000mA | 1 0 0 0 0 0 0 0 0 0 0 0 |
| +1.25000mA | 0 1 0 0 0 0 0 0 0 0 0 0 |
| 000000mA | 0 0 0 0 0 0 0 0 0 0 0 0 |

## DAC–HI 12B APPLICATION NOTES

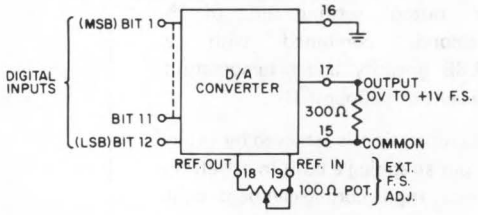
### CURRENT EQUIVALENT CIRCUIT




### VOLTAGE EQUIVALENT CIRCUIT



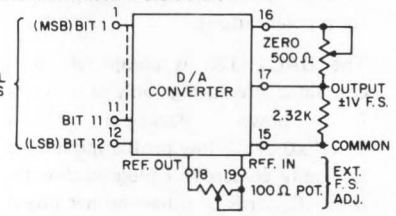

### UNIPOLAR CURRENT OUTPUT




### BIPOLAR CURRENT OUTPUT

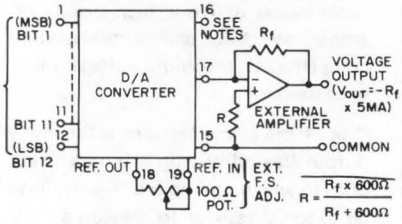
Connect external load resistor of 2.32K Ohms across pins 15 & 17. Connect a 500 Ω pot. as shown across pins 16 & 17. Connect a 100 Ω pot. as shown across pins 18 & 19.

**Calibration Procedure**
With input code 000000000000 adjust the 500 Ω pot. for −1.0000 volts output.
With input code 111111111111 adjust the 100 Ω pot. for +0.99976 volts output.




### UNIPOLAR OR BIPOLAR VOLTAGE OUTPUT

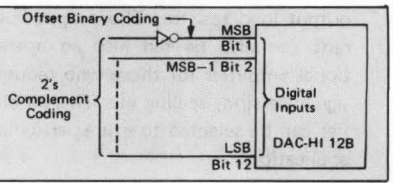
For Unipolar voltage output connect jumper between pins 15 & 16. For Bipolar voltage output connect a 500 Ohm potentiometer between pins 16 & 17 and adjust for zero output with 100000000000 input.




TRIMPOTS – $3. each
DATEL NO. TP100 (100 Ω)
DATEL NO. TP500 (500 Ω)

**Note: (1)** The converter does not directly accept 2's complement coding without first externally complementing the 2's comp MSB by using an external inverter or FF $\overline{Q}$ output. After this bit is complemented, the code appears as normal offset binary which the converter can process.

**2'S COMPLEMENT TO OFFSET BINARY CONVERSION (1)**




DATEL

DATEL SYSTEMS, INC.
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TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# HIGH SPEED 50Ω LINE DRIVER DIGITAL TO ANALOG CONVERTERS

## DAC-HV-100 SERIES

FEATURES

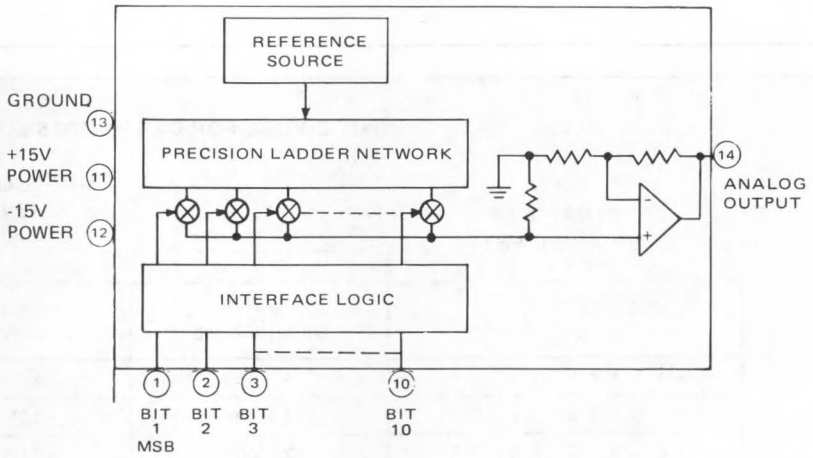
- Ultra High Speed
- High Output Current
- High Resolution
- Excellent Linearity
- Adjustment Free Operation

### DESCRIPTION

The Model DAC-HV-100 Series Digital to Analog Converters are ultra high speed devices with a settling time of 50 nanoseconds. Standard versions are available with six, eight or ten binary bit input resolution. The output swings from 0 to +5 volts and is capable of driving a 50 ohm transmission line.

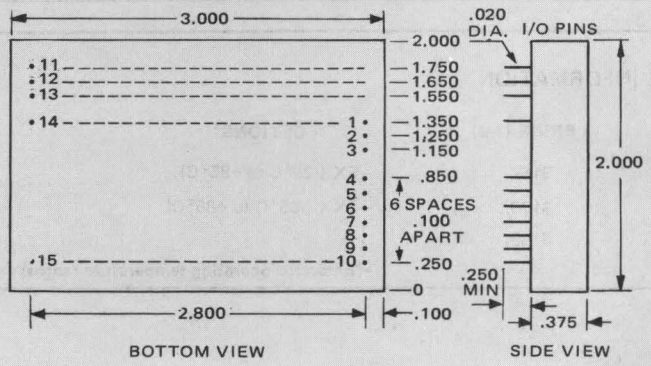
The superior transfer characteristic of the DAC-HV-100 Series include an accuracy of 0.1% of full scale, a linearity of ±1/2 LSB and a temperature coefficient of ±100 PPM/°C. Long term stability of these converters is ±0.5% per year.

Each D/A is completely self contained requiring only ±15 VDC power. Packaged in a 2"Wx3"L x.375"H low profile module, they are readily soldered or plugged into PC boards which can then be mounted on 1/2 inch centers. The module includes digital interface logic and precision resistor ladder networks, high speed electronic switches, a temperature compensated precision voltage reference source and featuring an ultra high speed amplifier capable of settling to within 0.4% accuracy in 50 nanoseconds after a full scale output excursion.


MODEL DAC-HV-100 SERIES BLOCK DIAGRAM

MECHANICAL DIMENSIONS (INCHES)




INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | BIT 1 (MSB) | 9 | BIT 9 |
| 2 | BIT 2 | 10 | BIT 10 |
| 3 | BIT 3 | 11 | +15V POWER INPUT |
| 4 | BIT 4 | 12 | -15V POWER INPUT |
| 5 | BIT 5 | 13 | GROUND |
| 6 | BIT 6 | 14 | ANALOG OUTPUT |
| 7 | BIT 7 | 15 | NO CONNECTION |
| 8 | BIT 8 | | |

## ELECTRICAL SPECIFICATIONS (typical @ 25° C, ±15 VDC unless otherwise specified)

DATEL

### DIGITAL INPUTS:

| | |
|---|---|
| Resolution | Optional 6, 8, or 10 Binary Bits |
| Coding | Parallel data in Straight Binary input format |
| Data Inputs | Binary "0" ≤ +0.8V (Switch off)<br>Binary "1" ≥ +2.0V (Switch on)<br>DTL or TTL compatible, positive logic |

| Input Code | Voltage Output |
|---|---|
| 0000000000 | 0V |
| 1111111111 | +5V −1 LSB |

Loading; 2 standard TTL loads (See coding chart below)

### ANALOG OUTPUT (@25° C)

| | |
|---|---|
| Accuracy | ±.2% of FS(6&8 Bits); ±.1% of FS (10 Bits) |
| Output Voltage Range | 0V to +5V |
| Full Scale Output | +5V @ 100mA |
| Output Load | 50 Ohm (min) |
| Output Settling Time | 50 typ., 75 max. nanoseconds to .4% of F.S. (6 & 8 Bits); 100 typ, 250 max. nanoseconds to .1% of FS (10 Bit) |
| Linearity | ±1/2 LSB |
| Temperature Coefficient of FS | ±60 ppm/° C |
| Temperature Coefficient of Zero | ±40 ppm/° C |

### INPUT POWER REQUIREMENTS

+15VDC, ±0.5VDC @ 70mA max.
-15VDC, ±0.5VDC @ 50mA max.

| | |
|---|---|
| Power Supply Rejection Ratio | 0.1% per Volt |

### PHYSICAL - ENVIRONMENTAL

| | |
|---|---|
| Operating Temperature Range | 0° C to +70° C (extended operating temperature ranges optionally available) |
| Storage Temperature Range | -55° C to +85° C |
| Relative Humidity | Up to 100% Non-Condensing |
| Size | 2"W X 3"L X 0.375"H Plug-in Module |
| Pins | 0.020" Round Gold Plated 0.250" Long, min. |
| Case Material | Black Diallyl Phthalate Per MIL-M-14 |
| Weight | 4 oz. |
| Mating Socket | Model DILS-2 2 Req'd per module, $4 per pair |

### INPUT CODING FOR DAC-HV-100 SERIES

| STRAIGHT BINARY INPUT (6 8 10) | ANALOG OUTPUT (+5V, FS) 6 BIT DAC-HV6B-100 | 8 BIT DAC-HV8B-100 | 10 BIT DAC-HV10B-100 |
|---|---|---|---|
| 1 1 1 1 1 1 1 1 1 1 | +4.9219V | +4.9805V | +4.9951V |
| 1 1 0 0 0 0 0 0 0 0 | +3.7500V | +3.7500V | +3.7500V |
| 1 0 0 0 0 0 0 0 0 0 | +2.5000V | +2.5000V | +2.5000V |
| 0 1 0 0 0 0 0 0 0 0 | +1.2500V | +1.2500V | +1.2500V |
| 0 0 0 0 0 0 0 0 0 0 | 0.0000V | 0.0000V | 0.0000V |

### ORDERING INFORMATION

| MODEL | NUMBER OF BITS | PRICE (1-9) | OPTIONS* |
|---|---|---|---|
| DAC-HV6B-100 | 6 BINARY BITS | $169. | −EX (-25° C to +85° C) |
| DAC-HV8B-100 | 8 BINARY BITS | $179. | −EXX (-55° C to +85° C) |
| DAC-HV10B-100 | 10 BINARY BITS | $189. | |

*(Extended operating temperature ranges)

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# GENERAL PURPOSE, HIGH PERFORMANCE DIGITAL TO ANALOG CONVERTERS

# DAC-R, DAC-TR SERIES

## FEATURES

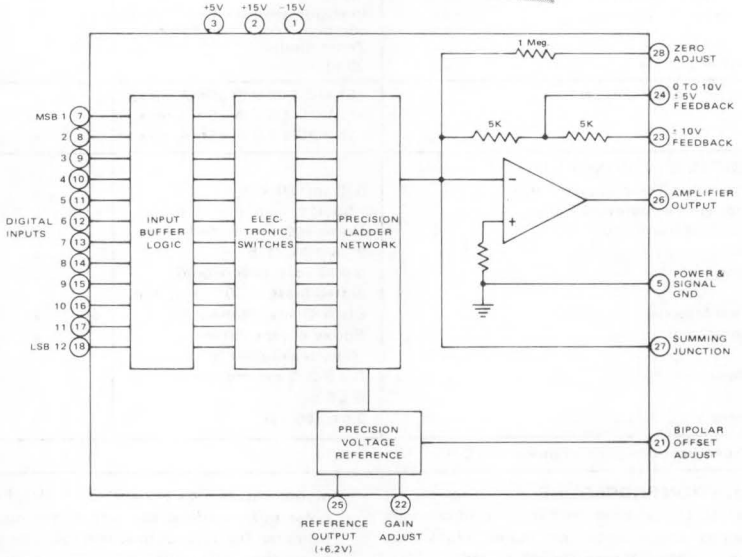
- ▶ 8, 10, 12 Bit Resolutions
- ▶ 5 $\mu$ sec Settling Time
- ▶ 5 Voltage Output Ranges
- ▶ Temp. Coeff. to 7ppm/°C
- ▶ 2 x 2 x .375 Inch Module

## GENERAL DESCRIPTION

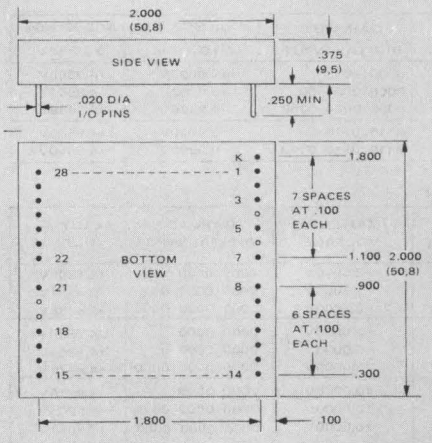
The DAC-R and DAC-TR series digital to analog converters feature high performance voltage outputs for 8, 10, and 12 bit resolutions. There are 5 different output voltage ranges which can be selected by external pin connection: 0 to +5V, 0 to +10V, -2.5V to +2.5V, -5V to +5V, and -10V to +10V. Internally these models contain input buffer logic and an electronic switch array, a precision resistor network, a precision stable zener voltage reference, and an output amplifier.

The output voltage settling time is 5 $\mu$sec. to specified accuracy, resulting in an update rate of 200kHz. The output can drive a load up to 5mA on the 0 to +10V and -10 to +10V ranges and up to 10mA on the other ranges. Input coding is complementary binary or complementary BCD for unipolar operation and complementary offset binary for bipolar operation. The logic inputs are DTL/TTL compatible. External offset and gain adjustments are made using two 100K ohm trimming pots., resulting in an accuracy of .01% FS±½ LSB. The DAC-R models have a gain temperature coefficient of 30 ppm/°C while the DAC-TR models feature an exceptionally low coefficient of 7 ppm/°C.

These converters are encapsulated in compact 2 x 2 x .375 inch modules with DIP compatible .100" pin spacing. Pins are .020" diameter gold plated. Input power requirements are +5VDC and ±15 VDC and are available from Datel Systems' broad line of modular power supplies. Extended temperature range versions are also available by consulting the factory.


## MECHANICAL DIMENSIONS INCHES (MM)




NOTE: Open dots indicate omitted pins. Pins 17 and 18 are omitted on 10 bit models. Pins 15, 16, 17, and 18 are omitted on 8 bit models. Pin position tolerance is ± 0.005" From datum, non-accumulative.

## INPUT/OUTPUT CONNECTIONS

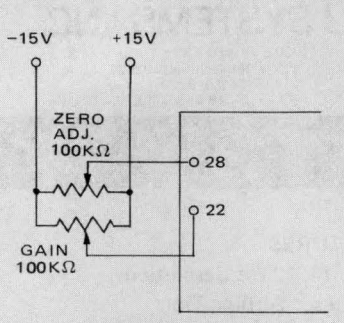
| PIN | FUNCTION |
|---|---|
| K | KEY |
| 1 | -15 Volt Power Input |
| 2 | +15 Volt Power Input |
| 3 | +5 Volt Power Input |
| 4 | No Connection (pin is omitted) |
| 5 | Power and Signal Ground |
| 6 | No Connection (pin is omitted) |
| 7 | Bit 1 (MSB) |
| 8 | Bit 2 |
| 9 | Bit 3 |
| 10 | Bit 4 |
| 11 | Bit 5 |
| 12 | Bit 6 |
| 13 | Bit 7 |
| 14 | Bit 8 |
| 15 | Bit 9* |
| 16 | Bit 10* |
| 17 | Bit 11* ** |
| 18 | Bit 12* ** |
| 19 | No Connection (pin is omitted) |
| 20 | No Connection (pin is omitted) |
| 21 | Bipolar Offset |
| 22 | Full Scale Gain Adjust |
| 23 | ± 10V Feedback |
| 24 | 0 to +10V, ±5V Feedback |
| 25 | Reference Output |
| 26 | Amplifier Output |
| 27 | Summing Junction |
| 28 | Zero Adjust |

* Omitted on eight bit models
** Omitted on ten bit models

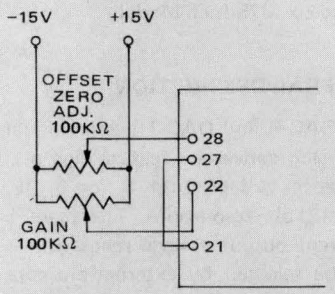
| SPECIFICATIONS (Typical @ 25°C unless otherwise noted) | DAC-R | DAC-TR |
|---|---|---|
| **INPUTS** | | |
| Resolution | 8, 10, 12 Bits | * |
| Coding, Unipolar Output | Complementary Binary | * |
| | Complementary BCD | * |
| Coding, Bipolar Output | Complementary Offset Binary | * |
| Input Logic (Input Code "1" / "0"; Voltage Input Min. +2V / 0V; Max. +5.5V / +0.8V; Bit Status OFF / ON) | DTL/TTL Compatible | * |
| | One TTL Load/Bit | * |
| Update Rate | 200 kHz | * |
| **OUTPUTS** | | |
| Accuracy, 25° | Adj. to .01% FS ±½ LSB | * |
| Linearity | ±½ LSB | * |
| Temperature Coefficient | | |
| Gain, FS | 30 ppm/°C of FS | 7 ppm/°C of FS |
| Zero, Unipolar | 10μV/°C | * |
| Offset, Bipolar | 100μV/°C | 20μV/°C |
| Output Voltage Ranges (selected by external pin connection) | 0 to +10V @ 5mA max. | * |
| | 0 to +5V @ 10mA max. | * |
| | −5V to +5V @ 10mA max. | * |
| | −10V to +10V @ 5mA max. | * |
| | −2.5V to +2.5V @ 10mA max. | * |
| Settling Time | 5 μsec to ±.01% of FS | * |
| Output Impedance | .02Ω | * |
| Internal Reference | Precision temperature compensated, derived from Zener diode | * |
| Power Supply Rejection | 20 ppm/% | * |
| **POWER REQUIREMENT** | +5VDC ±.25V @ 30mA max. | * |
| | +15VDC ±.5V @ 35mA max. | * |
| | −15VDC ±.5V @ 45mA max. | * |
| **PHYSICAL-ENVIRONMENTAL** | | |
| Operating Temperature Range | 0°C to +70°C | * |
| Storage Temperature Range | −55°C to +85°C | * |
| Relative Humidity | Up to 100% non-condensing | * |
| Size | 2" x 2" x .375" | * |
| Pins | 0.020" dia. round, gold-plated brass, .250" long, min. | * |
| Case Material | Black Diallyl Phthalate | * |
| Construction | Epoxy-encapsulated (fully repairable) | * |
| Mating Socket | DILS-2, 2 per module @ $5/pr. | * |
| Weight | 2 oz. (56.7g) | * |

*Specifications same as model DAC-R

## GAIN & OFFSET ADJUSTMENTS




UNIPOLAR ZERO AND GAIN ADJUST




### OUTPUT VOLTAGE RANGE EXTERNAL PIN-STRAPPING

| FULL SCALE OUTPUT RANGE | CONNECT THE FOLLOWING PINS TOGETHER | | |
|---|---|---|---|
| −2.5V to +2.5V | 21, 23 & 27 | 24 & 26 | |
| −5V to +5V | 21 & 27 | 24 & 26 | |
| −10V to +10V | 21 & 27 | 23 & 26 | |
| 0 to +5V | 23 & 27 | 24 & 26 | 21 & 5 |
| 0 to +10V | 24 & 26 | 21 & 5 | |

### CALIBRATION PROCEDURE

1. Refer to the unipolar and bipolar adjustment diagrams and the coding tables. Note that complementary binary coding is used.
2. OFFSET OR ZERO ADJUSTMENT: Set all digital inputs high (+2.0V to +5.5V). For unipolar output adjust the zero trimming potentiometer for zero output voltage. For bipolar operation adjust the offset trimming potentiometer to give −FS output voltage as shown in the coding table.
3. GAIN ADJUSTMENT: Set all digital inputs low (0V to +0.8V) and adjust the gain trimming potentiometer to give +FS output voltage as shown in the coding table.

### CODING TABLES

UNIPOLAR OUTPUT – Complementary Binary & Complementary BCD

| NO. BITS | OFFSET ADJ. DIGITAL INPUT | OUTPUT VOLTAGE | GAIN ADJ. DIGITAL INPUT | OUTPUT VOLTAGE RANGE 0 TO +10V | OUTPUT VOLTAGE RANGE 0 TO +5V |
|---|---|---|---|---|---|
| 8 Bin | 1111 1111 | 0V | 0000 0000 | +9.9609V | +4.9805V |
| 10 Bin | 1111 1111 11 | 0V | 0000 0000 00 | +9.9902V | +4.9951V |
| 12 Bin | 1111 1111 1111 | 0V | 0000 0000 0000 | +9.9976V | +4.9988V |
| 8 BCD | 1111 1111 | 0V | 0110 0110 | +9.9000V | +4.9500V |
| 12 BCD | 1111 1111 1111 | 0V | 0110 0110 0110 | +9.9900V | +4.9950V |

BIPOLAR OUTPUT – Complementary Offset Binary

| NO. BITS | OUTPUT VOLTAGE RANGE | OFFSET ADJ. DIGITAL INPUT | OUTPUT VOLTAGE | GAIN ADJ. DIGITAL INPUT | OUTPUT VOLTAGE |
|---|---|---|---|---|---|
| 8 | ±2.5V | 1111 1111 | −2.5000V | 0000 0000 | +2.4805V |
| 10 | | 1111 1111 11 | −2.5000V | 0000 0000 00 | +2.4951V |
| 12 | | 1111 1111 1111 | −2.5000V | 0000 0000 0000 | +2.4988V |
| 8 | ±5V | 1111 1111 | −5.0000V | 0000 0000 | +4.9609V |
| 10 | | 1111 1111 11 | −5.0000V | 0000 0000 00 | +4.9902V |
| 12 | | 1111 1111 1111 | −5.0000V | 0000 0000 0000 | +4.9976V |
| 8 | ±10V | 1111 1111 | −10.0000V | 0000 0000 | +9.9219V |
| 10 | | 1111 1111 11 | −10.0000V | 0000 0000 00 | +9.9805V |
| 12 | | 1111 1111 1111 | −10.0000V | 0000 0000 0000 | +9.9951V |

### ORDERING INFORMATION

DAC-R
DAC-TR

| NUMBER OF BITS AND CODING |
|---|
| 8B = 8 BIT COMPLEMENTARY BINARY |
| 10B = 10 BIT COMPLEMENTARY BINARY |
| 12B = 12 BIT COMPLEMENTARY BINARY |
| 8D = 2 DIGIT COMPLEMENTARY BCD |
| 12D = 3 DIGIT COMPLEMENTARY BCD |

**PRICES (1-9)**

| | | | |
|---|---|---|---|
| DAC-R8B | $69.00 | DAC-TR8B | $129.00 |
| DAC-R10B | $75.00 | DAC-TR10B | $159.00 |
| DAC-R12B | $79.00 | DAC-TR12B | $179.00 |
| DAC-R8D | $69.00 | DAC-TR8D | $129.00 |
| DAC-R12D | $79.00 | DAC-TR12D | $179.00 |

MATING SOCKET DILS-2 (2 per module @ $5/pair)

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# 16 BINARY BIT D/A CONVERTER-$109. SINGLE QUANTITY DIGITAL TO ANALOG CONVERTERS

# DAC-169 SERIES

## FEATURES

- High Resolution – One Part In 65,535
- 4 Digit BCD Version
- 3 Selectable Voltage Outputs
- 2 Selectable Current Outputs

## GENERAL DESCRIPTION

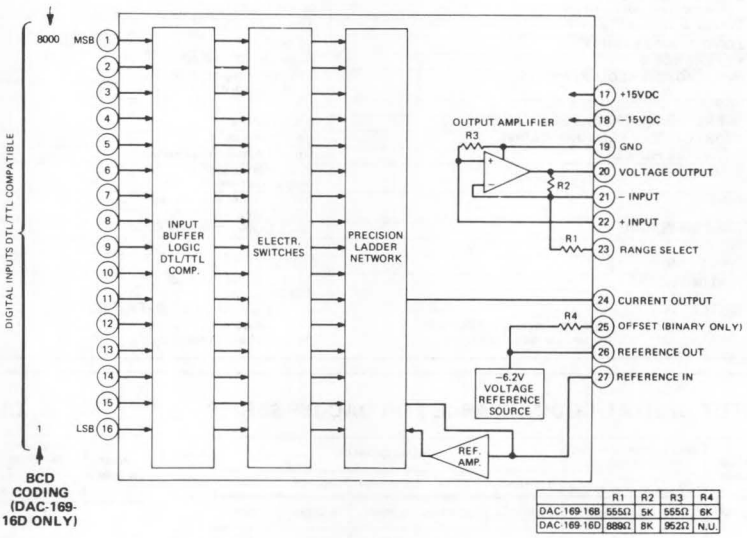
The DAC-169 series Digital-to-Analog Converters are low cost, moderate performance 16 binary bit or 4 digit BCD units contained in compact modular form, 2"Lx2"Wx0.375"H case, ideal for 0.5 inch card spacing.

Both models offer selectable current and voltage outputs. The user selects the desired output by externally jumping selector pins on the unit. There are five available output ranges for the 16 binary bit unit and three output ranges for the 4 digit BCD model.

Input digital coding is straight binary or binary coded decimal for unipolar operation and offset binary for bipolar applications. DAC-169 series were specifically designed for incorporation in systems and equipment demanding a wide dynamic range. For example, with a full scale output of ten volts, DAC-169 can resolve down to 150 microvolts, a 96.3 db change.

Output settling time is specified at 750 nanoseconds and 30 microseconds for current and voltage outputs respectively. Output settling time is defined as that time between the application of an input digital word and the output settling to ±0.005% of full scale, and it includes switch delay, nonlinear slewing time and final exponential decay time.

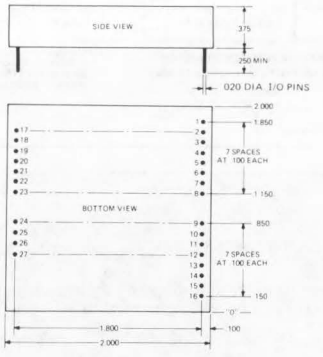
Full scale output ranges for the binary version are 0 to +10V, 0 to −10V, or +5V @ ±5ma. The current output can be selected for 0 to +2ma or ±1ma. The BCD model can have a full scale voltage output of 0 to +10V or 0 to −10V @ 5ma. The current output can be pin strapped for 0 to +1.25ma full scale.


| | R1 | R2 | R3 | R4 |
|---|---|---|---|---|
| DAC-169-16B | 555Ω | 5K | 555Ω | 6K |
| DAC-169-16D | 889Ω | 8K | 952Ω | N.U. |

BLOCK DIAGRAM MODELS DAC-169-16B, DAC-169-16D

## MECHANICAL DIMENSIONS (INCHES)




## INPUT/OUTPUT CONNECTIONS

| MODEL PIN | DAC−169−16B FUNCTION | DAC−169−16D FUNCTION | MODEL PIN | DAC−169−16B FUNCTION | DAC−169−16D FUNCTION |
|---|---|---|---|---|---|
| 1 | BIT 1 (MSB) | BIT 8000 (MSB) | 15 | BIT 15 | BIT 2 |
| 2 | BIT 2 | BIT 4000 | 16 | BIT 16 (LSB) | BIT 1 (LSB) |
| 3 | BIT 3 | BIT 2000 | 17 | +15 VDC POWER INPUT | +15 VDC POWER INPUT |
| 4 | BIT 4 | BIT 1000 | 18 | −15 VDC POWER INPUT | −15 VDC POWER INPUT |
| 5 | BIT 5 | BIT 800 | 19 | COMMON GROUND | COMMON GROUND |
| 6 | BIT 6 | BIT 400 | 20 | VOLTAGE OUTPUT | VOLTAGE OUTPUT |
| 7 | BIT 7 | BIT 200 | 21 | −INPUT | −INPUT |
| 8 | BIT 8 | BIT 100 | 22 | +INPUT | +INPUT |
| 9 | BIT 9 | BIT 80 | 23 | RANGE SELECT | RANGE SELECT |
| 10 | BIT 10 | BIT 40 | 24 | CURRENT OUTPUT | CURRENT OUTPUT |
| 11 | BIT 11 | BIT 20 | 25 | OFFSET (BINARY MODELS ONLY) | N/A |
| 12 | BIT 12 | BIT 10 | 26 | REFERENCE OUT | REFERENCE OUT |
| 13 | BIT 13 | BIT 8 | 27 | REFERENCE IN | REFERENCE IN |
| 14 | BIT 14 | BIT 4 | | | |

## SPECIFICATIONS (typical @ 25°C, unless otherwise noted)

| PARAMETERS | MODEL DAC–169–16B | MODEL DAC–169–16D |
|---|---|---|
| **DIGITAL INPUTS** | | |
| **RESOLUTION** | 16 Binary Bits | 4 Digit BCD |
| **CODING**<br>Parallel data in the following formats | Straight Binary (Unipolar Output)<br>Offset Binary (Bipolar Output) | BCD (8-4-2-1) (Unipolar Output) |
| **DATA INPUTS**<br>Input Code: "0" 0V Min. +0.8V Max. Bit Status OFF; "1" +2.0V Min. +5.5V Max. ON | DTL or TTL compatible<br>positive TRUE logic<br>LOADING: One Standard TTL Load | DTL or TTL compatible<br>positive TRUE logic<br>LOADING: One Standard TTL Load |
| **UPDATE RATE**<br>Voltage output limited by output amplifier settling time | 5 MHz typical | 5 MHz typical |
| ANALOG OUTPUT (@25°C) | | |
| **ACCURACY** | Adj. to 0.005% of F.S. | Adj. to 0.005% of F.S. |
| **LINEARITY** | ±0.005% of F.S. (4) | ±0.005% of F.S. (4) |
| **LINEARITY TEMPERATURE COEFFICIENT** | ±0.0005%/°C | ±0.0005%/°C |
| **TEMPERATURE COEFFICIENT (GAIN)** | ±10ppm/°C (1), ±15ppm/°C (5) | ±10ppm/°C(1), ±15ppm/°C (5) |
| **TEMPERATURE COEFFICIENT (OFFSET)** | ±50 µV/°C typ (+10V), ±10 µV/°C(−10V, ±5V) | ±50 µV/°C typ (+10V), ±10 µV/°C(−10V, ±5V) |
| **TYPE OF OUTPUT** | Current or Voltage | Current or Voltage |
| **OUTPUT**<br>Current output configuration | Externally selectable<br>0 to +2.0 mA or ±1 mA | 0 to +1.25mA |
| Voltage out configuration | Externally selectable<br>0 to +10V, 0 to −10V, or ±5V | Externally selectable<br>0 to +10V or 0 to −10V |
| **OUTPUT LOADING**<br>Current output configuration | 555 Ohms for +1.0V output<br>1.57K Ohms for ±1.0V output | 952 Ohms for +1.0V output |
| Voltage output configuration | 2K Ohms for 0 to +10V or 0 to −10V output<br>1K Ohms for ±5V output | 2K Ohms for 0 to +10V or 0 to −10V output |
| **OUTPUT SETTLING TIME**<br>Current output configuration | 750 nsec to ±0.005% of F.S. | 750 nsec to ±0.005% of F.S. |
| Voltage output configuration | 30 µsec to ±0.005% of F.S. | 30 µsec to ±0.005% of F.S. |
| **OUTPUT RESOLUTION**<br>Current output configuration | 30 nA (1 LSB) | 200 nA (1 LSD) |
| Voltage output configuration | 150 µV (1 LSB) | 1 mV (1 LSD) |
| **LONG TERM STABILITY** | ±0.005%/yr. | ±0.005%/yr. |
| **REFERENCE SOURCE** | Internal: TC = ±0.0005%/°C (2) | Internal: TC = ±0.0005%/°C (2) |
| **INPUT POWER REQUIREMENTS** | +15VDC ±.5VDC @ 25 mA<br>−15VDC ±.5VDC @ 25 mA (excluding output current) | +15VDC ±.5VDC @ 25 mA<br>−15VDC ±.5VDC @ 25 mA (excluding output current) |
| PHYSICAL ENVIRONMENTAL | | |
| **OPERATING TEMPERATURE RANGE** | 0°C to +70°C | 0°C to +70°C |
| **STORAGE TEMPERATURE RANGE** | −55°C to +85°C | −55°C to +85°C |
| **RELATIVE HUMIDITY** | Up to 100% non-condensing | Up to 100% non-condensing |
| **SIZE** | 2"L x 2"W x 0.375"H<br>plug-in module | 2"L x 2"W x 0.375"H<br>plug-in module |
| **PINS** | 0.020" round gold plated<br>0.250" long minimum | 0.020" round gold plated<br>0.250" long minimum |
| **CASE MATERIAL** | Black Diallyl Phthalate (3) | Black Diallyl Phthalate (3) |
| **WEIGHT** | 2 oz. | 2 oz. |
| **PRICE (1-9)** | $109.00 Each | $109.00 Each |
| **MATING SOCKET** | DILS-2 (2 per module)<br>$5.00 per pair | DILS-2 (2 per module)<br>$5.00 per pair |

**NOTES:** (1) Current output
(2) Power Supply rejection 0.005%/%
(3) Converters are fully repairable
(4) Linearity ±0.012% of F.S. for Unipolar positive outputs.
(5) Voltage output

## INPUT DIGITAL CODING TABLE FOR DAC-169 SERIES

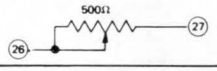
| ADJUSTMENT | BINARY INPUT WORD (16 BINARY BITS) MSB LSB | ANALOG OUTPUTS 0 to +2mA | ±1mA | 0 to +10V | 0 to −10V | ±5V |
|---|---|---|---|---|---|---|
| GAIN | 1111111111111111 | +1.99997mA | +.99997mA | +9.99985V | −9.99985V | −4.99985V |
| N/A | 1000000000000000 | 1mA | 0A | +5V | −5V | 0V |
| OFFSET | 0000000000000000 | 0mA | −1mA | 0V | 0V | +5V |

| ADJUSTMENT | 4 DIGIT BCD (8-4-2-1) INPUT WORD MSB LSB | ANALOG OUTPUTS 0 to +1.25mA | 0 to +10V | 0 to −10V |
|---|---|---|---|---|
| GAIN | 1001 – 1001 – 1001 – 1001 | +1.2499mA | +9.999V | −9.999V |
| OFFSET | 0000 – 0000 – 0000 – 0000 | 0mA | 0V | 0V |

## OUTPUT RANGE SETTING TABLE

| MODEL NUMBER | AVAILABLE OUTPUTS F.S. VALUE | AT PIN | EXTERNALLY JUMPER PINS | OFFSET ADJUSTMENT USING AN EXTERNAL POTENTIOMETER (3) VALUE | HIGH END | WIPER | LOW END | PINS NOT USED |
|---|---|---|---|---|---|---|---|---|
| DAC–169–16B (BINARY INPUTS) | 0 to +2mA | 24 | 19 to 25 | N/A | – | – | – | 20, 21, 22, 23 |
| | ±1mA | 24 | N/A | 500Ω | to pin 24 | to pin 25 | to wiper | 20, 21, 22, 23 |
| | 0 to +10V | 20 | 19 to 23 to 25, 22 to 24 | 100KΩ | to pin 17 | thru 1MΩ to pin 22 | to pin 18 | N/A |
| | 0 to −10V | 20 | 21 to 24, 19 to 25 | 100KΩ | to pin 17 | thru 1MΩ to pin 22 | to pin 18 | N/A |
| | ±5V | 20 | 21 to 24, to 25 | 100KΩ | to pin 17 | thru 1MΩ to pin 22 | to pin 18 | N/A |
| DAC–169–16D (BCD INPUTS) | 0 to +1.25mA | 24 | N/A | N/A | – | – | – | 20, 21, 22, 23, 25 |
| | 0 to +10V | 20 | 19 to 23, 22 to 24 | 100KΩ | to pin 17 | thru 1MΩ to pin 22 | to pin 18 | 25 |
| | 0 to −10V | 20 | 21 to 24 | 100KΩ | to pin 17 | thru 1MΩ to pin 22 | to pin 18 | 25 |

**EXTERNAL GAIN POTENTIOMETER FOR ALL OUTPUT CONFIGURATIONS**




(3) Use cermet type trimpots ≤100ppm/°C Datel model TP500 trimpot - $3.00 each.

## CALIBRATION PROCEDURE

(1) Make the appropriate connections as shown in the output range setting table.

(2) OFFSET ADJUSTMENT
Refer to the Input Digital Coding Table and connect the appropriate digital input.
Adjust the offset potentiometer in order to bring the analog output to the corresponding value as shown in table.

(3) GAIN ADJUSTMENT
Refer to the Input Digital Coding Table and connect the appropriate digital input.
Adjust the gain potentiometer in order to bring the analog output to the corresponding value as shown in table.

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# 16 BINARY BIT RESOLUTION DIGITAL TO ANALOG CONVERTERS

## DAC-HR SERIES

### FEATURES

- **Output Dynamic Range of 96db**
- **1.5ppm/°C Temperature Coefficient**
- **±0.0015% Accuracy**
- **1 μsec Output Settling Time (.0015%FS)**
- **±½ LSB Linearity**
- **2"Wx4"Lx0.4"H**

### GENERAL DESCRIPTION

The DAC-HR series Digital-to-Analog converters are characterized by a resolution of up to one part in 65,535, with a linearity error of ±0.0015% and the lowest temperature coefficient of any commercially available D/A converter of 1.5ppm/° C.

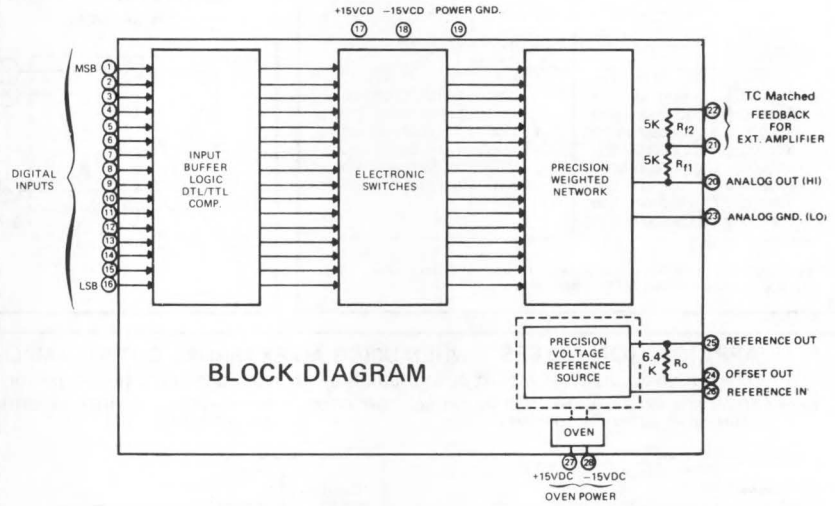
DAC-HR's excellence in both linearity and stability has been achieved by utilizing a precision thin film resistor ladder network which tracks to within 1ppm/°C; an oven controlled zener reference which exhibits a temperature coefficient of 0.25ppm/°C and is current controlled within a high gain servo loop; plus the use of four individual monolithic quad switches. These switches all being in close proximity on the same monolithic chip, have beta's which tend to track, both initially and with temperature. Also, the superior uniformity of these monolithic transistor switches leads to inherently high accuracy of matching thus requiring minor trimming.

The DAC-HR series are completely self contained in a 2"Wx4"Lx0.4"H plastic encapsulated module, yet fully repairable — a very significant consideration.

DAC-HR series were specifically designed for incorporation in systems and equipment demanding a wide dynamic range. For example, with a full scale output of one volt, DAC-HR can resolve down to 15 microvolts, a 96.3db change.

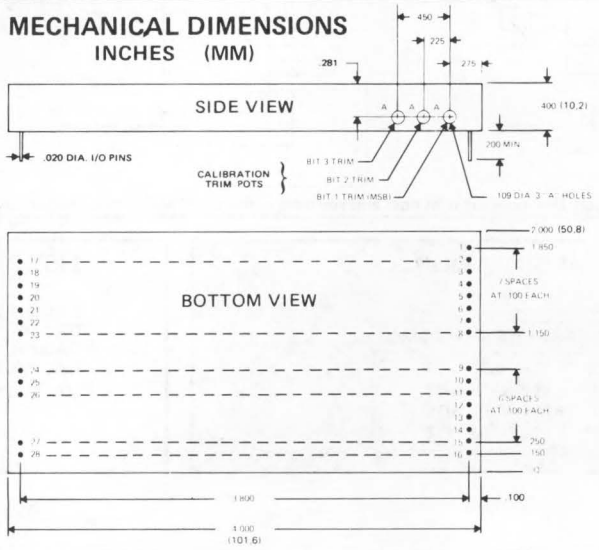
The output settling time is specified at 200 nanoseconds to 0.025% of full scale, and a maximum of 2 microseconds to 0.0015% of full scale. Output settling time is defined as that time between the application of an input digital word and the output settling to 0.0015% of full scale, it includes switch delay, nonlinear slewing time and final exponential decay time.

DAC-HR series may be used for either unipolar or bipolar applications. For unipolar operation full scale output is 0 to −2ma and ±1ma for bipolar output. Maximum voltage compliance is ±1V. Provisions have been provided for the user to connect an external operational amplifier for scaling, sign inversion, impedance transformation, etc. Feedback and offset resistors are included internally. These resistors have temperature coefficients matched to the ladder network. The values of the internal feedback and offset resistors are set to produce a unipolar (0V to +10V) or bipolar (±5V or ±10V) output from an external amplifier. The amplifier should be selected to suit particular applications.


BLOCK DIAGRAM

### MECHANICAL DIMENSIONS
INCHES (MM)




### INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | BIT 1 IN (MSB) |
| 2 | BIT 2 |
| 3 | BIT 3 |
| 4 | BIT 4 |
| 5 | BIT 5 |
| 6 | BIT 6 |
| 7 | BIT 7 |
| 8 | BIT 8 |
| 9 | BIT 9 |
| 10 | BIT 10 |
| 11 | BIT 11 |
| 12 | BIT 12 |
| 13 | BIT 13 |
| 14 | BIT 14 |
| 15 | BIT 15 |
| 16 | BIT 16 IN (LSB) |
| 17 | +15V |
| 18 | −15V |
| 19 | GROUND |
| 20 | ANALOG OUTPUT (HI) |
| 21 | FEEDBACK RES 5K |
| 22 | FEEDBACK RES 10K |
| 23 | ANALOG OUTPUT (LO) |
| 24 | OFFSET OUT |
| 25 | REF OUT |
| 26 | REF IN |
| 27 | +15V OVEN POWER |
| 28 | −15V OVEN POWER |

## SPECIFICATIONS (typical @ 25°C, unless otherwise noted)

DATEL

ELECTRICAL DIGITAL INPUTS:

**Resolution** . . . . . Up to 16 Binary Bits

**Coding** . . . . . Parallel data in the following format:
Straight Binary (Unipolar Output)
Offset Binary (Bipolar Output)
NOTE: Two's complement bipolar output can be achieved when an externally complemented MSB is provided.

**Logic Levels** . . . . . DTL/TTL compatible, NEGATIVE LOGIC TRUE

| INPUT CODE | V INPUT MIN. | V INPUT MAX. | BIT STATUS |
|---|---|---|---|
| "0" | +2.0V | +5.5V | OFF |
| "1" | 0V | +0.8V | ON |

**Loading** . . . . . One standard TTL load

ANALOG OUTPUT (@25 C)

**Accuracy** . . . . . Adjustable to ±0.0015% of FS ±½LSB

**Resolution** . . . . . 1LSB (30na for 16 Binary Bits)

**Zero Offset** . . . . . 5na

**Linearity** . . . . . ±½LSB(1)

**Temperature Coefficient** . . . . . 1.5ppm/°C with reference oven ON.
5.0ppm/°C with reference oven OFF

**Full Scale Output Current** . . . . . −2ma − Unipolar Output
±1ma − Bipolar Output

**Output Voltage Compliance** . . . . . −1V − Unipolar Output
±1V − Bipolar Output

**Output Impedance** . . . . . 5KΩ

**Output Settling Time** . . . . . 200 nanosec. to ±0.025% of FS
2 microsec. to ±0.0015% of FS

**Reference Source** . . . . . Internal − Oven Controlled

**Input Power Requirements** . . . . . D/A ONLY: +15VDC, ±0.5VDC @ 30ma; −15VDC, ±0.5VDC @ 35ma
REF. OVEN: +15VDC, ±0.5VDC @ 41ma; −15VDC, ±0.5VDC @ 41ma

PHYSICAL-ENVIRONMENTAL:

**Operating Temperature Range** . . . 0°C to +70°C

**Storage Temperature Range** . . . . . −55°C to +85°C

**Relative Humidity** . . . . . Up to 100% NON-CONDENSING

**Size** . . . . . 2"Wx4"Lx0.4"H

**Pins** . . . . . 0.020" round gold plated 0.250" long minimum

**Case Material** . . . . . Black Diallyl Phthalate, per MIL-M-14
Modules are fully repairable

**Weight** . . . . . 4 oz.

NOTE: An operating temperature range from −25°C to +85°C is available at additional cost. Add suffix "EX" to part number.

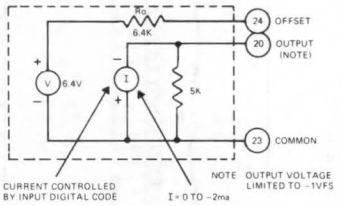
(1) Differential linearity is ±1 LSB for 16 Binary Bits (i.e., remains monotonic)

## CODING FOR DAC-HR SERIES

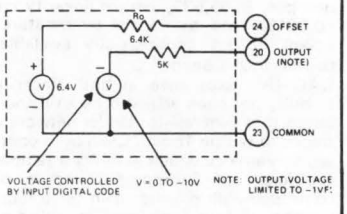
| ANALOG Output Range (+1ma, FS) | OFFSET BINARY | ANALOG Output Range (0 to −2 ma, FS) | STRAIGHT BINARY |
|---|---|---|---|
| −0.99997 | 1111111111111111 | −1.99997 | 1111111111111111 |
| −0.75000 | 1110000000000000 | −1.75000 | 1110000000000000 |
| −0.62500 | 1101000000000000 | −1.50000 | 1100000000000000 |
| −0.50000 | 1100000000000000 | −1.00000 | 1000000000000000 |
| 0.00000 | 1000000000000000 | −0.50000 | 0100000000000000 |
| +0.50000 | 0100000000000000 | −0.25000 | 0010000000000000 |
| +0.62500 | 0011000000000000 | 0.00000 | 0000000000000000 |
| +0.75000 | 0010000000000000 | | |
| +1.00000 | 0000000000000000 | | |

Note that 2's complement bipolar output is available when an externally complemented MSB is provided.

CURRENT EQUIVALENT CIRCUIT
DAC-HR SERIES



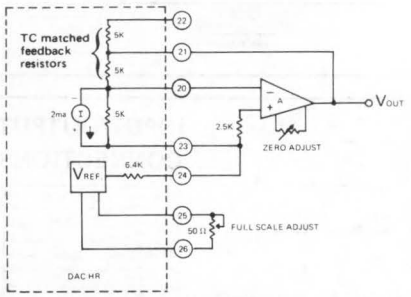

VOLTAGE EQUIVALENT CIRCUIT
DAC-HR SERIES



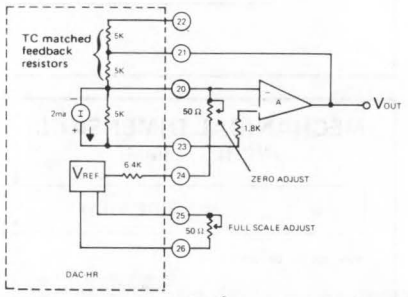

## APPLICATION NOTES — WHEN USING AN EXTERNAL OUTPUT AMPLIFIER

(Use a high accuracy, low drift output amplifier to avoid degrading system performance)

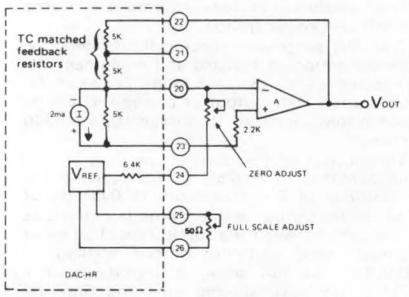
DAC-HR SERIES WITH EXTERNAL AMPLIFIER (INVERTING)
UNIPOLAR OUTPUT 0V TO +10VFS




DAC-HR SERIES WITH EXTERNAL AMPLIFIER (INVERTING)
BIPOLAR OUTPUT ±5VFS




DAC-HR SERIES WITH EXTERNAL AMPLIFIER (INVERTING)
BIPOLAR OUTPUT ±10VFS




**Note: Use external trim pots and resistors with 100 PPM/°C max tempco (available from Datel)**

## ORDERING INFORMATION

DAC-HR ——

| NUMBER OF BITS AND CODING |
|---|
| 13B = 13 BINARY BITS |
| 14B = 14 BINARY BITS |
| 15B = 15 BINARY BITS |
| 16B = 16 BINARY BITS |

## LIST PRICE (single quantity)

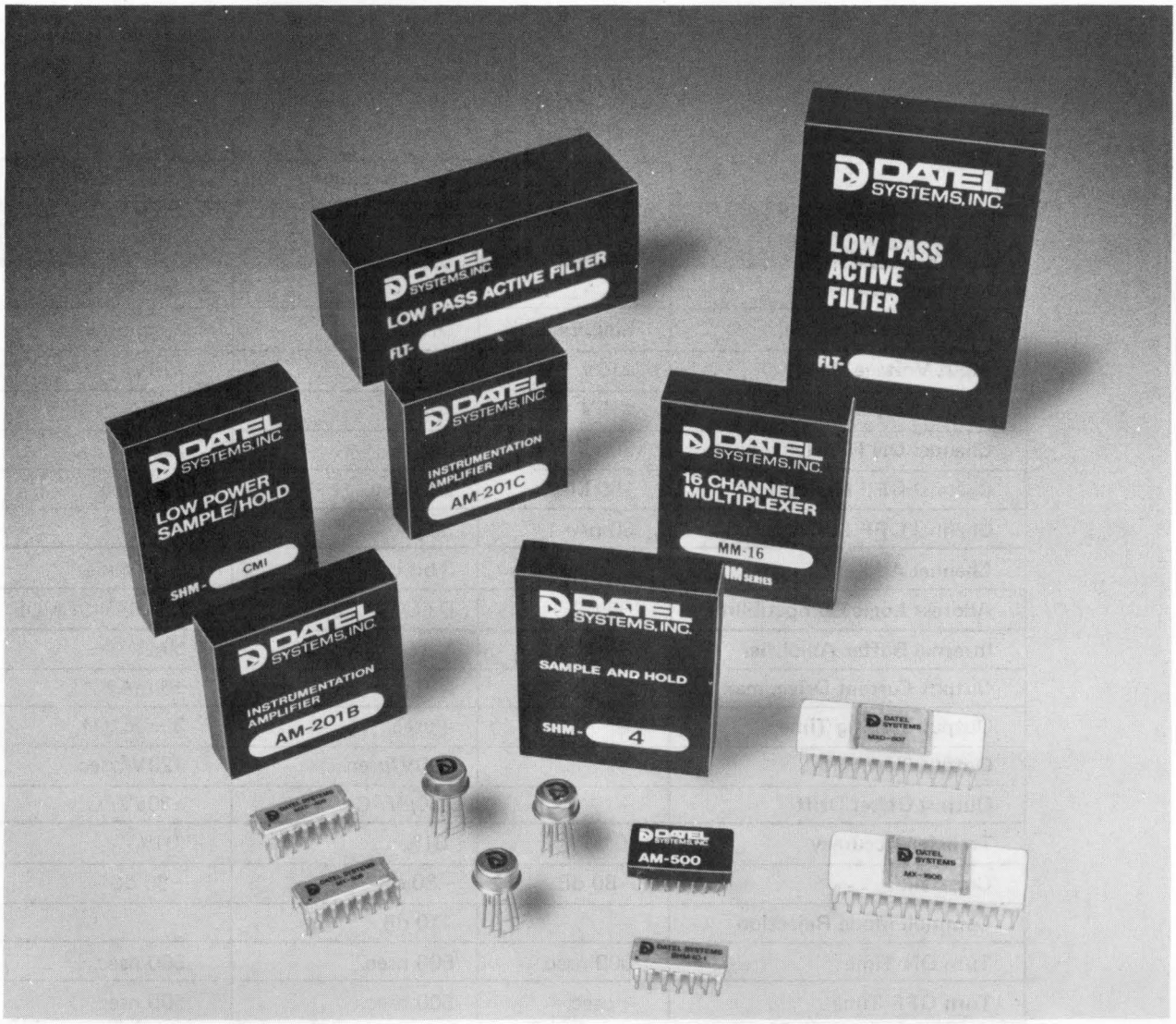
DAC-HR 13B . . . $249.
DAC-HR 14B . . . $263.
DAC-HR 15B . . . $276.
DAC-HR 16B . . . $299.

NOTE: Add 30% to List Price for Extended Temperature Range and Suffix "EX" to Model Number

MATING SOCKET DILS-2; 2 req'd per module
**$5.00 per pair**

DATEL
SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# Data Conversion Accessory Circuits



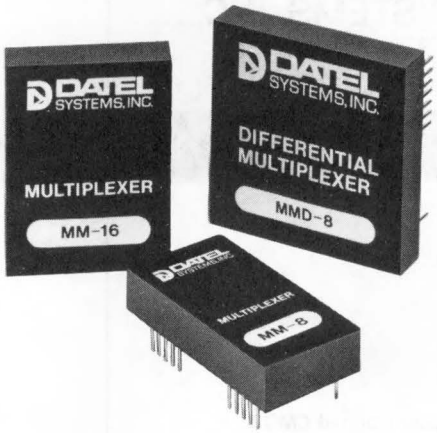
# Analog Multiplexers

| | Modular | Modular | Modular |
|---|---|---|---|
| | MM-8 | MMD-8 | MM-16 |
| Number of Channels | 8 | 8 | 16 |
| Type Input | Sing. End. | Differ. | Sing. End. |
| Input Voltage Range | ±10V | ±10V | ±10V |
| Input Overvoltage, max. | ±15V | ±35V | ±35V |
| Channel ON Resistance | 300 ohms | 2K | 2K |
| Channel OFF Resistance | 100 Meg. | 200 Meg. | 200 Meg. |
| Channel OFF Leakage | 30 pA | 30 pA | 30 pA |
| Channel Addressing | 3 bit code | 3 bit code | 4 bit code |
| Address Logic Compatibility | DTL/TTL | DTL/TTL/CMOS | DTL/TTL/CMOS |
| Internal Buffer Amplifier | No | Yes | Yes |
| Output Current Drive, max. | – | ±10 mA | ±5 mA |
| Output Settling Time | – | 4 μsec. (1) | 3 μsec. (1) |
| Output Slew Rate | – | 100V/μsec. | 120V/μsec. |
| Output Offset Drift | – | ±60μV/°C | ±30μV/°C |
| Transfer Accuracy | .01% | .01% | .01% |
| Crosstalk | –80 dB | –80 dB | –80 dB |
| Common Mode Rejection | – | 110 dB | – |
| Turn ON Time | 300 nsec. | 500 nsec. | 500 nsec. |
| Turn OFF Time | 1 μsec. | 500 nsec. | 500 nsec. |
| Power Requirement | +15V, –20V | ±15V | ±15V |
| Package Size, inches | 1 x 2 x 0.375 | 2 x 2 x 0.375 | 1.5 x 2 x 0.375 |
| Operating Temp. Range | 0 to 70°C | 0 to 70°C | 0 to 70°C |
| Price (1-9) | **$69.00** | **$169.00** | **$129.00** |

**NOTES:** 1. For 20V step to .01%

This complete line of analog multiplexers offers a choice of operating features and prices for data acquisition system applications. The four modular models offer 8 and 16 channel capability. The MMD-8 is an 8 channel model with differential inputs and output and an internal differential buffer amplifier. The MM-16 features single-ended 16 channel operation and also includes an internal buffer amplifier.

The four monolithic models use dielectrically isolated CMOS circuitry. The analog and digital inputs are protected from both the loss of power and from overvoltages that exceed the power supplies. The CMOS FET analog channel switches have fast settling time, low capacitance, low leakage current, and high OFF resistance. These monolithic devices offer 4, 8, and 16 channel single-ended operation and 8 channel differential operation at economical prices. Channel addressing is done by a 2, 3, or 4 bit binary code, depending on the particular model. There is also an inhibit input which enables or disables the multiplexer.




| | NEW | NEW | NEW | NEW |
|---|---|---|---|---|
| **Modular** | **Monolithic** | **Monolithic** | **Monolithic** | **Monolithic** |
| **MM-16-1** | **MXD-409** | **MX-808** | **MXD-807** | **MX-1606** |
| 16 | 4 | 8 | 8 | 16 |
| Sing. End. | Differ. | Sing. End. | Differ. | Sing. End. |
| ±10V | ±15V | ±15V | ±15V | ±15V |
| ±35V | ±35V | ±35V | ±35V | ±35V |
| 2K | 1.5K | 1.5K | 1.5K | 1.5K |
| 200 Meg. | 200 Meg. | 200 Meg. | 200 Meg. | 200 Meg. |
| 30 pA | 30 pA | 30 pA | 30 pA | 30 pA |
| 4 bit code | 2 bit code | 3 bit code | 3 bit code | 4 bit code |
| DTL/TTL/CMOS | DTL/TTL/CMOS | DTL/TTL/CMOS | DTL/TTL/CMOS | DTL/TTL/CMOS |
| No | No | No | No | No |
| – | – | – | – | – |
| – | – | – | – | – |
| – | – | – | – | – |
| – | – | – | – | – |
| .01% | .01% | .01% | .01% | .01% |
| -80 dB | –86 dB | –86 dB | –86 dB | –86 dB |
| – | 120 dB | – | 120 dB | – |
| 500 nsec. | 500 nsec. | 500 nsec. | 500 nsec. | 500 nsec. |
| 500 nsec. | 300 nsec. | 300 nsec. | 300 nsec. | 300 nsec. |
| ±15V | ±15V | ±15V | ±15V | ±15V |
| 1.5 x 2 x 0.375 | 16 Pin DIP | 16 Pin DIP | 28 Pin DIP | 28 Pin DIP |
| 0 to 70°C | 0 to 70°C | 0 to 70°C | 0 to 70°C | 0 to 70°C |
| **$119.00** | **$14.00** | **$14.00** | **$34.00** | **$34.00** |

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
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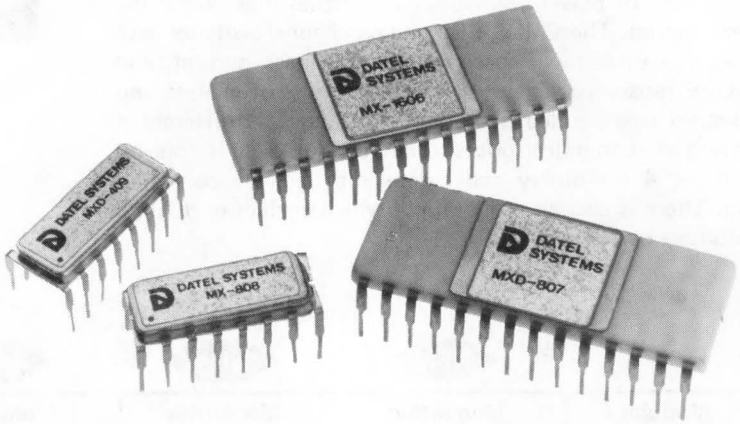
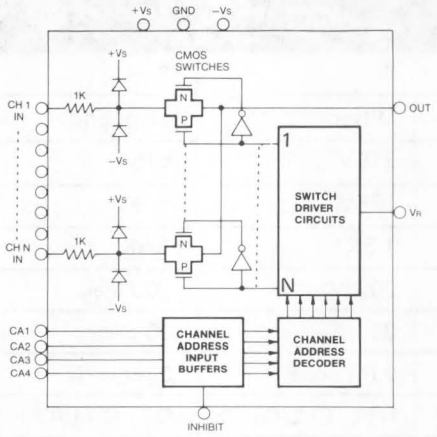
# 4,8, AND 16 CHANNEL CMOS MULTIPLEXERS

## MX SERIES




### FEATURES

- Dielectrically Isolated CMOS
- Break-Before-Make Switching
- Single-Ended and Differential
- Overvoltage Protection
- DTL/TTL/CMOS Compatible
- 7.5 mW Standby Power




### GENERAL DESCRIPTION

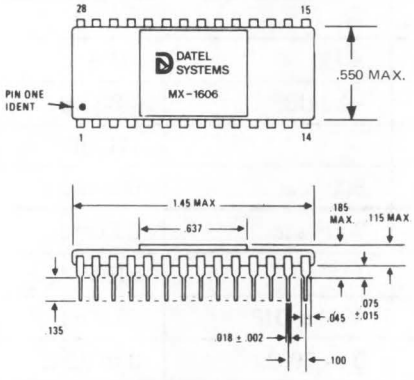
The MX series analog multiplexers are 4, 8, and 16 channel monolithic devices manufactured with a dielectrically isolated complementary MOS process. The circuits incorporate analog and digital input protection which protects the units from both overvoltage and loss of power. The digital inputs are DTL/TTL/CMOS compatible and address the proper channel by means of a 2, 3, or 4 bit binary code. An inhibit input enables or disables the entire device and thus permits expansion of the number of channels by using several devices together. Another important feature of these multiplexers is the use of break-before-make switching to insure that no two channels are ever momentarily shorted together.

Transfer accuracies of .01% can be achieved at channel sampling rates up to 200 kHz and over ±10V signal ranges. These multiplexers are ideal for multi-channel data acquisition systems where the multiplexer operates into a high impedance load such as a sample-hold, buffer amplifier, or instrumentation amplifier. Channel ON resistance is typically 1.5K at 25°C and is less than 2K over the operating temperature range.

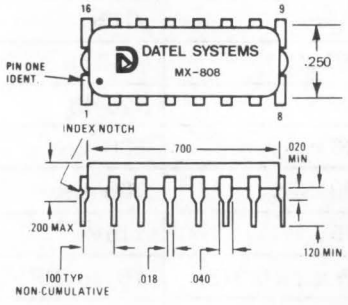
Power consumption is only 7.5 mW at standby and 15 mW at 100 kHz switching rate. Power supply range is ±5V to ±20V. The devices are packaged in 16 pin or 28 pin DIP's and operate over the 0°C to 70°C temperature range.

### MECHANICAL DIMENSIONS (INCHES)

**MX-1606, MXD-807**
**28 Pin DIP**




**MX-808, MXD-409**
**16 Pin DIP**



| SPECIFICATIONS, Typical at 25°C, ±15V supplies, R source <1K, unless otherwise noted. | | | | |
|---|---|---|---|---|
| | **MX-808** | **MX-1606** | **MXD-409** | **MXD-807** |
| **ANALOG INPUTS** | | | | |
| Number of Channels | 8 | 16 | 4 | 8 |
| Type Inputs | Single Ended | Single Ended | Differential | Differential |
| Input Voltage Range | ±15V | ±15V | ±15V | ±15V |
| Input Overvoltage, max. | ± \| Vs +20V \| | ± \| Vs +20V \| | ± \| Vs +20V \| | ± \| Vs +20V \| |
| Channel ON Resistance | 1.5K | 1.5K | 1.5K | 1.5K |
| Channel ON Resistance, max., 0 to 70°C | 2.0K | 2.0K | 2.0K | 2.0K |
| Channel OFF Input Leakage | 30 pA | 30 pA | 30 pA | 30 pA |
| Channel OFF Output Leakage | 1.0 nA | 1.0 nA | 1.0 nA | 1.0 nA |
| Channel ON Leakage | 100 pA | 100 pA | 100 pA | 100 pA |
| Channel OFF Input Capacitance | 5 pF | 5 pF | 5 pF | 5 pF |
| Channel OFF Output Capacitance | 25 pF | 50 pF | 12 pF | 25 pF |
| **DIGITAL INPUTS**[1] | | | | |
| Logic "0" Threshold, max. | +0.8V | +0.8V | +0.8V | +0.8V |
| Logic "1" Threshold, min. (TTL)[2] | +4.0V | +4.0V | +4.0V | +4.0V |
| Logic "1" Threshold, min. (CMOS)[3] | +6.0V | +6.0V | – | – |
| Input Current, max., high or low | 5 μA | 5 μA | 5 μA | 5 μA |
| Channel Address Coding | 3 Bits | 4 Bits | 2 Bits | 3 Bits |
| Channel Inhibit, all channels OFF | Logic "0" | Logic "0" | Logic "0" | Logic "0" |
| **PERFORMANCE** | | | | |
| Transfer Error, max.[4] | .01% | .01% | .01% | .01% |
| Crosstalk, 10 kHz | -86 dB | -86 dB | -86 dB | -86 dB |
| Common Mode Rejection | – | – | 120 dB | 120 dB |
| Settling Time, 20V step to 0.1% | 2 μsec. | 2 μsec. | 2 μsec. | 2 μsec. |
| Settling Time, 20V step to .01% | 5 μsec. | 5 μsec. | 5 μsec. | 5 μsec. |
| Turn ON Time | 500 nsec. | 500 nsec. | 500 nsec. | 500 nsec. |
| Turn OFF Time | 300 nsec. | 300 nsec. | 300 nsec. | 300 nsec. |
| Break Before Make Delay | 80 nsec. | 80 nsec. | 80 nsec. | 80 nsec. |
| Inhibit/Enable Delay | 300 nsec. | 300 nsec. | 300 nsec. | 300 nsec. |
| **POWER REQUIREMENT** | | | | |
| Rated Power Supply Voltage | ±15 VDC | ±15 VDC | ±15 VDC | ±15 VDC |
| Power Supply Voltage Range | ±5 to ±20V | ±5 to ±20V | ±5 to ±20V | ±5 to ±20V |
| Quiescent Current, max. | +5, -2mA | +5, -2mA | +5, -2mA | +5, -2mA |
| Power Consumption, 10 kHz sampling | 7.5 mW | 7.5 mW | 7.5 mW | 7.5 mW |
| **PHYSICAL-ENVIRONMENTAL** | | | | |
| Operating Temperature Range | 0 to 70°C | 0 to 70°C | 0 to 70°C | 0 to 70°C |
| Storage Temperature Range | -65 to +150°C | -65 to +150°C | -65 to +150°C | -65 to +150°C |
| Package | 16 Pin DIP | 28 Pin DIP | 16 Pin DIP | 28 Pin DIP |
| Package Dissipation, max. | 725 mW | 1200 mW | 725 mW | 1200 mW |
| **PRICE (1-9)** | **$14.00** | **$34.00** | **$14.00** | **$34.00** |

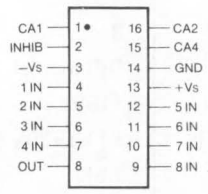
NOTES:
1. The digital inputs are the channel address inputs and the inhibit input.
2. To drive from DTL/TTL circuits 1K pull-up resistors to +5V are recommended. With models MX-1606 and MXD-807 pin 13 should be left open.
3. For a +6.0V threshold with models MX-1606 and MXD-807 pin 13 is connected to +10V.
4. For output load >20 megohms.

**THESE MULTIPLEXERS ARE COVERED BY GSA CONTRACT.**

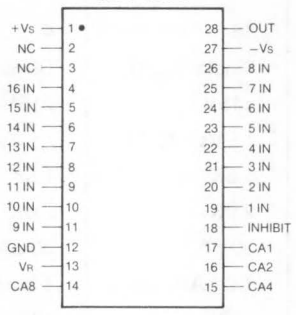
## CONNECTION & APPLICATION

### PIN CONNECTIONS

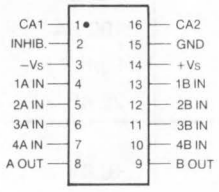
**MX-808**




**MX-1606**




**MXD-409**




**MXD-807**


**NOTES:**

CA = CHANNEL ADDRESS
Vs = SUPPLY VOLTAGE
VR = REFERENCE VOLTAGE
NC = NO CONNECTIONS

### CHANNEL ADDRESSING

**MX-1606**

| 8 | 4 | 2 | 1 | INHIB. | ON CHANNEL |
|---|---|---|---|---|---|
| X | X | X | X | 0 | NONE |
| 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 1 | 1 | 2 |
| 0 | 0 | 1 | 0 | 1 | 3 |
| 0 | 0 | 1 | 1 | 1 | 4 |
| 0 | 1 | 0 | 0 | 1 | 5 |
| 0 | 1 | 0 | 1 | 1 | 6 |
| 0 | 1 | 1 | 0 | 1 | 7 |
| 0 | 1 | 1 | 1 | 1 | 8 |
| 1 | 0 | 0 | 0 | 1 | 9 |
| 1 | 0 | 0 | 1 | 1 | 10 |
| 1 | 0 | 1 | 0 | 1 | 11 |
| 1 | 0 | 1 | 1 | 1 | 12 |
| 1 | 1 | 0 | 0 | 1 | 13 |
| 1 | 1 | 0 | 1 | 1 | 14 |
| 1 | 1 | 1 | 0 | 1 | 15 |
| 1 | 1 | 1 | 1 | 1 | 16 |

**MX-808, MXD-807**

| 4 | 2 | 1 | INHIB. | ON CHANNEL |
|---|---|---|---|---|
| X | X | X | 0 | NONE |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 2 |
| 0 | 1 | 0 | 1 | 3 |
| 0 | 1 | 1 | 1 | 4 |
| 1 | 0 | 0 | 1 | 5 |
| 1 | 0 | 1 | 1 | 6 |
| 1 | 1 | 0 | 1 | 7 |
| 1 | 1 | 1 | 1 | 8 |

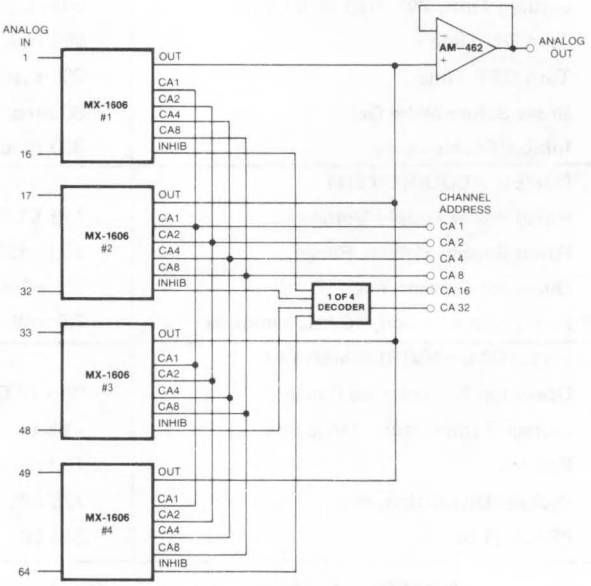
**MXD-409**

| 2 | 1 | INHIB. | ON CHANNEL |
|---|---|---|---|
| X | X | 0 | NONE |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 1 | 2 |
| 1 | 0 | 1 | 3 |
| 1 | 1 | 1 | 4 |

### TECHNICAL NOTES

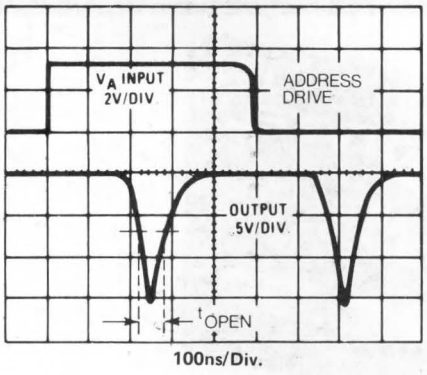
1. The transfer accuracy of these multiplexers depends on both the source resistance and the load resistance. With zero source resistance, and assuming 2K ohms max. channel ON resistance, the load impedance should be at least 20 megohms to achieve .01% accuracy. In practice it is recommended that a load impedance of at least 100 megohms be used to minimize errors. This can be done by using a good high gain, high CMR operational amplifier as a buffer (such as Datel's AM-462). Source resistance should be kept as low as possible so that accuracy is not affected; less than 1K ohms is recommended. Higher source resistance, in addition to affecting accuracy, will degrade the settling time of the multiplexer.
2. For differential operation two buffer amplifiers or a good quality instrumentation amplifier (such as Datel's AM-201) should be used. To maintain high CMR, source impedance unbalance should be kept to a minimum, the highest possible load impedance should be used, and an amplifier with high CMR should be chosen.
3. The maximum analog input overvoltage for these models is $\pm|Vs+20V|$. Maximum logic input overvoltage is $\pm|Vs+4V|$.
4. Channel expansion is accomplished by use of the inhibit input of the multiplexer. A logic "0" on this input disables the multiplexer. The expansion technique shown in the diagram to the right applies to all of the multiplexer models.
5. The reference terminal ($V_R$) sets the noise immunity level of the input logic for models MX-1606 and MXD-807. In most cases this terminal is left open (TTL inputs). For higher level inputs (+6V min.) this terminal should be connected to +10V. When addressing from DTL/TTL logic it is recommended that 1K ohm pull-up resistors to the +5V supply be used.

### EXPANSION TO 64 CHANNELS

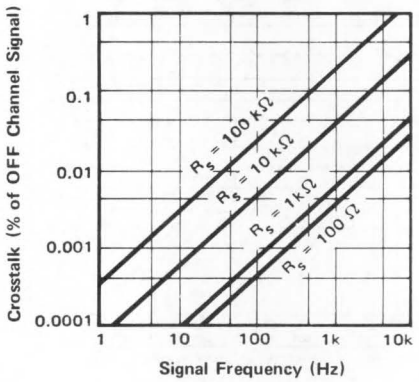


## PERFORMANCE GRAPHS

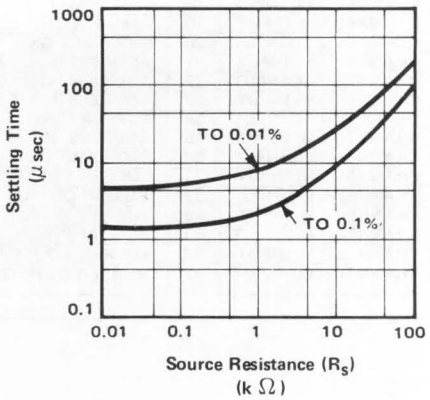
### BREAK-BEFORE-MAKE DELAY (t OPEN)



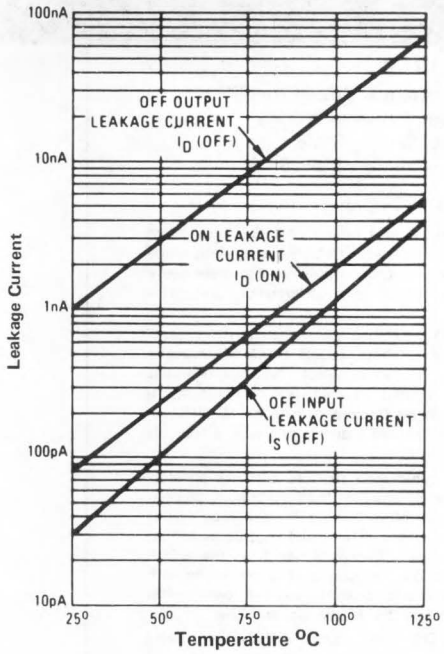

### CROSSTALK VS. FREQUENCY OF INPUT SIGNAL



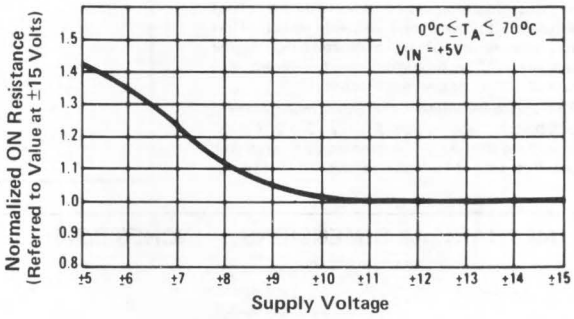

### SETTLING TIME VS. SOURCE RESISTANCE (20V STEP)



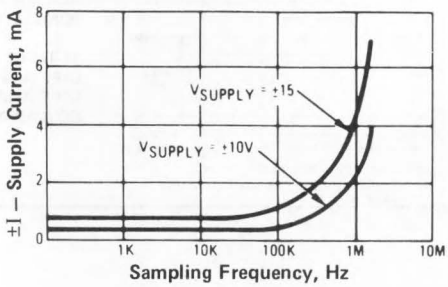

### LEAKAGE CURRENT VS. TEMP.




### NORMALIZED ON RESISTANCE VS. SUPPLY VOLTAGE




### SUPPLY CURRENT VS. SAMPLING FREQUENCY



DATEL SYSTEMS, INC.
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TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# 8 CHANNEL DIFFERENTIAL–ANALOG TIME SHARING, WITH THREE OUTPUT AMPLIFIERS ANALOG MULTIPLEXER

# MODEL MMD-8

## FEATURES

- Differential Output Amplifier
- High Transfer Accuracy
- Fast Settling Time
- Break-Before-Make Switching

## DESCRIPTION

The Datel Systems Model MMD-8 is a complete analog multiplexer with buffer amplifiers and a differential output amplifier for selectively switching one of eight differential input channels.

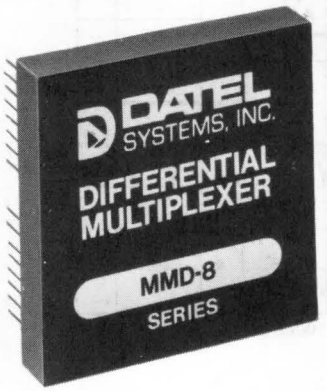
The MMD-8 exhibits excellent transfer characteristics with high speed break-before-make switching. A channel select inhibit (all channels off) is provided so that two MMD-8 multiplexers can be stacked to provide 16 differential input channel multiplexing with a four bit binary address.

The 1.6 cubic inch module contains an electronic switch array with an associated decoder and digital input buffers, two analog buffer amplifiers and a differential output amplifier. The common differential pair from the switch is brought out through an I/O pin along with the inputs and outputs of the two buffer amplifiers and the differential amplifier.

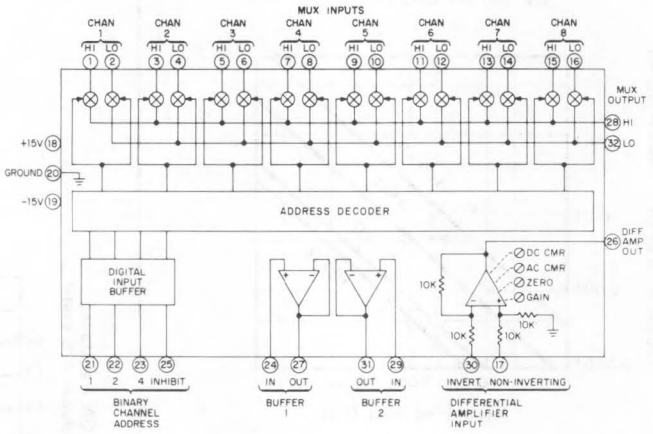
The MMD-8 can accept differential analog inputs of up to ±10 volts with a transfer accuracy of 0.01%. Without the amplifiers, the switching time is typically 500 nanoseconds. With the amplifier, the settling time is only 4 microseconds to 0.01% of full scale.

The differential output amplifiers will deliver ±10 milliamps at ±10 volts full scale. Linearity of this amplifier is 0.01% with an offset adjustable to less than 1 millivolt and an offset vs. temperature of 60 microvolts per degree centigrade. The amplifiers can be slewed at a rate of 100 volts per microsecond.

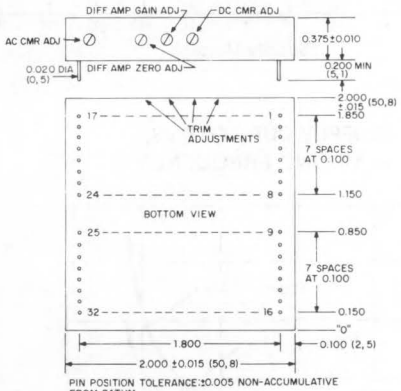
The entire 8-channel differential multiplexer is completely encapsulated in a 2"X2"X.375" module with dual in-line pinning (0.1" grid) and requires only ±15 volts at ±20 mA max for power.




## BLOCK DIAGRAM




## MECHANICAL DIMENSIONS – INCHES (MM)




**AC CMR ADJ (SINGLE TURN POTS)**

**15-TURN POTS:**
**DIFF AMP ZERO ADJ**
**DIFF AMP GAIN ADJ**
**DC CMR ADJ**

## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | CHANNEL 1 HI INPUT | 17 | DIFF. AMP. POS. IN |
| 2 | CHANNEL 1 LO INPUT | 18 | +15V POWER |
| 3 | CHANNEL 2 HI INPUT | 19 | –15V POWER |
| 4 | CHANNEL 2 LO INPUT | 20 | PWR & SIG. GND |
| 5 | CHANNEL 3 HI INPUT | 21 | ADDRESS INPUT 1 |
| 6 | CHANNEL 3 LO INPUT | 22 | ADDRESS INPUT 2 |
| 7 | CHANNEL 4 HI INPUT | 23 | ADDRESS INPUT 4 |
| 8 | CHANNEL 4 LO INPUT | 24 | BUFFER 1 INPUT |
| 9 | CHANNEL 5 HI INPUT | 25 | ADDRESS INHIBIT |
| 10 | CHANNEL 5 LO INPUT | 26 | DIFF. AMP. OUTPUT |
| 11 | CHANNEL 6 HI INPUT | 27 | BUFFER 1 OUTPUT |
| 12 | CHANNEL 6 LO INPUT | 28 | MUX. HI OUTPUT |
| 13 | CHANNEL 7 HI INPUT | 29 | BUFFER 2 INPUT |
| 14 | CHANNEL 7 LO INPUT | 30 | DIFF. AMP. NEG. IN |
| 15 | CHANNEL 8 HI INPUT | 31 | BUFFER 2 OUTPUT |
| 16 | CHANNEL 8 LO INPUT | 32 | MUX. LO OUTPUT |

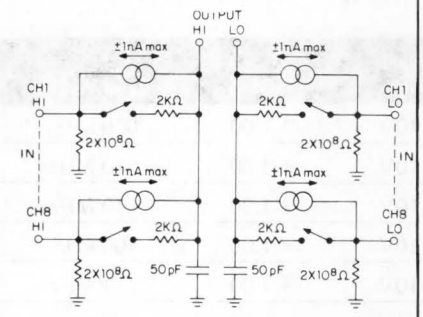
## SPECIFICATIONS (Typical @ 25°C)

| | |
|---|---|
| **ANALOG INPUT** | |
| **No. # of Inputs** | 8 channel differential |
| **Input Voltage Range** | ±10V |
| **Input Overvoltage** | ±35V max. |
| **Input Impedance** | |
| Without Buffer or Differential amplifier | 2k Ohm switch Res. with 50 pf to Gnd. (High & Low inputs) |
| With Buffer Amplifier | 100 meg Ohms (Channel on)<br>200 meg Ohms (Channel off) |
| **Leakage** | .03 nA typ. from off channels into source (±20V differential) |
| **Channel Select** | 3 lines straight binary code (1 through 8 channel select) |
| **Inhibit (All channels off)** | Logical "0" |
| **Input Logic Levels**<br>DTL/TTL/CMOS compatible (For TTL compatability use an open collector device with resistor pull up to +5V). | |

| INPUT CODE | V INPUT MIN. | V INPUT MAX. |
|---|---|---|
| "0" | 0V | +0.8V |
| "1" | +4V | +15V |

| | |
|---|---|
| **SWITCHING CHARACTERISTICS (Independent of Amplifier)** | |
| **Switching Time** | 500 ns typ., 1μSec max. |
| **Sequence Rate** | 500kHz |
| **Crosstalk** | @ 10kHz 1 mv p-p<br>@100kHz 4 mv p-p<br>@1MHz 40 mv p-p |
| **Enable/Inhibit Delay** | 300 ns Typ. |
| **Break Time (Break before make)** | 80 ns Typ. to 50% points |
| **Common mode Voltage** | Ein Diff + CMV = ±10Vpk |
| **Common mode rejection ratio, At 0 to 100 Hz** | Adjustable for both AC & DC to: 110dB with 1KΩ unbalance — Adjustable DC & AC |
| **OUTPUT AMPLIFIER CHARACTERISTICS** | |
| **Output Voltage** | ±10V max. |
| **Output Current** | ±10mA max. |
| **Output Loading** | 1kΩ in parallel with 1000 pf max. |
| **Gain** | 1.000 adjustable |
| **Linearity** | 0.01% of Full Scale |
| **Offset (Vout–Vin)** | Adjustable to <±1mV |
| **Offset – vs – Temperature** | ±60μV/°C |
| **Slew rate** | 100 V/μs |
| **Settling Time (20 V step in)** | 4μs to 0.01% of Full Scale |
| **Input Power Requirements** | ±15V @ ±20 mA max. |
| **PHYSICAL ENVIRONMENTAL** | |
| **Operating Temperature** | 0° to + 70°C |
| **Storage Temperature** | –55°C to +85°C |
| **Relative humidity** | Up to 100% non-condensing |
| **Size** | 2" L X 2" W X .375" H |
| **Price (1–9)** | $169.00 |
| **Mating Socket** | DILS-2, 2 req'd per module, $5/pr. |

## MULTIPLEXER SWITCH EQUIVALENT CIRCUIT

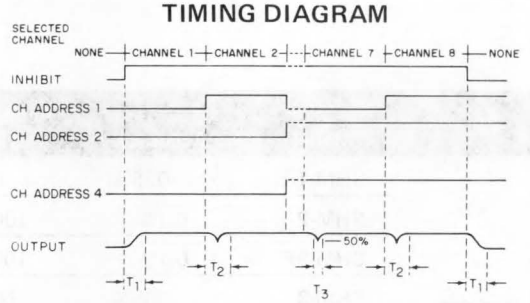



## CHANNEL ADDRESSING

| 4 | 2 | 1 | INHIB | "ON" CHANNEL |
|---|---|---|---|---|
| X | X | X | 0 | NONE |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 2 |
| 0 | 1 | 0 | 1 | 3 |
| 0 | 1 | 1 | 1 | 4 |
| 1 | 0 | 0 | 1 | 5 |
| 1 | 0 | 1 | 1 | 6 |
| 1 | 1 | 0 | 1 | 7 |
| 1 | 1 | 1 | 1 | 8 |

FOR EXPANDER OPERATION, CONSULT FACTORY

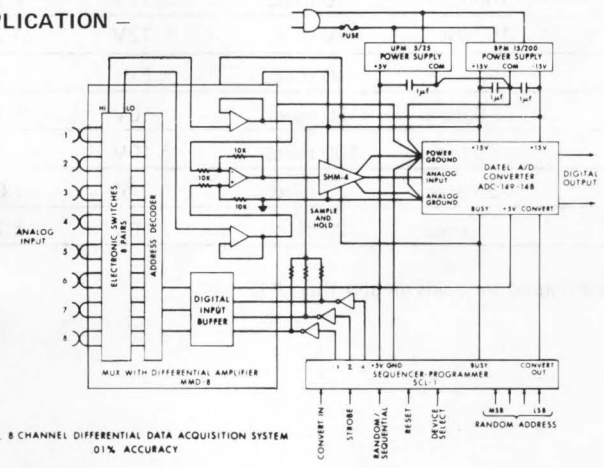
## TIMING DIAGRAM




| | |
|---|---|
| $T_1$ ENABLE/INHIBIT DELAY | 500nsec typ. |
| $T_2$ SWITCHING TIME | 500nsec typ. 1μsec max. |
| $T_3$ BREAK TIME (BREAK-BEFORE-MAKE) | 80nsec typ. to 50% points |

## TYPICAL SYSTEM APPLICATION –

An 8 Channel, Differential, Noninverting Data Acquisition System, using the MMD-8 along with other off-the-shelf Modules from Datel Systems.




14 BIT, 8 CHANNEL DIFFERENTIAL DATA ACQUISITION SYSTEM
0.1% ACCURACY

DATEL

### DIFFERENTIAL AMPLIFIER CALIBRATION PROCEDURE

1. Ground both the differential amplifier inverting and non-inverting inputs. Adjust the output to zero volts using the ZERO trim as seen on a DC-coupled scope.
2. Connect both the inverting and non-inverting inputs to a 100 Hz, 20V pk-pk squarewave source referenced to ground. Adjust the DC CMR trim for minimum output on a DC scope.
3. Repeat step 2 but use a 1 kHz sinewave source and adjust the AC CMR for minimum output.
4. Ground the inverting input. Connect the non-inverting input to a 20V pk-pk, 100 Hz sinewave source. Connect the differential inputs of a calibrated scope between the amplifier's non-inverting input and the amplifier output. Adjust the GAIN trim for minimum output on the scope. Note that the CMR trim is essentially independent of GAIN adjustments but the GAIN is affected by CMR adjustments.

# Sample-Holds

| | Model | Accuracy | Acquisition Time | Aperture Delay | Voltage Range | Gain | Band-Width |
|---|---|---|---|---|---|---|---|
| Modular NEW | SHM-1 | .025% | 5 μsec. | 50 nsec. | ± 10V | + 1.00 | 650 kHz |
| | SHM-2 | 0.1% | 100 nsec. | 10 nsec. | ± 10V | + 1.00 | 10 MHz |
| | SHM-2E | 0.1% | 100 nsec. | 10 nsec. | ± 10V | + 1.00 | 10 MHz |
| | SHM-3 | .005% | 50 μsec. | 40 nsec. | ± 10V | + 1.00 | 100 kHz |
| | SHM-4 | .005% | 7 μsec. | 40 nsec. | ± 10V | + 1.00 | 1 MHz |
| | SHM-5 | .01% | 350 nsec. | 20 nsec. | ± 10V | −1.00 | 5 MHz |
| | SHM-CM | .01% | 100 μsec. | 20 nsec. | ± 12V | + 1.00 | 40 kHz |
| | SHM-CMI | .01% | 150 μsec. | 20 nsec. | ± 12V | −1.00 | 40 kHz |
| | SHM-UH | 0.25% | 50 nsec. | 10 nsec. | ± 5V | + 0.95 | 45 MHz |
| Monolithic NEW | SHM-IC-1 | .01% | 5 μsec. | 50 nsec. | ± 10V | ± 1.00 (1) | 2 MHz |
| | SHM-LM-2 | 0.1% | 5 μsec. | 100 nsec. | ± 10V | + 1.00 | 1 MHz |
| Hybrid | SHM-HU | 0.1% | 25 nsec. | 6 nsec. | ± 2.5V | + 0.975 | 20 MHz |
| COMING! | SHM-6 | .01% | 1 μsec. | 20 nsec. | ± 10V | ± 1.00 (1) | 5 MHz |

NOTES: 1. Can also be configured for gains greater than ± 1.

This line of sample-hold devices includes modular, hybrid, and monolithic models and is the most comprehensive line in the industry. The models listed here cover a broad range of applications from ultra-fast and high accuracy down to low cost, moderate performance units.

**SHM-1:** General purpose, high accuracy model with 5 μsec. acquisition time.

**SHM-2, SHM-2E:** Very high speed units with open loop circuit to achieve acquisition times as fast as 100 nsec.

**SHM-3:** A low cost, .005% accuracy model with 50 μsec. acquisition time.

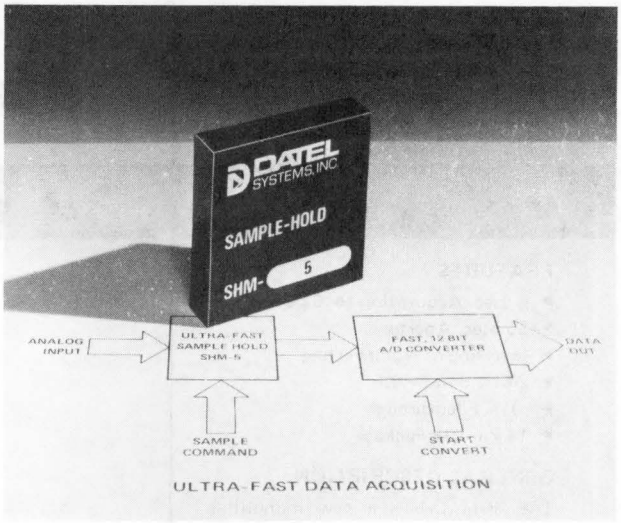
**SHM-4:** A low cost, .005% sample hold with a faster 7 μsec. acquisition time.

**SHM-5:** A new ultra-fast sample hold designed for use with fast 10 and 12 bit A/D converters. Acquisition time is 350 nsec. to .01% and 200 nsec. to 0.1%. The SHM-5 also features high input impedance.

**SHM-CM, SHM-CMI:** These two CMOS models are designed for low power applications such as portable data acquisition systems. They offer inverting or noninverting performance and can operate from a single polarity power supply.

**SHM-UH:** This ultra-fast model features acquisition time of 50 nsec. and is ideal for use with ultra-fast 8 bit A/D converters such as ADC-UH8B.

**SHM-IC-1:** This monolithic sample-hold offers excellent performance characteristics for .01% accuracy at a low cost.



ULTRA-FAST DATA ACQUISITION

**SHM-LM-2:** This "coming soon" monolithic unit also gives excellent performance at even lower cost.

**SHM-HU:** This "coming soon" hybrid model is specifically designed for ultra-fast video data conversion applications.

**SHM-6:** This "coming soon" hybrid unit features .01% accuracy with 1 μsec. acquisition time.

| Hold-Mode Droop | Tempco | Power Requirement | Case Size (inches) | Price (1-9) | See Page |
|---|---|---|---|---|---|
| 1 μV/μsec. | 20 ppm/°C | + 15V, – 20V | 2 x 1 x 0.375 | $ 69.00 | ** |
| 50 μV/μsec. | 30 ppm/°C | ± 15V | 2 x 1 x 0.375 | $ 89.00 | 120 |
| 330 μV/μsec. | 30 ppm/°C | ± 15V | 2 x 1 x 0.375 | $ 95.00 | 120 |
| 20 μV/msec. | 30 μV/°C | ± 15V | 2 x 1.5 x 0.375 | $ 49.00 | ** |
| 20 μV/msec. | 30 μV/°C | ± 15V | 2 x 1.5 x 0.375 | $ 59.00 | 122 |
| 20 μV/μsec. | 15 ppm/°C | ± 15V | 2 x 2 x 0.375 | $189.00 | ** |
| 2 μV/μsec. | 30 μV/°C | + 10 to +15V | 2 x 2 x 0.375 | $ 89.00 | ** |
| 2 μV/μsec. | 60 μV/°C | + 10 to +15V | 2 x 1.5 x 0.375 | $ 89.00 | ** |
| 50 μV/μsec. | 50 μV/°C | ± 15V, + 5V | 2 x 1.5 x 0.375 | $229.00 | 124 |
| 50 μV/msec. | 20 μV/°C | ± 15V | 14 Pin DIP | $ 19.00 | 116 |
| 200 μV/msec. | 40 μV/°C | ± 15V | 8 Pin TO-99 | $ 7.95 | ** |
| 20 μV/μsec. | 50 μV/°C | ± 15V, ± 5V | 24 Pin DIP | * | ** |
| 10 μV/μsec. | 50 μV/°C | ± 15V, + 5V | 32 Pin DIP | * | ** |

**THESE SAMPLE-HOLDS ARE COVERED BY GSA CONTRACT**

***To be announced.**

****Contact nearest Datel sales office for data sheet.**

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# INTEGRATED CIRCUIT SAMPLE AND HOLD

# MODEL SHM-IC-1

## FEATURES

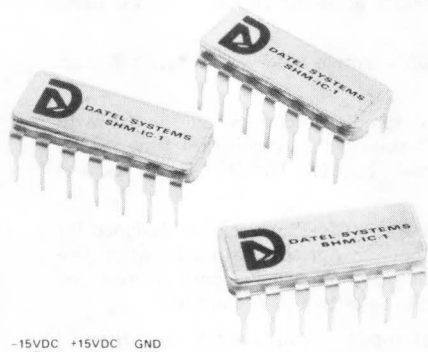
- **5 μsec. Acquisition to .01%**
- **50 nsec. Aperture**
- **Inverting or Noninverting**
- **2MHz Bandwidth**
- **.01% Feedthrough**
- **14 Pin DIP Package**

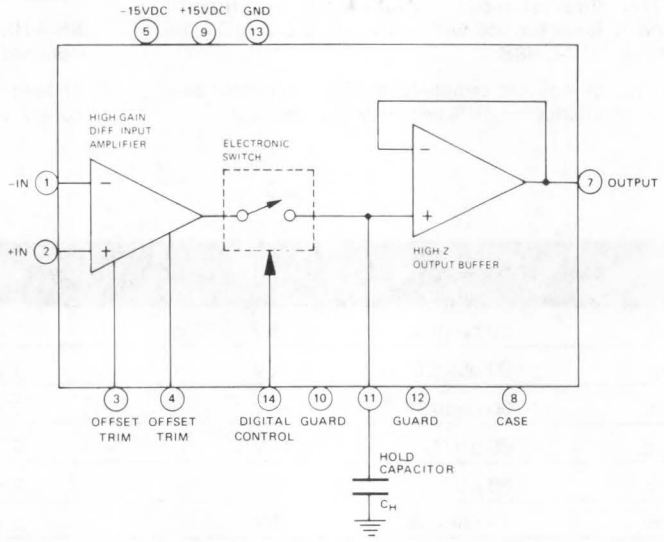
## GENERAL DESCRIPTION

The SHM-IC-1 is a new monolithic integrated circuit sample and hold with excellent performance features. It is a self-contained device requiring only an external holding capacitor, the value of which can be chosen by the user to achieve his desired speed and accuracy requirement. The unit consists of a high gain differential input amplifier, a digitally controlled electronic switch, and a high input impedance buffer amplifier. The SHM-IC-1 operates in a closed loop configuration, either inverting or noninverting, with accuracy and speed determined by the input amplifier characteristics and the value of the holding capacitor. The electronic switch is controlled by a DTL/TTL compatible logic input.

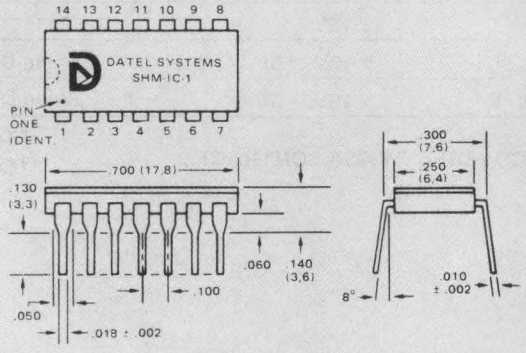
The most common configuration for the SHM-IC-1 is a unity gain, noninverting sample and hold. In this configuration the device has a ±10V input and output range with $10^8$ ohms input impedance. Specifications are given for this unit with two different values of holding capacitor, .001μF and .01μF. The .001μF capacitor gives a 4 μsec. acquisition time to 0.1% for a 10V change, a 2MHz tracking bandwidth and 50mV/sec. maximum hold mode droop. The .01μF capacitor gives a 10 μsec. acquisition time, 1MHz tracking bandwidth, and 5mV/sec. maximum droop. Characteristics for other values of holding capacitor can be determined from graphs which are shown. The SHM-IC-1 can also be configured as either an inverting or noninverting sample and hold with gain by the use of two external resistors.

This device is housed in a 14-pin hermetically sealed dual-in-line package. Operating temperature range is 0°C to +75°C.




## MECHANICAL DIMENSIONS INCHES (MM)




## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | - IN |
| 2 | +IN |
| 3 | OFFSET TRIM |
| 4 | OFFSET TRIM |
| 5 | -15VDC POWER |
| 6 | NO CONNECTION |
| 7 | OUTPUT |
| 8 | CASE |
| 9 | +15VDC POWER |
| 10 | GUARD |
| 11 | HOLD CAPACITOR ($C_H$) |
| 12 | GUARD |
| 13 | GROUND |
| 14 | DIGITAL CONTROL |

## SPECIFICATIONS, SHM-IC-1

**(Typical at 25°C, ±15V Supplies, unless otherwise noted)**

| | |
|---|---|
| **INPUT AMPLIFIER SPECIFICATIONS** | |
| DC Gain, volts/volt | 50K, 25K min. |
| Bias Current | 50nA, 200nA max. |
| Offset Current | 10nA, 50nA max. |
| Offset Voltage (adjust. to zero) | 3mV, 6mV max. |
| Offset Voltage Drift | 20 μV/°C |
| Common Mode Voltage Range | ±10V min. |
| Common Mode Rejection Ratio | 74dB min. |
| Power Supply Rejection | ±30μV/% max. |
| Gain Bandwidth Product | 2MHz |
| **GENERAL SPECIFICATIONS, SAMPLE & HOLD, G = +1** | |
| Input Voltage Range | ±10V min. |
| Input Impedance | $10^8$ ohms |
| Output Voltage Range | ±10V min. |
| Output Current, S.C. protected | ±10mA min. |
| Output Impedance | 0.2 ohm |
| Aperture Delay | 50 nsec. |
| Aperture Uncertainty | 5 nsec. |
| Gain Error, sampling mode | .01% max. |
| Hold Mode Noise | 350μV RMS |
| Digital Input, Sample Mode, DTL/TTL | 0 to +0.8V @ −0.8mA |
| Hold Mode, DTL/TTL | +2.0 to +5.5V @ +20μA |
| **SAMPLE & HOLD, G = +1, $C_H$ = .001μF** | |
| Acquisition Time, 10V to 0.1% | 4 μsec. |
| Acquisition Time, 10V to .01% | 5 μsec. |
| Bandwidth, small signal, sampling | 2.0MHz |
| Slew Rate | 5V/μsec. |
| Hold Mode Voltage Droop | 50mV/sec. max. |
| Hold Mode Feedthrough | .01% max. |
| Sample-to-Hold Offset Error, $V_{IN}$ = 0 | 20mV max. |
| Sample-to-Hold Gain Error, $V_{IN}$ = ±10V | .05% max. of output |
| Sample-to-Hold Nonlinearity Error | .01% max. of output |
| **SAMPLE & HOLD, G = +1, $C_H$ = .01μF** | |
| Acquisition Time, 10V to 0.1% | 10 μsec. |
| Acquisition Time, 10V to .01% | 12 μsec. |
| Bandwidth, small signal, sampling | 1.0MHz |
| Slew Rate | 3V/μsec. |
| Hold Mode Voltage Droop | 5mV/sec. max. |
| Hold Mode Feedthrough | .002% max. |
| Sample-to-Hold Offset Error, $V_{IN}$ = 0 | 2mV max. |
| Sample-to-Hold Gain Error, $V_{IN}$ = ±10V | .005% max. |
| Sample-to-Hold Nonlinearity Error | .001% max. |
| **POWER REQUIREMENT** | ±15VDC @ 5mA max. |
| **PHYSICAL-ENVIRONMENTAL** | |
| Operating Temperature Range | 0°C to +75°C |
| Storage Temperature Range | −65°C to +150°C |
| Package, hermetically sealed ceramic DIP | TO-116 |
| **PRICE (1-9)** | $19.00 |

## TECHNICAL NOTES

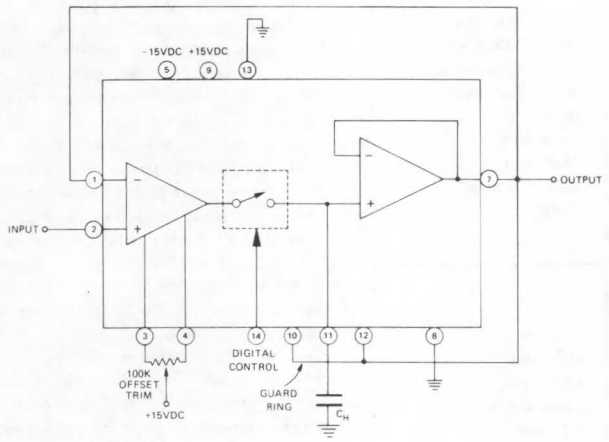
The most commonly used sample and hold configuration for the SHM-IC is the noninverting unity gain circuit. This gives a high input impedance of $10^8$ ohms, and the output voltage in the sample mode follows the input. Specifications are given for this configuration for two values of $C_H$, .001μF and .01μF. The .001μF capacitor gives excellent speed (4 μsec. acquisition) with good hold mode voltage droop (only 50mV/sec. max). For even better speed, a 100 pF capacitor may be used to give an acquisition time of only 2 μsec. The hold mode droop, however, increases by an order of magnitude to 500mV/sec., and the sample-to-hold errors also increase. For excellent accuracy a .01 μF capacitor should be used, giving an acquisition time of 10 μsec., and a hold mode droop of only 5mV/sec. max. Even larger values of holding capacitor can be used with proportionate increases in accuracy but slower speed. The application graphs show the results for the different values.

For best results, $C_H$ should be a good quality capacitor with very high insulation resistance and low dielectric absorption. For temperatures up to +85°C polystyrene type capacitors are recommended. It is also recommended for lowest hold mode droop that a guard ring be used around the $C_H$ terminal (pin 11) in the circuit board layout as shown on the last page. This is done to present leakage to other conductors on the circuit board due to board leakage and contamination. If a large value polystyrene capacitor is used, such as 1μF, hold mode droop as low as 20μV/sec. (typical) can be achieved with an acquisition time of about 3 milliseconds.

Three error contributions are specified for sample-to-hold errors: offset error, gain error, and nonlinearity error. These sampling errors are caused by a small amount of charge being dumped to or from the holding capacitor by the sampling switch and are reduced by a larger value of $C_H$. It is possible to compensate for these errors by changing the gain and offset elsewhere in the external circuitry for the noninverting unity gain case. For the inverting case, the gain can be accomplished by adjusting the external resistor values and an offset can be applied to pin 2 of the input amplifier. When this external compensation is used, the output will be in error during sampling, but will be accurate in the hold mode. Only the nonlinearity error will remain of the sample-to-hold errors. The offset adjustment of the input amplifiers should be used only to zero the device in the sample mode.

In the inverting gain of one operating mode, the feedback and input resistors should be carefully matched or trimmed to give the desired gain of one. In general, the operating parameters are the same as in the noninverting unity gain configuration except that the sampling bandwidth is reduced by a factor of two. Likewise, for higher gain configurations the sampling bandwidth is proportionately reduced.

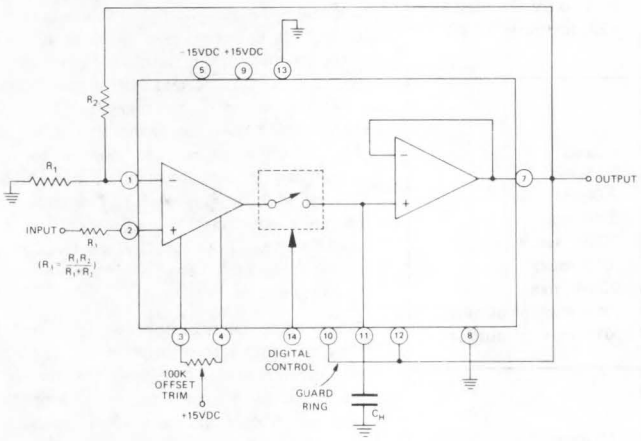
## OPERATING MODES




### SAMPLE & HOLD, UNITY GAIN, NONINVERTING

GAIN = +1

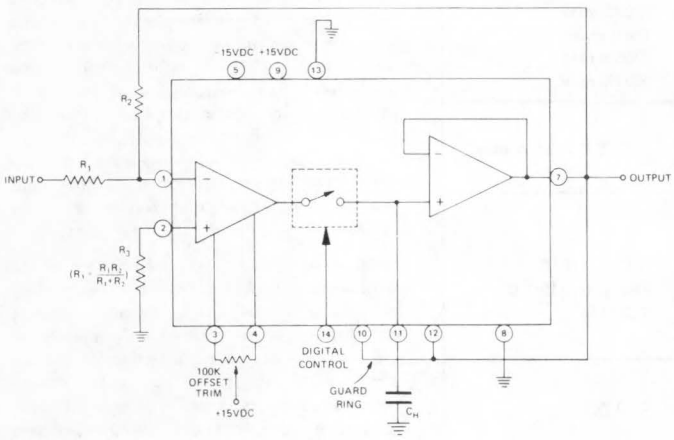
The 100K ohm offset trimming potentiometer should be a 100 ppm/°C cermet 15 turn type. These are available from Datel Systems at $3.00 each. To zero, ground input (pin 2) and digital control (pin 14) and adjust 100K offset trim for zero output (pin 7).




### SAMPLE & HOLD, NONINVERTING WITH GAIN

$$GAIN = 1 + \frac{R_2}{R_1}$$

Bandwidth decreases proportionately with gain. $R_3$ is equal to the parallel combination of $R_1$ and $R_2$ and is used to compensate for voltage offset caused by input bias current. $R_1$ and $R_2$ should be 100 ppm/°C metal film type resistors.




### SAMPLE & HOLD, INVERTING

$$GAIN = -\frac{R_2}{R_1}$$

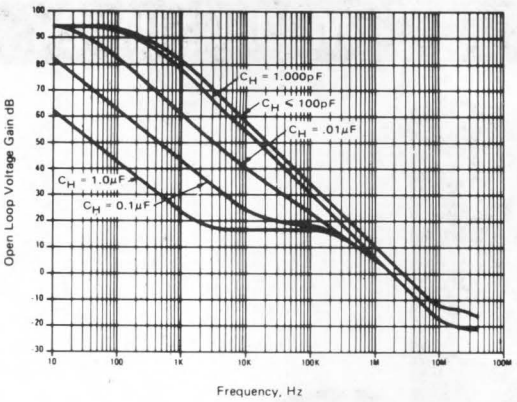
For a gain of −1 the bandwidth is one half of that given for the noninverting mode. $R_3$ is equal to the parallel combination of $R_1$ and $R_2$ and is used to compensate for voltage offset caused by input bias current. $R_1$ and $R_2$ should be matched 100 ppm/°C metal film type resistors for a gain of −1. For higher gains the ratio should be matched closely or trimmed with a small value carbon composition type resistor.

DATEL

## PERFORMANCE PARAMETERS

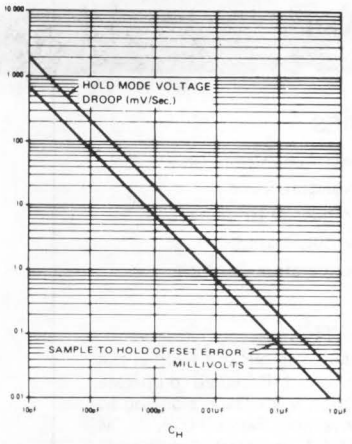
### OPEN LOOP FREQUENCY RESPONSE

**Typical at 25°C, ±15V Supplies**



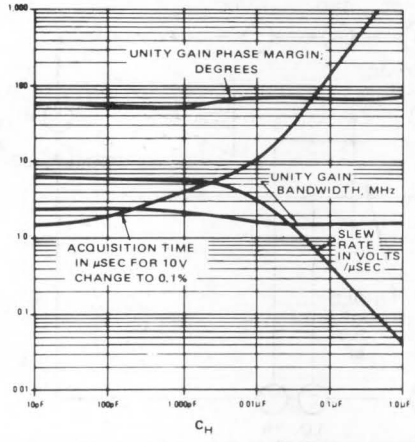

### ACCURACY CHARACTERISTICS VS. $C_H$

**Typical at 25°C, ±15V Supplies**



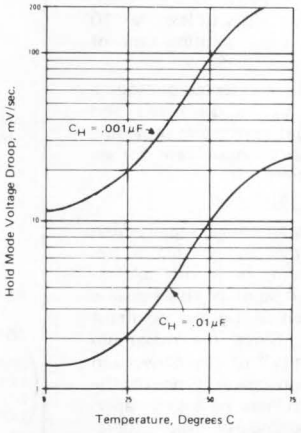

### SPEED CHARACTERISTICS VS. $C_H$

**Typical at 25°C, ±15V Supplies**

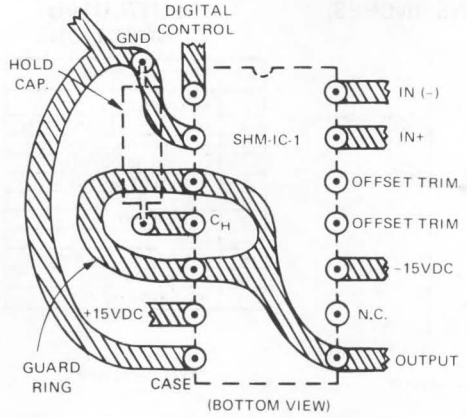



### HOLD MODE VOLTAGE DROOP VS. TEMPERATURE

**Typical, ±15V Supplies**




### RECOMMENDED CIRCUIT BOARD LAYOUT USING GUARD RING




### ORDERING INFORMATION

**PRICE (1-9)**

| | |
|---|---|
| Model SHM-IC-1 | $19.00 |
| Trimming Potentiometer TP100K (100KΩ) | $3.00 |

Contact Factory for Quantity Pricing

**The SHM-IC-1 is covered under GSA Contract**

DATEL

DATEL SYSTEMS, INC.
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TWX: 710-348-0135 TELEX: 924461

# ULTRA FAST / ACCURATE ANALOG STORAGE SAMPLE & HOLD

# MODEL SHM-2

## FEATURES

- Ultra Fast Acquisition Time
- Short Aperture Time
- Wide Frequency Response
- Fast Output Settling
- Low Temperature Coefficient

## DESCRIPTION

Model SHM-2 Sample and Hold is the ultimate in speed. Designed to operate in conjunction with Datel's analog to digital converters; Series H, P, N, M and L. SHM-2 can track a full scale analog input in less than 100 nsec's to within ±0.1% of full scale accuracy. Additional features include wide frequency response (D.C. to 500 KHz), an aperture uncertainty of less than 10 nsec's and an output settling time of one μsec to within ±0.1%.

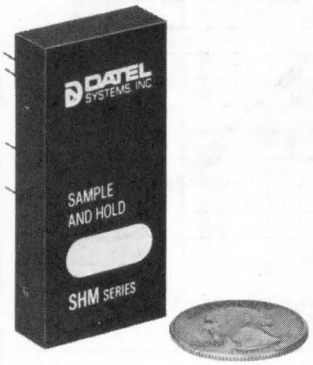
SHM-2 is usually connected between a signal source to be quantized and analog to digital converter, providing an excellent throughput rate for an overall data system.

## APPLICATION

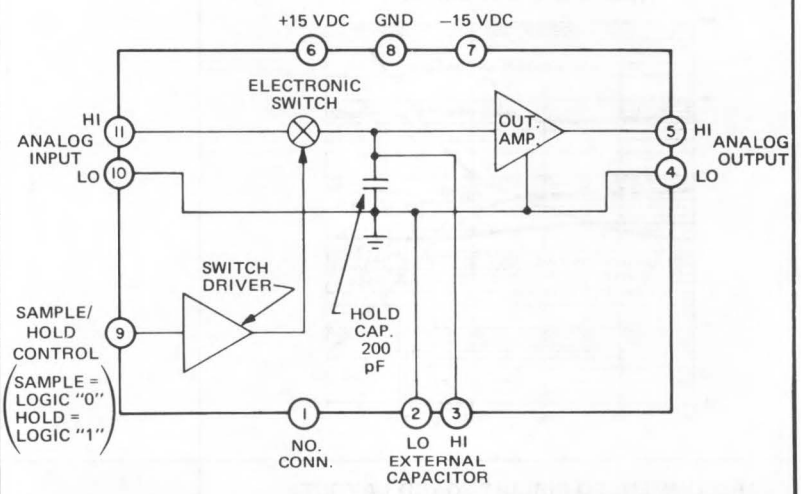
When digitizing an analog signal which varies with time and having a frequency spectrum, it is difficult to determine what point of this signal is exactly represented by the resultant digital output. Since the maximum time "uncertainty" of the conversion is the total conversion time of the converter which may be called "aperture time or ambiguity time"; therefore, the maximum error due to this uncertainty is the difference of two points of the analog signal under measurement from $T_0$ to time, $T_1$ representing the time required to convert the changing analog signal.

A faster converter will obviously shorten the aperture and the error will be reduced proportionately, but a device such as the SHM-2 with very narrow aperture characteristics, controlled by command, is far more useful in trying to determine the exact point of the changing analog signal when converting. The purpose of SHM-2 is to "hold" upon command at the beginning of the conversion ($T_0$ time) the analog voltage applied at its input. The "held" value will remain constant during the conversion process.

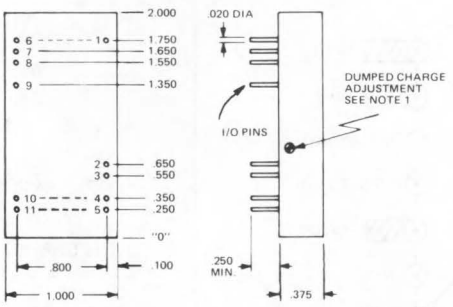
Relationships of error due to time uncertainty versus input frequency is plotted on the reverse side of this sheet.




### BLOCK DIAGRAM – SHM-2




### MECHANICAL DIMENSIONS (INCHES)




NOTE
1. ADJUST FOR HOLD OFFSET AT $V_{IN}$ = 0 VOLTS OR GROUNDED ANALOG INPUT.

### INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | NO CONNECTION |
| 2 | LO EXTERNAL CAPACITOR |
| 3 | HI EXTERNAL CAPACITOR |
| 4 | LO ANALOG OUTPUT |
| 5 | HI ANALOG OUTPUT |
| 6 | + 15 V POWER IN |
| 7 | – 15 V POWER IN |
| 8 | GROUND |
| 9 | SAMPLE/HOLD CONTROL |
| 10 | LO ANALOG INPUT |
| 11 | HI ANALOG INPUT |

USE POLYSTYRENE TYPE CAPACITOR

## SPECIFICATIONS (Typical @ 25°C unless noted)

### ELECTRICAL

#### Analog Input:

**Analog input voltage range** . . . Up to ±10 VFS

**Input overvoltage** . . . . . ±15V (max.) with a recovery time of 500 nsec

**Input source current** . . . . . ±12mA max drive during transition ±2mA bias during steady state. (Switching circuit is a diode bridge driven by 2 current sources.)

**Mode control input** . . . . . DTL or TTL compatible, positive logic

| Status | Input Code | Vinput Min. | Vinput Max. |
|---|---|---|---|
| Sample | "0" | 0V | +0.8V |
| Hold | "1" | +2.0V | +5.5V |

Rise and Fall time ≤ 10 nsec to maintain aperture time spec s.

#### Analog Output

**Output voltage range** . . . . . Up to ±10 VFS

**Output current** . . . . . ±5 mA

#### Dynamic Characteristics:

**Bandwidth** . . . . . DC to 500 KHz (max.) full power @ 3 db point

**Acquisition time** . . . . . 100 nsec (max.) to ± 0.1% of FS of input signal (5V step)

**Aperture time** . . . . . 10 nsec max. (8 nsec delay, 2 nsec jitter)

**Feedthrough @ any input frequency** . . . . . 0.5%

**Settling time** . . . . . 1 μsec (max.) to ±0.1%

**Hold decay rate** . . . . . 50 μV in 1 μsec

**Output slewing rate** . . . . . 30V/μsec

#### Performance:

**Gain** . . . . . + 1.00 Max. to +0.999 Min

**Accuracy (@ 25°C)** . . . . . ±0.1% of FS

**Linearity** . . . . . ±0.1% of FS

**Temperature coefficient** . . . . . ±30 ppm/° C of FS

**Long term stability** . . . . . ±0.025%/6 months (gain & offset)

**Input power requirements** . . . . +15±.5VDC @ 35 ma
−15±.5VDC @ 35 ma

### PHYSICAL-ENVIRONMENTAL

**Operating temperature range** . . 0°C to +75°C

**Storage temperature range** . . . . −55°C to +85°C

**Relative humidity** . . . . . Up to 100% non-condensing

**Size** . . . . . 2"L x 1"W x 0.375"H plug-in module

**Pins** . . . . . 0.020" round gold plated 0.250" long minimum

**Case material** . . . . . Black diallyl phthalate, per MIL-M-14. Fully repairable

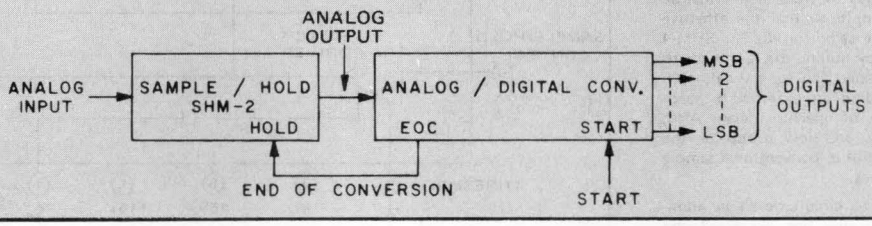
**Weight** . . . . . 2 oz.

**Mating Socket** . . . . . DILS-2, 2 Req'd.,

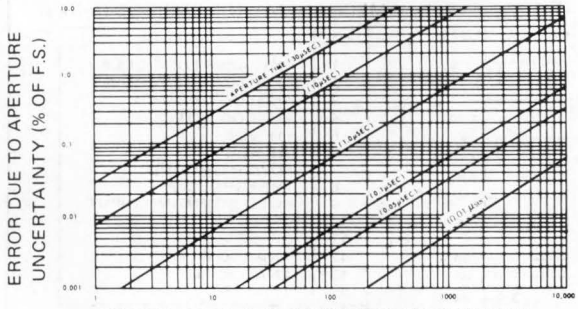
**Price (1-9)** Model SHM-2

Model SHM-2 sample and hold module is fully encapsulated and features dual in-line pinning compatibility (i.e., 0.100" grid pin spacing and 0.800" between rows of pins).

### TYPICAL SYSTEM CONFIGURATION




ERROR DUE TO TIME UNCERTAINTY (APERTURE TIME)
AS A FUNCTION OF INPUT SIGNAL FREQUENCY




TYPICAL EXAMPLE

ANALOG/DIGITAL CONV. W/WO SAMPLE & HOLD

| FULL SCALE ACCURACY | WITH S & H (10 NANOSEC APERTURE) | WITHOUT S & H (20 μsec CONVERSION TIME) |
|---|---|---|
| .06% | 10 KHz (MAX. INPUT FREQUENCY) | 400 Hz (MAX. INPUT FREQUENCY) |
| .01% | 2000 Hz (MAX. INPUT FREQUENCY) | < 1 Hz (MAX. INPUT FREQUENCY) |

DATEL

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# FOR SIMULTANEOUS SAMPLE AND HOLD APPLICATIONS SAMPLE AND HOLD

# SHM-4

## FEATURES

- Fast Acquisition Time
- Low Droop
- Adjustable Aperture Delay
- Low Gain Error
- High Input Impedance


## DESCRIPTION

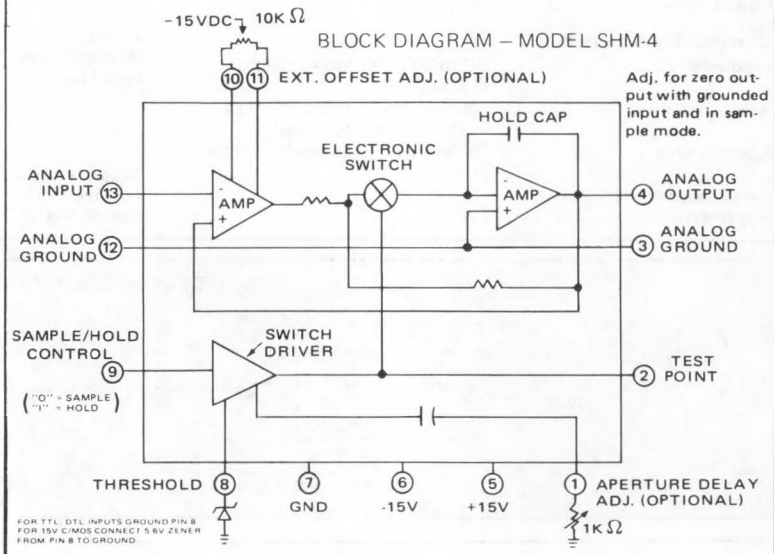
The SHM-4 is ideally suited to simultaneous sample and hold applications, where the gain and aperture delay between units must be matched, and where the output droop of the sampled signal is minimized for time shared A/D conversion.

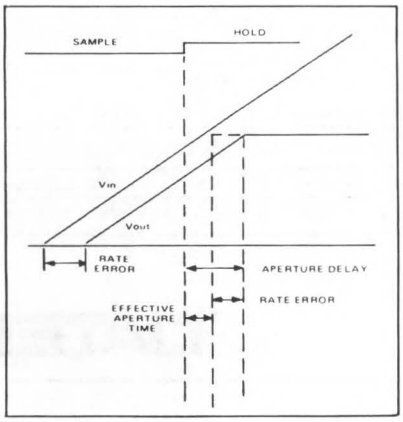
A double inversion circuit in the SHM-4 places the FET sampling switch near ground, which means that all variations of hold step and of aperture delay with input voltage are eliminated.

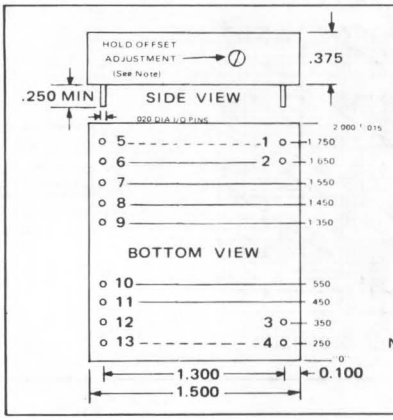
A unique closed loop design gives high accuracy and allows the rate error[1] to be factory nulled. Rate error is the delay by which the output lags an input ramp and may be expressed in nsec or in mV/V/μsec. For conventional sample and hold applications rate error is not serious because it merely causes an advance in the effective time of hold and tends to cancel out part of the aperture delay. However, for simultaneous applications the aperture delay minus the rate error must be matched between units so that the effective time of hold is the same for all. The SHM-4 accomplishes this by nulling the rate error to less than 1 nanosecond and for critical applications, by providing an external 5 nanosecond adjustment of aperture delay. Also, the high accuracy and low droop of the SHM-4 make it useful in conventional sample and hold applications.

Careful attention to circuit detail in eliminating leakage currents has decreased the output droop to less than 20 microvolts per millisecond allowing several SHM-4 modules to be time shared between one A/D converter.

BLOCK DIAGRAM – MODEL SHM-4




MECHANICAL DIMENSIONS (Inches)

| PIN | FUNCTION |
|---|---|
| 1 | EXT. APERTURE DELAY |
| 2 | APERTURE TEST POINT |
| 3 | ANALOG GROUND |
| 4 | ANALOG OUT |
| 5 | +15 VDC |
| 6 | -15 VDC |
| 7 | POWER GROUND |
| 8 | THRESHOLD |
| 9 | HOLD COMMAND INPUT |
| 10 | OFFSET |
| 11 | OFFSET |
| 12 | ANALOG GROUND |
| 13 | ANALOG IN |

Note: Adjust hold offset for minimum output with analog input at ground while toggling sample/hold control with moderate speed 0 to +2.4V. squarewave.

## SPECIFICATIONS (typical @ 25° C unless otherwise noted)

DATEL

### ELECTRICAL

**Analog Input**

| | |
|---|---|
| Input Voltage Range | ± 10V |
| Max. Safe Input | ± 15V |
| Impedance | $10^8$ ohms in parallel with: 1) 400 nA current source and 2) 33K ohm in series with 20pF. |

| **Digital Inputs (TTL, DTL, C/MOS Compatible)** | **Nominal** | **Limits** |
|---|---|---|
| Sample | 0V | 0 to +.8V @ -1.5 mA |
| Hold | 4V | +2 to +15V @ +0.1 mA |

(For 15V C/MOS threshold may be raised to 6.5V with a 5.6V zener from pin 8 to ground)

**Sample**

| | |
|---|---|
| Offset V, (Vout -Vin) @ Vin = 0 | Ext. Adj. to 0 |
| Offset V over temp. range (1) | ± 30 μ V/°C |
| Offset V vs Supply Voltage | ± 100 μ V/V |
| Gain Error (offset V vs Vin) | ± .005% |
| Gain Error over temp. range | ± .001%/70°C |
| Rate Error (offset V vs dVin/dt) (1) | 1 nsec |
| Bandwidth, 3db, 20V .p-p (1) | 200 KHz |
| Bandwidth, 3db, 1V .p-p (1) | 1.0 MHz |
| Slew Rate (1) | 5V/ μ sec |
| Settling Time, 20V step, to ± .05% (1) | 6 μ sec |
| to ± .005% (1) | 7 μ sec |
| Noise, wideband | 300 μ V rms |

**Sample to Hold**

| | |
|---|---|
| Hold Step (2) | Int. Adj. to 0 |
| Peak Transient | 400 mV |
| Aperture Delay (3) | Ext. Adj. 40-45 nsec |
| Aperture Jitter (One Unit) | 1 nsec |

**Hold**

| | |
|---|---|
| Droop | 20 μ V/msec |
| Droop vs Temp. | x2/10°C |
| Feedthrough | +.01% |

**Hold to Sample**

| | |
|---|---|
| Acquisition Time (1) | 20V step, to ± .05% 6 μ sec to ± .005% 7 μ sec |

**Output**

| | |
|---|---|
| Max. Current | ± 5 mA |
| Impedance | 50 milliohms |
| Short Circuit Protection | Output to GND indefinitely |
| **Input Power** | +15VDC @ 14 mA max |
| | -15VDC @ 12 mA max |

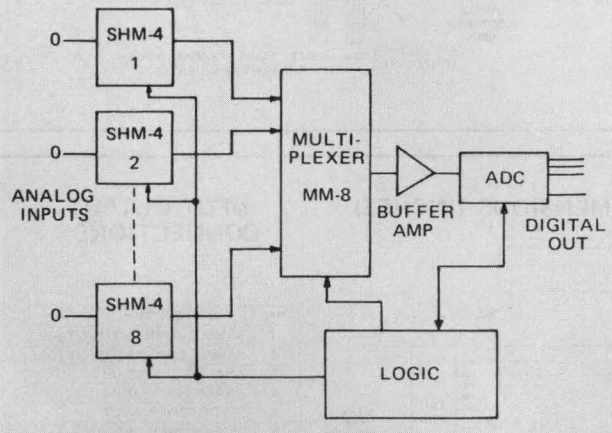
### PHYSICAL - ENVIRONMENTAL

| | |
|---|---|
| Operating Temperature Range | 0°C to +70°C |
| Storage Temperature Range | -55°C to +85°C |
| Relative Humidity | Up to 100% non-condensing |
| Size | 2"Lx 1.5"Wx0.375"H plug-in module |
| Pins | .020" round gold plated .250" Long Min. |
| Case Material | Black diallyl phthalate, per MIL-M-14 |
| Weight | 3 oz. |
| Mating Connector | DILS-2, 2 Req'd per module, $5/pr |
| **Price (1-9)** | **$59.00** |

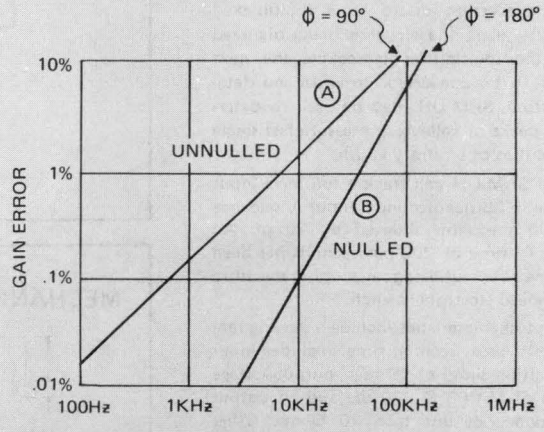
Model SHM-4 sample and hold module is fully encapsulated and features dual in-line pinning compatibility

NOTES: (1) Source resistance of 5K ohm or less
(2) Adjust for hold offset at Vin=0 Volts or with analog input at ground.
(3) Aperture delay is nominally 40 nsec independent of Vin. This delay may be increased by up to 5 nsec by connecting a 1K ohm pot from pin 1 to ground and viewing the delay at pin 2 when the test point voltage crosses -5V.

### TYPICAL SYSTEM CONFIGURATION




**Note:** The (8) Channel Select Input of the Mux 8 should go to the Inhibit Level (1 State) for 200 nsec beginning with an address change to protect the outputs of the SHM-4's.




INPUT FREQUENCY -20Vpp SINE WAVE

Curve A represents the SHM-4 before rate error nulling where the rate error is 450 nsec. Curve B shows a nulled production SHM-4. The quadrature error due to the first order pole has been removed leaving only a residual gain error due to a second order pole.

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# 200 PICOSECOND APERTURE TIME SAMPLE & HOLD

# SHM-UH

## FEATURES

- 100 MEG OHM Input Impedance
- 35 Nanosec Acquisition Time
- 500 V/μsec. Output Slew Rate
- 10 MHz Sample Rate
- ±30ma Output Current
- 2"Wx2"Lx.375"H


## GENERAL DESCRIPTION

Model SHM-UH is characterized primarily by very high speed. Its tracking capability of 35 nanoseconds with an aperture uncertainty time of less than 200 picoseconds is the most unique feature of the device.

A 200 picosecond aperture time (uncertainty) enables tracking and holding of high bandwidth Video, Radar, or Television signals as well as wide band data for communication systems. The SHM-UH ingredients consist of a high impedance FET input buffer amplifier, a floating high speed electronic switch, holding capacitor, and a high power FET output amplifier.

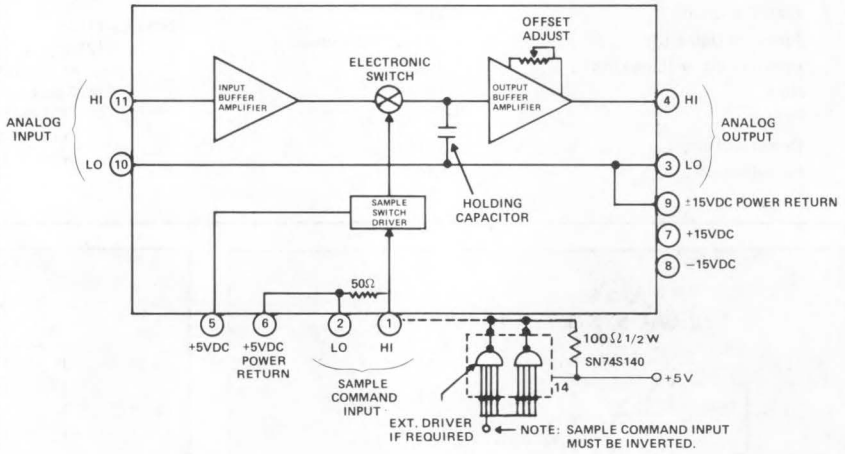
Model SHM-UH was primarily designed to "freeze" fast moving video signals during A/D conversion or to store multiplexed outputs while the signal is being digitized and the multiplexer is seeking the next signal to be converted. In wideband data-reduction, SHM-UH may be used to determine peaks or valleys, or measure fast single shot pulses of arbitrary width.

Model SHM-UH can track a full scale input (±5V) in 35 nanoseconds. Input impedance is 100 megohms shunted by 20 pf. An aperture time of 200 picoseconds has been obtained by utilizing a proprietary ultra high speed electronic switch.

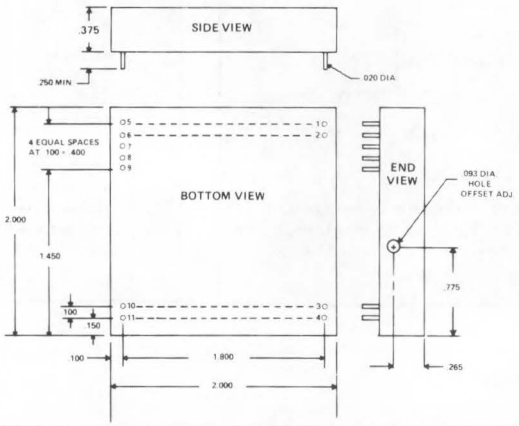
Output characteristics include a slewing rate of 500V/μsec, settling time (includes input acquisition time) of 50 nsec, output voltage range of ±5VFS @ ±30 ma and an output impedance of less than 10 Ohms. Other specifications include a Hold Decay Rate of 50μ volts/μsec, a feedthrough attenuation of −60db @ 10 MHz (Sine Wave input) and −46db for a step input.

The Sample Command input is transformer coupled to the electronic switch and has an input impedance of 50 Ohms and requires a 35 nanosecond positive going pulse. The maximum sample rate is 10 MHz. Input power requirements are ±15VDC @ ±50 ma and +5VDC @ 100 ma.

## BLOCK DIAGRAM – MODEL SHM-UH




## MECHANICAL DIMENSIONS (INCHES)




## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | SAMPLE COMMAND INPUT (HI) |
| 2 | SAMPLE COMMAND INPUT (LO) |
| 3 | ANALOG OUTPUT (LO) |
| 4 | ANALOG OUTPUT (HI) |
| 5 | +5VDC POWER INPUT |
| 6 | +5VDC POWER RETURN |
| 7 | +15VDC POWER INPUT |
| 8 | −15VDC POWER INPUT |
| 9 | ±15VDC POWER RETURN |
| 10 | ANALOG INPUT (LO) |
| 11 | ANALOG INPUT (HI) |

2. PINS #3 AND #10 ARE INTERNALLY CONNECTED TO PIN #9.

## SPECIFICATIONS

DATEL

### INPUTS:

**Analog Input Range** . . . . . Up to ±5VFS

**Input Impedance** . . . . . 100 Megohms (shunted with 20pf)

**Sample Command** . . . . . 35 ±10nsec 0V to +5V, POSITIVE PULSE. (3nsec max. rise and fall time) NOTE: This input is transformer coupled to the electronic switch.

**Sample Command Input Impedance** . . . . . 50 Ohms – Requires 100 ma of Source Current. NOTE: See Block Diagram for Buffer Input.

### PERFORMANCE:

**Output Voltage Range** . . . . . Up to ±5VFS

**Output Current** . . . . . ±30 ma, max.

**Output Impedance.** . . . . . 10 Ohms, max.

**Gain** . . . . . 0.92 to 0.95 non-inverting

**Linearity** . . . . . ±0.25% of F.S.

**Input Acquisition Time/ Output Settling Time to 0.2%** (including input acquisition time) . . . . . 35nsec for full scale input, 50nsec for full scale output

**Aparture Delay** . . . . . 10nsec

**Aperture Uncertainty** . . . . . 200 psec

**Output Slewing Rate** . . . . . 500V/μsec

**Maximum Sample Rate** . . . . . 10 MHz

**Hold Decay Rate.** . . . . . 50 μV/μsec

**Feedthrough** . . . . . –60db @ 10 MHz (Sine Wave Input)
–46db (Pulse Input)

**Output Zero T.C.** . . . . . ±50μV/°C

**Input Power Requirements** . . . . ±15VDC, ±0.2VDC @ ±50 ma
+5VDC, ±0.25VDC @ 100 ma

**Operating Temperature Range** . . 0°C to +70°C

**Storage Temperature Range** . . . –55°C to +85°C

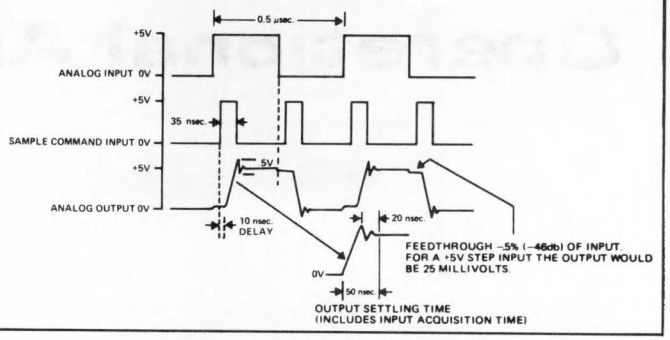
**Relative Humidity** . . . . . Up to 100% NON-CONDENSING

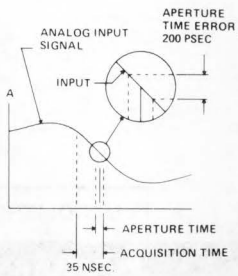
**Size** . . . . . 2"Lx2"Wx.375"H

**Case Material** . . . . . Black Dyallyl Phthalate, per MIL-M-14

**Weight** . . . . . 3 oz.

## TYPICAL TIMING DIAGRAM – SQUARE WAVE INPUT




### Acquisition Time

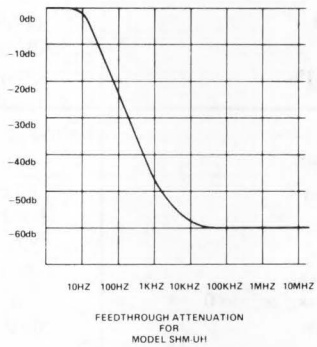
The *acquisition time* is the time necessary to charge the holding capacitor and start to track the input signal. To sample the input signal the Sample Command input must be a positive five volt signal with a duration of 35 ±10 nsec.

The total acquisition time for a five volt input step is 35 nanosec.

### Aperture Time

The *aperture time* is the uncertainty of the actual point in time the switch is opened. It is a measure of the repeatability of the switch characteristics. Aperture time for the SHM-UH is less than 200 psec. This time should not be confused with the fixed delays which can be compensated for. Typical delay between the hold command input and the actual switch open is approximately 10 nanosec.

SINEWAVE INPUT




FEEDTHROUGH ATTENUATION FOR MODEL SHM-UH

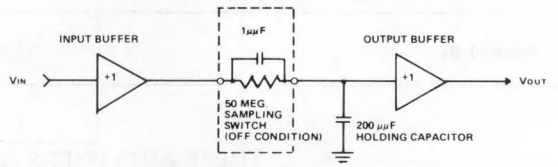
### Feedthrough Attenuation

After the switch has been opened and the signal is being held, a certain amount of the signal still on the input will couple over to the output.

## ZORO OFFSET ADJUSTMENT PROCEDURE

1) Connect the Analog Inputs together – Pin 11 to Pin 10.
2) Connect a precision pulse generator via a coaxial cable to the "Sample Command Input" terminals. Pin 1 (High) and Pin 2 (Low).
   Adjust its output to display the following:
   Pulse Repetition Rate . . . . . 10 KHz
   Pulse Width . . . . . 35 nsec, ±10 nsec
   Pulse Amplitude . . . . . +5V
   NOTE: Sample Command Input Impedance is 50 Ohms
3) Connect a precision D.C. digital voltmeter to the Analog Output terminals. Pin 4 (High) and Pin 3 (Low).
4) Adjust the offset control until the analog output is 0V.

## EQUIVALENT CIRCUIT OF SAMPLING SWITCH




## ORDERING INFORMATION

**MODEL–SHM–UH**
**PRICE (1-9) . . . . $229.00**

MATING SOCKET
MODEL DILS-2
2 req'd/module, $5/pr.

# Monolithic and Hybrid I.C. Operational Amplifiers

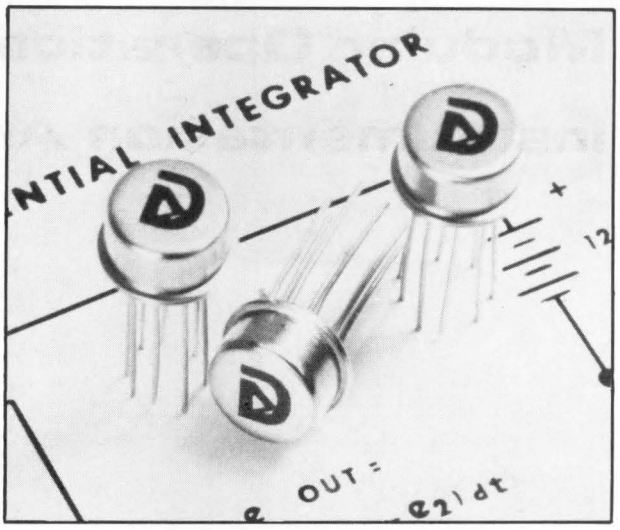
| SPECIFICATIONS (Typical at 25°C, ±15V supplies unless otherwise noted) | MONOLITHIC MOD.SLEW RATE AM-450-2 | MONOLITHIC FAST SETTLING AM-452-2 | MONOLITHIC LOW COST AM-460-2 | MONOLITHIC WIDEBAND AM-462-1/2 |
|---|---|---|---|---|
| DC Open Loop Gain | 25K | 15K | 150K | 150K |
| Gain Bandwidth Product | 12 MHz | 20 MHz | 12 MHz | 100 MHz |
| Slew Rate | 30V/μsec. | 120V/μsec. | 7V/μsec. | 35V/μsec. |
| Settling Time, 10V to 0.1% | 330 nsec. | 200 nsec. | 1.5 μsec. | 1.0 μsec. |
| Output, min. | ±10V @ 10mA | ±10V @ 10mA | ±10V @ 10mA | ±10V @ 10mA |
| Common Mode Range, min. | ±10V | ±10V | ±11V | ±11V |
| Common Mode Rejection | 90 dB | 90 dB | 100 dB | 100 dB |
| Input Impedance | 50 Meg. | 100 Meg. | 300 Meg. | 300 Meg. |
| Input Bias Current, max. | 250nA | 250nA | 25nA | 25nA |
| Input Offset Current, max. | 50nA | 50nA | 25nA | 25nA |
| Input Offset Voltage, max., adj. to 0 | ±8mV | ±10mV | ±5mV | ±5mV |
| Input Offset Voltage Drift | 20μV/°C | 30μV/°C | 10μV/°C | 15μV/°C |
| Power Requirement | ±15V @ 4mA | ±15V @ 4mA | ±15V @ 3mA | ±15V @ 3mA |
| Temperature Range | 0°C to 70°C | 0°C to 70°C | 0°C to 70°C | 0°C to 70°C |
| Package | TO-99 | TO-99 | TO-99 | TO-116/TO-99 |
| Price (1-9) | $7.50 | $10.50 | $6.50 | $9.00 |

See page 136

THESE AMPLIFIERS ARE COVERED BY GSA CONTRACT

This broad line of monolithic and hybrid operational amplifiers is designed for data acquisition and conversion applications where high speed and small size are required. The devices shown in this table are wide bandwidth, high slew rate, fast settling amplifiers. In addition to high speed, they also have excellent DC characteristics making them good choices for high accuracy applications.

Four basic models of bipolar input amplifiers are offered along with two FET input models. The AM-464-2 is a new high voltage, fast settling amplifier with ±35V output swing. The AM-500 is a new hybrid, ultra-fast amplifier for inverting-only applications. It features 1000V/μsec. slew rate, 100 MHz gain bandwidth product, and 200 nsec settling time to .01% for a 10V step input. The AM-490-2 series are monolithic, chopper stabilized operational amplifiers with open loop gain of $5 \times 10^8$ and input offset drifts of 1.0, 0.3, and 0.1 μV/°C maximum.




AM-490 Series: Monolithic Chopper Amplifiers

| | NEW | NEW | NEW | | |
|---|---|---|---|---|---|
| MONOLITHIC | MONOLITHIC | MONOLITHIC | HYBRID | MONOLITHIC | |
| FAST SLEW FET AM-405-2 | WIDEBAND FET AM-406-2 | ±35V SWING AM-464-2 | ULTRA FAST AM-500 | CHOPPER STABILIZED AM-490-2 | |
| | | | | A | B | C |
| 15K | 150K | 100K | $1 \times 10^6$ | $5 \times 10^8$ | | |
| 20 MHz | 100 MHz | 4 MHz | 100 MHz | 3 MHz | | |
| 120V/μsec. | 35V/μsec. | 5V/μsec. | 1000V/μsec. | 2.5V/μsec. | | |
| 400 nsec. | — | — | 100 nsec.(1) | — | | |
| ±10V @ 10mA | ±10V @ 10mA | ±35V @ 10mA | ±10V @ 50mA | ±10V @ 7mA | | |
| ±10V | ±10V | ±35V | — | ±10V | | |
| 90 dB | 90 dB | 74 dB | — | 120 dB | | |
| $10^{12}$ ohms | $10^{12}$ ohms | 200 Meg. | 30 Meg. | 100 Meg | | |
| 20 pA | 20 pA | 30nA | 4nA | 150 pA | | |
| 20 pA | 20 pA | 30nA | 0.5nA | 50 pA | | |
| ±30mV | ±15mV | ±6mV | ±3mV | ±20 μV | | |
| 50 μV/°C | 50 μV/°C | 15 μV/°C | 5μV/°C | 1.0 (2) | 0.3 (2) | 1.0 (2) |
| ±15V @ 6mA | ±15V @ 4mA | ±10V to ±40V @ 3.2mA | ±15V@22mA | ±12V to ±20VDC @ 5mA | | |
| 0°C to 70°C | 0°C to 70°C | 0°C to 70°C | 0°C to 70°C | 0°C to 70°C | | |
| TO-99 | TO-99 | TO-99 | 0.76 x 0.45 x 0.25" | TO-99 | | |
| **$16.00** | **$13.75** | **$6.75** | $75.00 | $29.00 | $34.00 | $39.00 |
| | | Contact Factory | Contact Factory | See page 140 | | |

**Notes:**
**(1.) Max. settling time for 10V to .01% is 200 nsec max.**
**(2.) μV/°C maximum.**

# Modular Operational Amplifiers and Instrumentation Amplifiers

## Fast Settling FET Operational Amplifiers

| SPECIFICATIONS (Typical at 25°C, ±15V supplies unless otherwise noted) | FAST SETTLING AM-100 | | | CAPACITIVE LOADS AM-101 | | FAST FOLLOWER AM-102 | | FAST SLEWING AM-103 | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | A | B | A | B | A | B |
| DC Open Loop Gain | 300K | | | 300K | | 130K | | 130K | |
| Gain Bandwidth Product | 13.5 MHz | | | 5.5 MHz | | 32 MHz | | 32 MHz | |
| Slew Rate | 45V/μsec. | | | 45V/μsec. | | 140V/μsec. | | 400V/μsec. | |
| Settling Time, 10V to .01% | 550 nsec. (1) | | | 1.0 μsec. (1) | | 550 nsec. (2) | | 350 nsec. (1) | |
| Output, min. | ±10V @ 20mA | | | ±10V @ 20mA | | ±10V @ 20mA | | ±10V @ 20mA | |
| Common Mode Range, min. | ±10V | | | ±10V | | ±10V | | ±10V | |
| Common Mode Rejection | 3,000 | | | 45,000 | | 45,000 | | 3,000 | |
| Input Impedance | $10^{12}$ ohms | | | $10^{12}$ ohms | | $10^{12}$ ohms | | $10^{12}$ ohms | |
| Input Bias Current, pA max. | 100 | 50 | 20 | 50 | 20 | 50 | | 50 | |
| Input Offset Current, max. | 10 pA | | | 10 pA | | 10 pA | | 10 pA | |
| Input Offset Voltage | Adj. to 0 | | | Adj. to 0 | | Adj. to 0 | | Adj. to 0 | |
| Input Off. Voltage Drift, μV/°C max. | 50 | 25 | 10 | 40 | 20 | 40 | 20 | 40 | 20 |
| Power Requirement | ±15V @ 13mA | | | ±15V @ 13mA | | ±15V @ 18mA | | ±15V @ 18mA | |
| Temperature Range | 0°C to 70°C | | | 0°C to 70°C | | 0°C to 70°C | | 0°C to 70°C | |
| Package | 1.12 x 1.12 x 0.4" | | | 1.12 x 1.12 x 0.4" | | 1.12 x 1.12 x 0.4" | | 1.12 x 1.12 x 0.4" | |
| Socket | MS-6 | | | MS-6 | | MS-6 | | MS-6 | |
| Price (1-9) | $40 | $45 | $52 | $46 | $52 | $49 | $55 | $49 | $55 |

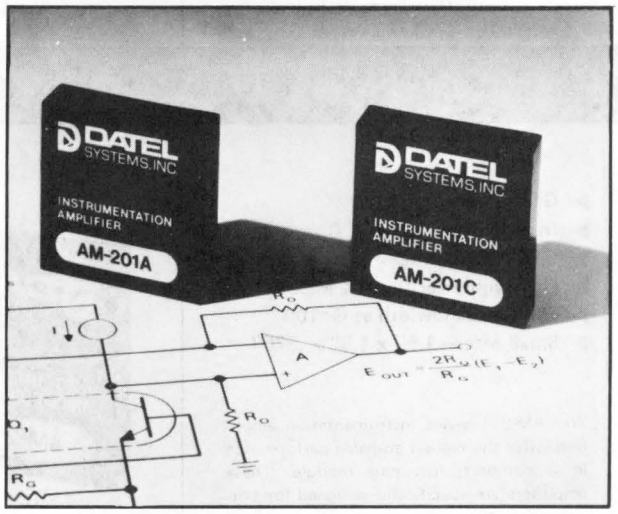
See page 134

Notes:
(1) Unity gain inverting
(2) Unity gain follower

## DESCRIPTION

The AM-100 series of fast settling, FET input amplifiers, is designed for data conversion applications where optimum settling time is desired for up to 12 bit accuracy. While featuring exceptionally fast slew rates, wide bandwidths, and settling times faster than one microsecond, these amplifiers also have low drift and exceptionally low input bias currents. Output currents are rated at 20mA for good load driving capability.

Datel Systems' new AM-201 amplifiers are high performance instrumentation amplifiers designed for critical data acquisition applications where programmable gain at very low drifts is required. Input offset voltage drifts are 1.0, 0.5, and 0.25$\mu$V/°C maximum for these models. In addition, these units have a bandwidth of 45 kHz at a gain of 1000.




**AM-201 Series: High Performance, Instrumentation Amplifiers Feature Low Cost**

NEW

| | ±140V FET AM 303 | |
|---|---|---|
| | **A** | **B** |
| | $10^6$<br>10 MHz<br>100V/$\mu$sec.<br>2.5 $\mu$sec. | |
| | ±140V @ 20mA<br>±140V<br>100,000<br>$10^{12}$ ohms | |
| | 100 pA | |
| | 30 pA<br>±1mV | |
| | 50 | 20 |
| | ±15V to ±150V @ 12mA<br>0°C to 70°C<br>1.8 x 2.4 x .61"<br>MS-11 | |
| | **$90** | **$120** |

# Instrumentation Amplifiers

NEW

| SPECIFICATIONS (Typical at 25 C, 15V supplies unless otherwise noted) | HIGH PERFORMANCE AM 201 | | |
|---|---|---|---|
| | **A** | **B** | **C** |
| **Gain Range** | 1 to 1000 | | |
| **Gain Nonlinearity, max.** | .01% | | |
| **Gain Equation** | $200K/R_G$ | | |
| **Bandwidth, G=1000** | 45 kHz | | |
| **Slew Rate** | 1V/$\mu$sec. | | |
| **Output, min., S.C. protected** | ±10V @ 5mA | | |
| **Common Mode Range, min., ±15V Supply** | ±10V | | |
| **Common Mode Rejection, min. G=1000** | 100 dB | 106 dB | 114 dB |
| **Input Impedance, differential** | $10^9$ ohms | | |
| **Input Bias Current, max.** | 50nA | 25nA | 25nA |
| **Input Offset Current** | 2.5nA | 1nA | 1nA |
| **Input Offset Current Drift, nA/°C** | .02 | | |
| **Input Offset Voltage** | Adj. to zero | | |
| **Input Off. V. Drift, $\mu$V/°C max., G=1000** | ±1.0 | ±0.5 | ±0.25 |
| **Output Offset Voltage Drift, G=1** | ±100$\mu$V/°C | | |
| **Power Requirement** | ±12V to ±18VDC | | |
| **Quiescent Current** | 5mA | | |
| **Temperature Range** | 0°C to 70°C | | |
| **Package** | 1.5 x 1.5 x .375" | | |
| **Socket** | MS-9 | | |
| **Price (1-9)** | **$69** | **$79** | **$89** |

See page 130

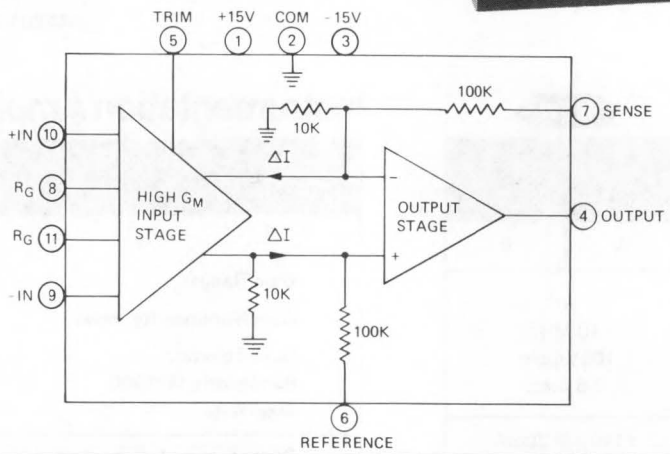
**THESE AMPLIFIERS ARE COVERED BY GSA CONTRACT**

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# HIGH PERFORMANCE INSTRUMENTATION AMPLIFIERS

# AM-201 SERIES

- Gain Range 1 to 1000
- Input Drift to .25 $\mu V/^{\circ}C$
- CMRR to 114 dB
- Gain Nonlinearity .01% Max.
- 180kHz Bandwidth at G=100
- Small Size – 1.5" x 1.5" x .375"

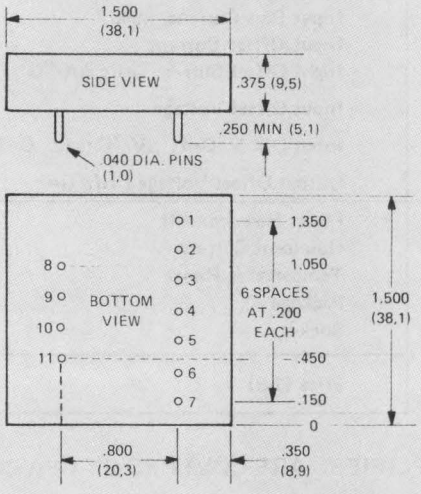




The AM-201 series instrumentation amplifiers offer the highest available performance in a compact, low cost module. These amplifiers are specifically designed for critical applications where the lowest input drifts and noise are required together with the highest possible common mode rejection; at the same time wide bandwidth and excellent settling time are achieved. This series rivals the performance of expensive rack-mounted instrumentation amplifiers and yet is packaged in a small 1.5 x 1.5 x .375 inch module.

The key to the performance of the AM-201 series is a unique very high transconductance (gm = 50 mhos) input stage which gives optimum results for high gains of 100 to 1000. The amplifiers are programmed by a single external resistor for gains of 1 to 1000 and give guaranteed total voltage offset drifts referred to the input of 1.0, 0.5, and 0.25$\mu V/^{\circ}C$ at a gain of 1000 for the three models AM-201A, AM-201B, and AM-201C respectively. At a gain of 1000 the common mode rejection ratio is 100, 106, and 114 dB minimum for the three models, with a source unbalance of 1 kilohm. The input stage gives very low bias currents and an input offset current drift of only 20pA/°C, allowing use of up to 50 kilohm balanced input source impedances. These performance characteristics are achieved without sacrificing good bandwidth: 3 dB bandwidth is 45 kHz at G=1000 and 180 kHz at G=100. Output settling time is 20 $\mu$sec. for a 10V step to .01%.

The gain equation for these models is: $G=200K/R_G$. Gain equation accuracy is ±0.5% with a gain nonlinearity of .01% maximum and gain temperature coefficient of 20ppm/°C maximum. Other input specifications include input voltage noise of 1$\mu$V peak to peak from 0.1 to 10 Hz and 1$\mu$V RMS from 10 Hz to 10 kHz. The input offset voltage is adjustable to zero by means of an external trimming potentiometer. These amplifiers also have sense and reference terminals for load sensing and externally offsetting the output voltage. Output capability is ±10V at 5mA, with output short circuit protection.

## MECHANICAL DIMENSIONS INCHES (MM)




## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | +15V POWER IN |
| 2 | COMMON |
| 3 | -15V POWER IN |
| 4 | OUTPUT |
| 5 | TRIM |
| 6 | REFERENCE |
| 7 | SENSE |
| 8 | $R_G$ |
| 9 | -INPUT |
| 10 | +INPUT |
| 11 | $R_G$ |

## SPECIFICATIONS, AM-201 SERIES

**Typical at 25°C and ±15V supplies unless otherwise noted.**

| | A | B | C |
|---|---|---|---|
| **INPUT CHARACTERISTICS** | | | |
| Differential Input Voltage Range | | ±10V min. | |
| Common Mode Input Voltage Range | | ±10V min. | |
| Input Overvoltage, no damage | | ±V supply | |
| Input Impedance, Diff. or Com. Mode | | $10^9$ ohms | |
| Input Bias Current, nA max. | 50 | 25 | 25 |
| Input Offset Current, nA | 2.5 | 1 | 1 |
| Input Impedance, Ref. & Sense Inputs | | 110K | |
| Input Offset Voltage | | Adj. to zero | |
| **OUTPUT CHARACTERISTICS** | | | |
| Output Voltage | | ±10V min. | |
| Output Current, S.C. protected | | ±5mA min. | |
| Output Impedance | | 0.1 ohm | |
| Capacitive Load | | .01μF max. | |
| Output Offset Range | | ±10V min. | |
| **PERFORMANCE** | | | |
| Gain Range | | 1 to 1000 | |
| Gain Equation | | $200K/R_G$ | |
| Gain Equation Accuracy | | ±0.5% | |
| Gain Nonlinearity | | .01% max. | |
| Gain Temperature Coefficient | | ±20ppm/°C max. | |
| CMR, ±10V, 1K unbal., DC-120 Hz | | | |
| G=1000, dB min. | 100 | 106 | 114 |
| G=100 dB min. | 80 | 86 | 94 |
| G=10 dB min. | 60 | 66 | 74 |
| G=1 dB min. | 40 | 46 | 54 |
| **DRIFT AND NOISE** | | | |
| Input Offset Voltage Drift[1], μV/°C max. at G=1000 | ±1.0 | ±0.5 | ±0.25 |
| Output Offset Voltage Drift, G=1 | | ±100μV/°C | |
| Input Bias Current Drift | | 100pA/°C | |
| Input Offset Current Drift | | 20pA/°C | |
| Power Supply Rej., μV/V at G=1000 | 10 | 5 | 2 |
| Input Voltage Noise, 0.1 to 10 Hz | | 1μV P-P | |
| Input Voltage Noise, 10 Hz to 10 kHz | | 1μV RMS | |
| Input Current Noise, 10 Hz to 10 kHz | | 20pA RMS | |
| **DYNAMIC RESPONSE** | | | |
| Small Sig. Bandwidth, –3 dB, G=1000 | | 45 kHz | |
| G=100 | | 180 kHz | |
| G=10 | | 300 kHz | |
| Slew Rate | | 1 V/μsec. | |
| Full Power Response, 20V P-P | | 15 kHz | |
| Settling Time, 10V to .01% at G=1000 | | 20 μsec. | |
| Overload Recovery | | 10 μsec. | |
| **POWER REQUIREMENT** | | | |
| Voltage, rated performance | | ±15VDC ±0.5V | |
| Voltage Range, operating[2] | | ±12V to ±18VDC | |
| Current, quiescent | | 5 mA | |
| **PHYSICAL-ENVIRONMENTAL** | | | |
| Operating Temperature Range | | 0°C to 70°C | |
| Storage Temperature Range | | –55°C to +85°C | |
| Relative Humidity | | Up to 100% non-condensing | |
| Case Size | | 1.5 x 1.5 x .375 inches (38,1 x 38,1 x 9,5 mm) | |
| Case Material | | Black Diallyl Phthalate per MIL-M-14 | |
| Pins | | .040 round, gold plated, .250" long min. | |
| Weight | | 2.5 oz. max. (71 g.) | |
| **PRICE (1-9)** | **$69.00** | **$79.00** | **$89.00** |

1. With input offset voltage initially zeroed.
2. Signal input and output range is ±7V to ±13V.

## TECHNICAL NOTES

1. The guaranteed input offset voltage drift specification requires that the input offset voltage be zeroed. This is done by means of an external 50K trimming potentiometer connected from the TRIM pin to +15V. For minimum effect upon input offset drift, a low tempco trimming pot is recommended such as Vishay type 1203 (20ppm/°C). If the operating temperature range is relatively constant, then a 100ppm/°C cermet type trimming pot may be used (Datel Systems TP50K at $3.00 each). A 100ppm/°C drift in the trimming pot causes a 0.3μV/°C input offset voltage drift in the amplifier.
2. For optimum gain stability a low tempco gain setting resistor is recommended. The temperature coefficient of this resistor adds directly to the 20ppm/°C maximum gain tempco of the amplifier. For negligible effect on tempco Vishay type S102 (±1ppm/°C) is recommended. For less critical applications a 5 or 10ppm/°C metal film resistor is recommended. The resistor should be located as close as possible to the $R_G$ terminals of the amplifier, and shunt capacitance across the resistor should be kept to a minimum in order to prevent noise pick-up or instability at low gains. For gain-switched applications it is recommended that reed relays located close to the amplifier be used rather than running leads from a panel switch to the $R_G$ terminals.
3. The differential input terminals require a bias current path to ground and therefore cannot be used with floating inputs. Due to the very low input offset current drift of 20pA/°C, balanced source resistances up to 50K ohms can be used with these amplifiers. For example, 50K ohms x 20pA/°C gives an equivalent input offset voltage drift of 1μV/°C.
4. The guaranteed input offset voltage drifts of 1.0, 0.5, or 0.25 μV/°C include both input and output drifts referred to the input at a gain of 1000. Drifts at other gains are approximately (referred to input):

$$\Delta Eos\ (\mu V/^\circ C) = (\Delta Eos)_{1000} + \frac{100}{G}$$

### ORDERING INFORMATION

PRICES (1-9)

| | |
|---|---|
| AM-201A | $69.00 |
| AM-201B | $79.00 |
| AM-201C | $89.00 |

Mating Socket: MS-9 . . . . . $3.50 each

Trimming Pot: 100ppm/°C Cermet Type TP50K . . . . . $3.00 each

**THE AM-201 SERIES AMPLIFIERS ARE COVERED BY GSA CONTRACT**

## TECHNICAL NOTES (Cont'd)

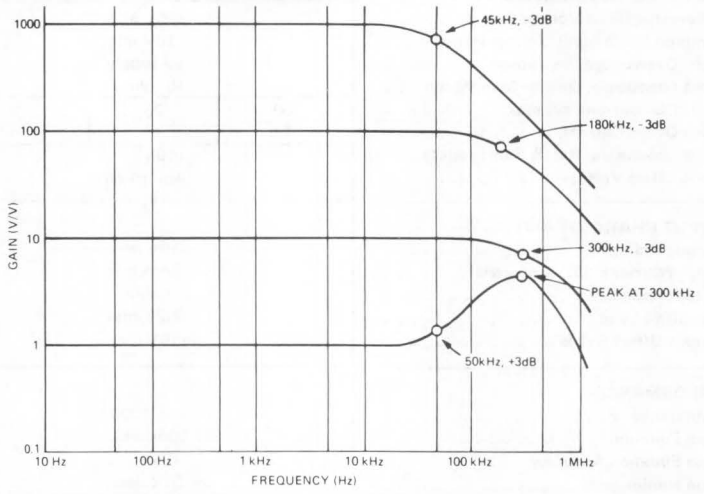
where $[\Delta\ Eos]_{1000}$ is the drift spec. at G=1000 and G is the programmed gain.

5. The sense terminal is normally connected to the output terminals, and the reference terminal is normally connected to ground. For remote loads or for load current sensing, the sense terminal is run separately to the load or to the current sensing resistor. The reference terminal may be connected to a voltage source in the range ±10V in order to directly offset the output of the amplifier by the same amount. Both sense and reference terminals should be connected only to low impedance sources (less than 10 ohms), as any impedance seen by these terminals will degrade the power supply rejection of the amplifier in proportion to the source impedance. A unity gain buffer amplifier can be used to isolate the reference terminal from high impedance sources. See application diagram.

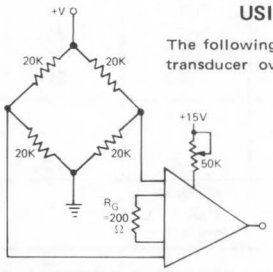
6. The AM-201 series amplifiers have a distinct advantage over many other instrumentation amplifiers in gain-switched applications. Because the gain formula is $200K/R_G$ the switched gain varies precisely inversely with $R_G$. If $R_G$ is halved, for example, the gain is exactly doubled. Therefore, unlike instrumentation amplifiers with a constant term of 1 in the gain formula, the selection of gain setting resistors is greatly simplified. In switched gain applications the AM-201 amplifiers should be zeroed at the highest gain. The input offset voltage then will not change with gain.

## PERFORMANCE DATA

### SMALL SIGNAL BANDWIDTH AT SELECTED GAINS




### ANALYSIS OF SIGNIFICANT ERROR SOURCES USING BRIDGE TRANSDUCER

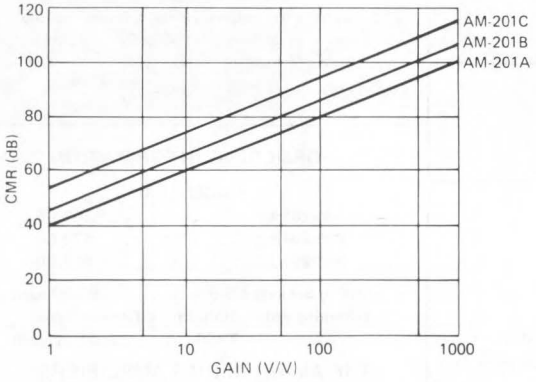



The following errors are computed for an AM-201C operated from a bridge transducer over a ±10°C ambient temperature range at a gain of 1000.

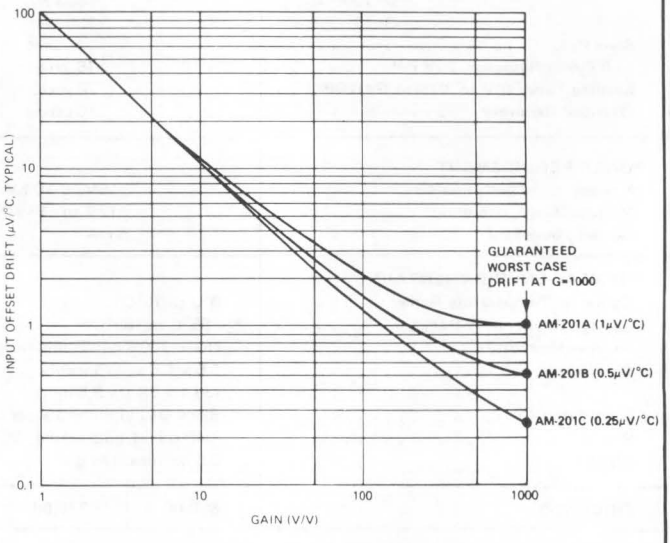
| Error Source | Calculation | Error (% 10V FS) |
|---|---|---|
| Volt. Offset Drift | .25 μV/°C x 10°C x 1000 | .025% |
| Cur. Offset Drift | 20 pA/°C x 10°C x 10K x 1000 | .020% |
| Gain Change | .002%/°C x 10°C | .020% |
| Noise (.1 to 10 Hz) | 1 μV P-P x 1000 | .010% |
| Gain Nonlinearity | .01% | .010% |
| Power Supply Drift | Negligible | — |
| | TOTAL OUTPUT ERROR | .085% |

Power supply drift (assuming .02%/°C) contributes a negligible amount to the error and therefore the computation is omitted. The total output errors for a 10°C temperature change are less than 0.1%.

### COMMON MODE REJECTION RATIO VS. GAIN



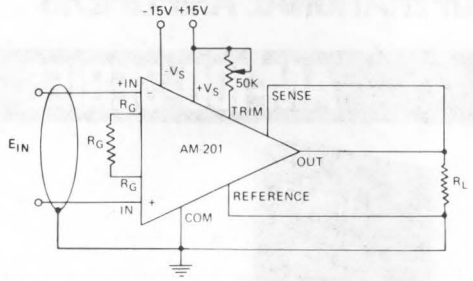

### TOTAL VOLTAGE OFFSET DRIFT (REFERRED TO INPUT) VS. GAIN




DATEL

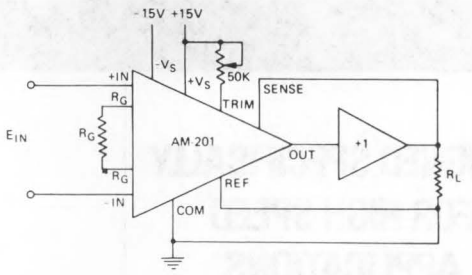
## APPLICATION DIAGRAMS

### STANDARD CONNECTION

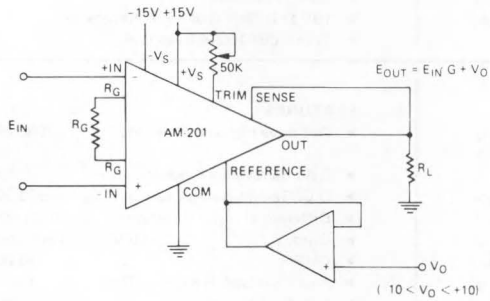



**INPUT OFFSET TRIMMING:** Short input terminals together and connect to ground or to common mode voltage at which input will be used. Adjust 50K trimming pot for zero output voltage. For critical applications $R_G$ should be a Vishay type S102 and the trimming pot should be a Vishay type 1203. See technical notes.

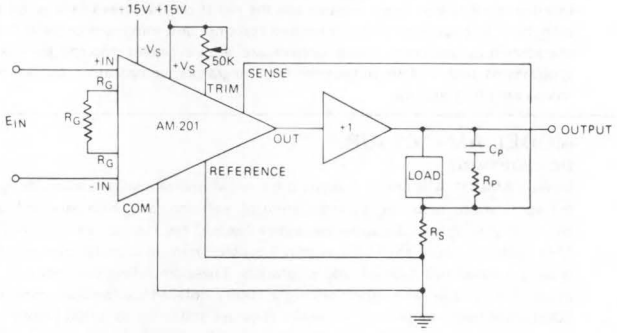
### USING AN OUTPUT CURRENT BOOSTER




### OFFSETTING THE OUTPUT BY USE OF THE REFERENCE TERMINAL

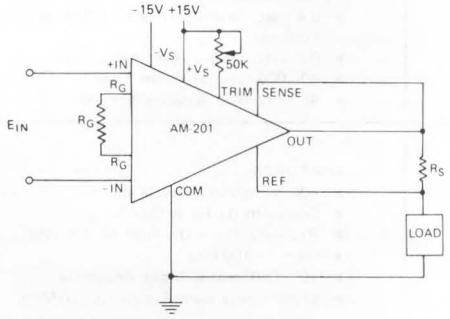



### CONNECTION FOR DRIVING LOAD WITH CURRENT BOOSTER USING LOAD CURRENT SENSING

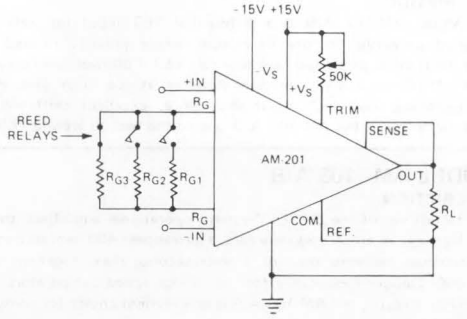



**NOTE:** The output voltage using the gain equation will appear across $R_S$. The load impedance and output of the current booster must be compatible with this. Highly inductive loads may cause ringing or oscillation. In this case add $R_P$ and $C_P$ as shown.

### DRIVING A GROUNDED LOAD USING CURRENT SENSING




### GAIN SWITCHING WITH THE AM-201




Gain is inversely proportional to $R_G$. Thus if $R_G$ is halved the gain is exactly doubled. Input offset voltage does not change with $R_G$.

DATEL

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# WIDE BAND FAST SETTLING FET INPUT OPERATIONAL AMPLIFIERS

# AM-100-SERIES

## DESIGNED SPECIFICALLY FOR HIGH SPEED APPLICATIONS


### MODEL AM–100 A/B/C

**DESCRIPTION:**

Designed specifically to drive C.R.T. displays, the DATEL Models AM-100 A/B/C permit settling (to 0.01%) of a 0.5 V step within 0.15 μsec. Clean, crisp alpha/numeric characters, together with sharp, linear vectors are the result on the screen face when these amplifiers with their fast settling, true 6dB/octave response and minimum overshoot and undershoot characteristics are used. These devices are also excellent choices for use in high speed applications such as D/A output drivers, integrators, comparators, buffers and many other analog sampling circuits.

**FEATURES:**

- 60 Volts/μsec. Slew Rate
- Settles to 0.01% Within 0.15 μsec. (Small Step)
- Recovery From Overload in 0.5 μsec.
- Gain of 500,000
- $10^{12}$ Ω Differential Input Resistance
- True 6 dB/Octave Response

### MODEL AM–101 A/B

**DESCRIPTION:**

Models AM-101 A/B are FET-input differential operational amplifiers designed specifically for applications requiring a combination of high accuracy, high gain and fast settling with the ability to drive substantial capacitive loads. They have a gain bandwidth product of 5 MHz and will settle to 0.01% within 1.5 μsec., min. in a unity gain inverting mode while driving a capacitive load of 300 picofarads. These amplifiers will settle to 0.01% within 1 μsec., min., in the same mode driving a 1000 picofarad load and are stable driving a load of 2000 picofarads, minimum. Typically they are stable up to 5,000 picofarads. In addition, low drift, low noise and excellent overload recovery characteristics together with a reasonable price make these amplifiers a must to consider wherever analog voltage sampling is required.

Model AM-101 A/B has a CMRR of 40,000 typical and 20,000 minimum and should be considered wherever a non-inverting amplifier is necessary such as in buffer or multiplexer applications. Since settling time to 0.01% is approximately the same in the non-inverting mode, excellent gain and linearity characteristics are achieved with the high CMRR of the AM-101 Series.

**FEATURES:**

- Will drive high capacitive load . . . . 2000 pF, min.
- Gain Bandwidth Product . . . . . 7 MHz
- D.C. Gain at Rated Load . . . . . 500,000
- Differential Input Resistance. . . $10^{12}$ Ω min.
- Output . . . . . ±10 V @ ±20 mA, min.
- CMRR . . . . . 40,000
- Fast Overload Recovery Time . . . . 1 μsec.
- Low Profile Case . . . . . 0.4"

### MODEL AM–102 A/B

**DESCRIPTION:**

The Model AM-102 A/B is a differential FET input fast settling operational amplifier designed primarily for use in circuits where polarity reversal is not desired. All the ingredients of a good, fast and accurate FET Follower can be found in the AM-102 A/B. High CMRR, very high common mode resistance, high gain, wide bandwidth and fast settling along with high input impedance, excellent drift and noise characteristics all combine to make the AM-102 A/B one of the best all around Follower Amplifiers available.

**FEATURES:**

- 140 Volts/μsec. Slew Rate
- 0.4 μsec, Settling Time to 0.01% as Follower
- 0.5 μsec. Overload Recovery Time
- 400,000 Gain at Rated Load
- 45 MHz Gain Bandwidth Product

### MODEL AM–103 A/B

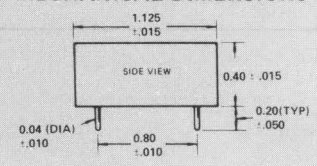
**DESCRIPTION:**

The fastest yet of the DATEL Systems operational amplifiers, the AM-103 A/B features a 250 Volt per microsecond slew rate, a guaranteed 400 nanosecond settling time (to 0.01%), an overload recovery time of 1 microsecond, max. together with a minimum gain of 100,000. Designed especially for use in high speed comparators, integrator, A/D and D/A converter circuits, the AM-103 A/B is an excellent choice for consideration whenever analog sampling is necessary.

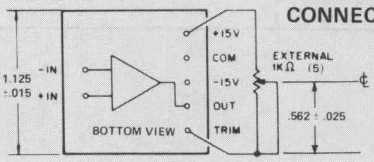
**FEATURES:**

- 400 Volts/μsec. Slew Rate
- Settles to 0.01% Within 0.3 μsec.
- Recovery From Overload in 0.5 μsec.
- Gain of 400,000
- $10^{12}$ Differential Input Resistance
- Stable Unity Gain Frequency 37 MHz

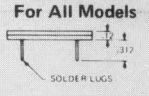
**MECHANICAL DIMENSIONS (INCHES)**

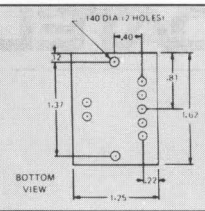



**INPUT/OUTPUT CONNECTIONS**




**Mating Socket MS-6 For All Models**



**THESE AMPLIFIERS ARE COVERED UNDER GSA CONTRACT**

DATEL

## SPECIFICATIONS

**Typical @ 25°C, ±15 VDC, rated load unless otherwise specified.**

| PARAMETER | MODEL AM-100 A | MODEL AM-100 B | MODEL AM-100 C | MODEL AM-101 A | MODEL AM-101 B | MODEL AM-102 A | MODEL AM-102 B | MODEL AM-103 A | MODEL AM-103 B |
|---|---|---|---|---|---|---|---|---|---|
| | HIGH SPEED DIFFERENTIAL FET 400 NANOSEC. SETTLING TIME | | | HIGH SPEED DIFFERENTIAL FET WILL DRIVE 2000pF CAP. LOAD | | HIGH SPEED FET FOLLOWER 45 MHz GAIN BANDWIDTH | | SUPER FAST DIFFERENTIAL FET 400 V/μSEC SLEW RATE | |
| **Input** | | | | | | | | | |
| Differential Voltage, max., no damage | ±15V | | | ±15V | | ±15V | | ±15V | |
| Common Mode Voltage Range | ±10V min. | | | ±10V min. | | ±10V min. | | ±10V min. | |
| Common Mode Rejection Ratio | 10,000 | | | 40,000 | | 40,000 | | 10,000 | |
| Common Mode Resistance | $10^{12}$ Ω min. | | | $10^{12}$ Ω min. | | $10^{12}$ Ω min. | | $10^{12}$ Ω min. | |
| Differential Input Resistance | $10^{12}$ Ω min. | | | $10^{12}$ Ω min. | | $10^{12}$ Ω min. | | $10^{12}$ Ω min. | |
| **Output** | | | | | | | | | |
| Voltage | ±10V min. | | | ±10V min. | | ±10V min. | | ±10V min. | |
| Current, Continuous | ±20mA min. | | | ±20mA min. | | ±20mA min. | | ±20mA min. | |
| Current, Transient | ±30mA | | | ±30mA | | ±30mA | | ±30mA | |
| Capacitive Load | 300 pF | | | 2000pF min. | | 300 pF | | 300 pF | |
| **Gain and Frequency Response** | | | | | | | | | |
| D.C. Gain at Rated Load | 500,000 | | | 500,000 | | 400,000 | | 400,000 | |
| Gain Bandwidth Product | 18 MHz | | | 7 MHz | | 45 MHz | | 45 MHz | |
| Stable Unity Gain Frequency | 18 MHz | | | 7 MHz | | 37 MHz | | 37 MHz | |
| Full Power Response | 900 KHz (1) | | | 900 KHz (1) | | 2 MHz (2) | | 6 MHz (1) | |
| **Transient Response** | | | | | | | | | |
| Slew Rate | 60V/μs. (1) | | | 60V/μs. (1) | | 140V/μs. (2) | | 400V/μs. (1) | |
| Settling Time to 0.01% | 0.4 μs. (1) | | | 1 μs. (1) | | 0.4 μs. (2) | | 0.3 μs. (1) | |
| Settling Time to 0.01% | 0.15 μs. (3) | | | 1.5 μs. (4) | | | | | |
| Overload Recovery Time | 0.5 μs. | | | 1 μs. | | 0.5 μs. | | 0.5 μs. | |
| Rise Time to 90% (Small Signal) | 50 ns. (1) | | | 100 ns. (1) | | 20 ns. (2) | | 20 ns. (1) | |
| **Offset and Noise** | (5) | | | (5) | | (5) | | (5) | |
| Offset Voltage (Initial) @ 25°C | Adj. to 0 | | | Adj. to 0 | | Adj. to 0 | | Adj. to 0 | |
| Vs. Temp. Range -25°C to +85°C, μV/°C | 50 max | 25 max | 10 max | 40 max. | 20 max | 40 max. | 20 max. | 40 max. | 20 max. |
| Vs. Power Supply | ±10μV/% | | | ±10μV/% | | ±10μV/% | | ±10μV/% | |
| Vs. Time | ±50μV/day | | | ±50μV/day | | ±50μV/day | | ±50μV/day | |
| Input Offset Current | ±10pA max. | | | ±10pA max. | | ±10pA max. | | ±10pA max. | |
| Bias Current @ 25°C, pA | 100 max. | 50 max. | 20 max | 50 max. | 20 max | 50 max. | | 50 max. | |
| Vs. Temperature Range -25°C to +85°C | Doubles every 10°C | | | Doubles every 10°C | | Doubles every 10°C | | Doubles every 10°C | |
| Input Noise (Voltage) | 25nV $\sqrt{Hz}$ | | | 25nV $\sqrt{Hz}$ | | 25nV $\sqrt{Hz}$ | | 25nV $\sqrt{Hz}$ | |
| **Power Requirements** | | | | | | | | | |
| Operating Voltage Range | ±15V | | | ±15V | | ±15V | | ±15V | |
| Quiescent Current | ±13mA max. | | | ±13mA max. | | ±18mA max. | | ±18mA max. | |
| **Temperature Range** | | | | | | | | | |
| Operating | -25 to +85°C | | | -25 to +85°C | | -25 to +85°C | | -25 to +85°C | |
| Storage | -55 to +125°C | | | -55 to +125°C | | -55 to +125°C | | -55 to +125°C | |
| CASE SIZE | 1.12"L x 1.12"W x 0.4"H | | | 1.12"L x 1.12"W x 0.4"H | | 1.12"L x 1.12"W x 0.4"H | | 1.12"L x 1.12"W x 0.4"H | |
| Mating Socket | MS-6 $3.50 ea. | | | MS-6 $3.50 ea. | | MS-6 $3.50 ea. | | MS-6 $3.50 ea. | |
| Price 1-9 | $40 | $45 | $52 | $46 | $52 | $49 | $55 | $49 | $55 |

**NOTES:** (1) Unity gain inverting. (2) As Follower. (3) Unity gain inverting 0.5 volt step. (4) Unity gain inverting with 1000pF capacitive load (5) Ext. balance pot, Model TP-1K – $3.00

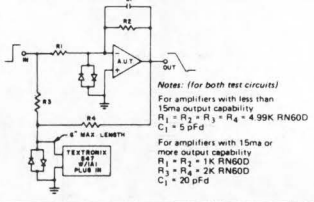
### SETTLING TIME

Settling time is one of the most important requirements an amplifier should meet for high speed applications. It is defined as the time that is required, after a full scale input step is applied, for the output voltage to reach a predetermined percentage of its final value. Settling time contributes a dynamic error. It characterizes the transient behavior of the amplifier, encompassing slew rate and other important effects. For high speed data system applications, the output signal should be within a specified error band before it is ready to be further processed. In all applications involving abrupt changes in gradient, the settling characteristics of an amplifier determine how long the output signal deviates from the true value and should be a prime consideration for its selection.

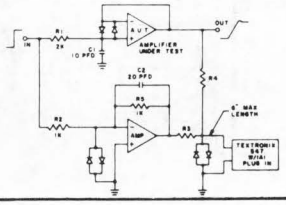
Settling time is a complex function of the open loop response and slewing rate under operating conditions. For optimum settling characteristics, the DATEL amplifiers have true 6 dB/octave stabilization determined by a single component instead of the usual multielement response shaping which introduces irregularities in the response curve.

Test circuits for measuring a settling time in both the inverting and non-inverting modes are shown. The test circuits are self explanatory but it is wise to keep the leads short, stray capacitance to a minimum and use a signal source that is a good clean squarewave with minimum aberrations. The oscilloscope and plug-in recommended in the test circuit will, in general, give good results on amplifiers with settling times of 1 microsecond or less. Many oscilloscopes of other types will introduce errors far in excess of the amplifier errors due to the overload condition to which they are subjected by this method of measurement.

**SETTLING TIME TEST CIRCUIT FOR INVERTING AMPLIFIERS**




**SETTLING TIME TEST CIRCUIT FOR NON-INVERTING AMPLIFIERS**



DATEL SYSTEMS, INC.
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# HIGH SPEED MONOLITHIC OPERATIONAL AMPLIFIERS

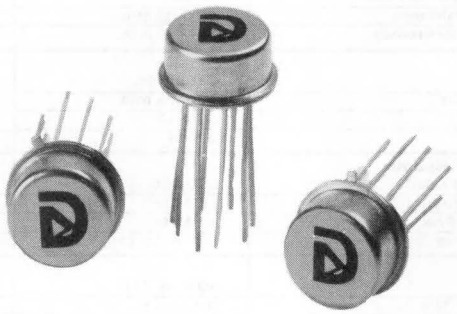
# AM-400 SERIES

## FEATURES

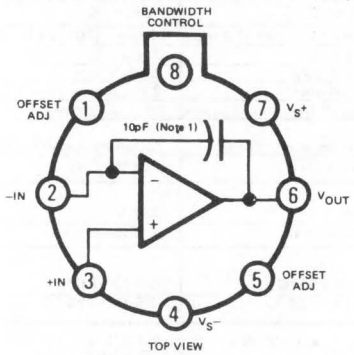
- 120 V/$\mu$Sec Slew Rate
- 2 MHz Full Power Bandwidth
- 200n Sec Settling to 0.1% of FS
- $10^{12}$ $\Omega$ Input Impedance
- FET or Bipolar Differential Input

## GENERAL DESCRIPTION

Datel's AM-400 Series operational amplifiers are designed specifically for fast acquisition of wide bandwidth signals. They feature high input impedance ($10^{12}$ Ohms, AM-405 and AM-406) and high full power bandwidth (2MHz, AM-405). Models AM-405 and AM-406 feature FET differential inputs and the remaining models employ bipolar differential inputs. Settling time less than 200 nsec (within 0.1% of FS, AM-452) and slew rates up to 120V/$\mu$sec (AM-452) are available and all models may be operated in non-inverting as well as inverting configurations. Because of their superior high speed, high input impedance characteristics, these devices are ideal for applications such as fast acquisition sample and hold amplifiers, D/A and A/D converter amplifiers.



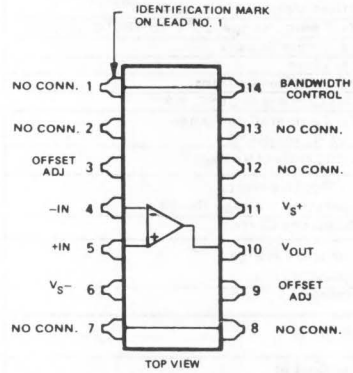
## BLOCK DIAGRAM AND INPUT/OUTPUT CONNECTIONS




**TO–99 PACKAGE**

Models AM-405-2, AM-406-2, AM-452-2, AM-462-2

Note (1) Internal feedback capacitor provided on models AM-405 and AM-406 only to cancel input capacitance phase shift.




**TO–116 PACKAGE**

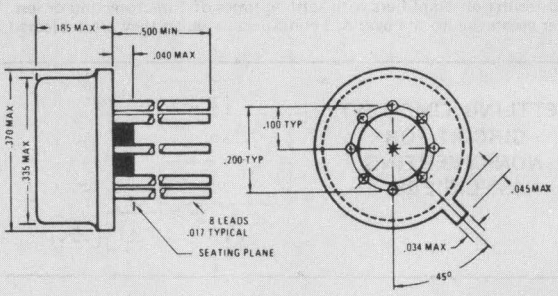
Model AM-462-1 Only.

## MECHANICAL DIMENSIONS (INCHES)

### JEDEC TO–99

8-Pin Metal Can Package

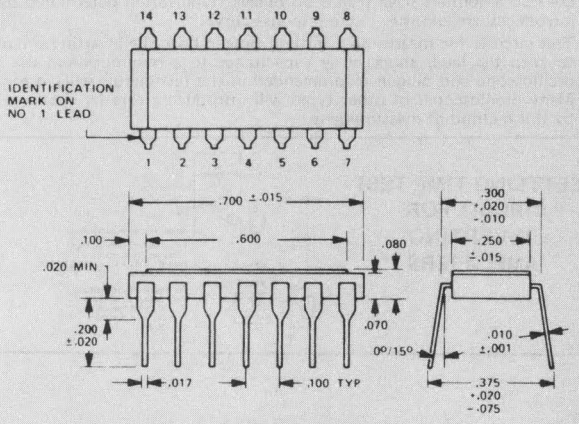
MODELS AM-405-2, AM-406-2, AM-452-2, AM-462-2




Note 1: All leads gold plated KOVAR

### JEDEC TO–116

14-Pin Dual Inline Ceramic Package
Model AM-462-1 Only




Note 1: All leads and base gold plated KOVAR

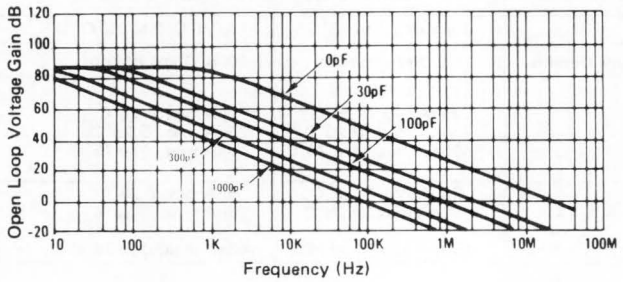
| SPECIFICATIONS | MODEL AM-405-2 | MODEL AM-406-2 | MODEL AM-452-2 | MODEL AM-462-1, AM-462-2 |
|---|---|---|---|---|
| **Typical @ 25°C $V_S$ = ±15VDC $R_L$ = 2K Ohms unless otherwise noted** | Differential FET input, 2MHz Full Power Bandwidth | Differential FET input 150 K DC Gain 100 MHz $f_t$ | Differential Bipolar input 200 nsec settling Slew 120 V/μsec | Differential olar Bipolar input 150 K DC Gain 100 MHz $f_t$ |
| Input Characteristics | | | | |
| **Differential Voltage** | ±15V max. | ±12V max. | ±15V max. | ±12V max. |
| **Common Mode Voltage Operating Range** | ±10V min. | ±10V min. | ±10V min. | ±11V min. |
| **Common Mode Rejection Ratio ($V_{CM}$ = ±5VDC)** | 90 db typ.<br>70 db min. | 90 db typ.<br>70 db min. | 90 db typ.<br>74 db min. | 100 db typ.<br>74 db min. |
| **Input Impedance (Differential)** | $10^{12}$ Ohms ‖ 5pF | $10^{12}$ Ohms ‖ 5pF | 100 MegOhms typ.<br>40 MegOhms min. | 300 MegOhms typ.<br>40 MegOhms min. |
| **Voltage Offset Initial (without external trim. Adjustable to zero with trim)** | 30mV typ. @ 25°C<br>60mV max. @ 25°C<br>65mV max, 0 to 75°C | 15mV typ. @ 25°C<br>60mV max. @ 25°C<br>65mV max, 0 to 75°C | 5mV typ. @ 25°C<br>10mV max. @ 25°C<br>14mV max, 0 to 75°C | 3mV typ. @ 25°C<br>5mV max. @ 25°C<br>7mV max, 0 to 75°C |
| **Voltage Offset vs. Temp** | – | – | 30μV/°C, 0 to 75°C | 15μV/°C, 0 to 75°C |
| **Zero Adjust (optional)** | 100K Ohms trimpot | 100K Ohms trimpot | 20K Ohms trimpot | 100K Ohms trimpot |
| **Bias Current** $= \left\lvert \frac{I^+ + I^-}{2} \right\rvert$ | 1pA typ. @ 25°C<br>20pA max. @ 25°C<br>20pA typ, 0 to 75°C<br>1nA max, 0 to 75°C | | 125nA typ. @ 25°C<br>250nA max. @ 25°C<br>500nA max, 0 to 75°C<br>– | 5nA typ. @ 25°C<br>25nA max. @ 25°C<br>40nA max, 0 to 75°C<br>– |
| **Offset Current** $= \lvert I^+ - I^- \rvert$ | 0.5pA typ. @ 25°C<br>20pA max. @ 25°C<br>5pA typ, 0 to 75°C<br>500pA max, 0 to 75°C | | 20nA typ. @ 25°C<br>50nA max. @ 25°C<br>–<br>100nA max, 0 to 75°C | 5nA typ. @ 25°C<br>25nA max. @ 25°C<br>–<br>40nA max, 0 to 75°C |
| **Equivalent Input Noise (10Hz to 10KHz, zero source impedance)** | 10 μV rms | | 2 μV rms | |
| Output Characteristics | | | | |
| **Voltage (Full Temperature Range)** | ±10V min. | | | |
| **Current, Continuous ($V_{OUT}$ = ±10V)** | ±10mA min. | | | |
| **Current, Peak** | 50mA max. | Short circuit protected (output to common) current limited | 50mA max. | Short circuit protected (output to common) current limited |
| Gain and Frequency Response | | | | |
| **Open loop gain, DC $V_{OUT}$ = ±10V** | 15K V/V typ.<br>7.5K V/V min. | 150K V/V typ.<br>80K V/V min. | 15K V/V typ.<br>7.5K V/V min. | 150K V/V typ.<br>80K V/V min. |
| **Full Power Bandwidth** | 2MHz typ.<br>– | 600KHz typ.<br>– | 1.6MHz typ.<br>1.2MHz min. | 600KHz typ.<br>320KHz min. |
| **Slew Rate ($V_{OUT}$ = ±10 Volt step transition, $C_L$ = 50pF)** | 120V/μsec typ.<br>– | 35V/μsec typ.<br>– | 120V/μsec typ.<br>80V/μsec min. | 35V/μsec typ.<br>20V/μsec min. |
| **Unity Gain, small signal** | 20MHz (closed loop gain > 10 | 100MHz (closed loop gain > 10) | 20MHz (closed loop gain > 10) | 100MHz (closed loop gain = 100, $C_L$ = 50pF) |
| **Stability** | Ext. comp. required at closed loop gain <3 | Ext. comp. required at closed loop gain <5 | Ext. comp. required at closed loop gain <3 | Ext. comp. required at closed loop gain <5 |
| **Settling time to within 0.1% ($V_{OUT}$ = ±10V step, $C_L$ = 50 pF, $A_v$ = +3)** | 400 nsec | – | 200 nsec | |
| Power Supply | | | | |
| **Operating Voltage** | ±15VDC, rated specifications | | | |
| **Max. Voltage Difference between $V_S$+ and $V_S$– Terminals** | 35V max | | 40V max | 45V max |
| **Absolute Max. Internal Power Dissipation** | 300mW | | | |
| **Quiescent Current** | 6mA typ.<br>8mA max. | 4mA typ.<br>6mA max. | 4mA typ.<br>6mA max. | 3mA typ.<br>4mA max. |
| Temperature Range | | | | |
| **Operating, rated specs.** | 0°C to 75°C | | | |
| **Storage** | –65°C to +150°C | | | |
| **Package** | TO-99 | TO-99 | TO-99 | AM-462-1 TO-116<br>AM-462-2 TO-99 |
| **Price (1-9) Contact factory for quantity pricing** | $16.00 | $13.75 | $10.50 | $ 9.00 |

## Open Loop Frequency Response and External Bandwidth Compensation

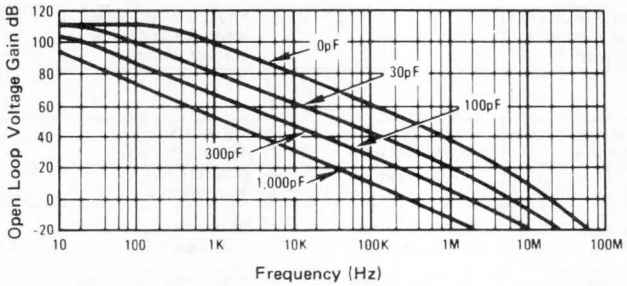
**(25°C, $R_L$ = 2KΩ, $V_S$ = ±15V, small signal)**

(Values of capacitance shown are to be connected between the bandwidth terminal and ground.)

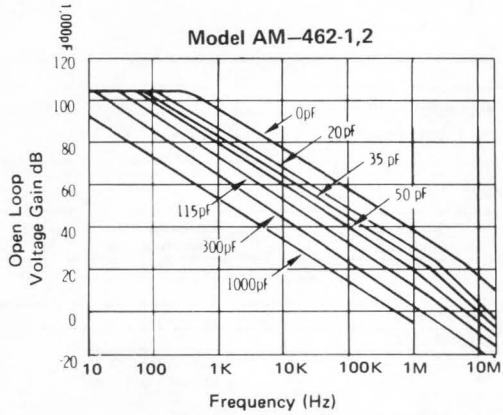
### Models AM–405-2 and AM–452-2




### Model AM–406-2

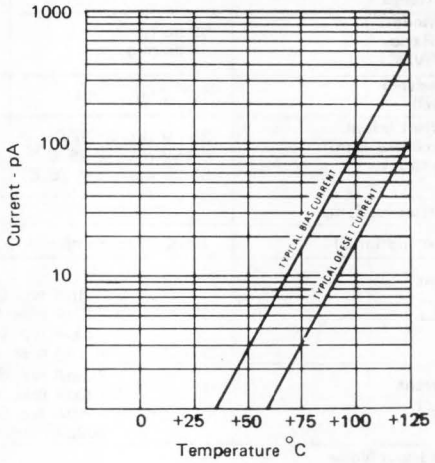



### Model AM–462-1,2

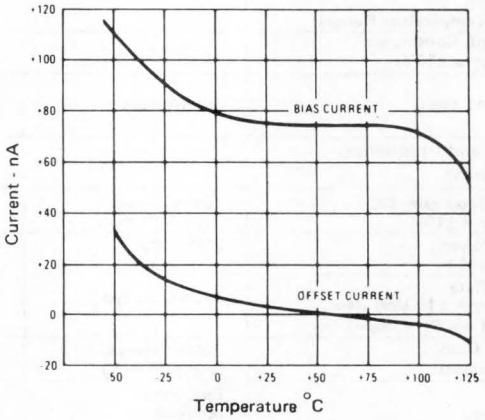



## Input Bias and Offset Current Vs. Temp ($V_S$ = ±15V)

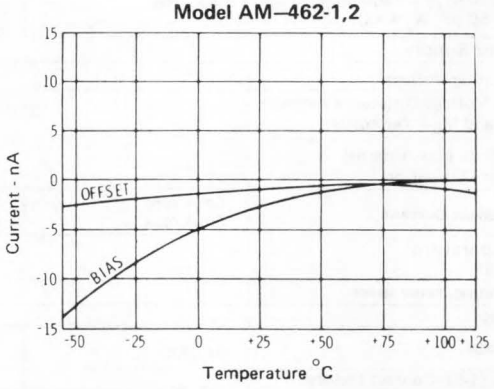
### Models AM–405-2 and AM–406-2




### Model AM–452-2




### Model AM–462-1,2

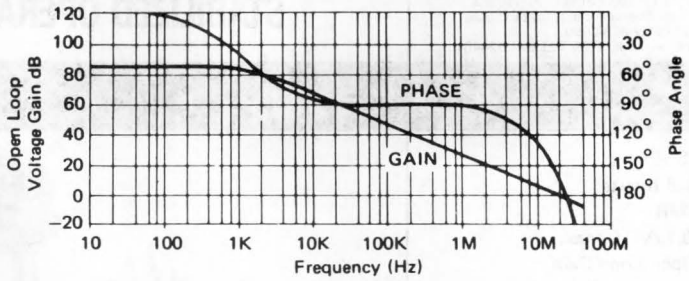


## TYPICAL OPEN LOOP FREQUENCY AND PHASE RESPONSE

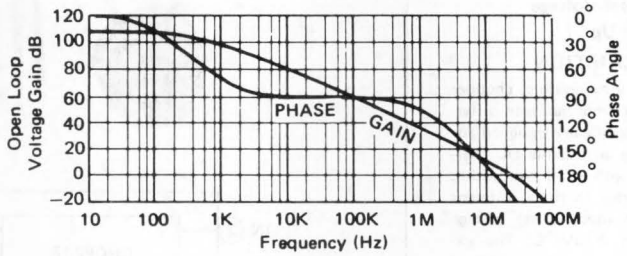
(25°C, $V_S$ = ±15VDC, Small Signal, Rated Load)

Model AM-405-2

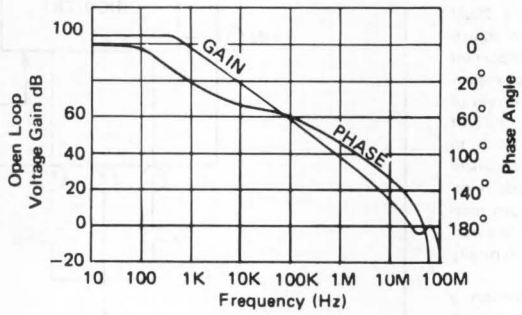
Model AM-452-2



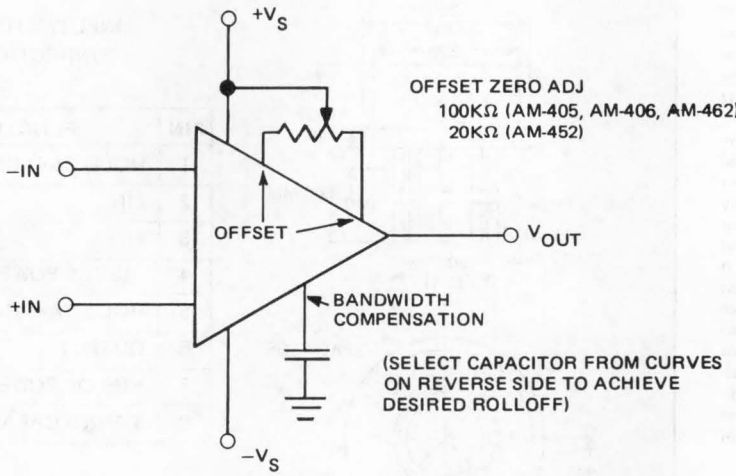

Model AM-406-2




Model AM-462-1, 2




## EXTERNAL OFFSET ADJUSTMENT AND BANDWIDTH COMPENSATION (All Models)

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DATEL SYSTEMS, INC.
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TWX: 710-348-0135 TELEX: 924461

# MONOLITHIC, DIFFERENTIAL INPUT, CHOPPER STABILIZED OPERATIONAL AMPLIFIER

# MODEL AM-490-2

## FEATURES

- ▶ Differential Inputs
- ▶ 120 dB CMR
- ▶ Drift to 0.1μV/°C max.
- ▶ 5 x $10^8$ Open Loop Gain
- ▶ 20μV Input Offset Voltage
- ▶ 200 msec. Warm-Up

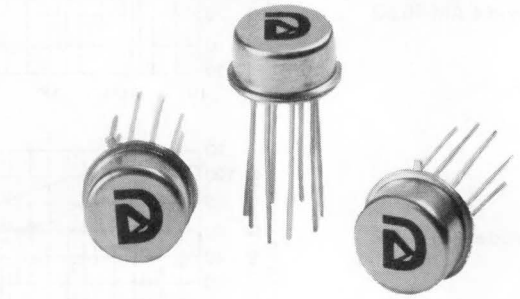
## GENERAL DESCRIPTION

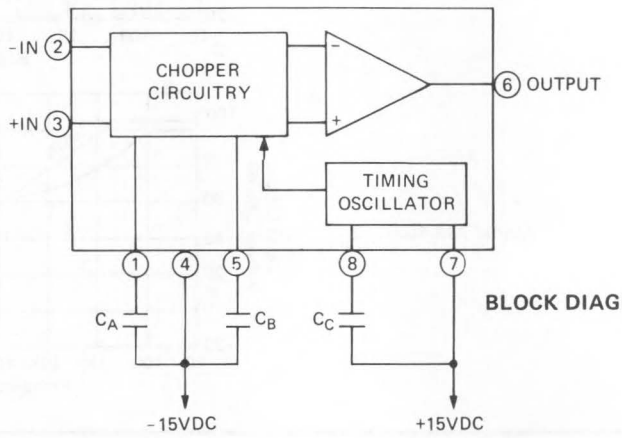
Model AM-490-2 is a monolithic, chopper stabilized operational amplifier with differential inputs; it is specifically designed for applications requiring ultra-stable DC characteristics together with good bandwidth. This device is available in three different grades of maximum input offset voltage drift: 1.0, 0.3, and 0.1μV/°C. The extremely low input offset voltage drift and initial input offset voltage of only 20μV eliminate the requirement for zero adjustment in most applications. Other important input characteristics include an input impedance of 100 megohms, input bias current of 150pA, and input offset current drift of 1pA/°C. This permits the AM-490-2 to operate accurately with source impedances over 100 kilohms. A common mode rejection of 120 dB minimum and open loop gain of 5 x $10^8$ result in extremely low output errors. Long term stability is typically 5μV per year.

The circuit of the AM-490-2 utilizes a complex monolithic chip 93 x 123 mils with 256 active devices. Both bipolar and N channel MOS FET's are used to implement the linear and switching portions of the circuitry. The chopper circuitry utilizes two DC coupled sample-hold circuits driven by a multivibrator circuit. The DC coupling, contrasted with AC coupling commonly used in chopper amplifiers, results in fast overload recovery. Three external capacitors are required for the sample-hold circuits and the multivibrator which generates a 750 Hz chopping square wave.

Other specifications of the AM-490-2 include ±10V input common mode range and ±10V output at 7mA which is short circuit protected. The operating power supply range is ±12V to ±20VDC with a constant quiescent current drain of 3.5mA typical over this range. Power supply rejection is 120 dB. The low power drain and fast warm-up time of 200 msec. make this device ideal for use in battery operated, interrupted service circuits. Other applications include inverting, noninverting, and balanced gain amplifier configurations in addition to very accurate integrators and sample-holds. The AM-490-2 is packaged in a hermetically sealed, 8 pin TO-99 case.

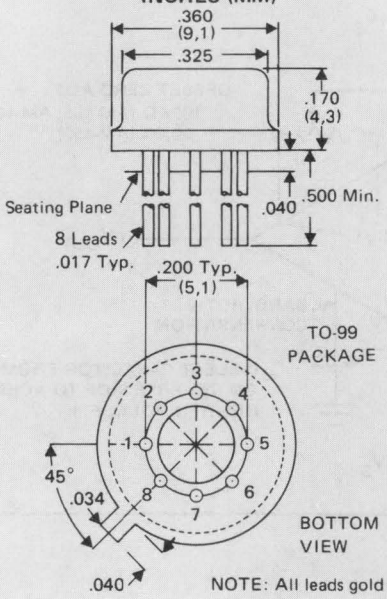
CAUTION: The AM-490-2 has MOS FET input devices and should be handled carefully to prevent static charge pick-up which might damage the devices. The amplifiers should be kept in the shipping carriers until ready for installation.






BLOCK DIAGRAM

## MECHANICAL DIMENSIONS INCHES (MM)




NOTE: All leads gold plated KOVAR

## INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | HOLD CAPACITOR ($C_A$) |
| 2 | -IN |
| 3 | +IN |
| 4 | -15VDC POWER |
| 5 | HOLD CAPACITOR ($C_B$) |
| 6 | OUTPUT |
| 7 | +15VDC POWER |
| 8 | TIMING CAPACITOR ($C_C$) |

## SPECIFICATIONS, AM-490-2

**(Typical at 25°C, ±15V supplies and $C_A = C_B = 0.1\mu F$, $C_C = .0015\mu F$ unless otherwise noted)**

| | A | B | C |
|---|---|---|---|
| **INPUT CHARACTERISTICS** | | | |
| Common Mode Voltage Range | ±10V min. | | |
| Maximum Diff. Input Voltage, no damage | ±Vs | | |
| Input Impedance, diff. or com. mode | 100 megohms | | |
| Input Capacitance | 10pF | | |
| Input Bias Current | 150pA | | |
| Input Offset Current | 50pA | | |
| Input Offset Voltage | ±20μV | | |
| **OUTPUT CHARACTERISTICS** | | | |
| Output Voltage | ±10V min. | | |
| Output Current, S.C. protected | ±7mA min. | | |
| Output Resistance | 200 ohms | | |
| Stable Capacitive Load | 1000pF | | |
| **PERFORMANCE** | | | |
| DC Open Loop Gain, 2K load | $5 \times 10^8$ | | |
| Common Mode Rejection, DC, ±5V | 120 dB min. | | |
| Warm-Up Time | 200 msec. | | |
| **DRIFT AND NOISE** | | | |
| Input Offset Voltage Drift, μV/°C max. | 1.0 | 0.3 | 0.1 |
| Input Offset Current Drift | ±1pA/°C | | |
| Input Voltage Noise, .01 to 10 Hz | 13μV P-P | | |
| Input Voltage Noise, 10 Hz to 10 kHz | 33μV RMS | | |
| Input Current Noise, .01 to 10 Hz | 8pA RMS | | |
| Input Current Noise, 10 Hz to 10 kHz | 700pA RMS | | |
| Chopper Voltage Noise, RTI, 100K unbal. | 200μV P-P | | |
| Power Supply Rejection | 120 dB min. | | |
| Long Term Stability | ±5μV/year | | |
| **DYNAMIC CHARACTERISTICS** | | | |
| Gain Bandwidth Product | 3 MHz | | |
| Rise Time, small signal, 10%–90%[1] | 200 nsec. | | |
| Slew Rate | 2.5V/μsec. | | |
| Full Power Frequency | 40 kHz | | |
| Overload Recovery Time | 200 msec. | | |
| **POWER REQUIREMENT** | | | |
| Voltage, rated performance | ±15VDC, ±0.5V | | |
| Voltage, operating | ±12V to ±20VDC[2] | | |
| Current, quiescent | 3.5mA typ., 5mA max. | | |
| **PHYSICAL-ENVIRONMENTAL** | | | |
| Operating Temperature Range | 0°C to 70°C | | |
| Storage Temperature Range | –65°C to +150°C | | |
| Package, hermetically sealed | TO-99 | | |
| **PRICE (1-9)** | $29 | $34 | $39 |

1. Connected as voltage follower.
2. Input common mode range and output range are ±7V to ±15V.

### ORDERING INFORMATION

**PRICES (1-9)**

| | | |
|---|---|---|
| AM-490-2A | 1.0μV/°C max. | $29.00 |
| AM-490-2B | 0.3μV/°C max. | $34.00 |
| AM-490-2C | 0.1μV/°C max. | $39.00 |

**AM-490-CK1 CAPACITOR KIT** $4.50

Consists of 3 miniature metallized polycarbonate capacitors for $C_A$, $C_B$, and $C_C$:

2 ea. 0.1μF ±10% (.203"D x .438"L)
1 ea. .0015μF ±10% (.156"D x .438"L)

THESE AMPLIFIERS ARE COVERED BY GSA CONTRACT.

## TECHNICAL NOTES

1. Three external capacitors are required for operation of the AM-490-2. One of these, $C_C$ (.0015 μF) is used to set the timing oscillator to give a chopper frequency of 750 Hz; the other two, $C_A$ and $C_B$ (both 0.1μF), are used as holding capacitors for the direct coupled internal sample-holds. All three of these capacitors should have good temperature stability, low leakage, and low dielectric absorption. Polystyrene, teflon or polycarbonate types are recommended. As a convenience, the capacitors are available as a kit of three miniature metallized polycarbonate types; the AM-490-CK1 capacitor kit is priced at $4.50.

2. In most requirements the AM-490-2 eliminates the need for a zeroing adjustment. Typical input offset voltage is only ±20μV while the maximum is only ±80μV over the operating temperature range. In cases where zeroing is still necessary, however, there are two methods shown in the application diagrams. In the inverting mode where the negative summing junction is at virtual ground, the zeroing can be accomplished by injecting an offset current into the summing junction by means of a high value resistor connected to a potentiometer. (See "Precision Integrator" diagram). In all other cases, zeroing is accomplished by means of a voltage divider connection to the positive input terminal. (See "Differential Amplifier Connection").

3. The superior input offset voltage drift (1.0, 0.3 or 0.1μV/°C max.) and input offset current drift (1pA/°C) of this amplifier permit it, when properly applied, to resolve microvolt and picoampere level signals. To successfully amplify these very low level signals, it is necessary to use great care in circuit layout and assembly with particular attention given to proper grounding and shielding. Other potential error sources include leakage, thermal environment, and thermocouple effects.

4. The highest practical input impedance which can be used with the AM-490-2 is determined by the point where input offset current drift and input offset voltage drift produce equal errors. Thus:

$$R_{MAX} = \frac{\Delta Eos/\Delta T}{\Delta Ios/\Delta T}$$

Where $R_{MAX}$ is the maximum practicable input resistance seen by either input terminal of the amplifier. This comes out to 1 megohm for the A version, 300 kilohms for the B version, and 100 kilohms for the C version.

5. The amplifier input terminals are differential and symmetrical; for best results the

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impedance to ground seen by each input terminal should be equal. Matched impedance (resistance and capacitance) as shown in the application diagrams result in minimum output offset drift due to bias currents and also minimum output chopper noise. Chopper noise appears as a common mode input current signal, and under balanced conditions of both resistance and capacitance this noise can be minimized to less than random noise at the output.

6. The AM-490-2 is dynamically stable with 100% feedback (unity gain follower) and 1000pF capacitive load. In very high closed loop gain configurations (>70 dB), it may become desirable to put a capacitor in parallel with the feedback resistor for better stability. This should be done to yield a gain-bandwidth product of 2MHz (RC=80 μsec.) to insure absolute stability. In general, the closed loop bandwidth should be limited to that necessary to pass the required signal frequency components only; this results in minimum output noise. Minimum bandwidth should also be used to eliminate small modulation effects of input signal frequencies near the chopper frequency (750 Hz).

7. Other features of these amplifiers include an exceptionally high open loop gain of 5 x $10^5$. For an output voltage swing of ±10V, this reduces the input error due to gain to only ± 20 nanovolts. Common mode rejection is very high (120 dB minimum) at DC, but falls off rapidly with frequency as shown in the graph under Performance Parameters. CMR is typically greater than 100 dB at 10 Hz. For best common mode rejection, therefore, the signal frequency should be limited to about 10 Hz. The noise performance of the amplifier can be readily computed from the two noise graphs shown under Performance Parameters.

8. The AM-490-2 amplifiers draw a quiescent current of only 3.5mA typical and 5mA maximum; the current is virtually constant over the operating power supply range of ±12V to ±20V. Bandwidth and slew rate change only slightly over this range as shown in the graph "Normalized AC Parameters vs. Power Supply". For the ±12V to ±20V supply range input common mode voltage range and output voltage range become ±7V to ±15V. The wide supply range together with the fast warm-up time of only 200 msec. make the AM-490-2 an excellent amplifier for precision, low power, interrupted supply operation in portable and remote instrumentation systems.

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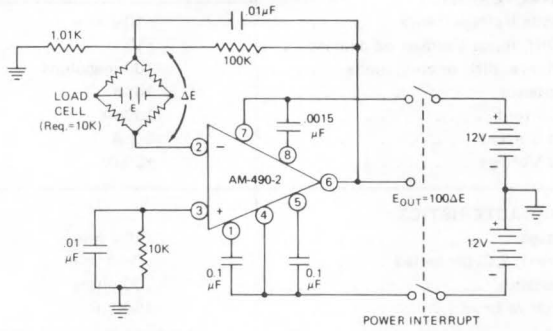
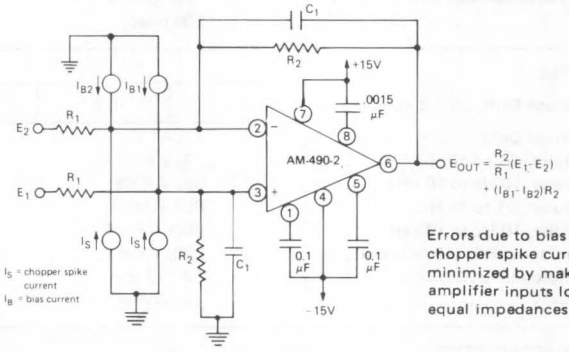
## BATTERY POWERED LOAD CELL AMPLIFIER FOR DISCONTINUOUS SERVICE



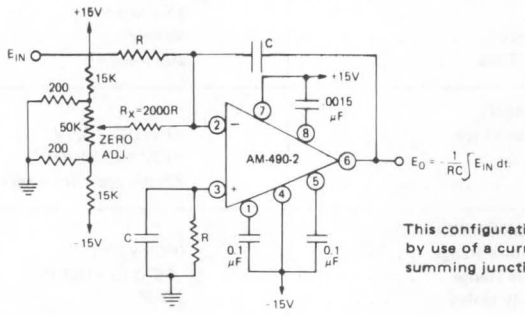

For power interrupt applications the amplifier has a warm-up time of only 200 msec.

## INPUT OFFSET CURRENT AND CHOPPER NOISE CONSIDERATIONS



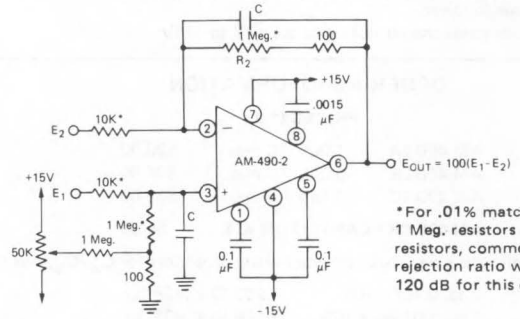

Errors due to bias current and chopper spike current are minimized by making both amplifier inputs look back into equal impedances to ground.

## PRECISION INTEGRATOR




This configuration shows zeroing by use of a current into the summing junction.

## DIFFERENTIAL AMPLIFIER CONNECTION

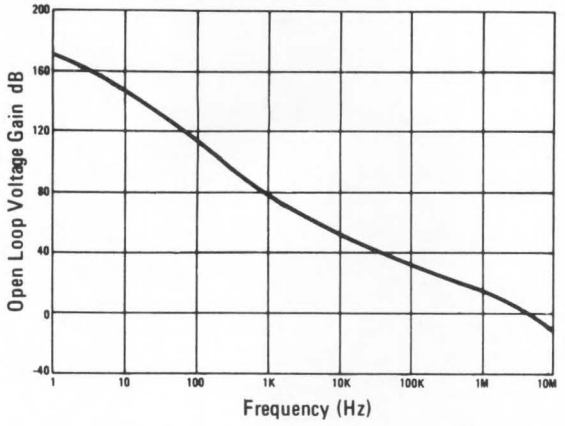



*For .01% match between 1 Meg. resistors and 10K resistors, common mode rejection ratio will be approx. 120 dB for this circuit.

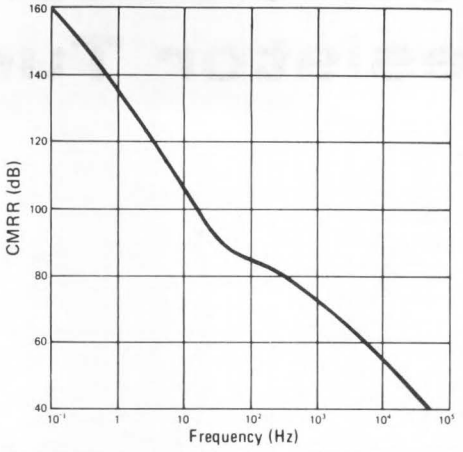
Capacitors C are used only to reduce bandwidth and hence output noise.

## PERFORMANCE PARAMETERS (Typical at 25°C, ±15VDC unless otherwise noted)

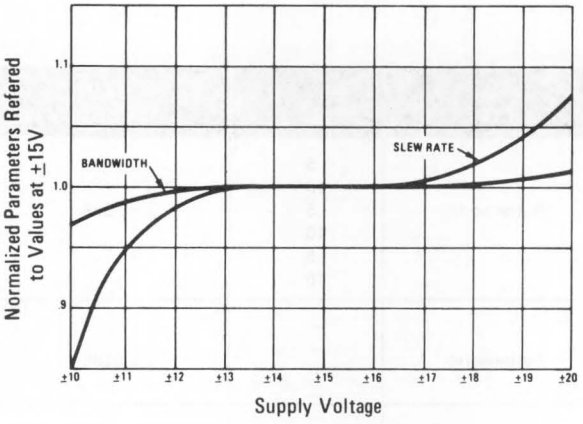
### OPEN LOOP FREQUENCY RESPONSE



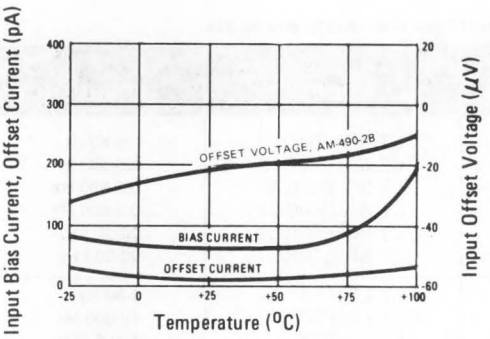

### COMMON MODE REJECTION VS. FREQUENCY (TYPICAL)



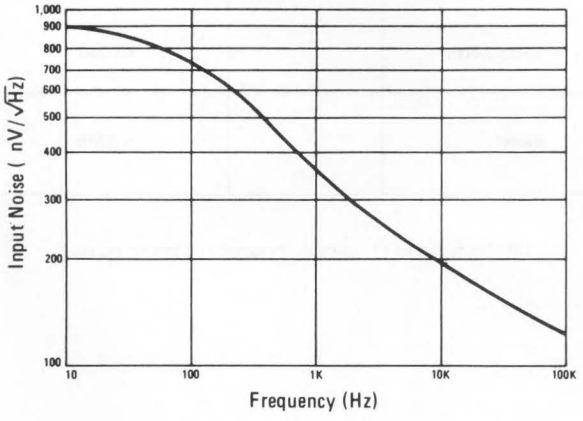

### NORMALIZED AC PARAMETERS VS. POWER SUPPLY



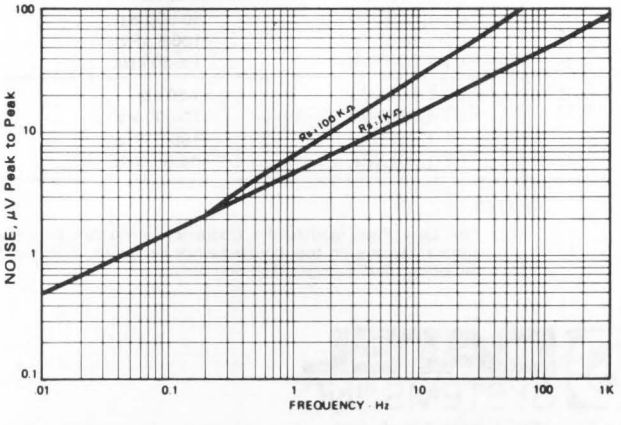

### TYPICAL INPUT DRIFT CHARACTERISTICS VS. TEMPERATURE




### INPUT VOLTAGE NOISE




### EQUIVALENT INPUT NOISE VS. CLOSED LOOP BANDWIDTH



# Active Filters: Resistor Tuned

**GSA Special Item Nos. 66-31a and 66-31b**

| | MODEL | FREQUENCY (1) | TYPE | Q | GAIN ACCURACY (2) |
|---|---|---|---|---|---|
| 4 POLE BAND PASS | FLT-BP4B50Q5 | .05-50 Hz | Butterworth | 5 | ±0.3dB |
| | FLT-BP4B50Q10 | .05-50 Hz | | 10 | |
| | FLT-BP4B500Q5 | 0.5-500 Hz | | 5 | |
| | FLT-BP4B500Q10 | 0.5-500 Hz | | 10 | |
| | FLT-BP4B20KQ5 | 20-20 kHz | | 5 | |
| | FLT-BP4B20KQ10 | 20-20 kHz | | 10 | |
| 4 POLE LOW PASS | FLT-LP4B50 | 1-50 Hz | Butterworth | – | ±.02dB |
| | FLT-LP4B500 | 10-500 Hz | | – | |
| | FLT-LP4B5K | 100-5 kHz | | – | |
| | FLT-LP4B50K | 1 k-50 kHz | | – | |
| | FLT-LP4L50 | 1-50 Hz | Bessel | – | ±.02dB |
| | FLT-LP4L500 | 10-500 Hz | | – | |
| | FLT-LP4L5K | 100-5 kHz | | – | |
| | FLT-LP4L50K | 1 k-50 kHz | | – | |
| 6 POLE LOW PASS | FLT-LP6B50 | 1-50 Hz | Butterworth | – | ±.02dB |
| | FLT-LP5B500 | 10-500 Hz | | – | |
| | FLT-LP6B5K | 100-5 kHz | | – | |
| | FLT-LP6B50K | 1 k-50 kHz | | – | |
| | FLT-LP6L50 | 1-50 Hz | Bessel | – | ±.02dB |
| | FLT-LP6L500 | 10-500 Hz | | – | |
| | FLT-LP6L5K | 100-5 kHz | | – | |
| | FLT-LP6L50K | 1k-50 kHz | | – | |

**NOTES:**

(1) For Low Pass models the frequency range can be extended another decade on the low frequency side with an increase by a factor of 10 of voltage offset and drift.

(2) For a gain of +1, using no external gain setting resistors.

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## GENERAL SPECIFICATIONS FOR ALL FILTERS:

**Accuracy of Center or Cutoff Frequency** ..... ±3% (using 1% tuning resistors)
**Input Voltage Range** ..... ±10V
**Offset Voltage (adj. to zero)** .. ±2mV
**Output Voltage Range** ..... ±10V
**Output Current (S.C. prot. to ground)** .... ±2mA
**Output Impedance** ..... 1 ohm
**Temperature Range, Operating** 0°C to 70°C
**Socket** ..... MS-12 ($5.00 each)

## TUNING RESISTOR FORMULA:

$$R = 2\left[\frac{f_0\ (max.)}{f_0} - 1\right]$$

R is in kilohms

$f_0$ is center frequency for Band Pass models or cutoff frequency for Low Pass models.

$f_0$ (max.) is the maximum specified frequency for the model chosen.


| INPUT IMPEDANCE | FREQUENCY DRIFT | OFFSET DRIFT | POWER REQUIREMENT | CASE SIZE | PRICE (1-9) |
|---|---|---|---|---|---|
| 100K ohms | ±.03%/°C | ±20μV/°C | ±15VDC @ 16mA | 2.0"×3.0"×0.99" | $109.00<br>$109.00 |
| | | | | 2.0"×3.0"×.605" | $ 99.00<br>$ 99.00<br>$109.00<br>$109.00 |
| 100K ohms | ±.05%/°C | ±50μV/°C | ±15VDC @ 22mA | 1.37"×2.87"×0.99" | $ 79.00<br>$ 79.00<br>$ 79.00<br>$ 79.00 |
| 100K ohms | ±.05%/°C | ±50μV/°C | ±15VDC @ 22mA | 1.37"×2.87"×0.99" | $ 79.00<br>$ 79.00<br>$ 79.00<br>$ 79.00 |
| $10^9$ ohms | ±.05%/°C | ±75μV/°C | ±15VDC @ 28mA | 2.0"×3.0"×0.99"<br>1.37"×2.87"×0.99"<br>1.37"×2.87"×0.99"<br>1.37"×2.87"×0.99" | $109.00<br>$109.00<br>$109.00<br>$109.00 |
| $10^9$ ohms | ±.05%/°C | ±75μV/°C | ±15VDC @ 28mA | 2.0"×3.0"×0.99"<br>1.37"×2.87"×0.99"<br>1.37"×2.87"×0.99"<br>1.37"×2.87"×0.99" | $109.00<br>$109.00<br>$109.00<br>$109.00 |

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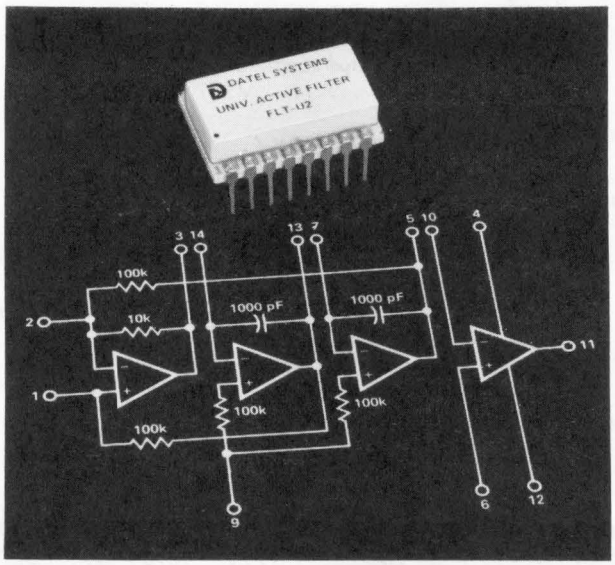
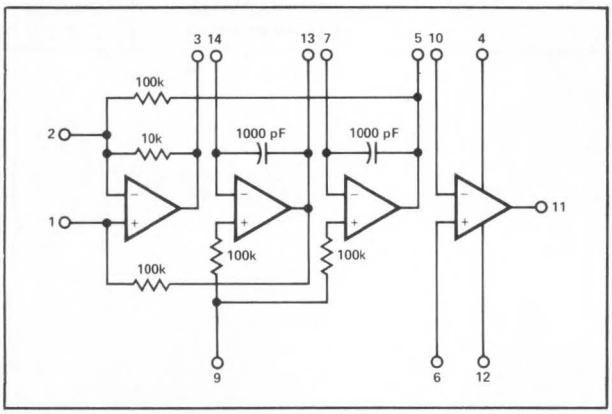
# Universal Active Filter




## DESCRIPTION

Datel Systems' model FLT-U2 is a universal-type active filter manufactured with hybrid technology. It uses the state variable active filter principle implemented with three committed op amps, resistors and capacitors, and a fourth uncommitted op amp which can be used to provide summing, buffering, gain, or an additional pole. The filter provides 2 pole lowpass, highpass, and bandpass functions simultaneously in addition to use in phase correction and notch circuits. The filter is tuned by 4 external resistors which set the gain, center frequency and Q of the circuit.

The Q range is up to 1000 and resonant frequency range is up to 200 kHz. Resonant frequency accuracy is typically ±5% and frequency stability is 100ppm/°C. The units are packaged in a 16 pin double spaced ceramic DIP.




## SPECIFICATIONS (Typical at 25°C, ±15V supplies)

| | |
|---|---|
| Frequency Range | .001 to 200 kHz |
| Q Range | 0.1 to 1000 |
| $f_0$ Accuracy | ±5% |
| $f_0$ Tempco | 100ppm/°C |
| Voltage Gain | 0.1 to 1000 |
| Output Voltage Range | ±10V |
| Output Voltage | ±10 mA |
| Amplifier Gain Bandwidth Prod. | 3 MHz |
| **Input Offset Voltage** | ±6 mV max. |
| Amp. Voltage Gain | 300,000 |
| Input Offset Current | 200 nA max. |
| Input Bias Current | 500 nA max. |
| Output Slew Rate | 1 V/μsec. |
| Power Supply, rated | ±15 VDC |
| Power Supply Range | ±5 to ±18 VDC |
| Quiescent Current | 9 mA |
| Operating Temperature Range | 0°C to 70°C |
| Package | 16 pin double DIP |
| Price (1-9) | $16.00 |

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# UNIVERSAL VOLTAGE TO FREQUENCY AND FREQUENCY TO VOLTAGE CONVERTER

## VFV SERIES

### FEATURES

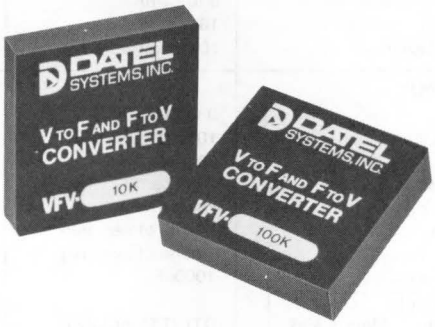
- Linearity to .005%
- V or I Input
- V/F or F/V Conversion
- 10kHz or 100kHz FS
- DTL/TTL or CMOS Output

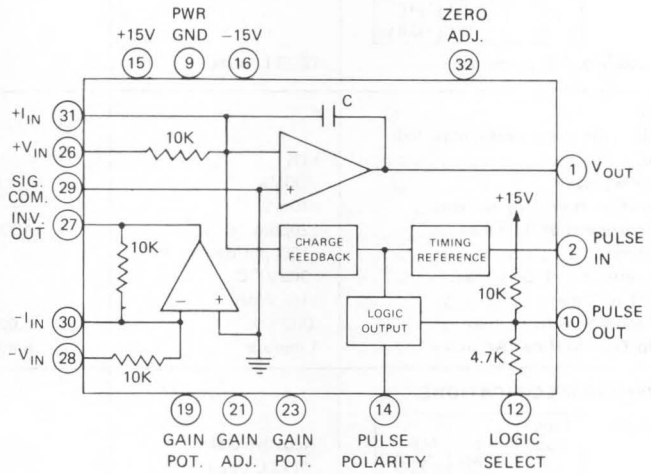
### GENERAL DESCRIPTION

The VFV series voltage to frequency converters, with universal operating characteristics, offers significant advantages over other available units. These converters can be operated as either voltage to frequency or frequency to voltage converters by external pin connection. In addition, voltage inputs of 0 to +10V or 0 to -10V and current inputs of 0 to +1mA or 0 to -1mA can be chosen by pin connection. As an F/V converter either 0 to +10V or 0 to -10V outputs can be chosen by pin connection. Output pulses can be selected to be positive or negative going, with DTL/TTL, CMOS, or high level logic interfacing. The output is short circuit proof to common or either supply voltage. The result of these universal pin connectable operating characteristics is wide flexibility in applications.

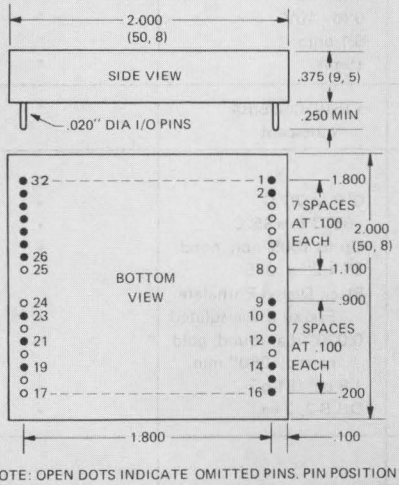
There are two basic models in this series, the VFV-10K and VFV-100K, with 10kHz and 100kHz full scale output frequencies respectively. Both models have a linear minimum overrange capability of 10%. The linearity holds down to zero input, resulting in an extremely wide dynamic range of operation. The output pulses are constant width pulses of 70 $\mu$sec. for the VFV-10K and 7 $\mu$sec. for the VFV-100K. Both models are internally trimmed to 1% accuracy with external offset and gain adjustments for precise calibration in a specific application. When used as an F/V converter, an external capacitor can be used to reduce output ripple to a specified level.

The modules are epoxy encapsulated in a compact 2 x 2 x .375 inch case with DIP compatible 0.100 inch pin spacing.




### MECHANICAL DIMENSIONS INCHES (MM)




NOTE: OPEN DOTS INDICATE OMITTED PINS. PIN POSITION TOLERANCE IS ±0.005" FROM DATUM, NON- ACCUMULATIVE.
WEIGHT: 1.8 OZ. (51 G)

### INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |
|---|---|
| 1 | VOLTAGE OUT |
| 2 | PULSE IN |
| 3 | OMITTED |
| 4 | " |
| 5 | " |
| 6 | " |
| 7 | " |
| 8 | " |
| 9 | POWER & LOGIC GND |
| 10 | PULSE OUT |
| 11 | OMITTED |
| 12 | LOGIC SELECT |
| 13 | OMITTED |
| 14 | PULSE POLARITY |
| 15 | +15 VDC POWER |
| 16 | -15 VDC POWER |
| 17 | OMITTED |
| 18 | " |
| 19 | GAIN POTENTIOMETER |
| 20 | OMITTED |
| 21 | GAIN ADJUST |
| 22 | OMITTED |
| 23 | GAIN POTENTIOMETER |
| 24 | OMITTED |
| 25 | " |
| 26 | +VOLTAGE IN |
| 27 | INVERTED OUT |
| 28 | -VOLTAGE IN |
| 29 | SIGNAL COMMON |
| 30 | -CURRENT IN |
| 31 | +CURRENT IN |
| 32 | ZERO ADJUST |

## SPECIFICATIONS

| Typical at 25°C, ±15V Supplies unless otherwise noted | VFV-10K | VFV-100K |
|---|---|---|
| **V/F CONVERTER INPUT** | | |
| Input Voltage Range | 0 to +10V | * |
| | 0 to −10V | * |
| Input Current Range | 0 to +1mA | * |
| | 0 to −1mA | * |
| Input Overrange, min. | 10% | * |
| Input Impedance, voltage in | 10K ohms | * |
| **V/F CONVERTER OUTPUT** | | |
| Frequency Range | 0 to 10kHz | 0 to 100kHz |
| Frequency Overrange, min. | 10% | * |
| Pulse Width | 70 µsec | 7 µsec |
| Rise and Fall Time, max. | 200 nsec. | * |
| Pulse Polarity | Pos. or Neg. | * |
| Settling Time to .01% | 1 pulse of new freq. | * |
| Overload Recovery | 1 pulse of new freq. | * |
| Capacitive Loading, max. | 1000pF | 100pF |
| Output Logic (Output Code: 1 = Min. +2.4V, Max. +15V; 0 = Min. 0V, Max. +0.4V) | DTL/TTL or CMOS | * |
| Output Loading, S.C. protected | 12 TTL loads | * |
| **ACCURACY** | | |
| Full Scale Error, pretrimmed, max. (adj. to zero) | ±1% | * |
| Nonlinearity, max. | ±.005% | ±.05% |
| Offset Voltage, max. (adj. to zero) | ±10mV | * |
| Temp. Coefficient of Gain max. | ±20ppm/°C | ±100ppm/°C |
| Gain vs. time | ±100ppm/day | * |
| Temp. Coefficient of Zero, max. | ±30µV/°C | * |
| Zero Drift vs. Time | ±10µV/day | * |
| Power Supply Sensitivity, max. | .002%/% | .02%/% |
| Warm Up Time to Rated Accuracy | 1 minute | 5 minutes |
| **F/V CONVERTER SPECIFICATIONS** | | |
| Input Pulses (Input Code: 1 = Min. 0V, Max. +0.8V; 0 = Min. +2.0V, Max. +15V) | Negative Going | * |
| | <1TTL Load | * |
| Input Impedance, min. | 30K ohms | 4K ohms |
| Input Pulse Width | 10 – 60 µsec. | 1 – 6 µsec. |
| Filter Time Constant | 0.5 msec. | .025 msec. |
| Output Voltage | 0 to +10V | * |
| | 0 to −10V | * |
| Output Impedance | 0.1 ohm | * |
| Output Current, S.C. protected | ±5mA | * |
| **POWER REQUIREMENT** | ±15VDC@25mA quiescent | * |
| **PHYSICAL-ENVIRONMENTAL** | | |
| Operating Temperature Range | 0°C to 70°C | * |
| Storage Temperature Range | −55°C to +85°C | * |
| Relative Humidity | Up to 100% non. cond. | * |
| Case Size | 2" x 2" x .375" | * |
| Case Material | Black Diallyl Phthalate, Epoxy Encapsulated | * |
| Pins | 0.020" dia. round, gold plated, .250" min. | * |
| Weight | 1.8 oz. (51 g.) | * |
| Mating Sockets | DILS-2, 2 ea. | * |

*Specifications same as VFV-10K

## TECHNICAL NOTES

### V/F CONVERTER OPERATION

The V/F converter can be thought of as an A/D converter with serial output pulses which must be counted. The first applications diagram shows the V/F converter used as A/D converter by connecting the output to a digital counter and register. The digital counter is shown with a one second counting time base and an output register to store the output data while the V/F converter is making a conversion. The VFV-10K has a resolution of 1 part in 10,000 using a 1 second time base. This is equivalent to better than 13 bits binary resolution (1 part in 8,192). The nonlinearity of this model is 50 ppm maximum which is equivalent (50 ppm = 1/2 LSB) to a better than 13 bit binary converter. With a gain temperature stability of 20 ppm/°C worst case, the VFV-10K is equivalent to a very high quality A/D converter in its performance.

The VFV-100K has a resolution of 1 part in 100,000 using a 1 second time base. This is equivalent to better than 16 bits binary resolution (1 part in 65,536). The VFV-100K can be used to give equivalent resolution to the VFV-10K with only one tenth the time base, or 0.1 second for a resolution of 1 part in 10,000.

An important characteristic of both the VFV-10K and VFV-100K is that their linearity does not fall off near zero as with some other converters. They are both linear right to zero, and this results in a wide dynamic operating range. In practice the lower limit of operation is about 1 millivolt input due to adjustment accuracy, long term stability, temperature drift, etc. This results in a dynamic range of 10,000 to 1 of 80dB for both models.

As a V/F converter positive inputs are achieved using inputs directly into the integrator (pins 26 or 31). For negative inputs the internal inverting amplifier is connected ahead of the integrator and the input is applied to pin 28 or 30. Using both the inverting amplifier inputs and the integrator inputs it is possible to algebraically add and subtract inputs for V/F converter operation.

The output logic level can be set from 0 to +15V by use of an external resistor connected to pin 10 while pin 12 is left open. The output voltage is determined by the resistor ratio with the internal 10K ohm resistor as shown in the Output Logic Connections diagram.

### F/V CONVERTER OPERATION

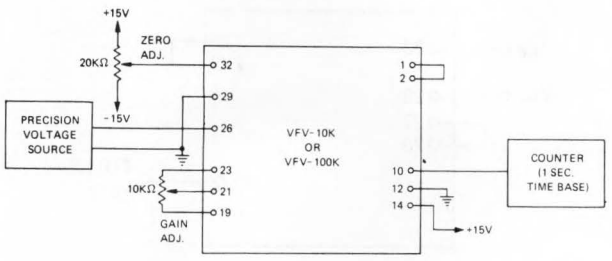
For operation as an F/V converter negative going input pulses must be used. The pulses must go from a HI logic level of +2.0V to +15V to a LO logic level of 0 to +0.8V. The pulse widths must be between 10 and 60 µsec for the VFV-10K and 1 and 6 µsec for the VFV-100K. If these pulse widths are not available, then input conditioning circuits must be used as shown in the diagrams of Input Conditioning for F/V Converter.

Output ripple of the F/V converter can be made arbitrarily low by using an external filtering capacitor. This also slows down the output response time. As an F/V converter, a positive output is taken directly from the integrator output (pin1). For a negative output voltage the internal inverting amplifier is used after the integrator and the output is taken at pin 27.

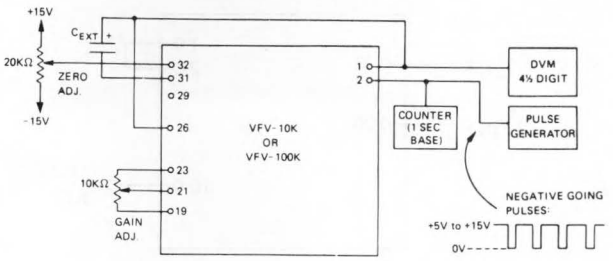
## CALIBRATION PROCEDURE

DATEL

### AS V/F CONVERTER




### AS F/V CONVERTER




Trimming potentiometers are 100ppm/°C, 15 turn type, available from Datel Systems at $3.00 each.

### V/F CONVERTER

1. Connect the unit as a V/F converter as shown above with zero and gain trimming potentiometers.
2. Connect a precision dial-up voltage source to +Vin (pin 26) and a digital counter and display set to a 1 second time base to PULSE OUT (pin 10) as shown.
3. Set the precision voltage source to +.010 volt and adjust the zero trimming potentiometer to give an output count of 10 for the VFV-10K or 100 for the VFV-100K.
4. Set the precision voltage source to +10.000 volts and adjust the gain trimming potentiometer to give an output count of 10,000 for the VFV-10K or 100,000 for the VFV-100K.

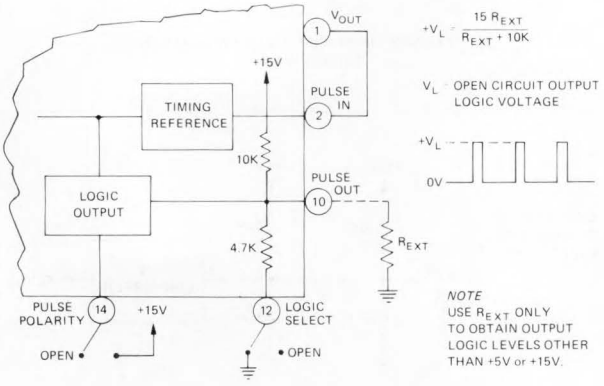
   The above procedure applies for a positive input voltage V/F converter. For a negative input voltage, connect pin 27 to pin 26 and use pin 28 as the input.

### F/V CONVERTER

1. Connect the unit as an F/V converter as shown with desired external filter capacitor and zero and gain trimming potentiometers.
2. Connect a 4-1/2 digit DVM to the Vout terminal (pin 1). Connect the PULSE IN terminal (pin 2) to +15 volt supply, and adjust the zero trimming potentiometer for 0.000 volts output.
3. Connect a pulse generator to PULSE IN (pin 2) and set the generator to give +5 volt negative going pulses 50 $\mu$sec wide for the VFV-10K or 5 $\mu$sec wide for the VFV-100K. Connect a digital counter to the pulse generator output and set the pulse rate to exactly 10kHz for the VFV-10K or 100kHz for the VFV-100K.
4. Adjust the gain trimming potentiometer to give +10.000 volts output.

   The above procedure applies for a positive output voltage F/V converter. If negative output voltage is desired, connect pin 1 to pin 28 and measure the output at pin 27.

### OUTPUT LOGIC CONNECTIONS

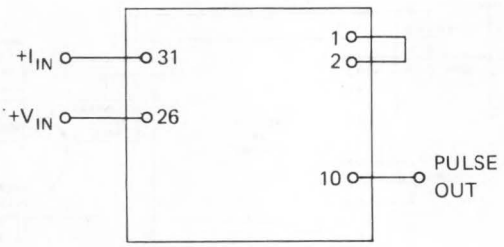



### OUTPUT PULSE PROGRAMMING

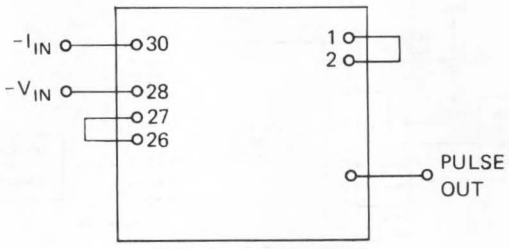
| PULSE TYPE | PULSE OUTPUT | LOGIC SELECT (PIN 12) | PULSE POLARITY (PIN 14) |
|---|---|---|---|
| POSITIVE GOING 5V PULSES | +5 / 0 | GND | +15V |
| NEGATIVE GOING 5V PULSES | +5 / 0 | GND | OPEN |
| POSITIVE GOING 15V PULSES | +15 / 0 | OPEN | +15V |
| NEGATIVE GOING 15V PULSES | +15 / 0 | OPEN | OPEN |

## VFV OPERATING MODES

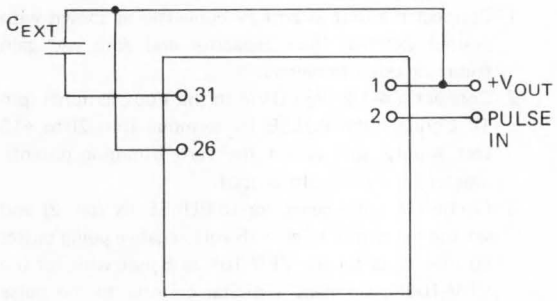
### V/F CONVERTER, +V or +I INPUT



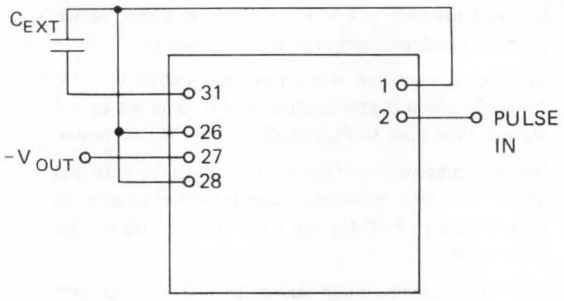

### V/F CONVERTER, -V OR -I INPUT




### F/V CONVERTER, +V OUT

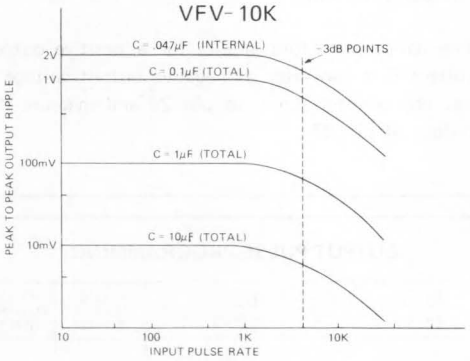



### F/V CONVERTER, -V OUT

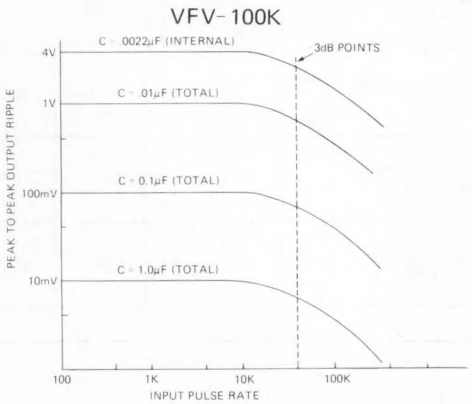



## OUTPUT RIPPLE FOR F/V CONVERTER

### VFV-10K



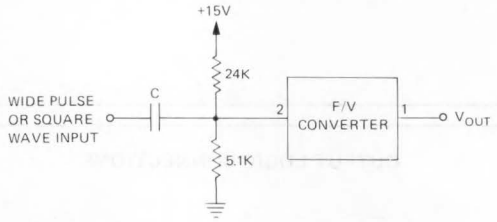

### VFV-100K



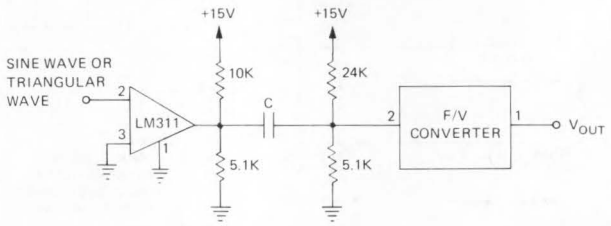

## INPUT CONDITIONING FOR F/V CONVERTER

NOTE: FOR VFV-10K C = .02μF
FOR VFV-100K C = .002μF

ALL RESISTORS SHOWN ARE FOR VFV-10K.
FOR VFV-100K DIVIDE ALL VALUES BY 10.

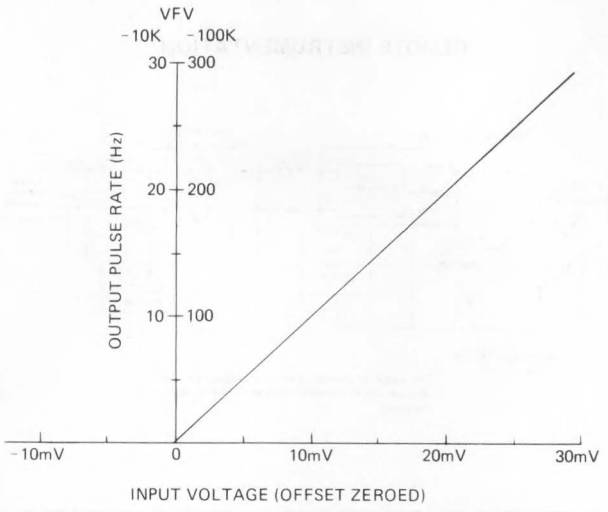



INPUT CONDITIONING CIRCUIT FOR WIDE PULSE OR SQUARE WAVE

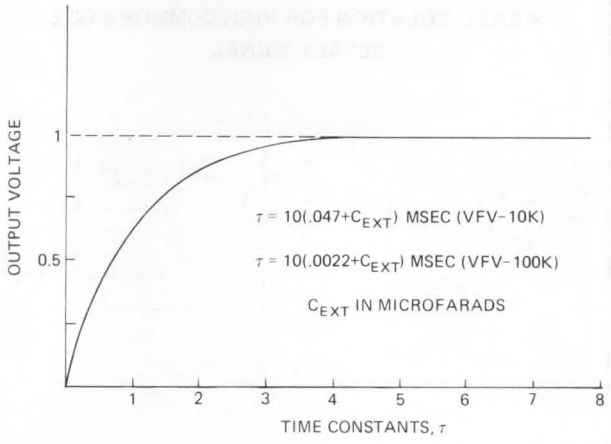



INPUT CONDITIONING CIRCUIT FOR SINE WAVE, TRIANGULAR WAVE, AND OTHER ZERO CROSSING WAVEFORMS

## LINEARITY NEAR ZERO INPUT, VFV-10K and VFV-100K

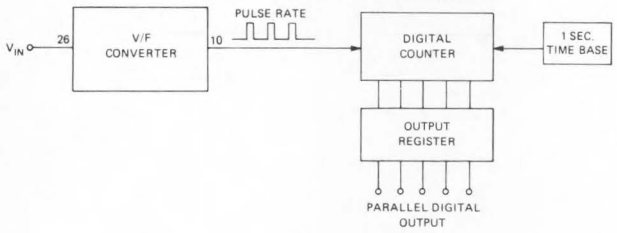



## NORMALIZED STEP RESPONSE, F/V CONVERTER

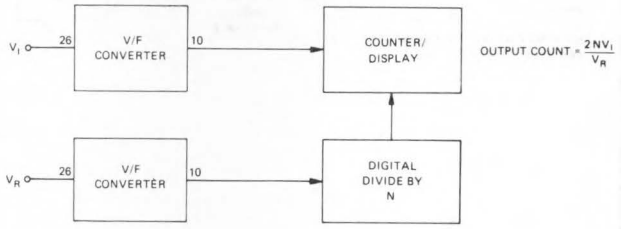



# APPLICATIONS

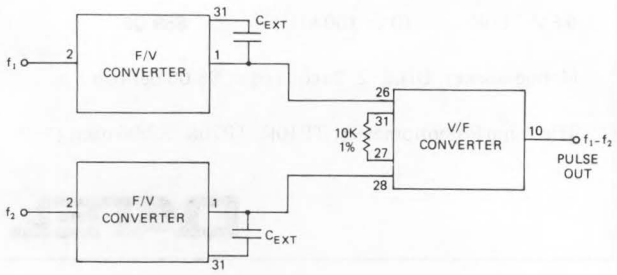
### A/D CONVERTER USING V/F CONVERTER



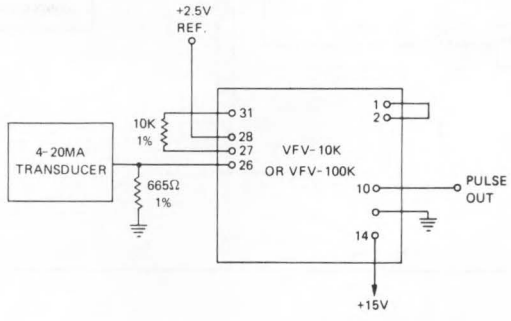

### RATIOMETRIC MEASUREMENT




### FREQUENCY DIFFERENCE MEASUREMENT



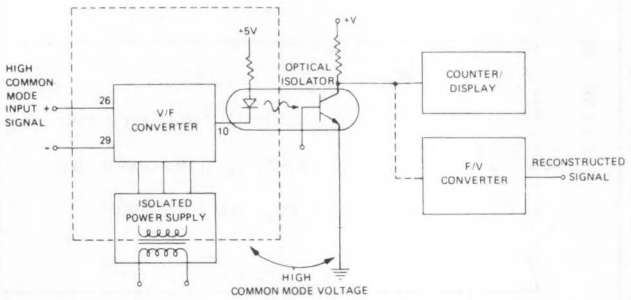

### INTERFACING WITH 4 TO 20 MA INDUSTRIAL TRANSDUCER



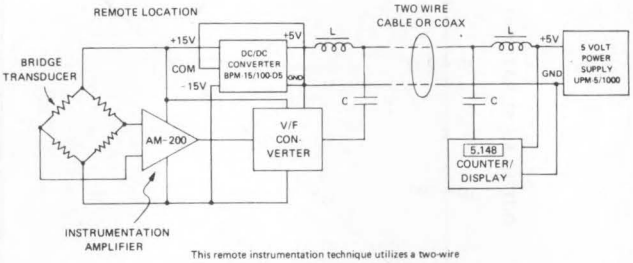

DATEL

## APPLICATIONS (cont'd)

### SIGNAL ISOLATION FOR HIGH COMMON MODE VOLTAGE SIGNAL

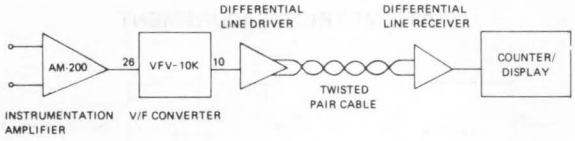



### REMOTE INSTRUMENTATION

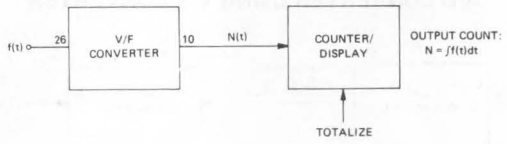



This remote instrumentation technique utilizes a two-wire DC power line for transmitting data back to the counter and display.

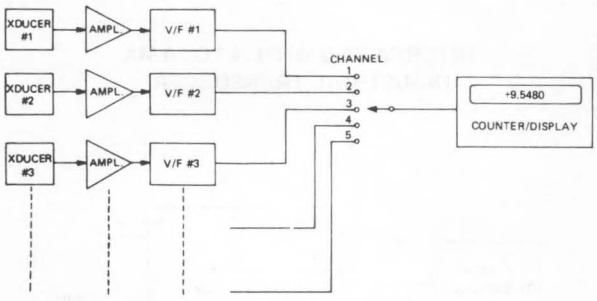
### HIGH NOISE IMMUNITY DATA TRANSMISSION




### ANALOG SIGNAL INTEGRATION




### MULTI-CHANNEL DATA TRANSMISSION AND READOUT




### ORDERING INFORMATION

**PRICES (1-9)**

| | | |
|---|---|---|
| VFV-10K | (0 to 10 kHz) | **$49.00** |
| VFV-100K | (0 to 100 kHz) | **$69.00** |

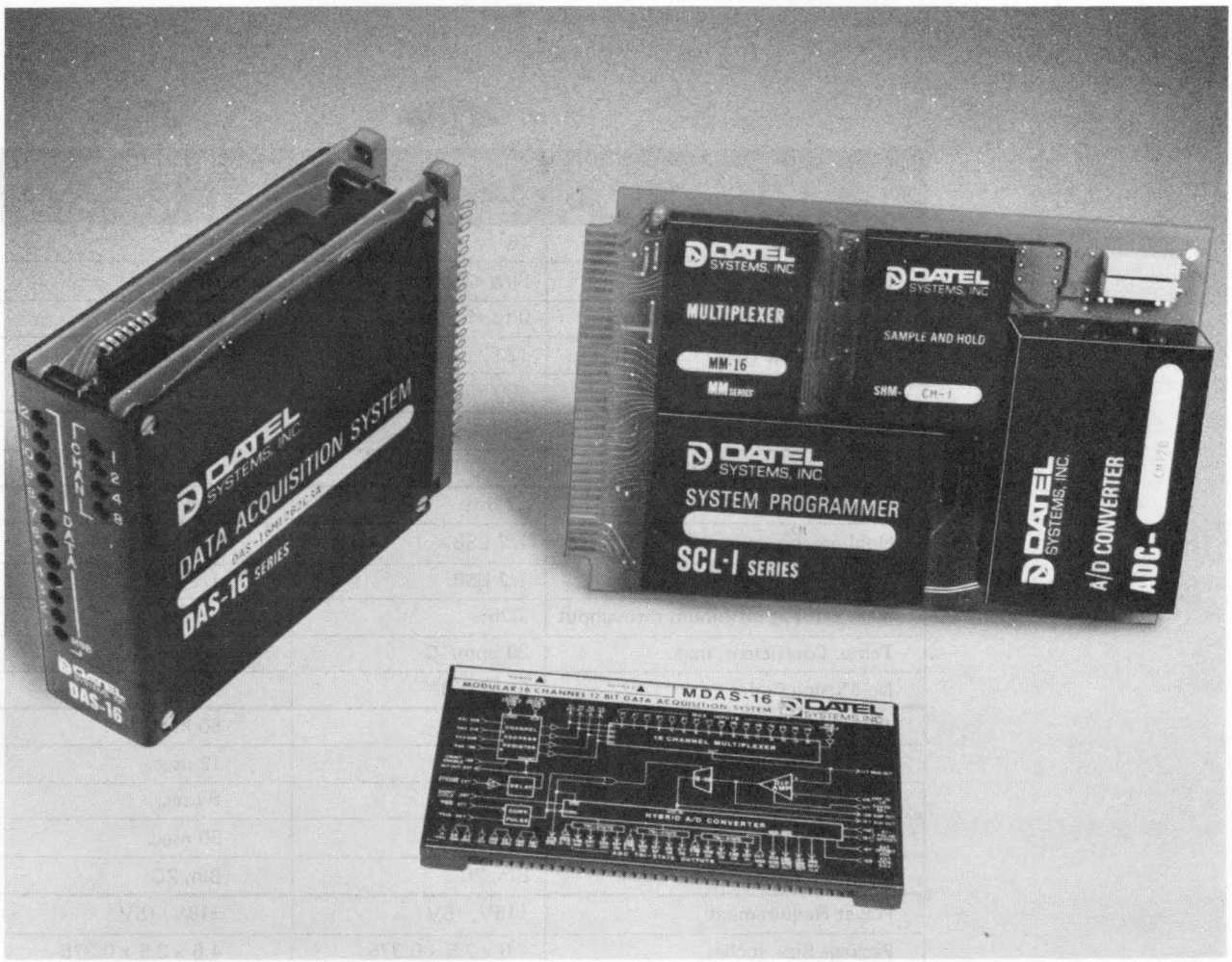
Mating Socket: DILS-2, 2 required at $5.00 per pair

Trimming Potentiometers: TP10K, TP20K, $3.00 each (1-9)

DATEL

DATEL
SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# Modular Data Acquisition Systems



# Modular Data Acquisition Systems

| | NEW MDAS-16 Low Cost | NEW MDAS-8D Low Cost |
|---|---|---|
| No. Channels | 16 | 8 |
| Input Type | Single Ended | Differential |
| Input Voltage Ranges, Unipolar | 0 to +5, +10V | 0 to +5, +10V |
| Input Voltage Ranges, Bipolar | ±2.5, ±5, ±10V | ±2.5, ±5, ±10V |
| Input Impedance | 100 Meg. | 100 Meg. |
| Channel Addressing | 4 Bit Code | 3 Bit Code |
| Address Logic Compatibility | DTL/TTL | DTL/TTL |
| Resolution | 12 Bits | 12 Bits |
| Nonlinearity, max. | 1/2 LSB | 1/2 LSB |
| Differential Nonlinearity, max. | 1/2 LSB | 1/2 LSB |
| Max. Error at maximum throughput | .025% | .025% |
| Temp. Coefficient, max. | 30 ppm/°C | 30 ppm/°C |
| No Missing Codes | 0 to 70°C | 0 to 70°C |
| Throughput Rate, max. | 50 kHz | 50 kHz |
| Acquisition Time | 12 μsec. | 12 μsec. |
| Conversion Time | 8 μsec. | 8 μsec. |
| Aperture Time | 50 nsec. | 50 nsec. |
| Output Coding | Bin, 2C | Bin, 2C |
| Power Requirement | ±15V, +5V | ±15V, +5V |
| Package Size, inches | 4.6 x 2.5 x 0.375 | 4.6 x 2.5 x 0.375 |
| Operating Temp. Range | 0 to 70°C | 0 to 70°C |
| Price (1-9) | **$295.00** | **$295.00** |

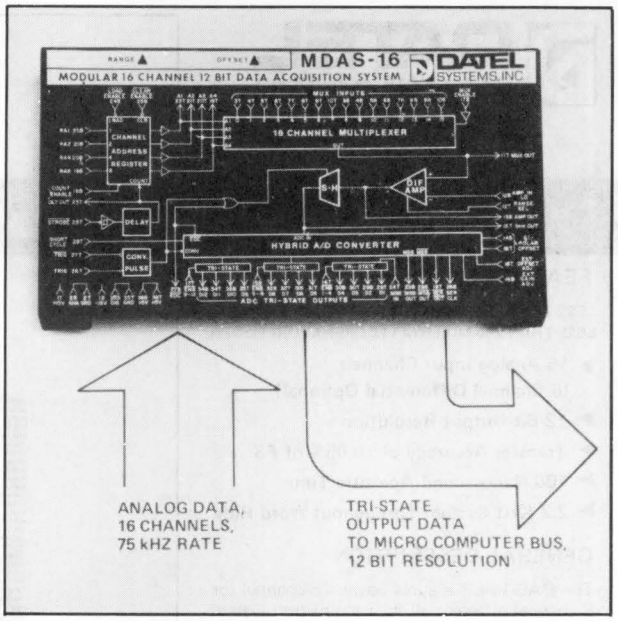
## DESCRIPTION

This comprehensive line of modular data acquisition systems gives the user a range of choices from a miniature low cost 8 or 16 channel system, a 16 channel high speed system, to an 8 or 16 channel low power CMOS system.

**MDAS-16, MDAS-8D:** These new models are only 4.6 x 2.5 x 0.375 inches in size and cost $295. Features are 5 programmed input ranges, 16 single-ended or 8 differential channels, 12 bit resolution, and 50kHz throughput rate. These models represent the best price-performance combination available.

**DAS-250:** This model, soon to be available, offers 16 channel capability at 250 kHz throughput rate. Resolution is 12 bits and the unit offers 0 to +10V or ±5V single-ended input ranges. Package size is 5.0 x 4.5 x 1.5 inches.

**DAS-16-LP12B, DAS-8D-LP12B:** These two CMOS systems are low power units specifically for battery operated portable and remote data acquisition requirements. Both units operate from a single +12V to +15V power supply. The package is a 6.5 x 4.5 inch circuit card.




**COMING SOON**

| DAS-250<br>High Speed | DAS-16-LP12B<br>Low Power CMOS | DAS-8D-LP12B<br>Low Power CMOS |
|---|---|---|
| 16 | 16 | 8 |
| Single Ended | Single Ended | Differential |
| 0 to +10V | 0 to +5, +10V | 0 to +5, +10V |
| ±5V | ±5, ±10V | ±5, ±10V |
| 100 Meg. | 1000 Meg. | 1000 Meg. |
| 4 Bit Code | 4 Bit Code | 3 Bit Code |
| DTL/TTL | CMOS | CMOS |
| 12 Bits | 12 Bits | 12 Bits |
| 1/2 LSB | 1/2 LSB | 1/2 LSB |
| 1/2 LSB | 1/2 LSB | 1/2 LSB |
| .025% | .05% | .05% |
| 40 ppm/°C | 150 ppm/°C | 150 ppm/°C |
| 0 to 70°C | 0 to 70°C | 0 to 70°C |
| 250 kHz | 2.2 kHz | 2.2 kHz |
| 2 μsec. | 150 μsec. | 150 μsec. |
| 2 μsec. | 310 μsec. | 310 μsec. |
| 20 nsec. | 100 nsec. | 100 nsec. |
| Bin, 2C | Bin, 2C | Bin, 2C |
| ±15V, +5V | +12 to +15V | +12 to +15V |
| 5.0 x 4.5 x 1.5 | 6.5 x 4.5 x 1.0 | 6.5 x 4.5 x 1.0 |
| 0 to 70°C | 0 to 70°C | 0 to 70°C |
| **$595.00** | **$495.00** | **$545.00** |

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

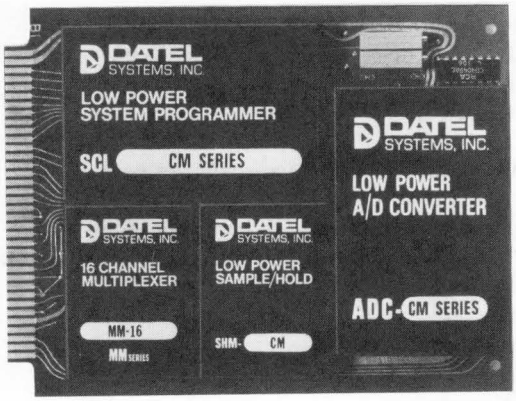
# LOW POWER 16 CHANNEL DATA ACQUISITION SYSTEM

# MODEL DAS-16-LP

## FEATURES

**LESS THAN 120 MICROWATTS STANDBY POWER**
**LESS THAN 200 MILLIWATTS OPERATING POWER**

- **16 Analog Input Channels (8 Channel Differential Optional)**
- **12 Bit Output Resolution**
- **Transfer Accuracy of ±0.05% of FS**
- **100 Nanosecond Aperture Time**
- **2.2 KHz System Throughput Word Rate**




## GENERAL DESCRIPTION

The DAS-16-LP is a low power 16-channel (or 8 channel differential) data acquisition system complete with an analog multiplexer, a high performance sample and hold amplifier, a high accuracy 12 bit analog-to-digital converter, plus all the necessary control logic for both random and sequential channel selection – all mounted on a 4½ by 6½ inch PC board.

The remarkable feature of the DAS-16-LP however is its low power consumption of less than 200 milliwatts while operating, and only 120 microwatts in stand-by. A unique power supply operating from +12 to +15 volts generates bipolar power to the analog section only when a conversion is in process, thus providing power savings during standby. In addition, the system can be operated continuously from a bipolar power source.

Since the DAS-16-LP can be powered from a 12 volt battery for long periods of time, it easily lends itself to remote applications. As such, the DAS-16-LP is an ideal acquisition system for gathering oceanographic, meteorological, seismological, pollution or general environmental data. The system's computer compatible interface also makes it ideal for laboratory or industrial control use.

The 16 single-ended input channels (or 8 channel differential) can accept either 0 to +5 volt or ±5 volt full scale signals with 12 volt power and when 15 volt power is provided, either 0 to +10 volt or ±10 volt full scale signals can be accepted in addition. System transfer accuracy is 0.05% of full scale, ±1/2 LSB, with a linearity of ±1/2 LSB and a temperature coefficient of 150 ppm/°C. Dynamically, the input data acquisition time is 150 microseconds and the aperture time of the sample and hold amplifier is less than 100 nanoseconds. Data conversion is completed in less than 460 microseconds therefore the system throughput rate is 2.2 KHz.

The control logic included with the DAS-16-LP provides for input command storage using the device select and strobe inputs to enable the other input commands. As such, the input commands are only required to be true during the strobe period thus allowing for party line or computer bus operation. Besides providing random access to the input channels, an internal counter allows sequential addressing and a frame sync output indicates when the counter is at channel one. Short cycle inputs and outputs are also provided so the counter can be preset to jump back to channel one from any channel.

## ORDERING INFORMATION

MODEL NUMBER DAS – ____ – ____ – ____

| NUMBER OF CHANNELS | OUTPUT DATA FORMAT |
|---|---|
| 8D-LP-12B= 8 DIFFERENTIAL<br>16-LP-12B= 16 SINGLE-ENDED | 1 = STRAIGHT BINARY (UNIPOLAR)<br>2 = OFFSET BINARY (BIPOLAR)<br>3 = 2's COMPLEMENT (BIPOLAR) |

| FULL SCALE ANALOG INPUT |
|---|
| A = 0 to +5V<br>B = 0 to +10V<br>C = ±5V<br>D = ±10V |

**PRICE** (SINGLE QUANTITY)
16 CHANNELS . . . . . **$495.00**
8 DIFF. CHANNELS . . . . . **$545.00**
CONNECTOR (3VH36/1JN-5). **$ 3.95**

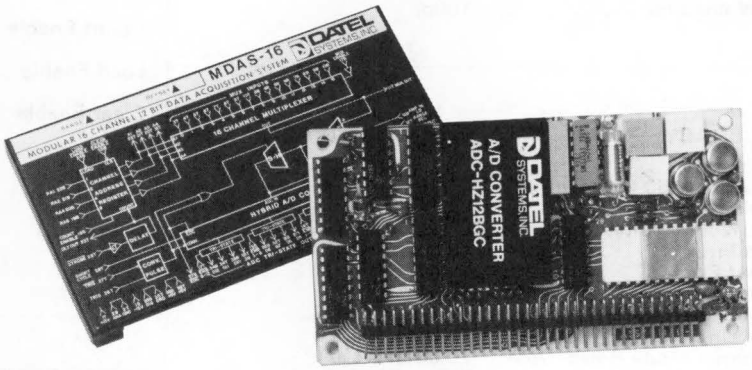
DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# MINIATURE MODULAR DATA ACQUISTION SYSTEM

# MODELS MDAS-16, MDAS-8D

## FEATURES

- **16 Channels Single Ended or 8 Channels Differential**
- **12 Bits Resolution**
- **50 kHz Throughput Rate**
- **Tri-State Outputs**
- **Low Cost -**
- **Miniature Size**




## DESCRIPTION

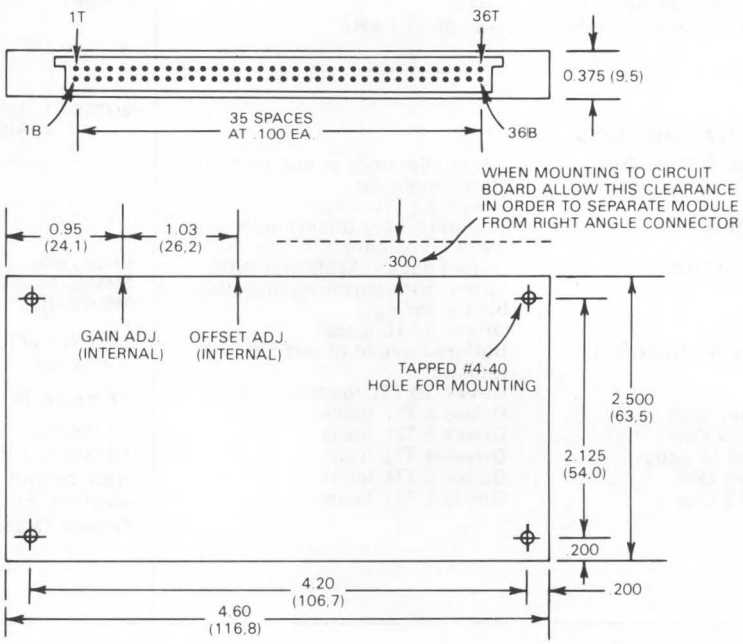
The MDAS-16 and MDAS-8D data acquisition modules are complete, self-contained systems featuring 16 channel single ended or 8 channel differential operation respectively. Resolution is 12 bits and throughput rate is 50 kHz. Output data is buffered tri-state for interfacing to mini or micro-computer data buses. Output data can be transferred in three 4 bit bytes. Output coding is straight binary for unipolar operation and offset binary or two's complement for bipolar operation.

The 4.6 x 2.5 x 0.375 inch size of these modules is ½ inch narrower than other competitive models. The small size and low cost are made possible by extensive use of hybrid and monolithic circuits to reduce parts count and increase reliability. Both models use Datel Systems' new ADC-HZ12BGC 12 bit hybrid A/D converter along with a monolithic sample-hold and analog multiplexer.

The MDAS-16 and MDAS-8D feature a high degree of user flexibility with pin-programmable input ranges of 0 to +5V, 0 to +10V, ±2.5V, ±5V, and ±10V. The systems may be operated in either random or sequential channel addressing modes. For applications where lower than 12 bit resolution can be used, the A/D converter can be short-cycled to achieve a faster conversion rate. Output data is also available in serial form with a gated clock output.

The modules are housed in a shielded steel case. Input-output connections are made by means of a 72-pin connector. The number of channels may be expanded by 32 for the MDAS-16 or by 16 for the MDAS-8D by use of the multiplexer expander modules MDXP-32, and MDXP-32-1.

## MECHANICAL DIMENSIONS - INCHES (MM)



## SPECIFICATIONS, MDAS-16 & MDAS-8D
## (Typical at 25°C, ±15V and +5V supplies unless otherwise indicated)

### ANALOG INPUTS

| | |
|---|---|
| **Number of Channels** | 16 Single Ended (MDAS-16)<br>8 Differential (MDAS-8D) |
| **Input Voltage Ranges** | |
| **unipolar** | 0 to +5V 0 to +10V |
| **bipolar** | ±2.5V, ±5V, ±10V |
| **Common Mode Range, min.** | ±10V |
| **Max. Input Voltage, no damage** | ±15V |
| **Input Impedance** | 100 megohms |
| **Input Bias Current** | 3nA, 10nA max. 0 to 70°C |
| **Input Capacitance** | |
| **OFF channel** | 10 pF |
| **ON channel** | 100pF |

### ACCURACY

| | |
|---|---|
| **Resolution** | 12 Bits |
| **Error, max. 50 kHz sampling** | ±.025% of FSR |
| **Nonlinearity, max.** | ±½ LSB |
| **Diff. Nonlinearity, max.** | ±½ LSB |
| **Gain Error** | Adj. to zero |
| **Offset Error** | Adj. to zero |
| **Temp. Coeff. of Gain, max.** | ±30ppm/°C |
| **Temp. Coeff. of Offset, max.** | ±7ppm/°C of FS |
| **Diff. Linearity Tempco, max.** | ±3ppm/°C of FS |
| **Common Mode Rejec., min.** | 70 dB at 1 kHz |
| **Monotonicity** | 0°C to 70°C |
| **Power Supply Rejection** | .01%/% Supply |

### DYNAMIC CHARACTERISTICS

| | |
|---|---|
| **Throughput Rate, max.** | 50 kHz |
| **Acquisition Time** | 12 µsec. |
| **Conversion Time** | 8 µsec. |
| **Aperture Time, max.** | 50 nsec. |
| **Sample-Hold Droop, max.** | 50 µV/msec. |
| **Feedthrough, max.** | .01% |
| **Channel Crosstalk (Mux.)** | -80 dB at 1 kHz |

### DIGITAL OUTPUTS

| | |
|---|---|
| **Parallel Data Out** | 12 parallel lines of buffered tri-state output data.<br>Drives 12 TTL loads. |
| **Coding** | Straight binary, offset binary, and two's complement |
| **Serial Out** | Output data in MSB first, NRZ format. Straight binary and offset binary coding.<br>Drives 5 TTL loads |
| **Mux Address Out** | Buffered output of address register<br>Drives 20 TTL loads |
| **Delay Out** | Drives 5 TTL loads |
| **Clock Out** | Drives 5 TTL loads |
| **EOC (Status)** | Drives 4 TTL loads |
| **MSB Out** | Drives 5 TTL loads |
| **MSB Out** | Drives 5 TTL loads |

### DIGITAL INPUTS

| | |
|---|---|
| **Enable** | Three separate inputs which enable tri-state outputs in 4 bit bytes.<br>1 TTL load |
| **Mux Address In** | 3 bit (MDAS-8D) or 4 bit (MDAS-16) binary address<br>1 LS TTL load |
| **Strobe** | 1 LS TTL load with 10K pull-up resistor |
| **A/D Trigger** | 1 LS TTL load with 10K pull-up resistor |
| **A/D Trigger** | 1 LS TTL Load |
| **Mux Enable** | 1 TTL load with 10K pull-up resistor |
| **Count Enable** | 1 LS TTL load with 10K pull-up resistor |
| **Load Enable** | 1 LS TTL load with 10K pull-up resistor |
| **Clear Enable** | 1 LS TTL load with 10K pull-up resistor |
| **MSB In** | 1 TTL load |
| **Short Cycle** | 1 TTL load with 10K pull-up resistor |

### POWER REQUIREMENT

+15VDC ±0.5V @ 65mA
-15VDC ±0.5V @ 60 mA
+5VDC ±0.25V @ 200mA

### PHYSICAL ENVIRONMENTAL

| | |
|---|---|
| **Operating Temp. Range** | 0°C to 70°C |
| **Storage Temperature Range** | -25°C to +85°C |
| **Package Size** | 4.6 x 2.5 x 0.375 inches (116,8 x 63,5 x 9,5 mm) |
| **Package Type** | Steel, shielded on 5 sides |
| **Weight** | 6 oz. (170 g) |

**NOTES:** 1. All outputs are Vout ("0") ≥+0.4V, Vout ("1") ≥+2.4V
2. All inputs are Vin ("0") ≥+0.8V, Vin ("1") ≥+2.0V

### ORDERING INFORMATION

Price (1-9)
MDAS-16 $295.00
MDAS-8D $295.00

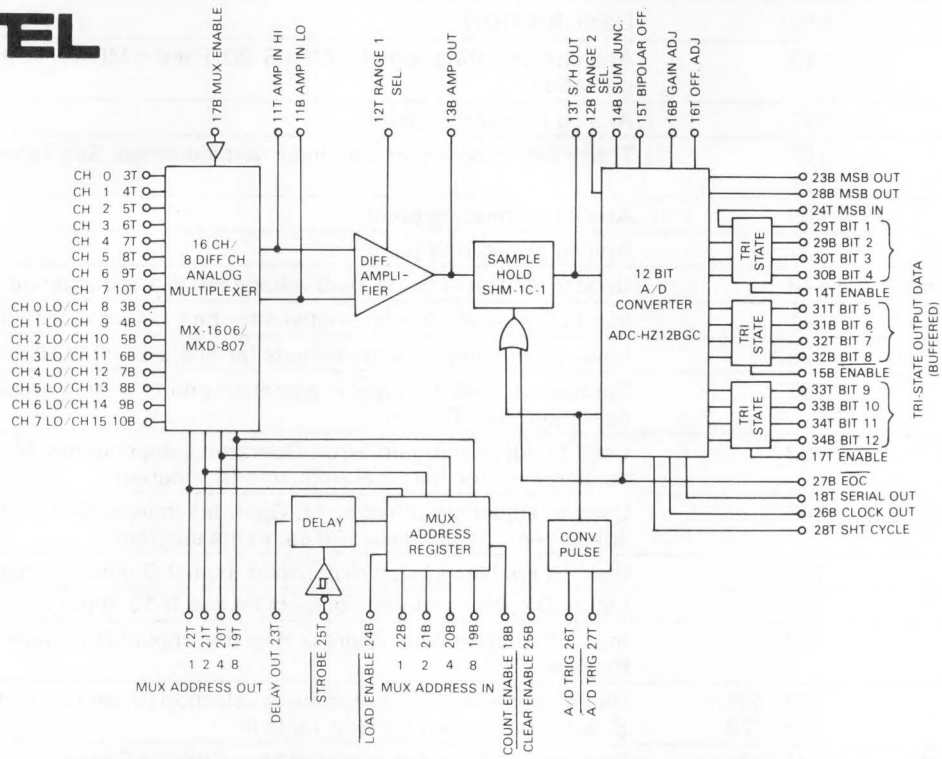
Included with each module is a mating right-angle 72 pin connector.

Trimming Potentiometers: TP 20K $3.00 each.

Multiplexer expander modules are also available. The MDXP-32 adds 32 single ended or 16 differential channels with control logic. Price is $199.00. The MDXP-32-1 is identical but without control logic. Price is $179.00. Consult factory for delivery.

DATEL

# BLOCK DIAGRAM MDAS-16, MDAS-8D




## PIN CONNECTIONS for MDAS-16

| | Top | Bottom | |
|---|---|---|---|
| +15VDC | 1T | 1B | -15VDC |
| Analog Gnd. | 2T | 2B | Analog Gnd. |
| Ch. 0 In | 3T | 3B | Ch. 8 In |
| Ch. 1 In | 4T | 4B | Ch. 9 In |
| Ch. 2 In | 5T | 5B | Ch. 10 In |
| Ch. 3 In | 6T | 6B | Ch. 11 In |
| Ch. 4 In | 7T | 7B | Ch. 12 In |
| Ch. 5 In | 8T | 8B | Ch. 13 In |
| Ch. 6 In | 9T | 9B | Ch. 14 In |
| Ch. 7 In | 10T | 10B | Ch. 15 In |
| Amplifier In Hi | 11T | 11B | Amplifier In Lo |
| Range 1 Select | 12T | 12B | Range 2 Select |
| Sample Hold Out | 13T | 13B | Amplifier Out |
| Enable (Bits 1-4 Out) | 14T | 14B | Sum. Junc. (Bipolar Off.) |
| Bipolar Offset | 15T | 15B | Enable (Bits 5-8 Out) |
| Ext. Offset Adjust | 16T | 16B | Ext. Gain Adjust |
| Enable (Bits 9-12) | 17T | 17B | Mux Enable |
| Serial Out | 18T | 18B | Count Enable |
| 8 Out } Mux | 19T | 19B | 8 In } Mux |
| 4 Out } Address | 20T | 20B | 4 In } Address |
| 2 Out } Lines | 21T | 21B | 2 In } Lines |
| 1 Out } | 22T | 22B | 1 In } |
| Delay Out | 23T | 23B | MSB Out (TTL) |
| MSB In (TTL) | 24T | 24B | Load Enable |
| Strobe | 25T | 25B | Clear Enable |
| A/D Trigger | 26T | 26B | Clock Out |
| A/D Trigger | 27T | 27B | EOC (status) |
| Short Cycle | 28T | 28B | MSB Out (TTL) |
| Bit 1 Out* (MSB) | 29T | 29B | Bit 2 Out* |
| Bit 3 Out* | 30T | 30B | Bit 4 Out* |
| Bit 5 Out* | 31T | 31B | Bit 6 Out* |
| Bit 7 Out* | 32T | 32B | Bit 8 Out* |
| Bit 9 Out* | 33T | 33B | Bit 10 Out* |
| Bit 11 Out* | 34T | 34B | Bit 12 Out* (LSB) |
| Digital Gnd. | 35T | 35B | Digital Gnd. |
| +5VDC | 36T | 36B | +5VDC |

*Tri-State Outputs

## PIN CONNECTIONS for MDAS-8D

| | Top | Bottom | |
|---|---|---|---|
| +15VDC | 1T | 1B | -15VDC |
| Analog Gnd. | 2T | 2B | Analog Gnd. |
| Ch. 0 Hi In | 3T | 3B | Ch. 0 Lo In |
| Ch. 1 Hi In | 4T | 4B | Ch. 1 Lo In |
| Ch. 2 Hi In | 5T | 5B | Ch. 2 Lo In |
| Ch. 3 Hi In | 6T | 6B | Ch. 3 Lo In |
| Ch. 4 Hi In | 7T | 7B | Ch. 4 Lo In |
| Ch. 5 Hi In | 8T | 8B | Ch. 5 Lo In |
| Ch. 6 Hi In | 9T | 9B | Ch. 6 Lo In |
| Ch. 7 Hi In | 10T | 10B | Ch. 7 Lo In |
| Amplifier In Hi | 11T | 11B | Amplifier In Lo |
| Range 1 Select | 12T | 12B | Range 2 Select |
| Sample Hold Out | 13T | 13B | Amplifier Out |
| Enable (Bits 1-4 Out) | 14T | 14B | Sum. Junc. (Bipolar Off!) |
| Bipolar Offset | 15T | 15B | Enable (Bits 5-8 Out) |
| Ext. Offset Adjust | 16T | 16B | Ext. Gain Adjust |
| Enable (Bits 9-12 Out) | 17T | 17B | Mux Enable |
| Serial Out | 18T | 18B | Count Enable |
| 8 Out } Mux | 19T | 19B | 8 In } Mux |
| 4 Out } Address | 20T | 20B | 4 In } Address |
| 2 Out } Lines | 21T | 21B | 2 In } Lines |
| 1 Out } | 22T | 22B | 1In } |
| Delay Out | 23T | 23B | MSB Out (TTL) |
| MSB In (TTL) | 24T | 24B | Load Enable |
| Strobe | 25T | 25B | Clear Enable |
| A/D Trigger | 26T | 26B | Clock Out |
| A/D Trigger | 27T | 27B | EOC (status) |
| Short Cycle | 28T | 28B | MSB Out (TTL) |
| Bit 1 Out* (MSB) | 29T | 29B | Bit 2 Out* |
| Bit 3 Out* | 30T | 30B | Bit 4 Out* |
| Bit 5 Out* | 31T | 31B | Bit 6 Out* |
| Bit 7 Out* | 32T | 32B | Bit 8 Out* |
| Bit 9 Out* | 33T | 33B | Bit 10 Out* |
| Bit 11 Out* | 34T | 34B | Bit 12 Out* (LSB) |
| Digital Gnd. | 35T | 35B | Digital Gnd. |
| +5VDC | 36T | 36B | +5VDC |

*Tri-State Outputs

## TABLE I DESCRIPTION OF CONTROL PIN FUNCTIONS

| FUNCTION | PIN | DESCRIPTION |
|---|---|---|
| Amplifier In Lo | 11B | Analog monitoring point for MDAS-8D. For the MDAS-16 this pin must be grounded. |
| Amplifier In Hi | 11T | Analog monitoring point. |
| Range 2 Select<br>Range 1 Select | 12B<br>12T | These pins program analog input voltage range. See Table II |
| Amplifier Out | 13B | Analog monitoring point. |
| Sample Hold Out | 13T | Analog monitoring point. |
| Summing Junction | 14B | Used to program analog input voltage range and bipolar offset. See Table II |
| Enable | 14T | Input LO enables tri-state outputs for bits 1-4. Input HI inhibits outputs. |
| Enable | 15B | Input LO enables tri-state outputs for bits 5-8. Input HI inhibits outputs. |
| Bipolar Offset | 15T | Connects to 14B for bipolar operation and to analog ground for unipolar operation. See Table II |
| Ext. Gain Adjust | 16B | Used to adjust out gain error. Operates independently of the internal adjustment. See External Adjustments diagram. |
| Ext. Offset Adjust | 16T | Used to adjust out offset error. Operates independently of the internal adjustment. See External Adjustments diagram. |
| Mux Enable | 17B | Input HI enables analog multiplexer. Input LO inhibits analog multiplexer. |
| Enable | 17T | Input LO enables tri-state outputs for bits 9-12. Input HI inhibits outputs. |
| Count Enable | 18B | Input HI enables Mux Address Register. Input LO inhibits Mux address Register. |
| Mux Address In | 19B, 20B,<br>21B, 22B | Digital inputs for channel address selection in random addressing mode. Straight binary coding. See Table III |
| Mux Address Out | 19T, 20T,<br>21T, 22T | Straight binary coded output of Mux Address Register. |
| MSB Out | 23B | Bit 1 TTL output of A/D converter. Connect to pin 24T for straight binary or offset binary output coding. |
| Delay Output | 23T | An output delay pulse set for 12$\mu$sec. to allow for multiplexer and amplifier settling time and sample hold acquisition time. This pin is normally connected to A/D Trigger (pin 27T) to initiate A/D conversion. |
| Load Enable | 24B | Input HI for sequential addressing. Input LO for random addressing. |
| MSB In | 24T | Bit 1 input to tri-state output buffers. Connect to either pin 23B (MSB Out) or pin 28B (MSB Out). |
| Clear Enable | 25B | Input LO and a negative transition on pin 25T resets Mux address counter to zero. |
| Strobe | 25T | Negative input transition initiates channel scanning sequence in sequential mode or a conversion in the random mode. A Schmidt trigger input adds hysteresis for good noise rejection. |
| Clock Output | 26B | A/D converter clock pulses for synchronization of serial data. Negative going pulses of approximately 100 nsec. duration. |
| A/D Trigger | 26T | A positive logic transition on this input initiates A/D conversion. |
| EOC (status) | 27B | End of conversion (status) output. Output HI during conversion and LO when conversion is complete. |
| A/D Trigger | 27T | A negative logic transition on this input initiates A/D conversion. This pin is normally connected to pin 23T (Delay Output). |
| MSB Out | 28B | Complemented bit 1 TTL output of A/D converter. Connect to pin 24T for two's complement output coding. |
| Short Cycle | 28T | For 12 bit resolution connect this pin to ground. To short cycle A/D converter for lower resolution, connect this pin to output bit n + 1 for a resolution of n bits. Short cycling of the A/D converter can only be done with the Enable inputs (pins 14T, 15B and 17T) LO. |

**TABLE II INPUT RANGE SELECTION**

| INPUT RANGE | CONNECT THESE PINS TOGETHER | | |
|---|---|---|---|
| | RANGE 1 PIN 12T | RANGE 2 PIN 12B | BIPOLAR OFF. PIN 15T |
| 0 TO +5V | 13B | 13T | 2B OR 2T |
| 0 TO +10V | 2B OR 2T | 13T | 2B OR 2T |
| ±2.5V | 13B | 13T | 14B |
| ± 5V | 2B OR 2T | 13T | 14B |
| ±10V | 2B OR 2T | OPEN | 14B |

**TABLE IV**
**THROUGHPUT RATES VS. NO. BITS FOR SHORT-CYCLED A/D CONVERTER**

| NO. BITS | THROUGHPUT RATE |
|---|---|
| 12 | 50 kHz |
| 10 | 53 kHz |
| 8 | 57 kHz |
| 4 | 67 kHz |

DATEL

**TABLE III MUX CHANNEL ADDRESSING**

| ← MUX ADDRESS → PIN | | | | | ON CHANNEL | |
|---|---|---|---|---|---|---|
| 19B | 20B | 21B | 22B | 17B | | |
| 8 | 4 | 2 | 1 | MUX ENAB. | | |
| X | X | X | X | 0 | NONE | |
| 0 | 0 | 0 | 0 | 1 | 0 | |
| 0 | 0 | 0 | 1 | 1 | 1 | |
| 0 | 0 | 1 | 0 | 1 | 2 | |
| 0 | 0 | 1 | 1 | 1 | 3 | |
| 0 | 1 | 0 | 0 | 1 | 4 | |
| 0 | 1 | 0 | 1 | 1 | 5 | |
| 0 | 1 | 1 | 0 | 1 | 6 | MDAS-8D (3 BIT ADDRESS) |
| 0 | 1 | 1 | 1 | 1 | 7 | |
| 1 | 0 | 0 | 0 | 1 | 8 | |
| 1 | 0 | 0 | 1 | 1 | 9 | |
| 1 | 0 | 1 | 0 | 1 | 10 | |
| 1 | 0 | 1 | 1 | 1 | 11 | |
| 1 | 1 | 0 | 0 | 1 | 12 | |
| 1 | 1 | 0 | 1 | 1 | 13 | |
| 1 | 1 | 1 | 0 | 1 | 14 | MDAS-16 (4 BIT ADDRESS) |
| 1 | 1 | 1 | 1 | 1 | 15 | |

**TABLE V**

**CALIBRATION TABLE**

| UNIPOLAR RANGE | ADJUST. | INPUT VOLTAGE |
|---|---|---|
| 0 TO +5V | ZERO<br>GAIN | +0.6 mV<br>+4.9982V |
| 0 TO +10V | ZERO<br>GAIN | +1.2 mV<br>+9.9963V |
| **BIPOLAR RANGE** | | |
| ±2.5V | OFFSET<br>GAIN | -2.4994V<br>+2.4982V |
| ±5V | OFFSET<br>GAIN | -4.9988V<br>+4.9963V |
| ±10V | OFFSET<br>GAIN | -9.9976V<br>+9.9927V |

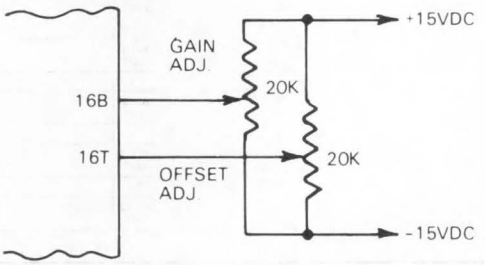



FIG. 1 EXTERNAL ADJUSTMENTS

## SET-UP AND CALIBRATION INSTRUCTIONS

1. Select input voltage range desired and connect pins 12B, 12T, and 15T in accordance with Table II. If the MDAS-16 is used, ground pin 11B. Ground all analog channel inputs which are not to be used. Leave pin 17B open.
2. Determine resolution to be used. For full 12 bits, ground pin 28T. For lower resolution requirements, connect pin 28T to bit output n + 1 for n bit resolution. For example: for 8 bit resolution connect pin 28T to pin 33T (Bit 9 Out). To operate the A/D converter in this short cycled mode, the Enable inputs (pins 14T, 15B, and 17T) must be connected to ground thereby enabling the tri-state outputs. For 12 bit resolution the tri-state outputs can be either enabled or disabled.
3. Select the output coding desired. For straight binary (unipolar) or offset binary (bipolar) connect pin 23B (MSB Out) to pin 24T (MSB In). For two's complement (bipolar) connect pin 28B (MSB Out) to pin 24T.
4. Select desired multiplexer mode. Connect pin 23T (Delay Out) to pin 27T (A/D Trigger).

   A. **Free Running Sequential Addressing**

   Connect pin 27B (EOC) to pin 25T (Strobe). Leave pins 24B (Load Enable) and 25B (Clear Enable) open. Sequencing is initiated by a positive logic transition applied to pin 26T (A/D Trigger). Pin 26T must remain HI during free running sequential addressing. Sequencing is stopped by a LO applied to pin 26T.

   B. **Triggered Sequential Addressing**

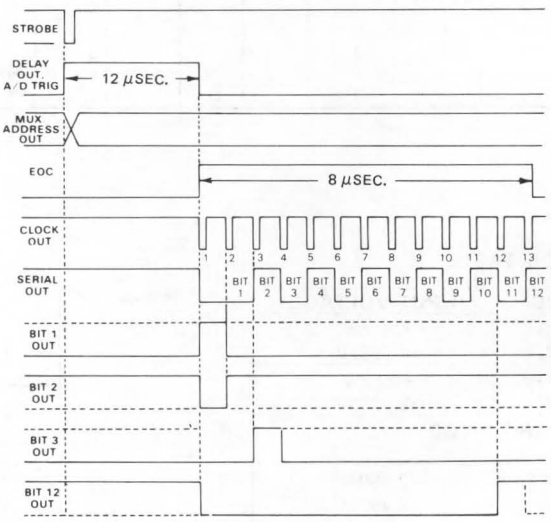
   Leave pins 24B (Load Enable) and 25B (Clear Enable) open. Apply a falling edge trigger to pin 25T (Strobe). The negative transition of the strobe will cause the contents of the address counter to be incremented by one.

   C. **Random Addressing**

   Ground pin 24B (Load Enable). Leave pin 25B (Clear Enable) open. Each negative transition applied to pin 25T (Strobe) will cause the data at pins 19B, 20B, 21B and 22B (Mux Address In) to be loaded into the Address Register. Address inputs must be stable for at least 300 nsec. after negative transition of Strobe.

5. Calibration Procedure
   A. Offset and gain adjustments may be made either internally or externally. Self-contained trimming potentiometers are provided for the internal adjustments. For external adjustment, 20K trimming potentiometers must be used with pins 16B and 16T. Connect as shown in Figure 1.
   B. Connect power supplies to the module and a precision voltage source to pin 3T (Chan 0 In). If the MDAS-8D is used, connect pin 3B (Chan 0 LO) to analog ground. Ground pin 25B (Clear Enable) and momentarily short pin 25T (Strobe) to ground. Use an oscilloscope to monitor the serial output code at pin 18T. Trigger the A/D converter with 50kHz positive going pulses applied to pin 26T (A/D Trigger).
   C. Adjust the precision voltage source to the value shown in the Calibration Table for the unipolar zero adjustment (zero + ½ LSB) or the bipolar offset adjustment (-FS + ½ LSB). Adjust the offset trimming potentiometer so that the output code flickers equally between 0000 0000 0000 and 0000 0000 0001.
   D. Change the output of the precision voltage source to the value shown in the Calibration Table for the unipolar or bipolar gain adjustment (+FS - 1½ LSB). Adjust the gain trimming potentiometer so that the output flickers equally between 1111 1111 1110 and 1111 1111 1111.

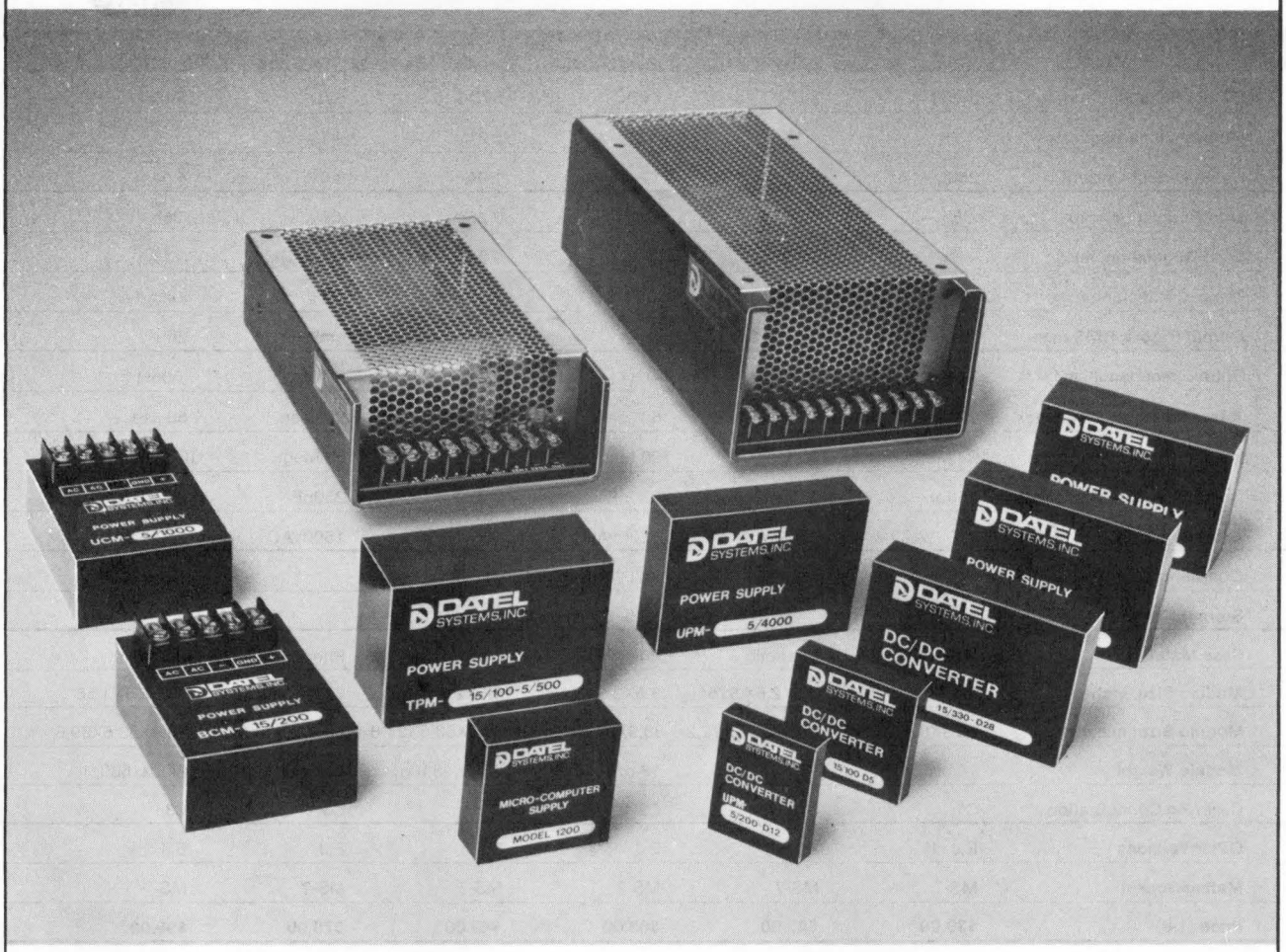
## MDAS-16, MDAS-8D TIMING DIAGRAM Output Code: 010101010101




DATEL

DATEL
SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# Power Supplies



# Single Output Line Operated Power Modules

NEW

| SPECIFICATIONS, 25°C | UPM-5/250 | UPM-5/500 | UPM-5/1000 | UPM-5/1000B | UPM-5/2000 | UPM-5/4000 |
|---|---|---|---|---|---|---|
| **Output Voltage** | 5VDC | 5VDC | 5VDC | 5VDC | 5VDC | 5VDC |
| **Output Voltage Accuracy** | ±1% | ±1% | ±1% | ±2% | ±1% | ±1% |
| **Rated Output Current** | 250mA | 500mA | 1.0A | 1.0A | 2.0A | 4.0A |
| **Line Regulation, max.** | .05% | .05% | .05% | 0.25% | .05% | .05% |
| **Load Regulation, max.** | 0.1% | 0.1% | 0.1% | 0.25% | 0.1% | 0.1% |
| **Temp. Coefficient, max.** | .02%/°C | .02%/°C | .02%/°C | .02%/°C | .02%/°C | .02%/°C |
| **Output Ripple, RMS max.** | 1mV | 1mV | 1mV | mV | 1mV | 2mV |
| **Output Impedance, max.** | .05Ω | .05Ω | .01Ω | .01Ω | .005Ω | .005Ω |
| **Trans. Recovery Time, max.** | 50 μsec. | 50 μsec. | 50 μsec. | 50 μsec. | 50 μsec. | 50 μsec. |
| **Isolation Resistance, min.** | 100 Meg. | 100 Meg. | 100 Meg. | 100 Meg. | 100 Meg. | 100 Meg. |
| **Isolation Capacitance, max.** | 250pF | 250pF | 250pF | 250pF | 250pF | 250pF |
| **Breakdown Voltage, min.** | 1500VAC | 1500VAC | 1500VAC | 1500VAC | 1500VAC | 1500VAC |
| **Operating Temp. Range** | | | −25°C to +71°C (No Derating) | | | |
| **Storage Temp. Range** | | | −25°C to +85°C | | | |
| **Case Material** | Phenolic | Phenolic | Phenolic | Phenolic | Phenolic | Phenolic |
| **Module Size, inches** | 3.5X2.5X.875 | 3.5X2.5X.875 | 3.5X2.5X1.25 | 3.5X2.5X1.25 | 3.5X2.5X1.56 | 3.5X2.5X1.56 |
| **Module Size, millimeters** | 88,9X63,5X22,2 | 88,9X63,5X22,2 | 88,9X63,5X31,8 | 88,9X63,5X31,8 | 88,9X63,5X39,6 | 88,9X63,5X39,6 |
| **Module Weight** | 14 oz.(397g) | 14 oz.(397g) | 18 oz.(510g) | 18 oz. (510g) | 24 oz.(680g) | 24 oz.(680g) |
| **Case/Pin Configuration** | C1 | C1 | C2 | C2 | C3 | C3 |
| **Other Versions** | E,J (1) | E,J (1) | E,J | E,J | E,J | E,J |
| **Mating Socket** | MS-7 | MS-7 | MS-7 | MS-7 | MS-7 | MS-7 |
| **Price (1-9)** | **$39.00** | **$49.00** | **$69.00** | **$49.00** | **$79.00** | **$99.00** |

**Note:**

1. For "E" version module size is C2 (3.5X2.5X1.25 inches, 18 oz.)


| UPM-6/150A | UPM-9/100A | UPM-12/100A | UPM-15/100A |
|---|---|---|---|
| 6VDC | 9VDC | 12VDC | 15VDC |
| ±1% | ±1% | ±1% | ±1% |
| 150mA | 100mA | 100mA | 100mA |
| .05% | .05% | .02% | .02% |
| 0.1% | 0.1% | .05% | .05% |
| .02%/°C | .02%/°C | .02%/°C | .02%/°C |
| 1mV | 2mV | 2mV | 2mV |
| .05Ω | 0.1Ω | 0.1Ω | 0.1Ω |
| 50 μsec. | 50 μsec. | 50 μsec. | 50 μsec. |
| 100 Meg. | 100 Meg. | 100 Meg. | 100 Meg. |
| 250pF | 250pF | 250pF | 250pF |
| 1500VAC | 1500VAC | 1500VAC | 1500VAC |
| | −25°C to +71°C (No Derating) | | |
| | −25°C to +85°C | | |
| Phenolic | Phenolic | Phenolic | Phenolic |
| 3.5X2.5X.875 | 3.5X2.5X.875 | 3.5X2.5X.875 | 3.5X2.5X.875 |
| 88,9X63,5X 22,2 | 88,9X63,5X 22,2 | 88,9X63,5X22,2 | 88,9X63,5X22,2 |
| 14 oz. (397g) | 14 oz. (397g) | 14 oz.(397g) | 14 oz.(397g) |
| C1 | C1 | C1 | C1 |
| E,J (1) | E,J (1) | E,J (1) | E,J (1) |
| MS-7 | MS-7 | MS-7 | MS-7 |
| **$39.00** | **$39.00** | **$49.00** | **$49.00** |

## DESCRIPTION

This line of single output, voltage regulated DC power supplies features six 5 volt output models with output currents from 250mA to 4 amperes. In addition, there are 4 other models with 6V to 15V outputs. All outputs have current limiting short circuit protection. Temperature coefficients are .02%/°C and output ripple voltage is 1 to 2 millivolts RMS.

Model UPM-5/4000 is a special high current, high efficiency supply in a compact C3 case size. Full load efficiency of 65% is achieved by a high performance switching regulator.

## INPUT VOLTAGE SPECIFICATIONS

Standard input specification: 115VAC ±10% @ 60 Hz
E version: 220VAC ±10% @ 50-60 Hz
J version: 100VAC ±10% @ 50-60 Hz

There is no extra charge for E and J versions. When ordering, add E or J suffix after model number. Note that in some instances the module size is larger for the E version. MS-7 sockets are $3.50 each.

**THESE POWER SUPPLIES ARE COVERED BY GSA CONTRACT**

# Dual Output, Line Operated Power Modules

| SPECIFICATIONS, 25°C | BPM-5/250 | BPM-5/500 | BPM-12/60 | BPM-12/100 | BPM-12/200 | BPM-12/300 |
|---|---|---|---|---|---|---|
| **Output Voltage** | ±5VDC | ±5VDC | ±12VDC | ±12VDC | ±12VDC | ±12VDC |
| **Output Voltage Accuracy** | ±1% | ±1% | ±1% | ±1% | ±1% | ±1% |
| **Rated Output Current** | ±250mA | ±500mA | ±60mA | ±100mA | ±200mA | ±300mA |
| **Line Regulation, max.** | .05% | .05% | .02% | .02% | .02% | .02% |
| **Load Regulation, max.** | 0.1% | 0.1% | .05% | .05% | .05% | .05% |
| **Temp. Coefficient, max.** | .02%/°C | .02%/°C | .02%/°C | .02%/°C | .02%/°C | .02%/°C |
| **Output Ripple, RMS max.** | 1mV | 1mV | 2mV | 2mV | 2mV | 2mV |
| **Output Impedance, max.** | .05Ω | .03Ω | 0.2Ω | 0.1Ω | .05Ω | .05Ω |
| **Trans. Recovery Time, max.** | 50 μsec. | 50 μsec. | 50 μsec. | 50 μsec. | 50 μsec. | 50 μsec. |
| **Isolation Resistance, min.** | 100 Meg. | 100 Meg. | 100 Meg. | 100 Meg. | 100 Meg. | 100 Meg. |
| **Isolation Capacitance, max.** | 250pF | 250pF | 250pF | 250pF | 250pF | 250pF |
| **Breakdown Voltage, min.** | 1500VAC | 1500VAC | 1500VAC | 1500VAC | 1500VAC | 1500VAC |
| **Operating Temp. Range** | | | −25°C to +71°C (No Derating) | | | |
| **Storage Temp. Range** | | | −25°C to +85°C | | | |
| **Case Material** | Phenolic | Phenolic | Phenolic | Phenolic | Phenolic | Phenolic |
| **Module Size, inches** | 3.5X2.5X.875 | 3.5X2.5X1.25 | 3.5X2.5X.875 | 3.5X2.5X.875 | 3.5X2.5X1.25 | 3.5X2.5X1.56 |
| **Module Size, millimeters** | 88,9X63,5X22,2 | 88,9X63,5X31,8 | 88,9X63,5X22,2 | 88,9X63,5X22,2 | 88,9X63,5X31,8 | 88,9X63,5X39,6 |
| **Module Weight** | 14 oz.(397g) | 18 oz.(510g) | 14 oz.(397g) | 14 oz. (397g) | 18 oz.(510g) | 24 oz.(680g) |
| **Case/Pin Configuration** | C1 | C2 | C1 | C1 | C2 | C3 |
| **Other Versions** | E,J (1) | E,J (2) | E,J (1) | E,J (1) | E,J | E,J |
| **Mating Socket** | MS-7 | MS-7 | MS-7 | MS-7 | MS-7 | MS-7 |
| **Price (1-9)** | **$69.00** | **$79.00** | **$39.00** | **$49.00** | **$59.00** | **$79.00** |

**Notes:**

(1) For "E" version module size is C2 (3.5X2.5X1.25 inches, 18 oz.)

(2) For "E" version module size is C3 (3.5X2.5X1.56 inches, 24 oz.)


| BPM-15/60 | BPM-15/100 | BPM-15/200 | BPM-15/300 |
|---|---|---|---|
| ±15VDC | ±15VDC | ±15VDC | ±15VDC |
| ±1% | ±1% | ±1% | ±1% |
| ±60mA | ±100mA | ±200mA | ±300mA |
| .02% | .02% | .02% | .02% |
| .05% | .05% | .05% | .05% |
| .02%/°C | .02%/°C | .02%/°C | .02%/°C |
| 2mV | 2mV | 2mV | 2mV |
| 0.2Ω | 0.1Ω | .05Ω | .03Ω |
| 50 μsec. | 50 μsec. | 50 μsec. | 50 μsec. |
| 100 Meg. | 100 Meg. | 100 Meg. | 100 Meg. |
| 250pF | 250pF | 250pF | 250pF |
| 1500VAC | 1500VAC | 1500VAC | 1500VAC |
| | −25°C to +71°C | (No Derating) | |
| | −25°C to +85°C | | |
| Phenolic | Phenolic | Phenolic | Phenolic |
| 3.5X2.5X.875 | 3.5X2.5X.875 | 3.5X2.5X1.25 | 3.5X2.5X1.56 |
| 88,9X63,5X,22,2 | 88,9X63,5X,22,2 | 88,9X63,5X31,8 | 8,9X63,5X39,6 |
| 14 oz. (397g) | 14 oz. (397g) | 18 oz.(510g) | 24 oz.(680g) |
| C1 | C1 | C2 | C3 |
| E,J (1) | E,J (1) | E,J | E,J |
| MS-7 | MS-7 | MS-7 | MS-7 |
| **$39.00** | **$49.00** | **$59.00** | **$79.00** |

## DESCRIPTION

This broad line of dual output, voltage regulated DC power supplies features 10 different models with a wide choice of output voltages and currents. Output voltages are ±5, ±12, and ±15VDC with ±1% accuracy. Rated output currents range from ±60 to ±500mA with output short circuit protection.

Temperature coefficient is .02% per degree Centigrade and output ripple voltage is 1 to 2 millivolts RMS. These rugged, encapsulated modules are useful for powering a wide variety of devices including linear IC's, op amps, data converters, and other analog circuits.

## INPUT VOLTAGE SPECIFICATIONS

Standard input specification: 115VAC ±10% @ 60Hz.

E version: 220VAC ±10% @ 50-60Hz.
J version: 100VAC ±10% @ 50-60Hz.

There is no extra charge for E and J versions. When ordering, add E or J suffix after model number. Note that in some instances the module size is larger for the E version. MS-7 sockets are $3.50 each.

**THESE POWER SUPPLIES ARE COVERED BY GSA CONTRACT**

# Triple Output Modules

These power modules are specially designed for operation with data conversion and other circuits where both a dual analog supply and a 5V logic supply are required. Using a triple output supply to power these circuits can be more economical than using two separate equivalent supplies.


## INPUT VOLTAGE SPECIFICATIONS

Standard input specification: 115VAC ±10% @ 60 Hz
E version: 220VAC ±10% @ 50-60 Hz
J version: 100VAC ±10% @ 50-60 Hz

Mating MS-13 sockets are $3.50 each

| SPECIFICATIONS, 25°C | NEW TPM-12/100-5/500 | NEW TPM-15/100-5/500 |
|---|---|---|
| Output Voltages | ±12VDC/5VDC | ±15VDC/5VDC |
| Output Voltage Accuracy | ±1% | ±1% |
| Rated Output Current | ±100mA/500mA | ±100mA/500mA |
| Line Regulation, max. | .02% / .05% | .02% / .05% |
| Load Regulation, max. | .05% / 0.1% | .05% / 0.1% |
| Temperature Coefficient, max. | .02%/°C | .02%/°C |
| Output Ripple, RMS max. | 2mV/1mV | 2mV/1mV |
| Output Impedance, max. | 0.1/.05 ohm | 0.1/.05 ohm |
| Transient Recovery Time, max. | 50μsec. | 50μsec. |
| Isolation Resistance, min. | 100 Meg. | 100 Meg. |
| Isolation Capacitance, max. | 250pF | 250pF |
| Breakdown Voltage, min. | 1500VAC | 1500VAC |
| Operating Temp. Range | −25°C to +71°C (No Derating) | |
| Storage Temp. Range | −25°C to +85°C | |
| Case Material | Phenolic | Phenolic |
| Module Size, inches | 3.5X2.5X1.56 | 3.5X2.5X1.56 |
| Module Size, millimeters | 88,9X63,5X39,6 | 88,9X63,5X39,6 |
| Module Weight | 24 oz. (681g) | 24 oz. (681g) |
| Case/Pin Configuration | E3 | E3 |
| Other Versions | E,J | E J |
| Mating Socket | MS-13 | MS-13 |
| Price (1-9) | **$67.00** | **$67.00** |

**THESE POWER SUPPLIES ARE COVERED BY GSA CONTRACT**

# Chassis Mounting Modules

This line of popular power supplies has input-output connections made to a terminal strip on top of the modules. These supplies are useful in applications where it is impractical or undesirable to use printed circuit cards or sockets. For simple mounting to a metal chassis, screw inserts are provided on the bottom of the modules.


## INPUT VOLTAGE SPECIFICATIONS

Standard Input Specification: 115VAC ±10% @ 60 Hz
E version: 220VAC ±10% @ 50-60 Hz
J version: 100VAC ±10% @ 50-60 Hz

| | NEW | NEW | NEW | NEW | NEW |
|---|---|---|---|---|---|
| SPECIFICATIONS, 25°C | SINGLE OUTPUT | | DUAL OUTPUT | | |
| | **UCM-5/1000** | **UCM-5/2000** | **BCM-15/100** | **BCM-15/200** | **BCM-15/300** |
| **Output Voltage** | 5VDC | 5VDC | ±15VDC | ±15VDC | ±15VDC |
| **Output Voltage Accuracy** | ±1% | ±1% | ±1% | ±1% | ±1% |
| **Rated Output Current** | 1.0A | 2.0A | 100mA | 200mA | 300mA |
| **Line Regulation, max.** | .05% | .05% | .02% | .02% | .02% |
| **Load Regulation, max.** | 0.1% | 0.1% | .05% | .05% | .05% |
| **Temperature Coefficient, max.** | .02%/°C | .02%/°C | .02%/°C | .02%/°C | .02%/°C |
| **Output Ripple, RMS max.** | 1mV | 1mV | 2mV | 2mV | 2mV |
| **Output Impedance, max.** | .01Ω | .005Ω | 0.1Ω | .05Ω | .05Ω |
| **Transient Recovery Time, max.** | 50μsec. | 50μsec. | 50μsec. | 50μsec. | 50μsec. |
| **Isolation Resistance, min.** | 100 Meg. | 100 Meg. | 100 Meg. | 100 Meg. | 100 Meg. |
| **Isolation Capacitance, max.** | 250pF | 250pF | 250pF | 250pF | 250pF |
| **Breakdown Voltage, min.** | 1500VAC | 1500VAC | 1500VAC | 1500VAC | 1500VAC |
| **Operating Temp. Range** | −25°C to +71°C (No Derating) | | | | |
| **Storage Temp. Range** | −25°C to +85°C | | | | |
| **Case Material** | Phenolic | Phenolic | Phenolic | Phenolic | Phenolic |
| **Module Size, inches** | 3.5X2.5X1.25 | 3.5X2.5X1.56 | 3.5X2.5X.875 | 3.5X2.5X1.25 | 3.5X2.5X1.56 |
| **Module Size, millimeters** | 88,9X63,5X31,8 | 88,9X63,5X39,6 | 88,9X63,5X22,2 | 88,9X63,5X31,8 | 88,9X63,5X39,6 |
| **Module Weight** | 18 oz.(510g) | 24 oz.(680g) | 14 oz.(397g) | 18 oz.(510g) | 24 oz.(680g) |
| **Case/Pin Configuration** | D2 | D3 | D1 | D2 | D3 |
| **Other Versions** | E,J | E,J | E,J (1) | E,J | E,J |
| **Price (1-9)** | **$69.00** | **$79.00** | **$54.00** | **$64.00** | **$79.00** |

**Note:**

1. For "E" version module size is D2 (3.5X2.5X1.25 inches, 18 oz.)

**THESE POWER SUPPLIES ARE COVERED BY GSA CONTRACT**

# Miniature Power Modules

## MINIATURE POWER MODULES

These miniature line operated, regulated power supplies are ideal for applications where space is at a premium, and yet power supply performance cannot be compromised. The two models offered in this series have outputs of 5VDC at 350mA and ±15VDC at ±60mA. Performance specifications include voltage accuracy of ±1%, temperature coefficient of .005%/°C, and isolation resistance of 100 megohms with only 100pF capacitive coupling.

## INPUT VOLTAGE SPECIFICATIONS

Standard input specification: 115VAC ±10% @ 60Hz.
J version: 100VAC ±10% @ 50-60Hz.

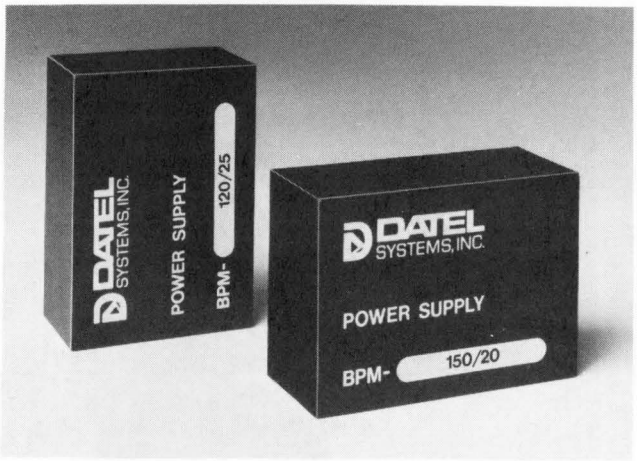
There is no extra charge for the J version. When ordering add J suffix after the model number.


| SPECIFICATIONS, 25°C | UPM-5/350 | BPM-15/60A |
|---|---|---|
| Output Voltage | 5VDC | ±15VDC |
| Output Voltage Accuracy | ±1% | ±1% |
| Rated Output Current | 350mA | ±60mA |
| Line Regulation, max. | .05% | .05% |
| Load Regulation, max. | 0.2% | .05% |
| Temperature Coefficient, max. | .005%/°C | .005%/°C |
| Output Ripple, RMS max. | 2mV | 1mV |
| Output Impedance, max. | .005 ohm | 0.15 ohm |
| Transient Recovery Time, max. | 50μsec. | 50μsec. |
| Isolation Resistance, min. | 100 Meg. | 100 Meg. |
| Isolation Capacitance, max. | 100pF | 100pF |
| Breakdown Voltage, min. | 300VAC | 300VAC |
| Operating Temp. Range | −25°C to +71°C (No Derating) | |
| Storage Temp. Range | −55°C to +85°C | |
| Case Material | Diallyl Phthalate | Diallyl Phthalate |
| Module Size, inches | 2x2x.432 | 2x2x.432 |
| Module Size, millimeters | 50,8x50,8x11,0 | 50,8x50,8x11,0 |
| Module Weight | 2.5 oz. (71g.) | 2.5 oz. (71g.) |
| Case/Pin Configuration | G1 | G1 |
| Other Versions | J | J |
| Mating Socket | DILS-1, DILS-2 | DILS-1, DILS-2 |
| Price | **$69.00** | **$69.00** |

**THESE POWER SUPPLIES ARE COVERED BY GSA CONTRACT**

# High Voltage Modules

This series of dual high voltage supplies is specially designed for use with high voltage operational amplifiers such as Datel Systems AM-300 series. The 3 supplies in this series offer output voltages of ±120, ±150, and ±180 volts with excellent regulation, stability, and low output ripple.




## INPUT VOLTAGE SPECIFICATIONS

Standard input specification: 115VAC ±10% @60 Hz
E version: 220VAC ±10% @ 50-60 Hz
J version: 100VAC ±10% @ 50-60 Hz

Mating MS-7 sockets are $3.50 each

| SPECIFICATIONS, 25°C | NEW BPM-120/25 | NEW BPM-150/20 | NEW BPM-180/16 |
|---|---|---|---|
| Output Voltage | ±120VDC | ±150VDC | ±180VDC |
| Output Voltage Accuracy | ±1% | ±1% | ±1% |
| Rated Output Current | 25mA | 20mA | 16mA |
| Line Regulation, max. | .05% | .05% | .05% |
| Load Regulation, max. | 0.1% | 0.1% | 0.1% |
| Temperature Coefficient, max. | .02%/°C | .02%/°C | .02%/°C |
| Output Ripple, RMS max. | 10mV | 10mV | 10mV |
| Output Impedance, max. | 5 ohms | 5 ohms | 5 ohms |
| Transient Recovery Time, max. | 50μsec. | 50μsec. | 50μsec. |
| Isolation Resistance, min. | 100 Meg. | 100 Meg. | 100 Meg. |
| Isolation Capacitance, max. | 250pF | 250pF | 250pF |
| Breakdown Voltage, min. | 1500VAC | 1500VAC | 1500VAC |
| Operating Temp. Range | −25°C to +71°C (No Derating) | | |
| Storage Temp. Range | −25°C to +85°C | | |
| Case Material | Phenolic | Phenolic | Phenolic |
| Module Size, inches | 3.5x2.5x1.56 | 3.5x2.5x1.56 | 3.5x2.5x1.56 |
| Module Size, millimeters | 88,9x63,5x39,6 | 88,9x63,5x39,6 | 88,9x63,5x39,6 |
| Module Weight | 24 oz. (681g.) | 24 oz. (681g.) | 24 oz. (681g.) |
| Case/Pin Configuration | C3 | C3 | C3 |
| Other Versions | E,J | E,J | E,J |
| Mating Socket | MS-7 | MS-7 | MS-7 |
| Price (1-9) | $79.00 | $79.00 | $79.00 |

**THESE POWER SUPPLIES ARE COVERED BY GSA CONTRACT**

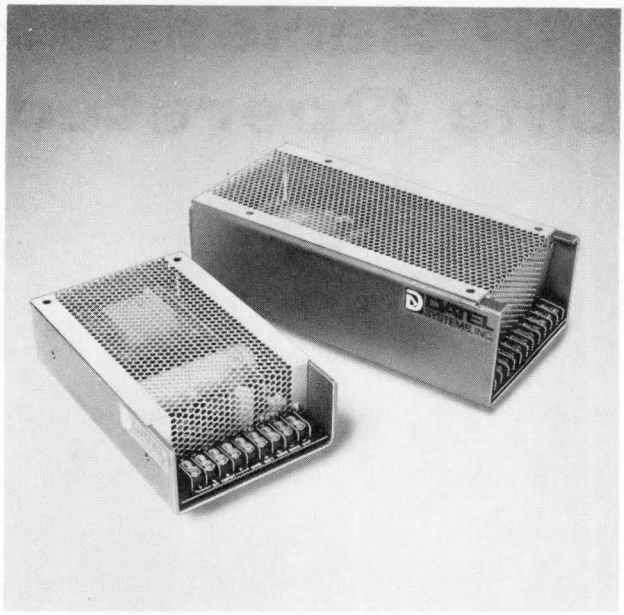
# MP Series: High Power, Line Operated Supplies

## MP SERIES: SUPPLIES FROM DATEL SYSTEMS ARE BETTER IN 12 WAYS

1. No output derating over 0°C to 65°C operation. Twice as much power available at 65°C compared with open frame type supplies.
2. No derating for 50 Hz operation. Open frame type supplies have 10% derating for 50 Hz operation.
3. Overvoltalge protection on 5 volt outputs is standard. This is optional on most open frame type supplies.
4. Barrier strip connector for input and output connections. Open frame type supplies require soldering connections directly to transformer and circuit board.
5. Aluminum cover protects power supply circuitry. Open frame type supplies have no cover.
6. High efficiency (40-50%) series regulated design. Open frame type supplies have efficiencies as low as 25%.
7. Rugged, four-sided anodized aluminum chassis has 3 different mounting positions.
8. Output current limiting protects supplies from short circuit or overload conditions.
9. Remote sensing with open lead protection is a standard feature.
10. No turn-on or turn-off overshoot for protection of your circuits.
11. Dual output supplies are tracking for best performance of your circuits.
12. Low prices start at $38.00 for 5V at 3 amps.

## CHECK THESE RELIABILITY FEATURES:

- ☑ Hermetically sealed series pass transistor with case temperature rise limited to 50°C.
- ☑ Computer grade 85°C aluminum electrolytic capacitors with conservative rating.
- ☑ Custom designed integral heat sink with conservative thermal design for cool operation.
- ☑ Layer wound, polyester impregnated transformer with integral Faraday shield.
- ☑ Single sided circuit board with wide conductor runs for best reliability.
- ☑ All heat generating components directly connected to heat sink.
- ☑ Low loss transformer and circuit technique to minimize internal power dissipation.
- ☑ 4 hour burn-in at full load and 65°C before shipment.



## GENERAL SPECIFICATIONS COMMON TO ALL MODELS

| | |
|---|---|
| **Input Voltage** | 115/230VAC ±10% |
| **Line Frequency** | 50-60 Hz |
| **Output Voltage Adjustment** | ±5% |
| **Output Ripple** | 1mV RMS, max. 3mV P-P typ. |
| **Transient Response** | 50 μsec. max. |
| **Output Protection** | Current Limiting or Foldback Limiting |
| **Overvoltage Protection, 5V outputs** | 6.2V ±5% |
| **Voltage Stability, after warmup** | ±0.25%, 24 hours |
| **Dual Output Tracking** | .05%, 0.1% over temp. range |
| **Operating Temperature Range** | 0°C to 71°C |
| **Storage Temperature Range** | -25°C to +85°C |

## DESCRIPTION

The MP Series high power, line operated supplies are new entries in the field of low cost, open frame type supplies. Although priced competitively with the open frame units, The MP Series offers significant advantage in performance and design features. The 16 models in this series offer popular single, dual, and triple outputs for use with data conversion devices, operational amplifiers, and other analog and digital circuits. Output power capability ranges from 15 Watts to 105 Watts and prices are from $38 to $149.

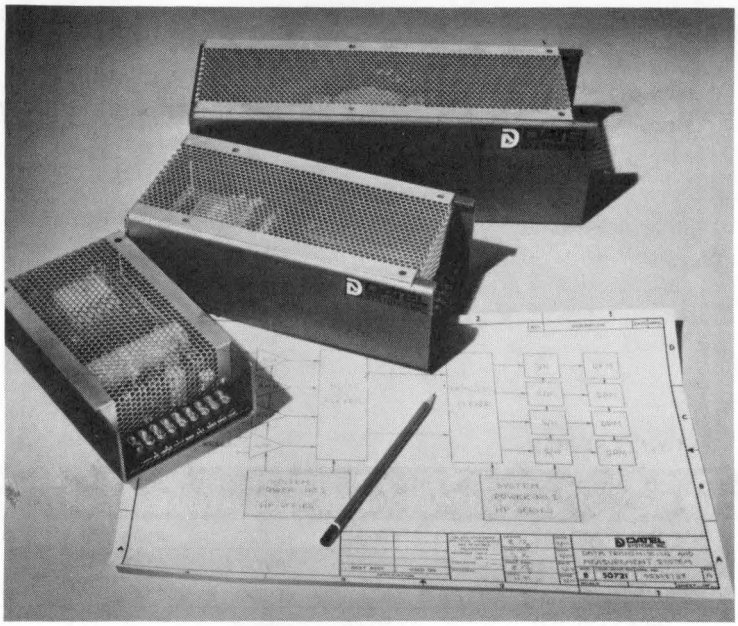
The unique feature of the MP Series over open frame type supplies is its conservative thermal design which results in full rated output over 0°C to 65°C ambient temperature and only 15% derating at 71°C. This results in approximately twice the output power at 65°C compared with open frame supplies. The careful attention to thermal design is evidenced by use of conservatively rated components including 85°C computer grade aluminum electrolytic capacitors, integral heat sink and chassis design, and a high efficiency linear regulator design. The power transformer is a low loss type with no derating for 50 Hz operation. It is layer wound with polyester impregnation, and incorporates a Faraday shield which is connected to chassis ground. Power supply efficiency is 50% for ±12V and ±15V outputs and 40% for 5V outputs.

Other significant features include output current limiting protection, .05% tracking of dual outputs, barrier strip terminal connector, ventilating protective cover, remote sensing with open lead protection, and ±5% output voltage adjustment by means of externally accessible trimming potentiometers. In addition, all 5V outputs have built-in overvoltage protection as a standard feature.

# MP Series: High Power, Line Operated Supplies

| MODEL | OUTPUT VOLTAGE & CURRENT (0 to 65°C) | OUTPUT I AT 71°C[1] | LINE REG. (MAX.)[2] | LOAD REG. (MAX.)[3] | TEMPCO (TYPICAL) | RIPPLE (RMS MAX.)[4] |
|---|---|---|---|---|---|---|
| **SINGLE OUTPUT** | | | | | | |
| **MPS-5/3** | 5V @ 3.0A | 2.5A | 0.1% | 0.1% | .01%/°C | 1mV |
| **MPS-5/6** | 5V @ 6.0A | 5.0A | 0.1% | 0.1% | .01%°C | 1mV |
| **MPS-5/12** | 5V @ 12.0A | 10.0A | 0.1% | 0.1% | .01%°C | 1mV |
| **MPS-5/18** | 5V @ 18.0A | 15.0A | 0.1% | 0.1% | .01%/°C | 1mV |
| **DUAL OUTPUT** | | | | | | |
| **MPD-12/1** | ±12V @ 1.0A | 0.85A | .05% | .05% | .01%/°C | 1mV |
| **MPD-15/1** | ±15V @ 1.0A | 0.85A | .05% | .05% | .01%/°C | 1mV |
| **MPD-12/1.5** | ±12V @ 1.5A | 1.25A | .05% | .05% | .01%/°C | 1mV |
| **MPD-15/1.5** | ±15* @ 1.5A | 1.25A | .05% | .05% | .01%/°C | 1mV |
| **MPD-12/3** | ±12V @ 3.0A | 2.5A | .05% | .05% | .01%/°C | 1mV |
| **MPD-15/3** | ±15V @ 3.0A | 2.5A | .05% | .05% | .01%/°C | 1mV |
| **TRIPLE OUTPUT** | | | | | | |
| **MPT-12/1-5/3** | ±12V @ 1A /5V @ 3A | 0.85/2.5A | .05/0.1% | .05/0.1% | .01%/°C | 1mV |
| **MPT-15/1-5/3** | ±15V @ 1A /5V @ 3A | 0.85/2.5A | .05/0.1% | .05/0.1% | .01%/°C | 1mV |
| **MPT-12/1.5-5/6** | ±12V @ 1.5A /5V @ 6A | 1.25/5.0A | .05/0.1% | .05/0.1% | .01%/°C | 1mV |
| **MPT-15/1.5-5/6** | ±15V @ 1.5A /5V @ 6A | 1.25/5.0A | .05/0.1% | .05/0.1% | .01%/°C | 1mV |
| **MPT-12/1.5-5/12** | ±12V @ 1.5A/5V @ 12A | 1.25/10.0A | .05/0.1% | .05/0.1% | .01%/°C | 1mV |
| **MPT-15/1.5-5/12** | ±15V @ 1.5V /5V @ 12A | 1.25/10.0A | .05/0.1% | .05/0.1% | .01%/°C | 1mV |

**NOTES** 1. 15% derating from 65°C output. 3. No load to full load. 5. 0.1% tracking over operating temp. range.
2. For ±10% line change. 4. Typically 3mV peak to peak.



| EFFICIENCY (NOM. LINE) | TRACKING (DUALS)[5] | REMOTE SENSING | OVER-VOLT. PROTECTION | CASE SIZE (HXWXL, INCHES/CM) | WEIGHT (LBS./KG) | PRICE (1-9) |
|---|---|---|---|---|---|---|
| 40% | — | YES | YES | 2.0X4.6X7.6 / 50,8X116,8X193,0 | 3.6/1,6 | $ 38.00 |
| 40% | — | YES | YES | 4.9X5.3X10.3 / 12,4X13,5X26,2 | 6.5/2,9 | $ 56.00 |
| 40% | — | YES | YES | 4.9X5.3X11.9 / 12,4X13,5X30,2 | 10.4/4,7 | $ 88.00 |
| 40% | — | YES | YES | 4.9X5.3X11.9 / 12,4X13,5X30,2 | 14.0/6,3 | $ 99.00 |
| 50% | .05% | YES | NO | 2.5X4.9X10.0 / 6,4X12,4X25,4 | 5.0/2,3 | $ 54.00 |
| 50% | .05% | YES | NO | 2.5X4.9X10.0 / 6,4X12,4X25,4 | 5.0/2,3 | $ 54.00 |
| 50% | .05% | YES | NO | 3.7X5.3X10.3 / 9,4X13,5X26,2 | 6.5/2,9 | $ 65.00 |
| 50% | .05% | YES | NO | 3.7X5.3X10.3 / 9,4X13,5X26,2 | 6.5/2,9 | $ 65.00 |
| 50% | .05% | YES | NO | 4.9X5.3X10.3 / 12,4X13,5X26,2 | 10.5/4,8 | $ 95.00 |
| 50% | .05% | YES | NO | 4.9X5.3X10.3 / 12,4X13,5X26,2 | 10.5/4,8 | $ 95.00 |
| 45% | .05% | 5V ONLY | 5V ONLY | 3.4X4.9X11.0 / 8,6X12,4X27,9 | 11.0/5,0 | $ 85.00 |
| 45% | .05% | 5V ONLY | 5V ONLY | 3.4X4.9X11.0 / 8,6X12,4X27,9 | 11.0/5,0 | $ 85.00 |
| 45% | .05% | 5V ONLY | 5V ONLY | 4.9X5.3X14.0 / 12,4X13,5X35,6 | 14.0/6,3 | $116.00 |
| 45% | .05% | 5V ONLY | 5V ONLY | 4.9X5.3X14.0 / 12,4X13,5X35,6 | 14.0/6,3 | $116.00 |
| 45% | .05% | 5V ONLY | 5V ONLY | 4.9X5.3X15.6 / 12,4X13,5X39,6 | 17.0/7,7 | $149.00 |
| 45% | .05% | 5V ONLY | 5V ONLY | 4.9X5.3X15.6 / 12,4X13,5X39.6 | 17.0/7,7 | $149.00 |

# 1 and 3 Watt DC-DC Converters

**1 WATT SERIES**

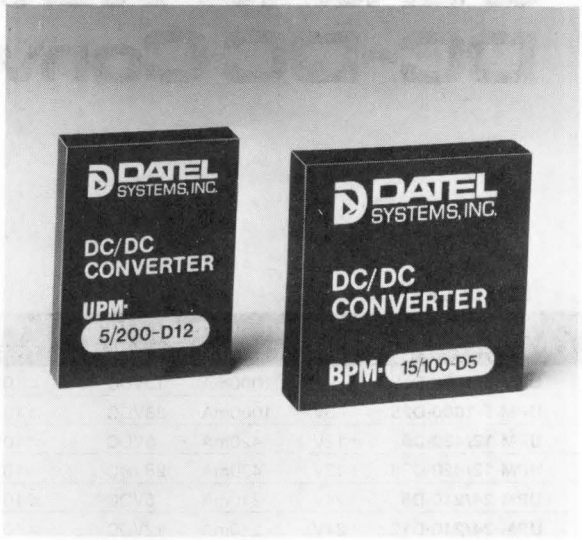
| MODEL | OUTPUT VOLTAGE | OUTPUT CURRENT | INPUT VOLTAGE | INPUT VOLT. TOLERANCE | NO LOAD INPUT CURRENT | FULL LOAD INPUT CURRENT | EFFICIENCY (FULL LOAD) | LINE REGULATION |
|---|---|---|---|---|---|---|---|---|
| **UPM-5/200-D12** | + 5V | 200mA | 12VDC | ±10% | 40mA | 170mA | 50% | .05% |
| **UPM-5/200-D28** | + 5V | 200mA | 28VDC | ±10% | 10mA | 75mA | 50% | .05% |
| **UPM-12/80-D5** | +12V | 80mA | 5VDC | ±10% | 85mA | 360mA | 53% | .05% |
| **UPM-12/80-D28** | +12V | 80mA | 28VDC | ±10% | 15mA | 62mA | 55% | .05% |
| **UPM-24/40-D5** | +24V | 40mA | 5VDC | ±10% | 95mA | 350mA | 55% | .05% |
| **UPM-24/40-D12** | +24V | 40mA | 12VDC | ±10% | 40mA | 145mA | 55% | .05% |
| **UPM-28/25-D5** | +28V | 25mA | 5VDC | ±10% | 95mA | 250mA | 55% | .05% |
| **UPM-28/25-D12** | +28V | 25mA | 12VDC | ±10% | 40mA | 105mA | 55% | .05% |
| **BPM-12/25-D5** | ±12V | 25mA | 5VDC | ±10% | 95mA | 210mA | 58% | .05% |
| **BPM-12/25-D12** | ±12V | 25mA | 12VDC | ±10% | 40mA | 85mA | 60% | .05% |
| **BPM-12/25-D28** | ±12V | 25mA | 28VDC | ±10% | 15mA | 36mA | 60% | .05% |
| **BPM-15/25-D5** | ±15V | 25mA | 5VDC | ±10% | 95mA | 260mA | 58% | .05% |
| **BPM-15/25-D12** | ±15V | 25mA | 12VDC | ±10% | 40mA | 105mA | 60% | .05% |
| **BPM-15/25-D28** | ±15V | 25mA | 28VDC | ±10% | 15mA | 45mA | 60% | .05% |
| **BPM-18/25-D5** | ±18V | 25mA | 5VDC | ±10% | 95mA | 310mA | 58% | .05% |
| **BPM-18/25-D12** | ±18V | 25mA | 12VDC | ±10% | 40mA | 125mA | 60% | .05% |
| **BPM-18/25-D28** | ±18V | 25mA | 28VDC | ±10% | 15mA | 55mA | 60% | .05% |

**3 WATT SERIES**

| MODEL | OUTPUT VOLTAGE | OUTPUT CURRENT | INPUT VOLTAGE | INPUT VOLTAGE TOLER. | NO LOAD INPUT CURRENT | FULL LOAD INPUT CURRENT | EFFICIENCY (FULL LOAD) | LINE REGULATION |
|---|---|---|---|---|---|---|---|---|
| **UPM-5/500-D5** | +5V | 500mA | 5VDC | ±10% | 240mA | 1100mA | 45% | .05% |
| **UPM-5/500-D12** | +5V | 500mA | 12VDC | ±10% | 90mA | 430mA | 48% | .05% |
| **UPM-5/500-D28** | +5V | 500mA | 28VDC | ±10% | 32mA | 180mA | 50% | .05% |
| **UPM-12/250-D5** | +12V | 250mA | 5VDC | ±10% | 240mA | 1100mA | 55% | .05% |
| **UPM-12/250-D28** | +12V | 250mA | 28VDC | ±10% | 30mA | 195mA | 55% | .05% |
| **UPM-24/125-D5** | +24V | 125mA | 5VDC | ±10% | 240mA | 1100mA | 55% | .05% |
| **UPM-24/125-D12** | +24V | 125mA | 12VDC | ±10% | 75mA | 450mA | 55% | .05% |
| **UPM-28/100-D5** | +28V | 100mA | 5VDC | ±10% | 200mA | 1000mA | 55% | .05% |
| **UPM-28/100-D12** | +28V | 100mA | 12VDC | ±10% | 75mA | 420mA | 55% | .05% |
| **BPM-12/100-D5** | ±12V | 100mA | 5VDC | ±10% | 190mA | 900mA | 53% | .05% |
| **BPM-12/100-D12** | ±12V | 100mA | 12VDC | ±10% | 75mA | 410mA | 50% | .05% |
| **BPM-12/100-D28** | ±12V | 100mA | 28VDC | ±10% | 30mA | 156mA | 55% | .05% |
| **BPM-15/100-D5** | ±15V | 100mA | 5VDC | ±10% | 240mA | 1100mA | 53% | .05% |
| **BPM-15/100-D12** | ±15V | 100mA | 12VDC | ±10% | 85mA | 470mA | 53% | .05% |
| **BPM-15/100-D28** | ±15V | 100mA | 28VDC | ±10% | 30mA | 195mA | 55% | .05% |
| **BPM-18/100-D5** | ±18V | 100mA | 5VDC | ±10% | 200mA | 1360mA | 53% | .05% |
| **BPM-18/100-D12** | ±18V | 100mA | 12VDC | ±10% | 75mA | 545mA | 55% | .05% |
| **BPM-18/100-D28** | ±18V | 100mA | 28VDC | ±10% | 30mA | 235mA | 55% | .05% |

**THESE POWER SUPPLIES ARE COVERED BY GSA CONTRACT**

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461




| LOAD REGULATION | TEMP. COEFFICIENT | OUTPUT IMPEDANCE | CASE CONFIG. | PRICE (1-9) |
|---|---|---|---|---|
| 0.1% | .02%/°C | .07Ω | F | $42.00 |
| 0.1% | .02%/°C | .07Ω | F | $42.00 |
| .05% | .02%/°C | 0.2Ω | F | $42.00 |
| .05% | .02%/°C | 0.2Ω | F | $42.00 |
| .05% | .02%/°C | 0.2Ω | F | $42.00 |
| .05% | .02%/°C | 0.2Ω | F | $42.00 |
| .05% | .02%/°C | 0.2Ω | F | $42.00 |
| .05% | .02%/°C | 0.2Ω | F | $42.00 |
| .05% | .02%/°C | 0.2Ω | F | $49.00 |
| .05% | .02%/°C | 0.2Ω | F | $49.00 |
| .05% | .02%/°C | 0.2Ω | F | $49.00 |
| .05% | .02%/°C | 0.2Ω | F | $49.00 |
| .05% | .02%/°C | 0.2Ω | F | $49.00 |
| .05% | .02%/°C | 0.2Ω | F | $49.00 |
| .05% | .02%/°C | 0.2Ω | F | $49.00 |
| .05% | .02%/°C | 0.2Ω | F | $49.00 |

| LOAD REGULATION | TEMP. COEFFICIENT | OUTPUT IMPEDANCE | CASE CONFIG. | PRICE (1-9) |
|---|---|---|---|---|
| 0.1% | .02%/°C | .07Ω | G1 | $64.00 |
| 0.1% | .02%/°C | .07Ω | G1 | $64.00 |
| 0.1% | .02%/°C | .07Ω | G1 | $64.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $64.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $64.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $64.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $64.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $64.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $64.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $69.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $69.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $69.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $69.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $69.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $69.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $69.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $69.00 |
| .05% | .02%/°C | 0.2Ω | G1 | $69.00 |

## DESCRIPTION

This broad line of DC-DC converters features 17 one watt models and 18 three watt models with single and dual output voltages. Input voltages are 5, 12, and 28V with single outputs of 5, 12, 24, and 28V, and dual outputs of ±12, ±15, and ±18V. Output voltage accuracies are ±1% with .02%/°C temperature coefficient. Other features include low output ripple, 100 megohm isolation, grounded internal copper shield, and output current limiting.

## GENERAL SPECIFICATIONS — ALL MODELS

| | |
|---|---|
| Output Voltage Accuracy | ±1% |
| Output Noise and Ripple, max. | 20mV P-P (2mV RMS) |
| Back Ripple Current, max. | 1% of $I_{IN}$ |
| Capacitive Coupling, max. | 250 pF |
| Breakdown Voltage, min. | 300VDC |
| Transient Recovery Time, max. | 50μsec. |
| Operating Temp. Range | −25°C to +71°C |
| Storage Temp. Range | −55°C to +85°C |
| Internal Shield | Copper, connected to common |
| Case Material | Diallyl Phthalate |

## MODULE SIZES

| | |
|---|---|
| F Case: | 1.5X2.0X0.375 inches<br>38,1X50,8X9,5 mm |
| Weight: | 1.5 oz. (43g.) |
| G1 Case: | 2.0X2.0X0.432 inches<br>50,8X50,8X11,0 mm |
| Weight: | 2.5 oz. (71g.) |

Both 1 and 3 watt series use 2 DILS-1 or DILS-2 terminal strips (at $5.00/pair) for sockets.

# 5 and 10 Watt DC-DC Converters

**5 WATT SERIES**

| MODEL | OUTPUT VOLTAGE | OUTPUT CURRENT | INPUT VOLTAGE | INPUT VOLTAGE TOLER. | NO LOAD INPUT CURRENT | FULL LOAD INPUT CURRENT | EFFICIENCY (FULL LOAD) | LINE REGULATION |
|---|---|---|---|---|---|---|---|---|
| UPM-5/1000-D12 | +5V | 1000mA | 12VDC | ±10% | 88mA | 776mA | 54% | .05% |
| UPM-5/1000-D28 | +5V | 1000mA | 28VDC | ±10% | 45mA | 300mA | 60% | .05% |
| UPM-12/420-D5 | +12V | 420mA | 5VDC | ±10% | 300mA | 1800mA | 56% | .05% |
| UPM-12/420-D28 | +12V | 420mA | 28VDC | ±10% | 40mA | 270mA | 67% | .05% |
| UPM-24/210-D5 | +24V | 210mA | 5VDC | ±10% | 300mA | 1800mA | 56% | .05% |
| UPM-24/210-D12 | +24V | 210mA | 12VDC | ±10% | 80mA | 760mA | 55% | .05% |
| UPM-28/180-D5 | +28V | 180mA | 5VDC | ±10% | 300mA | 1800mA | 56% | .05% |
| UPM-28/180-D12 | +28V | 180mA | 12VDC | ±10% | 80mA | 760mA | 55% | .05% |
| BPM-12/210-D5 | ±12V | 210mA | 5VDC | ±10% | 330mA | 1800mA | 56% | .05% |
| BPM-12/210-D12 | ±12V | 210mA | 12VDC | ±10% | 110mA | 660mA | 64% | .05% |
| BPM-12/210-D28 | ±12V | 210mA | 28VDC | ±10% | 43mA | 278mA | 65% | .05% |
| BPM-15/165-D5 | ±15V | 165mA | 5VDC | ±10% | 370mA | 1750mA | 56% | .05% |
| BPM-15/165-D12 | ±15V | 165mA | 12VDC | ±10% | 110mA | 660mA | 63% | .05% |
| BPM-15/165-D28 | ±15V | 165mA | 28VDC | ±10% | 43mA | 278mA | 64% | .05% |
| BPM-18/140-D5 | ±18V | 140mA | 5VDC | ±10% | 370mA | 1750mA | 58% | .05% |
| BPM-18/140-D12 | ±18V | 140mA | 12VDC | ±10% | 110mA | 660mA | 64% | .05% |
| BPM-18/140-D28 | ±18V | 140mA | 28VDC | ±10% | 43mA | 278mA | 65% | .05% |

**10 WATT SERIES**

| MODEL | OUTPUT VOLTAGE | OUTPUT CURRENT | INPUT VOLTAGE | INPUT VOLTAGE TOLER. | NO LOAD INPUT CURRENT | FULL LOAD INPUT CURRENT | EFFICIENCY (FULL LOAD) | LINE REGULATION |
|---|---|---|---|---|---|---|---|---|
| UPM-5/2000-D12 | +5V | 2000mA | 12VDC | ±10% | 105mA | 1700mA | 49% | .05% |
| UPM-5/2000-D28 | +5V | 2000mA | 28VDC | ±10% | 38mA | 550mA | 65% | .05% |
| UPM-12/840-D5 | +12V | 840mA | 5VDC | ±10% | 400mA | 3680mA | 55% | .05% |
| UPM-12/840-D28 | +12V | 840mA | 28VDC | ±10% | 38mA | 550mA | 65% | .05% |
| UPM-24/420-D5 | +24V | 420mA | 5VDC | ±10% | 400mA | 3400mA | 59% | .05% |
| UPM-24/420-D12 | +24V | 420mA | 12VDC | ±10% | 118mA | 1230mA | 68% | .05% |
| UPM-28/360-D5 | +28V | 360mA | 5VDC | ±10% | 400mA | 3400mA | 59% | .05% |
| UPM-28/360-D12 | +28V | 360mA | 12VDC | ±10% | 118mA | 1230mA | 68% | .05% |
| BPM-12/420-D5 | ±12V | 420mA | 5VDC | ±10% | 600mA | 3600mA | 56% | .05% |
| BPM-12/420-D12 | ±12V | 420mA | 12VDC | ±10% | 150mA | 1410mA | 60% | .05% |
| BPM-12/420-D28 | ±12V | 420mA | 28VDC | ±10% | 56mA | 613mA | 59% | .05% |
| BPM-15/330-D5 | ±15V | 330mA | 5VDC | ±10% | 600mA | 3600mA | 55% | .05% |
| BPM-15/330-D12 | ±15V | 330mA | 12VDC | ±10% | 150mA | 1410mA | 59% | .05% |
| BPM-15/330-D28 | ±15V | 330mA | 28VDC | ±10% | 56mA | 613mA | 58% | .05% |
| BPM-18/280-D5 | ±18V | 280mA | 5VDC | ±10% | 600mA | 3600mA | 56% | .05% |
| BPM-18/280-D12 | ±18V | 280mA | 12VDC | ±10% | 150mA | 1410mA | 60% | .05% |
| BPM-18/280-D28 | ±18V | 280mA | 28VDC | ±10% | 56mA | 613mA | 59% | .05% |

**THESE POWER SUPPLIES ARE COVERED BY GSA CONTRACT**

NEW

| LOAD REGULATION | TEMP. COEFFICIENT | OUTPUT IMPEDANCE | CASE CONFIG. | PRICE (1-9) |
|---|---|---|---|---|
| 0.1% | .02%/°C | .005Ω | G2 | $69.00 |
| 0.1% | .02%/°C | .005Ω | G2 | $69.00 |
| .05% | .02%/°C | .015Ω | G2 | $69.00 |
| .05% | .02%/°C | .15Ω | G2 | $69.00 |
| .05% | .02%/°C | .03Ω | G2 | $69.00 |
| .05% | .02%/°C | .03Ω | G2 | $69.00 |
| .05% | .02%/°C | .035Ω | G2 | $69.00 |
| .05% | .02%/°C | .035Ω | G2 | $69.00 |
| .05% | .02%/°C | .03Ω | G2 | $75.00 |
| .05% | .02%/°C | .03Ω | G2 | $75.00 |
| .05% | .02%/°C | .03Ω | G2 | $75.00 |
| .05% | .02%/°C | .03Ω | G2 | $75.00 |
| .05% | .02%/°C | .03Ω | G2 | $75.00 |
| .05% | .02%/°C | .03Ω | G2 | $75.00 |
| .05% | .02%/°C | .03Ω | G2 | $75.00 |
| .05% | .02%/°C | .03Ω | G2 | $75.00 |
| .05% | .02%/°C | .03Ω | G2 | $75.00 |

NEW

| LOAD REGULATION | TEMP. COEFFICIENT | OUTPUT IMPEDANCE | CASE CONFIG. | PRICE (1-9) |
|---|---|---|---|---|
| 0.1% | .02%/°C | .005Ω | CB | $89.00 |
| 0.1% | .02%/°C | .005Ω | CB | $89.00 |
| .05% | .02%/°C | .02Ω | CB | $89.00 |
| .05% | .02%/°C | .02Ω | CB | $89.00 |
| .05% | .02%/°C | .02Ω | CB | $89.00 |
| .05% | .02%/°C | .02Ω | CB | $89.00 |
| .05% | .02%/°C | .02Ω | CB | $89.00 |
| .05% | .02%/°C | .02Ω | CB | $89.00 |
| .05% | .02%/°C | .02Ω | CB | $94.00 |
| .05% | .02%/°C | .02Ω | CB | $94.00 |
| .05% | .02%/°C | .02Ω | CB | $94.00 |
| .05% | .02%/°C | .02Ω | CB | $94.00 |
| .05% | .02%/°C | .02Ω | CB | $94.00 |
| .05% | .02%/°C | .02Ω | CB | $94.00 |
| .05% | .02%/°C | .02Ω | CB | $94.00 |
| .05% | .02%/°C | .02Ω | CB | $94.00 |
| .05% | .02%/°C | .02Ω | CB | $94.00 |


## DESCRIPTION

This comprehensive line of higher power DC-DC converters features 34 different models with both single and dual outputs. Input voltages are 5, 12, and 28V with single output voltages of 5, 12, 24, and 28 volts, and dual outputs of ±12, ±15, and ±18 volts. Output voltage accuracies are ±1% with .02%/°C temperature coefficients. Other features include low output ripple, 100 megohm isolation, grounded internal copper shield, and output current limiting protection.

## GENERAL SPECIFICATIONS — ALL MODELS

| | |
|---|---|
| Output Voltage Accuracy | ±1% |
| Output Noise and Ripple, max. | 20mV P-P (2mV RMS) |
| Back Ripple Current, max. | 1% of $I_{IN}$ |
| Capacitive Coupling, max. | 250 pF |
| Breakdown Voltage, min. | 300VDC |
| Transient Recovery Time, max. | 50μsec. |
| Operating Temp. Range | −25°C to +71°C |
| Storage Temp. Range | −55°C to +85°C |
| Internal Shield | Copper, connected to common |
| Case Material | Diallyl Phthalate (G2)<br>Phenolic (CB) |

## MODULE SIZES

| | |
|---|---|
| G2 Size: | 2.0X2.0X.750 inches<br>50,8X50,8X19,1mm |
| Weight | 4.5 oz. (128g.) |
| CB Size: | 3.5X2.5X.875 inches<br>88,9X63,5X22,2 mm |
| Weight | 14 oz. (397g.) |

The 5 watt series use 2 DILS-1 or DILS-2 terminal strips (at $5.00/pair) for sockets. The 10 watt series use the MS-7 socket at $3.50 each.

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TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# 4.5 Watt DC-DC Converters

These miniature, aluminum cased DC-DC converters are ideal for applications where mounting space is tight, yet highly regulated ±15VDC is required at up to 150mA output current. Specifications include voltage accuracy of ±1%, line regulation of .05% max., load regulation of .05% max., and tempco of .005%/°C. For convenient heat sinking, two 2-56 studs are provided on the bottom of the case. All models have output current limiting protection.


### OTHER SPECIFICATIONS

| | |
|---|---|
| Isolation Resistance, min. | 100 Meg. |
| Isolation Capacitance, max. | 100 pF |
| Breakdown Voltage, min. | 300VDC |
| Operating Temp. Range | −25° to +71°C |
| Storage Temp. Range | −55°C to +85°C |

MS-6 sockets are $3.50 each.

NEW

| SPECIFICATIONS, 25°C | BPM-15/150-D5 | BPM-15/150-D24 | BPM-15/150-D28 |
|---|---|---|---|
| **Output Voltage** | ±15VDC | ±15VDC | ±15VDC |
| **Output Voltage Accuracy** | ±1% | ±1% | ±1% |
| **Rated Output Current**[1] | ±150mA | ±150mA | ±150mA |
| **Input Voltage** | 5VDC | 24VDC | 28VDC |
| **Input Voltage Tolerance** | ±.25V | ±3.5V | ±4V |
| **Maximum Input Current** | 1.75A | 0.35A | 0.3A |
| **Efficiency, full load** | 51% | 54% | 54% |
| **Line Regulation, max.** | .05% | .05% | .05% |
| **Load Regulation, max.** | .05% | .05% | .05% |
| **Temperature Coefficient, max.** | .005%/°C | .005%/°C | .005%/°C |
| **Output Ripple RMS max.** | 1mV | 1mV | 1mV |
| **Output Impedance, max.** | .05Ω | .05Ω | .05Ω |
| **Transient Recovery Time, max.** | 50μsec. | 50μsec | 50μsec. |
| **Case Material** | Aluminum | Aluminum | Aluminum |
| **Module Size, inches** | 2.0X2.0X0.4 | 2.0X2.0X0.4 | 2.0X2.0X0.4 |
| **Module Size, millimeters** | 50,8X50,8X10,2 | 50,8X50,8X10,2 | 50,8X50,8X10,2 |
| **Module Weight** | 3.0 oz.(85g) | 3.0 oz.(85g) | 3.0 oz.(85g) |
| **Case/Pin Configuration** | B | B | B |
| **Mating Socket** | MS-6 | MS-6 | MS-6 |
| **Price (1-9)** | **$79.00** | **$79.00** | **$79.00** |

**THESE POWER SUPPLIES ARE COVERED BY GSA CONTRACT**

**NOTE:**

1. Above 35°C (95°F) mounting surface temperature, derate 1.3mA/°C.

# Model 1200: μC Supply

Model 1200 microcomputer supply is a DC-DC converter designed to operate from a 5 volt logic supply to power a CPU and 4K of memory. The output voltages of +12, −5, and −9V in conjunction with the 5V input will power an 8080 CPU and four 2107A RAM's or four 1702A ROM'S. This supply operates with a full load efficiency of 58% and has output current limiting protection.

Operating temperature range is −25°C to +71°C and storage temperature range is −55°C to +85°C.

Mating sockets, 2 DILS-1 or DILS-2 terminal strips, are $5.00 per pair.


NEW

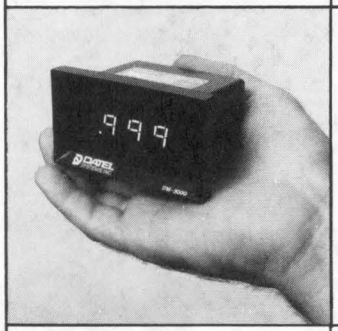
| SPECIFICATIONS, 25°C | MODEL 1200 |
|---|---|
| Outputs | +12VDC @ 160mA |
| | −9VDC @ 300mA |
| | −5VDC @ 2mA |
| Output Voltage Accuracy | ±1% (+12V & −9V), ±5% (−5V) |
| Input Voltage | 5VDC ±0.25V |
| Input Current, no load | 0.3 Amp. |
| Input Current, full load | 1.6 Amp. |
| Efficiency, full load | 58% |
| Line Regulation, max., all outputs | .05% |
| Load Regulation, max., +12V out | .05% |
| Load Regulation, max., −9V out | 0.1% |
| Load Regulation, max., −5V out | 1.0% |
| Temperature Coefficient, max. | .02%/°C |
| Output Ripple, RMS max. | 1mV |
| Transient Recovery Time, max. | 25μsec. |
| Case Material | Diallyl Phthalate |
| Module Size, inches | 2.0X2.0X0.75 |
| Module Size, millimeters | 50,8X50,8X19,1 |
| Module Weight | 4.5 oz.(128g) |
| Case/Pin Configuration | K |
| Mating Socket | DILS-1, DILS-2 |
| Price (1-9) | **$89.00** |

**THIS POWER SUPPLY IS COVERED BY GSA CONTRACT**

# DATEL

# DIGITAL PANEL METER SHORT FORM GUIDE
## SPECIFICATIONS • COVERED BY GSA CONTRACT

| DATEL MODEL ▶ | DM-350<br>3-1/2 Digits .43" H Displays<br>AC or +5 VDC Portable Display Only | DM-3000<br>3 digit, 0 to +1V Input DPM/Counter<br>.43"H Displays +5V Power, $99 | DM-2100<br>3-1/2 digits ±200mV, ±2V<br>Differential Input, +5V Power, $129 |
|---|---|---|---|




**SPECIFICATIONS COMMON TO ALL MODELS**

**PHYSICAL**

Case Size . . . . . 3"W x 1.75"H x 2.25"D (76,2 x 44,5 x 57,2 mm)

Case Material . . . . . Black Polycarbonate plastic. Impact and Chemical resistant.

Front Panel Cutout & Mounting . . Through a 1.812" x 3.062" (46 x 77,8 mm) cutout secured by (4) 4-40 flathead screws

Temperature Ranges
- Operating . . . . . 0 to +50° C
- Storage . . . . . −55° to +85° C

| | Specifications (typical at +25° C unless noted) | | |
|---|---|---|---|
| **ANALOG INPUT** | | | |
| Configuration | Single Ended, Unipolar or Bipolar | Single-ended unipolar | Differential Bipolar |
| Range, Full Scale | 0 to +1.999V or ±1.999V | 0 to +999mV, (+9.99, +99.9V opt) | ±199.9mV or ±1.999V |
| CMR | 70 db @ DC (AC Models Only) | NA (unipolar) | 70dB, DC to 60Hz (See ordering |
| CMV | ±300 VDC (AC Models Only) | NA (unipolar) | ±2V to logic gnd. guide) |
| Bias Current | 45nA typ, 500 nA Max. | 100nA typ, 250nA max | 20nA |
| Impedance | 100 Megohms, Min. | 100 Megohms, min (1V), .1mΩ (10,100V) | 100 Megohms, min |
| **PERFORMANCE** | | | |
| Accuracy | Adj. to ±0.05% of F.S. ±1 Digit | Adj. to ±0.1% of Reading ±1 digit | Adj. to ±0.05% of Reading ±1 digit |
| Temp Drift | ±100ppm FS/°C typ. | ±100ppm FS/° C max | ±50ppm FS/° C max |
| Sample Rate | 2 Samples Per Sec, Adj. | 0 to 250 Samples per Sec | 0 to 200 Samples per Sec |
| LED Digit Height | 0.43" (11 mm) | 0.43" (11 mm) | 0.30" (7,6 mm) |
| BCD Outputs | NONE | Full parallel Std. | Full parallel Std. |
| Power Supply | AC Line or +5 VDC, 300 mA Max. | +5VDC, 800 mA max | +5VDC, 650mA max |
| **NOTES** | Low Cost for Display Only Applications | DM-3000 has count and reset inputs and optional crystal clock so that it can be configured as a 10Mz counter, frequency meter, tachometer or 4-wire slave display. | DM-2100 has true differential bi-polar inputs and choice of ±200mV or ±2V input ranges. |

**ORDERING GUIDE**

Datel's products are available both direct and through GSA. If you are connected with a military or federal agency or receive federal funds, you may be entitled to purchase Datel's Digital Panel Meters and other products through the General Services Administration. Datel's DPM's are approved under FSC Group 66-17, Part II, GSA Contract No. GS-00S-27959. Contact Datel for assistance.

DM-350

POWER SUPPLY
- D=5VDC
- A=115 or 230 VAC (User-selected on rear connector)

INPUT POLARITY
- 1= Unipolar 0 to +1.999V
- 2= Bipolar -1.999V to +1.999V

DM-3000

500KHz Clock
- R=Ceramic Resonator
- X=Quartz Crystal

Input Range and Resistance
- 1=0 to +999mV 100MΩ impedance
- 2=0 to +9.99V 100KΩ impedance
- 3=0 to +99.9V 100KΩ impedance

DM-2100

Input Range
- A=±199.9mV
- B=±1.999V

Another version of the DM-2100 (model DM-1100) has special options available (optoisolation, low input bias, input filter, etc.) Contact Datel for details.

| | | | |
|---|---|---|---|
| **PRICES (1-9 quantity)** (contact Datel for quantity discounts and International prices and GSA orders) | DM-350D1 (5V, unipolar) . . . . . $69<br>DM-350D2 (5V, bipolar) . . . . . $75<br>DM-350A1 (AC, unipolar) . . . . . $79<br>DM-350A2 (AC, bipolar) . . . . . $89 | DM-3000RI . . . . . $99<br>for 10V or 100V inputs . . add $10<br>for crystal clock . . . . . add $10 | DM2100A . . . . . $129<br>DM2100B . . . . . $129 |
| **DPM CONNECTORS** (not included with DPM). Dual 18-pin, PC-type | 2335-1 (Solder Tab) . . . . . $4.95<br>2335-2 (Wire Wrap) . . . . . $4.95 | 2335-1 (solder tab) . . . . . $4.95<br>2335-2 (wire wrap) . . . . . $4.95 | 2335-1 (solder tab) . . . . . $4.95<br>2335-2 (wire wrap) . . . . . $4.95 |
| **Suggested +5VDC POWER SUPPLY** (not included with DPM) See Pg. 4 | Not Required On AC Powered Versions | UPM-5/1000B Power Supply $49.00<br>MS-7 Power Supply Socket $3.50 | UPM-5/1000B Power Supply $49.00<br>MS-7 Power Supply Socket $3.50 |
| **FOR FURTHER INFORMATION** | SEE PAGE 184 | SEE PAGE 186 | SEE PAGE 191 |

# DIGITAL PANEL METER SHORT FORM GUIDE
# SPECIFICATIONS • COVERED BY GSA CONTRACT

DATEL

| DM-2115 | DM-2000AR | DM-4000 | DM-4300 |
|---|---|---|---|
| 3-1/2 digits .43"H Displays<br>AC or +5V portable Differential, $159 | 3-1/2 digit Autoranging ±200mV,<br>2V, 20V Input Ranges, $169 | 4-1/2 digit, ±2V Input Autozeroed<br>Optoisolated Ratiometric, $219 | 4-3/4 digit, ±4V Input Autozeroed<br>Optoisolated Ratiometric $235 |

**DIGITAL CONTROLS & OUTPUTS – All digital controls and outputs are compatible with TTL logic levels**

**All panel meters have the following controls and outputs:**

Internal Start Clock . . . . . Internal TTL start clock trigger pulse, initially set at two samples per second

External Start Adjust . . . . External adjustment of internal start clock sample rate, (not included DM-4000, 4300)

Internal Start Gate . . . . . Provides external asynchronous gating of the internal start clock, or for hold to read.

BCD Data Outputs . . . . . Full parallel binary coded decimal (BCD) outputs are valid when the EOC pulse goes low. BCD is standard on all models except the DM-2115, DM-4000, and DM-4300 where it is optional. Overrange bit on all models except DM-3000.

Overflow . . . . . Overflow output indicates when full scale input has been exceeded.

EOC . . . . . End of Conversion (Status or Busy) indicates when conversion is complete and BCD output data is valid.

Sign . . . . . Automatically indicates polarity of input (except unipolar DM-3000).

Decimal Points . . . . . Any left-of-full-digit decimal points may be illuminated by grounding appropriate rear PC connector pins (except DM-2000AR which automatically lights the proper decimal point).

Input/Output Connector . . Dual 18-pin PC edge-board type, 0.1" centers, Viking 3VH18/1JN-5, or equivalent $4.95.

Displays . . . . . All digits are red LED (Light Emitting Diode) 7-segment displays with automatic overflow indication and autopolarity (except unipolar DM-3000)

| DM-2115 | DM-2000AR | DM-4000 | DM-4300 |
|---|---|---|---|
| Differential Bipolar<br>0 to ±1.999 Volts<br>70dB, DC to 60Hz<br>±3V to logic gnd.<br>3nA typ, 2nA max<br>100 Megohms, min | Single-ended Bipolar floating (opt)<br>0 to ±199.9mV, ±1.999V, ±19.99V<br>70 dB, DC to 60Hz (optional)<br>±100V to logic gnd (optional)<br>2nA<br>1 Megohm to summing junction | Differential Bipolar floating<br>0 to ±1.9999 Volts<br>120dB, DC to 60Hz<br>±300V to logic gnd<br>100pA max<br>100 Megohms, min | Differential Bipolar floating<br>0 to ±3.9999 Volts<br>120dB, DC to 60Hz<br>±300V to logic gnd<br>100pA max<br>100 Megohms, min |
| Adj. to ±0.05% of Reading ±1 digit<br>±50ppm FS/° C max<br>0 to 40 Samples per Sec<br>0.43" (11 mm)<br>Full parallel optional<br>AC line or +5VDC, 400mA max | Adj. to ±0.1% of Full Scale ±1 digit<br>±100ppm FS/° C max<br>0 to 30 samples per Sec<br>0.30" (7,6 mm)<br>Full parallel Std.<br>+5VDC, 800m A max | Adj. to ±0.01% of Reading ±1 digit<br>±15ppm/° C of Reading max<br>0 to 5 samples per Sec<br>0.43" (11 mm)<br>Full parallel optional<br>+5VDC, 600mA max | Adj. to ±0.01% of Reading ±1 digit<br>±15ppm/° C of Reading, max<br>0 to 3.3 samples per Sec<br>0.30" (7,6 mm)<br>Full parallel optional<br>+5VDC, 600mA max |
| DM-2115 may be operated AC or portable with +5VDC, 400mA max power. With blanked display, current drops to 120mA, ideal for "press to read" instruments. | DM-2000AR is a 3-decade autoranging DPM which automatically switches ranges and decimal point over ±0.2V, ±2V, and ±20V Full Scale. | DM-4000 features optoisolated inputs, crystal oscillator counter for 60dB NMR AC line noise rejection and autozeroing to eliminate residual offset errors. DM-4000 includes a 3-wire ratiometric input. | DM-4300 features optoisolated inputs, crystal oscillator counter for 60dB NMR AC line noise rejection and autozeroing to eliminate residual offset errors. DM-4300 includes a 3-wire ratiometric input. |
| DM-2115<br>Power Supply<br>A=115VAC<br>E=230VAC<br>J=100VAC<br>D=+5VDC<br>(AC, 47 to 440Hz)<br>Full Parallel BCD Output<br>1=without<br>2=with | DM-2000AR<br>Add suffix –2 for optoisolated differential input<br>(DM-2000AR less optoisolation has a single-ended input to logic ground) | DM-4000<br>Parallel TTL BCD Output<br>A=without<br>B=with<br>Synch. to AC line frequency of<br>5=50Hz<br>6=60Hz | DM-4300<br>Parallel TTL BCD Output<br>A=without<br>B=with<br>Synch. to AC line frequency of<br>5=50Hz<br>6=60Hz |
| DM-2115 +5V, no BCD . . . . $129<br>DM-2115 +5V, with BCD. . . . $145<br>DM-2115 AC, no BCD . . . . . $159<br>DM-2115 AC, with BCD . . . . $175 | DM-2000AR<br>no optoisolation . . . . . $169<br>DM-2000AR-2<br>with optoisolation . . . . . $218 | DM-4000A without BCD . . . . $219<br>DM-4000B with BCD . . . . . $239 | DM-4300A without BCD . . . $235<br>DM-4300B with BCD . . . . . $255 |
| 2335-3 (solder tab) . . . . . $4.95<br>2335-4 (wire wrap). . . . . $4.95 | 2335-1 (solder tab). . . . . $4.95<br>2335-2 (wire wrap). . . . . $4.95 | 2335-1 (solder tab) . . . . . $4.95<br>2335-2 (wire wrap) . . . . . $4.95 | 2335-1 (solder tab) . . . . . $4.95<br>2335-2 (wire wrap) . . . . . $4.95 |
| Not required DM-2115 includes Internal AC Power Supply | UPM-5/1000B Power Supply $49.00<br>MS-7 Power Supply Socket $3.50 | UPM-5/1000B Power Supply $49.00<br>MS-7 Power Supply Socket $3.50 | UPM-5/1000B Power Supply $49.00<br>MS-7 Power Supply Socket $3.50 |
| SEE PAGE 197 | SEE PAGE 193 | SEE PAGE 201 | SEE PAGE 201 |

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TWX: 710-348-0135 TELEX: 924461

# 3½ DIGIT MINIATURE LOW COST DIGITAL PANEL METER

# MODEL DM-350

Covered by GSA Contract No. GS-OOS-27959

## FEATURES

- **Large 0.43" (11 mm) LED Display**
- **Very Low Cost, $69.**
- **Choice of Unipolar or Bipolar 1.999V Ranges**
- **Choice of AC or 5VDC Power Supply**
- **Very Low Power Consumption for Portable Instruments, 5VDC @ 300 mA max.**

## DESCRIPTION

Datel's model DM-350 Digital Panel Meter features very low cost but high performance in a miniature case for display-only applications. The instrument uses advanced CMOS LSI circuits for a very low overall parts count, high reliability and low internal heat rise. The large red high-efficiency LED displays measure 0.43 inches (11 mm) high for easy, no-parallax viewing from comfortable working distances.

The DM-350 employs a high impedance (100 Megohms min.) single-ended input with a choice of 0 to +1.999 Volt or −1.999 Volt to +1.999 Volt input ranges.

The optional AC powered models are transformer-isolated, allowing operation in differential circuits not exceeding ±300 Volts to the AC line. AC power voltages are user-selected by jumpers on the rear connector for 115 or 230 VAC, 47 to 440 Hz input. The +5VDC models require only 300 mA max. current, making them ideal for battery-operated instruments.

Additional application features include an automatic polarity sign for bipolar models and user-selected decimal points on the rear connector for scaling inputs. The sampling rate of 2 per second may be varied by using external resistors, and the display may be held using a rear connector input. Overscale inputs are automatically indicated with horizontal bars on the display.

The DM-350 is housed in an impact-resistant, solvent-proof polycarbonate plastic case with four screwholes for front-panel mounting. The operating temperature range is 0 to +50°C.

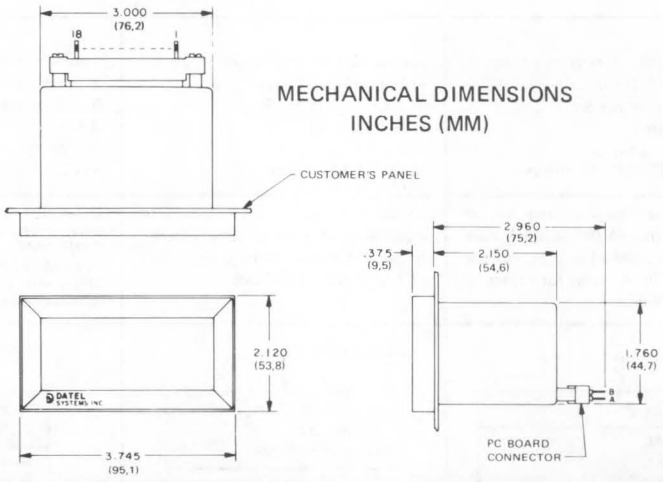
**Rear Connector Wiring**

LEFT

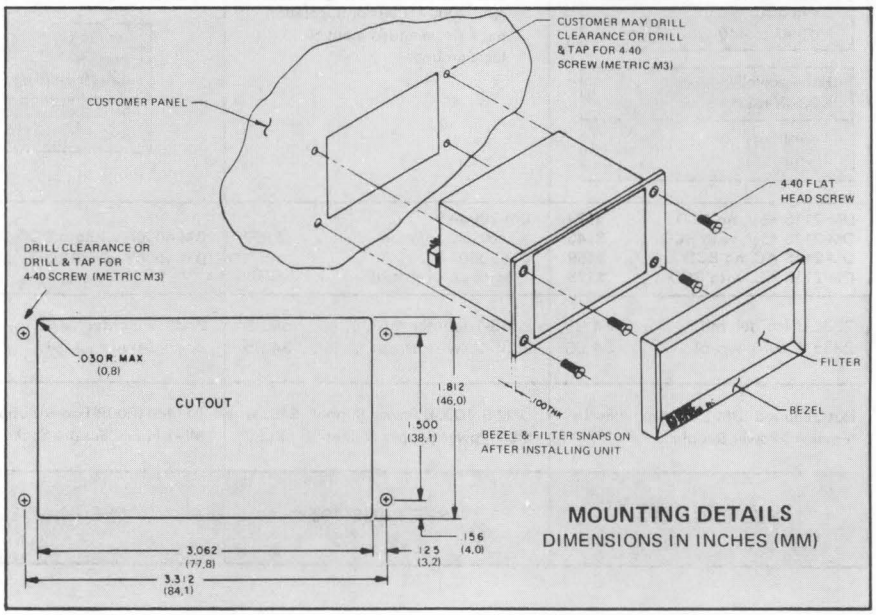
| | |
|---|---|
| 1 | ANALOG HI INPUT |
| 2 | ANALOG LO (NO INTERNAL CONNECTION) |
| 3 | ANALOG GROUND } INTERNALLY |
| 4 | POWER COMMON } CONNECTED |
| 5 | DECIMAL POINT .000 ← KEYWAY |
| 6 | DECIMAL POINT .00 |
| 7 | DECIMAL POINT .0 |
| 8 | |
| 9 | LAMP TEST |
| 10 | HOLD DISPLAY |
| 11 | SAMPLE RATE ADJUST |
| 12 | |
| 13 | +5VDC POWER |
| 14 | |
| 15 | AC POWER WINDING A HI |
| 16 | AC POWER WINDING B HI |
| 17 | AC POWER WINDING A LO |
| 18 | AC POWER WINDING B LO |

RIGHT

Pins A and B (Bottom and Top) are wired in parallel


MECHANICAL DIMENSIONS
INCHES (MM)




MOUNTING DETAILS
DIMENSIONS IN INCHES (MM)

## SPECIFICATIONS (Typical @ +25°C unless noted)

DATEL

**DISPLAY**

| | |
|---|---|
| **Number of Digits** | 3-½ digits with sign and 3 decimal points (+1.9.9.9) |
| **Display Type** | Red, Light Emitting Diode (LED) |
| **Display Size** | 0.43 inches (11 mm) high |
| **Overscale** | Inputs greater than 1.999V indicated by steady horizontal bars and a "one" |
| **Polarity** | Plus and minus sign automatically displayed on bipolar models. No sign on unipolar models. |
| **Lamp Test** | All display segments may be tested (using 888) by grounding pin 9. |
| **Sampling Rate** | 2 samples per second, may be varied using ext. resistors |
| **Underscale** | Reads all zero's |

**ANALOG INPUT**

| | |
|---|---|
| **Configuration** | Single-ended referenced to ground and common or single-ended transformer isolated (AC models) |
| **Full Scale Input Ranges** | 0 to +1.999 Volts (unipolar) or −1.999 Volts to +1.999 Volts (bipolar) |
| **Input Bias Current** | 45nA, typical, 500nA, maximum |
| **Displayed Accuracy** | Within 2mV of correct reading after calibration at steady operating temperature. (±0.05% of F.S. ±1 count) |
| **Temp. Drift** | Within 10mV between 0 and +50°C (±100ppm of F.S./°C) |
| **Operating Temp. Range** | 0 to +50°C |
| **Storage Temp. Range** | −25°C to +85°C |
| **Input Overvoltage** | ±50V continuous maximum for no damage |
| **Input Impedance** | 100 Megohms minimum |
| **Common Mode Voltage** | ±300VDC to AC pwr gnd (AC models only) |
| **Common Mode Rejection** | 70dB @ DC (AC models only) |
| **Warm Up Time** | Essentially None |

**DIGITAL INPUTS (Disregard These Inputs If Not Required)**

| | |
|---|---|
| **LAMP TEST** | (Pin 9) Ground this pin to illuminate the three '8's" in the display. 1 TTL load (Sink 1.6mA) |
| **Hold Display** | (Pin 10) Switch this input to +5VDC to freeze the last displayed reading. 10 Kilohm load to ground. |
| **Sample Rate Adjust** | (Pin 11) Sampling rate is 2 samples per second with no connection on pin 11. Connect a 680 Kohms resistor to ±5V for 4 samples/second. Connect a 1μF, 10V capacitor to ground for 1 sample/second. (Plus lead of cap to pin 11). |
| **Decimal Points** | (Pins 5, 6, and 7) Ground each pin to illuminate corresponding decimal points. Sink 20mA. |

**ADJUSTMENTS**

| | |
|---|---|
| **Zero, Full Scale, Balance** | Screwdriver trim pots for calibration adjustable by removing front panel bezel and filter. |

**POWER SUPPLY**

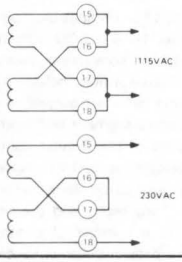
| | |
|---|---|
| **+5VDC** | (Pin 13) +5VDC power ±.25VDC @ 300 mA max. Noise and spikes must be less than 50mV. Approximately 50mA may be used from pin 13 for external circuitry on AC models. Avoid errors by using a regulated supply. |
| **AC** | (Pins 15 thru 18) 115 to 230 VAC, ±10%, 47 to 440 Hz 5W max. required at these pins. Externally pin-strapped by the user as shown below. |

**PHYSICAL**

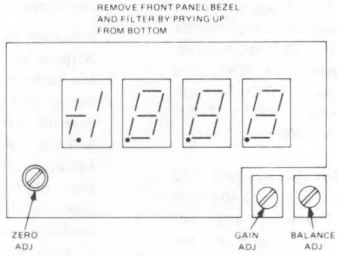
| | |
|---|---|
| **Case Size** | 3"W X 1.75"H X 2.25"D |
| **Case Material** | Black polycarbonate plastic |
| **Weight** | Approx. 10 oz. (280 g) AC Models<br>Approx. 5 oz. (140 g) DC Models |
| **Mounting** | Panel mounted through a 1.812" X 3.062" cutout with 4-40 flathead screws. |
| **Connector** | Dual 18-pin, PC edgeboard type 0.1" centers, Datel #2335-1. (Viking 3VH18/IJN-5) |

## CALIBRATION PROCEDURE

**AC POWER CONNECTIONS**




**LOCATION OF TRIM POTS**




**Calibration Procedure** (perform at a steady operating temperature)

1. The instrument will have factory calibrated accuracy of 0.1% at +25°C when power is first applied, but a full 15 minutes is required for warm-up before recalibration.
2. **BIPOLAR** Models
   Connect pins 1 and 3 (i.e., short the analog input or apply a known zero DC input). Adjust the BALANCE pot until the sign flickers equally between + and − (ignore the numerical content of the display).
   Apply +0.0005 Volts from a precision reference source to pin 1 and adjust the ZERO potentiometer until the display flickers between +000 and +001. Rotating the ZERO control below the 000 reading will produce readings of 999, 998, ··· etc. If the instrument is calibrated infrequently or operated over a wide temperature range, we recommend that the +000 to +001 change be calibrated with an input of **+0.00075** volts. This will produce a slightly "wide" zero but will preclude false 999, 998 ··· displays at zero.
   **UNIPOLAR** Models
   Apply any negative input between −0.1 and −2V. and adjust the ZERO pot to display 000. Apply +0.0005V. and adjust the BALANCE pot so the display flickers between 000 and 001.
3. Apply +1.900 Volts and adjust the GAIN pot to display +1.900. Bipolar models will automatically read within ±1 count of −1.900 if the polarity is reversed to −1.900 Volts input.

RECALIBRATION IS SUGGESTED EVERY 90 DAYS OR MORE OFTEN FOR VARIABLE CONDITIONS.

## APPLICATION NOTES

If you are new to digital panel meters, you'll find them easy to use if you observe some simple precautions. Digital Panel Meters differ from mechanical meters in important ways. These include:

1. Input Characteristics — DPM's have very high input impedance and present a negligible load to most circuits. Because of input bias current error, an external buffer amplifier is recommended for input source resistance of 10KΩ or greater. Always connect the signal source between ANALOG HI and ANALOG COMMON. Do not use the POWER COMMON as an analog return in order to prevent a ground loop.
2. AC and noise on the input terminals and power supply can cause variations in the display and possible loss of readings around zero. If this occurs, try to reduce input source noise and hum. An input filter consisting of 10KΩ from ANALOG HI to the source and 10μF from ANALOG HI to ANALOG COMMON can be tried. Increase the capacitor for more filtering or use an external multi-pole active filter. Note that input filters give delayed response time. DPM's are sampling devices and measure DC or slowly-varying signals and require special external circuits to measure AC or complex waveforms. If in doubt, make sure the input is truly noiseless, slow DC by checking with a direct-coupled oscilloscope connected right at the DPM's input terminals.

Always use a regulated power supply for 5V-powered DPM's. A filtered 7805 or LM309K 3-terminal regulator can be used or Datel's UPM-5/1000B supply. Current varies rapidly as digits turn off and on so that unregulated supplies cannot be used.

The DM-350 includes a hold display input to freeze the last reading. Instrument manufacturers typically connect this input to a front panel pushbutton to allow an operator long enough to copy down a momentarily-stabilized reading. Contact Datel if you need assistance.

## ORDERING GUIDE

**Model Number**

DM-350 —

| POWER SUPPLY | INPUT RANGE |
|---|---|
| D = +5VDC | 1 = Unipolar 0 to +1.999V |
| A = 115 or 230 VAC (User-selected on rear connector) | 2 = Bipolar −1.999V to +1.999V |

| **Prices (Single Quantity)** | *Covered by GSA Contract No. GS-OOS-27959* |
|---|---|
| DM-350D1 (5V, unipolar) | $69 |
| DM-350D2 (5V, bipolar) | $75 |
| DM-350A1 (AC, unipolar) | $79 |
| DM-350A2 (AC, bipolar) | $89 |

Connector: Datel #2335-1, Solder Tab $4.95 (Viking 3VH18/1JN-5)

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# MULTIFUNCTION DIGITAL PANEL METER AND COUNTER DISPLAY

# MODEL DM-3000

Covered by GSA Contract No. GS-00S-27959

### USE AS:

- 3 digit DPM
- 4-wire slaved display
- 0.1% tachometer, period or frequency meter using optional crystal clock
- DC to 10 MHz general purpose counter with 0 to 999 selectable full count

### FEATURES

- 3 red, 0.43" high LED displays
- Dimmable display using external variable duty cycle blanking input
- −5V, 5mA short-circuit proof output for external bipolar or differential op amps
- Built in 2 sample/second variable start clock
- Externally triggerable up to 250 conversions/second
- Selectable leading zero suppression


**$99 (1-9)**

**$79 (100's)**

## GENERAL DESCRIPTION

The model DM-3000 combines a low-cost unipolar digital panel meter, a DC to 10 MHz 3 digit general-purpose counter or slaved BCD digital display using only 4 lines in a single instrument. By using simple external circuits the DM-3000 3 digit DPM may be converted to a frequency meter, event counter, absolute value bipolar or differential input digital panel meter or 3-digit period measuring instrument.

The DM-3000 has a built-in short circuit proof −5V, 5 mA power supply to operate external input amplifiers or other circuitry, yet the DM-3000 is a complete 3-digit digital panel meter which includes its own internal start clock. Other operating modes include count termination at any arbitrary full scale displayed count. Many suggested circuits are shown in this brochure. A 0.02% crystal clock option may be ordered for precision period and frequency measurement.

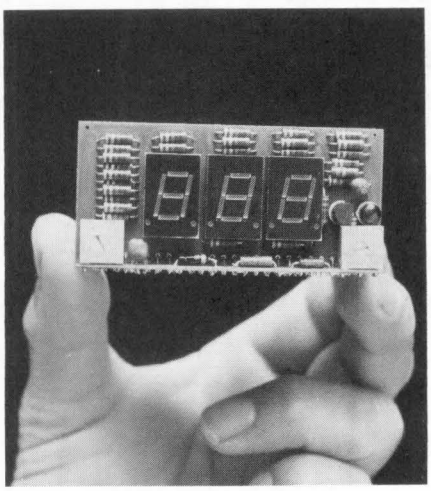
The DM-3000 accepts analog inputs from 0 to +0.999 volts, (10V and 100V ranges optional), uses a single slope conversion and displays the input on three seven-segment LED digits to an accuracy of 0.1% of reading, ±1 digit. The instrument uses conventional +5VDC TTL logic power (such as Datel's model UPM-5/1000B power supply) and consumes 800 mA (320 mA with blanked display).

The single-ended input has greater than 100 megohms input impedance and typically 100 nanoamps, bias current. The temperature coefficient is ±100 ppm/°C max. over an operating temperature range of 0 to +50°C. Storage temperature is from −20°C to +85°C. The DM-3000 can accept from 0 to 250 conversions per second from an external start pulse. A built-in start clock operates at 2 conversions/second and may be speeded up using an external resistor.

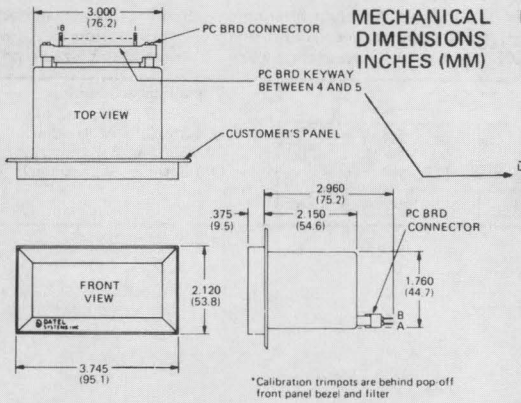
The red 7-segment LED displays are 0.43" high and each left-of-digit decimal point may be illuminated using contacts on the rear connector. Counter overflow is indicated by a blanked display and a high output on the rear connector contact.

Included in the DTL/TTL compatible logic outputs are full parallel 1-2-4-8 BCD outputs for each digit, an end of conversion (busy) output and overflow. Digital inputs include the external start clock, internal start output, and gate (for hold-to-read) and a segment test input. Leading zero suppression of the 2 most significant digits can be selected as well as display blanking. Clock output and gated clock out are available with counter zero reset, and the end of scale inputs. The large number of control inputs and outputs are provided for extended system use and for custom programming.

The DM-3000 is packaged in a rugged Lexan case with overall dimensions of 3.745" W x 2.960" D x 2.120" H. The case mounts with 4 screws through a 1.812" H x 3.062" W front panel cutout identical to other Datel digital panel meters. A large degree of electrical and pin-out commonality is shared with other Datel DPM's for simple interchangeability.



## MECHANICAL DIMENSIONS INCHES (MM)




*Calibration trimpots are behind pop-off front panel bezel and filter

## INPUT/OUTPUT CONNECTIONS

| | P.C. BOARD CONNECTOR BOTTOM A | TOP B | |
|---|---|---|---|
| 10V, 100V in (opt) | 1 | 1 | ANALOG INPUT (HI) |
| ANALOG GND. | 2 | 2 | LOGIC GROUND |
| DISPLAY BLANK | 3 | 3 | 0'S RESET INPUT |
| LEADING ZERO SUPP. | 4 | 4 | 500 KHz CLOCK OUT |
| DECIMAL POINT 100 | 5 | 5 | BIT 1 OUT |
| DECIMAL POINT 10 | 6 | 6 | BIT 2 OUT |
| DECIMAL POINT 1 | 7 | 7 | BIT 4 OUT |
| E.O.C. (STATUS) | 8 | 8 | BIT 8 OUT |
| OVERSCALE OUT | 9 | 9 | BIT 10 OUT |
| INT. START GATE | 10 | 10 | BIT 20 OUT |
| INT. START ADJ. | 11 | 11 | BIT 40 OUT |
| INT. START OUT | 12 | 12 | BIT 80 OUT |
| START INPUT | 13 | 13 | BIT 100 OUT |
| LAMP TEST | 14 | 14 | BIT 200 OUT |
| GATED CLOCK OUT | 15 | 15 | BIT 400 OUT |
| COUNTER INPUT | 16 | 16 | BIT 800 OUT |
| −5V OUT | 17 | 17 | END OF SCALE INPUT |
| PWR. GND. | 18 | 18 | PWR. INPUT +5V D.C. |

Note: For normal operation, connect jumpers as shown in application note.

## SPECIFICATIONS (Typical at 25°C unless otherwise stated)

DATEL

### INPUTS

| | |
|---|---|
| Input Voltage Range (Full Scale) | 0 to +999mV, (+9.99V, or +99.9V with atten.) |
| Input Impedance | 100 Megohms min. See pg. 3. |
| Input Bias Current | 100nA typ., 250nA max. |
| Input Configuration | Single-ended unipolar |
| Max. Continuous Input Overvoltage | ±35V |
| Max. Momentary Input Overvoltage (5 sec. max.) | ±125V |

### PERFORMANCE

| | |
|---|---|
| Accuracy @ 25°C | Adjustable to ±0.1% of reading ± 1 digit |
| Resolution | ±1mV |
| Temperature Coefficient | ±100ppm/ ° C max. of FS. |
| Conversion Speed | 0-250 conversions/sec. |
| Internal Trigger Rate | 2/sec. adjustable upwards by external resistor. See note. |
| Operating Temperature Range | 0 to +50°C |
| Storage Temperature Range | −20° to +85°C |
| Warm Up Time | Essentially zero |
| Adjustments | Zero, Full Scale (±8mV typ range) |
| Input Power | +5VDC ±5% @ 800 mA max. (320 mA with display blanked). See note. |
| Output Power | −5VDC @ 5 mA ±10%. Short circuit proof. For operation of external amplifiers etc. |

### DISPLAY OUTPUT

| | |
|---|---|
| Display Type | Seven segment LED, Red 0.43" high full digits (0 to 9) and decimal points. |
| Overscale | Display blanked |
| Decimal Points | Selectable at rear connector. Decimal points are displayed left of each digit. |
| Negative Analog Input | Displays 000 |

### DATA OUTPUTS — All DTL/TTL Compatible

| | |
|---|---|
| BCD Outputs | 12 parallel lines unlatched 8-4-2-1 BCD positive true. Loading 5 TTL loads, Totem-pole. |
| Overscale | > 1000 counts indicated by high output, 5 TTL loads. |
| End of Conversion | High during conversion, low conversion complete, 2 TTL loads. |
| Logic Levels | Inputs<br>+2V ≤ "1" (HI) ≤ +5.0V<br>0V ≤ "0" (LO) ≤ +0.8V<br>Outputs<br>+2.4V ≤ "1" (HI) ≤ +5.0V<br>0V ≤ "0" (LO) ≤ +0.4V |

### INPUT/OUTPUT CONTROL

| | |
|---|---|
| External Start Input (A13) | Positive pulse 100 nS min. transition from low to high resets register and blanks readout. Negative edge initiates conversion. 10 TTL loads. |
| Internal Start Gate (A10) | Low input holds last conversion. 3 TTL loads. |
| Internal Start Adjust (A11) | Resistor to +5V increases trigger rate. See note. |
| Internal Start Out (A12) | Positive pulse — see application. Has low cuty cycle to avoid display blanking and flicker. |

### INPUT/OUTPUT CONTROL -Continued

| | |
|---|---|
| $\overline{\text{Lamp}}$ $\overline{\text{Test}}$ $\overline{\text{Input}}$ (A14) | Low input lights all segments. 3 TTL loads. |
| $\overline{\text{Leading}}$ $\overline{\text{Zero}}$ $\overline{\text{Suppression}}$ (A4) | Low input provides suppression of zeros on the two most significant digits. 1 TTL load. |
| $\overline{\text{Display}}$ $\overline{\text{Blanking}}$ (A3) | Low input blanks display. Does not affect conversion. May be used for intensity modulation of display and conserving power. 1 TTL load. |
| $\overline{\text{Decimal}}$ $\overline{\text{Point}}$ $\overline{\text{Inputs}}$ (A5, 6, 7) | Grounding inputs illuminates corresponding decimal point. Sink 20 mA. |
| Clock Output (B4) | 500 kHz ± 10 kHz 50% duty cycle. 2 TTL loads. 500 kHz ±0.02% crystal optional |
| Counter Input (A16) | Provides input to counter. Counting occurs on negative transition. 2 TTL loads. |
| Gated Clock Out (A15) | Provides pulse train of N+1 counts where N is displayed number. 5 TTL loads. Used for slave display or counter. |
| Zeros Reset (B3) | High input resets counter to zero. 100 nS min. duration. 3 TTL loads. |
| $\overline{\text{End}}$ $\overline{\text{of}}$ $\overline{\text{Scale}}$ $\overline{\text{Input}}$ (B17) | Activates overflow flip-flop and blanks display on negative input transition. 1 TTL load. Used to short cycle counter. |

*Note: unused inputs should be grounded or tied to +5V as required to avoid false readings in noisy environments.*

### PHYSICAL

| | |
|---|---|
| Case Size | 3" W x 1.75" H x 2.25" D |
| Case Material | Black Lexan Plastic |
| Weight | 6 oz. approx. |
| Mounting | Through 1.812" x 3.062" cut out. Secured with four 4-40 flathead screws. See mounting diagram. |
| Price | (1-9) $99.00 |
| Connector | Dual 18-pin PC Brd. Edge Connector Type, 0.1" Centers (not included with DPM) |

### OPTIONS

1. Quartz crystal timebase 500 kHz . ±.02%. Operating temp. range drift undetectable on display.
2. 0.1% Precision resistor attenuator kit (RN-DM-3000) 900K, 90K, 10K for 10V and 100V ranges.

*NOTE:*
*BCD outputs are invalid while EOC is HI.*

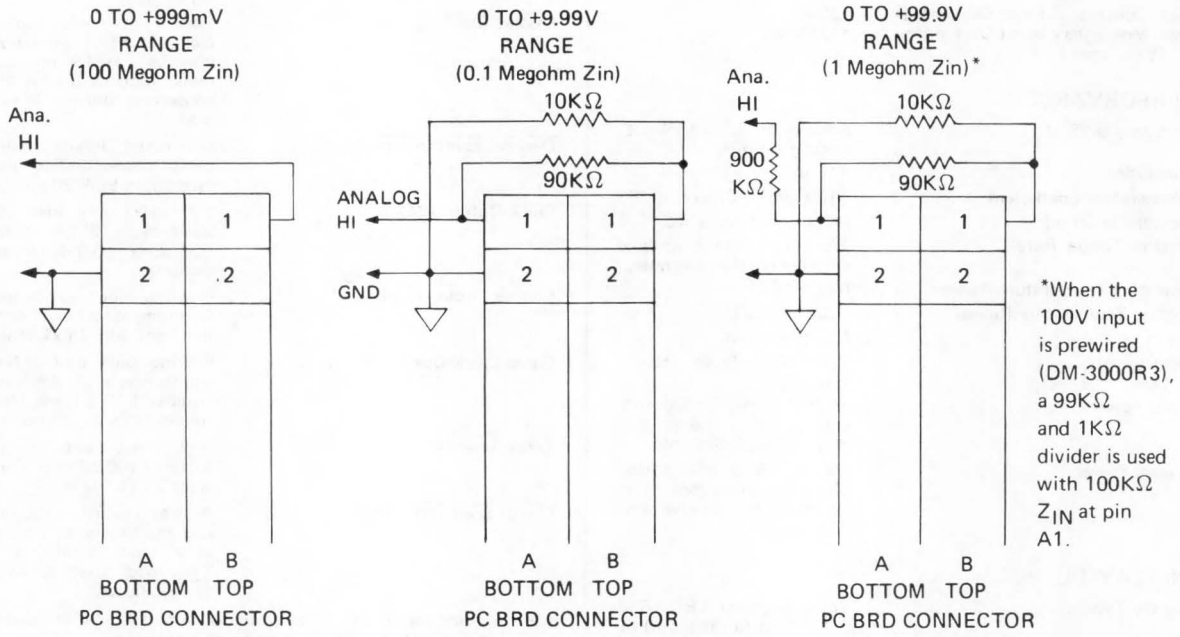
Note: Internal start clock can be speeded up using an external resistor from A11 to +5V. The resistor value is: $R(K\Omega) \simeq \frac{440-\text{Rate}}{\text{Rate}-2}$

(Rate is in conversions/second) $R \geq 4K\Omega$

A recommended power supply is Datel's model UPM-5/1000B or equivalent highly regulated type. Avoid spikes entering DPM on +5V power input. Use external filtering or regulation if required. Significant power supply spikes (> 10mV) increase the chance of false readings. DPM current varies rapidly up to 800mA depending on digits displayed and sample rate.

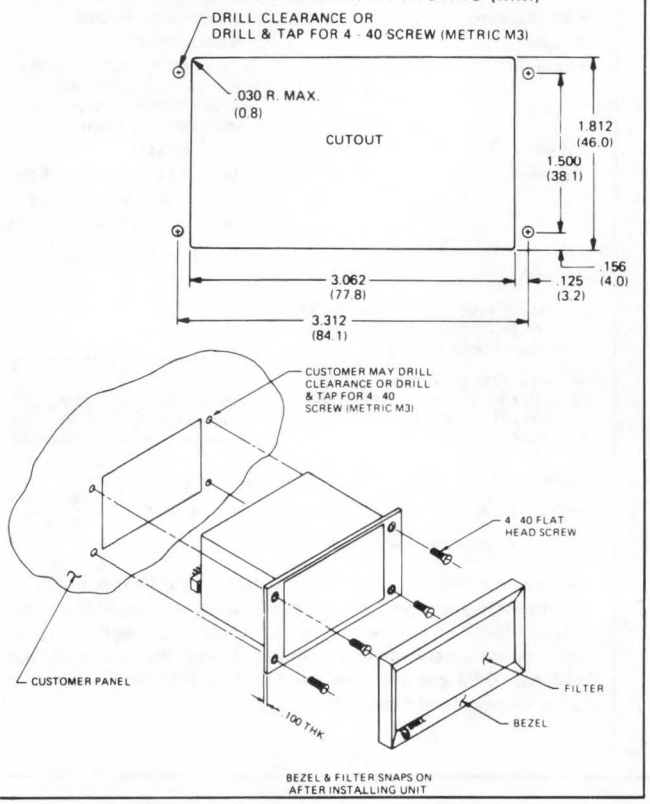
## INPUT RANGE SELECTION

To facilitate use of the DM-3000 for +9.99V and +99.9V ranges, a separate kit of matched, low drift input attenuator 0.1% resistors is available (part number RN-DM-3000). These resistors mount directly on the PC board connector and provide 0.1 and 1 Megohm input impedance on the +9.99V and +99.9V ranges. They are ratio matched and will track within ±25ppm/°C over the 0 to +50°C operating range of the DM-3000. They are customer connected as shown below. Input attenuators may be ordered prewired. See ranges 2 and 3 in ordering guide below.




*When the 100V input is prewired (DM-3000R3), a 99KΩ and 1KΩ divider is used with 100KΩ $Z_{IN}$ at pin A1.

### MOUNTING DETAILS DIM. IN INCHES (MM)




### ORDERING GUIDE

DM-3000 ____ ____

| 500 KHz CLOCK | Input Range and Impedance |
|---|---|
| | 1 = 0 to + 999mV input (pin B1) 100 MΩ |
| | 2 = 0 to + 9.99V input (pin A1) 0.1MΩ |
| | 3 = 0 to + 99.9V input (pin A1) 0.1MΩ |
| | Options 2 or 3 have installed divider resistors with $Z_{IN}$ shown. |
| R = CERAMIC RESONATOR (±2%) | |
| X = QUARTZ CRYSTAL (±.02%) | |

PRICES (1-9)

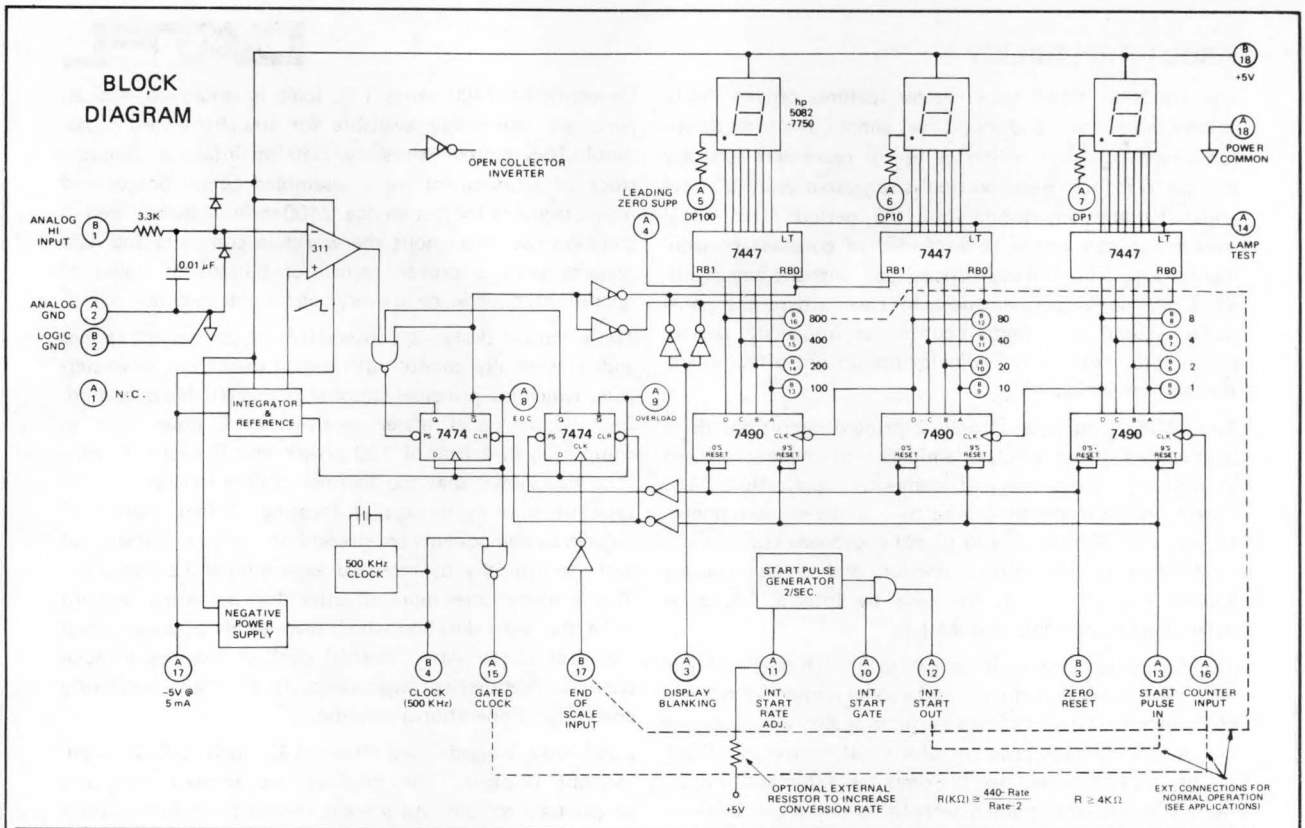
| | |
|---|---|
| DM-3000R1 (less connector) | $99 |
| Add for crystal clock | $10 |
| Add for 10V or 100V input | $10 |
| RN-DM-3000 (Attenuator resistors) | $5 |
| Solder Tab Connector, Datel # 2335-1 | |
| Viking 3VH18/1JN-5 or equiv.) | $4.95 |
| Wire Wrap Connector, Datel # 2335-2 | |
| Viking 3VH18/1JND-5 or equiv.) | $4.95 |

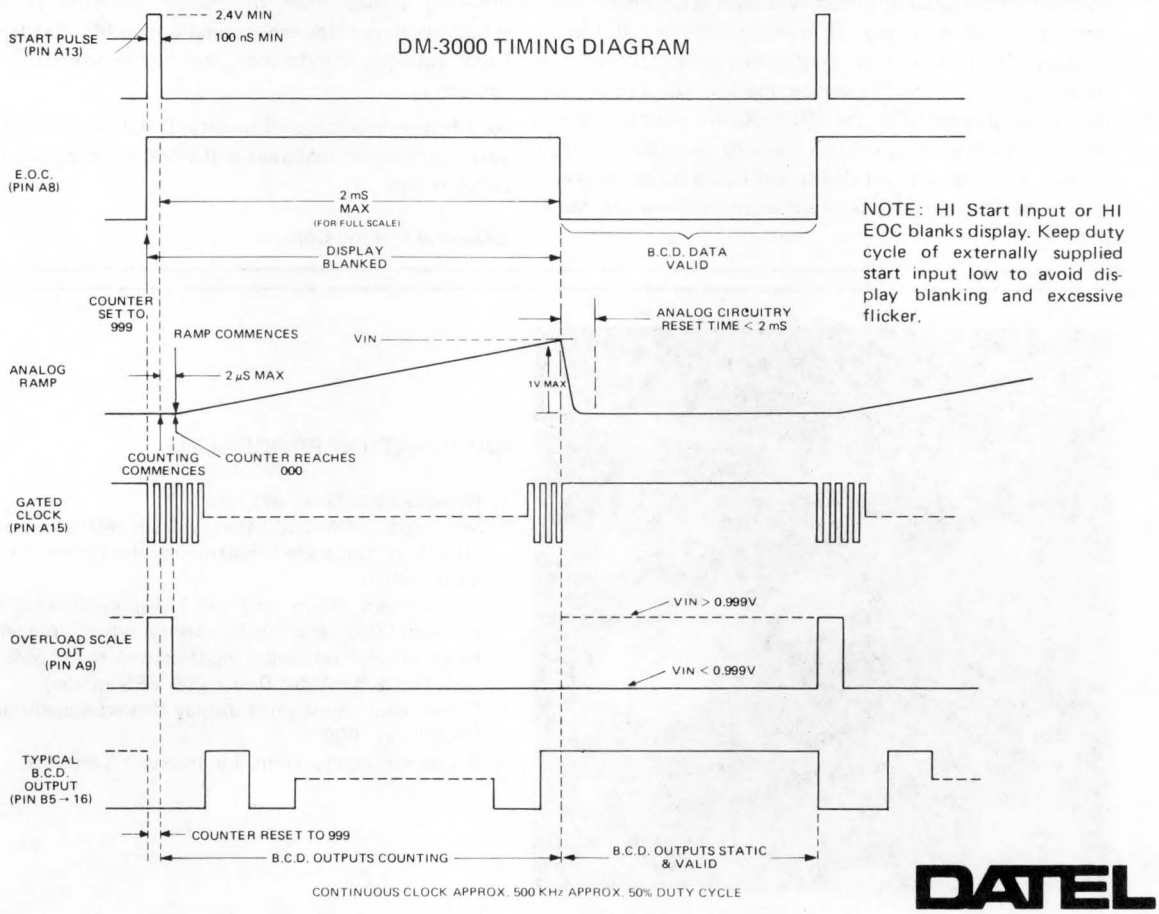
Connectors are not included with DPM. Please order connectors with your DPM.

UPM-5/1000B 5V,1A
115VAC power supply $49.00
MS-7 Power supply socket $3.50

For special functions in OEM quantities, contact factory.

All Datel DPM's are covered by GSA Contract No. GS-00S-27959




NOTE: HI Start Input or HI EOC blanks display. Keep duty cycle of externally supplied start input low to avoid display blanking and excessive flicker.

DATEL

## ABOUT RELIABILITY

The DM3000 digital panel meter features proven mechanical construction and sound, yet simple, electrical design for a long trouble free service life of repeatable accuracy and performance. Recalibration is suggested every 90 days under variable conditions but the period after initial adjustment can safely be extended in constant environments, e.g., laboratories, offices, etc. without any significant change in performance. In cases where the panel meter is used as a digital counter for frequency, period, events, etc., front panel adjustments do not affect operation and can be ignored.

The DM3000 consists of only 2 printed circuit boards of high grade G10 epoxy-glass laminate (not phenolic) as used in military, aerospace and computer applications. The boards are permanently joined by a soldered interconnect to assure reliability. A gold plated edgeboard connector is used for all input/output connections and can be positively located and secured to the case by integral bosses. A polarizing key prevents mislocation.

The electronic circuitry is composed of high quality digital and linear integrated circuits and a small number of discrete components. Datel's extensive vendor quality assurance and incoming inspection program allows full control of reliability at the component level. Computer automated inspection, selection and grading techniques and a continuously updated vendor quality history file have established a very efficient, reliable supply of components for all Datel's products. Reliability at the component level is extended to reliability at the circuit level by the low parts count and functional simplicity of the DM3000. In addition, this is achieved in a small rugged black Lexan® case that requires a modest 3 inches of panel depth and leaves no doubt about the mechanical integrity of attachment or electrical insulation.

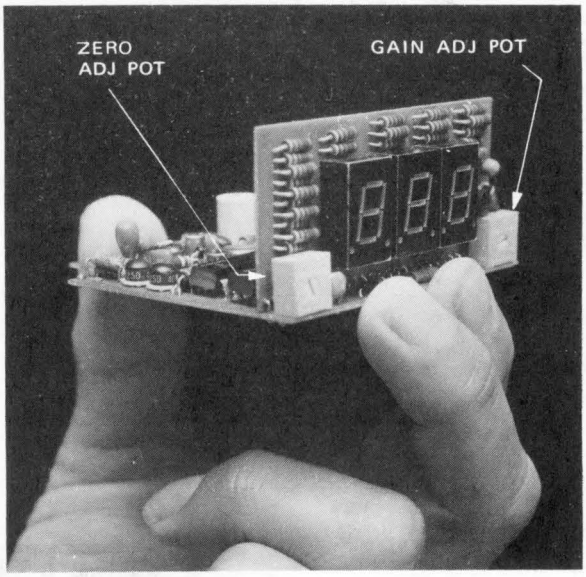
Conventional 7400 series TTL logic is employed, and all parts are commonly available for straightforward repair should it ever prove necessary. Datel maintains a complete stock of replacement parts, assembled circuit boards and repair facilities for fast service. 7400 series logic has been in common use throughout the world in computer and data systems with a proven record of billions of hours of operational experience in every conceivable circuit.

The electrical design is conservative of component ratings and is especially careful with regard to thermal characteristics which is a principal factor affecting reliable operation. Each Datel panel meter receives a 72 hour burn in comprising in excess of 100 power on/off cycles. Experience has shown that the thermal cycling inherent in this type of burn-in is best at locating "infant mortality" failures as components are stressed not only electrically but also mechanically by repeated expansion and contraction. This is many times more effective than a continuous burn in of the same duration which would only apply constant electrical stress. Also, thermal cycling provides a much closer accelerated correspondence to the most frequently encountered operational conditions.

Datel uses rugged solid state 0.43 inch L.E.D. seven segment displays. The displays are located behind a proprietary scratch and solvent resistant red filter with a diffusing surface that minimizes annoying reflections. L.E.D. displays offer exceptionally long life, freedom from lethal voltages, interference, and highly stressed interface circuitry.

As a further assurance of quality, Datel provides a full one year warranty on materials and workmanship for its digital panel meters.

®General Electric Corp.




## CALIBRATION PROCEDURE

1. Remove front bezel and filter.
2. Set input to DM-3000 from voltage reference source to +0.05% of full scale (+500 microvolts for the 0 to +.999 VFS model).
3. Rotate zero adjust pot until display flickers equally between "000" and "001". (±8mV typ adj. range)
4. Reset voltage reference input source to 99.85% of full scale (+998.5 mV for 0 to +.999 VFS model).
5. Rotate gain adjust until display flickers equally between "998" and "999".
6. Recommended recalibration interval: 3 months.

DATEL SYSTEMS, INC.
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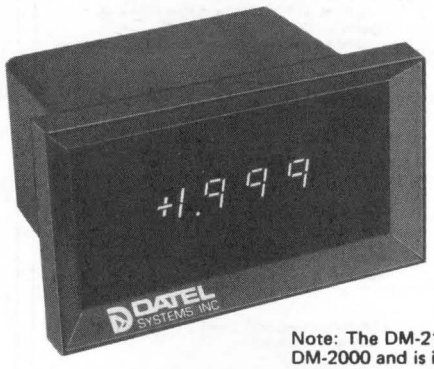
# 3-1/2 DIGIT LOW COST DIGITAL PANEL METER

# DM-2100 SERIES

- **±199.9mV or ±1.999V Full Scale Inputs**
- **True Floating Bipolar Differential Input**
- **Automatic Polarity and Overflow Display**
- **Up to 200 Readings per Second Using External Trigger**
- **Includes 2 Samples/Second Internal Trigger Clock**
- **Operates From Single +5VDC Supply**
- **Solid State LED Display, Full parallel BCD outputs**
- **Adjustable Zero Control Compensating For External Offset Voltages**
- **Priced under $100 in OEM quantities**

Covered by GSA Contract No. GS-00S-27959




Note: The DM-2100 replaces the DM-2000 and is identical except for external timing capacitor wiring and conversion rate and displays. DM-2000 is available by contacting factory.

## DESCRIPTION

Featuring accurate, stable readings with 3½ digit resolution, the DM-2100 digital panel meter has wide acceptance because of its proven record of performance and reliability.

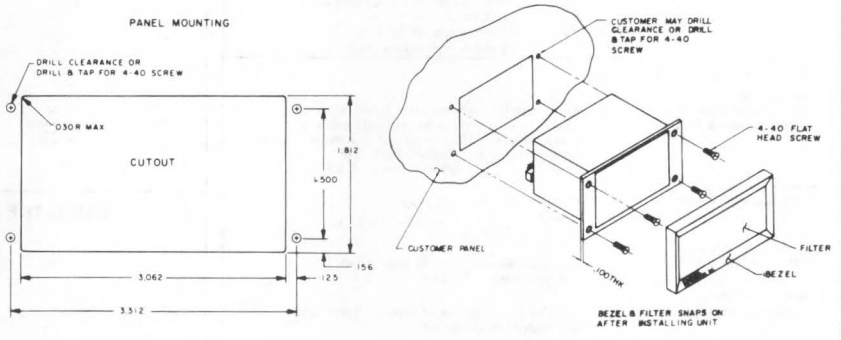
The DM-2100 combines the ease and accuracy of digital readout with high input impedance and noise rejection to provide an inexpensive digital panel meter (digital voltmeter) that will enhance the operation, performance and appearance of any instrumentation system.

The DM-2100 is ideal for new equipment design or may be utilized in updating existing instruments or systems that require a stable, accurate digital readout for voltage. Simple to install, the DM-2100 is supplied complete and ready to operate requiring only a connection of an input signal and power cable. Applications include measuring of any parameter for which a suitable output voltage is available. These include absorption, acceleration, current, displacement, distortion, emission, flow, frequency, Ph, pressure, strain, torque, and many others.

The DM-2100 provides a differential input with a 100 MegOhms input impedance and a common mode rejection of 70 db at 60 Hz. The input range is ±1.999 volts or ±199.9 millivolts. The display is 3½ digits including automatic polarity and overflow indication. In addition the output is presented to the I/O connector as BCD/TTL information.

High quality computer grade components, superior workmanship and wide-safety margin designs combine to make the DM-2100 a must in your designs.

## MOUNTING DETAILS




## CALIBRATION PROCEDURE

(Using Trimpots Shown At Right)

The following adjustment procedure is recommended after allowing for a five minute warm-up.

**Balance Control**

1) Short the analog input terminals to analog common. (See I/O chart for proper pin connection.)

2) Rotate the balance control until the display is flickering between (+) zero and (-) zero.

**Zero Control**

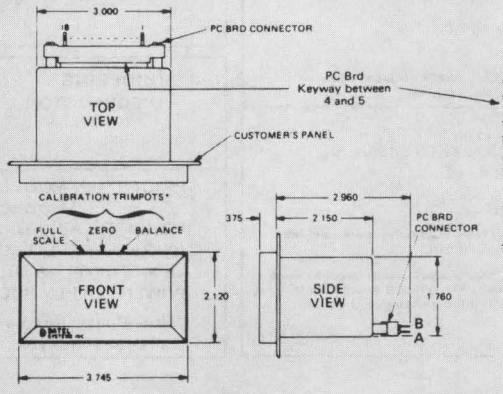
1) Connect a precision voltage reference source to the analog input terminals.

2) Adjust the voltage output from the reference source to .3LSD (30μV Model A, 300μV Model B). Rotate the zero control until the LSD (Least significant digit) flickers between zero and one.

**Full Scale Control**

1) Adjust the output from the reference source to 1.990 volts. Rotate the full scale control of the panel meter until the meter displays 1.990 volts. Recalibration is suggested every 90 days or more often for variable conditions.

## MECHANICAL DIMENSIONS (INCHES)




*Calibration trimpots are behind pop-off front panel bezel and filter

## INPUT/OUTPUT CONNECTIONS

| | BOTTOM A | TOP B | |
|---|---|---|---|
| ANALOG INPUT (LO) | 1 | 1 | ANALOG INPUT (HI) |
| SHIELD GROUND | 2 | 2 | SHIELD GROUND |
| NOT USED | 3 | 3 | NOT USED |
| NOT USED | 4 | 4 | LOGIC GROUND |
| DECIMAL POINT 100 | 5 | 5 | BIT 1 OUT |
| DECIMAL POINT 10 | 6 | 6 | BIT 2 OUT |
| DECIMAL POINT 1 | 7 | 7 | BIT 4 OUT |
| E.O.C (STATUS) | 8 | 8 | BIT 8 OUT |
| OVERLOAD SCALE OUT | 9 | 9 | BIT 10 OUT |
| INT START GATE | 10 | 10 | BIT 20 OUT |
| INT START ADJ | 11 | 11 | BIT 40 OUT |
| INT START OUT | 12 | 12 | BIT 80 OUT |
| START INPUT | 13 | 13 | BIT 100 OUT |
| LAMP TEST | 14 | 14 | BIT 200 OUT |
| 1000 OUT | 15 | 15 | BIT 400 OUT |
| SIGN OUT | 16 | 16 | BIT 800 OUT |
| NOT USED | 17 | 17 | NOT USED |
| POWER COMMON | 18 | 18 | POWER INPUT, +5VDC |

Edge board PC contacts are on 0.1" centers

## SPECIFICATIONS Typical @ 25°C, 5 minutes warm up

### INPUT

| | |
|---|---|
| **Input Voltage Range** | ± 199.9mV DM-2100A } ±15V max.<br>± 1.999V DM-2100B } (no damage) |
| **Input Impedance** | > 100 MEGOHMS |
| **Input Bias Current** | 20 nA |
| **Input Configuration** | Differential |
| **Input Polarity** | Bipolar – Automatic |
| **Common Mode Rejection** | 70dB @ 60Hz |
| **Common Mode Voltage** | ± 2V max. to digital output common |

### PERFORMANCE

| | |
|---|---|
| **Accuracy @ 25°C** | ± 0.05% of Reading ± 1 Count |
| **Resolution** | 100μ Volts (DM-2100-A), 1m Volt (DM-2100-B) |
| **Temperature Coefficient** | 50ppm/°C |
| **Max Conversion Speed (1)** | 0 to 200 Conversions/Second. See Diagrams below |
| **Input Settling Time** | 50 μsec for a F.S. Change |
| **Operating Temperature Range** | 0°C to +50°C |
| **Storage Temperature Range** | -20°C to +85°C |
| **Warm Up Time** | 5 Minutes to Specified Accuracy |
| **Adjustments** | Zero, Balance, Full Scale Located Behind Snap On Front Bezel |
| **Input Power** | 5 VDC ± 0.25 VDC @ 650mA max **(3)** |

### DISPLAY OUTPUT

| | |
|---|---|
| **Display Type** | Solid State LED for Data Digits, 100% Overrange, Overflow, Decimal point and Polarity – Character Height .3 in. |
| **Overflow** | Indicated by the Letters "OF" |
| **Decimal Points** | Selectable at rear Connector |

### DATA OUTPUTS (1) (2)

| | |
|---|---|
| **BCD Outputs** | 12 Parallel Lines, BCD (8–4–2–1) Positive Logic<br>Loading: 2TTL loads |
| **Overrange (Connection A 15)** | 1000 to 1999 counts only indicated with a HIGH.<br>Loading: 2TTL loads LOW on overflow. |
| **Polarity (Connection A 16)** | Input signal polarity indicated with a HIGH-positive LOW-negative.<br>Loading: 2TTL loads |
| **$\overline{\text{Overflow}}$ (OF)(A9)**<br>**> ± 0.2V (MODEL A)**<br>**> ± 2V (MODEL B)** | HIGH-input signal within range.<br>LOW-input signal outside range.<br>Loading: 2TTL loads |
| **End of Conversion (EOC) (Connection A8). See Note (2)** | HIGH – During the conversion period. Output invalid, display blanked.<br>LOW – Conversion complete. Output valid<br>Loading: 2TTL loads<br>Period: 4.5 mSec typ. at full scale<br>1.5 mSec typ. at zero input |

### INPUT/OUTPUT CONTROL (3)

| | |
|---|---|
| **External Start Conversion Command (Connection A 13)** | Positive pulse 100 nsec min. Transition from "LOW" to "HIGH" resets output register and blanks readout. The conversion process is initiated upon return from "HIGH" to "LOW".<br>Loading: 1 TTL load. Max. Input 5.5V |
| **Internal Start Gate (Connection A 10)** | Controls internal start clock<br>"HIGH" – Run<br>"LOW" – Stop loading: 1 TTL load |
| **Internal Start Adjust (Connection A 11)** | Controls Rate of Internal Start Clock – see Applications Section. |
| **Internal Start Out (Connection A 12)** | Positive Pulse Output of Internal Start Clock – see Applications Section. |
| **$\overline{\text{Lamp Test}}$ Input (Connection A 14)** | Grounding this input displays + 1888 for testing all display segments.<br>Loading: Sink 35mA |
| **$\overline{\text{Decimal Point}}$ Inputs (DP1, DP10, DP100)** | Grounding inputs illuminates corresponding decimal points on the display.<br>Loading: Sink 15mA |

### PHYSICAL

| | |
|---|---|
| **Case Size** | 3"W x 1.75"H x 2.25"D |
| **Case Material** | Black LEXAN |
| **Weight** | 6 oz. Approx. |
| **Mounting** | Through a 1.812" x 3.062" Cut-Out and Secured with Four 4-40 Tapped Holes |

Notes:

Digital Inputs: "0" ≤ +0.8V, "1" ≥ +2.0V
Digital Outputs: "0" ≤ +0.4V, "1" ≥ +2.4V (TTL Compatible)

**DPM is fully repairable and features snap-together PC Boards.**

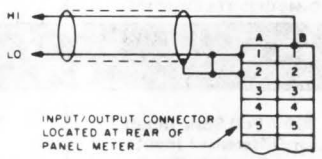
**(1) 200 conv/sec requires external trigger. DM-2100 includes 2 conv/sec adjustable internal clock.**

**(2) BCD Data outputs are counting while the EOC is high. BCD outputs are valid only when the EOC goes low.** Display is blanked during HI EOC.

**(3) Avoid logic spikes entering the DPM on the +5V power input. Use external filtering if required. Recommended power supply is a Datel UPM-5/1000B or equivalent highly regulated type. Power current is 350 to 650 mA depending on digits displayed and conversion rate.**

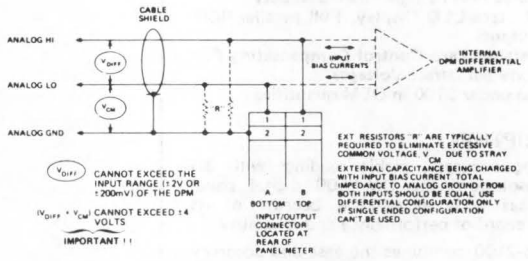
## APPLICATIONS DATEL

### SINGLE ENDED INPUT

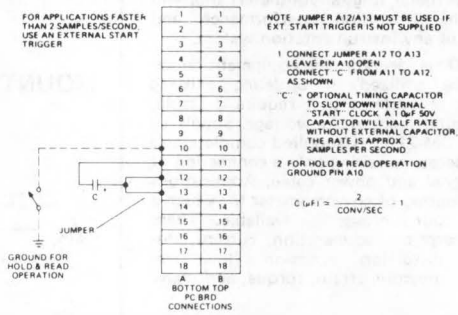



FOR SINGLE ENDED INPUT, CONNECT "LO" AND "SHIELD" TOGETHER AT THE CONNECTOR (A1 TO A2)

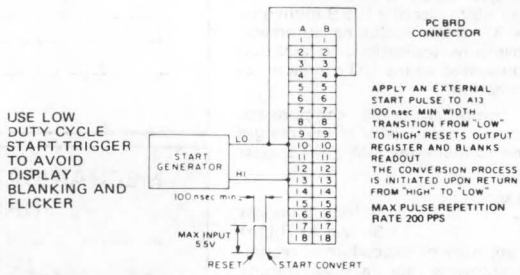
### DIFFERENTIAL INPUT




### USING THE METER WITH THE INTERNAL "START" CLOCK




### USING THE METER WITH AN EXTERNAL "START"




### ORDERING INFORMATION

DM-2100 ⊤

| INPUT RANGE |
|---|
| A = ± 199.9mV INPUT |
| B = ± 1.999V INPUT |

**PRICES (1-9)** MODEL DM-2100A (less connectors*) . . . $129.00 ea.
MODEL DM-2100B (less connectors*) . . . $129.00 ea.
(SOLDER TAB) I/O CONNECTOR # 2335-1 . . . . . $ 4.95 ea.
(WIRE WRAP) I/O CONNECTOR # 2335-2 . . . . . $ 4.95 ea.
UPM-5/1000B, +5VDC, IA POWER SUPPLY . . . . . $ 49.00 ea.
POWER SUPPLY SOCKET, MS-7 . . . . . $ 3.50 ea.

*Note-Connectors are not included in the basic price. Be sure to include connectors with your order.

DATEL SYSTEMS, INC.
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# WORLD'S FIRST AUTOMATIC RANGING DIGITAL PANEL METER

# MODEL DM-2000AR

Covered by GSA Contract No. GS-00S-27959

## DESCRIPTION

The Datel DM-2000AR is the first digital panel meter to feature automatic ranging over three full scale input ranges. It measures readings from 20 volts down to 100 microvolts without external scaling and increases the dynamic range of the instrument to 103 db over conventional DPM's. The unique autoranging circuitry operates by first sampling an input on the most sensitive range (±199.9mV). If an overange condition is indicated, the circuitry is automatically switched to the next higher range and recycled, and again to the highest range if the second is exceeded. The worst case conversion time is 33 milliseconds (30 conversions per second) if the highest range is selected and somewhat faster on the lower ranges.

The automatic ranging feature, with three full scale input voltage ranges of ±19.99 volts, ±1.999 volts and ±199.9mV offers the user a number of advantages. The cost savings over the parts, installation and test of a front panel range switch alone would justify the use of DM-2000AR. Another advantage is the savings in operator time and the associated errors incurred with the use of a range switch. Also, the versatility of a 20 volt to 100 microvolt dynamic range cannot be discounted in bench testing situations.

The DM-2000AR has a single ended input with an input impedance of 1 Megohm and overvoltage protection to ±100 volts. Accuracy is ±.1% of full scale, ±1 count with a maximum conversion time of 33 milliseconds. The temperature coefficient of the DM-2000AR is ±100 PPM/°C.

The display of the DM-2000AR is a 3-1/2 digit, seven-segment LED display with automatic polarity indication and automatic overflow indication. A digital input allows for the testing of all readout segments by displaying "+1888". All segments are viewed through a red filter which sharpens contrast and eliminates internal reflections.

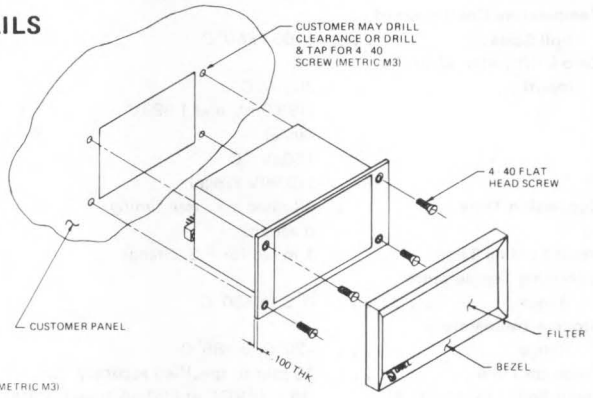
All displayed information is available at the I/O connector in BCD form. Digital inputs and outputs also allow for start-stop control and external clocking. Also, the automatic ranging can be overriden for external (manual) control. In addition, an optical isolation option is available which decouples the analog input section from the digital logic so that ground disturbances caused by the fast-switching digital circuits will not affect the analog input.

The DM-2000AR is packaged in a rugged 3"W x 1-3/4"H x 2-1/4"D LEXAN case with a total weight of less than 6 oz. Construction is entirely modular with snap-apart PC boards. The unit can easily be panel mounted with access to calibration controls obtained by snapping off the front bezel. The entire unit can be removed from its mounting panel and disassembled with just a screw driver in less than one minute.

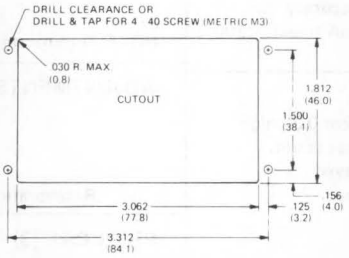

## FEATURES

- **3 Full-Auto Ranging-Scales: ±19.99V, ±1.999V, ±199.9mV**
- **3-1/2 Digit Solid State LED Display**
- **Automatic Polarity and Overflow Display**
- **Operates From Single +5V DC Supply**
- **Optional Optically Isolated Input**
- **Optional External Ranging Control**

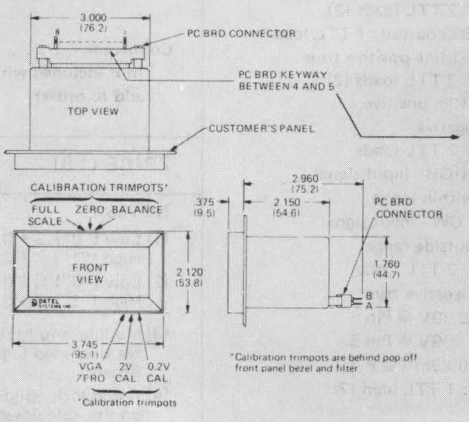
## MOUNTING DETAILS




### PANEL MOUNTING




## MECHANICAL DIMENSIONS INCHES (MM)




## INPUT/OUTPUT CONNECTIONS

| | PC BRD CONNECTOR BOTTOM A | PC BRD CONNECTOR TOP B | |
|---|---|---|---|
| ANALOG GROUND | 1 | 1 | ANALOG INPUT (HI) |
| SHIELD GROUND | 2 | 2 | SHIELD GROUND |
| NOT USED | 3 | 3 | NOT USED |
| RANGE MODE | 4 | 4 | LOGIC GROUND |
| DECIMAL POINT 100 | 5 | 5 | BIT 1 OUT |
| DECIMAL POINT 10 | 6 | 6 | BIT 2 OUT |
| DECIMAL POINT 1 | 7 | 7 | BIT 4 OUT |
| E.O.C. (STATUS) | 8 | 8 | BIT 8 OUT |
| OVERLOAD SCALE OUT | 9 | 9 | BIT 10 OUT |
| INT. START GATE | 10 | 10 | BIT 20 OUT |
| INT. START ADJ. | 11 | 11 | BIT 40 OUT |
| INT. START OUT | 12 | 12 | BIT 80 OUT |
| START INPUT | 13 | 13 | BIT 100 OUT |
| LAMP TEST | 14 | 14 | BIT 200 OUT |
| 1000 OUT | 15 | 15 | BIT 400 OUT |
| SIGN OUT | 16 | 16 | BIT 800 OUT |
| EXTERNAL RANGING | 17 | 17 | EXTERNAL RANGING |
| POWER COMMON | 18 | 18 | POWER INPUT, +5VDC |

Edge board PC contacts are on 0.1" centers

Ground A 4 for normal autoranging operation. Jumper A12 to A13 unless using ext. clock. SEE APPLICATIONS

## SPECIFICATIONS (Typical @ 25°C, 15 minutes warm-up)

### ANALOG INPUT

(single ended)

Note: Display reads in volts on high ranges, millivolts on low range.

| | |
|---|---|
| **Full Scale Input Ranges (automatic ranging)** | ±19.99V<br>±1.999V<br>±199.9mV |
| **Input Bias Current** | 2nA (all ranges) |
| **Input Overvoltage** | ±100V max. |
| **Input Impedance** | 1 MEGOHM (Note 5) |

Additional specifications (available only with optical isolation option):

| | |
|---|---|
| **Input Configuration** | Single ended Bipolar Floating |
| **Common Mode Voltage** | ±100$V_{CM}$ max. to digital output common |
| **Common Mode Rejection** | 70dB @ 60 Hz |

### PERFORMANCE

| | |
|---|---|
| **Accuracy** | ±.1% of F.S. ±1 count (5) |
| **Resolution** | ±1 count (±100μvolts) |
| **Temperature Coefficient of Full Scale** | ±100 PPM/°C |
| **Zero Drift (referred to the input)** | 30μV/°C (199.9mV and 1.999V range)<br>150μV/°C (19.99V range) |
| **Conversion Time** | 33 msec max (see timing diagram) |
| **Input Settling Time** | 1 m sec for F.S. change |
| **Operating Temperature Range** | 0°C to +50°C |
| **Storage Temperature Range** | -20°C to +85°C |
| **Warm-up Time** | 15 min to specified accuracy |
| **Input Power (See Note 4)** | +5 ±.25VDC at 800mA (max), <50mV spikes |

### DISPLAY OUTPUT

| | |
|---|---|
| **Display Type** | red LED seven segment 0.3" high |
| **Data** | 3-1/2 digits (1999 max count) |
| **Polarity** | ±automatically displayed |
| **Decimal Point** | automatically displayed |
| **Overflow** | "OF" automatically displayed |

### DIGITAL OUTPUTS

| | |
|---|---|
| **BCD (3LSD's) Data Outputs (pins B5 thru B16)** | 3 digits (8421) 12 lines positive true<br>Loading: 2 TTL loads (2)<br>Except 800 output: 1 TTL load |
| **1/2 Digit (MSD) Data Output (pin A15)** | 1/2 digit-1 line-positive true<br>Loading: 2 TTL loads (2) |
| **Polarity (pin A16)** | 1 line, "1" = positive, "0" = negative<br>Loading: 2 TTL loads |
| **$\overline{\text{Overload}}$ $\overline{\text{Scale Out}}$ (pin A9)**<br>**Note: Negative True** | 1 line, HIGH - input signal within range<br>LOW - input signal outside range<br>Loading: 2 TTL loads |
| **$\overline{\text{Decimal Point Outputs}}$** | 3 lines, negative true<br>Range 19.99V @ Pin 6<br>Range 1.999V @ Pin 5<br>Range 199.9mV @ Pin 7<br>Loading: 1 TTL load (2) |

Note: Negative True, Decimal points are controlled by auto-ranging logic.

| | |
|---|---|
| **$\overline{\text{End of Conversion}}$ (pin A8, Busy)** | 1 line, HIGH - during the conversion period (display blanked)<br>LOW - conversion complete<br>Loading: 2 TTL loads (2) |
| **Internal Start Output (pin A12)** | 1 line, positive true pulse<br>Loading: 1 TTL load (2) |

### DIGITAL INPUTS (Dynamic inputs should have TTL rise times)

| | |
|---|---|
| **Ranging Mode Control (pin A4)** | 1 line, "1" = external ranging, "0" = automatic ranging<br>Loading: 3 TTL loads (1) |
| **External Ranging Control (pins B17 and A17)**<br>Shown with pin A4 at HI.<br>A17 & B17 are disabled if A4 is LO. | 2 lines - Loading: 1 TTL load (1)<br>Range / Pin A17 / Pin B17<br>19.99V / "0" / "1"<br>1.999V / "1" / "0"<br>199.9mV / "0" / "0"<br>"11" Range code lights 2 D.P.<br>Don't use. |
| **External Start Convert Command (Pin A13)**<br>Start Trigger Clock, may be supplied from int. start, A12 | 1 line-min pulse width-100 nsec "0" to "1" (⎍) resets output register and blanks display, "1" to "0" (⎍) initiates conversion process.<br>Loading: 1 TTL load (1) |
| **Internal Start Gate (Pin A10)** | 1 line, gates internal clock "1" = run, "0" = stop<br>Loading: 1 TTL load (1) |
| **Internal Start Adjust (Pin A11)** | Controls rate of Internal Start Clock (see application section) |
| **Lamp Test (Pin A14)** | 1 line, negative true, displays +1888 to test all display segments<br>Loading: sink 35mA. |

NOTE: Internal start clock is 2 samples/second and is externally adjustable

### ADJUSTMENTS

Zero, balance, full scale, VGA zero, 2V cal and 0.2V cal trimpots accessible behind snap-on front bezel

**Recalibration Interval** (Normal conditions) 90 days

### PHYSICAL (3)

| | |
|---|---|
| **Case Size** | 3"W x 1.75"H x 2.25"D |
| **Case Material** | Black polycarbonate plastic |
| **Weight** | 6 oz. approx. |
| **Mounting** | Panel mounted through a 1.812" x 3.062" cutout with four 4-40 screws. |
| **Connector (not included with DPM, add to order)** | Dual 18-pin, PC Edgeboard Type, 0.1" centers (Viking #3VH18/IJN-5 or equal) with key between pins 4 and 5 |

### PRICE (1-9)

$169.
(no optoisolation, less connectors)

### NOTES:

(1) Low ("0") ≤ +0.8V
High ("1") ≥ +2.0V

(2) Low ("0") ≤ +0.4V
High ("1") ≥ +2.4V

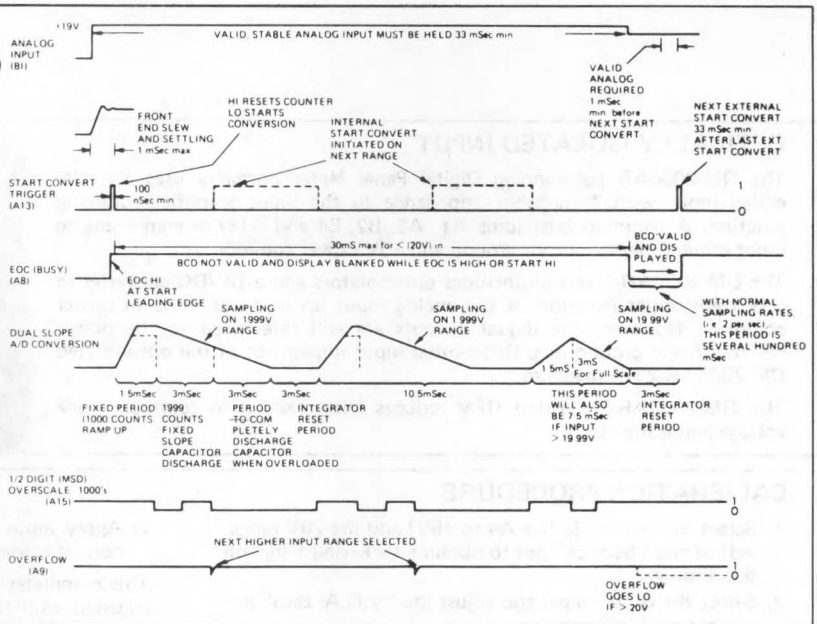
(3) Module is fully repairable and features snap together PC Boards

(4) Avoid logic spikes entering DPM on the +5V power input. Use external filtering if required. Recommended power supply is a Datel UPM-5/1000B or equivalent highly regulated type. Power current is 400 to 800mA max depending on digits displayed and sample rate

(5) 1 Megohm input resistor is in series with input summing junction. Accuracy specification will degrade with significant external source impedance (> 1KΩ)

## DM-2000AR DPM TIMING DIAGRAM

### AUTORANGING MODE (PIN A4 GROUNDED)
### 19.0 VOLTS ANALOG INPUT




**NOTES:**

1. TIMING IS NOT TO SCALE
2. TIMING IS TYPICAL EXCEPT WHERE INDICATED MIN OR MAX
3. EOC WILL FALL 4.5 TO 33mSec TYP AFTER START CONVERT DEPENDING ON ANALOG INPUT LEVEL
4. DUTY CYCLE OF DISPLAY BLANKING DURING EOC HIGH VARIES WITH SAMPLE RATE AND INPUT RANGE. MAY CAUSE DISPLAY FLICKER IN SOME APPLICATIONS. IF AN EXTERNAL START TRIGGER CLOCK IS USED, KEEP DUTY CYCLE LOW TO AVOID DISPLAY BLANKING AND FLICKER.

## COMPLETE MODULAR CONSTRUCTION

Total modular construction is another plus for the DM-2000 AR.

Servicing is simple and straightforward.

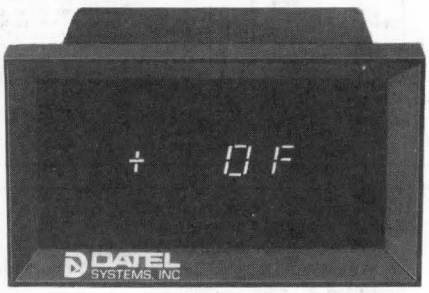
The unit can be removed through the front panel without opening the users' instrument. Once the snap-on front bezel and four mounting screws are removed, the meter slides out of its Lexan case. The procedure is uncomplicated and takes less than one minute. Once removed, modular service is possible due to the five plug-in interconnected PC boards – no wiring or soldering is required.

Troubleshooting is accomplished through board substitution and servicing can be completed within five minutes.

A full complement of replacement boards are readily available from Datel's Service Department.


## ALPHA NUMERIC INDICATION OF OVERFLOW

When the voltage input exceeds full scale by a minimum of one least significant digit, the characters "OF" are displayed. All data digits are blanked. An example of this would be when full scale is +19.99V, then +20.00V would be the smallest possible overload.




## BUILT IN DISPLAY TEST FOR PERIODIC TESTING

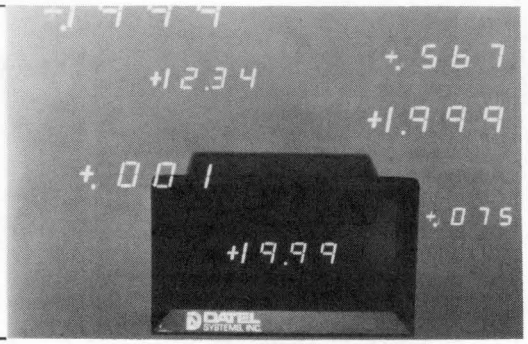
Testing for faulty display segments can be achieved in a matter of moments guarding against erroneous readings. Grounding pin 14 at the rear connector will display +1888 to test all possible segment combinations.

## OPTICALLY ISOLATED INPUT

The DM-2000AR autoranging Digital Panel Meter normally uses a single-ended input with 1 megohm impedance to the input amplifier summing junction. A common bus, (pins A1, A2, B2, B4 and A18) reference analog input ground, digital output ground and +5V power common.

The DM-2000AR-2 version includes optoisolators and a DC/DC converter to give transformer isolation of the analog input up to ±100 Volts to power common. However, the digital outputs are still referenced to the power common/logic ground bus. Differential input impedance of the optoisolated DM-2000AR-2 is 1 megohm.

The DM-2000AR-2 isolated DPM reduces false readings in common mode voltage applications.

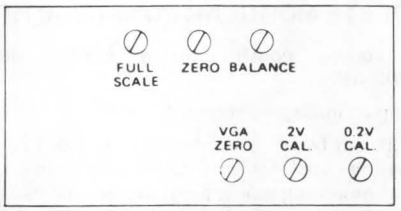



## CALIBRATION PROCEDURE

1. Select manual mode (tie A4 to +5V) and the 20V range. Adjust the "balance" pot to obtain a flickering ± sign on the display.
2. Select the 0.2V range, and adjust the "V.G.A. zero" pot to obtain a flickering sign.
3. Repeat steps 1 and 2 until a flickering sign is obtained on both the 0.2V and 20V ranges (takes 2-3 adjustments).
4. On the 0.2V range, apply an input of ±300μV (be careful of noise on such a small input). Adjust the "zero" pot to obtain a reading of ±003 ±1 digit.
5. Select auto mode (ground A4) and apply input of +18.00V from a precision voltage reference source. Adjust "full scale" to obtain correct reading.
6. Apply input of +1.800V. Adjust "2VCAL" to obtain correct reading.
7. Apply input of +.1800V. Adjust "0.2VCAL" to obtain correct reading.

This completes calibration. Small drifts in the zero can be adjusted with the "V.G.A. zero" pot only which will not require selection of manual mode.

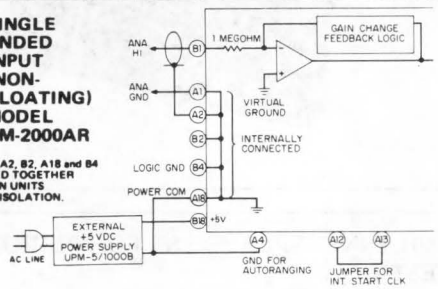
Location of trim pots




View behind front Bezel and Filter

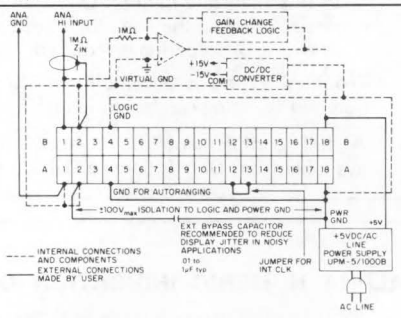
**DON'T FLOAT A4. GROUND A4 FOR AUTORANGING, JUMPER A12/A13 FOR INT. START CLOCK**

**SINGLE ENDED INPUT (NON-FLOATING) MODEL DM-2000AR**

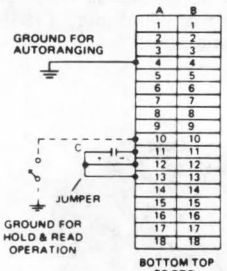



NOTE: PINS A1, A2, B2, A18 and B4 ARE CONNECTED TOGETHER INTERNALLY ON UNITS WITHOUT OPTOISOLATION.

**SINGLE ENDED FLOATING INPUT (Optoisolated DM-2000AR-2 Only)**




**USING THE METER WITH THE INTERNAL "START" CLOCK**




NOTE: JUMPER A12/A13 MUST BE USED IF EXT. START TRIGGER IS NOT SUPPLIED

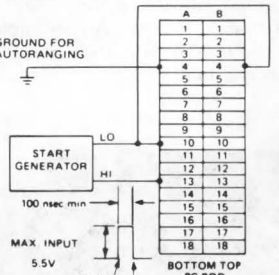
1. CONNECT JUMPER A12 TO A13 LEAVE PIN A10 OPEN. CONNECT "C" FROM A11 TO A12. AS SHOWN

"C" = OPTIONAL TIMING CAPACITOR TO SLOW DOWN INTERNAL "START" CLOCK. A 1.0μF 50V CAPACITOR WILL HALF RATE WITHOUT EXTERNAL CAPACITOR THE RATE IS APPROX. 2 SAMPLES PER SECOND.

2. FOR HOLD & READ OPERATION GROUND PIN A10

$$C\,(\mu F) \geq \frac{2}{\text{CONV/SEC}} - 1$$

**USING THE METER WITH AN EXTERNAL "START"**




USE LOW DUTY CYCLE START TRIGGER TO AVOID DISPLAY BLANKING AND FLICKER

APPLY AN EXTERNAL START PULSE TO INITIATE CONVERSION (100 nsec MIN. WIDTH) TRANSITION FROM "LOW" TO "HIGH" RESETS OUTPUT REGISTER READOUT BLANKS WHILE EOC IS HIGH. THE CONVERSION PROCESS IS INITIATED UPON RETURN FROM "HIGH" TO "LOW".

## ORDERING INFORMATION

**Model DM-2000AR**

Add -2 suffix for optoisolated inputs

## PRICES (1–9 quantity)

| | |
|---|---|
| DM-2000AR (no optoisolation, less connectors) | $169.00 |
| DM-2000AR-2 (with optoisolation, less connectors) | $218.00 |

Covered by GSA Contract No. GS-00S-27959

**Connectors** (not included with DPM. Be sure to add to your DPM order)

| | |
|---|---|
| Solder Tab, Datel #2335-1 (Viking 3VH18/1JN-5) | 4.95 |
| Wire Wrap, Datel #2335-2 (Viking 3VH18/1JHD-5) | 4.95 |

**Suggested AC power supply:**

| | |
|---|---|
| UPM-5/1000 B 5V, 1A, 115VAC input | $ 49.00 |
| UPM-5/1000 BE 5V, 1A, 230VAC input | $ 54.00 |
| Power supply Socket, MS-7 | $ 3.50 |

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# MINIATURE 3½ DIGIT AC-POWERED DIGITAL PANEL METER

# MODEL DM-2115

Covered by GSA Contract No. GS-00S-27959

## FEATURES

- **Choice of AC line or +5VDC power**
- **Compact: Only 1.75" H. x 2.25" D. x 3" W.**
- **Large, Bright, 0.43" High Red LED Displays**
- **Automatic Polarity and Overflow Display**
- **5V/400mA Optional Power Input — Ideal for Portable Use**
- **Differential Input**
- **Optional Parallel BCD/TTL Output**

## GENERAL DESCRIPTION

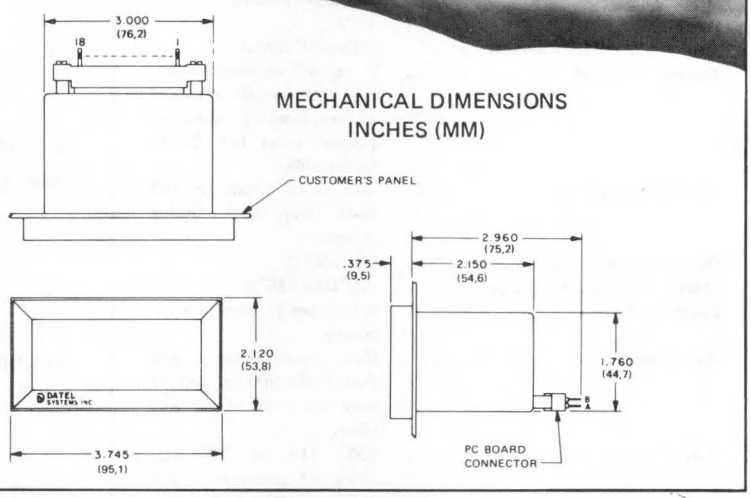
Datel Systems' DM-2115 is the world's smallest AC line operated Digital Panel Meter. Packaged in a compact 1.75" H. x 2.25" D x 3" W. Polycarbonate plastic case and using large 0.43" high seven-segment LED digits, Model DM-2115 provides an easy-to-read 3½ digit display of ±1.999 volt full scale inputs complete with automatic polarity and overflow indication. Both the size and the power consumption of the DM-2115 have been significantly reduced through extensive use of MSI CMOS logic. Power input options include AC inputs of 100VAC, 115VAC or 230VAC at 47 to 440 Hz, or from +5VDC at 400mA, max. All AC supplies use a high quality C-core, strip-wound line transformer that consumes a low 3.5 watts of input power. For portable applications using the +5VDC input option, current drain can be further reduced to 120mA by blanking the display and using a press-to-read switch, or the display can be separately duty cycled.

Model DM-2115 provides true differential input characteristics with an input impedance of 100 Megohms, min., and common mode rejection of 70 dB from DC to 60 Hz. The instrument accepts a single-ended or differential input voltage range of ±1.999V and generates a display that is accurate to within ±0.05% of reading ±1 count. The temperature coefficient is 50ppm/°C, max. over the operating temperature range of 0 to +50°C. Optional models are available with full parallel, BCD TTL data outputs and auxiliary signals at the PC board I/O connector.

An internal start clock commands 4 conversions per second but an external capacitor will reduce this sampling rate. Or this internal clock can be inhibited to hold and display the last sample. An external start trigger pulse may be used to sample from 0 to 40 conversions per second.

Convenience features include display test and decimal point illumination by grounding pins. In AC versions, the high isolation line transformer and the separation of analog and digital grounds provide additional protection against ground loops.

Applications for the DM-2115 include measurement and display of any variable that can be converted to a voltage. These include pH, pressure, distortion, torque, liquid level, temperature, displacement and many others.

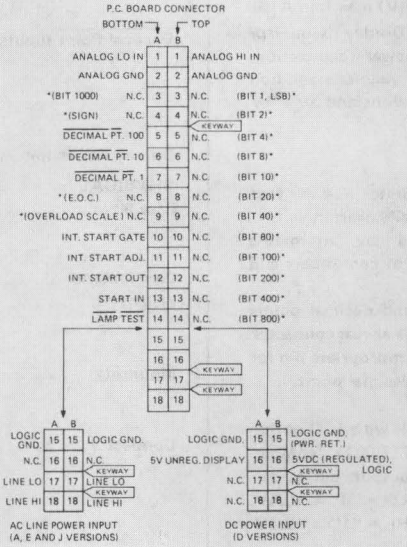




MECHANICAL DIMENSIONS
INCHES (MM)

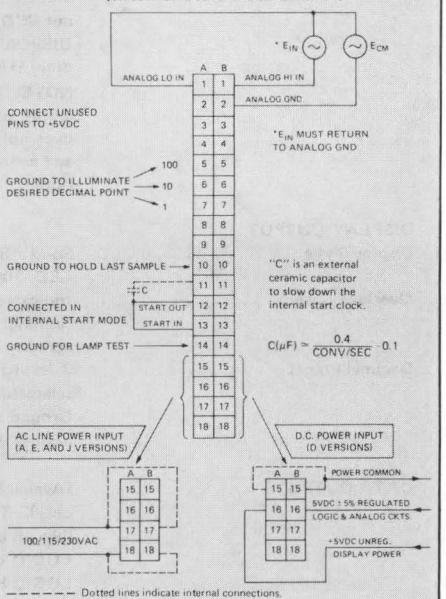
## INPUT/OUTPUT CONNECTIONS

### PIN FUNCTIONS

NOTE: *Parallel BCD Outputs appear at asterisked pins for BCD Models only. Models without BCD have no connections at these pins.




### POWER AND SIGNAL CONNECTIONS
(Internal Start Mode Shown)



## SPECIFICATIONS (Typical @ +25°C unless noted)

**INPUTS**

| | |
|---|---|
| Input Voltage Range | ±1.999 Volts DC |
| Input Impedance | 100 Megohms, min. |
| Type of Input | True Differential |
| Input Bias Current | Analog HI Input 3nA Typ, 7nA Max. Analog LO Input 45nA Typ, 500nA Max. |
| Input Polarity | Bipolar-Automatic |
| Common Mode Rejection | 70 dB, DC-60 Hz |
| Common Mode Range | ($E_{IN}$ + $E_{CM}$) Must be within ±3.0V to logic or Analog Ground, ±300V to AC line |
| Input Overvoltage | ±50V Max. continuous ±200V Max. 5 sec. duration |

**PERFORMANCE**

| | |
|---|---|
| Accuracy @ 25°C | ±0.05% of reading ± 1 count |
| Resolution | 1mV |
| Temperature Coefficient | ±50ppm/°C Max. |
| Conversion Speed | 0 to 40 conversions/sec. max. (ext. trigger required at max. rate) 4 samples/sec. normal from Int. Clock. (adjustable) |
| Input Settling Time | 500 µs to 0.05% for full scale step. See timing diagram. |
| Operating Temperature Range | 0 to +50°C |
| Storage Temperature Range | −20°C to +85°C |
| Warm Up Time | 5 minutes to specified accuracy. |
| Adjustments | Diff. Amp. Balance and Full Scale located behind snap on front Bezel and filter. |
| Power Supply | 100, 115 or 230VAC, ±10%, 47 to 440 Hz @ 3.5 Watts or +5VDC ±5%, regulated at 400mA max. total, spikes ⩽ 10 mV. LOGIC and Analog: 150mA drain (+5V) (120mA without BCD outputs) DISPLAY: (+1888), 250mA drain (+5V) max (pin A16) NOTE: Display is on separate power connection, does not require regulation and can withstand 5V ±1V ripple. |

**DISPLAY OUTPUT**

| | |
|---|---|
| Display Type | Solid State 0.43" Red LED. 100% overrange. |
| Overload Scale | Indicated by alternating flashing of center bars and zeroes. |
| Decimal Points | 3 left-hand decimal points selectable at rear connector. Ground appropriate pin for desired decimal point. |
| DATA OUTPUTS | (Available with BCD option only) TTL/DTL compatible, all outputs buffered. LOGIC LO = "0" ⩽ +0.4V LOGIC HI = "1" ⩾ +2.4V |
| BCD Outputs | 12 latched parallel lines 8-4-2-1 positive true binary coded decimal. Loading 2 TTL loads. BCD not valid until 400 µsec after EOC trailing edge. See timing. |
| Overrange (Pin A3) | Counts between 1000 and 1999 only, indicated by logic high (2TTL loads) |
| Overload Scale (Pin A9) | > 1999 counts indicated by logic high (2 TTL loads) |
| Polarity (Pin A4) | Logic high for positive inputs, logic low for negative inputs (2 TTL loads) |
| End of Conversion (Busy) (Pin A8) | High on leading edge of start pulse and during conversion. BCD outputs are counting while EOC is HI, and, therefore, are not valid. BCD outputs are valid 400 µSec after EOC goes LO, indicating conversion complete (2 TTL loads). |

**INPUT/OUTPUT CONTROL**

| | |
|---|---|
| External Start Input (Pin A13) | Positive pulse, 0 to +5V min., 1 µs min. duration CMOS input. For TTL compatibility, connect start input through 1KΩ to +5V TTL supply. Max. input +5.5V. |

ALL INPUT CONTROLS ARE TTL/DTL COMPATIBLE EXCEPT EXT. START (A13) (SEE PG. 4)

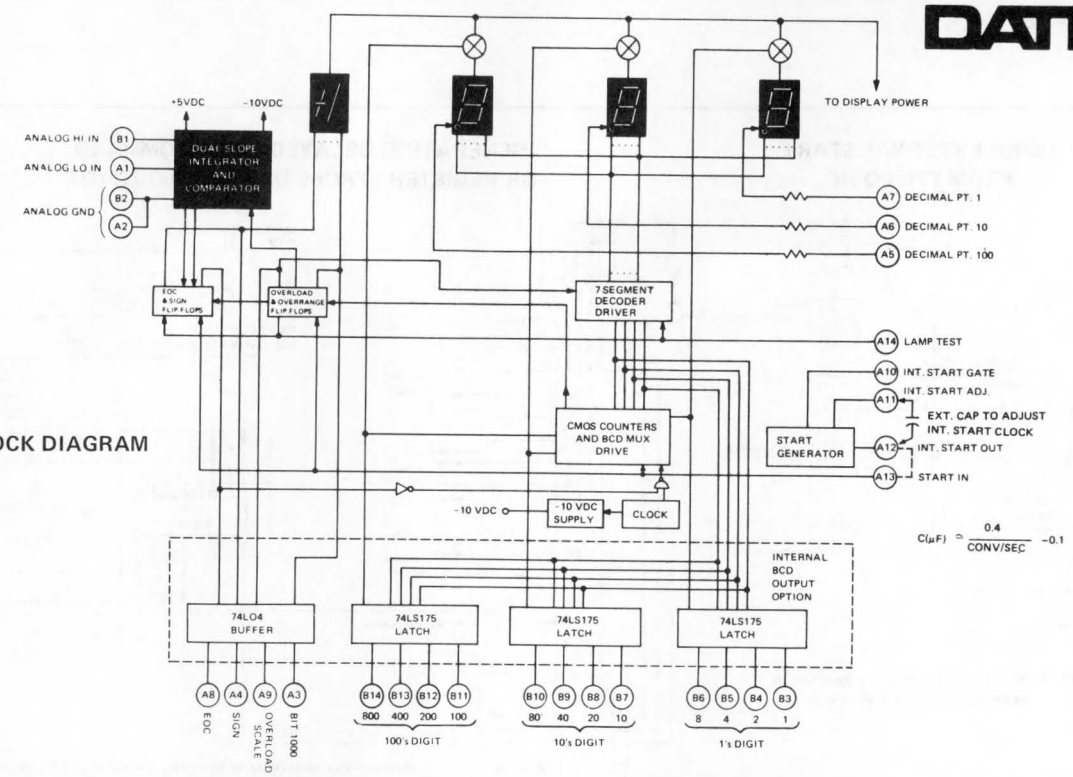
LOGIC LO = 0V ⩽ "0" ⩽ +0.8V
LOGIC HI = +2.0V ⩽ "1" ⩽ +5.0V

| | |
|---|---|
| Internal Start Gate (Pin A10) | HIGH – RUN / LOW – HOLD } Loading, 1 TTL load. |
| Internal Start Adjust (Pin A11) | Controls rate of Internal Start Pulse. See pg. 1. |
| Internal Start Out (Pin A12) | +5V positive pulse 1 mS duration. 4 samples/sec.(adj) |
| $\overline{\text{Lamp Test}}$ Input (Pin A14) | Grounding this input displays +1888 for testing all segments (4 TTL loads) |
| $\overline{\text{Decimal Point}}$ Inputs (Pins A5, 6, 7) | Grounding these inputs illuminates corresponding decimal points on the display. Sink 40mA, 80 µsec, 33% duty cycle |
| Display Power (pin A16) | 250 mA max. at +5VDC |

**PHYSICAL**

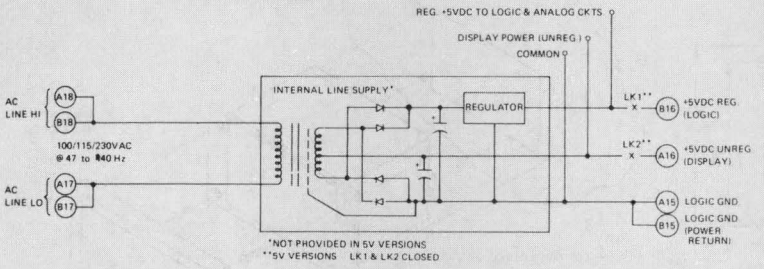
| | |
|---|---|
| Case Size | 3" W x 1.75" H x 2.25" D (76,2 mm x 44,4 mm x 57,2 mm) |
| Case Material | Black polycarbonate plastic |
| Weight | Line Power Units – 10 oz. (284g) 5V Units – 5 oz. (141g) |
| Mounting | 1.812" x 3.062" cut out attached by four 4-40 flathead countersunk screws. |
| Connector | DUAL 18-pin PC edgeboard type on 0.1" centers (Viking 3VH18/1JN-5 or 1JHD-5 equiv. w/keys). |

## BLOCK DIAGRAM

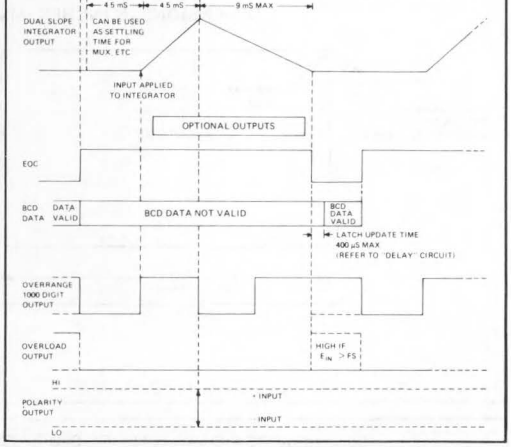



$$C(\mu F) \simeq \frac{0.4}{CONV/SEC} - 0.1$$

## POWER SUPPLY BLOCK DIAGRAM



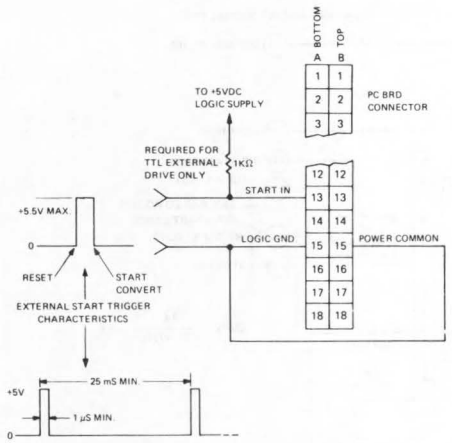

## TIMING DIAGRAM




## CALIBRATION PROCEDURE

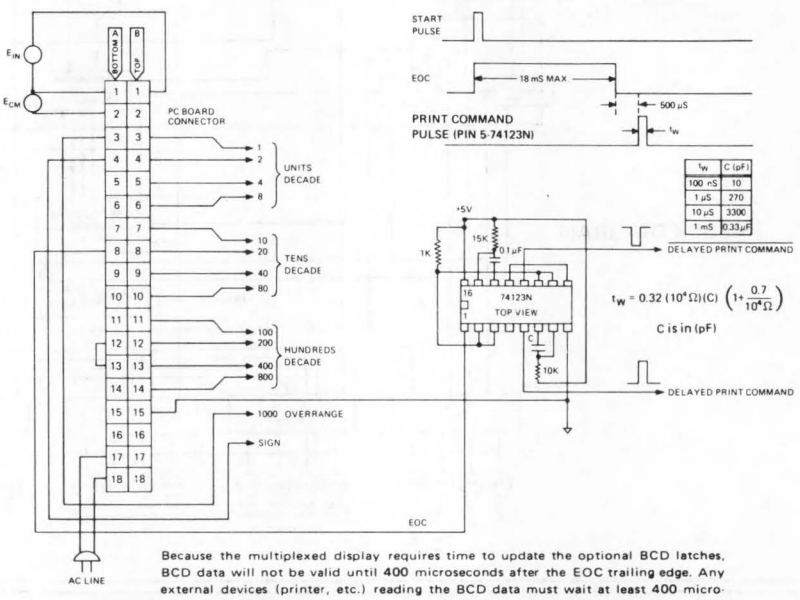
1. Remove the front bezel and filter and jumper pins A12 and A13 to initiate repetitive sampling using the internal start clock.
2. Connect both ANALOG INPUT pins to ANALOG GROUND and apply power.
3. After 5 minutes of warmup, adjust the BALANCE potentiometer so that all display digits read zero while the display polarity indicator flickers equally between plus and minus. Offset range is approximately ±15 mV.
4. On the DM-2115 under test, jumper ANALOG LO IN and ANALOG GND. Then, apply +1.9905VDC from a calibrated precision voltage reference to ANALOG HI IN, using ANALOG GND as signal input return.
5. Adjust the GAIN potentiometer of the unit under test so that the display flickers equally between +1.990 and +1.991VDC.

## USING EXTERNAL START FROM TTL LOGIC




NOTE: Keep duty cycle of start trigger low to avoid display blanking and flicker.

## GENERATING DELAYED PRINT COMMAND OR REGISTER STROBE USING BCD OUTPUTS



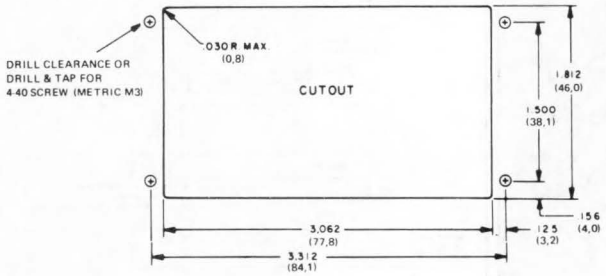

Because the multiplexed display requires time to update the optional BCD latches, BCD data will not be valid until 400 microseconds after the EOC trailing edge. Any external devices (printer, etc.) reading the BCD data must wait at least 400 microseconds. The suggested circuit shown performs this function by generating a pulse delayed 500 microseconds after the trailing edge of the EOC. The width $t_W$ of the delayed pulse is adjustable to accommodate different output devices.

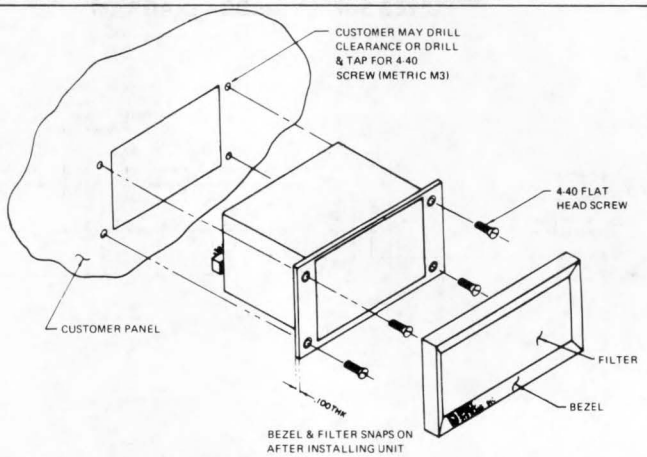
DATEL

JUMPER A12/A13 FOR INTERNAL START CLOCK. LIGHT DISPLAY WITH 5V ON A16 (DC MODELS)

## MOUNTING DETAILS

DIMENSIONS IN INCHES (MM)




Covered by GSA Contract No. GS-00S-27959

## ORDERING GUIDE

DM-2115 ____ ____

| POWER SUPPLY | FULL PARALLEL BCD OUTPUT |
|---|---|
| A = 115V ± 10%, 47 to 440 Hz<br>E = 230V ± 10%, 47 to 440 Hz<br>J = 100V ± 10%, 47 to 440 Hz<br>D = +5VDC ± 5% @ 400mA max. | 1 = without<br>2 = with |

Line cord is not included

**PRICES (1-9)** (Contact Datel for quantity and International prices)

Prices do not include mating connectors. Please order connectors with your DPM.

| | | |
|---|---|---|
| +5V Powered, No BCD | DM-2115D1 . . . . | $129.00 |
| +5V Powered, w/BCD | DM2115D2 . . . . . | 145.00 |
| AC Powered, No BCD | DM2115A1 . . . . . | 159.00 |
| | DM2115E1 . . . . . | |
| | DM-2115J1 . . . . . | |
| AC Powered, w/BCD | DM-2115A2 . . . . . | 175.00 |
| | DM-2115E2 . . . . . | |
| | DM-2115J2 . . . . . | |

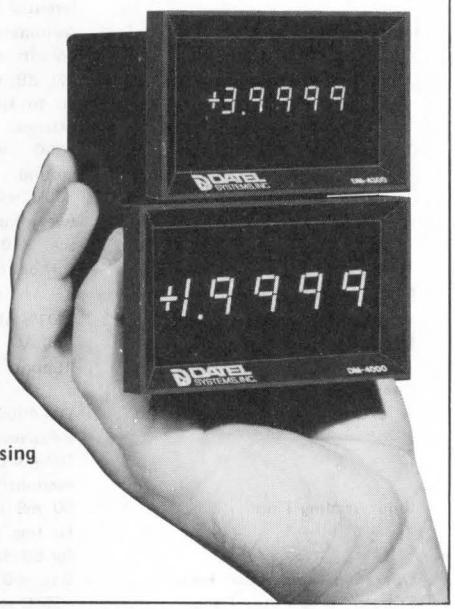
Mating connector, dual 18-pin PC board type with keys installed:
- 2335-3 (Solder Tab, . . . . . $4.95 ea.
  Viking 3VH18/1JN-5 or equiv.)
- 2335-4 (Wire Wrap, . . . . . $4.95 ea.
  Viking 3VH18/1JHD-5 or equiv.)

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# MINIATURE 4½ AND 4¾ DIGIT DIGITAL PANEL METERS

# MODELS DM-4000 AND DM-4300

Covered by GSA Contract No. GS-00S-27959




- Miniature Case With 5 Large, Red LED Displays
- Autozeroing, Optoisolated Floating Input
- Operates From +5VDC Logic Power
- High Noise Immunity using 120 dB CMR, ±300 $V_{CM}$ Bipolar Floating Input
- AC Hum Rejection (60 dB NMR) using Line-synchronized Quartz Crystal Counter
- 3-Wire Ratiometric Input Reduces Drift Errors from Bridge Inputs

## GENERAL DESCRIPTION

The Datel Models DM-4000 and DM-4300 are, respectively, the world's smallest 4½ and 4¾ digit LED digital panel meters, and include input offset autozeroing.

Both models feature large, easy to read red LED displays that are 0.43" high in the DM-4000 and 0.3" high in the DM-4300. Input power for either model is +5VDC at 600mA, max.

These DPM's employ a differential, optically isolated floating input that withstands ±300 volts common mode to digital ground with 120 dB common mode rejection from DC to 60 Hz. This provides high noise immunity in industrial applications.

The counter circuits are driven by a stable crystal controlled oscillator which may be specified to synchronize with either 50 or 60 Hz, the common AC power line frequencies. Dual slope integration synchronized to 50 or 60 Hz provides 60 dB of normal mode rejection to power hum on the signal input.

An internal ±6.4 VDC reference and the reference input may be externally connected for 3-wire, TC-tracking ratiometric measurements. This configuration reduces temperature drift errors by normalizing to a single positive reference voltage.

Model DM-4000 measures and displays a full scale input of ±1.9999V. The full scale input/display range of Model DM-4300 is ±3.9999V. Both models have an input impedance in excess of 100 megohms, input bias current of 100 pA max. – which doubles each 10°C.

Accuracy of Models DM-4000/4300 is ±0.01% of reading ± 1 digit, with a temperature coefficient of 15 ppm/°C max. over the 0 to +50°C operating range. When operating from the internal clock both models update their display at a 2 sample per second rate, but when driven by an external start pulse the DM-4000 sampling rate can be varied from 0 to 5 per second and the DM-4300 from 0 to 3.3 per second. Calibration adjustments after a 15 minute warmup are easily accessible behind the front panel filter.

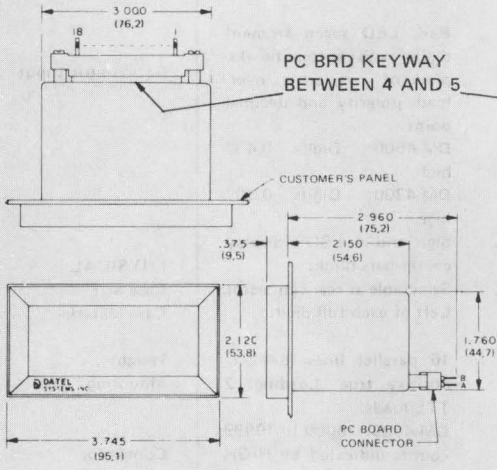
The red LED seven segment digits provide automatic display of overrange, overload, polarity and decimal point: Overload is indicated by alternate flashing of the center bars of the sign and 4 LSD displays. The decimal points are illuminated by grounding the appropriate connector pin.

DTL/TTL compatible overrange, polarity, overload and EOC outputs are available at the rear case, 18-pin dual PC board connector in both models. Sixteen lines of BCD data are optionally available at the rear connector in full parallel, 8-4-2-1 positive true format.

These DPM's are housed in a high-impact polycarbonate case that measures only 3" W x 1.75" H x 2.25" D.

High immunity to common mode and normal mode voltages combined with the ratiometric feature especially recommend these DPM's for use with many bridge transducers. Applications include temperature measurement, motion, stress and many other physical phenomena.

MECHANICAL DIMENSIONS
INCHES (MM)




INPUT/OUTPUT CONNECTIONS

| | P.C. BOARD CONNECTOR BOTTOM A | TOP B | |
|---|---|---|---|
| ANALOG INPUT (LO) | 1 | 1 | ANALOG INPUT (HI) |
| + REFERENCE IN | 2 | 2 | + REFERENCE OUT (+6.4V) |
| – REFERENCE OUT (–6.4V) | 3 | 3 | BIT 1 OUT |
| DECIMAL POINT 10,000 | 4 | 4 | BIT 2 OUT |
| DECIMAL POINT 1000 | 5 | 5 | BIT 4 OUT |
| DECIMAL POINT 100 | 6 | 6 | BIT 8 OUT |
| DECIMAL POINT 10 | 7 | 7 | BIT 10 OUT |
| DECIMAL POINT 1 | 8 | 8 | BIT 20 OUT |
| OVERLOAD SCALE | 9 | 9 | BIT 40 OUT |
| EOC (STATUS) | 10 | 10 | BIT 80 OUT |
| INT. START GATE | 11 | 11 | BIT 100 OUT |
| INT. START OUT | 12 | 12 | BIT 200 OUT |
| START INPUT | 13 | 13 | BIT 400 OUT |
| BIT 20,000 OUT (OVER RANGE) | 14 | 14 | BIT 800 OUT |
| BIT 10,000 OUT (OVER RANGE) | 15 | 15 | BIT 1000 OUT |
| POLARITY (SIGN) OUT | 16 | 16 | BIT 2000 OUT |
| BIT 8000 OUT | 17 | 17 | BIT 4000 OUT |
| POWER COMMON | 18 | 18 | PWR. INPUT +5VDC |

NOTE: INTERNAL CONNECTIONS TO BIT 1 THROUGH BIT 8000 EXIST IN BCD OUTPUT OPTION VERSIONS ONLY. DECIMAL POINT 10,000 IS AVAILABLE ONLY IN THE DM-4300

## SPECIFICATIONS (Typical @ +25°C unless noted)

### INPUT CHARACTERISICS

| | |
|---|---|
| Input Voltage Range (Full Scale) | DM-4000: ±1.9999 Volts<br>DM-4300: ±3.9999 Volts |
| Input Impedance | Greater than 100 megohms |
| Input Bias Current | 100pA max. @ 25°C (doubles/10°C) |
| Input Configuration | Single-ended floating. Optical isolation to digital ground employed for differential characteristics. |
| Input Polarity | Automatic bipolar with polarity display indication. |
| Common Mode Rejection | 120 dB, DC to 60 Hz with up to 1K ohm source unbalance. |
| Common Mode Voltage Range | ±300 Volts to digital ground. |
| Input Overvoltage | ±50V min. (sustained) between inputs without damage. ±100V to 5 seconds without damage. |

### PERFORMANCE

| | |
|---|---|
| Accuracy (@ 25°C) | ±.01% of reading ± 1 digit. |
| Resolution | 100μV |
| Temperature Coefficient of Reading | 15ppm/°C max. |
| Conversion Speed (Adjustable using ext. trigger) | DM-4000: 0 to 5 conversions/sec.<br>DM-4300: 0 to 3-1/3 conversions/sec. |
| Input Settling Time | 50 mS integration for 60 Hz line. 60 mS integration for 50 Hz line optional. |
| Operating Temperature Range | 0 to +50°C. |
| Storage Temperature Range | −55°C to +85°C. |
| Warm Up Time | 15 minutes to rated accuracy. |
| Adjustments | Full scale (Gain) trim located behind front bezel. Separate ± adjustment and ratio zero trim. Autozeroing. |
| Input Power | +5 ± .25 VDC @ 600mA max. (with input logic spikes 10mV max.). Suggested power supply is a Datel UPM-5/1000B or equivalent highly regulated type. Power current varies rapidly with digits displayed, conversion rate, etc. |

### DISPLAY OUTPUT

| | |
|---|---|
| Display Type | Red, LED seven segment digits with automatic display of overrange, overload, polarity and decimal point:<br>DM-4000: Digits 0.43" high<br>DM-4300: Digits 0.30" high |
| Overload Scale | Sign and 4 LSD's display center bars blink. |
| Decimal Points | Selectable at rear connector. Left of each full digit. |

### OPTIONAL DATA OUTPUTS

| | |
|---|---|
| BCD Outputs | 16 parallel lines (8-4-2-1) positive true. Loading: 2 TTL loads. |
| Overrange | DM-4000: 10000 to 19999 counts indicated by HIGH on pin A15 with LOW on overflow (pin A9).<br>DM-4300: 10000 to 39999 counts indicated by a positive true 2-1 BCD code on pins A14 and A15 along with a LOW on overflow (pin A9) |
| Polarity | Input signal polarity positive indicated with a HIGH. Negative polarity indicated with a LOW. |
| Overload Scale | DM-4000: Greater than 19999 counts indicated by a HIGH (positive true) on overflow (pin A9). Less than 19999 counts indicated by a LOW.<br>DM-4300: Greater than 39999 indicated by HIGH on overflow (pin A9). Less than 39999 counts indicated by a LOW. |
| End of Conversion (EOC) | HIGH – during conversion, BCD outputs counting and invalid.<br>LOW – conversion complete. BCD outputs valid 500 μsec after EOC. (See timing diagram) |

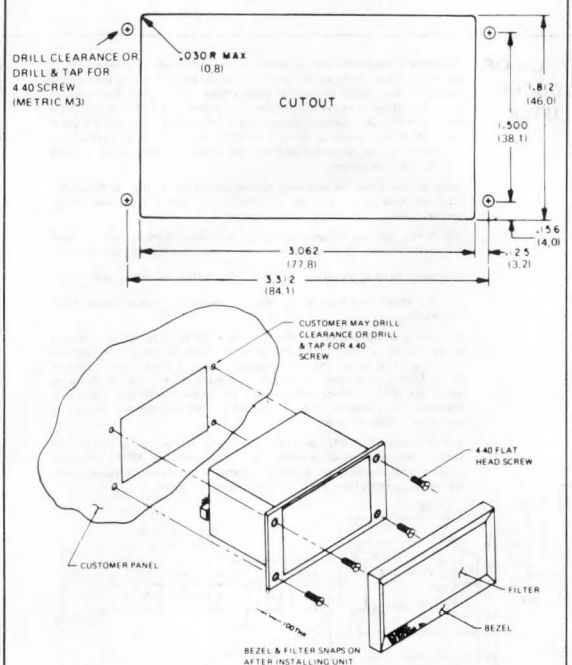
### INPUT/OUTPUT CONTROL

| | |
|---|---|
| External Start Conversion Command | Positive pulse 100 nsec. min. width. 2.0V min. 5V max. height. Conversion initiated upon return from "HIGH" to "LOW". |
| Internal Clock Start Gate | Controls internal start clock<br>"HIGH" – Run<br>"LOW" – Stop<br>Loading – 1 TTL load. |
| Internal Start Output | Positive pulse output of internal start clock. 2 pulses/second. |
| Decimal Point Inputs | Grounding these inputs illuminates corresponding decimal points on the display. |
| Ratiometric Output | Derived from internal reference for TC-tracking. Provides ±6.4V @ 2mA max. for 3-wire ratiometric measurement. Ratiometric inputs can be normalized to a single positive reference voltage. |
| Ratiometric Input | Calibrated for +6.4 V±5% input (avail. from ratiometric output, above). May be varied from +3V to +10 VDC for TC-tracking bridge applications. Reading (volts) $= \frac{V_{IN} \times 6.4}{V_{REF\ IN}}$ |

### PHYSICAL

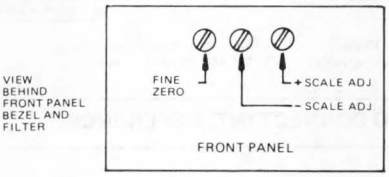
| | |
|---|---|
| Case Size | 3"W x 1.75"H x 2.25"D |
| Case Material | Black high-impact polycarbonate plastic. |
| Weight | 8-10 oz. |
| Mounting | Through a 1.812" x 3.062" cutout secured with four 4-40 screws. |
| Connector | Dual 18-pin PC edgeboard type, 0.1" centers (not included, see ordering guide) |

## MOUNTING DETAILS
## DIM. IN INCHES (MM)

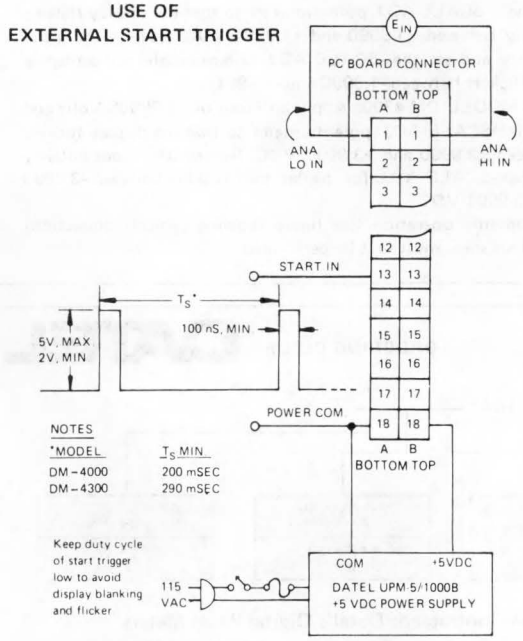



## CALIBRATION POTENTIOMETERS

SEE CALIBRATION PROCEDURE, PG. 4

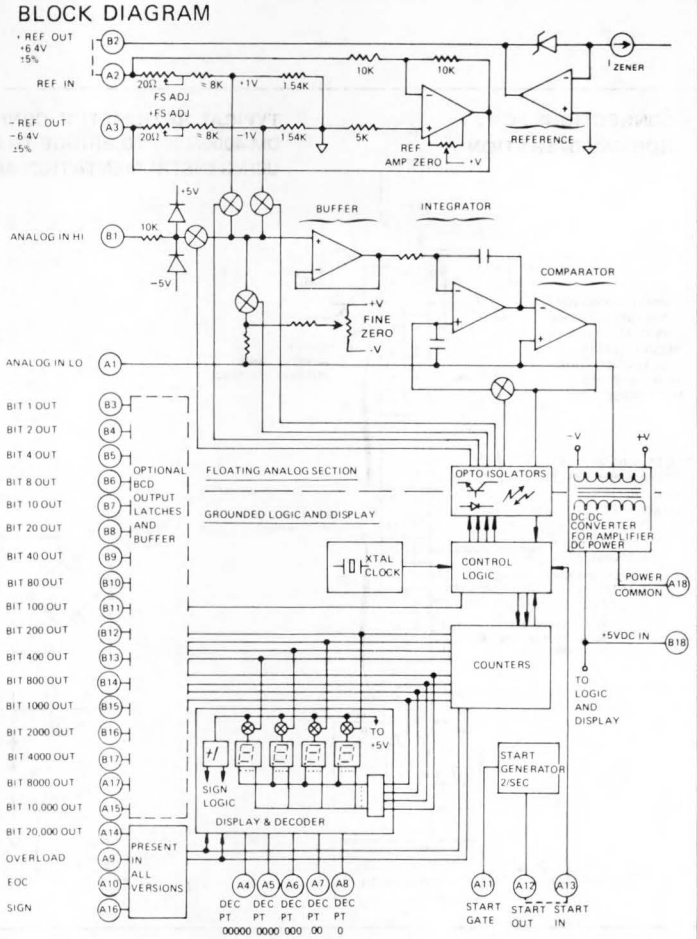



## USE OF
## EXTERNAL START TRIGGER

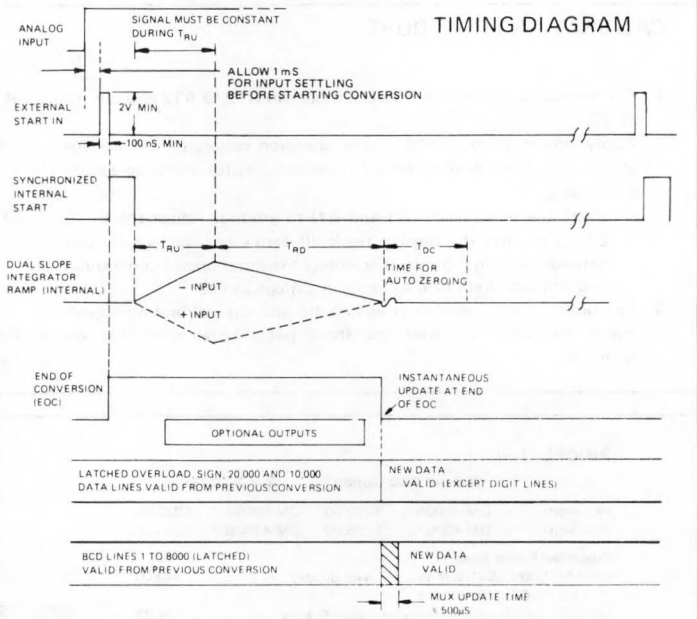



DATEL

## BLOCK DIAGRAM

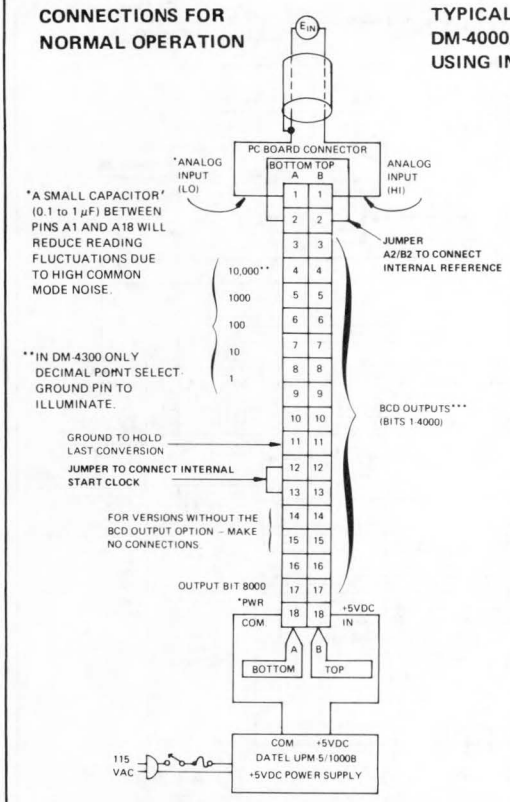



## TIMING DIAGRAM

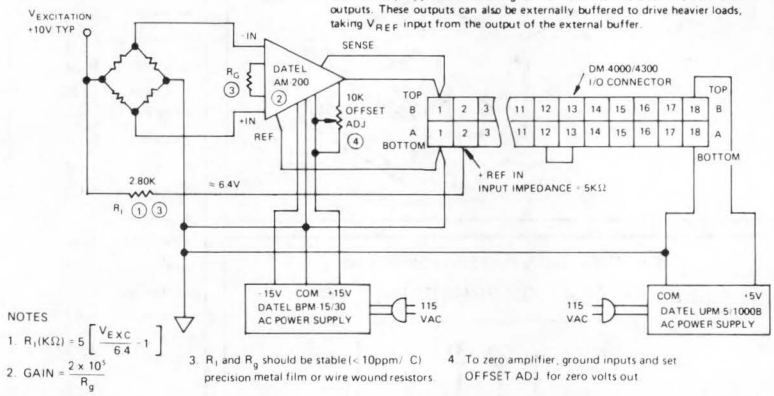



| MODEL | $T_{RU}$ RAMP UP TIME | $T_{RD}$ MAX RAMP DOWN TIME | $T_{DC}$ DRIFT CORRECT TIME | TOTAL |
|---|---|---|---|---|
| DM 4000 A & B/5 | 60 mS ± 0.02% | 120 mS | 80 mS | 260 mS |
| DM 4000 A & B/6 | 50 mS ± 0.02% | 100 mS | 80 mS | 230 mS |
| DM 4300 A & B/5 | 60 mS ± 0.02% | 240 mS | 80 mS | 380 mS |
| DM 4300 A & B/6 | 50 mS ± 0.02% | 200 mS | 80 mS | 330 mS |

## CONNECTIONS FOR NORMAL OPERATION




## TYPICAL RATIOMETRIC CONNECTION OF DM-4000/4300 TO BRIDGE TRANSDUCER USING INSTRUMENTATION AMPLIFIER




NOTES

1. $R_i(K\Omega) = 5\left[\frac{V_{EXC}}{6.4} - 1\right]$
2. GAIN = $\frac{2 \times 10^3}{R_g}$
3. $R_i$ and $R_g$ should be stable (< 10ppm/ C) precision metal film or wire wound resistors.
4. To zero amplifier, ground inputs and set OFFSET ADJ. for zero volts out.

Ratiometric operation uses a single voltage reference in a measurement system to reduce errors caused when two or more references are used. In the typical bridge circuit application shown here, an external excitation or reference voltage is required to power the bridge. The DPM also requires a nominal +6.4 VDC reference voltage input (to pin A2). The DM-4000 and DM-4300 DPM's include an internal +6.4 VDC reference voltage output (pin B2) which may be connected back into the reference voltage input using the rear PC board connectors.

However, the entire measurement system (excitation voltage, bridge, DPM, etc.) will have better drift performance if only one of these two voltage sources is used.

This better drift performance using one reference results because the DPM effectively changes its gain inversely with its reference input according to the expression Reading (in volts) = $\frac{V_{IN} \times 6.4}{V_{REF}}$. The DPM is calibrated when $V_{REF}$ (pin A2) equals +6.4V but $V_{REF}$ may be varied over a limited range (+3 to +10 VDC).

By using a voltage divider ($R_i$ plus the DPM's 5 K ohms resistance to ground at A2, the $V_{REF}$ input), the DPM derives its reference voltage input directly from the +10V bridge excitation voltage. Then, if the excitation voltage varies, (with a corresponding variation in bridge output to the DPM's analog input) the DPM reference will vary and effectively change the DPM's gain inversely. This scheme tends to cancel out errors normally caused by excitation voltage variations.

In this example the DPM's own reference source was not used but it could be used in any application drawing 2mA max. from the DPM's reference outputs. These outputs can also be externally buffered to drive heavier loads, taking $V_{REF}$ input from the output of the external buffer.

**JUMPER A12/A13 TO USE INTERNAL START CLOCK, JUMPER A2/B2 TO CONNECT INT. REFERENCE**

## CALIBRATION PROCEDURE

1. For normal operation (see figure) jumper pin A12 to A13 and pin A2 to B2.
2. Apply power to the DPM and a precision calibrated DC voltage source and allow both at least fifteen minutes for warm up before proceeding.
   a) Short the input leads (A1 and B1) to ground. Adjust the FINE ZERO so that the display reads all zero's and the sign flickers between plus and minus. Disconnect the input leads from ground and connect them to the precision voltage source.
3. For both models, zeroing is automatic and the calibration adjustments are accessible after the front panel bezel and filter are removed.
   a) FOR MODEL DM-4000: Apply an input of +1.99905 volts and set the + SCALE ADJ. potentiometer so that the display flickers equally between +1.9990 and +1.9991 VDC. Reverse the input polarity and set the -SCALE ADJ. potentiometer for a display that flickers between -1.9990 and -1.9991.
   b) FOR MODEL DM-4300: Apply an input of +3.99905 Volts and set the +SCALE ADJ. potentiometer so that the display flickers between +3.9990 and +3.9991 VDC. Reverse the input polarity and Set -SCALE ADJ. for display that flickers between -3.9990 and -3.9991 VDC.
4. For ratiometric operation (see figure showing typical connection) the previous steps must first be performed.

**PRICES (1-9)**

| | Without BCD Option | With BCD Option |
|---|---|---|
| (4½ digit) | DM-4000A . . .$219.00 | DM-4000B . . .$239.00 |
| (4¾ digit) | DM-4300A . . .$235.00 | DM-4300B . . .$255.00 |

**Suggested Power Supply:**

UPM-5/1000B +5VDC Modular Power Supply . . . . . $49.00
(115VAC Input)
UPM-5/1000BE +5VDC Modular Power Supply . . . . . $54.00
(230 VAC Input)
MS-7 Mating Power Supply Socket . . . . . $3.50

**Connectors** (Not included with DPM. Please order with your DPM)

Solder Tab, Datel #2335-1 (Viking 3VH18/1JN-5 . . . . . $4.95
or equivalent with key)
Wire Wrap, Datel #2335-2 (Viking 3VH18/1JHD-5 . . . . . $4.95
or equivalent with key)

**ORDERING GUIDE** DATEL

DM- ____ ____ ____

| MODEL | PARALLEL BCD OUTPUT OPTION | SYNCH. TO AC LINE FREQUENCY |
|---|---|---|
| 4000 = 4½ Digit<br>4300 = 4¾ Digit | A = Without<br>B = With | 5 = 50 Hz<br>6 = 60 Hz |

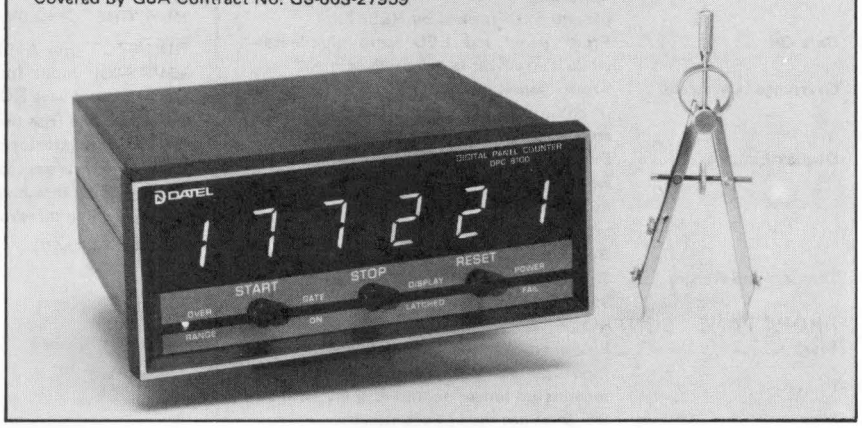
**GSA Contracted: Datel's Digital Panel Meters are covered by GSA Contract GS-00S-27959**

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# 6-DIGIT, PANEL-MOUNT COUNTER/ TOTALIZER WITH TIMEBASE

# MODEL DPC-8100

Covered by GSA Contract No. GS-00S-27959




## FEATURES

- **Count capacity 999,999 pulses (6 decades) displayed on .6" high digits, AC line or +5 VDC powered**
- **Accepts several input types:**
  1. **Switch inputs, Form A, B & C**
  2. **Comparator, 25 mV to 2 V, 300 V rms isolation**
  3. **Logic to 10 MHz, or optoisolated logic to 500 kHz**
- **Full parallel BCD data outputs**
- **Optional stored BCD outputs can be gated or multiplexed onto a data bus.**
- **Optional crystal timebase to measure frequency, countrate or tachometer inputs.**

## DESCRIPTION

The DPC-8100 Digital Panel Counter records and displays up to 6 digits of input counts or events (999,999 capacity) on bright .6" (15 mm) high LED readouts. The panel mounting instrument accepts a very wide variety of inputs so that one basic instrument will serve many applications.

The all-electronic counting circuitry can record up to 10 million counts per second. Applications include industrial event counting and totalizing and process control batch counting.

Inputs may be derived from Form A, B or C switch closures with anti-bounce filtering provided. Low level signals down to ±25 mV with ±300V isolation may be accepted at rates up to 1 MHz using the optional low level comparator. Optoisolated inputs are also available with count rates up to 500 kHz and isolation to ±300V RMS. Control inputs such as start, stop and reset as well as the count input may be optoisolated. Finally, direct TTL logic inputs will accept up to 10 MHz count rate.

The DPC-8100 Counter features digital logic outputs of the displayed count for data transmission to a computer or digital processor. These outputs are in full parallel standard binary coded decimal form (BCD) with TTL/DTL compatible logic levels. An optional second PC board with a fully latched and gated BCD register will store the digital outputs.

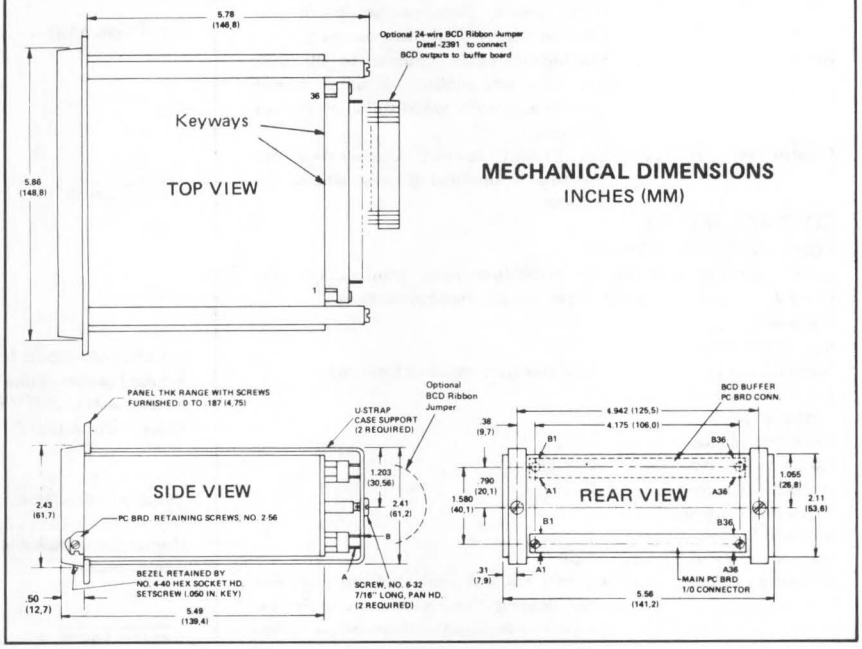
These stored outputs may be transmitted at any time on external command to a remote processor using a data bus. Gating is compatible to open collector TTL/DTL logic and outputs can be multiplexed in groups of 4 lines up to 24 lines (6 digits).

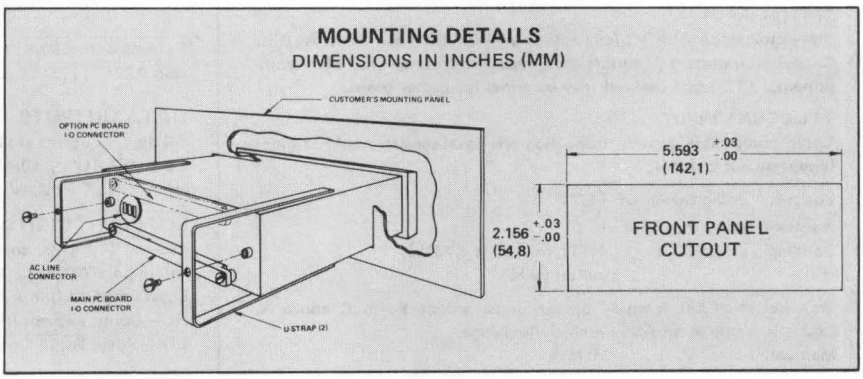
The optional second PC board can also contain a high accuracy timebase to allow precise gating of external count inputs. The crystal-controlled timebase converts the DPC-8100 into a countrate, frequency or period meter or a tachometer. When used with the BCD buffer, very short samples (down to 10 $\mu$s) of count rates may be taken then displayed for convenient viewing. (See Display Modes).

Front panel controls on the DPC-8100 manually control start, stop, and reset functions while logic inputs duplicate these functions. Many other input/output functions and displays are provided to adapt to a range of applications.

The DPC-8100 Counter is powered by a choice of 100, 115 or 230 VAC, 47 to 440 Hz or from +5VDC at 1.5 Amps max.

A black anodized extruded aluminum case houses the DPC-8100 for high electrical noise rejection in industrial environments. Additional power line filtering is offered by a bifilar-wound choke and regulated power supply.



## SPECIFICATIONS (typical @ +25°C unless noted)

### GENERAL

**Count Displays** ..... Six (6) self-illuminated digits, red LED 0.6" (15mm) high, 7-segment format. Count capacity: 999,999 counts. Replacable LED's on individual sockets.

**Power Fail** ..... Front panel red LED lamp illuminates to warn if power has been interrupted, indicating possible incorrect count displayed. Extinguished by RESET.

**Gate On** ..... Front panel red LED lamp illuminates while instrument is accepting counts.

**Overrange (Overscale)** .. Front panel red LED lamp illuminates if count has exceeded 999,999. Display continues counting after 999,999 counts.

**Display Latched** ..... Front panel red LED lamp illuminates when a count is being stored in the optional display latches. Display test not available with optional display latch. Regulated 5V must be used.

**Temperature Ranges** ... Operating: 0 to +50°C
Storage: −25°C to +85°C

### FRONT PANEL CONTROLS

**Start** ..... Pushbutton opens count gate to accept input pulses. Hold start button in two seconds or longer to test display with all 8's. Does not disrupt counting.

**Stop** ..... Pushbutton closes count gate to block input pulses. Accumulated counts remain on display until Reset occurs.

**Reset** ..... Pushbutton clears counter to 000,000, but does not inhibit additional counts (can be externally wired to inhibit further counting).

**Display Test** ..... See START control. Display test not available if optional display latches are ordered.

### CONTROL INPUTS

#### LOW LEVEL COMPARATOR

Level − sensitive (rise time not critical) to inputs from ±25mV min. to −2V, +5V max. using ext. threshold adj. (see applications).

**Hysteresis** ..... 15mV
**Max count rate** ..... 1 MHz
**Isolation** ..... 300V rms from input to logic gnd.
**Input Impedance (differential)** ..... 1 MΩ
**Input Impedance (to Lo Level Com.)** .... 500 KΩ
**Input Bias Current** .... 10 μA
**Capacitive Coupling (Inputs and floating power leads to logic gnd.)** ..... 50 pF
**Excitation current** ..... Up to 1 mA out available from +10V and −5V floating power outputs to excite external threshold potentiometer, or bridge circuit.

#### SWITCH INPUT

Transistor stage with int./ext anti-bounce filtering for Form A, B or C switch inputs. 50 counts/sec, max., adj. using ext. filtr. components. TTL input (below) may be wired for higher speed.

#### TTL COUNT INPUT

Logic compatible inputs, using Schmitt level-sensitive NAND gates (rise time not critical).

**Positive − going threshold** +1.7V
**Negative−going threshold** +0.9V
**Loading** ..... 1 TTL load plus 4.7 KΩ pullup to +5V

May be wired for latching operation to accept Form C contacts. Count is recorded on A31 (latch) falling edge.
**Max count rate** ..... 10 MHz

#### OPTOISOLATOR FOR TTL INPUT

− Externally wired to TTL input. Pins A33 (+) and A34 (−), see applications.
**Isolation** ..... 300 V rms
**Max count rate** ..... 500 KHz

### DIGITAL INPUTS

ALL DIGITAL INPUTS ARE COMPATIBLE WITH DTL/TTL LOGIC SOURCES:
LO = "ZERO" < +0.8V
HI = "ONE" > +2.0V

$\overline{\text{RUN}}$/STOP (pin A15) − 1 line, 1 TTL load, plus 4.7 KΩ pullup to +5V. $\overline{\text{STOP}}$ input (pin A18) must be grounded when using $\overline{\text{RUN}}$/STOP input. Leave $\overline{\text{RUN}}$/STOP floating or HI if not used.
Level sensitive (rise time not critical) using Schmitt logic
HI − Counting is stopped
LO − Counts are accepted
**Positive-going threshold** . +1.7V
**Negative-going threshold** +0.9V

$\overline{\text{START}}$ (pin A17) ..... 1 line, 1 TTL load plus 4.7 KΩ pullup to +5V. Counts accepted after falling edge of LO pulse, 50 nsec min. width, until $\overline{\text{STOP}}$ is pulsed. $\overline{\text{RESET}}$ must be HI to enable start of counting. $\overline{\text{START}}$ LO pulse will be stored if $\overline{\text{RESET}}$ is LO but will not be enabled until RESET goes HI. (Note: $\overline{\text{START}}$ and $\overline{\text{STOP}}$ form an RS latch circuit. The last input to be LO determines the latch state.

$\overline{\text{STOP}}$ (pin A18) ..... 1 line, 1 TTL load plus 4.7 KΩ pullup to +5V. Counting is stopped on falling edge of LO pulse, 50 nsec min. width. Count pulse in progress is recorded if $\overline{\text{STOP}}$ occurs. Gnd. if using $\overline{\text{RUN}}$/STOP control. Counts are held after $\overline{\text{STOP}}$ until cleared by $\overline{\text{RESET}}$.

$\overline{\text{RESET}}$ (pin A16) .....
1 line, 1 TTL load, LO pulse 50 nsec min. clears counter to 000,000 but does not inhibit additional counts unless STOP has occurred. Schmitt level-sensitive input. Negative going threshold to +0.9V. Positive−going threshold +1.7V.

Optoisolated inputs for START, STOP, and RESET are also provided, see applications. Pulse resolution, 1 microsecond. Max. pulse rate, 500 KHz. Isolation 300 V rms

Display Blank (pin A11) 1 line, 3 TTL load. Ground to illuminate display. Float to blank display, or connect to TTL logic.

Display Follow/$\overline{\text{Hold}}$ (pin A12) ..... 1 line, 1 TTL load plus 4.7 KΩ pullup to +5V. LO latches display on current count. BCD outputs not latched. Display test not available with latch display option. +5V regulated must be used on $V_{LED's}$. (for optional latchable display only)

$\overline{\text{Decimal Points}}$ ..... 6 lines, ground to illuminate corresponding left of digit decimal point (see pin out). 16 mA sink req'd for logic drive.

$\overline{\text{Leading Zero Blank}}$ (pin A22) ..... 1 line, 1 TTL load. LO blanks leading zeroes.

### DATA OUTPUTS

All digital outputs are compatible with DTL/TTL logic levels.
LO = "ZERO" < +0.4V
HI = "ONE" > +2.4V
Positive True Logic

BCD COUNT DIGITS (pins B13 thru B36) Full parallel binary coded decimal (1-2-4-8), consecutively spaced in ascending order. 24 lines, totem-pole TTL logic levels out, positive true. 7 TTL loads.
Overrange Out (pin A23) − 1 line, 10 TTL loads
HI − Count exceeds 999,999
LO − When $\overline{\text{RESET}}$ occurs, or if count is less than 1,000,000.

## SPECIFICATIONS (cont.)

### CONTROL OUTPUTS

**$\overline{\text{Reset}}$ Out (pin A35)** .... 1 line, 10 TTL loads. Logic output of $\overline{\text{RESET}}$ function, can be tied to STOP input to clear and inhibit counts. Totem-pole format.

**$\overline{\text{Gate}}$ Out (pin B8)** ..... 1 line, 10 TTL loads
LO – counts are accepted. Count pulse in progress holds $\overline{\text{GATE}}$ LO until count is recorded, if $\overline{\text{STOP}}$ is pulsed.
HI – counting is stopped

**$\overline{\text{Power Fail}}$ (pin B9)** .... 1 line, 10 TTL loads
LO – power has been interrupted, counts may be invalid. LO at power turn-on.
HI – when $\overline{\text{RESET}}$ occurs.

### ADDITIONAL CONNECTIONS

**$V_{LED\ 1}$ (pin A36) 3MSD's / $V_{LED\ 2}$ (pin B7) 3LSD's** Each input connects +5V power to 3 display digits. 300 mA max. @ +5VDC each connection. Internally connected on AC versions. (Don't connect.)

**+5VDC Power (pins A1 & B1 internally connected)** These pins are for +5VDC logic power input on +5V powered units, 1 Amp max. On AC-powered models, an output of +5VDC @ 200 mA max is available from these pins.
A1 & B1 are not internally connected to the displays except on AC models. (Use $V_{LED\ 1\ \&\ 2}$ for displays)

**Power and Logic Ground (pins A2 & B2 internally connected** ..... +5V power return for display and logic.

### POWER SUPPLY

Choice of 100, 115 or 230 VAC ±10%, 10 watts typ, 47 to 63 Hz.
OR –
+5 ±0.25VDC @ 1.6A max (displays & logic), logic noise 50 mV max.
BCD Buffer/Timebase +5VDC @ 175 mA, regulated (spikes < 50 mV)

### CONNECTORS

Dual 36-pin PC edgeboard type, 0.1" centers, solder tabs, Datel 2597-14 (Viking 3VH 36/1JN-5 or equivalent) AC power connected by triple ¼" tab assembly, recessed male, center tab grounded to case. PC board connectors included with each unit, plus a U.S. 3-prong type 9115 line cord.

### MOUNTING

Panel-mounting through a cutout measuring 2.16"H X 5.59"W (54,8 X 142,1 mm) and secured by 2 U-Straps. See mounting diagram.

### MECHANICAL DIMENSIONS

**Case** ..... 5.56"W X 2.11"H X 5.78"D (141,2 X 53,6 X 146,8 mm)

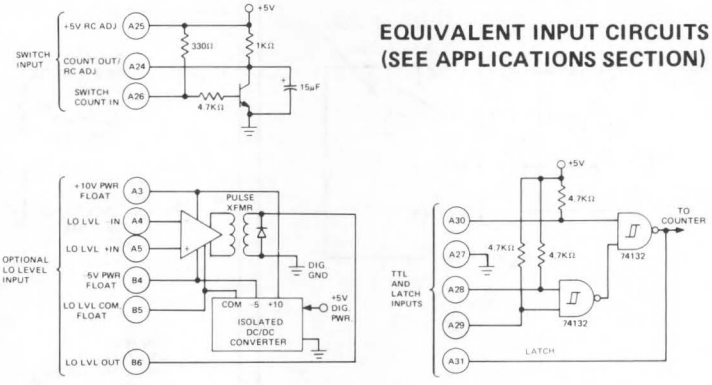
**Bezel** ..... 5.86"W X 2.25"H X 0.50" THK (148,7 X 57,0 X 12,7 mm) (See Diagrams) Bezel, filter and PC Brds are removable from front while unit remains secured in panel.

**Weight** ..... 2.25 LB (1,0 Kg)

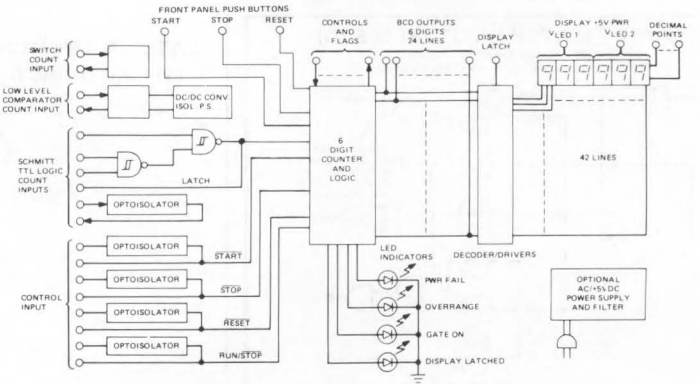
### INPUT/OUTPUT CONNECTIONS
### DPC–8100 DIGITAL PANEL COUNTER
### (REAR PC BRD)

| A BOTTOM | LEFT | B TOP |
|---|---|---|
| +5V POWER | 1 | +5V POWER |
| PWR & DIG. GND | 2 | PWR & DIG. GND |
| +10V PWR. FLOAT. | 3 | ISOL. RESET + |
| LO LEVEL – IN | 4 | -5V PWR. FLOAT. |
| LO LEVEL + IN | 5 | LO LVL. COM. FLOAT. |
| ISOL. RESET – | 6 | LO LEVEL OUT |
| ISOL. START + | 7 | +5V TO $V_{LED\ 2}$ |
| ISOL. START – | 8 | $\overline{\text{GATE}}$ OUT |
| ISOL. STOP + | 9 | $\overline{\text{POWER FAIL}}$ OUT |
| ISOL. STOP – | 10 | $\overline{\text{DEC. PT.}}$ .0 |
| DISPLAY BLANK | 11 | $\overline{\text{DEC. PT.}}$ .00 |
| DISPLAY FOLLOW/$\overline{\text{HOLD}}$ | 12 | $\overline{\text{DEC. PT.}}$ .000 |
| ISOL. $\overline{\text{RUN}}$/STOP + | 13 | BCD OUT 1 |
| ISOL. $\overline{\text{RUN}}$/STOP – | 14 | BCD OUT 2 |
| $\overline{\text{RUN}}$/STOP IN | 15 | BCD OUT 4 |
| $\overline{\text{RESET}}$ IN | 16 | BCD OUT 8 |
| $\overline{\text{START}}$ IN | 17 | BCD OUT 10 |
| $\overline{\text{STOP}}$ IN | 18 | BCD OUT 20 |
| $\overline{\text{DEC. PT.}}$ .0000 | 19 | BCD OUT 40 |
| $\overline{\text{DEC. PT.}}$ .00000 | 20 | BCD OUT 80 |
| $\overline{\text{DEC. PT.}}$ .000000 | 21 | BCD OUT 100 |
| $\overline{\text{LEAD ZERO BLANK}}$ | 22 | BCD OUT 200 |
| OVERRANGE OUT | 23 | BCD OUT 400 |
| CNT. OUT/RC ADJ | 24 | BCD OUT 800 |
| +5V RC ADJ | 25 | BCD OUT 1K |
| SW. COUNT IN | 26 | BCD OUT 2K |
| AUX. DIG. GND | 27 | BCD OUT 4K |
| $\overline{\text{COUNT IN TTL}}$ | 28 | BCD OUT 8K |
| $\overline{\text{COUNT IN TTL}}$ | 29 | BCD OUT 10K |
| COUNT IN TTL | 30 | BCD OUT 20K |
| COUNT LATCH | 31 | BCD OUT 40K |
| ISOL. COUNT OUT | 32 | BCD OUT 80K |
| ISOL. COUNT + IN | 33 | BCD OUT 100K |
| ISOL. COUNT – IN | 34 | BCD OUT 200K |
| $\overline{\text{RESET}}$ OUT | 35 | BCD OUT 400K |
| +5V to $V_{LED\ 1}$ | 36 | BCD OUT 800K |
| A BOTTOM | RIGHT | B TOP |

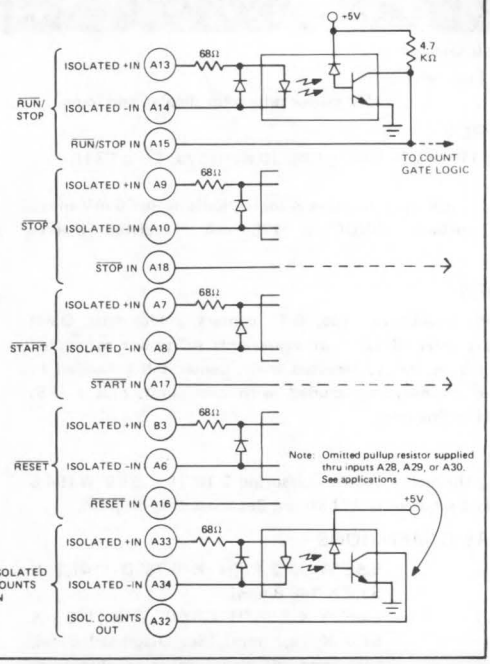
### EQUIVALENT INPUT CIRCUITS (SEE APPLICATIONS SECTION)




### COUNTER BLOCK DIAGRAM

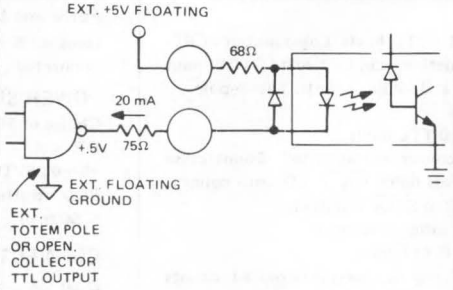


## OPTOISOLATED INPUTS

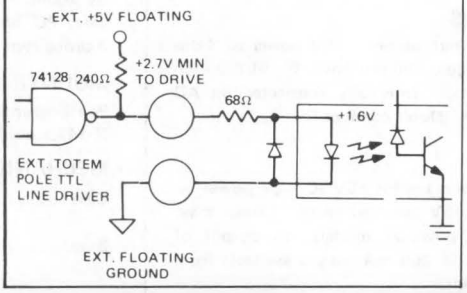



## OPTOISOLATOR TYPICAL WIRING

### RECOMMENDED CONNECTION

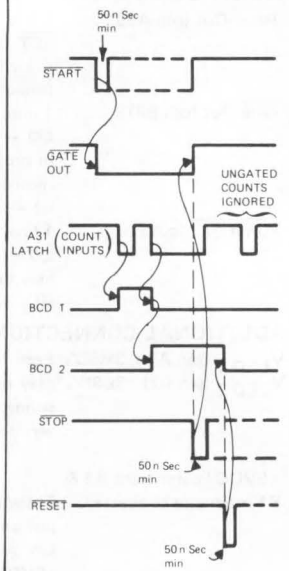



### ALTERNATE CONNECTION



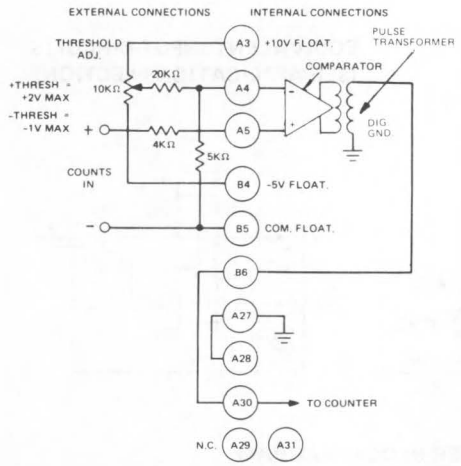

## COUNTER TIMING DIAGRAM

### TYPICAL CONTROL SEQUENCE



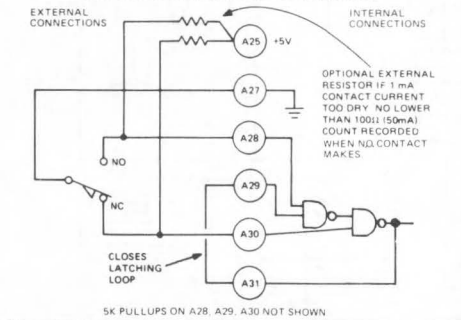

# APPLICATIONS

## LOW LEVEL OPTION




## 3-WIRE SWITCH INPUT (HI SPEED)

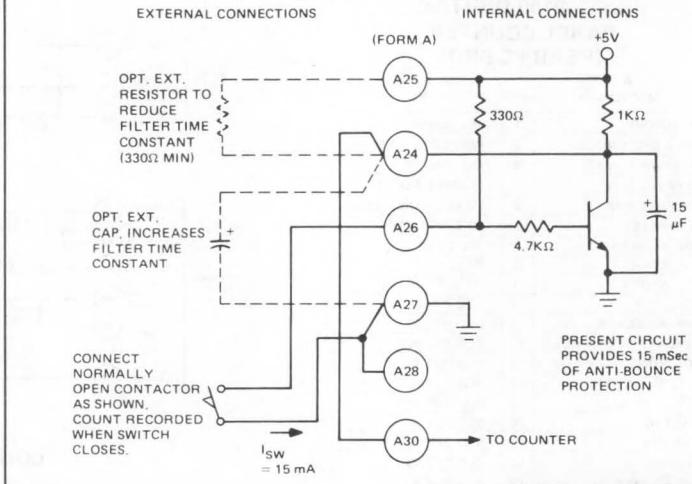
CONNECT SPDT (FORM C, BREAK-BEFORE-MAKE) CONTACTS AS SHOWN BELOW FOR LATCHING OPERATION




5K PULLUPS ON A28, A29, A30 NOT SHOWN

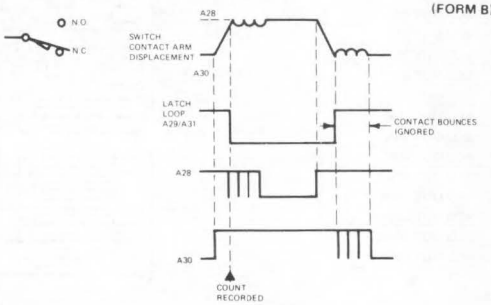
## SWITCH INPUT WIRING

### 2-WIRE, 50 COUNTS/SEC, MAX

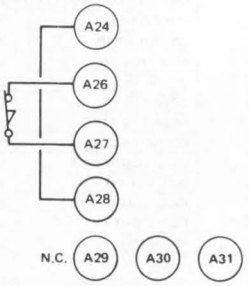



## LATCHING SWITCH INPUT

### TYPICAL TIMING DIAGRAM




CONNECT NORMALLY CLOSED CONTACTORS (FORM B) AS SHOWN BELOW:




DATEL

## OPTIONAL BCD OUTPUT BUFFER/PROGRAMMABLE TIME BASE

**A second PC board mounted in the upper card slot is available with the DPC-8100 Counter. This second board can contain a latchable, gatable BCD output buffer *and/or* a high-accuracy crystal-controlled timebase generator. The timebase produces count gates which are pin-selectable from 10 μS to 10 seconds in decade steps. Overall accuracy of the timebase is ±50 ppm ±50 nanoseconds (0 to +50° C).**

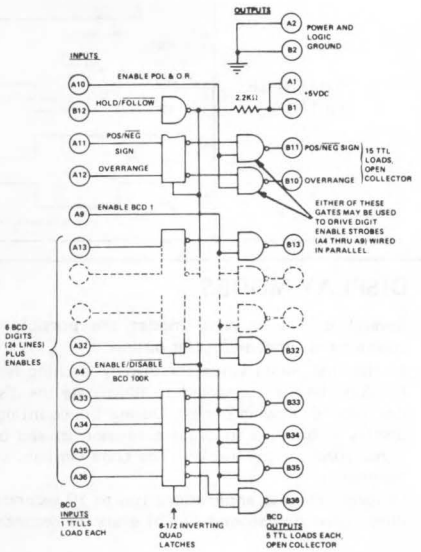
**The BCD Buffer and Timebase allow for storing and transmitting count outputs, for frequency, period or tachometer counting modes and for several display viewing modes.**

### INPUT/OUTPUT CONNECTIONS

| A BOTTOM | LEFT | B TOP |
|---|---|---|
| +5V POWER @ 175 mA | 1 | +5V POWER @ 175 mA |
| PWR. & DIG. GND | 2 | PWR. & DIG. GND |
| HOLD/FOLLOW OUT | 3 | HLD OR BLANK OUT |
| ENABLE BCD 100K | 4 | RESET OUT |
| ENABLE BCD 10K | 5 | ON/OFF IN |
| ENABLE BCD 1K | 6 | TIMEBASE 1 |
| ENABLE BCD 100 | 7 | TIMEBASE 2 |
| ENABLE BCD 10 | 8 | TIMEBASE 4 |
| ENABLE BCD 1 | 9 | RUN OUT |
| ENABLE POL.& O.R. | 10 | OVERSCALE OUT |
| POS/NEG SIGN IN | 11 | POS/NEG SIGN OUT |
| OVERSCALE IN | 12 | HOLD/FOLLOW IN |
| BCD 1 IN | 13 | BCD 1 OUT |
| BCD 2 IN | 14 | BCD 2 OUT |
| BCD 4 IN | 15 | BCD 4 OUT |
| BCD 8 IN | 16 | BCD 8 OUT |
| BCD 10 IN | 17 | BCD 10 OUT |
| BCD 20 IN | 18 | BCD 20 OUT |
| BCD 40 IN | 19 | BCD 40 OUT |
| BCD 80 IN | 20 | BCD 80 OUT |
| BCD 100 IN | 21 | BCD 100 OUT |
| BCD 200 IN | 22 | BCD 200 OUT |
| BCD 400 IN | 23 | BCD 400 OUT |
| BCD 800 IN | 24 | BCD 800 OUT |
| BCD 1K IN | 25 | BCD 1K OUT |
| BCD 2K IN | 26 | BCD 2K OUT |
| BCD 4K IN | 27 | BCD 4K OUT |
| BCD 8K IN | 28 | BCD 8K OUT |
| BCD 10K IN | 29 | BCD 10K OUT |
| BCD 20K IN | 30 | BCD 20K OUT |
| BCD 40K IN | 31 | BCD 40K OUT |
| BCD 80K IN | 32 | BCD 80K OUT |
| BCD 100K IN | 33 | BCD 100K OUT |
| BCD 200K IN | 34 | BCD 200K OUT |
| BCD 400K IN | 35 | BCD 400K OUT |
| BCD 800K IN | 36 | BCD 800K OUT |
| A BOTTOM | RIGHT | B TOP |

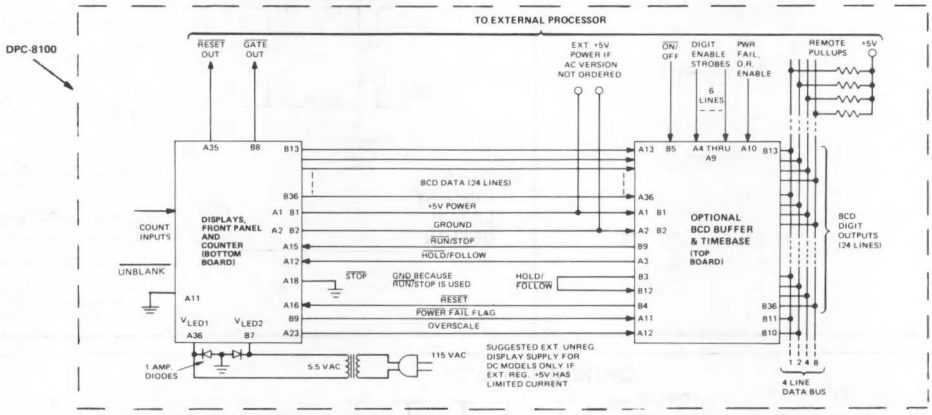
**BCD Buffer/Timebase power required +5VDC regulated @ 175 mA max (spikes 50 mV max)**

### OPTIONAL BCD BUFFER BLOCK DIAGRAM




DATEL

## TYPICAL DATA TRANSMISSION APPLICATION




**This block diagram shows the optional BCD Buffer and Timebase connected to the DPC-8100 Counter to create a complete data bussing system. This system utilizes a 4-bit, open-collector TTL data bus which is compatible with most microprocessors and minicomputers. By grouping appropriate DIGIT ENABLE STROBE lines, 8-Bit, 16-Bit or full parallel data transmission can be used for higher speeds.**

This application shows all 6 BCD digits multiplexed onto 4 lines using bit-parallel, digit-serial format. The power fail and overscale flags are also multiplexed as a 2-bit 7th word after the (6) 4-bit BCD words. Six enable lines successively multiplex the open collector BCD digits and a seventh enable (A10) multiplexes the power fail and over range flags.

## TIMEBASE OPTION

The timebase option produces a $\overline{\text{RUN}}$ pulse of precise duration controlled by a crystal oscillator. The overall timing accuracy is ± 50 ppm ± 50 nSec over 0 to +50°C. This $\overline{\text{RUN}}$ pulse may be initiated asynchronously at any time by the $\overline{\text{ON}}$/OFF control (B5). The RUN pulse is normally connected to the $\overline{\text{RUN}}$/STOP control (A15) of the counter to gate in external counts during accurately measured intervals. This mode of operation allows the counter to be used as a frequency meter, tachometer or digital integrator.

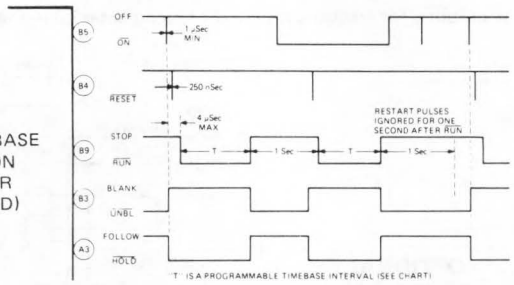
After each fixed length $\overline{\text{RUN}}$ pulse, a one second viewing pause is generated during which external counts are locked out and the display shows the last group of accumulated counts.

The fixed length $\overline{\text{RUN}}$ timebase pulse can be started at any time or the $\overline{\text{ON}}$/OFF control may be held LO continuously to give a repeating series of $\overline{\text{RUN}}$ pulses followed by one second viewing intervals.

The length of the $\overline{\text{RUN}}$ timebase pulse is programmable using a 3 bit code wired to rear connector pins B6, B7, and B8. Timebase periods may be selected from 10 microseconds to 10 seconds (see chart).

A 250 nanosecond $\overline{\text{RESET}}$ pulse is issued just before the $\overline{\text{RUN}}$ pulse to clear the counter to zero. Complementary BLANK and FOLLOW/$\overline{\text{HOLD}}$ outputs are also issued for display and BCD buffer control (see Display Modes description).

## TIMING DIAGRAM (OPTIONAL TIMEBASE)




## TIMEBASE PERIOD

| Programmable timebase period, "T" = | Timebase code pin connections (B8) | (B7) | (B6) |
|---|---|---|---|
| 10 µsec | 0 | 0 | 1 |
| 100 µsec | 0 | 1 | 0 |
| 1 msec | 0 | 1 | 1 |
| 10 msec | 1 | 0 | 0 |
| 100 msec | 1 | 0 | 1 |
| 1 sec | 1 | 1 | 0 |
| 10 sec | 1 | 1 | 1 |

(0 = tie to gnd. 1 = tie to +5VDC using 1KΩ to 10KΩ resistor)

## DISPLAY MODES

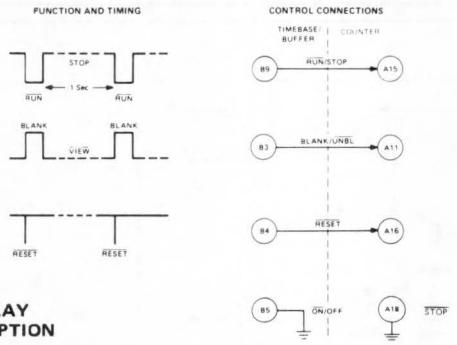
Several display viewing modes are possible with the DPC-8100 counter and timebase/buffer option.

In the first mode when the display latching feature is not used, the blanking line is connected to illuminate the display only during the one second viewing period. During the counting interval (RUN), the display is blanked to avoid confusion caused by counts rapidly accumulating on the display. The Gate On light shows that counts are accumulating.

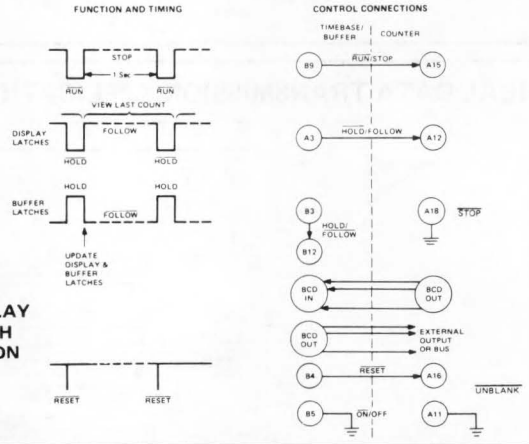
In long timebase applications (up to 10 seconds) the display will be illuminated one second out of every 11 seconds. If counts are accumulated slowly and the user wants to observe this, the blanking line can be left disconnected.

In the second mode, the display latch option is used so that the display is never blanked. At the end of the count interval, the display (and optional BCD buffer latches) are updated (unlatched) to follow the count now stored in the DPC-8100 output register. After the one second viewing period, this count is stored in the latches and the counter is cleared by a RESET pulse. The counter begins accumulating counts again while the previous count is displayed. The display is never blanked.

**NO DISPLAY LATCH OPTION**




**WITH DISPLAY LATCH OPTION**




## ORDERING GUIDE

The DPC-8100 Counter is covered by GSA Contract No. GS-00S-27959

DPC-8100

| POWER SUPPLY | INPUT * OPTOISOLATION | SELECTABLE LATCHING DISPLAY ** | LOW LEVEL INPUT | BCD OUTPUT | TIMEBASE |
|---|---|---|---|---|---|
| A* = 115VAC<br>D = +5VDC<br>E* = 230VAC<br>J* = 100VAC<br>*47 to 440 Hz | 1 = without<br>2 = with | A = non-latching<br>B = latchable | 1 = without<br>2 = with | A = Standard<br>B = latchable and gatable | 1 = without<br>2 = with |

Prices (1-9)

| | | |
|---|---|---|
| DPC-8100 A2A1A1 (E, J) | $299. | AC pwr, std. BCD, no low level, no timebase |
| DPC-8100 D2A1A1 | $245. | +5V pwr, std. BCD, no low level, no timebase |

Add for gatable, latchable BCD $70.
Add for timebase $65.
Add for low level input $30.
24-wire BCD Ribbon Jumper #2391 $10.
Prices include rear PC board connectors.
AC models include a 9115 line cord with U.S. 3-prong plug.

*Note: Input optoisolation omitted on special order only. Standard units include optoisolated inputs.

**Note: Standard units will have non-latched displays, i.e. data latching must be performed using the optional BCD buffer board or by customer's external latching register. The latching display option is available on special order only (Add $50. to price).

DATEL

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# 6-DIGIT, PANEL-MOUNT TIMER/STOPCLOCK

# MODEL DSC-8200

**Covered by GSA Contract No. GS-OOS-27959**


## FEATURES

- **6-Digit timing ranges available from 999999 μSec to 999:59.9 Hrs./Min**
- **Bright 0.6" high (15 mm) LED displays**
- **High accuracy event or interval timer or period meter with full parallel BCD outputs**
- **Use with 8400-series comparators to form preset timers for process control**
- **Accepts switch contact or logic control**
- **Optional stored BCD outputs can be gated or multiplexed onto a data bus**

## DESCRIPTION

The model DSC-8200 Digital Stop Clock is a general purpose count-up timer using all-electronic timing and display. A host of expandable systems features allow the user to progress from a simple hand-operated Stop Clock to a complete minicomputer data-bus-compatible period measuring instrument. Yet, the DSC-8200 retains the small size and appearance of other panel-mounting instruments in Datel's 8000 series.

All DSC-8200 models have time displays consisting of six Light Emitting Diode (LED) 7-segment digits 0.6 inches (15 mm) high. A leading zero suppression control allows right-justified display of time periods less than six full digits. Five basic display formats using one or two colons or no colons, provide an extremely wide choice of full scale time ranges covering hours, minutes, seconds, milliseconds or microseconds. (See chart, Page five) An accurate, stable quartz crystal timebase is standard on all units providing ±10ppm maximum drift over the 0 to +50° C operating temperature range. The user may select the optional 50 or 60Hz AC line timebase which provides very high long term accuracy periodically corrected by power utilities. The AC line timebase may be used with the +5VDC-powered versions of the DSC-8200 as well as 100, 115 or 230 VAC line-powered versions.

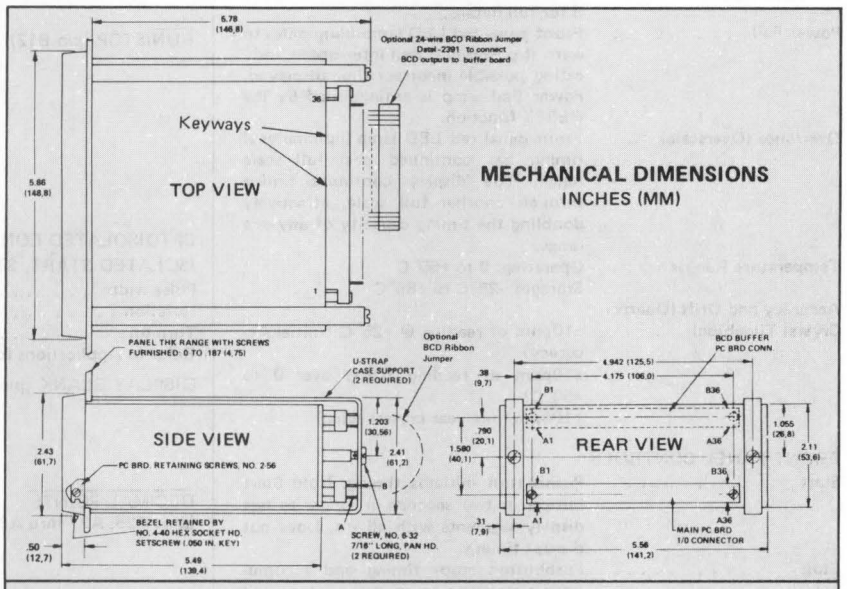
Front panel pushbuttons control the start, stop and reset functions of the DSC-8200 but for high speed, high accuracy event timing or automatic control, these functions are duplicated by rear connector logic inputs. These logic inputs accept digital commands from TTL/DTL compatible logic devices or from Form A or B Switch contacts. The switch contact inputs may be used for remote single or multiple station accumulated time functions as well as position or cam-operated limit switches.

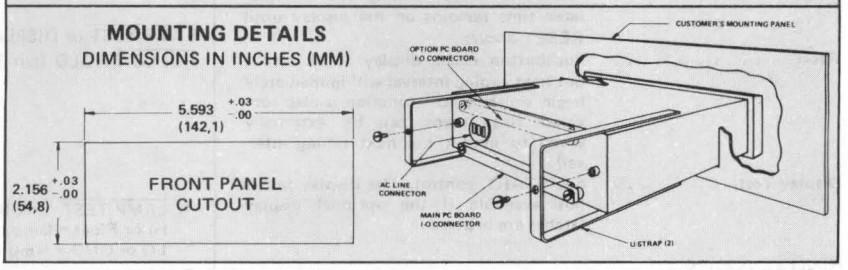
Special care was taken in the DSC-8200 design to eliminate timing errors due to electrical or logic noise. The instrument is fully enclosed in a rugged shielded aluminum housing. The regulated AC power supply uses a bifilar-wound choke to filter line noise and all control inputs employ Schmitt level-sensitive logic (not edge-sensitive). Optional input optoisolation provides further immunity to digital noise or for use with floating AC inputs.

Full parallel, binary-coded-decimal (BCD) 1-2-4-8 outputs of the displayed time period are provided on the rear I/O connector. These logic outputs have TTL/DTL levels and may be externally connected to an optional BCD Buffer board which fits in the top PC board slot. The BCD Buffer option will store one full output of the accumulated time and will transmit this data on external command in full parallel or in groups of 4 bits at a time.

The BCD Buffer provides storage and gating to asynchronous open-collector TTL data busses used on most main frame processors, minicomputers and microprocessors. A processing system can automatically poll the DSC-8200 to transmit its data as part of the instruction program of a complete control system.

Many other systems features are incorporated in the DSC-8200. These include power failure and overscale indicators and outputs. Optional display latches let the user view one time period while the next timing interval is counting. This feature is useful for short, high-speed measurements such as period meters requiring longer display viewing times.



## SPECIFICATIONS (Typical @ +25°C unless noted)

DATEL

### GENERAL

**Displays** . . . . . Six (6) self-illuminated digits, red LED 0.6" (15 mm) high, 7-segment format. Replaceable displays are mounted on individual sockets.

**Full Scale Time Ranges** . . (Type 1) 999:59.9 (center colon) minutes: seconds or hours: minutes
(Type 2) 99:59:59 (2 colons) hours: minutes: seconds
(Type 3) 99:59.99 (left colon) minutes: seconds or hours: min
(Type 4) 999999 (no colons including programmable left-of-digit decimal point)
Least significant digit is 1, 10 or 100 μS, 1, 10 or 100mS, 1 Sec, or 0.1 minute. LSD's are user-selected on rear I/O connector.
(Type 5) 9999:59 (right colon) minutes: seconds
Refer to the time format charts on page 5 for full details.

**Power Fail** . . . . . Front panel red LED lamp illuminates to warn if power has been interrupted, indicating possible incorrect time displayed. Power Fail lamp is extinguished by the RESET function.

**Overrange (Overscale)** . . Front panel red LED lamp illuminates if timing has continued past full scale range. The display continues timing through another full scale, effectively doubling the timing capacity of any one range.

**Temperature Ranges** . . . Operating: 0 to +50°C
Storage: −25°C to +85°C

**Accuracy and Drift (Quartz Crystal Timebase)** . . . . . ±10ppm of reading @ +25°C (Initial Accuracy)
±10ppm of reading (Drift over 0 to +50°C)
±10ppm (one year crystal aging)

### FRONT PANEL CONTROLS

**Start** . . . . . Pushbutton initiates timing. Hold Start button in two seconds or longer to test display segments with all 8's. Does not disrupt timing.

**Stop** . . . . . Pushbutton stops timing and accumulated time remains on the display until RESET occurs.

**Reset** . . . . . Pushbutton clears display to all zero's, but next timing interval will immediately begin unless STOP function is also activated (instrument can be externally wired to inhibit the next timing interval).

**Display Test** . . . . . See START control. The display test is not available if the optional display latches are ordered.

### DIGITAL INPUTS

All digital inputs are compatible with DTL/TTL logic sources:

"ZERO" 0V ≤ LO ≤ +0.8V
"ONE" +2.0V ≤ HI ≤ +5.0V
} EXCEPT AS NOTED

All control inputs are level sensitive (rise time is not critical). All other dynamic inputs must use TTL-compatible risetimes.

$\overline{\text{START}}$ (pin B11) . . . . . 1 line, 1 TTL load plus 4.7KΩ pullup to +5V. Timing begins on falling edge of LO pulse, 50nsec minimum width. $\overline{\text{RESET}}$ must be HI to enable start of timing. $\overline{\text{START}}$ LO pulse will be stored if $\overline{\text{RESET}}$ is LO but will not be enabled until $\overline{\text{RESET}}$ goes HI.
(Note: $\overline{\text{START}}$ and $\overline{\text{STOP}}$ form an RS latch circuit. The last input to be LO determines the latch state.)

$\overline{\text{STOP}}$ (pin A6) . . . . . 1 line, 1 TTL load plus 4.7KΩ pullup to +5V. Timing stops on falling edge of LO pulse, 50 nsec minimum width. Ground $\overline{\text{STOP}}$ if using the $\overline{\text{RUN}}$/STOP INPUT. Time is held after $\overline{\text{STOP}}$ until cleared to zero by $\overline{\text{RESET}}$.

$\overline{\text{RESET}}$ (pin A5) . . . . . 1 line, .75 TTL loads plus 4.7KΩ pullup to +5V. Schmitt level-sensitive input.
Negative-going threshold +0.9V.
Positive-going threshold +1.7V.
LO: Falling edge of $\overline{\text{RESET}}$ LO pulse jams time at all zero's but does not affect the $\overline{\text{START}}$-$\overline{\text{STOP}}$ latch. A $\overline{\text{START}}$ LO pulse may be stored, but will be inhibited until $\overline{\text{RESET}}$ goes HI. Minimum $\overline{\text{RESET}}$ LO pulse width is 50 nsec.
HI: $\overline{\text{START}}$ or $\overline{\text{STOP}}$ functions may be stored and enabled.

$\overline{\text{RUN}}$/STOP (pin B12) . . . 1 line, 1 TTL load plus 4.7KΩ pullup to +5V. Gnd. pin A6 when using $\overline{\text{RUN}}$/STOP. Float $\overline{\text{RUN}}$/STOP if not used.
HI: Timing is stopped.
LO: Timing in progress.
(Schmitt level-sensitive input)
Positive-going threshold +1.7V.
Negative-going threshold +0.9V.

### OPTOISOLATED CONTROL INPUTS

ISOLATED START, STOP, RESET AND RUN/STOP (See page 4)

**Pulse width** . . . . . 1 μsec, min.
**Isolation** . . . . . 300 Volts, RMS
**Turn-on** . . . . . 15 mA sink
Refer to Applications for wiring details

DISPLAY BLANK (pin A36) 1 line, $I_{IL}$ = 5 mA (sink), $I_{IH}$ = 0 @ +2.5$V_{IN}$, = 6.25 mA @ 5$V_{IN}$
HI (float or cutoff open collector TTL) = Blank Display
LO or GND = illuminate display

$\overline{\text{DECIMAL}}$ $\overline{\text{POINTS}}$
(pins A25, A27 thru A31) 6 lines, ground LO to illuminate corresponding left-of-digit decimal point (see I/O connections). 16 mA sink (10 TTL loads) for logic drive.

$\overline{\text{LAMP}}$ $\overline{\text{TEST}}$ or DISPLAY $\overline{\text{FOLLOW}}$/HOLD (pin B3) 1 line
This input will test the display with all 8's if the latchable display option is not included. With the display latch option, this input stores a displayed time until updated, but the lamp test is not available.

1. $\overline{\text{LAMP}}$ $\overline{\text{TEST}}$, sink 9.6 mA (6 TTL loads)
   HI or Float = lamp test disabled.
   LO or GND = lamp test enabled.
2. DISPLAY $\overline{\text{FOLLOW}}$/HOLD; sink 2.4 mA (1.5 TTL loads)
   HI or Float - display will latch on last time input.
   LO or GND = display will follow time inputs.
   $\overline{\text{FOLLOW}}$ pulse width must be 100 nS minimum if input time is stabilized (i.e. allow 500 nsec minimum after the COUNT TIMEBASE IN falling edge). The $\overline{\text{FOLLOW}}$ update latch pulse must be triggered no later than the falling edge of COUNT TIMEBASE IN (pin B7). See timing diagram.

### TIMEBASE INPUTS

AC SINE WAVE SYNC
(Pin B8) . . . . . 1 line, ≃500Ω to GND, to provide an AC timebase reference when used with

## SPECIFICATIONS (Cont'd)

+5V powered units with a least significant digit of 100 mS, 1 sec or 0.1 minute. 3V to 10V RMS, referenced to power ground at 50 or 60 Hz. Internally wired on AC models, make no connection. Do not use pin B8 for least significant digits less than 100 mS or when using the crystal timebase. See note under "AC TIMEBASE OUT."

60 Hz TIMEBASE IN (pin A11)
50 Hz/XTAL TIMEBASE IN (pin A13)
100 mS TIMEBASE IN (pin A19)

These lines must be externally jumpered for AC or crystal timebases. Refer to format charts.

COUNT TIMEBASE IN
(pin B7) . . . . . 1 line, 1 TTL load. This line is the clock input to the display counter and is tapped from the timebase counter as shown in the format charts.

DATA OUTPUTS
All digital outputs are compatible with DTL/TTL logic levels:
"ZERO" = 0V ≤ LO ≤ +0.4V.
"ONE" = +2.4V ≤ HI ≤ +5.0V.

BCD TIMING DATA
(Pins B13 thru B36) . . . 24 lines, consecutively spaced in ascending order. Full parallel 1-2-4-8 binary coded decimal (BCD). Positive true, 7 TTL loads per line, totem pole format (drives HI or LO). Digits immediately to the right of a colon only count up to 5 (bits 1, 2, & 4) but vacant terminals for the unused BCD "8" bits occur on the pinout sequence. Interfacing equipment will usually require grounding corresponding unused input terminals.

OVERSCALE OUT
(pin A35) . . . . . 1 line, 10 TTL loads out, totem-pole format.
HI = Time exceeds full scale.
LO = when $\overline{\text{RESET}}$ occurs or if time is less than full scale.

TIMEBASE OUTPUTS
AC TIMEBASE OUT
(pin A12) . . . . . 1 line, provides TTL-compatible, squared-up 50 or 60 Hz pulses for input to the timebase counter chain as shown in the format charts. Note: START and STOP circuits are not synchronized to the AC lines. Therefore timing uncertainty will be ±1/50 or 1/60 sec.

TIMEBASE OUTPUTS
(pins A15 thru A18 and A20 thru A24) . . . . . 1 line each, totem-pole. Connect as shown in the format charts for desired full scale time.

DIGITAL CONTROL OUTPUTS
$\overline{\text{RESET}}$ OUT (pin A4) . . 1 line, 10 TTL loads, totem-pole. Logic output of RESET function, can be externally tied to $\overline{\text{STOP}}$ input to clear and inhibit further timing.

$\overline{\text{TIMING GATE OUT}}$
(pin B4) . . . . . 1 line, 10 TTL loads, totem-pole.
LO = Timing is in progress.
HI = Timing is halted. The rising edge of $\overline{\text{TIMING GATE OUT}}$ inhibits the crystal oscillator gate counter chain input. A major carry will take 500 nS maximum to propagate thru all decades.

$\overline{\text{POWER FAIL}}$ (pin A34) . 1 line, 10 TTL loads, totem-pole.
LO indicates power has been interrupted, time may be invalid. Clear to HI when RESET occurs.

ADDITIONAL CONNECTIONS
$V_{LED\ 1}$ (pin A33)
$V_{LED\ 2}$ (pin A3)

$V_{LED\ 1}$ supplies +5V display power to the three left digit display LED's and $V_{LED\ 2}$ is for the three right digits. Each input is 300 mA maximum +5VDC. Do not use on AC-powered models (internally connected). For DC models, the +5VDC may be full wave DC rectified, or +5VDC regulated 300mA each connection.

+5VDC POWER
(pins A1 and B1 internally connected) . . . . . On DC-powered models, +5VDC @ 1 Amp regulated (50 mV maximum spikes) must be connected on these pins. On AC-powered models, up to 200 mA out at +5VDC regulated is available from these pins for optional external use.

GROUND (pins A2 and B2 internally connected) . . . +5V Power, Display and Logic ground return.

POWER REQUIREMENTS (See Ordering Guide)
AC – powered models: Choice of 100, 115 or 230 VAC, ±10%, 47 to 440 Hz, 10 watts typical. Line freq. must be 50 or 60 Hz if the AC line timebase is used.
DC – power models:
Logic: +5 ±0.25 VDC @ 1 Amp maximum regulated, 50 mV max. spikes.
Display: +5VDC @ 600 mA maximum regulated or full wave rectified DC.

BCD Buffer (optional upper PC Board) . . . . . +5VDC regulated @ 175 mA.
(See separate specifications for the BCD Buffer)

CONNECTORS
Dual 36-pin PC edgeboard type 0.1" centers, solder tabs, Datel P/N 2597-14 (Viking 3VH36/1JN-5) included with instrument.

TEMPERATURE RANGES
Operating: 0 to +50°C
Storage: −25°C to +85°C

MOUNTING
Panel-mounting through a cutout measuring 2.16"H × 5.59"W (54,8 × 142,1 mm) and secured by 2 U-straps. See mounting diagram.

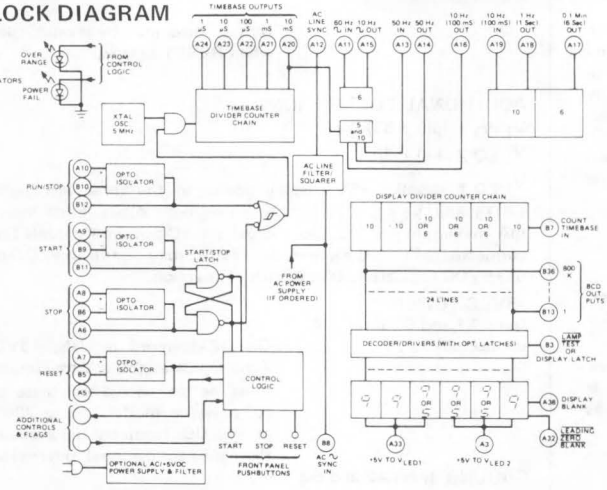
MECHANICAL DIMENSIONS
Case . . . . . 5.56"W × 2.11"H × 5.78"D (141,2 × 53,6 × 146,8 mm)
Bezel . . . . . 5.86"W × 2.25"H × 0.50" thick (148,7 × 57,0 × 12,7 mm). See diagrams. Bezel, filter, and PC boards are removable from front while the unit remains secured in the panel.
Weight . . . . . 2.25 pounds (1,0Kg)

PRICE (See Ordering Guide)

| | | |
|---|---|---|
| DSC-8200 | +5V power, std. BCD, no display latch | $269 |
| DSC-8200 | AC power, std. BCD, no display latch | $299 |
| Optional BCD Buffer | | Add $70 |
| Optional latchable displays | | Add $50 |

# DSC-8200 BLOCK DIAGRAM

## BLOCK DIAGRAM

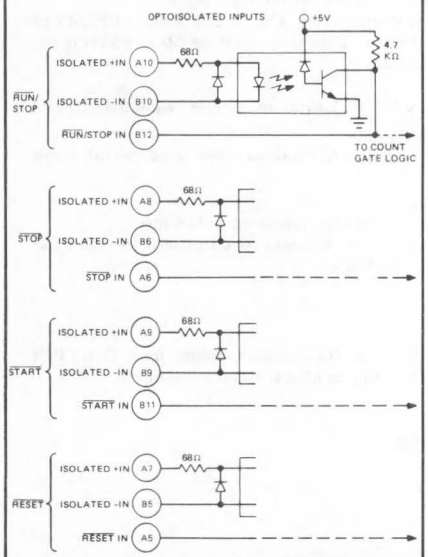



## INPUT/OUTPUT CONNECTIONS

(LOWER PC BOARD)

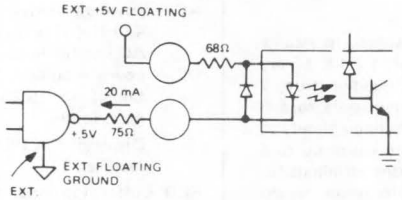
| A BOTTOM | LEFT | B TOP |
|---|---|---|
| +5VDC POWER | 1 | +5VDC POWER |
| PWR & DIG. GND | 2 | PWR & DIG. GND |
| +5V TO $V_{LED2}$ | 3 | LAMP TEST OR DISP HLD/HLD |
| $\overline{\text{RESET}}$ OUT | 4 | TIMING GATE OUT |
| $\overline{\text{RESET}}$ IN | 5 | ISOL. RESET |
| $\overline{\text{STOP}}$ IN | 6 | ISOL. STOP |
| ISOL. RESET + | 7 | COUNT TIMEBASE IN |
| ISOL. STOP + | 8 | AC SINE WAVE SYNC |
| ISOL. START + | 9 | ISOL. START |
| ISOL. RUN/STOP + | 10 | ISOL. RUN/STOP |
| 60 Hz TIMEBASE IN | 11 | $\overline{\text{START}}$ IN |
| AC TIMEBASE OUT | 12 | $\overline{\text{RUN}}$/STOP IN |
| 50 Hz XTAL TIMEBASE IN | 13 | BCD 1 OUT |
| XTAL TIMEBASE OUT 20mS | 14 | BCD 2 OUT |
| 100 mS 60 Hz REF OUT | 15 | BCD 4 OUT |
| 100 mS 50 Hz REF OUT | 16 | BCD 8 OUT |
| 0.1 MIN TIMEBASE OUT | 17 | BCD 10 OUT |
| 1 SEC TIMEBASE OUT | 18 | BCD 20 OUT |
| 100 mS TIMEBASE IN | 19 | BCD 40 OUT |
| 10 mS TIMEBASE OUT | 20 | BCD 80 OUT |
| 1 mS TIMEBASE OUT | 21 | BCD 100 OUT |
| 100 µS TIMEBASE OUT | 22 | BCD 200 OUT |
| 10 µS TIMEBASE OUT | 23 | BCD 400 OUT |
| 1 µS TIMEBASE OUT | 24 | BCD 800 OUT |
| $\overline{\text{DEC PT}}$ 0 | 25 | BCD 1K OUT |
| NO INTERNAL CONN | 26 | BCD 2K OUT |
| $\overline{\text{DEC PT}}$ 00 | 27 | BCD 4K OUT |
| $\overline{\text{DEC PT}}$ 000 | 28 | BCD 8K OUT |
| $\overline{\text{DEC PT}}$ 0000 | 29 | BCD 10K OUT |
| $\overline{\text{DEC PT}}$ 00000 | 30 | BCD 20K OUT |
| $\overline{\text{DEC PT}}$ 000000 | 31 | BCD 40K OUT |
| LEAD. ZERO BLANK | 32 | BCD 80K OUT |
| +5V TO $V_{LED1}$ | 33 | BCD 100K OUT |
| $\overline{\text{POWER FAIL}}$ OUT | 34 | BCD 200K OUT |
| OVERSCALE OUT | 35 | BCD 400K OUT |
| DISPLAY BLANK | 36 | BCD 800K OUT |
| A BOTTOM | RIGHT | B TOP |

## OPTOISOLATED INPUTS

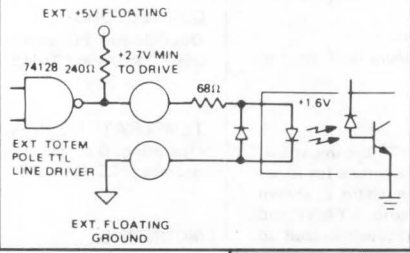



## OPTOISOLATED WIRING

### RECOMMENDED CONNECTION

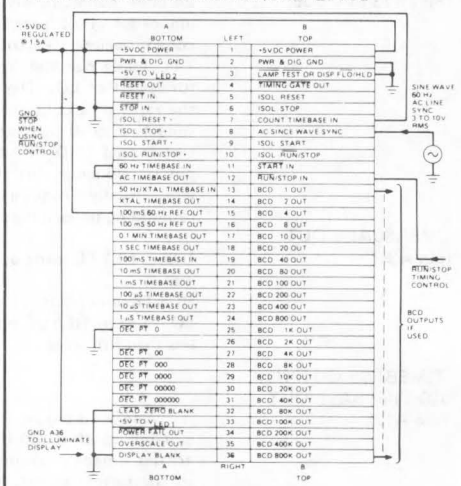



### ALTERNATE CONNECTION




## TYPICAL WIRING EXAMPLE

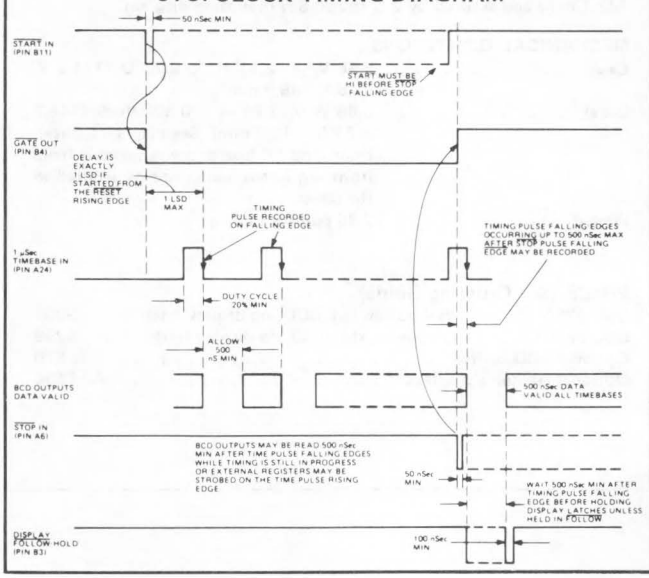
+5VDC-POWERED MODEL WITH LATCHABLE DISPLAY
TIME FORMAT: 999:59.9 MIN/SEC
TIMEBASE: 60 Hz AC LINE
TIMING CONTROL USING RUN/STOP LEVEL




| A BOTTOM | LEFT | B TOP |
|---|---|---|
| +5VDC POWER | 1 | +5VDC POWER |
| PWR & DIG. GND | 2 | PWR & DIG. GND |
| +5V TO $V_{LED2}$ | 3 | LAMP TEST OR DISP HLD/HLD |
| $\overline{\text{RESET}}$ OUT | 4 | TIMING GATE OUT |
| $\overline{\text{RESET}}$ IN | 5 | ISOL. RESET |
| $\overline{\text{STOP}}$ IN | 6 | ISOL. STOP |
| ISOL. RESET + | 7 | COUNT TIMEBASE IN |
| ISOL. STOP + | 8 | AC SINE WAVE SYNC |
| ISOL. START + | 9 | ISOL. START |
| ISOL. RUN/STOP + | 10 | ISOL. RUN/STOP |
| 60 Hz TIMEBASE IN | 11 | $\overline{\text{START}}$ IN |
| AC TIMEBASE OUT | 12 | $\overline{\text{RUN}}$/STOP IN |
| 50 Hz XTAL TIMEBASE IN | 13 | BCD 1 OUT |
| XTAL TIMEBASE OUT | 14 | BCD 2 OUT |
| 100 mS 60 Hz REF OUT | 15 | BCD 4 OUT |
| 100 mS 50 Hz REF OUT | 16 | BCD 8 OUT |
| 0.1 MIN TIMEBASE OUT | 17 | BCD 10 OUT |
| 1 SEC TIMEBASE OUT | 18 | BCD 20 OUT |
| 100 mS TIMEBASE IN | 19 | BCD 40 OUT |
| 10 mS TIMEBASE OUT | 20 | BCD 80 OUT |
| 1 mS TIMEBASE OUT | 21 | BCD 100 OUT |
| 100 µS TIMEBASE OUT | 22 | BCD 200 OUT |
| 10 µS TIMEBASE OUT | 23 | BCD 400 OUT |
| 1 µS TIMEBASE OUT | 24 | BCD 800 OUT |
| $\overline{\text{DEC PT}}$ 0 | 25 | BCD 1K OUT |
| | 26 | BCD 2K OUT |
| $\overline{\text{DEC PT}}$ 00 | 27 | BCD 4K OUT |
| $\overline{\text{DEC PT}}$ 000 | 28 | BCD 8K OUT |
| $\overline{\text{DEC PT}}$ 0000 | 29 | BCD 10K OUT |
| $\overline{\text{DEC PT}}$ 00000 | 30 | BCD 20K OUT |
| $\overline{\text{DEC PT}}$ 000000 | 31 | BCD 40K OUT |
| LEAD. ZERO BLANK | 32 | BCD 80K OUT |
| +5V TO $V_{LED1}$ | 33 | BCD 100K OUT |
| $\overline{\text{POWER FAIL}}$ OUT | 34 | BCD 200K OUT |
| OVERSCALE OUT | 35 | BCD 400K OUT |
| DISPLAY BLANK | 36 | BCD 800K OUT |
| A BOTTOM | RIGHT | B TOP |

Model DSC-8200D1A1B

## STOPCLOCK TIMING DIAGRAM




## PC BOARD REMOVAL

Both the upper and lower printed circuit boards may be removed for servicing thru the front of the 8000 series instruments without having to dismount the instrument from a front panel. If the rear PC board connectors can be loosened and pulled away from the boards, less force will be needed to slide the boards out the front. Proceed as follows:

1. Loosen both 0.050-inch (4-40) Allen hex key setscrews on the bottom of the bezel. The bezel may be removed by pulling out and up from the bottom, lifting the bezel off the two engaging pins on the case top.
2. Remove the switch knobs on models with a plastic filter. This will require some force to overcome the catching ridges molded into the knobs and switch shafts. Small pliers are suggested. Be careful not to twist the knobs during removal. Remove the filter when all knobs are off.
3. The PC boards will slide out after the board retaining screws blocking the boards guide tracks are removed. Locate the cluster of four screws on the sides of the case panel seats. The bottom screw on both sides frees the bottom PC board and the top screws free the top board. Do not remove the two center screws on each seat.
4. For AC-powered models, slide the board partially out and unplug the four colored power wires from their board pins. DC-powered models have no other wiring to be removed. If the rear connectors are still in place, wiggle the board to slide out of the connectors.

# APPLICATIONS

## TIME FORMATS

Rear Connector Timebase Wiring

Center colon (999:59.9 min/sec or hrs/min display)
Models DSC-8200 _1_ _

| Display Full Count and Timebase | Timebase Jumpers | Dec. Pt. | LSD Jumper |
|---|---|---|---|
| 999:59.9 min/sec crystal timebase | A13-A14 | Gnd. A25 | B7-A16 |
| 999:59.9 min/sec 50 Hz timebase | A12-A13 | Gnd A25 | B7-A16 |
| 999:59.9 min/sec 60 Hz timebase | A11-A12 | Gnd A25 | B7-A15 |
| 999:59.9 hrs/min crystal timebase | A13-A14 A16-A19 | Gnd A25 | B7-A17 |
| 999:59.9 hrs/min 50 Hz timebase | A12-A13 A16-A19 | Gnd A25 | B7-A17 |
| 999:59.9 hrs/min 60 Hz timebase | A11-A12 A15-A19 | Gnd A25 | B7-A17 |

Two colon (99:59:59 hrs/min/sec display)
Models DSC-8200 _2_ _

| Display Full Count and Timebase | Timebase Jumpers | LSD Jumper |
|---|---|---|
| 99:59:59 hrs/min/sec crystal timebase | A13-A14 A16-A19 | B7-A18 |
| 99:59:59 hrs/min/sec 50 Hz timebase | A12-A13 A16-A19 | B7-A18 |
| 99:59:59 hrs/min/sec 60 Hz timebase | A11-A12 A15-A19 | B7-A18 |

Left colon (99:59:59 hrs/min/sec display)
Models DSC-8200 _3_ _

| Displays Full Count and Timebase | Timebase Jumpers | Dec. Pt. | LSD Jumper |
|---|---|---|---|
| 99.59.99 min/sec crystal timebase (can't use 50 or 60 Hz timebases) | NONE | Gnd A27 | B7-A20 |
| 99:59.99 hrs/min (Xtal, no 50/60) | A20-A19 | Gnd A27 | B7-A17 |

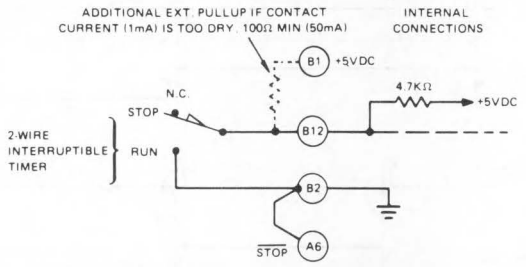
No-Colon Decimal (999999 display)
Models DSC-8200 _4_ _

| | Display Full Count | Timebase Jumpers: Xtal | 50 Hz | 60 Hz | Dec. Pt. | LSD Jumper |
|---|---|---|---|---|---|---|
| Sec | .999999 sec | None | can't use | can't use | Gnd A31 | B7-A24 |
| | 9.99999 sec | None | can't use | can't use | Gnd A30 | B7-A23 |
| | 99.9999 sec | None | can't use | can't use | Gnd A29 | B7-A22 |
| | 999.999 sec. | None | can't use | can't use | Gnd A28 | B7-A21 |
| | 9999.99 sec | None | can't use | can't use | Gnd A27 | B7-A20 |
| | 99999.9 sec | A13-A14 | A12-A13 | A11-A12 | Gnd A25 | B7-A19 |
| | 999999 sec | A13-A14 A16-A19 | A12-A13 A16-A19 | A11-A12 A15-A19 | RH Dec. Pt. not Available | B7-A18 |
| Min | 99999.9 min | A13-A14 A16-A19 | A12-A13 A16-A19 | A11-A12 A15-A19 | Gnd A25 | B7-A17 |
| | 9999.99 min | A20-A19 | can't use | can't use | Gnd A27 | B7-A17 |
| mS | 999.999 mS | None | can't use | can't use | Gnd A28 | B7-A24 |
| | 9999.99 mS | None | can't use | can't use | Gnd A27 | B7-A23 |
| | 99999.9 mS | None | can't use | can't use | Gnd A25 | B7-A22 |
| | 999999 mS | None | can't use | can't use | RH Dec. Pt. not Available | B7-A21 |
| µS | 999999 µS | None | can't use | can't use | RH Dec. Pt. not Available | B7-A24 |

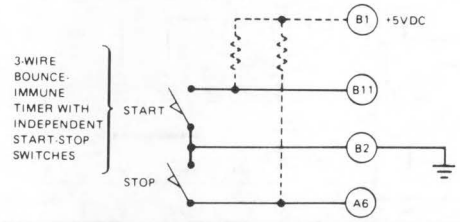
Right colon (9999:59 min/sec display)
Models DSC-8200 _5_ _

| Display Full Count and Timebase | Timebase Jumpers | LSD Jumper |
|---|---|---|
| 9999:59 min/sec crystal timebase | A13-A14 A16-A19 | B7-A18 |
| 9999:59 min/sec 50 Hz timebase | A12-A13 A16-A19 | B7-A18 |
| 9999:59 min/sec 60 Hz timebase | A11-A12 A15-A19 | B7-A18 |

## LIMIT SWITCH OR CAM-CONTACTOR WIRING



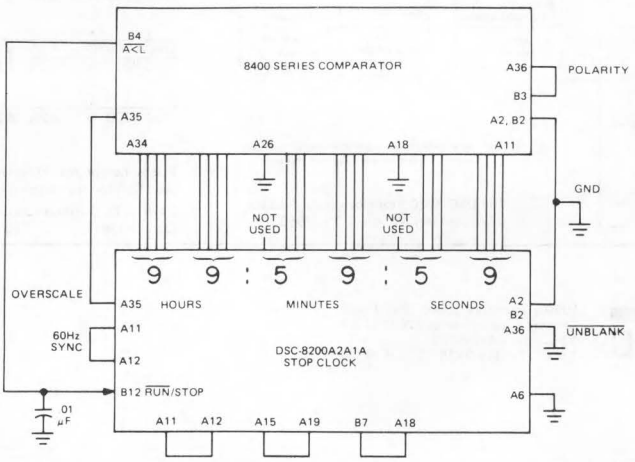

*The suggested circuits shown here illustrate typical applications. Datel cannot warrant the performance of these circuits or their possible patent status by other manufacturers.*




This diagram shows a 100 hour capacity count-up timer using a Datel model DSC-8200 stopclock and Datel 8400 Series Comparator.

Front panel controls start and stop the DSC-8200. Logic controls can be wired to stop timing and hold at the preset time or clear to zero and stop or to clear and start timing. Note that bits BCD 800 (A18) and BCD 80K (A26) are grounded LO since the count in those decades doesn't exceed 5.

**100-HOUR PRESET TIMER WITH 1 SECOND RESOLUTION**




DATEL

# OPTIONAL BCD OUTPUT BUFFER/STORAGE REGISTER

An optional BCD Buffer/Storage Register is available with the DSC-8200 Stopclock. This Buffer printed circuit board mounts in the upper card guides inside the DSC-8200 housing. The BCD Buffer/Storage Register allows for storing accumulated timing intervals and for transmitting this data to an external instrument such as Datel's 8400-series comparators or a computer data bus.

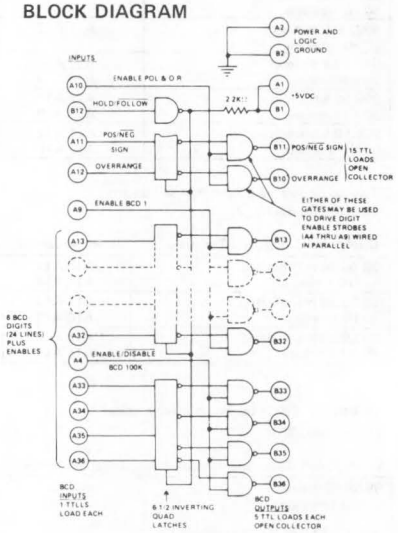
Full parallel timing data is user-wired externally from the top pins of the bottom connector to the underside pins of the top connector. A Datel 24-wire ribbon jumper (Model 2391, $10, singles) offers a convenient connection method between the two rear connectors. On external command through the hold/follow latch input (pin B12) the buffer will store one full parallel data word (26 lines total) with less than one microsecond acquisition time. A second group of external commands (the digit strobes, pins A4 through A10) enable the open collector output gates. These gate strobes are organized in 4-bit BCD groups so that output gating can be multiplexed in 4-bit multiples onto 4, 8 or 16-wire TTL data busses or 26-wire full parallel. The uncommitted open collectors accept up to 5 TTL loads for wide compatibility to mainframe processors, minicomputer or microprocessor data busses. Gating on or off is less than one microsecond using standard TTL loading and short leads. Cable reactance will lengthen this gating time. Logic levels are compatible to 7400-series TTL logic gates. The open collector format allows multiplexing the DSC-8200 outputs along with other instruments sharing the same bus.

## OPTIONAL BCD BUFFER INPUT/OUTPUT CONNECTIONS (TOP PC BRD)

POWER REQUIRED FOR BCD BUFFER:
+5V ±0.25VDC @ 175mA,
LOGIC NOISE 50mV MAX.

| A BOTTOM | LEFT | B TOP | |
|---|---|---|---|
| +5V POWER @ 175mA | 1 | +5V POWER @ 175mA | |
| PWR & DIG. GND | 2 | PWR & DIG. GND | |
| | 3 | | |
| ENABLE BCD 100K | 4 | | |
| ENABLE BCD 10K | 5 | | |
| ENABLE BCD 1K | 6 | | |
| ENABLE BCD 100 | 7 | | |
| ENABLE BCD 10 | 8 | | |
| ENABLE BCD 1 | 9 | | |
| ENABLE POL & O.R | 10 | OVERRANGE OUT | |
| POS/NEG IN | 11 | POS/NEG IN | |
| OVERRANGE IN | 12 | HOLD/FOLLOW IN | |
| BCD 1 IN | 13 | BCD 1 OUT | SEC |
| BCD 2 IN | 14 | BCD 2 OUT | |
| BCD 4 IN | 15 | BCD 4 OUT | |
| BCD 8 IN | 16 | BCD 8 OUT | |
| BCD 10 IN | 17 | BCD 10 OUT | 10 S SEC |
| BCD 20 IN | 18 | BCD 20 OUT | |
| BCD 40 IN | 19 | BCD 40 OUT | |
| BCD 80 IN | 20 | BCD 80 OUT | |
| BCD 100 IN | 21 | BCD 100 OUT | MIN |
| BCD 200 IN | 22 | BCD 200 OUT | |
| BCD 400 IN | 23 | BCD 400 OUT | |
| BCD 800 IN | 24 | BCD 800 OUT | |
| BCD 1K IN | 25 | BCD 1K OUT | 10 S MIN |
| BCD 2K IN | 26 | BCD 2K OUT | |
| BCD 4K IN | 27 | BCD 4K OUT | |
| BCD 8K IN | 28 | BCD 8K OUT | |
| BCD 10K IN | 29 | BCD 10K OUT | HRS |
| BCD 20K IN | 30 | BCD 20K OUT | |
| BCD 40K IN | 31 | BCD 40K OUT | |
| BCD 80K IN | 32 | BCD 80K OUT | |
| BCD 100K IN | 33 | BCD 100K OUT | 10 S HRS |
| BCD 200K IN | 34 | BCD 200K OUT | |
| BCD 400K IN | 35 | BCD 400K OUT | |
| BCD 800K IN | 36 | BCD 800K OUT | |
| A BOTTOM | RIGHT | B TOP | |

## BLOCK DIAGRAM




## PERIOD METER APPLICATION

The DSC-8200 is easily connected to operate as a period meter. This particular circuit uses a few external components and a floating analog comparator, part number 2543, available from Datel. The comparator is the same circuit used on Datel's model DPC-8100 Counter and includes a DC/DC converter for 300V RMS isolated operation. An external potentiometer is adjusted to set the triggering threshold (– 1V to + 2V threshold range).

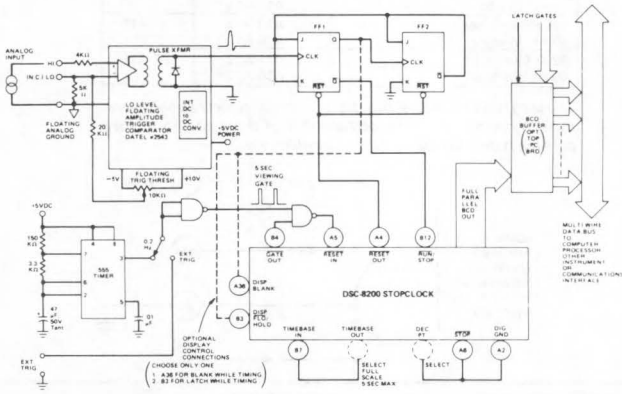
After the 555 viewing gate timer resets the previous timing and both control flip flops, the next positive-going threshold crossing starts the timing.

Timing stops on the next following threshold crossing. The control flip flops lock out restart triggers and the timed period is displayed for the remainder of the five second viewing pause.

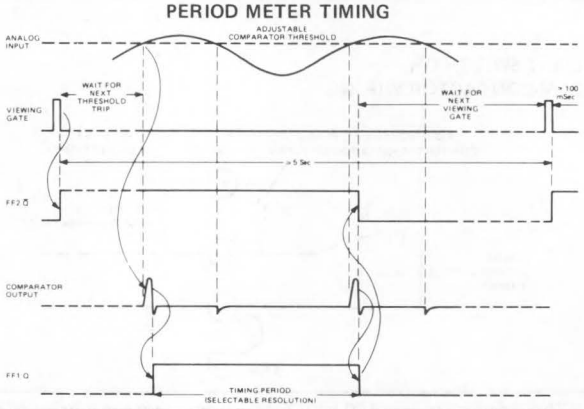
The DSC-8200 is by no means limited to this type of period timing. By selecting timebases, periods from microseconds to hours may be measured. The display may be blanked or latched and a different external circuit may be designed for full synchronous period timing triggered by the analog waveform. Complex waveforms may be measured for pulse widths or time between pulses.

## PERIOD METER

**Asynchronously triggered with 5 Second Viewing Pause**




## PERIOD METER TIMING




## ORDERING GUIDE

DSC-8200

| POWER SUPPLY | TIME FORMAT | INPUT * OPTOISOLATION | BCD OUTPUT | LATCHABLE DISPLAY |
|---|---|---|---|---|
| A* = 115VAC<br>D = +5VDC<br>E* = 230VAC<br>J* = 100VAC<br>(*47 to 440 Hz)<br>+5VDC powered units can be AC line or Xtal time-base, pin selectable | 1 = 999:59.9 min/sec or hrs/min<br>2 = 99:59:59 hrs/min/sec<br>3 = 99:59.99 min/sec<br>4 = 999999 (LSD is 1 µs, 10 µs, 100 µs, 1 mS, 10 mS, 100 mS, 1 sec, or 0.1 min rear connector pin strappable)<br>5 = 9999:59 min/sec<br>(10 mS or lower least significant digit must use crystal timebase) | A = with<br>B = without | 1 = Standard<br>2 = Latchable & gatable | A = without<br>B = with |

*Note: Input optoisolation *omitted* on special order only. Standard units include optoisolated inputs.

The DSC-8200 Stopclock is covered by GSA Contract No. GS-OOS-27959

Prices (1-9)

| | | | |
|---|---|---|---|
| DSC-8200 A – A1A | $299. | AC pwr, std. BCD Outputs |
| E<br>J | | |
| DSC-8200 D – A1A | $269. | +5V pwr, std. BCD Outputs |
| DSC-8200 A – A2A | $369. | AC pwr, latchable BCD Outputs |
| E<br>J | | |
| DSC-8200 D – A2A | $339. | +5V pwr, latchable BCD Outputs |

Prices include rear PC board connectors.
Add $50 for the latching display option.

24-Wire BCD Ribbon Jumper
Datel #2391 . . . . . $10 ea.


DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

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# 6-DIGIT, PANEL MOUNT DIGITAL TIME CLOCK

# MODEL DTC-8300

**Covered by GSA Contract No. GS-00S-27959**

## FEATURES

- **Bright, long-life 0.6 inch high (15 mm) LED displays**
- **Full parallel TTL/DTL compatible BCD data outputs – optionally latched and gated.**
- **Choice of power supply: AC line or +5VDC.**
- **Both AC line frequency or crystal controlled time base are built in.**
- **Choice of 12, 24 or 100 hour displays.**

## DESCRIPTION

The Model DTC-8300 displays the time of day in hours, minutes and seconds in 12 or 24 hour formats on .6" (15 mm) high LED digits. The panel mounting instrument features digital logic outputs of the displayed time for use in data logging systems and time-controlled automatic process systems.

The 12 and 24 hour time formats have two colon and one colon display modes respectively. The 12-hour format carries on 12:59:59 to 1:00:00 and the 24-hour version carries from 2359:59 to 0000:00. These modes are customer wired on the rear PC board connector. However, the left colon may be blanked or illuminated on any model. A 100 hour carry may also be connector-wired.

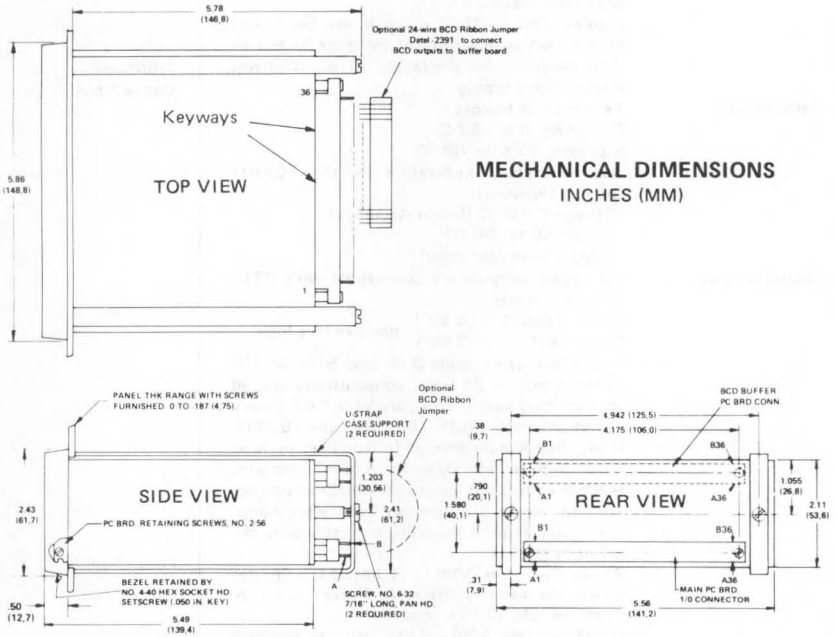
Power required for the DTC-8300 is 100, 115 or 230 VAC at 50 or 60 Hz or +5 volts DC at 1.5 Amps max.

The timebase for the clock is available from an internal quartz crystal oscillator supplied on all units or from a choice of 50 or 60 Hz AC line frequencies.

The line frequency timing reference may also be used on +5VDC powered units for long term accuracy periodically corrected by power utilities. AC line powered versions contain their own internal +5VDC regulated supply and 100mA at +5VDC may be tapped for external use.

The DTC-8300 is housed in a black anodized aluminum case measuring 5.562" wide x 2.125" high x 5.467" deep (141 x 54 x 139 mm). The clock is mounted through a front-panel cut out and secured by two U-straps. The grounded case acts as shielding for the clock circuitry and additional power line filtering is provided by a bifilar-wound choke and bypass capacitors.

All displayed digits have a corresponding set of digital logic outputs available at the rear connector. These outputs are in full-parallel standard binary coded decimal form (BCD) with TTL/DTL compatible logic levels. Standard BCD versions have a HOLD input which stabilizes the output for one second minimum (2 sec. max. synchronously) for readout by an external device. This "HOLD" function stores one clock pulse during the 2 second read interval and reinserts this pulse so as not to disrupt timing accuracy.

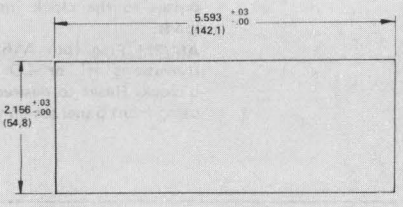




**MECHANICAL DIMENSIONS**
INCHES (MM)

An AM/PM logic output for 12-hour versions may be used for data logging applications. A "power fail" front panel LED lamp and corresponding logic output is set whenever power is momentarily interrupted, indicating to an external device that the time may be invalid. Resetting the clock using the front panel controls will extinguish the "power fail" lamp and flag.

An optional second PC board provides fully latched and gated BCD capability so that a clock word may be stored and transmitted at any time on external command. Gating is open collector TTL/DTL-compatible and gatable by individual digit These digits may be multiplexed onto 4 or 8 line data busses as well as transmitted in full parallel.

**FRONT PANEL CUTOUT**
**INCHES (MM)**



## SPECIFICATIONS (Typical @ +25°C unless noted)

**GENERAL**

**Displays** . . . . . Six (6) self-illuminated digits, red LED 0.6" (15 mm) high, 7-segment format.
Full scale readouts (with LED colons):
12:59:59 (HOURS:MINUTES:SECONDS)
2359:59 (HOURS MINUTES:SECONDS)

**Power Fail** . . . . . Front panel red LED lamp illuminates to warn if power has been interrupted, indicating possible incorrect time displayed. Corresponding logic output (pin A15).

**Front Panel Controls** Set/Run Switch – (Pushbutton switch which can be locked by pushing in and rotating 1/8 turn clockwise).
"Run" Mode (pushbutton in) – Clock is running. Hours and minutes set pushbuttons (see below) are disabled.
"Set" Mode (pushbutton released out) – Clock is stopped. Hours and minutes set pushbuttons are enabled. Seconds display will be stopped at the current:00 to :59 count.
Hours Set Pushbutton – Push in to set hours if Set/Run Switch is in "set". Push in will cycle hours display at approx. 4 digits per second. Release on desired hours.
Minutes Set Pushbutton – Functions same as Hours Set for minutes display. [See "How to Set Clock" section]
Display Test – Hold in both the hours and minutes set pushbuttons at any time to test all digit segments by displaying all 8's. Will not disrupt clock timing.

**Performance** . . . . . Temperature Ranges
Operating: 0 to +50°C
Storage: −25°C to +85°C
Accuracy and Temperature Drift – (Quartz Crystal Timebase)
±10ppm @ +25°C (Initial Accuracy)
±10ppm (0 to +50°C)
±10ppm (one year aging)

**Digital Outputs** . . . . All digital outputs are compatible with DTL/TTL logic levels
LO = "ZERO" ⩽ +0.4V
HI = "ONE" ⩾ +2.4V
} positive true logic
BCD Clock Data (pins B13 thru B36, see I/O connections) – 24 lines, consecutively spaced in ascending order. Full parallel 1-2-4-8 binary coded decimal (BCD). Positive true, 6 TTL loads, totem pole format (drives high or low)
Note: Tens of seconds and tens of minutes only reach 5 count, but vacant terminal location for "8" bit occurs in sequence. Interfacing equipment may require strapping corresponding terminal to ground.
$\overline{\text{Power Fail}}$ (pin A15) – 1 line, LO indicates power has been interrupted. Cleared to HI by "Set" switch. 10 TTL loads out.
$\overline{\text{Data Valid}}$ (pin A36) – 1 line, provides squared-up 1 Hz logic output for external clock slave, read functions, etc. BCD valid on falling edge and while LO. Connected downstream from AC line or crystal oscillator input (see wiring diagram). 10 TTL loads.
Crystal Clock Out (pin A6) – 1 line, provides 1 Hz, 31.25 millisec. wide crystal oscillator clock pulses to the clock input, pin A35. 1 TTL load.
AC Line Clock Out (pin A14) – 1 line, provides 1 Hz, square wave AC line-synchronized clock pulses to the clock input, pin A35. 10 TTL loads.
AM/PM Flag (pin A16) – 1 line, alternately transitions HI or LO at carry to 12:00:00 o'clock. Reset to desired level by cycling clock using front panel set controls. 10 TTL loads.
$\overline{\text{Set}}$/Run Output (pin A27) – 1 line, switch contact to ground with 4.7K ohm pullup to +5V.
GND – Clock is being set, BCD outputs are invalid.
HI – Clock is running if Run/$\overline{\text{Hold}}$ (A7) is HI.

**Digital Inputs** . . . . All digital inputs are compatible with DTL/TTL logic levels.
LO = "ZERO" ⩽ +0.8V
HI = "ONE" ⩾ +2.0V
} positive true logic
Run/$\overline{\text{Hold}}$ (pin A7) – 1 line, 1.6 TTL loads
HI – Clock is running.
LO – BCD outputs stabilized.
May be held 1 sec. max. asynchronous to $\overline{\text{Data Valid}}$ output without disrupting timing. (Saves one pulse which is reinserted when HOLD is released) Hold longer than 2 seconds disrupts timing. (See timing.) 1.6 TTL loads.
Clock In (pin A35) – 1 line, accepts 1 Hz pulses from Crystal Clock (A6) or AC Line Clock (A14). 1 TTL load.
$\overline{\text{Leading Zero Blank}}$ (pin A26) – 1 line, LO blanks the leading zero. 1 TTL load.
Display Blank (pin A30) – 1 line, HI blanks display. 3 TTL loads. Works from jumper, open collector, totem pole TTL, or DTL. Must sink 5mA pullup. Colons remain illuminated while display is blanked. Must ground for normal operation.

**Additional Connections** . . . . $\overline{\text{LIGHT LEFT COLON}}$ (B28) Gnd. to light
$V_{LED}$ 1 (pin A28)
$V_{LED}$ 2 (pin A3)
} Each input connects +5V power to 3 display digits. 550mA max. @ +5VDC each connection. Internally connected to +5V power on AC models.
+5VDC POWER (pins A1 & B1 in parallel) – These pins are for +5VDC logic power input on +5V-powered units, 400mA max. On AC-powered models, output of +5VDC power @ 275mA max. is available from these pins. Not internally connected to displays on DC models. (Use $V_{LED}$ 1 & 2 for displays.)
Power and Logic Ground (pins A2 & B2 in parallel) +5V power return for display and logic.
Carry Controls (pins A29, A31-A34) – For selecting 12, 24 or 100 hour full scale carries (see chart).
Ext. AC Line Synch. (pin B8) – 1 line, to provide an AC timebase reference when used with +5V powered units. 3V RMS to 10V RMS input, referenced to power supply ground, 50 or 60 Hz.

**Power Supply** . . . . Choice of 100, 115, or 230VAC, ± 10% 10 W typ., 47-63 Hz (unless using AC line for timing reference). Fuse .15A (100, 115 VAC), .10A (230VAC) OR +5 ± 0.25VDC @ 1.5A max., logic noise 50mV max.

**Connectors** . . . . . Dual 36 pin PC edgeboard type, 0.1" centers, solder tabs, Datel 2597-14 (Viking 3VH36/1JN-5 or equivalent), (AC power connected by triple 1/4" tab, recessed male, center tab case ground) PC Board connectors are included with unit.

**Mounting** . . . . . Panel mounting through a cutout measuring 2.156" H x 5.593" W (54,8 x 142,1mm) and secured by 2 U-straps. See mounting diagram.

**Mechanical Dimensions** . . . . . Case 5.56" H x 2.11" H x 5.78" D (141,2 x 53,6 x 146,8 mm) behind front panel to rear of U-strap.
Bezel 5.86" W x 2.25" H x 0.50" Thk (148,7 x 57,0 x 12,7 mm) (See Diagrams) Removable from front while unit remains secured in panel.

**Weight** . . . . . 2.25 pounds (1,0 Kg)

## HOW TO SET CLOCK

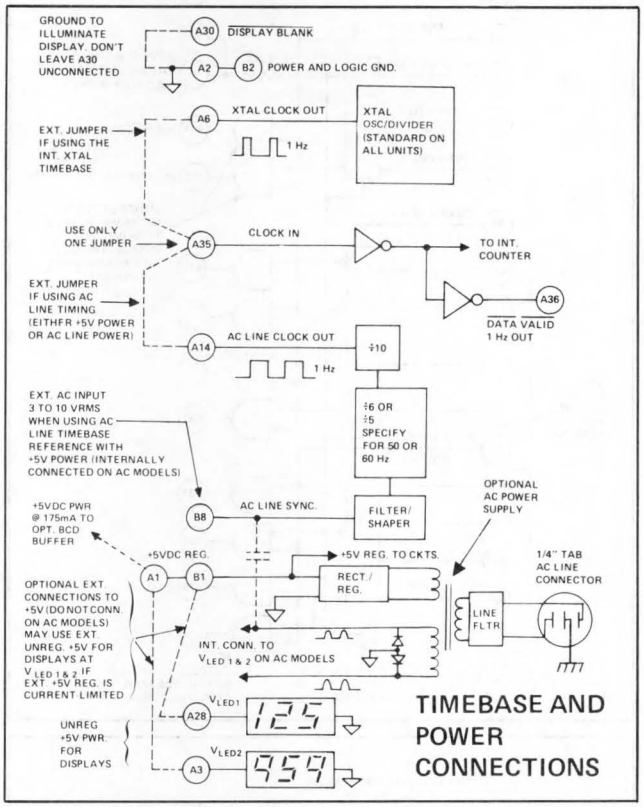
1. Release Set/Run pushbutton to "Set". Seconds display will stop at the current :00 to :59 indication.
2. Push hours set pushbutton in and the hours display will advance at approx. 4 digits/second. Release pushbutton on correct hour.
3. Push minutes set pushbutton and release on *next* correct minute indication.
4. Wait until seconds display matches external reference clock then push in Set/Run switch to start digital clock. Twist Set/Run switch 1/8 turn clockwise to lock in Run position.

## DTC-8300 CLOCK INPUT/OUTPUT CONNECTIONS

Ground A30 to illuminate display

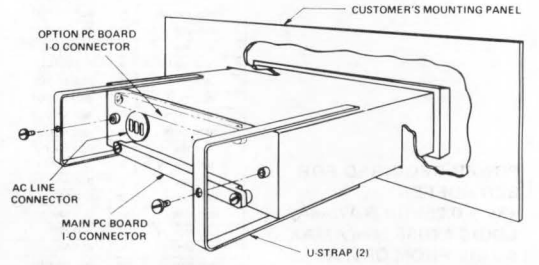
| A BOTTOM | LEFT | B TOP |
|---|---|---|
| +5V POWER | 1 | +5V POWER |
| PWR. & DIG. GND. | 2 | PWR. & DIG. GND |
| +5V to $V_{LED2}$ | 3 | |
| | 4 | |
| | 5 | |
| XTAL 1 Hz OUT | 6 | |
| RUN/$\overline{\text{HOLD}}$ IN | 7 | |
| | 8 | EXT. AC LINE SYNCH. |
| | 9 | |
| | 10 | |
| | 11 | |
| | 12 | |
| | 13 | BCD SEC. 1 |
| AC LINE 1 Hz OUT | 14 | BCD SEC. 2 |
| $\overline{\text{POWER FAIL}}$ OUT | 15 | BCD SEC. 4 |
| AM/PM OUT | 16 | BCD SEC. 8 |
| | 17 | BCD SEC. 10 |
| | 18 | BCD SEC. 20 |
| | 19 | BCD SEC. 40 |
| | 20 | N.C. |
| | 21 | BCD MIN. 1 |
| | 22 | BCD MIN. 2 |
| | 23 | BCD MIN. 4 |
| | 24 | BCD MIN. 8 |
| | 25 | BCD MIN. 10 |
| $\overline{\text{LEAD. ZERO BLANK}}$ | 26 | BCD MIN. 20 |
| $\overline{\text{SET}}$/RUN OUT | 27 | BCD MIN. 40 |
| +5V TO $V_{LED1}$ | 28 | $\overline{\text{LIGHT LEFT COLON}}$ |
| ADD 1 HR. IN | 29 | BCD HRS. 1 |
| DISPLAY BLANK | 30 | BCD HRS. 2 |
| LAST HR. BIT IN | 31 | BCD HRS. 4 |
| LAST HR. BIT IN | 32 | BCD HRS. 8 |
| LAST HR. BIT IN | 33 | BCD HRS. 10 |
| ADD 1 HR OUT | 34 | BCD HRS. 20 |
| 1 Hz CLOCK IN | 35 | BCD HRS. 40 |
| $\overline{\text{DATA VALID}}$ OUT | 36 | BCD HRS. 80 |
| A BOTTOM | RIGHT | B TOP |

DATEL




## TIMEBASE AND POWER CONNECTIONS

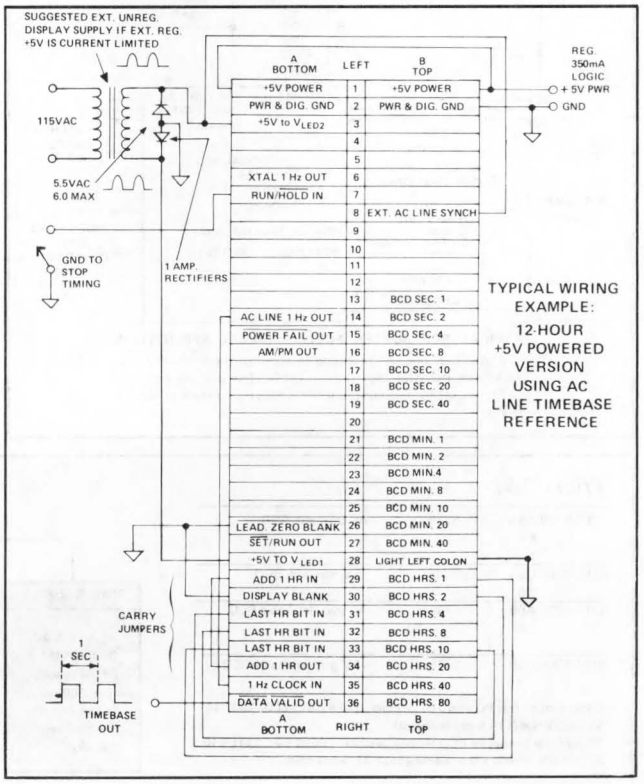
## PANEL MOUNTING DETAILS (REAR VIEW)




## FULL SCALE CARRY

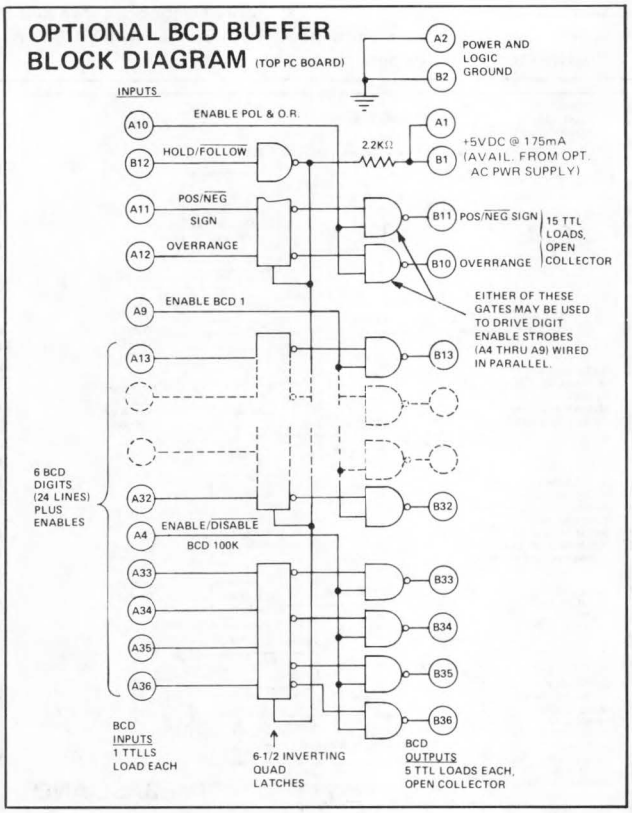
Left colons may be illuminated or blank on any model.

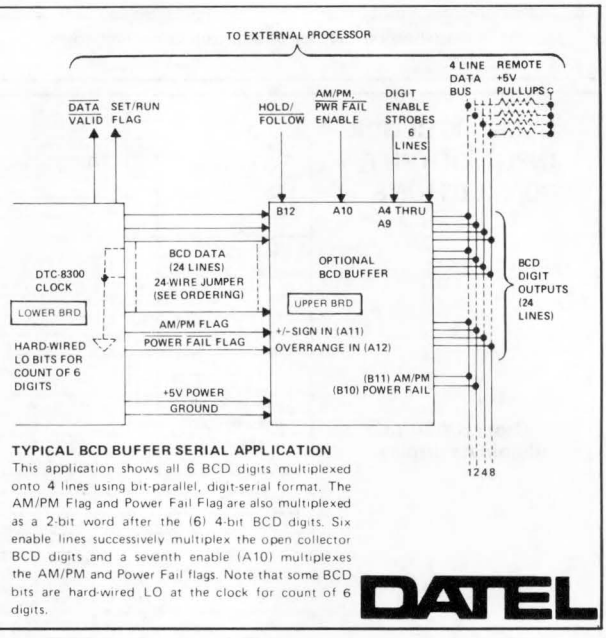
| For Clock to carry | | Jumper between | | | |
|---|---|---|---|---|---|
| From | To | A31 | A32 | A33 | A29 |
| 11:59:59 | 00:00:00 | B30 | B33 | B33 | N.C. |
| 12:59:59 | 01:00:00 | B30 | B33 | B29 | A34 |
| 2359:59 | 0000:00 | A32 | B31 | B34 | N.C. |
| 2459:59 | 0100:00 | B29 | B31 | B34 | A34 |
| 99:59:59 | 00:00:00 | N.C. | N.C. | GND | N.C. |




TYPICAL WIRING EXAMPLE: 12-HOUR +5V POWERED VERSION USING AC LINE TIMEBASE REFERENCE

## OPTIONAL BCD BUFFER BLOCK DIAGRAM (TOP PC BOARD)

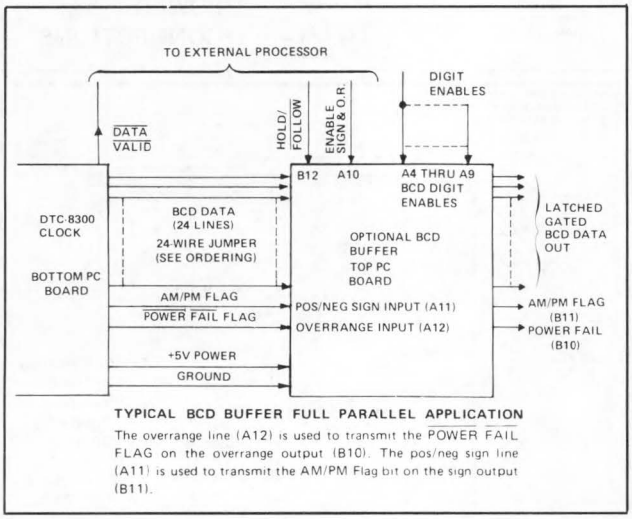



**TYPICAL BCD BUFFER SERIAL APPLICATION**

This application shows all 6 BCD digits multiplexed onto 4 lines using bit-parallel, digit-serial format. The AM/PM Flag and Power Fail Flag are also multiplexed as a 2-bit word after the (6) 4-bit BCD digits. Six enable lines successively multiplex the open collector BCD digits and a seventh enable (A10) multiplexes the AM/PM and Power Fail flags. Note that some BCD bits are hard-wired LO at the clock for count of 6 digits.

DATEL




**TYPICAL BCD BUFFER FULL PARALLEL APPLICATION**

The overrange line (A12) is used to transmit the POWER FAIL FLAG on the overrange output (B10). The pos/neg sign line (A11) is used to transmit the AM/PM Flag bit on the sign output (B11).

## OPTIONAL BCD BUFFER INPUT/OUTPUT CONNECTIONS (TOP PC BRD)

| A BOTTOM | LEFT | B TOP | |
|---|---|---|---|
| +5V POWER @175mA | 1 | +5V POWER @175mA | |
| PWR. & DIG. GND. | 2 | PWR. & DIG. GND. | |
| | 3 | | |
| ENABLE BCD 100K | 4 | | |
| ENABLE BCD 10K | 5 | | |
| ENABLE BCD 1K | 6 | | |
| ENABLE BCD 100 | 7 | | |
| ENABLE BCD 10 | 8 | | |
| ENABLE BCD 1 | 9 | | |
| ENABLE POL. & O.R. | 10 | OVERRANGE OUT | |
| POS/NEG IN | 11 | POS/NEG IN | |
| OVERRANGE IN | 12 | HOLD/FOLLOW IN | |
| BCD 1 IN | 13 | BCD 1 OUT | SEC |
| BCD 2 IN | 14 | BCD 2 OUT | |
| BCD 4 IN | 15 | BCD 4 OUT | |
| BCD 8 IN | 16 | BCD 8 OUT | |
| BCD 10 IN | 17 | BCD 10 OUT | 10'S SEC |
| BCD 20 IN | 18 | BCD 20 OUT | |
| BCD 40 IN | 19 | BCD 40 OUT | |
| BCD 80 IN | 20 | BCD 80 OUT | |
| BCD 100 IN | 21 | BCD 100 OUT | MIN |
| BCD 200 IN | 22 | BCD 200 OUT | |
| BCD 400 IN | 23 | BCD 400 OUT | |
| BCD 800 IN | 24 | BCD 800 OUT | |
| BCD 1K IN | 25 | BCD 1K OUT | 10'S MIN |
| BCD 2K IN | 26 | BCD 2K OUT | |
| BCD 4K IN | 27 | BCD 4K OUT | |
| BCD 8K IN | 28 | BCD 8K OUT | |
| BCD 10K IN | 29 | BCD 10K OUT | HRS |
| BCD 20K IN | 30 | BCD 20K OUT | |
| BCD 40K IN | 31 | BCD 40K OUT | |
| BCD 80K IN | 32 | BCD 80K OUT | |
| BCD 100K IN | 33 | BCD 100K OUT | 10'S HRS |
| BCD 200K IN | 34 | BCD 200K OUT | |
| BCD 400K IN | 35 | BCD 400K OUT | |
| BCD 800K IN | 36 | BCD 800K OUT | |
| A BOTTOM | RIGHT | B TOP | |

**POWER REQUIRED FOR BCD BUFFER:**
**+5V ± 0.25VDC @ 175mA, LOGIC NOISE 50mV MAX. AVAIL FROM OPT. AC PWR SUPPLY**

### Prices (1-9)

| | | |
|---|---|---|
| DTC-8300 A5A<br>E6<br>J | $299. | AC pwr, std. BCD |
| DTC-8300 D5A<br>6 | $245. | +5V pwr, std. BCD |
| DTC-8300 A5B<br>E6<br>J | $369. | AC pwr, latchable BCD |
| DTC-8300 D5B<br>6 | $315. | +5V pwr, latchable BCD |

Prices include rear PC board connectors. (Datel part #8000-2597-14 Viking 3VH36/1JN-5 or equivalent)
24-wire rear connector BCD Ribbon Jumper – Datel part 2391, $10
AC models include a U.S. 3-prong type 9115 line cord.

### ORDERING GUIDE

**DTC-8300** ____

**POWER SUPPLY**
A* = 115VAC
D = +5VDC
E* = 230VAC
J* = 100VAC
*47 to 440 Hz (see timebase specifier)

**TIMEBASE (SELECTABLE)**
6 = AC line
60 Hz plus quartz crystal
5 = AC line
50 Hz plus quartz crystal
(Both AC and +5VDC powered units can be AC line or Xtal timebase – pin selectable)

**BCD OUTPUT**
A1 = Standard
B1 = Latchable & gatable

**The DTC-8300 Digital Clock is available under GSA Contract No. GS-00S-27959**

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

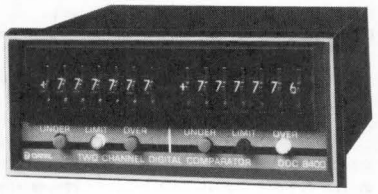
# PRESET LIMIT DIGITAL COMPARATORS

# MODELS DDC-8400 AND DLC-8400

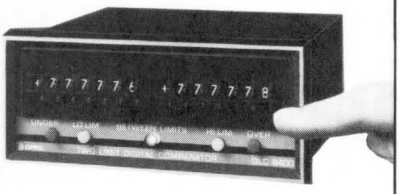
## FEATURES

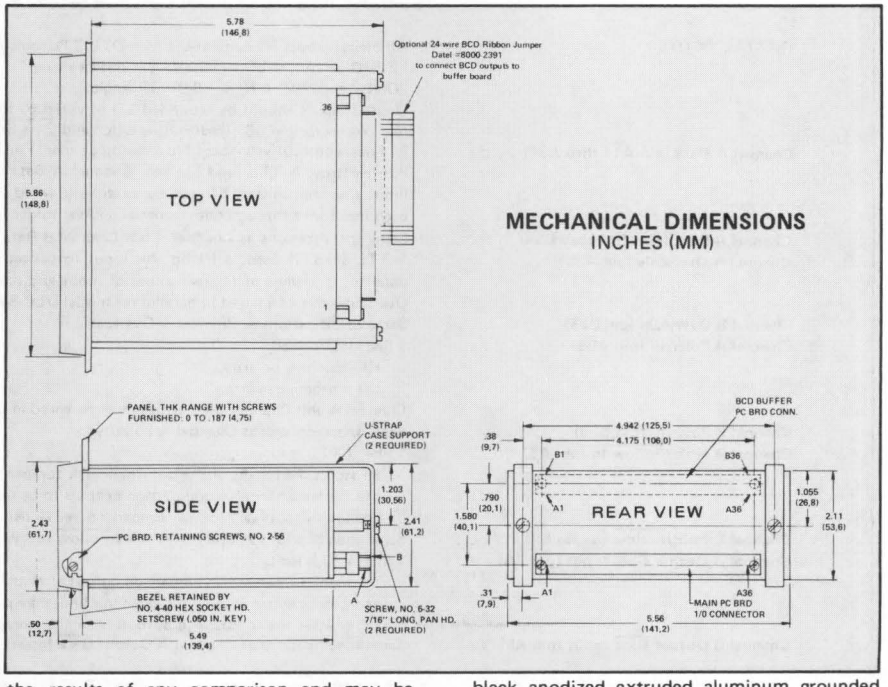
- **Front panel lights and logic outputs indicate under, over, between or equal to preset limits selected on thumbwheel switches.**
- **Two Models:**
  **DDC-8400: Two independent single-channel single-limit comparators**
  **DLC-8400: A single-channel, two-limit, 3-zone comparator**
- **Optional relay outputs control external lamps, motors, pumps, valves, solenoids, etc.**
- **Compatible with Datel's counters and stopclocks to create mixing/batching controllers, preset timers, limit alarms, etc.**
- **Limit tests may be stored and multiplexed onto a data bus.**
- **Full parallel BCD inputs make rapid limit tests in less than 1 microsecond.**

**DDC-8400**




**DLC-8400**




## GENERAL DESCRIPTION

Models DDC-8400 and DLC-8400 are full parallel, high speed digital comparators housed in small aluminum panel-mounting cases. Digital inputs are connected at the rear of the instrument and are compared to bipolar decimal numbers selected on the front panel 6-digit thumbwheel switches. Front panel lights indicate various limit modes and rear connector logic outputs are available to operate other digital instruments or optional relays.

These instruments differ from lower cost count-up comparators (predetermining counters) which require a gated serial input and take longer to determine a comparison. The 8400 comparators have 6 digit resolution with polarity for both the inputs and the preset limits. Separate over scale inputs force an out of limit indication, in the appropriate direction depending on polarity.

These comparators are fully algebraic in operation. Comparisons are fully bipolar so that true 4 quadrant operation is provided.

Logic data inputs are full parallel 1-2-4-8 binary coded decimal (BCD) and are compatible to DTL/TTL logic sources. Inputs may be derived from digital panel meters, counters, clocks, timers, test equipment and digital processors.

Applications include: Precision count-up timers, digital setpoint controllers, batching/mixing/sorting controllers requiring a predetermining counter, level or flowrate monitors and alarms. The instruments are ideal for automatic test equipment applications performing component and system check-outs. New test parameters for pass-fail inspection may be quickly dialed in on the front panel limit selectors.

A full set of seven latchable, gatable logic outputs of comparator tests is available on the rear connector. These outputs indicate the results of any comparison and may be stored and transmitted via open collector data bus to a remote processor upon external command. This bussing arrangement is compatible to most minicomputers and microprocessors. Using this bus, the 8400-series comparators will interface with a remote digital processor, providing limit indications when polled by the processor, yet retaining full manual control of the set-points at the site of measurement.

The digital outputs from the 8400 series comparators may also be rear-wired to an optional internal PC board containing relays. These relays will operate isolated circuits or power actuators, motors, alarm lamps or horns, pumps, valves or solenoids from the AC line. These relays are a choice of either Form C mechanical types with 2 Amp ratings or zero-switching optoisolated solid state relays. Both types of relays may also be used in pilot service for larger electrical equipment.

The 8400 series comparators are housed in a black anodized extruded aluminum grounded case for high electrical noise rejection in industrial environments. Power required is a choice of 100, 115, or 230 VAC, 47 to 440 Hz or +5VDC at 400 mA max. Additional power line filtering on AC models is provided by a bifilar-wound choke and filtered, regulated power supply.

**Two Models**

**Model DDC-8400** consists of 2 separate single-limit, single-channel comparators in one case. Each comparator has 3 lights to indicate UNDER/AT LIMIT/OVER limit status of the input compared to the thumbwheel set-point limits selected. There are two sets of 3 lights per channel for 6 lights total. **Model DLC-8400** accepts a single input channel and compares it to upper and lower set-point limits selected on two front panel thumbwheel switches. This is a 3-zone comparator with 5 lights indicating whether the input is UNDER/BETWEEN/OVER the LO and HI limits or equal to the LO or HI limits.

## SPECIFICATIONS (Typical from 0 to +50°C)

GENERAL

**Function** . . . . . Digital comparators accepting full parallel binary coded decimal (BCD) logic inputs and comparing them to 6-digit decimal values selected by thumbwheel switches. Comparisons are fully bipolar (4 quadrant true algebraic with out of limit overscale input).

**DDC-8400:** Two independent single-channel, single-limit comparators.

**DLC-8400:** A single-channel, two-limit, 3-zone comparator with assigned LO and HI limits.

**Displays** . . . . . Front panel indicator lights display the status of limit comparisons. The lamps are long-life type 683 incandescent .05 mean spherical candlepower and are replaceable by removing the front panel colored lenses.

**DDC-8400:** Each of 2 comparator channels A and B indicates:
- UNDER (Below limit, red lamp)
- AT LIMIT (Equal to limit, green lamp)
- OVER (Above limit, red lamp)

**DLC-8400:** The single-channel comparator indicates:
- UNDER LIMIT (Below both limits, red lamp)
- LO LIMIT (Equal to lower limit, yellow lamp)
- BETWEEN LIMITS (Green lamp)
- HI LIMIT (Equal to upper limit, yellow lamp)
- OVER LIMIT (Above both limits, red lamp)

Standard lamp lens colors are listed above. Colored lenses may be interchanged on special order using red, green, amber, blue, white or yellow lenses. Contact Datel for assistance.

**Front Panel Controls** . . . . . Two set of thumbwheel switches, each with six digits and polarity, are used to manually select limit setpoints. On the 3-zone model (DLC-8400) the lower limit is assigned to the left thumbwheel selector and the upper limit is assigned to the right thumbwheel. Decimal points are not included, therefore, significant digits must be coincident with BCD input wiring. (See applications.)

DIGITAL INPUTS

All digital inputs are compatible with DTL/TTL logic levels:
"ZERO" = 0V. ≤ LO ≤ +0.8V } positive true
"ONE" = +2.0V. ≤ HI ≤ +5.0V } logic

Unused inputs should be grounded LO or wired HI through an internal pullup resistor available on rear connector pin B3. Hold/$\overline{\text{Follow}}$ Latch and $\overline{\text{Gate}}$ Enable Inputs must use TTL rise and fall times.

**Channel A Data (pin A11 thru A34)** . . . . . 24 lines, consecutively spaced in ascending order. Full parallel 1-2-4-8 binary coded decimal (BCD). Positive true, 1 TTL load per line. Channel A Data is compared to the left thumbwheel selector limit. Channels A and B must be externally wired in parallel for model DLC-8400 by inserting each input wire through both upper and lower solder tabs.

**Channel B Data (pins B11 thru B34)** . . . . . Same specifications as Channel A but Channel B Data are compared to the right thumbwheel limit.

**Channel A Overscale (pin A35)** . . . . . 1 TTL load. If used, a HI on this input forces an out of limit indication depending on input polarity, regardless of relative values of input and scale limit mantissas. Channel A and Channel B Overscales must be wired in parallel for model DLC-8400. Ground LO if not used.

**Channel B Overscale (pin B35)** . . . . . Same specifications as Channel A Overscale.

**Channel A Polarity (pin A36)** . . . . . 1 line, 1 TTL load.
- HI = positive polarity
- LO = negative polarity

Channel A and Channel B Polarities must be wired in parallel for model DLC-8400.

**Channel B Polarity (pin B36)** . . . . . Same specifications as Channel A Polarity.

**Channel A Hold/$\overline{\text{Follow}}$ In (pin A5)** . . . . . 1 line, 1 TTL load.
- HI stores the results of the last Channel A comparison. Outputs will be stabilized.
- LO causes Channel A comparison outputs to be updated within 500 nSec of input channel data change; outputs will follow comparison decisions. Momentary LO acts as update clock.

**Channel B Hold/$\overline{\text{Follow}}$ In (pin B6)** . . . . . Same specifications as Channel A Hold/$\overline{\text{Follow}}$ In. Wire Channels A and B in parallel for DLC-8400

**Channel A Output $\overline{\text{Gate}}$ Input (pin A6)** . . . . 1 line, 1 TTL load.
- HI disables Channel A comparison output after the storage circuits. (Output collectors are cut off and other devices sharing the same bus lines may pull these lines down.)
- LO enables the comparison outputs after the storage circuits.

**Channel B Output $\overline{\text{Gate}}$ Input (pin A8)** . . . . . Same specifications as Channel A Output $\overline{\text{Gate}}$ Input. Wire Channels A and B in parallel for DLC-8400

DIGITAL OUTPUTS

All digital outputs are compatible with DTL/TTL logic. Max. $I_{sink}$ = 16 mA
"ZERO" = 0V. ≤ LO ≤ +0.4V. } Maximum output pullup
"ONE" = Open coll. output } Potential +5.5V

Note that the comparison outputs are valid when LO (negative true). Logic outputs are open collector.

**Channel A $\overline{\text{A<L}}$ Output (pin B4)** . . . . . 1 line, 10 TTL loads
- HI means that the Channel A input is equal to or greater than the left (lower) thumbwheel limit.
- LO means that the Channel A input is less than the left (lower) thumbwheel limit.

**Channel B $\overline{\text{B<U}}$ Output (pin A7)** . . . . . 1 line, 10 TTL loads
- HI means that the Channel B input is equal to or greater than the right (upper) thumbwheel limit.
- LO means that the Channel B input is less than the right (upper) thumbwheel limit.

**Channel A $\overline{\text{A = L}}$ Output (pin B5)** . . . . . 1 line, 10 TTL loads
- HI means that the Channel A input is not equal to the left (lower) thumbwheel limit.
- LO means that the channel A input is equal to the left (lower) thumbwheel limit.

**Channel B $\overline{\text{B=U}}$ Output (pin A4)** . . . . . 1 line, 10 TTL loads
- HI means that the Channel B input is not equal to the right (upper) thumbwheel limit.
- LO means that the Channel B input is equal to the right (upper) thumbwheel limit.

**Channel A $\overline{\text{A>L}}$ Output (pin B7)** . . . . . 1 line, 10 TTL loads
- HI means that the Channel A input is equal to or lower than the left (lower) thumbwheel limit.
- LO means that the Channel A input is greater than the left (lower) thumbwheel limit.

## SPECIFICATIONS (Cont'd)

**Channel B $\overline{B>U}$ Output (pin A3)** . . . . . 1 line, 10 TTL loads
HI means that the Channel B input is equal to or lower than the right (upper) thumbwheel limit.
LO means that the Channel B input is higher than the right (upper) thumbwheel limit.

**$\overline{(B>U) \cdot (A<L)}$ Output (pin B8)** . . . . . 1 line, 10 TTL loads
This line is provided on both models DDC- and DLC-8400.
LO on this line for the 3-zone model DLC-8400 indicates that the single input channel (A and B wired in parallel) is between the upper and lower limits *or* equal to either limit. If both input channels A and B on model DDC-8400 are wired in parallel, this output line has the same meaning. Note that the "between limits" light on the DLC-8400 is dark if the single input is equal to either limit although pin B8 will be low.

ADDITIONAL CONNECTIONS

**Spare Inverters (pins A9, A10, B9, B10)** . . . . . Two spare TTL logic inverters are available for optional customer use. (A9, Inv. 1 Out; A10 Inv. 2 Out / B9, Inv. 2 In; B10 Inv. 1 In)
Outputs are open collector with 2.2 Kilohm pull ups to +5 volts
8 TTL loads out, 1 TTL load in, each inverter.

**Aux. Pullup Resistor (pin B3)** . . . . . Spare 2.2 Kilohm resistor connected to +5V for optional customer use.

**+5VDC Power (pins A1 and B1 internally connected)** . . . . . On DC-powered models, +5VDC @ 400mA max. regulated input should be connected to these pins. On AC-powered models, up to 200mA out at +5VDC regulated is available from these pins for optional external use.

**Ground (pin A2 and B2 internally connected)** . +5V Power and Logic ground return.

**Power Supply. (See Ordering Guide)** . . . . . AC powered models: Choice of 100, 115 or 230 VAC, ±10%, 47 to 440Hz, 10 watts typical.
DC powered models: +5 ±0.25 volts DC at 400mA max. Logic noise 50mV max.
(See separate specifications for optional upper PC relay boards)

PHYSICAL-ENVIRONMENTAL

**Operating Temperature Range** . . . . . 0° to +50°C

**Storage Temperature Range** . . . . . −25°C to +85°C

**Connectors** . . . . . Controls, data, DC power, and relays (lower and upper PC boards): Connected by a dual 36-pin PC edgeboard connector for each board, 0.1" centers, solder tab terminals, Datel Connector #2597-14 (Viking 3VH36/1JN-5), included with unit.
AC Power is connected by a triple ¼" tab assembly, recessed male, center tab grounded to case. A U.S. 3-prong line cord (P/N 9115) is included with AC models.

**Mechanical Dimensions**

**Case** . . . . . 5.56"W × 2.11"H × 5.78"D
(141,2 × 53,6 × 146,8 mm)

**Bezel** . . . . . 5.86"W × 2.25"H × 0.50" THK
(148,7 × 57,0 × 12,7 mm)
Bezel, filter and PC boards are removable from front while unit remains installed in a panel.

**Mounting** . . . . . Panel-mounting through a cutout measuring 2.16"H × 5.59"W (54,8 × 142,1 mm) and secured by 2 U-straps.

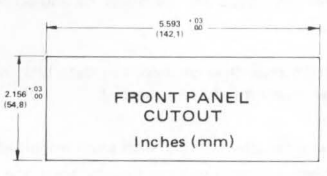
**Weight** . . . . . 2.25 pounds (1,0 Kg)

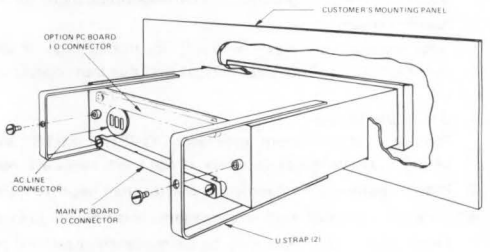
## INPUT/OUTPUT CONNECTIONS

LOWER PC BOARD (COMPARATORS, THUMBWHEELS, LATCHES, GATES AND LIGHTS)

| A BOTTOM | LEFT | B TOP |
|---|---|---|
| +5V POWER IN | 1 | +5V POWER IN |
| PWR. & DIG. GND. | 2 | PWR. & DIG. GND. |
| CH. B $\overline{B>U}$ OUTPUT | 3 | AUX. PULL UP |
| CH. B $\overline{B=U}$ OUTPUT | 4 | CH. A $\overline{A<L}$ OUTPUT |
| CH. A HOLD/$\overline{\text{FOLLOW}}$ IN | 5 | CH. A $\overline{A=L}$ OUTPUT |
| CH. A OUTPUT $\overline{\text{GATE}}$ IN | 6 | CH. B HOLD/$\overline{\text{FOLLOW}}$ IN |
| CH. B $\overline{B<U}$ OUTPUT | 7 | CH. A $\overline{A>L}$ OUTPUT |
| CH. B OUTPUT $\overline{\text{GATE}}$ IN | 8 | $\overline{(B>U) \cdot (A<L)}$ OUTPUT |
| SPARE INVERTER 1 OUT | 9 | SPARE INVERTER 2 IN |
| SPARE INVERTER 2 OUT | 10 | SPARE INVERTER 1 IN |
| CH. A IN 1 | 11 | CH. B IN 1 |
| CH. A IN 2 | 12 | CH. B IN 2 |
| CH. A IN 4 | 13 | CH. B IN 4 |
| CH. A IN 8 | 14 | CH. B IN 8 |
| CH. A IN 10 | 15 | CH. B IN 10 |
| CH. A IN 20 | 16 | CH. B IN 20 |
| CH. A IN 40 | 17 | CH. B IN 40 |
| CH. A IN 80 | 18 | CH. B IN 80 |
| CH. A IN 100 | 19 | CH. B IN 100 |
| CH. A IN 200 | 20 | CH. B IN 200 |
| CH. A IN 400 | 21 | CH. B IN 400 |
| CH. A IN 800 | 22 | CH. B IN 800 |
| CH. A IN 1K | 23 | CH. B IN 1K |
| CH. A IN 2K | 24 | CH. B IN 2K |
| CH. A IN 4K | 25 | CH. B IN 4K |
| CH. A IN 8K | 26 | CH. B IN 8K |
| CH. A IN 10K | 27 | CH. B IN 10K |
| CH. A IN 20K | 28 | CH. B IN 20K |
| CH. A IN 40K | 29 | CH. B IN 40K |
| CH. A IN 80K | 30 | CH. B IN 80K |
| CH. A IN 100K | 31 | CH. B IN 100K |
| CH. A IN 200K | 32 | CH. B IN 200K |
| CH. A IN 400K | 33 | CH. B IN 400K |
| CH. A IN 800K | 34 | CH. B IN 800K |
| CH. A IN OVERSCALE | 35 | CH. B IN OVERSCALE |
| CH. A IN POLARITY | 36 | CH. A IN POLARITY |
| A BOTTOM | RIGHT | B TOP |

## MOUNTING DETAILS




## LIMIT INDICATIONS

DLC-8400 SINGLE-CHANNEL, 2-LIMIT, 3-ZONE COMPARATOR

| | UNDER | LO LIM | BETWEEN LIMITS | HI LIM | OVER |
|---|---|---|---|---|---|
| FRONT PANEL LIGHTS | ○ RED | ○ YELLOW | ○ GREEN | ○ YELLOW | ○ RED |
| Indication when lamp is lit. | Input is less than both thumbwheel limits. | Input is equal to the LO thumbwheel limit. | Input is greater than the LO thumbwheel limit and is less than the HI thumbwheel limit. | Input is equal to the HI thumbwheel limit. | Input is greater than both thumbwheel limits. |

ONLY ONE LAMP CAN BE LIT
IF RIGHT THUMBWHEEL LIMIT IS GREATER THAN THE LEFT THUMBWHEEL LIMIT

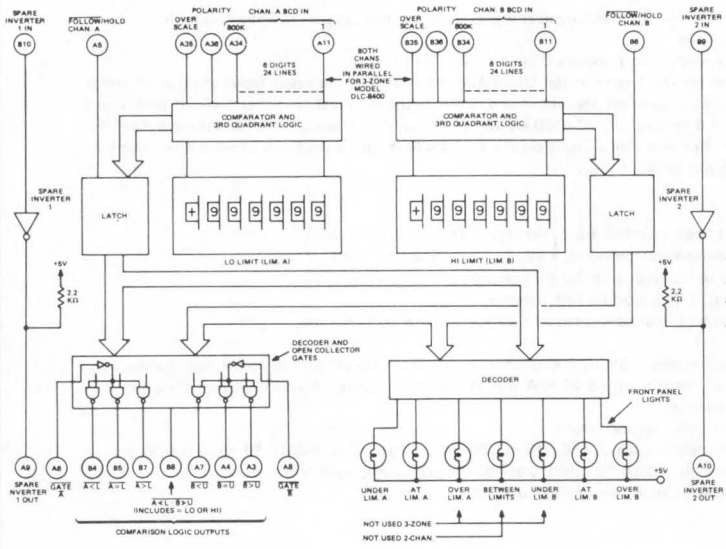
DDC-8400 TWO CHANNEL, TWO LIMIT COMPARATOR

| | LIMIT A CHANNEL A | | | LIMIT B CHANNEL B | | |
|---|---|---|---|---|---|---|
| | UNDER | LIMIT | OVER | UNDER | LIMIT | OVER |
| FRONT PANEL LIGHTS | ○ RED | ○ GREEN | ○ RED | ○ RED | ○ GREEN | ○ RED |
| Indication when lamps are lit. | Chan. A Input is less than thumbwheel Limit A. | Chan. A Input is equal to Thumbwheel Limit A. | Chan. A Input is greater than Thumbwheel Limit A. | Chan. B Input is less than Thumbwheel Limit B. | Chan. B Input is equal to Thumbwheel Limit B. | Chan. B Input is greater than Thumbwheel Limit B. |

ONLY ONE LAMP CAN BE LIT. ONLY ONE LAMP CAN BE LIT.

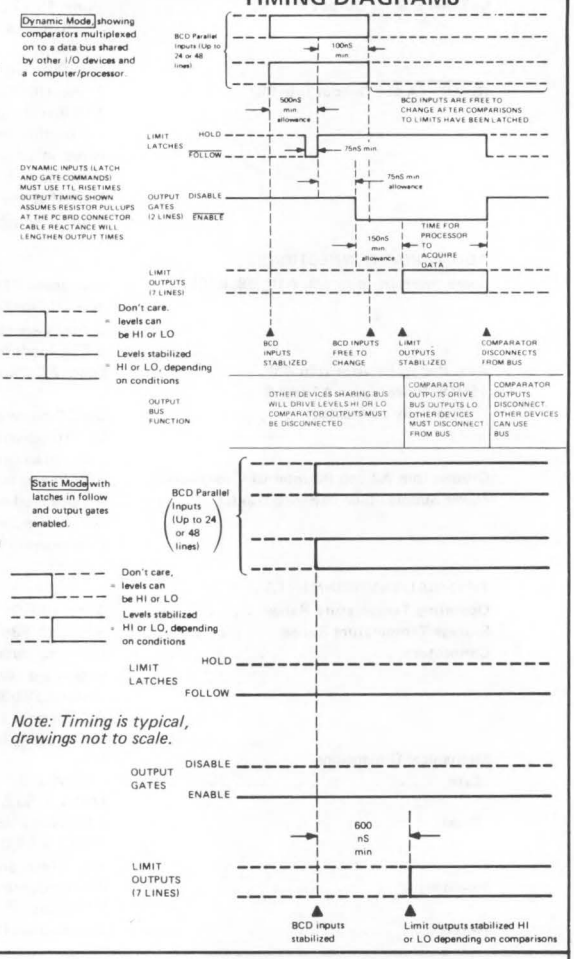
## BLOCK DIAGRAM

### MODELS DDC-8400 and DLC-8400




The 8400 series Comparators include built-in latches and gates for the limit outputs. The latches and gates can be hard-wired so they continuously transmit all outputs as shown in the static mode drawing. Or the latches and gates can be externally controlled in the dynamic mode by an A/D converter, DPM, computer, microprocessor or logic circuits to transmit outputs on command on a common data bus shared by other devices. In the static mode, valid outputs can be expected within 600 nanoseconds after the BCD inputs stablize. In the dynamic mode, valid limit outputs are available within 725 nS, if the timing shown in the chart is observed. Any delay in the latch or gate commands will produce a corresponding limit output delay. Also, commands must use the sequence and timing shown to avoid multiplexing invalid data onto the bus.

### TIMING DIAGRAMS




*Note: Timing is typical, drawings not to scale.*

## RULES

1. **Dual Limit Models**
   Left switch is for setting lower limit.
2. **Input Bits Not Used**
   Should be wired to ground, and corresponding digits on setpoint switches set to zero.
3. **Polarity Inputs**
   Negative sign enters as low level, positive as high. If unused, tie to +5V (pins A1, B1) through 1000 ohms resistor and leave setpoint polarity switches on (+). This gives normal first quadrant operation. For third quadrant operation, tie unused polarity sign to ground and leave setpoints on (–).
4. **Over Scale Inputs**
   Positive overscale input generates "OVER LIMITS" indication regardless of incoming data bits; negative overscale input generates "UNDER LIMITS" regardless of data bits. If not used, overscale input terminals should be grounded.
5. Positive numbers are handled as greater than negative numbers.
6. A negative number with large magnitude is smaller (lower) than a negative number with small magnitude.
7. Latch update terminals may be permanently grounded (enabled) so lamps will continually track the comparator decisions. Output logic lines are still under control of output gate terminals, for strobing.
8. For latched input sampling operation, actuate latch update terminals at desired time for usual TTL clock duration. Lamp and logic outputs will hold until next update clock. Output logic is still subject to output gate control (low level permissive).
9. When input is from a digital clock, two data bit inputs have to be grounded (i.e. the "8" bit line in the tens of seconds digit and tens of minutes digit). These lines are not controlled by digital clock outputs.

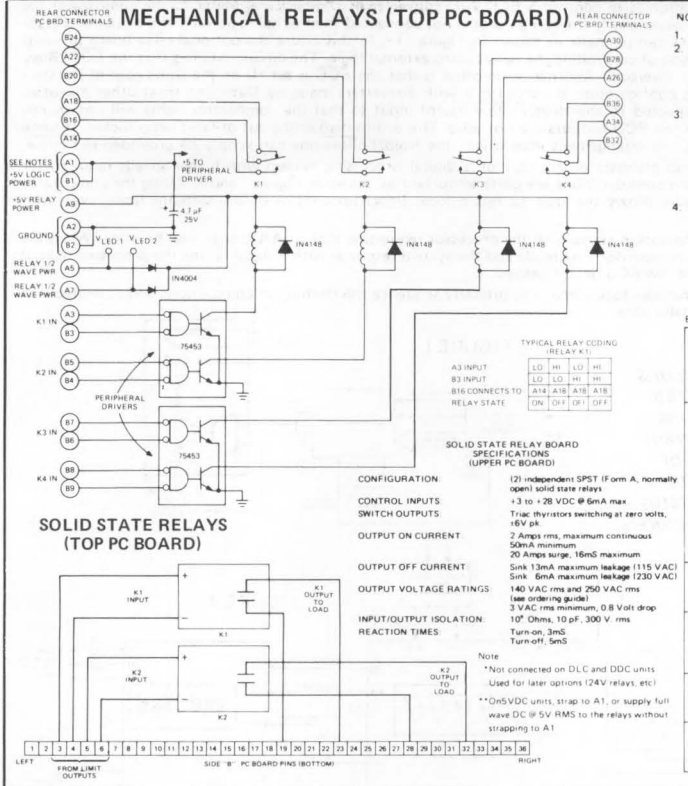
## OPTIONAL RELAY BOARDS

The 8400 series comparators have a spare PC card slot available in the upper portion of the instrument for optional relay boards to control external devices using various limit outputs from the lower board. Because limit outputs from the lower board are externally wired to the upper (relay) board, a wide variety of control functions can be made. External devices such as pumps, motors, valves, solenoids, lamps, horns, etc. may be turned on or off either above, below, between, or outside of limits. Control and alarm limit functions may also be cascaded using the relay as logic gates. Thus, a pump could be turned on only if a valve was open and a tank level was below setpoint. Cascaded interlocking alarms can be created whereby a local lamp alarm is activated first then a loud horn if the alarm condition isn't corrected after a time delay.

The relay boards directly control DC or AC line-powered devices and provide high isolation to external circuits. Larger electrical equipment may be controlled by using the 8400 relays in pilot service to secondary external relays.

Two types of relay boards are offered:
The first type includes (4) electromechanical relays with Form C SPDT contacts. The second type of relay board contains (2) solid-state relays. These solid-state relays are triac thyristor output devices simulating SPST normally-open relays. The solid-state relays use photocoupled optoisolation for very high resistance between input and output. Zero-voltage switching minimizes RFI and switches heavy loads (20 Amp surge for one line cycle). There are no contacts to pit, weld together, or burn out after many switching operations because all-semiconductor construction is used. The solid-state relays are ideal for lamp load surges and inductive loads (motors, solenoids, actuators, etc.)

# OPTIONAL RELAY BOARDS (Cont'd)




Note
*Not connected on DLC and DDC units Used for later options (24V relays, etc)
**On5VDC units, strap to A1, or supply full wave DC @ 5V RMS to the relays without strapping to A1

NOTES FOR MECHANICAL RELAYS

1. RELAYS ARE SHOWN IN DE-ENERGIZED STATE.
2. PERIPHERAL DRIVERS ARE SHOWN WITH NEGATIVE "AND" CODING, NEGATIVE "OR" CODING OR POSITIVE "AND" CODING ARE AVAILABLE ON SPECIAL ORDER.
   -8400-4 = NAND
   -8400-5 = NOR
   -8400-6 = AND
3. POWER INPUTS
   A1/B1 – +5VDC LOGIC POWER FOR PERIPHERAL DRIVERS. 250 mA MAX.
   A9– +5VDC FOR RELAYS. A9 IS INTERNALLY CONNECTED ON AC MODELS. DO NOT USE ON DC MODELS, +5VDC REGULATED OR FULL WAVE DC, 5VRMS SHOULD BE CONNECTED TO A9. 80mA MAX. PER ENERGIZED RELAY. A5 & A7 SHOULD NOT BE USED ON DDC-8400 OR DLC-8400 MODELS. THESE PINS CARRY 1/2 WAVE DC INTERNALLY CONNECTED FROM $V_{LED}$ OUTPUTS ON POWER SUPPLY OF AC MODELS.
4. CONTACT RATINGS
   30VDC 2 AMPS RESISTIVE — 115VAC 2 AMPS RESISTIVE
   250VDC 0.2 AMPS RESISTIVE — 230VAC 2 AMPS RESISTIVE

DUAL SOLID STATE RELAYS (OPTIONAL UPPER PC BOARD)

| A BOTTOM | LEFT | | B TOP |
|---|---|---|---|
| | 1 | | |
| | 2 | | |
| | 3 | | K1 CONTROL + |
| | 4 | | K1 CONTROL - |
| | 5 | | K2 CONTROL + |
| | 6 | | K2 CONTROL - |
| | 7 | | |
| | 8 | | |
| | 9 | | |
| | 10 | | |
| | 11 | | |
| | 12 | | |
| | 13 | | |
| | 14 | | |
| | 15 | | |
| | 16 | | |
| | 17 | | |
| | 18 | | |
| | 19 | | K1 N.O. OUTPUT |
| | 20 | | |
| | 21 | | |
| | 22 | | |
| | 23 | | K1 N.O. OUTPUT |
| | 24 | | |
| | 25 | | |
| | 26 | | |
| | 27 | | |
| | 28 | | K2 N.O. OUTPUT |
| | 29 | | |
| | 30 | | |
| | 31 | | |
| | 32 | | K2 N.O. OUTPUT |
| | 33 | | |
| | 34 | | |
| | 35 | | |
| | 36 | | |

RIGHT

OPTIONAL QUAD RELAY BOARD (UPPER PC BOARD)
MODELS DDC - 8400 A 4
DLC D E J

| A BOTTOM | LEFT | B TOP |
|---|---|---|
| +5V to Logic (250mA) | 1 | +5V to Logic |
| Logic Ground | 2 | Logic Ground |
| K1 Logic Input A | 3 | K1 Logic Input B |
| | 4 | K2 Logic Input A |
| Relay Half Wave 1 Input* | 5 | K2 Logic Input B |
| | 6 | K3 Logic Input A |
| Relay Half Wave 2 Input* | 7 | K3 Logic Input B |
| | 8 | K4 Logic Input A |
| Relay 5VDC Input** | 9 | K4 Logic Input B |
| | 10 | |
| | 11 | |
| | 12 | |
| | 13 | |
| K1 N.O. Contact | 14 | |
| | 15 | |
| | 16 | K1 Contact Arm |
| | 17 | |
| K1 N.C. Contact | 18 | |
| | 19 | |
| | 20 | K2 N.O. Contact |
| | 21 | |
| K2 Contact Arm | 22 | |
| | 23 | |
| | 24 | K2 N.C. Contact |
| | 25 | |
| K3 N.O. Contact | 26 | |
| | 27 | |
| | 28 | K3 Contact Arm |
| | 29 | |
| K3 N.C. Contact | 30 | |
| | 31 | |
| | 32 | K4 N.O. Contact |
| | 33 | |
| K4 Contact Arm | 34 | |
| | 35 | |
| | 36 | K4 N.C. Contact |

RIGHT

## APPLICATIONS

Because of the variety of relay configurations and output logic on the 8400 series comparators, a very broad range of applications can be implemented. Figures A through G shown here describe connections between the lower PC board limit outputs and the upper PC board relays. Figures A through D discuss the mechanical relays and E, F and G are concerned with the solid state relays.

The negative true, open collector limit outputs can be wire-OR'ed externally (shown in several applications). The input NAND configuration of the mechanical relays allows external gating of individual relays. The applications are by no means limited to those shown here.

The output gate and latch controls, A5, B6, A6, and A8 are shown grounded LOW. If the gate lines are externally disabled, the relays will simultaneously be de-energized.

Figure H shows a 5-zone sorting system using two comparators in cascade. A bipolar BCD input is bussed to both comparators and five output lines indicate which zone the input falls into. The configuration could be used to sort items by weight, size, electrical, mechanical or any measurable physical property. The logic outputs would be connected to relays and solenoids which would route the sorted items into bins or slots. The selection limits are dialed in on the comparator front panel thumbwheels, allowing a variation for different items. At least one and only one of the five limit output lines is valid at any one time so that there is no ambiguity or dead zones. Additional comparators can be cascaded to add two more zones per added comparator.

## RECOMMENDED CONNECTIONS

FIGURE A

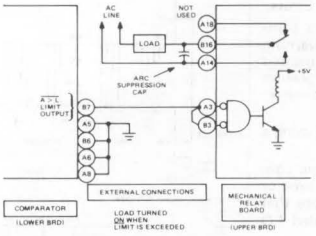



FIGURE B

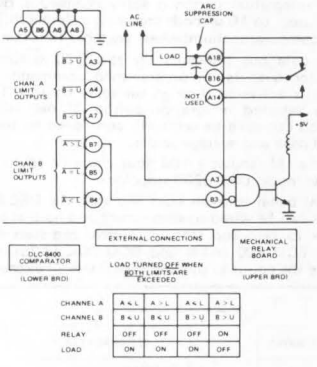



FIGURE C

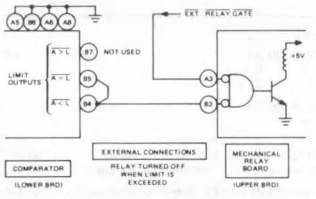



FIGURE D

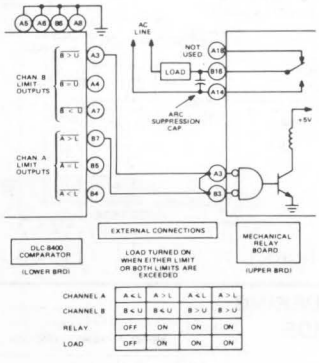



FIGURE E

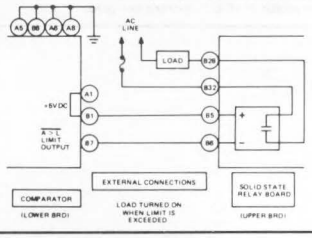



FIGURE F

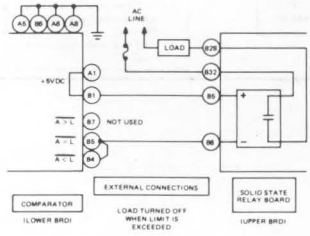
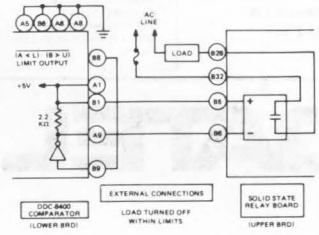



FIGURE G



## APPLICATIONS (Cont'd)

### 5-ZONE CASCADED SORTING COMPARATOR

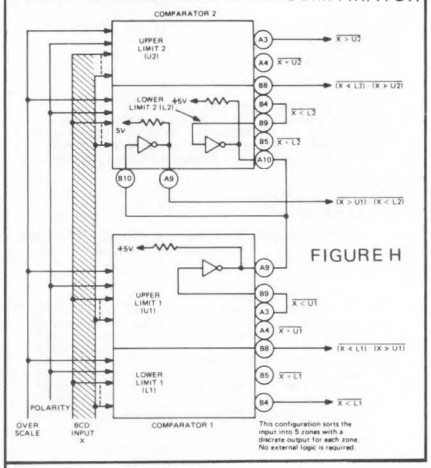



FIGURE H

A very common application is to connect a BCD A/D converter or Digital Panel Meter to the comparator for high resolution limit observation. If the comparator is not connected to external logic such as a digital processor or computer, connections can be made as shown in Figure I. In this figure the optional relay board (if used) shows an alternate method of controlling the relays using external logic. The circuit assumes that the $\overline{EOC}$ (Busy or Status) is HI during conversion. Another assumption is that the $\overline{EOC}$ is set HI on the rising edge of the start convert command. This configuration is compatible with converters made by Datel and most other manufacturers. The $\overline{EOC}$ is connected to the Hold/$\overline{Follow}$ (latch) input so that the comparator lights will not change during conversion when the BCD outputs are not valid. This avoids distracting out-of-limit lamp flicker. If some special condition makes this arrangement impractical, the Hold/$\overline{Follow}$ line can simply be grounded in $\overline{Follow}$.

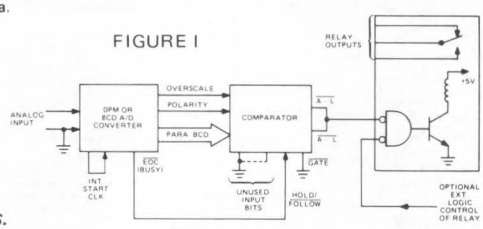
If the A/D converter and comparator are part of a digital processing system with higher speeds required for automatic control, timing considerations are quite important as shown in Figure J and K. Using the comparator on-site at the application allows the user to retain local finger-tip control of the setpoint limit, even with multiple stations.

A typical sequence of operation starts with the processor requesting that an A/D conversion be made. When the conversion is complete, comparisons are made and the system responds with a signal telling the processor to read the limit outputs and the raw BCD data if desired.

This particular system includes logic circuits to properly sequence the latching of comparisons and to protect the processor from reading false data.

*The suggested circuits shown here illustrate typical applications. Datel cannot warrant the performance of these circuits or their possible patent status by other manufacturers.*

FIGURE I



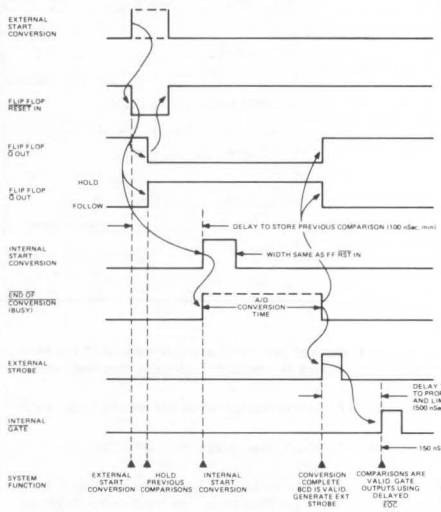




FIGURE K

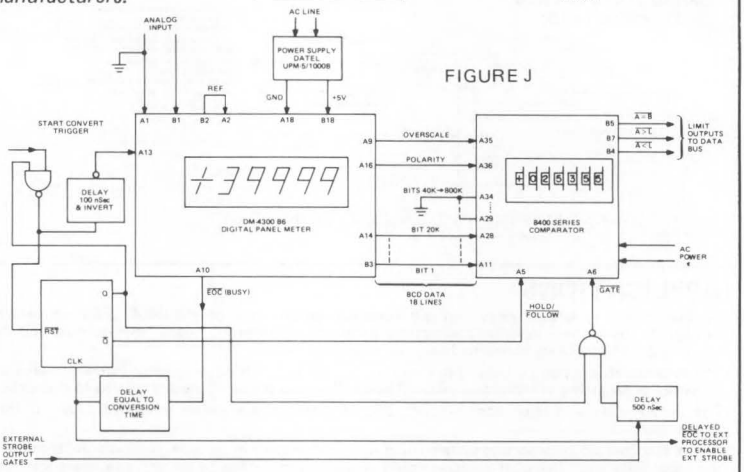



FIGURE J

### DIGITAL INTEGRATOR LEVEL ALARM

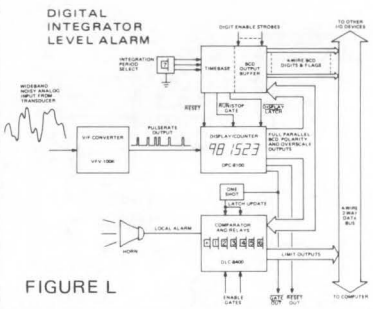



FIGURE L

The circuit shown in Figure L shows a comparator system with output on a 4-wire data bus. The system integrates a varying analog input and compares the average to preset limits. The integration period is easily changed in decade steps from 100 μsec. to 10 seconds requiring a simple shift right or left on the comparator thumbwheel switches to retain the same limits.

The data bus transmits the raw BCD outputs and the comparator outputs on programmed command. A local warning horn is activated through the relay board if limits are tripped in a selected integration period. If desired, the integration period can even be remotely controlled by the processor to record peak and average values.

Figure M shows a 100 hour capacity count-up timer using a Datel model DSC-8200 stopclock.

Front panel controls start and stop the DSC-8200. Logic controls can be wired to stop timing and hold at the preset time or clear to zero and stop or to clear and start timing. Note that bits BCD 800 (A18) and BCD 80K (A26) are grounded LO since the count in those decades doesn't exceed 5.

### 100-HOUR PRECISION TIMER WITH 1 SECOND RESOLUTION

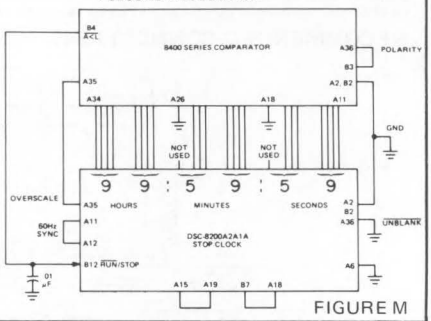



FIGURE M

## ORDERING GUIDE

ALL MODELS ARE AVAILBLE UNDER GSA CONTRACT NO. GS-00S-27959

| MODEL AND LIMIT FUNCTION | POWER SUPPLY | OPTIONAL RELAYS |
|---|---|---|
| DDC-8400 = 2 INDEPENDENT, SINGLE-CHANNEL, SINGLE LIMIT COMPARATORS<br>DLC-8400 = A SINGLE-CHANNEL, 2-LIMIT, 3-ZONE COMPARATOR WITH ASSIGNED HI AND LO LIMITS | A* = 115VAC<br>D = +5VDC<br>E* = 230VAC<br>J* = 100VAC<br>*47 to 440 Hz | 1 = None<br>2 = (2) 2 Amp isolated solid state zero-switching relays for 100 or 115 VAC.<br>3 = (2) 2 Amp isolated solid state zero-switching relays for 230 VAC.<br>4 = (4) 2 Amp mechanical contact relays. |

Prices (1-9)

| | | |
|---|---|---|
| DDC-8400 A1 or E<br>DLC- J | $399. | AC pwr, no relay output |
| DDC-8400 D1 or<br>DLC- | $335. | +5V pwr, no relay output |
| Add for type 2 or 3 Solid State Relays<br>Add for type 4 Mechanical Relays | $120.<br>$ 75. | Choose only one type. |

Prices include rear PC board connectors, AC models include a Datel model 9115 U.S. 3-prong line cord.

DATEL

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# 0.005% MINIATURE DIGITAL VOLTAGE CALIBRATOR

# MODEL DVC-8500

## FEATURES

- ±19.999 Volts Isolated
- Bipolar Output @ 25mA
- 1mV Settability With ±1.5mV Continuous Vernier, 100μV Graduations
- Accuracy ±1mV of Setting With Low ±20μV/°C Drift
- Miniature Aluminum Case Includes Bench-Top Stand or Can Be Panel-Mounted
- Low Cost $295.00 (1-9)


## GENERAL DESCRIPTION

A digital voltage calibrator small enough for bench-top use or panel-mounting is available from Datel Systems and fulfills many laboratory and portable applications. Datel's model DVC-8500 Calibrator offers full 4½ digit resolution (1mV steps) with a +19.999 Volt bipolar output. Up to 25mA output current may be drawn at the +1mV rated accuracy. This short-circuit proof output may be continuously varied within +1.5mV for precise vernier control. The ±20μV/°C drift specification applies over the 0°C to +50°C operating temperature range.

The DVC-8500 uses easy-to-operate digital lever switches to set the output voltage. Front panel banana jacks simplify the connection to calibration circuits while rear panel sense feedback inputs insure output accuracy.

An overload LED lamp is lit when output loading exceeds 25mA. The rear connector accommodates either standard dual 36-pin gold-plated PC board connectors or solder or crimp lugs using 4-40 hardware. The +10V reference is derived from an oven-stabilized zener diode and is brought out at the rear connector for voltage-tracking of external circuits.

The DVC-8500 is powered by a choice of 100, 115, or 230 VAC +10%, 47 to 440 Hz at 5 watts typical. The black-anodized extruded aluminum housing provides excellent shielding to electrical noise and a regulated power supply provides excellent stability and performance.

## SPECIFICATIONS: (Typical between +20°C to +30°C at steady ambient temperature after 5 minute warm-up)

### VOLTAGE OUTPUT

**Output Voltage Range** ..... 0 to +19.999 Volts DC or 0 to -19.999 Volts DC, lever switch selected.

**Output Current Range** ..... 0 to ±25mA (source or sink) to rated voltage output accuracy.

**Output Overload** ..... Greater than ± 25mA (source or sink) will illuminate front panel LED overload lamp. Output is current limited (continuous short-circuit proof) to ±70mA (source or sink) at any voltage up to ±20VDC.

**Output Impedance:** ..... Less than 10 milliohms.

### PERFORMANCE

**Accuracy @ +25°C.** ..... Within ±1mV of setting when calibrated. (equivalent to ±0.005% of Full Scale) Due to all effects except temperature drift.

**Resolution** ..... ±1mV increments and ±1.5mV Vernier with 100=V graduations.

**Temperature Drift** ..... Within ±20μV/°C

**Operating Temperature Range**..... 0°C to +50°C

**Output Noise** ..... 25μV p-p, wideband

**Reference Source** ..... 6.4V oven-stabilized zener diode

### FRONT PANEL

**Output Selector Switches** .. Six lever-operated, detented switches

**Output Vernier.** ..... Rotary potentiometer, range ±1.5mV of selected output. Graduated in 100μV divisions.

### INPUT/OUTPUT CONNECTIONS

**Front Panel.** ..... Voltage output and output common available from two (2) gold plated brass deep banana jacks.

### POWER SUPPLY

**Power Required** ..... Choice of 100, 115, or 230 VAC, ±10% 47 to 440 Hz, 10 watts. 3-prong U.S. captive line cord installed. Ground wire connected to case, but transformer isolated ±300VDC from output common.

### MECHANICAL DIMENSIONS

**Case** ..... 5.56"W x 2.11"H x 5.78"D (141,2 x 53, 6 x 146, 8mm)

**Bezel** ..... 5.86"W x 2.25"H x 0.50"THK (148,7 x 57.0 x 12,7 mm)

**Weight** ..... 2.25 pounds (1,0 Kg)

**MOUNTING** ..... Choice of bench-top mounting or panel mounting through a cutout measuring 2.16"H x 5.59W (54,8 x 142,1 mm) and secured by 2 U-Straps. See ordering guide for optional panel-mount kit.

MODEL NO. DVC-8500 —

| AC POWER SUPPLY |
|---|
| A=115VAC |
| E=230VAC |
| J= 100VAC |
| *±10%, 47 to 440Hz |

## PRICE (1-9)

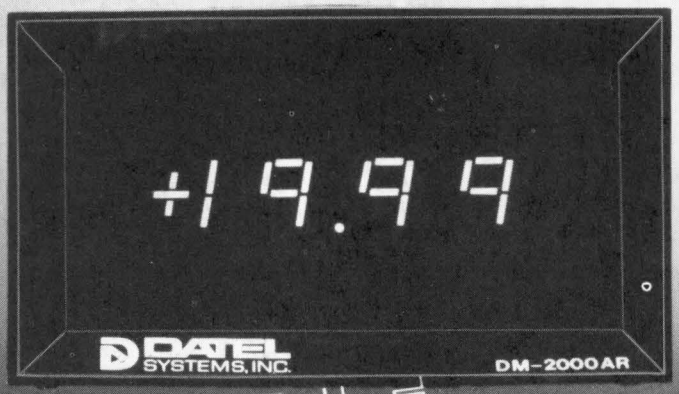
DVC-8500 ..... $295.00

Panel-Mounting Kit ..... $ 10.00

(Consists of (2) U-Straps, rear PC-board connector, and hardware. Rubber feet and tilt-stand bale supplied for bench-top use are screwed to case bottom and must be removed before panel mounting).

# DIGITAL PANEL PRINTER

## Model DPP - 7



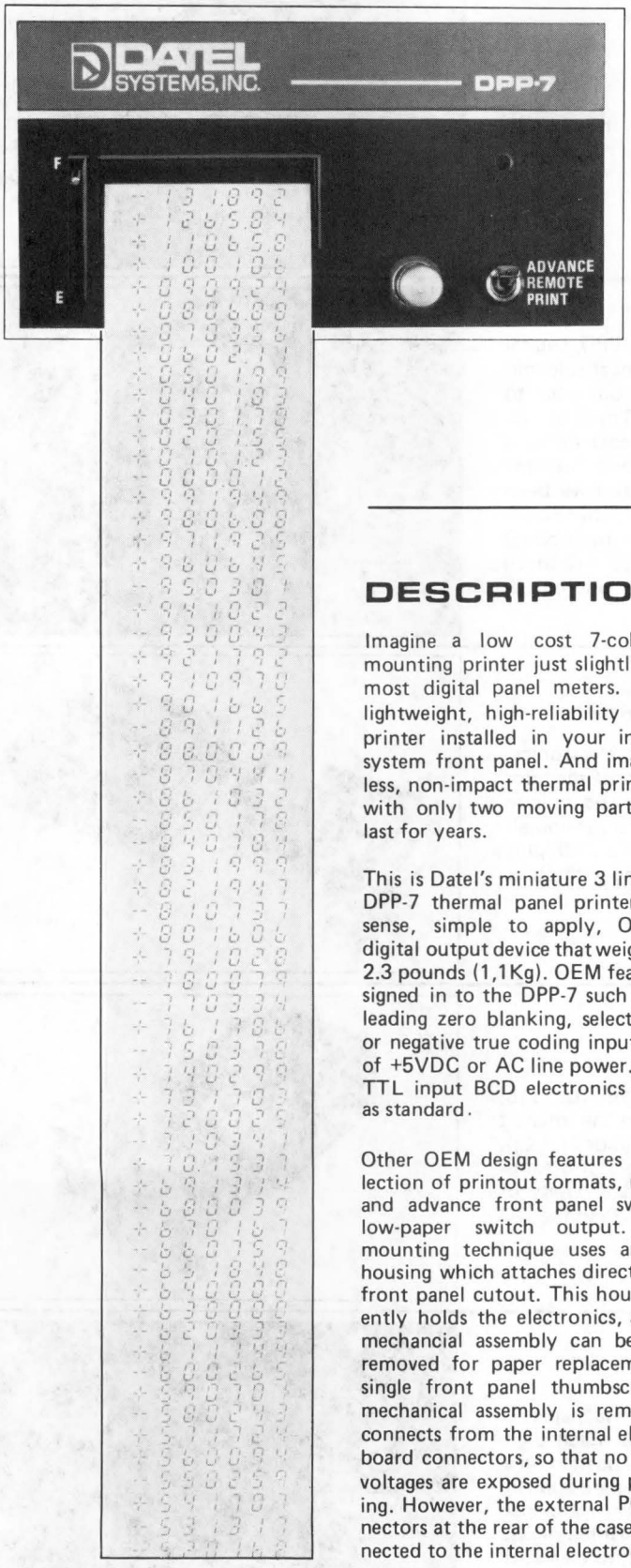

- THERMAL PRINTHEAD USES NO INK OR HAMMERS
- PANEL-MOUNTING FEATHERWEIGHT (2.3LB.)
- 6 DIGITS AND SIGN UP TO 3 LINES PER SECOND
- +5VDC OR AC LINE POWER
- INCLUDES ALL BCD TTL ELECTRONICS PLUS INPUT STORAGE REGISTER

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461


*Connect a miniature DPP - 7 Thermal Printer to your Digital Panel Meter. The DPP - 7 understands a DPM's language!!*

**COVERED BY GSA CONTRACT**

# DPP-7 DIGITAL PANEL PRINTER




## FEATURES

- 3 Lines/Second OEM-Reliable Thermal Printer
- Includes All Electronics for BCD Inputs with Input Storage Register
- 6 Numeric Columns and Sign
- Selectable Leading Zero Blanking
- Positive or Negative True TTL/DTL Inputs
- +5VDC Power (2.3 lbs.) or AC (4.2 lbs.)
- $475.00 Single Quantity
- Last Line Visible Immediately After Printing

## DESCRIPTION

Imagine a low cost 7-column panel-mounting printer just slightly larger than most digital panel meters. Imagine this lightweight, high-reliability digital panel printer installed in your instrument or system front panel. And imagine an ink-less, non-impact thermal printing method with only two moving parts which will last for years.

This is Datel's miniature 3 line per second DPP-7 thermal panel printer. A no-nonsense, simple to apply, OEM-designed digital output device that weighs in at only 2.3 pounds (1,1Kg). OEM features are designed in to the DPP-7 such as selectable leading zero blanking, selectable positive or negative true coding inputs and choice of +5VDC or AC line power. Full parallel TTL input BCD electronics are included as standard.

Other OEM design features include a selection of printout formats, manual print and advance front panel switch, and a low-paper switch output. A unique mounting technique uses an aluminum housing which attaches directly through a front panel cutout. This housing permanently holds the electronics, although the mechancial assembly can be completely removed for paper replacement using a single front panel thumbscrew. As the mechanical assembly is removed, it disconnects from the internal electronics PC board connectors, so that no lethal power voltages are exposed during paper reloading. However, the external PC board connectors at the rear of the case remain connected to the internal electronics.

The housing supports the weight of the mechanical assembly and is mounted on a front panel through a 4.50" x 2.72" cut-out and secured by four screws. Three DPP-7 panel printers can conveniently be mounted across a 19" x 3-1/2" high rack mount panel.

OEM pricing makes the DPP-7 ideal for instrument products. Comparable impact parallel printers with BCD decoding and drive electronics usually list for more than the DPP-7.

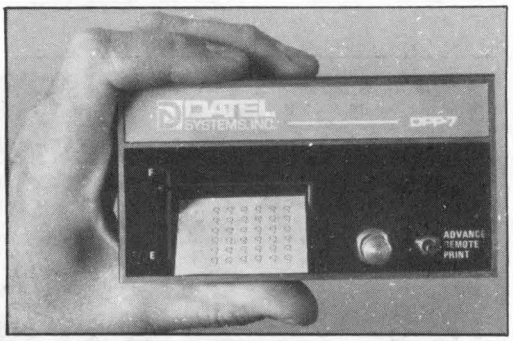
Standard 1-¾" wide thermographic papers are used in handy 150 foot rolls giving about 9,000 lines per roll with 5 lines per inch. The 7-segment digits are .155" high with left-of-digit decimal points selectable at each digit. Seven column printing formats include sign and six digits or 2-channel (ident) digits, sign and 4 data digits. Other 7 column decimal formats are also available.

The DPP-7 Digital Panel Printer extends back 6.2" from the front surface of the mounting panel (8.62" for the AC powered versions), including space allowance for the two 30-conductor PC board connectors or AC fuses.

Three universal AC line voltages (100, 115, and 230 VAC) will power the DPP-7 Printer as well as +5VDC at 20 watts average (8 Amps peak).

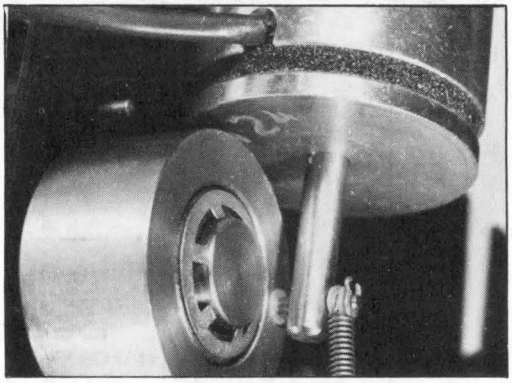
The DPP-7 is ruggedly built, using a simple, but sophisticated mechanical design which is optimized for heavy duty OEM applications. A proprietary printhead character coating allows the head to be conservatively rated at 3 million lines.

# HIGHLIGHTS



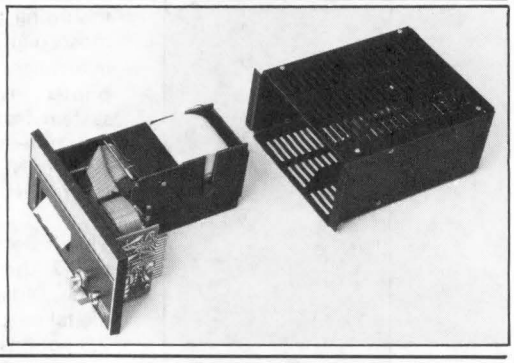

### 2.3 Lb. Panel-Mounting Featherweight

**At 2.3 pounds (1,1Kg) the DPP-7 DC version is one of the lightest panel-mounted recording instruments available. It is directly compatible with the size, shape and interfacing of Digital Panel Meters.**



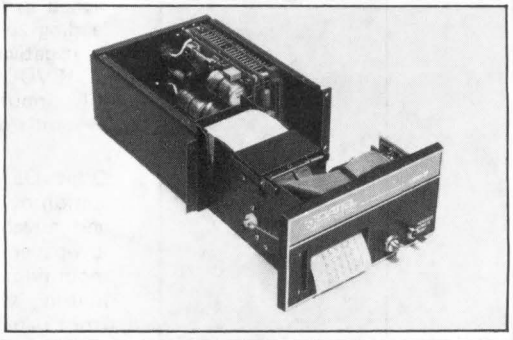
### OEM Reliable – only Two Moving Parts

Instead of the usual assembly of ratchets and gears, the DPP-7 Digital Panel Printer needs only two long-life moving parts – a linear solenoid and rotary clutch. Two 1/8" excursions of this solenoid connected to the one-direction rotary clutch cause one line advance. There are no banging hammers or twirling printwheels to fail and to cost extra in assembly. All electronics use low power Schottky TTL logic, assuring minimal heat rise and long, service-free life. Components have been generously derated and were selected particularly for their OEM reliability. A full one-year warranty provides further assurance of product excellence. An absolute minimum of maintenance is needed. Printhead cleaning required in other thermal printers can safely be ignored because of the wiping action of the paper.



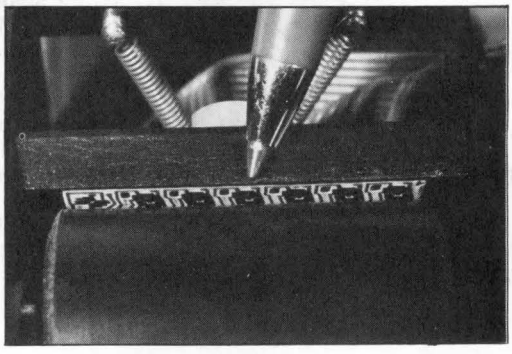
### Complete with Binary Coded Decimal Inputs and Storage Register

Datel's Miniature DPP–7 Printer is complete with BCD electronics. Many competitive printers don't include full parallel BCD or if they do, it is an expensive additional chasses with bulky cabling and unique power requirements. Datel's little DPP-7 printer is ready to use and all BCD I/O logic (with selectable positive or negative true TTL coding) is built in. A strobed input storage register allows multiplexing with other I/O devices sharing the same data bus lines.



### +5VDC or AC Line Powered

Take your pick of power voltages. Use either +5 Volts DC or 100, 115, or 230 Volts AC, 47 to 440 Hz. The +5VDC printer offers the smallest package, only 6.2 inches (158 mm) deep and only 2.3 pounds (1,1Kg). The +5V version requires a regulated power supply capable of 8 Amps peak during print cycles while the AC version can accept a variety of universal worldwide power voltages and is slightly longer than the DC version.



### Thermal Printhead

Printing couldn't be simpler. Heat-sensitive thermographic paper is positioned under six decimal digits in 7-segment format. Each digit consists of conductive thickfilm resistor matrix segments deposited on a ceramic substrate. Segment-parallel, digit-serial power pulses are applied to each digit for 25 milliseconds. $I^2R$ heating then darkens the paper in contact with the heated segments, leaving crisp, black printed digits. A proprietary, thermally conductive surface on the thickfilm elements has high wear resistance allowing a conservative 3 million line printhead life. Characters are formed along the bottom edge of the printhead so they may be viewed immediately after printing.

## General

**Number of columns:** 7
7-column formats available:

a) Leading ± sign and 6 decimal digits
b) 2 leading ident or channel digits, ±sign and 4 data digits

**Decimal digit format:**
7-segment 0 to 9 digits .155" (4 mm) high with 10° slant and selectable left decimal point.

**Printing method:**
Thick film thermal print head, black characters on white paper (using 3M Type 161 paper)

**Printer paper:**
1.75" wide x 150 feet long, (44,5 mm x 45 m), 3M-type 161 thermal paper roll with the thermal surface facing away from the center of the roll.

**Paper advance:**
Via linear solenoid and one-direction rotary clutch. Paper tears off cleanly by lifting against the paper slot top edge.

## Performance

Max. printing rate: 3 lines per second
Print and paper advance cycle: 330 milliseconds
Line spacing: 0.2 inch (5 mm)
Line density: 5 lines per inch
Line capacity per paper roll: approx. 9,000 lines
Minimum print head life: 3 million lines
Average print pulse on-time: 25 mSec. (height varied by temperature feedback)

## Inputs

DTL/TTL compatible, selectable positive or negative true, level sensitive. TTLLS low power Schottky logic used on all inputs.

**Logic Levels:**

| | | |
|---|---|---|
| Positive true: | $+2.0V \leqslant$ "1" $\leqslant +5.0V$<br>$0V \leqslant$ "0" $\leqslant +0.5V$ | Note TTLLS logic levels |
| Negative true | $0V \leqslant$ "1" $\leqslant +0.5V$<br>$+2.0V \leqslant$ "0" $\leqslant +5.0V$ | |

Note: Pullup resistors to +5V may be optionally removed on all inputs and outputs.

**Data: (24 lines)**
Full parallel BCD (1-2-4-8), selectable positive or negative true, 1 TTLLS load plus 10 K ohm pullup to +5V. May be used with Form A (normally open) or Form B (normally closed) switch closure inputs. Level sensitive (rise-time non-critical). Data is stored (see timing, pg. 8)

**Change Data Polarity: (Pin C1-B11)**
Selects input polarity of data, decimal points and ± sign simultaneously.
LOW = positive true coding
HIGH = negative true coding
6 TTLLS loads, plus 1 K ohm pullup to +5V, level sensitive

**Print and Advance Command: (Pin C1-B14)**
Level sensitive for Form A or Form B contact closure, selectable positive or negative true.
1 TTLLS load plus 10K ohm pullup to +5V.

Pulse Width: 1 miscrosecond to 200 mSec (data must be valid 1 μsec. after leading edge and 500 nSec. before the print command).
Maximum print command rate: 3 per second.
Paper advance automatically occurs after digit printing. Holding print command TRUE longer than the busy output is true (200 to 330 mSec, typ) causes continuous 3 lines/sec. printing.

**Change Print Polarity: (Pin C1-B7)**
HIGH = negative true coding
LOW = positive true coding
1 TTLLS load, plus 10K ohm pullup to +5V, level sensitive.

**Leading Zero Suppress: (Pin C1-B4)** blanks all leading zero's to the left of decimal point except a zero just left of the decimal point
HIGH = Leading 0's blanked
LOW = full print (no suppression)
2 Low Power TTL loads, plus 10K ohm pullup to +5V, level sensitive.

**Minus Sign: (Pin C1-B1)**
Selectable positive or negative true using data level select input.
1 TTLLS load, plus 10K ohm pullup to +5V, level sensitive.

**Plus Sign: (Pin C1-A5)**
(Selectable positive or negative true using change data polarity input). (Minus sign must also be printed since it is used as the horizontal portion of the plus sign).
1 TTLLS load, plus 10K ohm pullup to +5V, level sensitive.
Note: Printing "plus" sign only results in vertical portion of plus sign. See above. Usable as 100% overrange digit.

**Blanked Character:**
Created by loading 1-1-1-1 in a given column. Can be hard-wired.

**Decimal Points: (6 lines)**
1 TTLLS load, plus 10K ohm pullup to +5V, level sensitive.
(Selectable positive or negative true using change data polarity inputs).

**No-Print Paper Advance: (Pin C1-A3)**
Ground this line 70±5 mSec to advance one line. Hold to ground for continuous advance at 6.7 lines per second.
1 TTLLS load plus 10K ohm pullup to +5V.

**No Print Paper Advance:**
May also be created by loading the illegal BCD character 1-1-1-1 in all decimal locations, and disabling all decimal points and ± signs, then initiating a print/advance command.

**Test: (Pin C2-B6)**
LOW = ± .8 .8 .8 .8 .8 .8 printout when print/advance command is given.
1 TTLLS load, plus 10K ohm pullup to +5V, level sensitive.

**Change Busy Polarity: (Pin C1-A2)**
HIGH = positive true busy out
LOW = negative true busy out
1 TTLLS load, plus 10K ohm pullup to +5V, level sensitive.

## Outputs

**DTL/TTL compatible**

Positive true: 0V ≤ "0" ≤ +0.4V
+2.4V ≤ "1" ≤ +5.0V

Negative true: +2.4V ≤ "0" ≤ +5.0V
0V ≤ "1" ≤ +0.4V

**Busy: (Pin C2-B12)** (Open collector TTL 7438 with 1K ohm pullup to +5V)

Remains TRUE during print and advance cycle (approximately 200 to 330 milliseconds). Data inputs may be changed 500 nSec. after transition to TRUE. Next print command can be enabled when busy goes FALSE. Selectable positive or negative true. 10 TTL loads.

**Out of Paper: (Pin C2-B4) see dwg. pg. 10**

Switch opening via mechanical pawl when approx. 6' (2m) of paper are left on roll. Paper roll visually indicates "low paper" within 10 to 15 feet (3 to 4.5m) of end of roll using red stripe on roll. Switch is in series with PC board contacts which disconnect if printer mechanism is not completely seated in case. Open switch contacts or print mechanism removed will disable both local and remote print command. Pin C2-B4 has an internal 1K ohm pullup to +5V normally grounded by switch before paper is low.

## Front Panel

**LED red power-on lamp**

**Paper Quantity Indicator:**

Mechanical pointer which rides on paper roll, indicating relative amount of paper left.

**Paper Roll Replacement:**

By sliding out front panel printer assembly. PC board interlock automatically disconnects all power to printer assembly and power supply with electronics remain with housing case. Removal by a single Dzus-type front panel thumbscrew.

**Print/Remote/Advance**

Front panel 3 position toggle switch, stable in center position (REMOTE), must be held in top (ADVANCE) or bottom (PRINT) positions.

ADVANCE:
When switch is held up, the printer continuously advances paper without printing at a 6.7 line per second rate. Paper may be manually advanced simply by pulling paper out of front opening at any time.

REMOTE:
Center position enables all external inputs.

PRINT:
When switch is pushed down, printer prints one line and stops. After print and advance, external input is accepted even if the switch is held down.

## Temperature Ranges

**Operating:** 0 to +40°C (to +50°C at derated speed)
**Storage:** -25°C to +85°C (Paper darkens above +60°C)
Active printhead temperature sensor is employed to maintain proper print head temperature at all ambient temperatures and during warmup.

## Power Supply

**+5 Volt Version:**

4 Amps average current (20 watts dissipation) at 3 lines/sec. max. printing rate. (10 Watts, typ in standby)

Segment-parallel, character-serial printing requires +5V @ 8 Amps peak, duty cycle is 10 to 90% during print and advance period.*

Separate PC board connection available to supply "clean" (±2% @ .3 Amp) 5 volts to logic section. Logic spikes must be held to 50mV max. pk-pk.

Unregulated +5V (±10%) connected through 1/4" spade terminal connector, 16 gauge wire or larger not to exceed ten feet (3 meters).

**Fuse:**
7 Amp SLO-BLO, 1/4" x 1-1/4"

*8 Amp current pulses on and off during print and advance cycle from 10 to 90% duty cycle (depends on character printed, leading zeros, etc.). 8 Amp, 5 to 20 msec. pulses occur several times per second in standby.

Power consumption varies with print rate, leading zeroes, digits printed, signs and decimal points.

## Power Supply

**AC Version:**
105-125 VAC, 47-440Hz @ 40 watts max (10 watts, typ standby)

**Optional:**
205-240 VAC, 47-440Hz @ 40 watts max (10 watts, typ standby)

**Optional:**
90-110 VAC, 47-440Hz @ 40 watts max (10 watts, typ standby)

**AC Fuse:** 1/4" x 1-1/4" Buss MDL or equivalent 1/2 A, SLO-BLO, 115VAC, 1/4A, SLO-BLO, 230 VAC.

Note: Case is isolated from 5V ground and AC line. A separate spade terminal is included to ground case.

+5V, 200mA max. logic power out available with AC version.

## Connectors

**Data and Controls:** (and optional logic +5V)
(2)30-conductor (15 per side).
Double-sided PC board connectors.
0.1" centers, Viking #3VH15/1JN-5 or equivalent
, 2 included with printer).

**+5V Power**
(2) 1/4" spade terminal connectors, included.

**AC Power**
(1)Double 1/4" spade terminal connector. Mates to a 9115 AC line cord (included).

## Weight (with housing and full paper roll)

| | | |
|---|---|---|
| 5 Volt Version: | 2.3 lbs. | (1,1Kg) |
| AC Version: | 4.2 lbs. | (1,9Kg) |

## Dimensions (Uses #4 hardware)

Front panel mounting cutout:
4.50" WIDE x 2.72" HIGH (115 mm x 69 mm)

Front panel Bezel dimensions:
5.25" WIDE x 2.82" HIGH (134 mm x 72 mm)

Depth behind front surface of mounting panel including clearance for rear PC connectors and fuses:

5V Version: 6.2" (158 mm)
AC Version: 8.7" (221 mm)

# APPLICATIONS

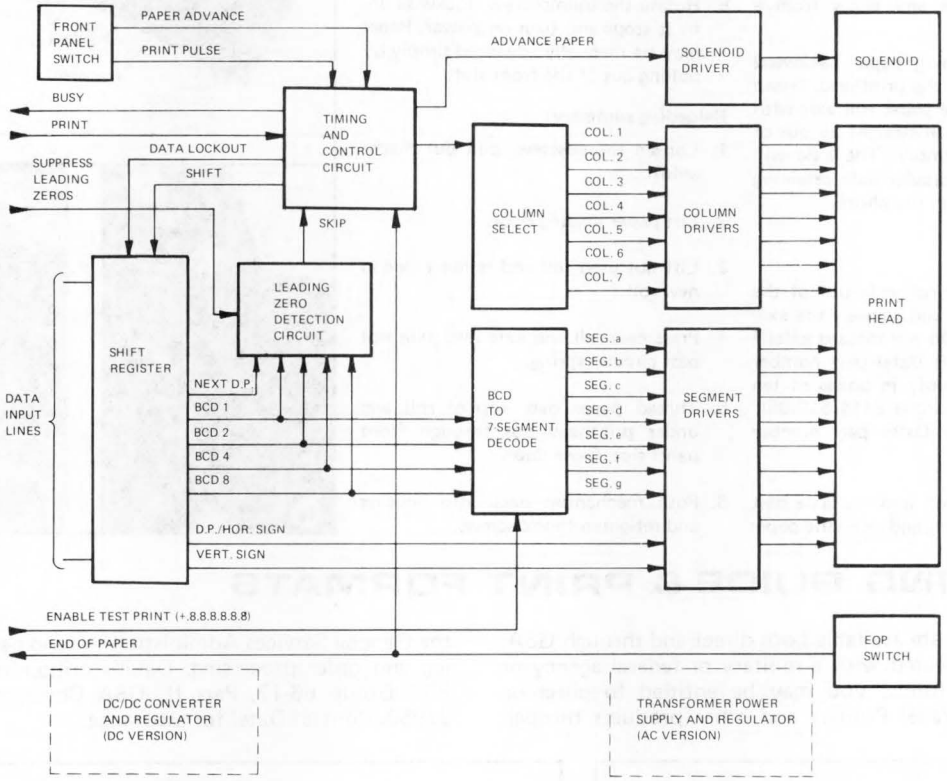
An ideal use for the DPP-7 is to record analog values from a BCD output A/D converter or Digital Panel Meter. A simple external clock circuit or an A/D converter with an adjustable conversion rate can be used to form a printing data logger. With the addition of Datel's digital time-of-day clock and data acquisition module, a complete multi-channel logging system can be made. See page 11.

Most scientific and analytical instruments with digital interfacing capability will have full parallel BCD outputs which can be directly connected to the DPP-7.

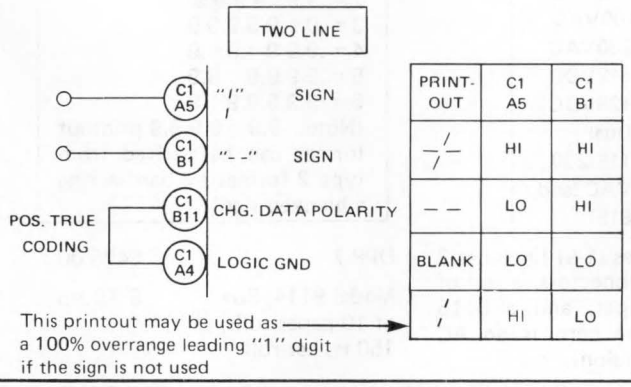
Use the DPP-7 with Datel's autoranging DM-2000AR Digital Panel Meter to create an analog sampling system with 3-½ digit resolution over 3 decades from 200mV to 20V full scale. See page 11.

Using the DPP-7 printer with a DPM will allow faster sampling than taking readings by hand or by visual sampling of the DPM readout. Longer-term variations and drifts are more easily viewed when the printer and DPM work hand-in-hand.

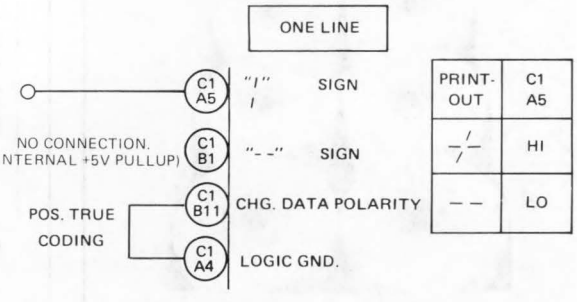
## PRINTER BLOCK DIAGRAM




## ± SIGN WIRING




| PRINT-OUT | C1 A5 | C1 B1 |
|---|---|---|
| -/ / | HI | HI |
| - - | LO | HI |
| BLANK | LO | LO |
| / / | HI | LO |




| PRINT-OUT | C1 A5 |
|---|---|
| -/ / | HI |
| - - | LO |

Use the coding schemes above since the vertical and horizontal portions of the sign are separate inputs.

# PAPER LOADING

DATEL

1. Shut off all power to the printer if the printer uses a separate power switch.

2. Slide out the printer mechanism by first loosening the front panel thumbscrew counterclockwise until it stops. Pull the thumbscrew firmly straight out and the front panel/printer assembly will slide out all the way. Some force may be needed to release the internal PC connection.

3. Raise the paper loading door by pulling forward until it stops. This automatically lifts the thermal printhead from the paper drive roller (see photo). Remove any paper from a previous roll.

4. Pull the remaining paper backward out from under the printhead. Grasp both ends of the paper roll axle with fingertips and pull straight up out of the printer assembly. The axle will slide past the circular axle retaining spring as shown in the photo.

**Inserting new roll**

5. Slide the paper roll axle out of the used paper roll and reinsert the axle in a new roll. Do not discard axle!!! The paper roll is Datel part number 9101 supplied only in boxes of ten rolls. Order box number 9114 ($19.95). Spare axles are Datel part number 9062, $5 each.

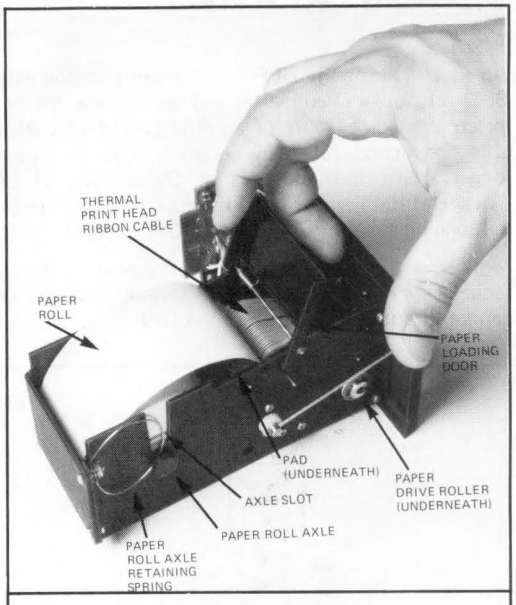
6. Slide the new roll and the axle past the retaining spring and insert the paper over the pad and under the printhead ribbon cable (see photo) until paper appears at front panel slot. Be sure the paper is threaded from the rear and passes over the roll. Paper should be cut straight across for easy insertion. Only the outside paper surface is treated for printing.

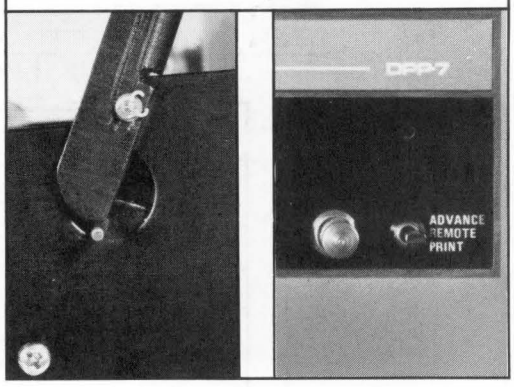
7. Pull paper through front panel slot, close the paper loading door and slide the printer mechanism back into the housing. Press the front panel printer assembly firmly into the housing as far as it will go. This will seat the internal PC board connection.

8. Rotate the thumbscrew clockwise until it stops and turn on power. Paper may be manually advanced simply by pulling out of the front slot.

**Reloading summary:**

1. Loosen thumbscrew, pull out mechanism.
2. Lift paper loading door.
3. Lift out used roll and reinsert axle in new roll.
4. Press new roll and axle into axle slot past circular spring.
5. Thread paper over top of roll and under printhead out through front panel slot. Close door.
6. Push mechanism back into housing and retighten thumbscrew.




## ORDERING GUIDE & PRINT FORMATS

Datel's products are available both direct and through GSA. If you are connected with a military or federal agency or receive federal funds, you may be entitled to purchase Datel's Digital Panel Printers and other products through the General Services Administration to expedite requisitioning and order processing. Datel's printer is covered under FSC Group 66-17, Part II, GSA Contract No. GS-OOS-27959. Contact Datel for assistance.

Model 9114, Box of 10 paper rolls

**MODEL NUMBER**

DPP-7 ┬ ┬

| Power | Print Format |
|---|---|
| D = +5VDC<br>A = 115VAC<br>J = 100VAC<br>E = 230VAC<br>Y = +12VDC<br>Z = +28VDC<br>B = Dual 115/230 VAC (add $15) | 1 = ±.9.9.9.9.9.9<br>2 = .9.9±.9.9.9.9<br>3 = .9.9±.9.9.9.9.9<br>4 = .9.9.9 .9.9.9<br>5 = .9.9.9.9 .9.9<br>6 = .9.9.9.9.9 .9<br>(Note: .9.9 .9.9.9.9 printout format can be derived from type 2 format by hard-wiring a blanked sign) |

Prices (1-9) (includes 2 connectors, a roll of paper, and a 9115 line cord if an AC version).

| | |
|---|---|
| DPP-7 | $475.00 |
| Model 9114, Box of 10 paper rolls, 150 ft. per roll | $ 19.95 |

CONTACT DATEL FOR OPTIONAL HEXADECIMAL PRINTOUT

DATEL
SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# Data Loggers

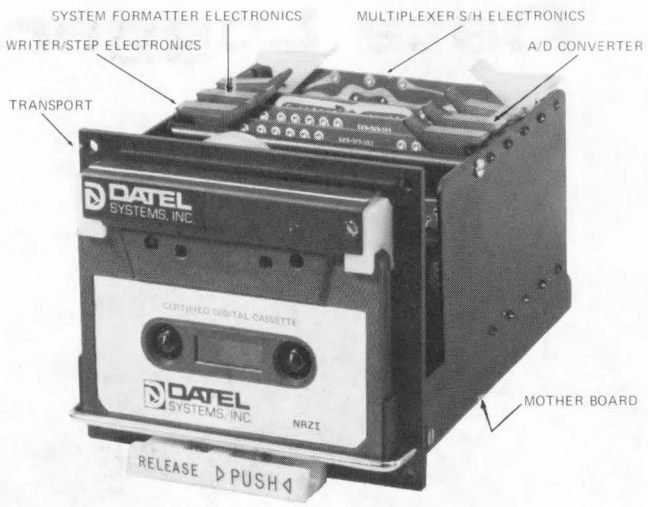
DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# LOW POWER CASSETTE DATA ACQUISITION AND LOGGING SYSTEM

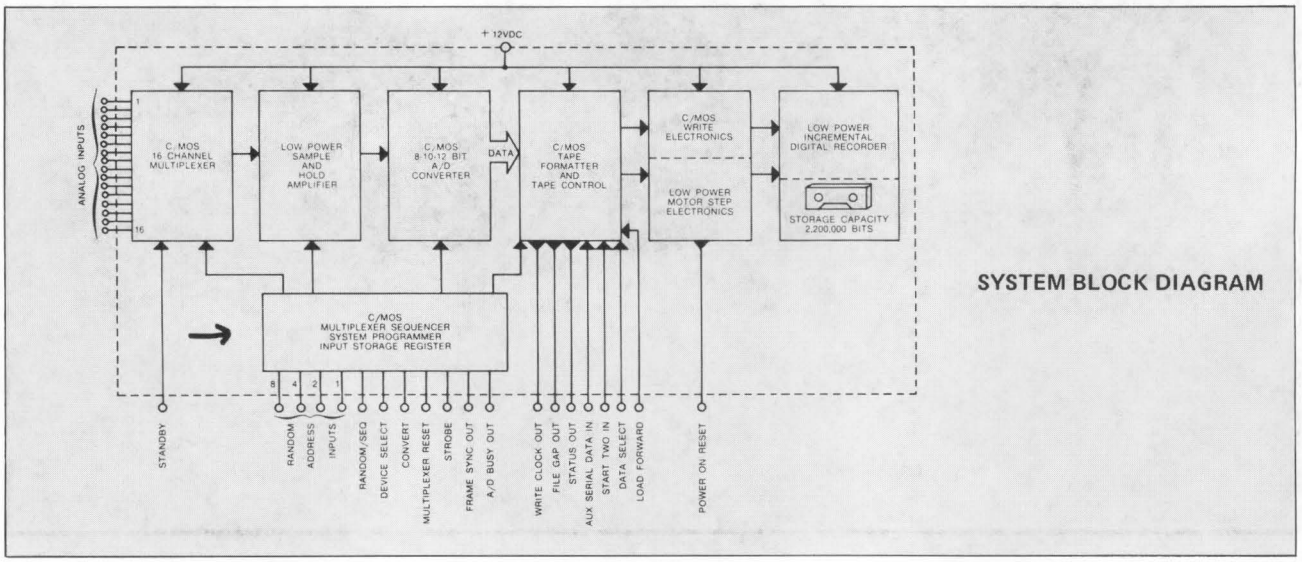
## MODEL LPS-16 DATALOGGER

### FEATURES

- Sixteen Channel Analog Input
- Digital Input for Timing Information
- 12 Bit A/D Resolution
- 12VDC Battery Operated
- 900 Milliwatts Maximum Power Consumption
- C/MOS Logic Throughout
- True Incremental Recording
- Certified Phillips Cassette
- 2.2 Million Bit Capacity
- Total Weight 2 Lbs.
- Cassette Reader for Computer Entry




## SYSTEM I/O CONTROLS PROVIDE TOTAL SYSTEM FLEXIBILITY




SYSTEM BLOCK DIAGRAM

## INTRODUCTION

DATEL

Datel Systems announces a new approach to the Data Logging system, a complete *Data Logging system in a Module*, occupying only 134 cubic inches weighing less than 2 lbs. and operating from a single 12VDC source requiring only 900 milliwatts when recording and microwatts during standby.

Through the use of C/MOS electronics and a unique incremental digital cassette recorder, Datel Systems has significantly reduced the size, power drain and cost over competitive systems.

In incremental recording, the cassette tape moves only when information is presented. This conserves power in portable operation, and no tape is wasted because data is uniformly recorded in precise tape increments. Further, the length of time a cassette can be left unattended can be accurately predicted from the data rate, the number of bits, and the tape length.

Applications include oceanography, pollution monitoring, meteorology, seismology, or other remote data logging requirements. It is also ideal for other scientific and technical data acquisition uses both in the laboratory and in the field.

A cassette reader is available which allows the user to transcribe the digital data on the cassette to computer compatible media. These readers may be interfaced to produce IBM 1/2" tape or to teletype, data terminals, acoustic coupler, or directly into a digital computer.

### GENERAL DESCRIPTION

The LPS-16 Data Logging System is a complete package for recording multi-channel analog data and single channel digital data. It features low power consumption and compactness making it especially suitable for remote data logging applications in unattended areas over long time periods. It will accommodate up to 16 channels of analog input and any number of 16 bit bytes of digital data in serial form. The analog data inputs can be sequentially or randomly multiplexed, converted into digital form, formatted and stored on a standard Phillips cassette. Approximately 120,000 samples of data along with identifying channel number can be stored on one cassette.

A functional Block Diagram of the system is shown below. The inputs required are up to 16 analog voltages, one digital input channel, control logic signals and power. The system can be conveniently divided into two subsystems; analog multiplexing and digitizing is one, and the digital recording is the other.

System LPS-16 utilizes C/MOS type logic throughout, thus negligable stand-by power is consumed. Only during the actual A/D conversion and storage on tape is any appreciable current consumed. Therefore, system LPS-16 may be operated for long periods on battery with low average power.

Cassette tapes prepared in the system may be read with the Datel Systems LPR-16 Reader system which provides a 16 bit parallel output of the data on tape at a rate of about 90 sixteen bit words per second. Each word consists of a 12 bit A/D value plus 4 bit channel address. This LPR-16 reader recognizes and stops on record gaps for convenient computer interface.

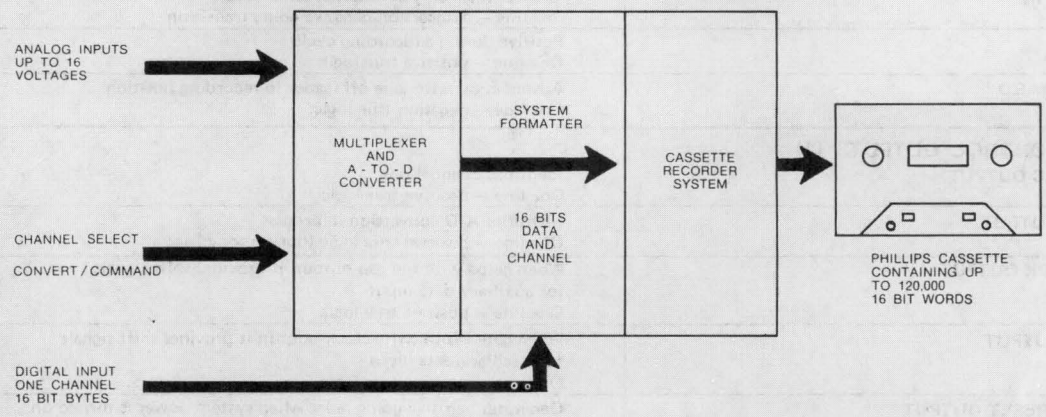



**FIG: 1, DATA-LOGGER SYSTEM FUNCTIONAL BLOCK DIAGRAM SYSTEM–LPS–16**

## LPS-16 SYSTEM SPECIFICATIONS

| DATA ACQUISITION SECTION | |
|---|---|
| **ANALOG INPUTS** | |
| **NUMBER OF ANALOG INPUTS** | 16 |
| **INPUT CHANNEL CONFIGURATION** | Single ended |
| **INPUT VOLTAGE RANGES** | 0V to −5VFS or ±5VFS, 0 to +5VFS |
| **CHANNEL INPUT IMPEDANCE** | 100 MegOhms "ON" or "OFF"<br>NOTE: When the 12VDC system power is turned off each channel has an input impedance of 10K Ohms |
| **CHANNEL INPUT OVERLOAD** | ±10V (max.) |
| **CHANNEL MODE OF OPERATION** | Random or Sequential |
| **CHANNEL INPUT ACQUISITION TIME** | 100 μsec − includes input settling time |
| **SYSTEM PERFORMANCE:** | |
| **SYSTEM APERTURE TIME** | 50 nsec |
| **SYSTEM ACCURACY** | ±0.025% of FS ±1/2LSB |
| **SYSTEM LINEARITY** | ±1/2LSB |
| **A/D RESOLUTION** | 8, 12 Binary Bits |
| **SYSTEM TEMPERATURE COEFFICIENT** | ±0.004%/°C |
| **SYSTEM THROUGHPUT RATE** | 200 msec per 16 bit word<br>(12 bit A/D plus 4 bit channel address) |
| **INPUT CHANNEL SCAN RATE** | Up to 5 per second |
| **A/D DIGITAL OUTPUT CODING** | Straight Binary − Unipolar Input<br>Offset Binary or 2's complement − Bipolar Input |
| **CASSETTE TAPE STORAGE METHOD** | Two channel NRZI: Track #1 − Data, Track #2 − Data (complement) |
| **CASSETTE TAPE FORMAT (2)** | 16 bit words (12 A/D bits plus 4 bits for channel address) |
| **CASSETTE TAPE RECORD GAP** | Two bit gap separates each 16 bit word |
| **CASSETTE TAPE END-OF-FILE GAP (3)** | Twelve bit file gap every 64th word, or per order. See guide. |
| **SYSTEM CONTROL INPUTS (1)** | |
| **RANDOM ADDRESS INPUTS** | Selects analog channel<br>Four lines 8-4-2-1-negative true logic |
| **RANDOM/SEQUENTIAL INPUT** | Selects multiplexer mode<br>One line − logic zero selects random mode |
| **DEVICE SELECT INPUT** | Controls all input command lines<br>One line − negative true logic |
| **CONVERT INPUT** | Initiates A/D conversion<br>One line − negative true logic |
| **MULTIPLEXER RESET** | Resets multiplexer to channel one<br>One line − negative true logic |
| **STROBE INPUT** | Strobes all input lines and internally stores them<br>One line − negative true logic |
| **AUXILIARY SERIAL DATA IN** | Permits cassette recording of EXT. serial data in 16 bit bytes − One line |
| **DATA SELECT INPUT** | Permits recording of either A/D output or EXT. serial digital data<br>One line − Logic one selects A/D output |
| **START TWO IN** | Initiates recording of external serial data<br>One line − Triggers on negative going transition |
| **STATUS** | Positive during a recording cycle<br>One line − positive true logic |
| **LOAD FORWARD** | Advances cassette tape off leader to recording position<br>One line − negation true logic |
| **SYSTEM CONTROL OUTPUTS (1)** | |
| **FRAME SYNC OUTPUT** | Identifies channel one<br>One line − positive true logic |
| **A/D BUSY OUTPUT** | Identifies A/D conversion in process<br>One line − positive true logic (during conv.) |
| **WRITE CLOCK OUTPUT** | When gated with file gap output, it provides shift signals for auxiliary data input<br>One line − positive true logic |
| **FILE GAP OUTPUT** | When gated with write clock output, it provides shift signals for auxiliary data input<br>One line − positive true logic |
| **POWER ON RESET OUTPUT** | Generates negative going pulse when system power is turned on<br>One line − negative true logic |

**NOTES:** (1) All input/output control signals are at standard C/MOS logic levels, Logic zero − 0V to +3V, Logic one − +9V to +12V
(2) Jumper connections can be made on the formatter card allowing selection of either 12 or 16 bit words. For example an 8 bit A/D converter with 16 analog channels would require only a 12 bit word length.
(3) Jumper connections can be made on the formatter card allowing for file gaps every 1, 2, 4, 8, 16, 32, or 64 words.

## LPS-16 SYSTEM SPECIFICATIONS (continued)

| RECORDER CHARACTERISTICS | |
|---|---|
| **STORAGE MEDIA** | Standard Phillips certified data cassette 300 foot length |
| **STORAGE METHOD** | 2 channel NRZI |
| **NUMBER OF TRACKS** | TWO: Data on track one<br>Data complement on track two |
| **TAPE FORMAT** | 16 bit words<br>(12 A/D data bits and 4 channel address bits) |
| **RECORD GAP** | Two step record gap for every 16 bit word |
| **FILE GAP** | Twelve bit file gap every 64th word, or per order. See guide. |
| **TAPE STORAGE CAPACITY** | 120,000 sixteen bit words including gaps and load forward |
| **WRITE SPEED** | 90 steps per second<br>5 sixteen bit words per second (max.) |
| **DATA INPUT/OUTPUT** | Serial NRZI or parallel 16-bit thru the A/D Converter connector |
| **PLAY-BACK SPEED** | See Datel's LPR-16 Reader |
| **MOTOR** | Single 1.5° angle stepper coupled to take-up reel by slip clutch mechanism |
| **MOTOR STEP ANGLE** | 1.5° |
| **ANGULAR ACCURACY** | ±8 min. of arc non-accumulative |
| **TAPE MOTION CONTROL** | Single capstan pinch roller drive<br>Head engages mechanically during write time |
| **TAPE TENSION** | 0.4 oz. inches |
| **ERROR RATE** | 1 bit in $10^7$ |
| **TYPE OF CASSETTE LOADING** | Front |
| **RECORDING HEAD** | Dual channel single gap<br>High quality digital type |
| **OPERATING MODE** | Write only |
| PHYSICAL ENVIRONMENTAL SPECIFICATIONS | |
| **INPUT POWER REQUIREMENTS** | + 12VDC ± 8%<br>80ma when recording (960 mw)<br>10μa during standby (120 μw)<br>NOTE: Includes tape transport plus all electronics |
| **OPERATING TEMPERATURE RANGE** | -10°C to +60°C |
| **STORAGE TEMPERATURE RANGE** | -35°C to +70°C |
| **RELATIVE HUMIDITY** | 10% to 95% w/o condensation |
| **SHOCK & VIBRATION** | 1.0G @ 0-50 cps, all 3 axes |
| **PHYSICAL SIZE W/ELECTRONICS (includes electronics)** | 4" high x 4 1/2" wide x 7 1/2" deep<br>(6 1/2" deep behind panel) |
| **ELECTRONICS** | Contained on four plug-in PC cards mounted on a removeable PC mother board |
| **WEIGHT** | 2 lbs. includes recorder and electronics |
| **I/O MATING CONNECTORS** | Cinch-part #251-22-30-160 – (I/O Command Signals)<br>Elco-part #00-8218-24-722-005-(16 channel analog inputs, located on top rear of mux/S&H card) |

NOTES: 1) The LPS-16 data logger is shipped completely assembled and ready to operate. It is only necessary to connect the analog input signals, control signals, and 12 VDC power source plus inserting a cassette to begin recording.

2) An extremely important factor in the reliability of the LPS-16 data logging system is the cassette itself. Only a properly certified tape cassette should be used. The mechanical tolerances of the cassette cartridge and tape tension are also significant factors in the reliability of operation of the LPS-16 system. The preffered tape cassette is Datel Systems Type 12123-1

### ORDERING INFORMATION

LPS–16–

| NUMBER OF BITS & CODING |
|---|
| 8B = 8 BINARY BITS |
| 10B = 10 BINARY BITS |
| 12B = 12 BINARY BITS |

| FULL SCALE ANALOG INPUT |
|---|
| 1 = 0V to -5V |
| 2 = ± 5V, inverted analog |
| 3 = 0 to + 5V |
| 4 = ± 5V, conventional |

| A/D OUTPUT FORMAT |
|---|
| A = STRAIGHT BINARY, UNIPOLAR INPUT |
| B = OFFSET BINARY, BIPOLAR INPUT |
| C = 2's COMPLEMENT, BIPOLAR INPUT |

| FILE LENGTH |
|---|
| 00 = NONE |
| 01 = 1 WORD |
| 02 = 2 WORDS |
| 04 = 4 WORDS |
| 08 = 8 WORDS |
| 16 = 16 WORDS |
| 32 = 32 WORDS |
| 64 = 64 WORDS |
| EX = EXTERNALLY CONTROLLED FILE LENGTH |

FOR EXAMPLE:

LPS-16- 12B 4 B 32

- 12B: 12 Binary Bits
- 4: ±5V Conventional
- B: Offset Binary
- 32: 32 Words

Connectors are included with each unit.

| MODEL | PRICE (1-9) |
|---|---|
| LPS - 16 - 8B | $1195. |
| LPS - 16 - 10B | $1245. |
| LPS - 16 - 12B | $1295. |

TAPE CASSETTE MODEL 12123-1 $ 9.95

PRERECORDED CASSETTE MODEL TC-1R $35.00

GSA Contracted: Datel's products are available both direct and through the General Services Administration (GSA). If you are connected with a military or federal agency or receive federal funds, you may be entitled to purchase Datel's data loggers and other products through GSA to expedite requisitioning and order processing. Datel's data loggers are covered under FSC Group 66-56, Part II, Section K, Contract GS-00S-29002

DATEL SYSTEMS, INC.
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TEL: (617) 828-8000
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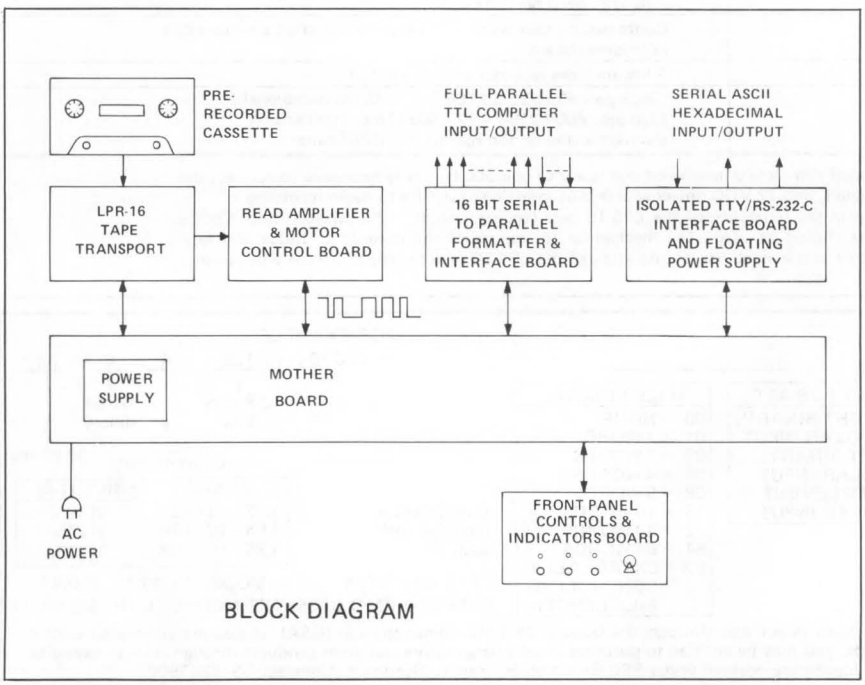
# CASSETTE TAPE READER/INTERFACE FOR MODEL LPS-16 DATALOGGER

## LPR-16 CASSETTE READER

### FEATURES

- Digital Tape Cassette Reader for the 16-channel battery-powered LPS-16 Data Logger
- Full parallel interface to minicomputer or mainframe processor
- Teletypewriter/RS-232-C serial I/O interface
- Selectable I/O loading and logic coding for complete data buss compatibility
- Complete "handshaking" computer controls and flags for "on-line" external control
- Tape-to-Tape Interface for ½" 7/9 track tape transports
- Open collector parallel interface can be multiplexed with other I/O devices sharing common data bus




BLOCK DIAGRAM

### GENERAL DESCRIPTION

The LPS-16 Data Logger tape cassettes, containing up to 16 channels of analog data can be fed directly into a minicomputer or mainframe processor using the LPR-16 Cassette Reader. The LPR-16 will also simultaneously connect directly to a teletypewriter or RS-232C I/O device. The LPR-16 has two side-by-side interface card slots with identical pinout so that two interfaces can be simultaneously connected.

A special feature of the LPR-16 is selectable positive or negative true coding of the TTL outputs and a variety of input/output loading for full compatibility with an external minicomputer data bus.

# DATEL LPR-16 CASSETTE TAPE READER SPECIFICATIONS (Typical @+25°C unless otherwise noted)

**For Full Parallel TTL Computer Interface.**

GENERAL

Function . . . . . Read Only
Media . . . . . Standard Phillips-type certified digital tape cassette
Number of Tracks . . . . . Two
Tape Motion . . . . . One direction, capstan stepper motor drive
Tape Speed . . . . . 2.75 inches per second
Reading Format . . . . . Complementary NRZI
Reading Density . . . . . 615 bits per inch
Bit Rate . . . . . 1700 bits per second
Bit Capacity . . . . . 2.2 million bits per cassette (including all gaps)
Word Length . . . . . 8, 12 or 16 bits
Record, Word or Intercharacter Gap . . . . . 2 bits
File gap . . . . . 16 bits
Words per File . . . . . Any (Standard is 64 words per file)
Power Required . . . . . 100, 115 or 230 VAC, 47 to 63 Hz, 60 Watts max.

LOGIC OUTPUT CHARACTERISTICS (Computer Interface)

Logic Levels . . . . . TTL compatible
"0" = (LO) = 0 to +0.4 Volts
"1" = (HI) = +2.4V to +5.0 Volts
Output Loading . . . . . Optional Open Collector
7406 TTL Hex driver *or* with 1KΩ pullup to +5V
*or* with 330Ω pullup to +5V and 470Ω pulldown to ground
Output Coding . . . . . Selectable positive or negative true coding using Level Control Inputs.

LOGIC OUTPUTS (Computer Interface)

(All outputs are selectable as positive or negative true unless otherwise noted.)

Data Format . . . . . 16 lines: Normally 12 A/D lines and 4 address lines. However a 16 bit digital word can also be used.
Word Sync Output . . . . . 1 line
End of File (EOF) Output . . 1 line, normally flags every 64 words.
Rewind Status Output . . . . 1 line
Busy Status Output . . . . . 1 line
Load Forward Status Output . . . . . 1 line
Cassette-in-Place Status Output . . . . . 1 line
Head Down Status Output . . 1 line
EOT/BOT Status Output . . . 1 line
Shift Clock Output . . . . . 1 line, positive pulse
Tape Clock Output . . . . . 1 line, positive pulse
Serial Data Output . . . . . 1 line, positive true, NRZI coding

LOGIC INPUT CHARACTERISTICS (Computer Interface)

Logic Levels . . . . . TTL Compatible
"0" = (LO) = 0 to +0.8 volts
"1" = (HI) = +2.0V to +5.0 volts
Input Loading . . . . . Optional one TTL load, *or* 1 TTL load with 1KΩ pullup to +5V, *or* 1 TTL load with 330Ω pullup to +5V and 470Ω pull down to ground.

LOGIC INPUTS (Computer Interface)

Start Input . . . . . 1 line, positive true
Start Input . . . . . 1 line, negative true

| OUTPUT LEVEL CONTROL INPUTS 1 | 2 | OUTPUT CODING |
|---|---|---|
| 1 | 1 | POS. TRUE |
| 1 | 0 | NEG. TRUE |
| 0 | 1 | Jammed LO |
| 0 | 0 | ONE'S* |

The output Level Control Inputs control the coding of most outputs as shown in the chart – see the listing of outputs.

*With both Output Level Control Inputs at zero, most outputs whose coding is controlled by these inputs will have cutoff open collectors. In this state, external open collector devices sharing the same data buss lines as the LPR-16 may be multiplexed onto these lines.

CONTROLS AND INDICATORS

Power On/Off (Pushbutton Switch) . . . . . Turns power on and off. Illuminates when power is on.
EOT/BOT (LED indicator) . . Illuminates when on clear leader beginning of tape or at clear end of tape.
Load Forward (Pushbutton Switch) . . . . . Depressed to cause tape to load forward from clear leader to oxide portion of tape. (EOT/BOT lamp will extinguish over oxide).
Rewind (Pushbutton switch) . Depressed to cause tape to rewind to the beginning of tape clear leader.
Busy (LED Indicator) . . . . . Illuminates when the tape is in motion.
Rewind (LED Indicator) . . . Illuminates while tape is rewinding.
Run/Standby (Toggle Switch) When in "RUN", tape will continuously read. When in "STANDBY" tape will read one file each time the START switch is depressed.
Start (Pushbutton Switch) . . When in standby mode, this switch will cause one file to be read each time it is depressed.
Size . . . . . 19"W x 5.25"H x 19"D (16.25" chassis width)
Connector Type . . . . . Dual 25/pin PC Brd type, 0.1" Centers, Viking 3VH25/1JN-5 (1 included with unit)

## ORDERING GUIDE

PRICES (Single Quantity)

LPR-16-1 Full Parallel Interface . . . . . $1695
LPR-16-2 TTY/RS-232-C Interface . . . . . $1995
LPR-16-3 Interfaces 1 and 2 . . . . . $2095
LPR-16-4 Incremental ½" Tape Interface . $1995
LPR-16-5 Interfaces 1 and 4 . . . . . $2095

LPR-16 —

**INTERFACE OPTIONS**
1 = Full Parallel TTL Computer Interface
2 = Teletypewriter/RS-232C serial Interface
3 = Options 1 and 2
4 = Incremental ½" 7/9 Track Tape Interface
5 = Options 1 and 4

**INPUT LOADING**
0 = Parallel Interface not supplied
1 = 1 TTL Load
2 = 1KΩ pullup to +5V
3 = 330Ω pullup to +5V and 470Ω pulldown to gnd.
(Input loading applies to parallel interface only).

**BAUD RATE**
(For Serial Interface Only)
A=75 F=1200
B=110 G=2400
C=150 H=4800
D=300 J=9600
E=600 X = Serial Interface not supplied
(Programmed via PC jumpers)

**SERIAL INTERFACE TYPE**
(For Serial Interface only)
R=RS-232-C
T=Teletypewriter
(This selects an internal jumper which floats the TTY power supply)
B=Both TTY and RS-232-C Interfaces. Power supply will be grounded for both versions.
X=Serial Interface not supplied

**POWER SUPPLY**
A=115 VAC*
E=230 VAC*
J=100 VAC*
*47 to 63 Hz

**OUTPUT LOADING**
0=Parallel Interface not supplied
1=Open collector 7406
2=1KΩ pullup to +5V
3=330Ω pullup to +5V and 470Ω pulldown to gnd.
(Output loading applies to parallel interface only)
+5Volts must be supplied from the external device.

**NUMBER OF A/D WORDS PER FILE**
(For Serial Interface only)
01 = 1 16 = 16
02 = 2 32 = 32
04 = 4 64 = 64
08 = 8 99 = Serial Interface not supplied
(Programmed by PC jumpers)

DATEL

# Data Logger 2: A New Instrument for Field Data Logging


Scientists and industrial researchers have long required a battery-powered, portable multi-channel analog recording system for long term unattended data logging of slowly varying signals. The power and long-term requirements have been particularly difficult to achieve in a portable commercial instrument. Many applications in meteorology, pollution monitoring, oceanography, biomedicine, geophysics and natural resource exploration require an instrument which can literally be left in the field to run on its own batteries, recording slowly changing data unattended for up to a year.

## SYSTEM DESCRIPTION

Datel System's new Data Logger 2 provides the missing link needed for a remote analog recorder with an output system compatible with most computer systems. Using this system, up to 64 analog inputs derived from physical variables can be displayed or printed out on a computer with the date and time of each measurement. Up to 120,000 separate measurements or samples can be recorded using a single digital magnetic tape cassette. By using a suitable computer program, each input can be displayed – identifying the physical quantity being measured – and properly offset and scaled to the correct engineering units. In this way the Data Logger 2 system and computer will print out the day, hours, minutes and seconds, and then the actual measurement (i.e. temperature in degrees F, wind speed in miles per hour, etc.). Connected to a set of sensors, the sealed Data Logger 2 makes an ideal weather station, geophysical monitor, or oceanographic buoy data acquisition and recording system.

The complete Data Logger 2 system consists of three separate instruments: the Data Logger, the Tester, and the Reader/Interface. The Logger is the data acquisition and write-only digital cassette recording system. It runs from its own internal battery and makes scans of up to 64 channels at preselected intervals from 1 second to 30 hours. The Logger is housed in a rugged weatherproof metal case and weighs 20 pounds (9,1 Kg). Analog inputs are connected through sealed I/O connectors on the case. A typical data recording system consists of one Tester, one Reader/Interface, and several Loggers deployed for data collection at different locations. The tester is taken to the field to test and calibrate each Logger during set-up; completed digital cassettes are taken back to the laboratory for playback on the Reader/Interface.

## DATA LOGGER 2 TESTER

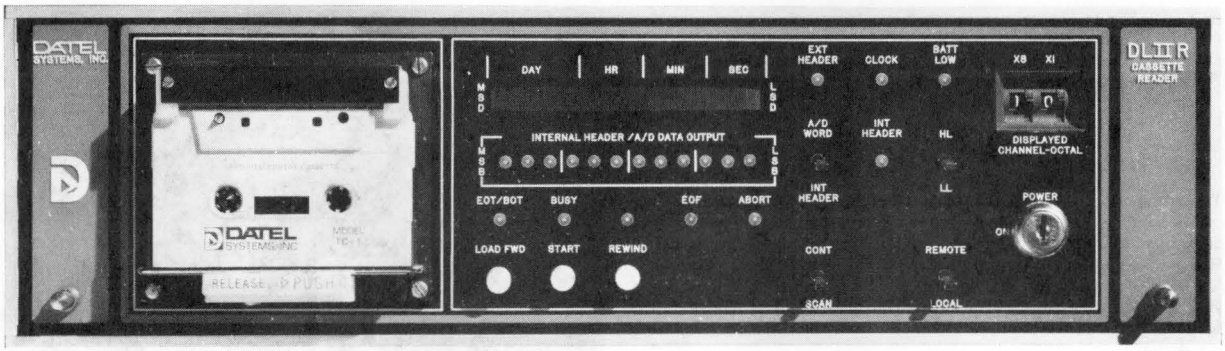
The Tester is used to calibrate the Logger and to test all its functions before it is committed to long-term unattended recording. The tester checks all controls of the Logger, the battery status (voltage and current), Logger power drain, and tape heads. Simulated data generated on the Tester can be recorded on the Logger. The Tester will also display actual data or the simulated data on the Tester's LED readouts. In addition the Tester performs a complete self-check of all its own switches, displays, and batteries. The Tester is housed in a portable weatherproof case identical to that of the Logger.

## READER/INTERFACE AND INTERFACE OPTIONS

The Reader/Interface for the Data Logger 2 system is a complete computer front end for playing back the digital cassettes recorded on the Logger. The Reader can be operated from front panel controls or can be remotely controlled

**KEY SPECS: DATA LOGGER 2**

| | |
|---|---|
| No. Channels | Up to 64 |
| Analog Inputs, HI Level | 0 to +5V or -5V to +5V (Single Ended) |
| Analog Inputs, LO Level | 0 to +10mV or -5mV to +5mV (Differential) |
| Input Impedance | 100 Megohms |
| Common Mode Voltage Range | ±5V |
| Common Mode Rejection | 110dB |
| Resolution | 12 Bits, Hi Level<br>8 Bits, Lo Level |
| Accuracy, HI Level | .04%FS ± 1/2 LSB |
| Temperature Coefficient | ±12 ppm/°C |
| Data Capacity | 120,000 samples/300' Cassette (2000 64 Channel Scans) |
| Scan Intervals | 1 Second to 30 hours |
| Throughput Rate | 5 samples/second |
| Power Requirement | 12VDC (5 Lithium D-Cells) (100mA Recording, 1mA standby) |
| Operating Temperature Range | -20° C to +70° C |
| Weight | 20 lbs. (9,1Kg) |




**Data Logger 2 Reader**

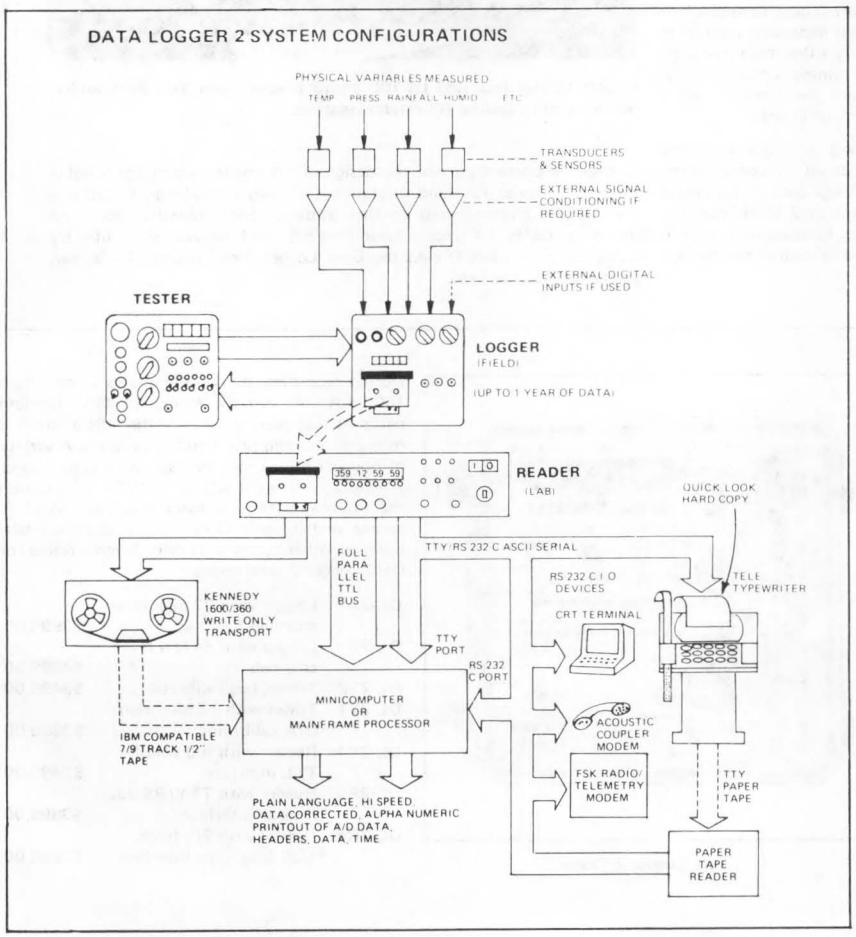
on-line by a minicomputer, mainframe processor or other I/O device. Front panel displays allow the operator to manually step through a recording to find a sample on a particular date and time. Front panel binary and decimal LED's will display this date and time in addition to the raw binary data for that sample on a selected channel. By suitable computer programming an automatic search for a particular sample can be conducted.

The Reader is available with one of three interface types. A full parallel interface provides buffered TTL binary data at rates up to 100 samples per second with the cassette tape moving continuously. This interface provides the highest output rate and may be used to load a computer memory in interrupt mode or block transfer (direct memory access).

The second interface is full serial (2 wire) to connect to teletypewriters and RS-232-C I/O devices such as CRT terminals and high speed printers in ASCII format. The teletypewriter (TTY) output provides a simple way to connect to a computer which has a TTY port. The teletypewriter can be used off-line to prepare paper tapes of the raw data and to get a "quick look" at the data. Feeding the paper tape back to the computer on-line will then produce a plain language print out with suitable programming. The RS-232-C outputs may also operate an acoustic coupler modem for telephone transmission or frequency-shift keying of a radio link. The TTY/RS-232-C serial interfaces are programmable from 75 to 9600 baud rates to accommodate different output devices and transmission lines.

The third Reader interface connects to a Kennedy 1600 incremental 1/2" magnetic tape transport. Tapes prepared using this transport may be played back at high speed on any 7/9-track mainframe processor tape deck. This tape-to-tape interface provides simplified no-wiring data entry to a computer and user retention of the data on a high speed tape medium.

Various user configurations of the Data Logger 2 system are shown in the "Data Logger 2 System Configurations" diagram.




## LOGGER OPERATION

The Logger and Reader both employ Datel Systems' low power stepper-motor incremental cassette tape transport. This transport features very fast power turn-on permitting the transport to be normally off except during actual recording. Extensive use of fast turn-on circuits using MOS devices allows the Logger to operate for a year or longer (depending on sample rate) using only 5 D cell Lithium batteries mounted inside the front cover. While recording, the tape transport and data acquisition electronics are powered up for only 11 seconds maximum to record all 64 channels. The system then turns off except for a CMOS crystal-controlled clock circuit which

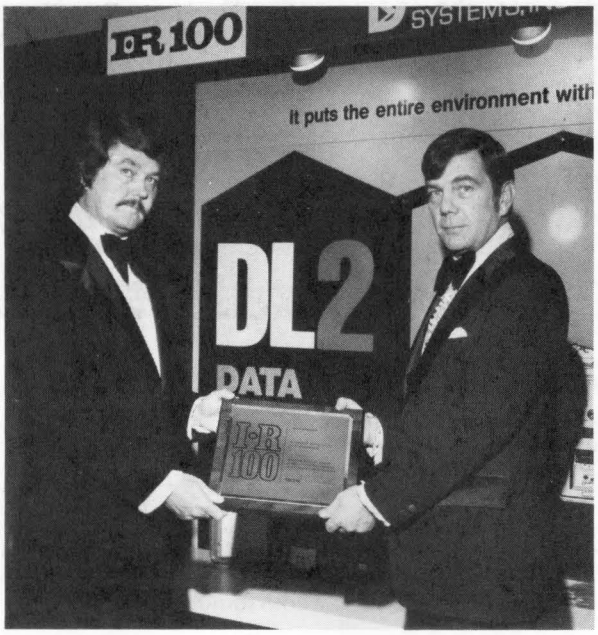
DATEL

# The Data Logger 2 Story

The conception and development of Data Logger 2 goes back a little over a year, and culminates on September 18, 1975 when Robert L. Hill, developer of the unit, received an IR-100 award from Industrial Research Magazine at its awards banquet. The awards are given annually for the 100 most significant new products developed during the past year. Products are selected by a distinguished panel of judges on the basis of importance, uniqueness, and usefulness, from a technical standpoint.

The Data Logger 2 design was conceived out of customer interest in another Datel Systems product, the LPS-16, an OEM type low power digital cassette recorder with built-in data acquisition system (see product description on page 10). Mr. Hill found that many customers were interested in a complete packaged instrument for field use and indeed were using the LPS-16 to build such units themselves. The field model needed to have features such as these: high and low level analog inputs; low temperature operation; low power consumption to permit extended unmanned field operation; provision for external digital inputs in addition to analog inputs; provision for recording operator identifying information on the cassette; and internal data/time clock to record when data was taken. The companies who expressed interest in such a system, which was not available from any other manufacturer, were in such diverse fields as oil exploration, mining, oceanography, meteorology, and ecology. A further important requirement was a ruggedized all-weather type enclosure for field environment.

Robert Hill designed the Data Logger 2 based on these customer requirements, using the low power incremental cassette recorder of the LPS-16 along with low power CMOS circuitry. A key part of this design is the crystal-controlled CMOS clock which runs at 2.1MHz continuously while the Logger is in the standby mode; total current drain is typically 500$\mu$A in standby. While running and recording the current drain is typically 75 mA.




**Robert L. Hill receiving IR-100 award plaque from Tim Burkholder, publisher of Industrial Research magazine.**

Another important part of the design effort was the search for suitable internal batteries for field operation. Lithium batteries in D cell size were finally chosen based on their superior characteristics: operation down to -65°F, 10 ampere-hour capacity, and 10 year shelf life. By using just 5 of these D cells the Data Logger 2 can operate for a year, unattended in the field.

initiates the next scan at the time determined by the manually selected scan rate. During each scan the data and time are automatically recorded on the cassette tape. A battery monitor will record if the battery voltage falls too low.

The Logger is rated for a year or more of operation at moderate sample rates over an operating temperature range of -20°C to +70°C. External inputs may be used to record 36 bit parallel digital data on command or to make an analog scan on external command.

Both high and low level analog inputs are accepted with unipolar, bipolar, or two's complement coding on the 12 bit A/D converter. The high level ranges are -5V to +5V or 0 to +5V; low level ranges are 0 to +10mV or -5mV to +5mV with 8 bit accuracy. The low level inputs are differential with 100 meghom input impedance, ±5V common mode range, and 110dB common mode rejection out to 100 Hz. Basic high level accuracy is ±.04% of full scale ±1/2 LSB with a temperature coefficient of ±12ppm/°C.


Data Logger 2 Tester

During recording the Logger draws a maximum 100 mA of current from its 12V Lithium batteries; between scans only the crystal clock is running, drawing just 1 mA maximum. A variety of power options may be used with Data Logger 2 including external AC, or +12VDC. In addition the internal battery holders may be rewired to accept rechargeable D cell nickel cadmium batteries or other types of D cells. Sample prices for Data Logger 2 systems are:

| | | |
|---|---|---|
| **DL-2A** | **Logger with 32 high level channels** | **$3995.00** |
| **DL-2E** | **Logger with 64 low level channels** | **$4995.00** |
| **DL-2T2** | **Tester, less calibrator** | **$3495.00** |
| **DL-2T1** | **Tester with 12 bit + sign D/A calibrator** | **$3995.00** |
| **DL-2R1** | **Reader with full parallel TTL interface** | **$3495.00** |
| **DL-2R2** | **Reader with TTY/RS-232-C serial interface** | **$3895.00** |
| **DL-2R4** | **Reader with 7/9-track, 1/2" Mag. tape interface** | **$3895.00** |

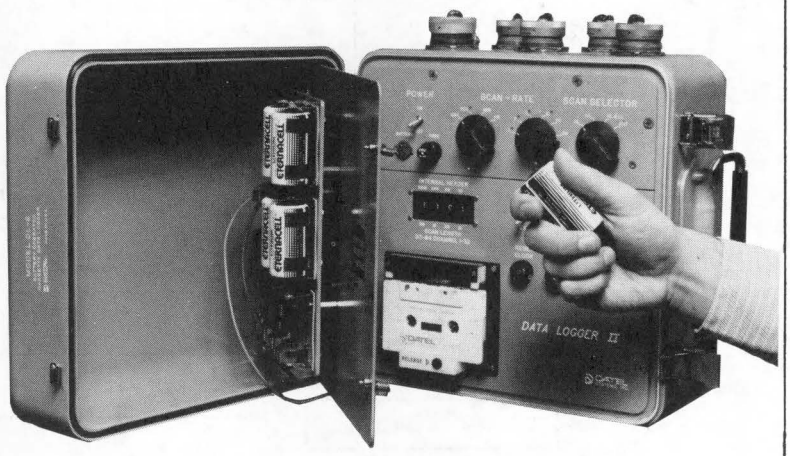
DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# DATA LOGGER 2
# 64-CHANNEL, BATTERY-POWERED, WEATHERPROOF CASSETTE DATA LOGGER

# MODEL DL-2

## FEATURES

- 64 channel cassette digital tape data acquisition system in a sealed weatherproof, high reliability ruggedized metal case
- One year lithium battery supply
- -20°C to +70°C operating temperature range
- +10mV, ±5mV or ±5V, 0 to +5V Volt input ranges, 100 megohm impedance, 100dB CMR differential configuration
- 6mW standby power CMOS design, 1 watt power while scanning, +12VDC power
- 1 second to 30 hour selectable scan rates
- $3995. single quantity




## GENERAL DESCRIPTION

For remote environmental recording or long term unattended field measurement of any variable, the battery powered Data Logger 2 will record up to 64 channels of analog data on a Philips-type digital tape cassette. The Data Logger 2 is housed in a sealed, weatherproof ruggedized metal case and will operate for more than a year on its internal lithium battery supply in temperatures from -20°C to +70°C. Military type sealed connectors are used for all analog inputs and CMOS circuitry is employed for a low standby drain of 6 milliwatts.

Philips-type digital cassettes with 300 feet of tape are used to record analog data in selectable scan lengths from 1 second to 30 hours. The number of channels to be scanned is preset on front panel thumbwheel switches for efficient use of the tape. The incremental single direction NRZI recording method combined with low power electronics results in a running current of 100mA max. In addition, a header word may be recorded on the tape for later computer indentification of that particular tape. A longer 36-bit external header may be entered using the input connectors.

In each scan of the selected number of input channels, a 40-bit clock word is recorded before each scan. This 40-bit clock word contains a 36-bit one-year digital clock derived from a CMOS crystal oscillator and having one second resolution. The last 4-bits of the clock word are used to flag a low battery voltage. The system will continue running with a low battery voltage but the user is advised that readings may be unreliable.

A normal scan consists of the clock word, a 12-bit file gap and a string of 14-bit data words up to 64 channels.

The 14-bit data words consist of an analog voltage represented by 12 binary bits and 2 additional high level/low level bits to describe whether full scale is ±5 millivolts or 5 volts. A 2-bit character gap begins each word.

The Data Logger 2 can accept up to 64 high level or 64 low level channels or a mix of 32 high level and 32 low level channels. Full external control of the Data Logger 2 is also provided using the input connectors. This includes such flexibility as varied scan rate for selected inputs by using a second external clock and control circuit.

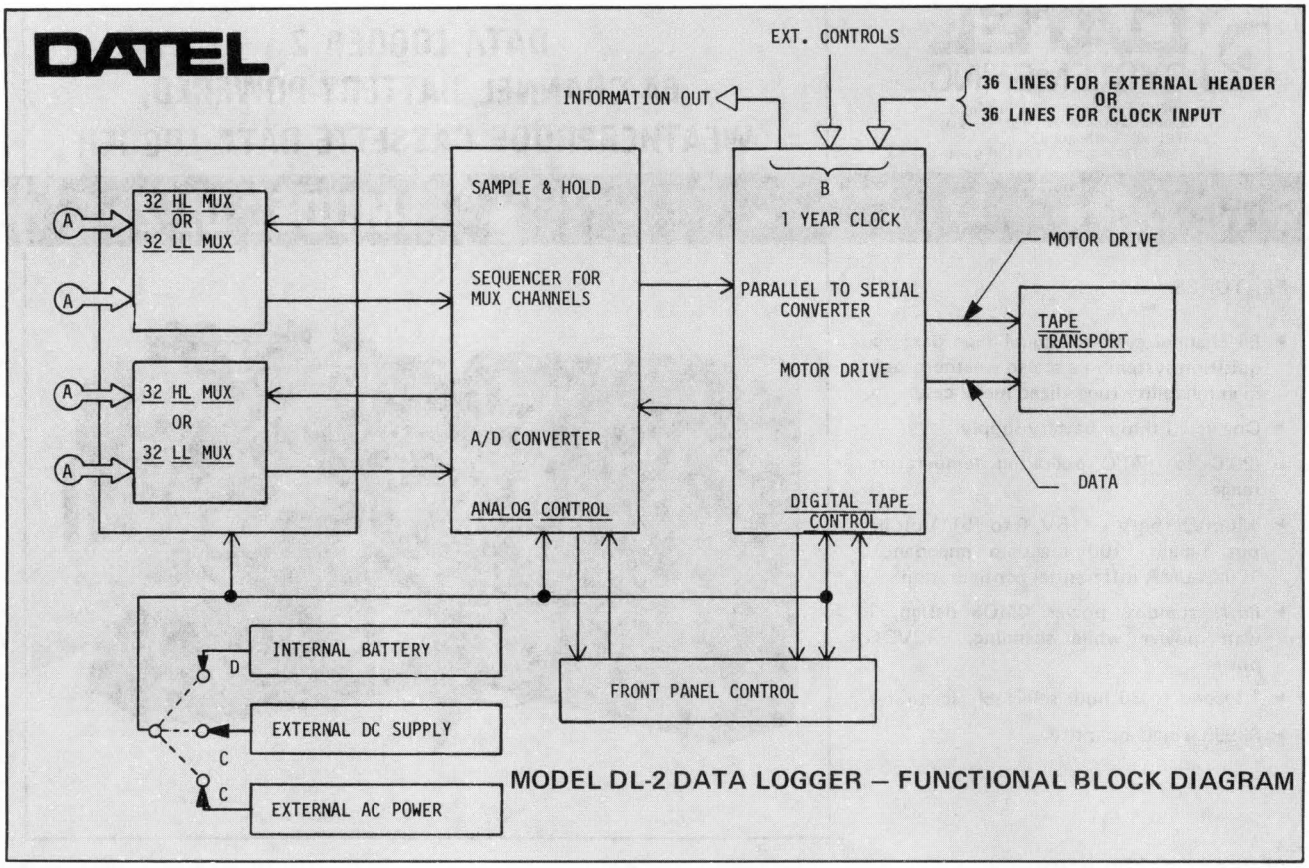
A 5-cell, long life, 10 Amp-hour lithium battery supply is mounted on the front inside cover of the Data Logger 2. A second set of D-size battery holders allows rewiring to alkaline, mercury or carbon-zinc batteries or for a parallel set of lithium batteries, or any other D cells.

The internal CMOS circuitry of the Data Logger 2 features fast power turn-on initiated by the clock control. An MOS high accuracy analog multiplexer is followed by a differential FET front end instrumentation amplifier for low level inputs. A fast acting sample and hold amplifier is followed by a 12-bit A/D converter at the output. The parallel A/D words are then assembled and formatted into serial information fed to the tape head driver amplifiers. Motor stepper drive circuits, clock and control/addressing systems complete the electronics.

The instrumentation amplifier provides low level differential inputs down to 10mV span full scale. Common mode rejection of 110dB is maintained over ±5V for high noise immunity. Overall accuracy (high level) is ±.04% of Full Scale ±12ppm/°C temperature drift. Low level accuracy is ±0.3% of Full Scale ±½ LSB (8 bits) ±100ppm/°C tempco. (See specifications)

The sample and hold exhibits a 100 nsec. aperture time and A/D settling and conversion occurs within 450 microseconds. The tape is stepped at 100 bits per second so that A/D words are written in 160 msec. (120 msec. for the 12-bit data, 20 msec. for the High Level/Low Level bits and 20 msec. for the intercharacter tape gap). A complete recording of a 64-channel scan takes about 11 seconds. This limits the maximum sampling rate unless a smaller number of channels is selected. Tape capacity is about 2 megabits including all gaps. About six hours is required to fill a tape at continuous running.

The complete system weighs 20 lbs. (9, 1 Kg) with batteries and measures 12"H x 12"W x 10"D (305 mm x 305 mm x 254 mm).




MODEL DL-2 DATA LOGGER – FUNCTIONAL BLOCK DIAGRAM

## DATA LOGGER 2

**Specifications** (Typical over -20°C to +70°C unless otherwise noted)

**Number of Analog Channels:**
Selectable up to 64. Can be mixed up to 32 Low Level and 32 High Level channels or up to 64 High Level or Low Level channels.

**Power Supply:**
+14.75 Volts DC composed of (5) D-size Lithium cells, non-rechargeable, +2.85 to +2.95 Volts per cell. 10 Amp-hours per cell. (10) D-size battery holders provided for customer conversion to NiCad, Alkaline or Carbon-Zinc D-cells, or for a parallel set of Lithium batteries.

**Power Supply Requirement:**
12V (-.5, +1V):
70 mA typ, 100mA max during motor stepping
10μA typ, 100μA max during standby

**Power Supply Operating Range:**
+10 Volts to +14.5 Volts DC. Low battery flag is encoded on tape when voltage drops to +11 Volts or +5.5V at low power supply tap. However, system will continue operating down to +10 Volts at rated specifications.

**Battery Power Usage:**
Approximately 615mA-Hrs. per cassette.

**AC Supplies: (optional)**
115VAC ±10%
100VAC ±10%
230VAC ±10%

**AC Line Frequencies:**
47 to 440 Hz

**External Battery Supply:**
Connected through sealed I/O connectors.

**System Weight:**
20 lbs. (9, 1Kg)

**Dimensions:**
12"H x 12"W x 10"D (305mm x 305mm x 254mm)

**System Temperature Ranges:**
Operating: -20° to +70°C
Storage: -55°C to +70°C

## DATA LOGGER 2:

**Analog Specifications** (Typical over -20°C to +70°C unless otherwise noted)

**Input Ranges:**
Low Level differential -5mV to +5mV or 0 to +10mV, (Other LL ranges > 10mV span available on special order). High Level single-ended -5V to +5V or 0 to +5V.

**Input Impedance:**
⩾ 100 megohm single-ended or differential.

**CMV:**
±5V (differential only)

**CMRR:**
110dB to 100Hz (differential only with 1K source unbalance).

**Accuracy:**
(High Level) ±.04% of Full Scale (± ½ LSB) + (±0.0012%/°C).

**Accuracy:**
(Low Level) ±0.3% of Full Scale (± ½ LSB 8 bits) + (±0.01% FS/°C) + (.002%/°C x Gain*).
*Where gain = 10 volts ÷ FS LL Input Range.

**Resolution:**
12 binary bits

**Aperture Time:**
100 nanoseconds max. (sample & hold).

**A/D Conversion Time:** (including input settling time)
450 microseconds.

**Sample Time:**
150 microseconds.

**Input Connection** (Differential, Low Level):
Analog HI, Analog LO and shield ground for each input. (Single-Ended, High Level): Analog HI and ground

**Overvoltage:**
±10V (HL)
±5V (LL)

## DATA LOGGER 2

### Recorder Characteristics

**Storage Media:**
Standard Philips certified data tape cassette 300' length (91 m).

**Storage Method:**
2 channel complementary NRZI, one recording direction.

**Storage Density:**
615 bits per inch.

**Number of Tracks:**
Two, data on Track one, $\overline{\text{data}}$ on Track two.

**Tape Format:**
40-bit digital clock word, 12-bit file gap and one scan of 14 bit binary A/D words (up to 64 A/D words). Internal header 12 bits (4 digit octal) written from front panel push button and 4 digit thumbwheel switch. External header 36 bits written from external source and strobe. (parallel data).

**Gaps:**
2 bit gap written before every 14 bit A/D word, (12 bit A/D word +2 bit HL/LL Channel ID) 12 bit gap written after every clock or header word (Int. or Ext.)

**Tape Storage Capacity:**
2.2 megabits (gaps are considered as bits) per 300 ft. cassette.

**Write Speed:**
100 steps/sec. (one bit (data gap)/step). Incremental.

**Data Format:**
Serial NRZI

**Motor:**
Single 1.5° angle capstan drive stepper motor coupled to take up reel by slip clutch mechanism.

**Capstan:**
.250" diameter

**Step Angle:**
1.5°

**Angular Accuracy:**
±8 min. of arc non-accumulative.

**Tape Motion Control:**
Single capstan pinch roller. Drive head is engaged mechanically during write time.

**Tape Tension:**
0.4 oz.

**Error Rate:**
1 bit in $10^7$

**Type of Cassette Loading:**
Front (after instrument housing sealed front cover is opened).

**Recording Head:**
Dual channel single gap high quality digital type.

**Operating Mode:**
Write only.

---

### FRONT PANEL CONTROLS;

**Scan Rate:**
1, 2, 5, 10, 20 or 30 seconds, minutes or hours and max. (Max. is maximum rate allowed by the setting of the scan length switches), to nearest second resolution.

**Scan Length:**
Four digit octal thumbwheel switch selects the number of channels/scan. (Two digits for High Level and two digits for Low Level), or (two switches for CH-1-32 and two switches for CH33-64 for all HL or LL channels).

**Header (Octal):**
Four digit octal thumbwheel switch may be entered on tape. (Same switch as scan length).

**Enter Internal Header: (Int./Ext.)**
Push button switch enters front panel header on tape. (When in the Ext. Mode). Locking toggle switch. When in Int., the Internal Clock has control of the Data Logger via the scan length switches. (Except in between scans, external data may be entered). When in the Ext. position, the logger may be externally controlled; also an Internal Header or External Header may be entered.

**Load Forward:**
Push button switch will light BOT (Beginning of tape) lamp if tape is over clear leader and will move tape forward to oxide while depressed. (When in the EXT. Mode).

**BOT Lamp:**
Will indicate, (when load forward button is depressed) when tape is on clear leader. Lamp is on when over clear leader and off when over oxide coating on tape.

**Clock Reset:**
Push button switch, will reset 1 year internal clock to zero. (When in the Ext. Mode).

**Power On/Off:**
Toggle switch will turn the power on or off.

**Analog Input Selector:**
Four position selector switch selects High Level/Low Level, or High Level and Low Level channels to be scanned.
There is also an Ext. position which is used for optional external control of thse functions.

---

## DATA LOGGER 2

### Digital Inputs

**NOTE:** CMOS logic levels used. External CMOS driver logic should be used and should track Vdd logic bus from the 3-cell tap or drive through protective external diodes. (Avail. from Ext. connector). 22K ohm pulldowns on all external digital inputs, 1 uSec min.

**Clock Inputs:**
36 lines for pre-setting internal 1 year digital clock or for entering External Header.

**Load Clock:**
1 line presets internal clock to comply with 36 line input.

**Enter Header:**
1 line enters External Header. Must be spaced 500 mSec min. from adjacent scans.

**Start Scan:**
1 line will cause a clock to be written and a word scan to occur (used for external calibration or control). One microsecond minimum duration.

---

## DATA LOGGER 2

### Digital Outputs

**Status Output:**
1 line, indicates when system is busy. This line is used if external data is to be written in between scans. 36 bits of external data may be entered on tape from the external header inputs, provided time is allowed by selecting the proper scan rate position for the number of channels to be scanned, plus the 36 external bits. i.e.: it takes 450 ms to write the 36 bits on tape.

**Clock Output:**
1 line, 1 second time base.

**Head Track 1 & 2:**
4 lines, represent data written on Track 1 and Track 2 respectively. When the Data Logger 2 Tester is used, these lines are used to recover data from the Head to be displayed on the Tester.

Data Logger 2

Ordering Guide

Available under GSA Contract
No. GS-00S-29002

DL-2 _ _ _

**CHANNEL CONFIGURATION**

A = 32 High Level
B = 32 Low Level
C = 32 High Level and 32 Low Level
D = 64 High Level
E = 64 Low Level

**INPUT RANGES & CODING**

Note:
High Level (HL) Inputs are single-ended
Low Level (LL) Inputs are differential

1 = Bipolar (offset binary) (not useable if TTY, RS-232-C output is used)
LL: -5mV to +5mV and/or
HL: -5V to +5V
2 = Bipolar (2's complement)
LL: -5mV to +5mV and/or
HL: -5V to +5V
3 = Unipolar (straight binary)
LL: 0 to +10mV

and/or

HL: 0 to +5V
4 = Special (contact factory)
Notes: 1 Coding types 1, 2, & 3 cannot be intermixed.
2 Coding must be specified at time of order.
3 High level and low level channels may be ordered in the same unit, but all coding must be the same.
4 Low level 0 to +5mV is not offered.

**INTERNAL POWER SUPPLIES**

A* = (10) internal D-cell battery holders installed and internal 115 VAC/60Hz supply
E* = (10) internal D-cell battery holders installed and internal 220 VAC/50Hz supply
J* = (10) internal D-cell battery holders installed and internal 100 VAC/60Hz supply
X = External battery connector and (10) internal D-cell holders installed. No internal AC power supply furnished.

Batteries are not included, please order separately below.

Low temperature operation (-40°C to +70°C) available on special order, contact Datel.

Data Logger 2

Prices (single quantity)

| | | |
|---|---|---|
| DL-2A | (32HL) | $3995. |
| DL-2B | (32LL) | $4245. |
| DL-2C | (32HL & 32LL) | $4745. |
| DL-2D | (64HL) | $4495. |
| DL-2E | (64LL) | $4995. |

"Naked DL-2":
(Panel-mounting version of any model above less housing and connectors --- less $1000.

*Add $175. for A, E, or J power supply options.

Prices include connectors and a cassette but do not include Lithium batteries.

Lithium batteries are D-SIZE "Eternacell" Model 550 manufactured by:

Power Conversion Inc.
70 Mac Questen Parkway South
Mt. Vernon, NY 10550

or available from Datel, part number DL-2-12049-24, $15.00 each. (5 required)

Certified digital tape cassettes, 300 feet (91 m)

| Model | Operating Temp. | Price (1-9) |
|---|---|---|
| 12123-1 | +10°C to +45°C | $ 9.95 |
| 12123-2 | -40°C to +70°C | $11.95 |

DATEL

**PRICES & SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.**

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# DATA LOGGER II READER
# DIGITAL CASSETTE TAPE READER

# MODEL DL-2R

## FEATURES

- **Digital tape cassette reader for the 64-channel Data Logger II.**
- **Displays digital calendar clock, binary A/D data words, int. octal or ext. digital header words.**
- **Provides full parallel computer data buss interfacing or 7/9 track ½" IBM tape interface.**
- **Also provides teletypewriter (TTY) RS-232-C I/O serial interface.**
- **Selectable I/O TTL loading and coding options for complete data buss compatibility.**
- **Complete "handshaking" computer controls and flags, for automatic external computer control, or "off-line" front panel control.**

## GENERAL DESCRIPTION

Digital cassette tapes written on the Data Logger II containing up to 64 channels of analog data may be read directly on the Data Logger II Reader, model DL-2R. This reader accepts Philips-type tape cassettes written in Datel's NRZI digital format. Information recorded on tape such as temperature, pressure, rainfall, and wind velocity from external sensors may be transferred directly into a mainframe computer or minicomputer data buss using the DL-2R Cassette Reader.

The Data Logger II Reader has two front panel displays, one to list 12 bit binary A/D data words and another decimal display for the calendar clock or external header word. The 9-digit calendar clock in the Data Logger II records up to one year of data with one-second resolution. Using clock words, the DL-2R Reader can be stepped through manually or by computer control to find a particular record written at any time. The binary display also shows octal internal headers and the decimal display can be used for external digital header words.

The Data Logger II Reader has complete front panel controls to select the channel of interest, to properly start the tape and load data into a computer. A complete full parallel computer interface and/or serial teletypewriter/RS-232-C interface is included inside the 19" x 19" x 5¼" cabinet of the DL-2R. The full parallel computer interface features open collector TTL bussing including a variety of output loading and selectable positive or negative-true coding. This flexibility enables universal connection to majority of digital processors without any modifications.

The serial teletypewriter/RS-232-C interface directly connects to a variety of I/O devices such as CRT terminals, and mainframe computers accessed by remote TTY terminals.

The DL-2R Reader contains special handshaking functions for full computer compatibility. These include word sent and word taken signals and an abort flag which stops the Reader if transmitted words are not accepted 3 times in succession.

Another important feature of the DL-2R Reader is that it connects directly to a variety of Datel data acquisition/processing systems. These include connection to a local, "quick-look" teletypewriter terminal with or without arithmetic capabilities. Another option is direct connection to an IBM compatible 7 or 9-track ½" tape drive. The DL-2R Reader with the Datel processor will correctly format the serial information being read from the cassette tape.

The housing of the DL-2R Reader is brushed aluminum and is 5¼" high, 19" deep, and 19" wide. It can be rack mounted or set up for stand-alone, table top configuration. The DL-2R Reader is complete and includes AC power supplies for 115/60 , 220/50 or 100/60 power voltages.

Cassette tapes are mounted directly on the front panel tape deck. The system can be completely operated through the front panel controls or remotely by computer or teletypewriter terminal.

The complete system weights approximately 25 pounds.

DATEL

DATA LOGGER 2 CASSETTE TAPE READER

MODEL DL–2R

**SPECIFICATIONS (Typical @ +25°C unless otherwise noted)**

## GENERAL

| | |
|---|---|
| Function | Read Only |
| Media | Standard Philips-type certified digital tape cassette |
| Number of Tracks | Two |
| Tape Motion | One direction, capstan stepper motor drive |
| Tape Speed | 2.75 inches per second |
| Reading Format | Complementary NRZI |
| Reading Density | 615 bits per inch |
| Bit Rate | 1700 bits per second |
| Bit Capacity | 2.2 million bits per cassette (including all gaps) |
| Record, Word or Intercharacter Gap | 2 bits |
| File Gap | 12 bits |
| Power Required | 115/100/230 VAC 47 to 63Hz (specify) 65W max. |
| Mechanical Dimensions | 19"D x 19"W x 5.25"H (48,3 cm x 48,3 cm x 13,3 cm) |

## TAPE DATA FORMAT

The DL–2R Reader is designed to respond to the tape data format of the Model DL–2 Data Logger II data acquisition/recording system.

The Data Logger II normally records a full scan starting with a 40-bit clock word, 12 bit gap and up to 64 channels of 12 bit binary A/D words. The exact tape format of the Data Logger II is as follows:

| | |
|---|---|
| 2 bit | Intercharacter gap |
| 36 bit | Calendar clock word |
| 4 bit | Battery low voltage flag |
| 12 bit | File gap |
| 2 bit | Intercharacter gap |
| 12 bit | Binary A/D data word |
| 2 bit | High Level/Low Level flag |
| 2 bit | Intercharacter gap |
| 12 bit | Binary A/D data word |
| • | • |
| • | • |
| • | • |

Up to 64 12-bit A/D data words and 2 bit HL/LL flags and 2 bit gaps per scan.
Note that intercharacter gap, word gap, tape gap and interrecord gap all refer to the 2 bit gap.

The Data Logger II Reader is designed to decode the calendar clock word first and to stop and display this word in the 12-bit file gap. This allows an operator to decide if he wishes to select a particular A/D word in that scan for display. When the system is under external computer control the same sequence applies. That is, the computer decodes each calendar clock word in its search for a particular channel at a given time.

### LOCAL MODE

In the Local mode all of the front panel controls and displays may be utilized. They are:

#### CONTROLS

**Local/Remote:** Toggle Switch
**Continuous/Scan:** Toggle Switch
**High Level/Low Level:** Toggle Switch
**A/D or Internal Header Word:** Toggle Switch
**Load Forward:** Momentary Switch
**Start:** Momentary Switch
**Rewind:** Momentary Switch
**Power:** ON/OFF key lock switch (key removable in either ON/OFF position).
**Displayed Channel (Octal):** 2 Octal thumbwheel switches. Channel to be displayed.

#### DISPLAYS

**Internal Header:** LED Lamp
**EOT/BOT:** LED Lamp
**Busy:** LED Lamp
**Rewind:** LED Lamp
**Abort:** LED Lamp
**Clock (ID):** LED Lamp
**External Header (ID):** LED Lamp
**Battery Low:** LED Lamp
**End of File:** LED Lamp
**A/D or Internal Header Readout:** 12 LED Lamps
**External Header or Clock Readout:** 9 Digit 7 Segment Display

#### INPUT LINES

There are 10 input lines to the Computer Interface Board, they are:

1) Level Control Status Output 1 (L Cont 1 Stat Ø)
2) Level Control Status Output 2 (L Cont 2 Stat Ø)
3) Level Control Data Output 1 (L Cont 1 Data Ø)
4) Level Control Data Output 2 (L Cont 2 Data Ø)
5) Level Control, Control Input 1 (L Cont 1 I)
6) Level Control, Control Input 2 (L Cont 2 I)
7) Initialize Input (Init I)
8) Word taken Input (WDT I)
9) Start Input (STRT I)
10) External Rewind

The Level Control Lines determine the logic coding (positive or negative true) of all I/O signals. The 3 sets of these inputs are: Status Output Level Controls, Data Output Controls, and Control Input Level Controls.

### LOCAL/REMOTE

When the DL-2R Reader is in the "Local" mode, it is operated from its own front panel controls. In the "Remote" mode, the system is operated by an external computer and its own front panel controls are inoperative except for the Local/Remote switch.

### PROGRAM SEQUENCE

When the DL-2R Reader is externally controlled by a "Remote" computer, the program will ordinarily begin its chores by initializing the Reader. This involves checking to see that a number of conditions are met in the proper sequence.

The program will poll various status output lines to see if the cassette is in place, if the head is down, the end of file status, rewind not in progress, local/remote switch position and EOT/BOT status. If all conditions are met, the initialize sequence will begin, proceeding with a Load Forward onto the tape oxide and a Start command if the computer is ready to accept data. Operation then proceeds with simple exchanges of controls between the computer and the DL-2R Reader. The Reader assembles a word in its output register and flags its Word Ready control output. Assuming the computer's input register is ready to accept data, the Word Ready signal will strobe this register and the computer will return a Word Taken signal to the Reader. The return of the Word Taken signal is to inform the DL-2R Reader that the computer is continuing to process data words. The computer also returns a Start signal to keep the tape moving or to start it again if it has stopped in a file gap waiting for the Word Taken signal.

## ORDERING INFORMATION

DL-2R _____

**INTERFACE OPTIONS**

1 = Full parallel computer interface
2 = TTY/RS-232C serial interface
4 = 7 or 9 track 1/2" incremental mag tape interface

**INPUT LOADING**
(For full parallel interface)

0 = No parallel interface
1 = 1 TTL load
2 = 1K ohm pullup to +5V
3 = 330 ohm pullup to +5V and 470 ohm pulldown to ground

**BAUD RATE**
(TTY/RS-232 interface)

| | |
|---|---|
| A = 75 | F = 1200 |
| B = 110 | G = 2400 |
| C = 150 | H = 4800 |
| D = 300 | J = 9600 |
| E = 600 | X = No serial interface |

(Programmed via PC jumpers)

**SERIAL INTERFACE TYPE**
(For TTY/RS-232 interface)

X = No serial interface
R = RS-232C
T = Teletypewriter
(This option selects an internal jumper which floats the TTY power supply)
B = Both TTY and RS-232-C interfaces, power supply grounded for both versions.

Note 1: Both interfaces supplied with option 3 but can be used only one at a time. Can be swapped by removing DL-2R top cover.

**POWER SUPPLY**

A = 115VAC, 60Hz
E = 230VAC, 50Hz
J = 100VAC, 60Hz
(Power consumption, 65 watts max., either version)

**OUTPUT LOADING***
(For full parallel interface)

0 = No parallel interface
1 = Open collector 7406
2 = 1K ohm pullup to +5V
3 = 330 ohm pullup to +5V and 470 ohm pulldown to ground
*+5V must be supplied from external device

Note 2: 1/2" Mag tape interface wired for Kennedy 1600/360 incremental, off-line write-only transport. Other transports require customer modification. Playback is 7/9 track, high speed 1/2" IBM compatible.

Price for the DL-2R Cassette Reader/Display/Interface are as follows:

| | | |
|---|---|---|
| DL-2R-1 | with full parallel computer interface | $3495.00 |
| DL-2R-2 | with TTY/RS232C serial interface | $3895.00 |
| DL-2R-4 | with 7 or 9-track ½" tape interface | $3895.00 |

**Covered by GSA Contract No. GS-00S-29002**

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# BATTERY-POWERED, WEATHERPROOF PORTABLE TESTER/CALIBRATOR FOR THE DATA LOGGER 2

# MODEL DL-2T

## FEATURES

- Completely exercises and calibrates all functions of the Data Logger 2 weatherproof analog cassette recording system.
- Functionally tests all displays and the A/D converter.
- Tests all batteries under full operational load.
- Contains A/D and Digital clock readouts for full calibration and presetting of the Data Logger 2.
- Operates from built-in lithium battery supply or AC power supply.
- Performs a complete self-test to ensure proper Tester operation.

## DESCRIPTION

The Data Logger 2 weatherproof, battery-powered data acquisition and cassette data-logging system will normally require a complete system check-out before committing it to prolonged unattended data monitoring. In addition, the Data Logger 2 will occasionally need on-site field calibration to establish its accuracy. The ideal instrument to perform these tests and calibration is the Data Logger 2 Tester, model DL-2T.

The DL-2T Tester is particularly valuable because it tests the Data Logger 2 and itself. The DL-2T Tester completely exercises the Data Logger 2 on location and performs a self-check to be sure all internal systems are functioning properly in the Data Logger 2.

When testing the Data Logger 2, the DL-2T Tester provides input control signals to recover data directly from the head of the cassette transport. Data is displayed on one of two readouts on the front panel of the DL-2T Tester.

To ensure a complete test of all systems, the DL-2T Tester operates from the internal lithium battery power supply of the Data Logger 2 with the exception of display lamps and drivers powered by a separate 6 volt battery in the DL-2T Tester, or from the internal AC power supply.

The Tester has 2 basic operating modes. In the Logger Mode, the Data Logger 2 is tested. In the Tester Mode, the DL-2T tests itself.

## ORDERING INFORMATION

DL-2T

| D/A Calibration | Number of Channels | Power Supply | Coding |
|---|---|---|---|
| 1 = With<br>2 = Without | A = 32 HL<br>B = 32 LL<br>C = 32 HL & 32 LL<br>D = 64 HL<br>E = 64 LL | 1 = 115 VAC<br>2 = 230 VAC<br>3 = 100 VAC<br>(All AC supplies ±10%, 47 to 440 Hz)<br>Battery clips are standard on all models, so that AC or DC operation may be used. | A = Straight Binary<br>B = Offset Binary<br>C = 2's complement |

Power Supply and Cables included
Batteries are not included
Batteries are Datel part 12131-1 , $15.00 each, (Lithium D-cells, Power Conversion Inc. type 550)

**Price (Single quantity)**

| | | |
|---|---|---|
| **DL-2T1** | Tester with 13-bit D/A calibrator | **$3995.00** |
| **DL-2T2** | Tester less D/A calibrator | **$3495.00** |

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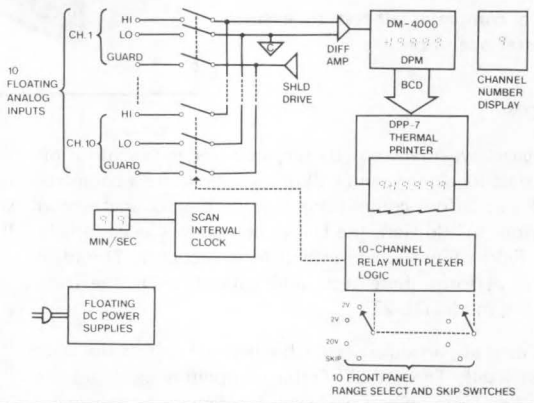
# PRINTING DATA LOGGER

# MODEL PDL-10

$1195^{00}$ COMPLETE




## DESCRIPTION

**Meeting the demand for a high performance laboratory-grade printing data recorder, Datel's model PDL-10 Printing Data Logger accepts up to 10 floating analog input voltages and automatically prints them out at preselected intervals. The PDL-10 digitizes all selected inputs to 4½ digit accuracy, displays and prints them out as decimal voltages on a very compact inkless thermal printer. Analog inputs are accepted over ±199.99mV, ±1.9999V and ±19.999 Volt front-panel selected voltage ranges and are printed out every second with the channel number at preselected scan intervals.**

## PDL-10 SPECIFICATIONS

### ANALOG INPUT

**Number of Channels** . . . . . 10

**Configuration**
3-Wire differential inputs, transformer-isolated using a mechanical relay multiplexer.

**Input Voltage Ranges**
Choice of 3 DC ranges:
± .19999V,
± 1.9999V,
± 19.999V
preselected by ten front panel slide switches for each channel.

**Overvoltage**
Input is diode-protected for up to ±100V maximum continuous.

**Common Mode Rejection**
108dB, DC to 60 Hz with 1000Ω maximum input unbalance.

**Common Mode Voltage Range**
±20 volts maximum to signal guard. ±300 volts maximum to AC power ground.

**Input Impedance** (±20V input max)
(Differential) . . . . . 500 Megohms minimum.
(To Signal Guard) . . . . . 100 Megohms minimum.

**Input Bias Current**
500pA typ.,
8nA maximum

### PERFORMANCE

**Accuracy @ +25°C**
Within ±0.01% when calibrated due to all effects except temperature drift.

**Resolution**
10 μV (200mV range)
100 μV (2V range)
1mV (20V range)

**Temperature Drift**
ZERO: ±1μV/°C
GAIN: 20ppm/°C
BIAS CURRENT: 1%/°C

**Operating Temperature Range**
0°C to +45°C

**Storage Temperature Range**
-25°C to +85°C

**Sampling Rate**
Pre-selected channels are advanced, displayed and printed one channel per second.

**Scan Intervals**
Intervals from 00 to 99 seconds or minutes

## DISPLAYS

**Input**
A digital panel meter (DPM) displays the analog input voltage using Light Emitting Diode red digits. The digits are 0.43" high (11 mm) and 4½ digit resolution. Decimal points, overscale, and polarity (±) are automatically printed and displayed.

**Channel**
A single 0.43" (11 mm) red LED digit indicates channel 0 through 9.

**Printing Method**
Seven segment digits are formed on thermal paper using a thick-film resistor matrix printhead requiring no ink, hammers or ribbons.

**Printer Digits**
7-segment 0 to 9 digits 0.155" (4 mm) high. Spacing between printed lines: 0.2 inch (5 mm).

**Line Capacity**
Approximately 9000 lines.

**Printout Format**
Printout format is 9± .1.9.9.9.9 with the leading digit indicating channel number. Three lines are skipped between scans.

**Printing Paper**
Using heat sensitive thermal printing paper, 1.75"W (44, 5 mm) and supplied in rolls 150 feet (45 mm) long.

## FRONT PANEL CONTROLS

**Channel Select and Input Range**
(Ten 4-position slide switches) ",2V, 2V, 20V and SKIP". "SKIP" prevents the multiplexer relay for the channel from cycling.

**Scan Interval**
(Two decade thumbwheel switch) Sets the time interval between scan starts from 00 to 99 seconds or minutes.

**Minutes/Seconds**
(2 position toggle switch) Determines whether the Scan is set for minutes or seconds.

**No Print/Run/Reset & Start**
(Three position toggle switch) In NO PRINT, the instrument scans and displays but does not print. In RUN the instrument scans, displays and prints out.

In RESET & START, the scan timer is reset and starts timing. One scan is printed out one second from switch release.

**One Channel/Scan**
(Two position toggle switch) The ONE CHANNEL position prevents the multiplexer relay for the selected channel from disconnecting with each scan. In the SCAN position, normal relay cycling, display and printout occur.

**Paper Quantity**
A lever indicates relative quantity of paper remaining.

## REAR PANEL INPUT CONNECTIONS

Analog input voltages are connected using screwdriver barrier terminal strips. (30 terminals).

## POWER SUPPLY

Choice of 115 or 230 VAC ±5, 10, 15 or 20 volts at 50 or 60 Hz only. Power voltages and frequency may be rewired by the user. Three-prong grounded U.S. captive line cord supplied. Power consumption (all models) 30 watts, typical.

## PHYSICAL DIMENSIONS

**Mounting**
Bench-top mounting with tilt-up stand and mar-proof plastic feet. Users can remove the feet and stand for optional ½-rack mounting.

**Outline Dimensions**
5.25"H x 8.5"W x 12"D (133 x 216 x 305 mm)

**Weight**
12 pounds (5,5Kg)

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## ORDERING GUIDE

DATEL

**Model Number**

**PDL–10**

### POWER SUPPLY VOLTAGE

A* = 115 VAC
E* = 230 VAC
J* = 100 VAC

*±10%, May be user-rewired to other voltages, see specs.

### POWER SUPPLY FREQUENCY

5 = 50Hz
6 = 60Hz

May be user-rewired to either frequency.

**PRICES (single quantity)**

PDL–10 ..... $1195.00

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# COMPUTER COMPATIBLE DATA ACQUISITION/ DISTRIBUTION SYSTEM

# SYSTEM 256

## INTRODUCTION

System 256 is a complete high reliability computer input-output system for analog signals. It is capable of operating *on-line* or *off-line*. It has been designed to provide a versatile and permanent solution to the problem of interfacing analog signals to and from a digital computer. The modular principle used throughout enables the user to realize the most economic solution to any problem while maintaining maximum flexibility. Further expansion to an initial system is made by plug-in cards.

A wide range of options outlined elsewhere in this catalog allows a comprehensive system to be specified for applications to an instrumentation or control problem.

System 256 offers the flexibility, speed, economy and reliability necessary in today's world of real time applications.

It can function as an interface between an analog and digital computer in hybrid computer systems or as a peripheral device for general purpose digital computers.

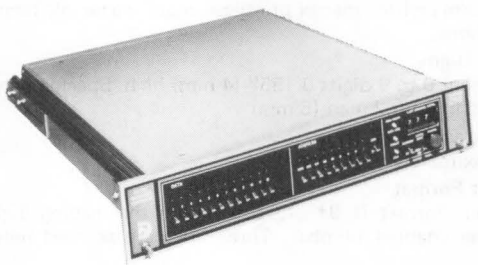
It fills a growing need in industrial process control systems.

The ability to mix Analog Multiplexers, A/D's, Sample and Hold amplifiers and D/A's in virtually any configuration makes System 256 a valuable and dynamic systems tool.

## GENERAL DESCRIPTION

The most unique feature of System 256 is its large analog input channel capacity while at the same time providing extremely low power consumption. The power consumed is a fraction of any system offered today while providing four times the channel capacity in the same package area. System 256 offers up to 256 analog channels and 32 Digital-to-Analog channels in a 19"Wx19"Dx3.5"H rack mounted enclosure, while competitors' systems offer 64 analog channels and 8 Digital-to-Analog channels in the same area, and still System 256 consumes less power. System 256 utilizes C/MOS (Complementary Metal Oxide Silicon) logic throughout.

C/MOS logic provides the necessary high-speed capability while at the same time drastically reduces power consumption. The quiescent power consumed by C/MOS logic is extremely low, or more precisely, the product of the supply voltage and the leakage current of the device (measured in pA). Its dynamic power consumption is somewhat more complex in that it is dependent on the supply voltage, operating speed and load capacitance. With a supply voltage of +15V operating at IMHz into 15pF, the dynamic power consumption per logic function is approximately ImW. When this is compared with TTL logic at approximately 10.5mW per logic function, both quiescent and dynamic, it can be seen that a considerable reduction in power dissipation throughout the system will result by using C/MOS logic rather than TTL or DTL logic. The advantages of this low power dissipation in the system are obvious – less drift due to temperature rise, smaller power requirements, no cooling required, and more hardware per area.



## SYSTEM DESCRIPTION

System 256 is designed to accept up to 256 single-ended or 128 differential analog signals plus 64 simultaneous sample & hold channels in the basic package. The analog inputs are multiplexed one at a time into a high impedance buffer amplifier then supplied to a sample & hold amplifier. The buffered analog signals are converted to digital data via a high speed successive approximation Analog to Digital Converter of up to 14 bits. The analog multiplexing process may be accomplished in either a sequential scan or a random address mode of operation. The digital output data is then fed to an LSB (least significant bit) positioning circuit which assures that regardless of the resolution of the converter, the LSB will always be on the extreme right hand position. This is in compliance with most minicomputer programming requirements.

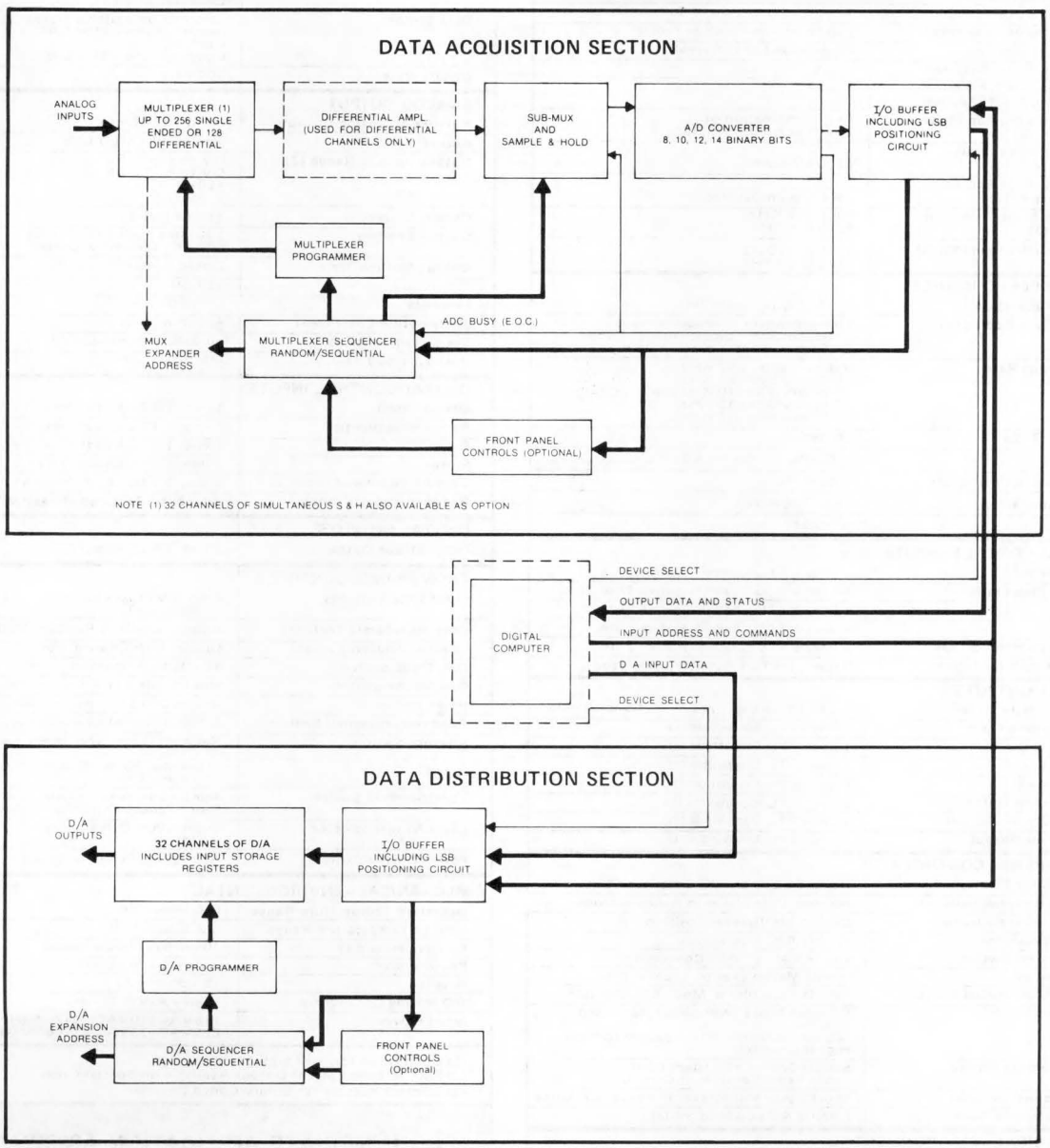
| THROUGHPUT TIME | A/D RESOLUTION | | | |
|---|---|---|---|---|
| | 8 Bits | 10 Bits | 12 Bits | 14 Bits |
| 100 KHz | √ | √ (opt) | √ (opt) | |
| 70 KHz | | √ | | |
| 50 KHz | | √ | √ | |
| 17 KHz | | | | √ |

SYSTEM THROUGHPUT TIME VS RESOLUTION

Display and Control in both the Local and Remote mode of operation are provided on the front panel. This includes an LED display of digitized input data and A/D-D/A channel address. The Local Control features allow selection of input A/D channel address via an advance pushbutton switch, continuous conversion cycles on the same channel via a convert pushbutton switch, D/A channel address and manual insertion of D/A data via toggle switches.

Contained in the same package are provisions for supplying up to 32 Digital to Analog Converters. This conversion process again utilizes the LSB positioning circuit and is supplied with C/MOS storage registers. The Digital to Analog Converters accept up to 12 binary bits and generate an analog output corresponding to the selected channel. Four standard voltage range outputs are supplied to provide up to 10 milliamperes.

## SYSTEM 256 BLOCK DIAGRAM



# SYSTEM 256 SPECIFICATIONS

| PARAMETER | A/D SECTION |
|---|---|
| **ANALOG INPUTS** | |
| Number of Multiplexer Channels Single Ended Input | Expandable to 256 channels in 32 channel increments |
| Number of Multiplexer Channels Diff. Input (Optional) | Expandable to 128 channels in 16 channel increments |
| Number of Simultaneous Sample/Hold Channels | Expandable to 64 channels in 2 channel increments |
| Input Voltage Ranges | +5V FS, + 10V FS, ± 5V FS, ± 10V FS |
| Channel Input Acquisition Time | 5usec to ± 0.025% of FS |
| Channel Input Impedance | 100 Megohms—"on" or "off" |
| Input Configuration | Single ended or Differential |
| Maximum Input Overload | ± 15V |
| Input Channel Time Skew Simultaneous S/H Section | 50nsec |
| Maximum Common Mode Voltage — (3) | Any Combination of 20V P to P — Es + ECM |
| Common Mode Input Impedance — (3) | >100 Megohms |
| Common Mode Source Impedance — (3) | 1 Kohms unbalanced |
| Common Mode Rejection Ratio — (3) | 60db @ 1 KHz<br>80db @ 60 Hz |
| Crosstalk (Between inputs) | 80db @ 100 Hz<br>45db @ 10MHz |
| **SYSTEM PERFORMANCE** | |
| Output Resolution | 8, 10, 12, 14 binary bits |
| Output Data Coding (4) | Straight Binary — unipolar input<br>Offset Binary — bipolar input<br>2's Complement — bipolar input |
| Throughput Rate | 8 Binary Bits—100 KHz<br>10 Binary Bits—50 KHz<br>10 Binary Bits—70 KHz (opt.)<br>12 Binary Bits—50 KHz<br>14 Binary Bits—17 KHz |
| Aperture Time | 50nsec |
| Accuracy | ± 0.02% of FS ± ½ LSB |
| Temperature Coefficient | 40ppm/°C |
| Throughput Rate | up to 100 KHz |
| Linearity | ± ½ LSB |
| **DIGITAL CONTROL INPUTS** | |
| Device Select | 1 line, 1 TTL Load—Negative True |
| Random/Sequential | 1 line, 1 TTL Load—Negative True (seq.) |
| Reset | 1 line, 1 TTL Load—Negative True |
| Strobe | 1 line, 1 TTL Load—Negative True |
| Convert Command Input | 1 line, 1 TTL Load—Negative True |
| Random Address Inputs | 9 lines, 1 TTL Load—Negative True |
| **DIGITAL OUTPUTS** | |
| A/D Converter Data | Up to 14 parallel lines—TTL Compatible (1) |
| Serial Output Train | 1 line—TTL Compatible (1) |
| Busy (E.O.C.) | 1 line—TTL Compatible (1) |
| Frame Sync | 1 line—TTL Compatible (1) |
| A/D Clock | 1 line—TTL Compatible (1) |
| Input Strobe Output | 1 line—TTL Compatible (1) |
| Output Strobe Output | 1 line—TTL Compatible (1) |
| Buffer Full Output | 1 line—TTL Compatible (1) |
| **FRONT PANEL CONTROLS** | |
| Output Data Display | Up to 14 Bits of A/D Data Read Out |
| Channel Address Switches | Address Multiplexer in Random Mode |
| Channel Address Lamps | Display Multiplexer Position |
| A/D Mode Switch | Selects A/D Operation |
| A/D Convert Switch | Will Initiate an A/D Conversion |
| Reset Switch | Resets Multiplexer to Channel One |
| Random/Sequential Switch | Selects Multiplexer Mode of Operation |
| Advance Switch | Random Mode—Will Select Addressed Channel<br>Sequential Mode—Will Advance to Next Higher Channel |
| Local/Remote Switch | Selects Source of System Control, Front Panel Controls or Computer |
| Last Channel Selector | Short Cycle Multiplexer in Sequential Mode |
| Power ON/OFF Switch | Applies AC power to System |
| **MECHANICAL—ENVIRONMENTAL** | |
| Operating Temperature Range | 0°C to +70°C |
| Storage Temperature Range | -55°C to 85°C |
| Relative Humidity | 10% to 90% Non-condensing |
| Physical Size | 3½" H x 19"W x 19"D |
| Weight | 12 LBS (Typ.) |
| I/O Mating Connectors | Up to Eleven<br>Viking #3VH25/1JN5 |
| Input Power | 115VAC + 10 VAC @ 47-63Hz<br>225 VAC ± 15 VAC @ 50-400Hz (opt.) |

(1) Open Collector. Will Sink 30 ma
(2) Optional
(3) Pertains only to Differential Input
(4) Contact Factory for Binary Coded Decimal

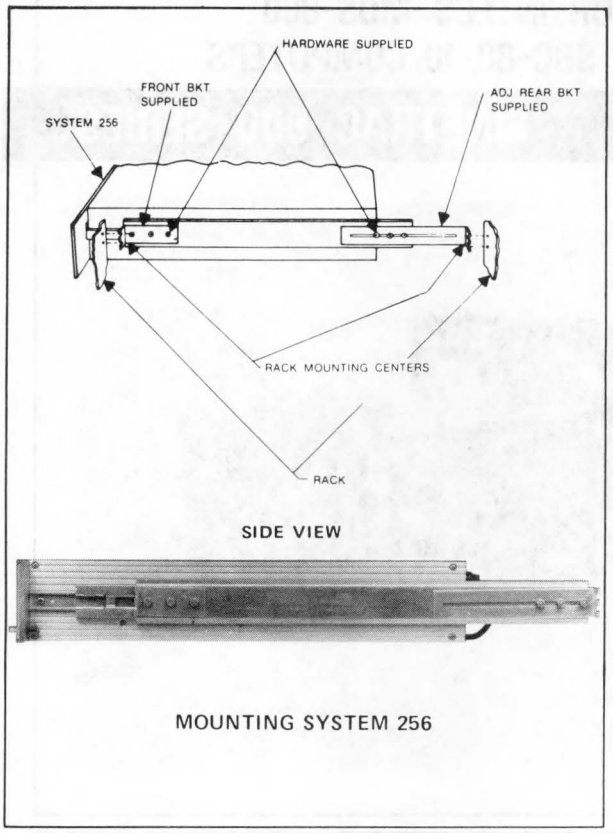
| PARAMETER | D/A SECTION |
|---|---|
| **DIGITAL INPUTS** | |
| Number of Channels | Expandable to 32 channels in 1 channel increments |
| Resolution | 8, 10, 12, 14 Binary Bits |
| Digital Coding (3) | Straight Binary<br>Offset Binary<br>Two's Complement |
| Data Inputs | DTL or TTL compatible<br>Negative True Logic<br>Loading: one TTL Load |
| Data Strobe | Information must be present at the register inputs of the DAC prior to strobing.<br>Loading: one TTL Load |
| Update Rate | 500 KHz |
| **ANALOG OUTPUT** | |
| Number of Analog Outputs | up to 32 channels |
| Accuracy | ±0.01% of FS ± ½ LSB |
| Output Voltage Range (2) | OV to + 10V FS<br>OV to + 5V FS<br>±10V FS<br>± 5V FS |
| Output Current | ±10ma (typ.) |
| Output Loading | 1 Kohms for + 10V Output<br>500 ohms for + 5V Output |
| Output Settling Time | 2 usec to ±0.025% of FS |
| Resolution | ±1 LSB |
| Linearity | ±½ LSB |
| Temperature Coefficient | ±20ppm/°C of FS |
| Long Term Stability | ±0.01%/6 month period |
| Reference Source | Internal |
| **DIGITAL CONTROL INPUTS** | |
| Device Select | 1 line, 1 TTL Load—Negative True |
| Random/Sequential | 1 line, 1 TTL Load—Negative True (seq.) |
| Reset | 1 line, 1 TTL Load—Negative True |
| Strobe | 1 line, 1 TTL Load—Negative True |
| Convert Command Input | 1 line, 1 TTL Load—Negative True |
| Random Address Inputs | 9 lines, 1 TTL Load—Negative True |
| **DIGITAL OUTPUTS** | |
| Input Strobe Output | 1 line, TTL Comp. (1) |
| **FRONT PANEL CONTROLS** | |
| Input Data Switches | Allows Manual Loading of Data Into Each D/A |
| Channel Address Switches | Address D/A's in Random Mode |
| Channel Address Lamps | Display D/A Channel Position |
| D/A Mode Switch | Selects D/A Operation |
| D/A Strobe Switch | Will Initiate a D/A Conversion |
| Reset Switch | Resets D/A's to Channel One |
| Random/Sequential Switch | Selects Mode of Operation |
| Advance Switch | Random Mode—Will Select Addressed Channel<br>Sequential Mode—Will Advance to Next Higher Channel. |
| Local/Remote Switch | Selects Source of System Control. Front Panel Controls or Computer. |
| Last Channel Selector | Short Cycle D/A Channels in Sequential Mode |
| Power On/Off Switch | Applies AC Power to System |
| **MECHANICAL—ENVIRONMENTAL** | |
| Operating Temperature Range | 0°C to + 70°C |
| Storage Temperature Range | -55°C to + 85°C |
| Relative Humidity | 10% to 90% Non-condensing |
| Physical Size | 3½"Hx19"Wx19"D |
| Weight | 12 LBS (Typ.) |
| I/O Mating Connectors | Viking #3VH25/1JN5 |
| Input Power | 115VAC±10VAC @ 47- 63Hz<br>225VAC±15VAC @ 47-63Hz (opt.) |

(1) Open Collector. Will Sink 30ma
(2) Fast Settling Current Output Available on Special Order
(3) Contact Factory for Binary Coded Decimal

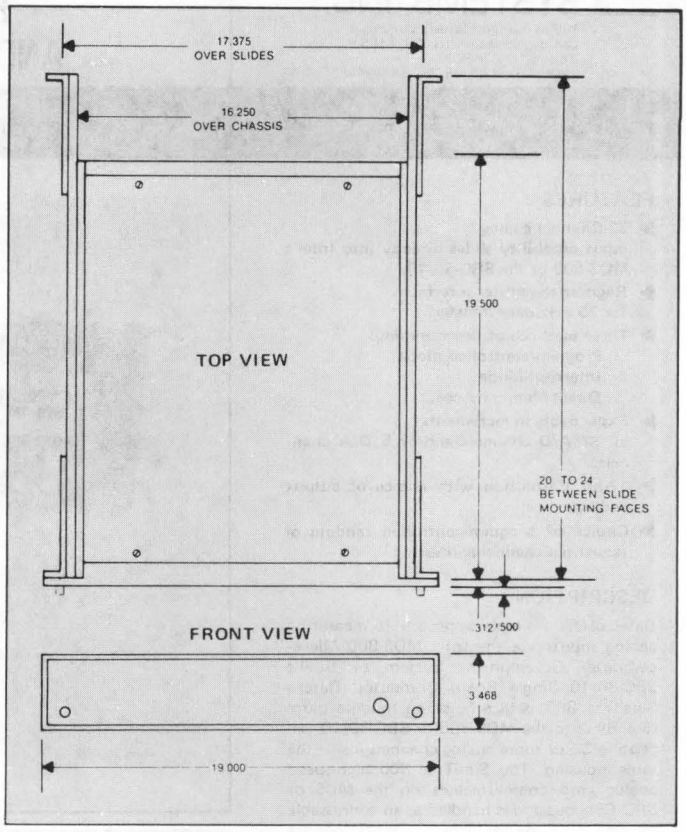
**FOR IMMEDIATE APPLICATION ASSISTANCE –**

**CALL OR WRITE**


DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461




MOUNTING SYSTEM 256




## SPECIFYING SYSTEM 256 TO MEET YOUR PARTICULAR NEEDS

DAS–256– _ _ _ _ _ _ _ _

**NUMBER OF ANALOG [3] MULTIPLEXER CHANNELS**

( ) = SINGLE ENDED INPUT – FROM 32 TO 256 INCREMENTS OF 32 CHANNELS

( ) = DIFFERENTIAL INPUT – FROM 16 TO 128 INCREMENTS OF 16 CHANNELS

**NUMBER OF SIMULTANEOUS SAMPLE/HOLD CHANNELS [1]**

1 = ZERO CHANNELS

( ) = NUMBER OF CHANNELS FROM 2 TO 64 INCREMENTS OF 2 CHANNELS SINGLE ENDED INPUT ONLY

**A/D RESOLUTION, OUTPUT CODING AND SYSTEM THROUGHPUT RATE**

| | | |
|---|---|---|
| 8B | = | 8 BINARY BITS–100KHz THROUGHPUT RATE |
| 10B | = | 10 BINARY BITS–100KHz THROUGHPUT RATE |
| 12B | = | 12 BINARY BITS– 50KHz THROUGHPUT RATE |
| 14B | = | 14 BINARY BITS– 20KHz THROUGHPUT RATE |
| 8D | = | 2 BCD DIGITS |
| 12D | = | 3 BCD DIGITS |

**MULTIPLEXER INPUT CONFIGURATION**

S = SINGLE ENDED–256 CHANNELS MAX.
D = DIFFERENTIAL–128 CHANNELS MAX.

**FULL SCALE ANALOG INPUT**

A = 0V TO +5V
B = 0V TO +10V
C = ±5V
D = ±10V
E = OTHER

**SYSTEM OUTPUT DATA FORMAT**

| | | | |
|---|---|---|---|
| 1 | = | STRAIGHT BINARY | (UNIPOLAR INPUT) |
| 2 | = | OFFSET BINARY | (BIPOLAR INPUT) |
| 3 | = | 2's COMPLEMENT | (BIPOLAR INPUT) |
| 4 | = | BINARY CODED DECIMAL | (UNIPOLAR INPUT) |

DDS-32– _ _ _ _

**NUMBER OF D/A CHANNELS [1]**

( ) FROM 1 TO 32 INCREMENTS OF 1 CHANNEL

**D/A RESOLUTION**

8B = 8 BINARY BITS
10B = 10 BINARY BITS
12B = 12 BINARY BITS
14B = 14 BINARY BITS

**INPUT DATA FORMAT**

| | | | |
|---|---|---|---|
| A | = | STRAIGHT BINARY | (UNIPOLAR OUTPUT) |
| B | = | OFFSET BINARY | (BIPOLAR OUTPUT) |
| C | = | 2's COMPLEMENT | (BIPOLAR OUTPUT) |
| D | = | BINARY CODED DECIMAL | (UNIPOLAR OUTPUT) |

**FULL SCALE OUTPUT VOLTAGE RANGE**

1 = 0V TO +5V
2 = 0V TO +10V
3 = ±5V
4 = ±10V

NOTE: [1] D/A Channels are Limited to 16 when any number of Simultaneous SAMPLE/HOLD Channels are ordered. Otherwise up to 32 D/A Chennels may be ordered.

[2] When Both A/D and D/A Sections Are Required, Make the Appropriate Selection Using Both Ordering Numbers.
**Example A/D Section: DAS-256-32-S-A-8B-1**
**Example D/A Section: DDS-32-16-8B-A-4**
Also specify one or two device select lines.

[3] Single Ended Inputs and Differential Inputs Cannot be Combined.

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
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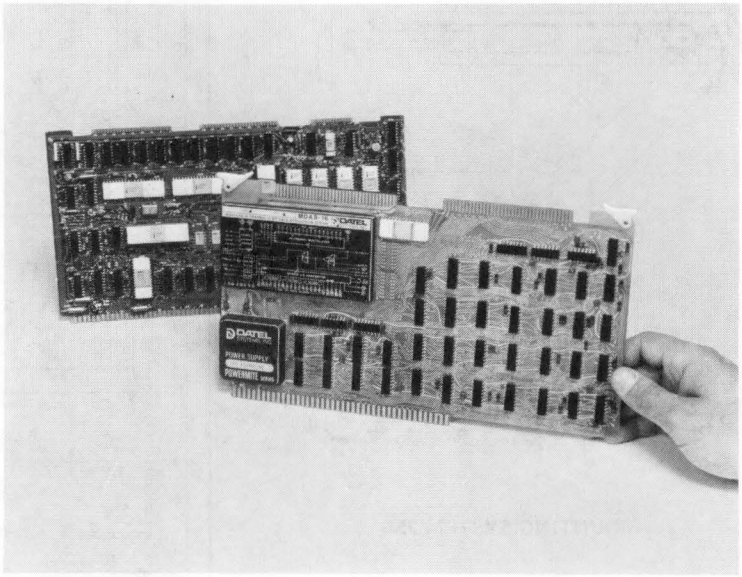
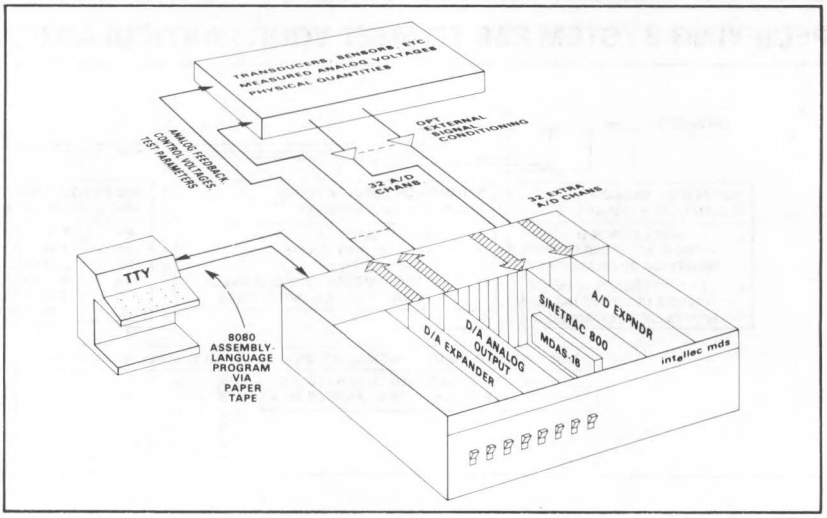
# ANALOG DATA SYSTEMS FOR INTEL'S MDS-800 AND SBC-80/10 COMPUTERS

# SINETRAC 800 SERIES

## FEATURES

- **32-Channel analog input capability slides directly into Intel's MDS-800 or the SBC-80/10.**
- **Register-to-register interface for 75 kHz data transfer.**
- **Three methods of programming:**
  - **Program-controlled mode**
  - **Interrupt Mode**
  - **Direct Memory Access**
- **Expandable in increments of 32 A/D channels and/or 8 D/A channels.**
- **12-bit Resolution with choice of output coding.**
- **Choice of program-controlled random or sequential channel addressing.**






## DESCRIPTION

Datel offers a simple approach to measuring analog inputs via the Intel MDS-800 Microcomputer Development System or Intel's SBC-80/10 Single Board Computer. Datel's SineTrac 800 data acquisition module plugs directly into the MDS-800 or SBC-80/10, accepting 32 or more analog channels inside the same housing. The SineTrac 800 high-speed analog card communicates on the MDS or SBC CPU bus and is handled as an addressable peripheral I/O device. Analog connections are made through convenient rear-panel connections on the MDS-800 housing. Programs written in universal 8080 microprocessor assembly language instructions completely control all activities of the SineTrac 800 data acquisition card. These include random or sequential channel addressing with automatic reset on user-specified first and last channels. By using the I/O device communications capability resident in Intel's monitor program, the SineTrac 800 analog inputs can be directly printed out on a teletypewriter, punched onto paper tape or magnetic tape cassette or left in memory for further arithmetic manipulation before printout.

The SineTrac 800 card is ideal for process control, automatic test systems, laboratory measurement systems and similar applications. Additional SineTrac 800 boards allow for (1) A/D channel expansion in increments of 32 channels per board or (2) a D/A board with eight 12-bit D/A analog output converters per board (expandable to 256 channels).

The D/A option board contains storage registers for each 12-bit analog word to maintain a stabilized analog output between output cycles. The D/A option is ideal for plotter, chart recorder, oscilloscope or actuator drive.

The SineTrac 800 can accept three modes of operation including program control, direct memory access (DMA) or interrupt operation. Program mode consists of direct operation of the SineTrac 800 system by assembly language instructions at the time and sequence specified by the program. DMA operation accommodates direct memory loading in blocks using Intel's DMA board but without routing through the CPU. DMA operation can accommodate block transfers up to the SineTrac 800's full speed of 75,000 samples per second. Interrupt operation is ideal for serving other peripherals besides the SineTrac 800 whenever the device or the data is ready. Interrupt can accept virtually simultaneous data conversion, output formatting and printout.

The SineTrac 800 card is organized around Datel's MDAS-16, a high density data acquisition module employing a hybrid successive approximation A/D converter, FET multiplexer switches, integrated circuit Sample/Hold amplifier and tri-state TTL output buffer/registers. Address decoders, bidirectional bus drivers and receivers, status registers, FET MUX switches, a ±15V DC/DC converter and control logic complete the rest of the SineTrac 800.

Using an assembly language application program developed on the MDS-800 or SBC-80/10, the SineTrac 800 channels can be randomly addressed or in automatic sequential operation incremented with each conversion and resetting when a preloaded last channel is reached.

## SPECIFICATIONS (typical @ +25°C when calibrated unless noted)

### Data Acquistion Section

**ANALOG INPUT**

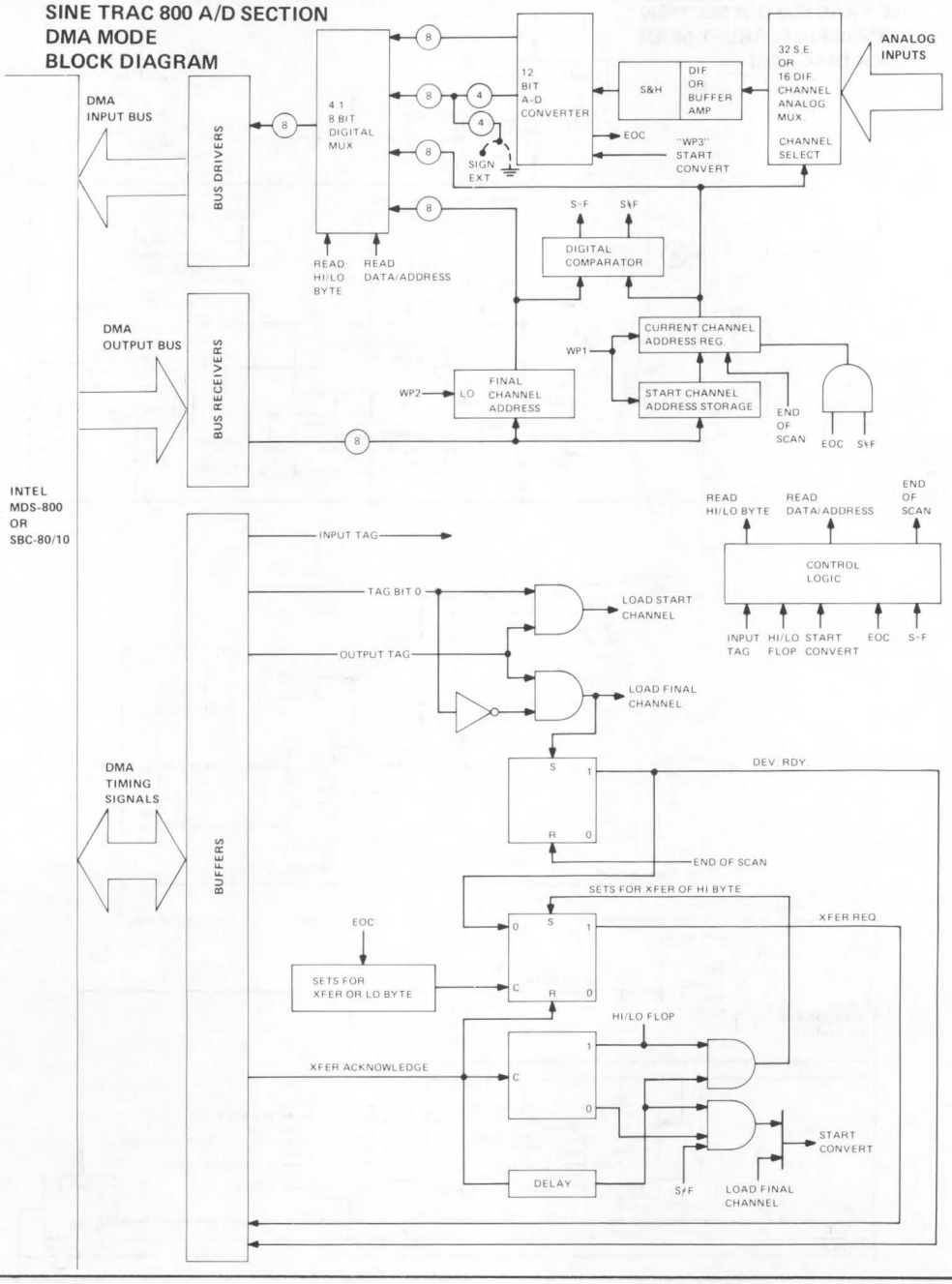
**Number of Channels** . . . . 32 single-ended or 16 differential (prewired or jumper-selectable)
**Resolution** . . . . . 12 Binary Bits (1 part in 4096)
**Full Scale Input Voltage Ranges** . . . . . 0 to +5V, 0 to +10V, −5V to +5V, −10V to +10V (prewired or jumper-selectable)
**Input Impedance.** . . . . . 100 Megohms
**Input Bias Current.** . . . . . 3nA
**Common Mode Rejection.** (Sinetrac 800-16 only) . . 70 dB, DC to 1kHz
**Common Mode Voltage.** (Sinetrac 800-16) . . . Within the selected input voltage range

**Linearity Error** . . . . . Within ±.0125% of full scale of actual value
**System Accuracy** . . . . . Within ±.025% of full scale of actual value
**System Temperature Drift** . . . . . Within ±30ppm of full scale/°C of actual value
**Throughput Rate (Data Transfer), minimum,**
**Data Acquisition Section** . . 75,000 samples per second
**Channel Acquisition Time** . 6 microseconds
**System Aperture Time** . . . 50 nanoseconds

**DIGITAL INPUT/OUTPUT**

**Output Coding** . . . . . Straight Binary (unipolar), Offset Binary (bipolar), 2's complement (bipolar) } prewired or jumper-selectable

**SINE TRAC 800 A/D SECTION**
**DMA MODE**
**BLOCK DIAGRAM**




DATEL

## SPECIFICATIONS (cont.)

**Output Format** . . . . . Buffered 2-Byte Bidirectional TTL Data Bus compatible to MDS-800 and SBC-80/10 Intellec Bus characteristics

**Channel Addressing** . . . . . Program – controlled Random address or automatic sequential with preloaded last channel

**Power Consumption** . . . . . 2 Amps typical @ +5VDC derived from MDS-800 backplane connector. On-board ±15V DC/DC converter supplies power to linear circuits.

**Operating Temperature Range** . . . . . 0° to +70°C

**Storage Temperature Range** . . . . . –25°C to +85°C

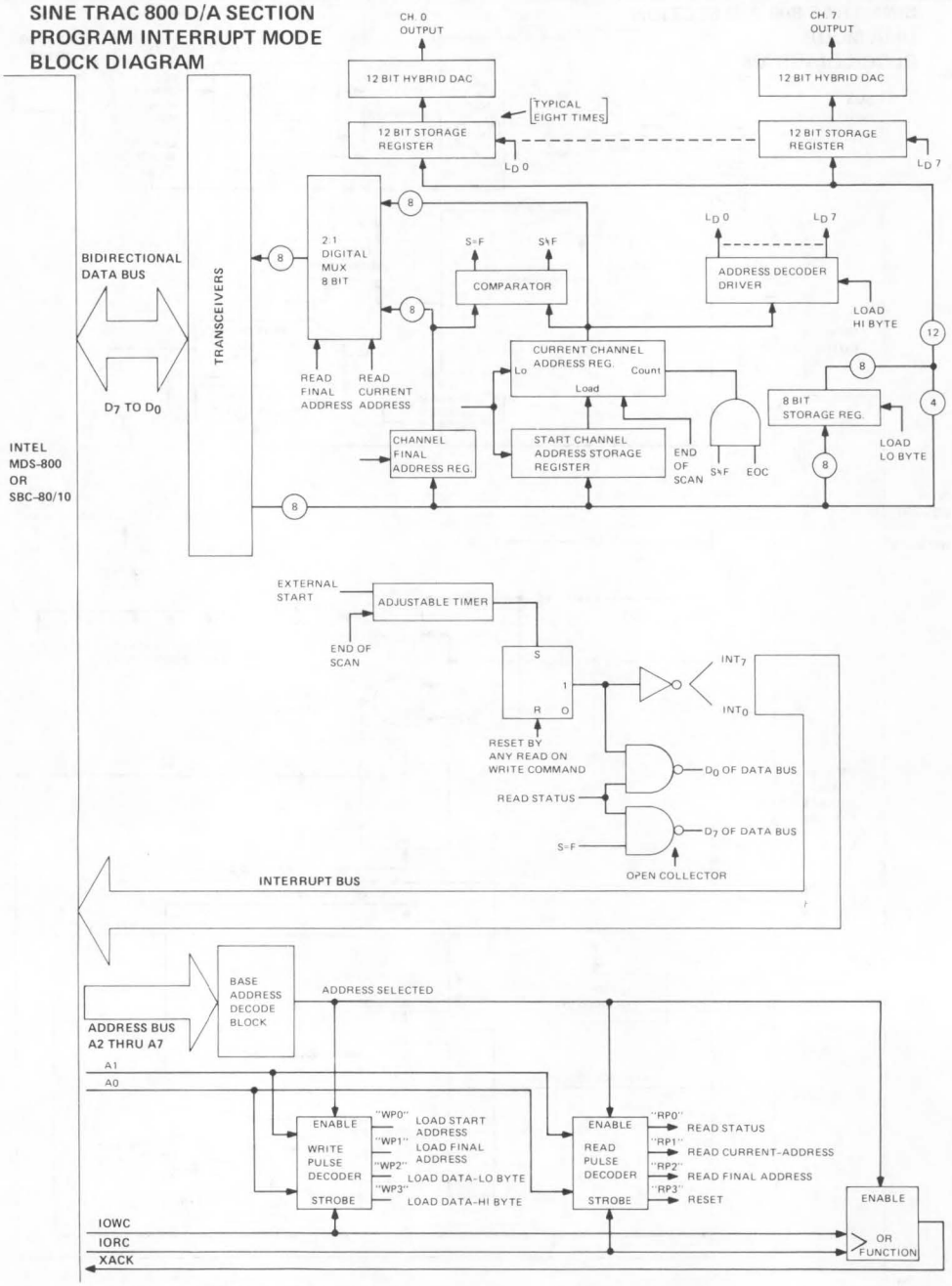
**Card Size** . . . . . 12" x 6.75" compatible to 0.75" guide spacing and I/O pinout of MDS-800 backplane connector and SBC-80/10

**Peripheral* Address** . . . . . Prewired at fixed address 000100XX
Selectable using PC board jumpers, two (2) octal characters

**Interrupt* Level** . . . . . Prewired at fixed level 4
Selectable from 0 to 7 using PC board jumpers

*Test tapes supplied to customers for system verification and checkout are written with the peripheral address and interrupt level shown. If other addresses and interrupts are required, these should be altered using the Intellec Monitor *after* system verification has been performed.

### SINE TRAC 800 D/A SECTION PROGRAM INTERRUPT MODE BLOCK DIAGRAM




DATEL

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Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
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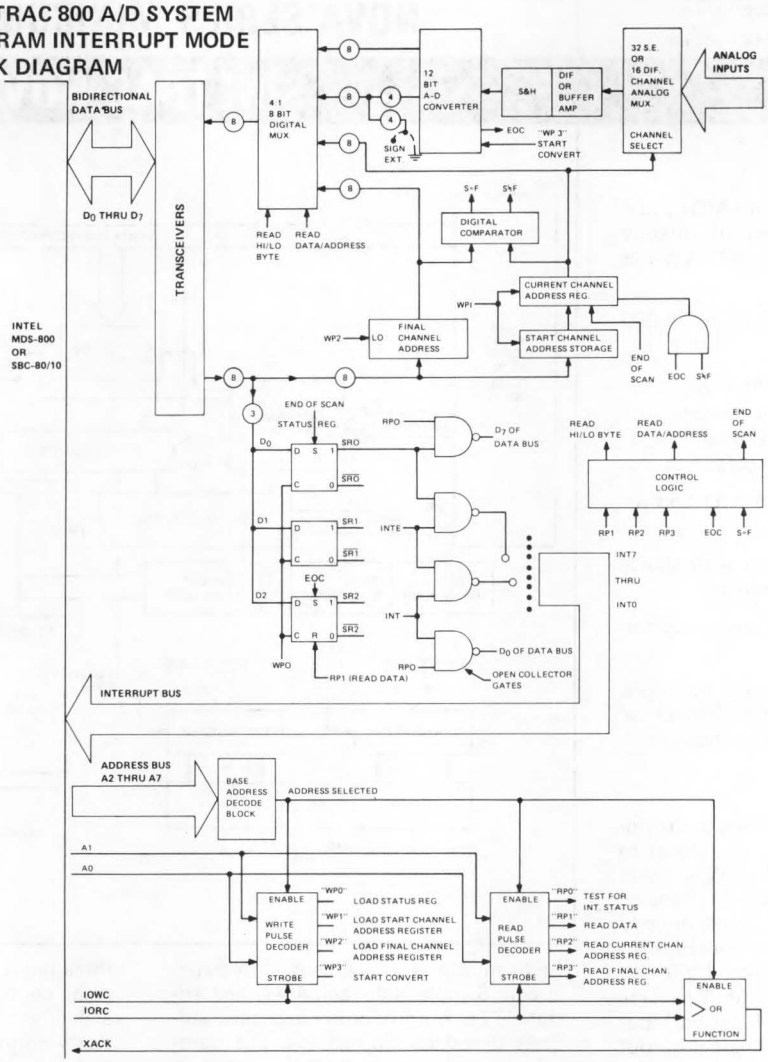
## SINE TRAC 800 A/D SYSTEM PROGRAM INTERRUPT MODE BLOCK DIAGRAM




## ORDERING GUIDE

SINETRAC 800 A/D SYSTEMS

ST-800-

| NUMBER OF CHANNELS AND TYPE | FULL SCALE INPUT VOLTAGE RANGES | OUTPUT CODING | DMA OPTION |
|---|---|---|---|
| 32S = 32 Single-ended<br>16D = 16 Differential | Unipolar Ranges<br>A = 0 to +5V<br>B = 0 to +10V<br>Bipolar Ranges<br>C = −5V to +5V<br>D = −10V to +10V | 1 = Straight Binary, unipolar<br>2 = Offset Binary, bipolar<br>3 = 2's Complement, bipolar | A = Included (requires Intel's DMA Board)<br>B = Not included (Prog. control or prog. interrupt only) |

SINETRAC 800 D/A SYSTEMS

ST-800-

| MASTER OR SLAVE EXPANDER | NO. CHANNELS/CARD AND DC/DC CONVERTER | FULL SCALE OUTPUT VOLTAGE RANGE | INPUT CODING |
|---|---|---|---|
| DA = Master<br>DAX = Slave (Master req'd for control) | 4 = 4 D/A channels DC/DC conv. included<br>8 = 8 D/A channels no DC/DC conv. (ext. +15V pwr req'd) | Unipolar Ranges<br>A = 0 to +5V<br>B = 0 to +10V<br>Bipolar Ranges<br>C = −5V to +5V<br>D = −10V to +10V<br>E = −2.5V to +2.5V | 1 = Straight binary, unipolar<br>2 = Offset binary, bipolar<br>3 = 2's complement, bipolar |

## PRICES (SINGLE QUANTITY) AND ADDITIONAL PC BOARDS

INCLUDES PROGRAM AND MANUAL (1-9)

| | | |
|---|---|---|
| **ST-800-32S** | 32 A/D CHANNELS (SE), ONE BOARD SLOT | **$495** |
| **ST-800-16D** | 16 A/D CHANNELS (DIFF.), ONE BOARD SLOT | **$495** |
| **ST-800-ADX32S** | A/D SLAVE EXPANDER BOARD, 32 SE CHANNELS, REQUIRES ONE ST-800-32S | **$295** |
| **ST-800-DA8** | 8 D/A CHANNELS, REQUIRES EXT. ±15V @ .32A, ONE SLOT | **$495** |
| **ST-800-DAX8** | D/A SLAVE EXPANDER BOARD, 8 CHANNELS, REQUIRES ONE ST-800-DAS MASTER, EXT. ±15V @ .32A, ONE SLOT | **$475** |
| **ST-800-DA4** | 4 D/A CHANNELS, INCLUDES DC/DC CONVERTER FOR ±15V, ONE SLOT | **$429** |
| **ST-800-DAX4** | D/A SLAVE EXPANDER BOARD, 4 CHANNELS, REQUIRES ONE ST-800-DA4 MASTER, INCLUDES DC/DC CONV. | **$395** |

**CONTACT DATEL FOR OTHER A/D EXPANDERS AND ACCESSORIES**

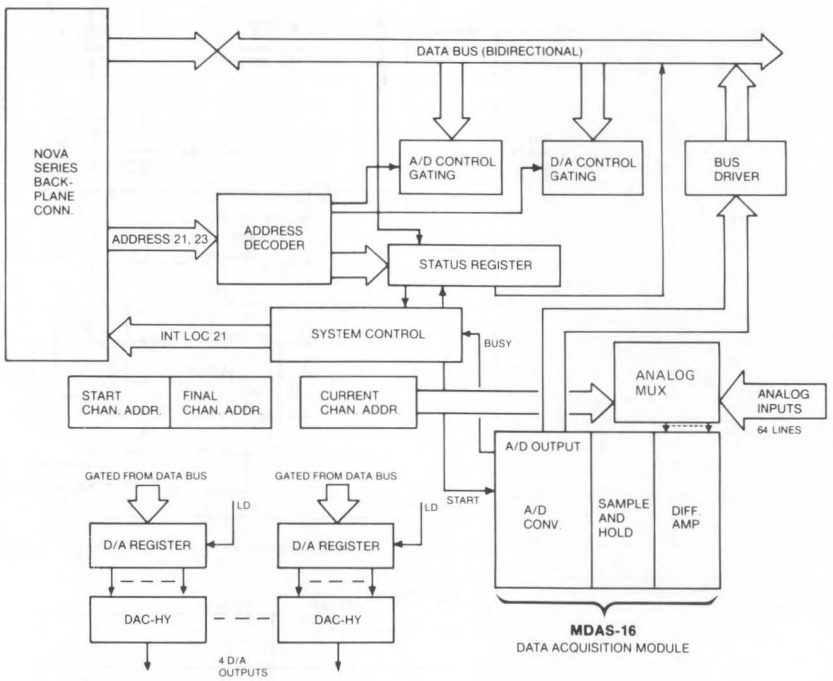
DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# ANALOG DATA PERIPHERALS FOR DATA GENERAL'S NOVA SERIES MINICOMPUTERS

## SINETRAC NOVA SERIES

### FEATURES

- 64-channel analog input (A/D) and 4 output (D/A) channels fit directly inside Data General's NOVA series minicomputers.
- Data Acquisition rates up to 75,000 samples per second.
- Three modes of programming.
  - Program-controlled mode
  - Program-interrupt mode
  - Direct Memory Access
- Expandable up to 256 A/D and /or 256 D/A channels.
- 12-bit analog resolution with choice of coding and voltage ranges.
- Optional auto-zeroing and programmable gain.
- Includes on-board control for block transfer and automatic channel sequencing and for random channels.




### DESCRIPTION

Datel offers a simple approach to providing analog signal inputs and outputs to Data General's popular NOVA series minicomputers. Datel's Sine Trac analog peripheral I/O module plugs directly into the card guides and connector slots inside NOVA, NOVA 800, 1200 and Super NOVA housings. The Sine Trac module accepts up to 64 analog input (A/D) channels and 4 analog output (D/A) channels on the same interface card.

The Sine Trac analog I/O card communicates directly with the NOVA bidirectional bus, thereby, eliminating all CPU cabling. Sine Trac is handled as an addressable peripheral I/O device. Analog connections are made through PC board connectors to the NOVA housing.

Assembly language or high level languages completely control all activities of the Sine Trac analog I/O card. These include random or sequential analog channel addressing with automatic reset on program-specified first and last channels. By using the appropriate I/O instructions, Sine Trac analog channels may be transferred to a teletypewriter, paper or magnetic tape, tape cassettes, CRT terminal or other peripherals.

The Sine Trac board is organized around Datel's MDAS-16, a high density data acquisition module employing a hybrid successive approximation A/D converter FET multiplexer switches, integrated circuit Sample/Hold amplifier, and tri-state TTL output buffer/registers. Address decoders, bidirectional bus transceivers, status and address registers, a ±15V DC/DC converter and control logic complete the rest of the Sine Trac system.

The Sine Trac NOVA card is ideal for process control, automatic test systems, laboratory measurement systems and similar applications. Datel's System 256 will allow for expansion up to 256 A/D channels and/or 256 D/A channels.

The D/A analog output channels available on Sine Trac A/D boards contain storage registers for each 12-bit analog word to maintain a stable analog output between CPU output cycles. The D/A option is ideal for plotter, chart recorder, oscilloscope or actuator drive. It is also excellent for analog feedback or test waveforms to systems under test. Digitally synthesized analog waveforms may be program-generated with a settling time of 4 microseconds per D/A step.

The Sine Trac analog system can accept three modes of operation including program control, program interrupt mode and direct memory access (DMA). Program control requires simple instruction sequences and controls the interface at the time and sequence specified by the program. Interrupt operation is ideal for releasing the CPU for other chores while an A/D conversion is in progress. DMA operation bypasses the CPU and uses the Sine Trac's start and final channel and word counter registers to transfer Sine Trac-controlled blocks of data addresses sequenced by the Sine Trac's memory address register and frame clock.

Very fast auto zeroing circuits and programmable gains are optional on Sine Trac systems. The auto zeroing corrects for voltage offsets and programmable gains of 1, 2, 5, and 10 provide input ranges down to ±500mV full scale. The gain is program controlled and is ideal for applications requiring extended range. Systems without the auto zero/programmable gain option have A/D data throughput of 75,000 samples per second. Throughput for systems with the option is 40,000 samples per second.

## SPECIFICATIONS (Typical @ +25°C, dynamic conditions unless otherwise specified.)

### SINETRAC NOVA SERIES
### ANALOG DATA SYSTEMS

#### DATA ACQUISITION SECTION (A/D Analog Inputs)

#### ANALOG INPUTS

**Number of Channels** . . . . . 64 single-ended
64 pseudo-differential
32 full differential

**Channel Expansion** . . . . up to 256 single-ended channels or
*(using Datel's System 256 in an external housing)* 128 full differential channels

**Input Voltage Ranges** . . . . 0 to +5 Volts
0 to +10 Volts
−5 to +5 Volts
−10 to +10 Volts

**Programmable Gains and Auto zero (optional)** x1, x2, x5, x10 (not avail. 0 to +5 Volt range)

**Common Mode Range** . . . ±10V Volts - guaranteed max.

**Input Overvoltage,** *(no damage)*. . . . . ±15V, max. sustained

**Input Impedance** . . . . . 100 megohms differential or to ground

**Input Bias Current** . . . . 3nA typical, 10nA max.

**Input Capacitance** *(to ground)* . . . . . 10pF, OFF channel, 100pF, ON channel

#### PERFORMANCE

**Accuracy @ +25°C and 75kHz Sampling** . . . . . Within ±.025% of full scale

**Resolution** . . . . . 12 Binary Bits

**Nonlinearity** . . . . . ± 1/2 LSB, max.

**Differential Nonlinearity** . . ± 1/2 LSB, max.

**Gain Error** . . . . . Adjustable to zero

**Offset Error** . . . . . Adjustable to zero

**Gain Temperature Drift** . . . . . Within ± 30ppm of full scale/°C

**Offset Temperature Drift** . . . . . Within ±7ppm of full scale/°C

**Common Mode Rejection** *(with 1 kilohm unbalance)* . . 70 dB min., DC to 1 kHz

**Power Supply Rejection** *(to +5V bus)*. . . . . 100 dB

#### DYNAMIC CHARACTERISTICS

**Throughput Rate** *(without prog. gain/auto zero)* . . . . . 75,000 samples/sec., max.

**Throughput Rate** *(with prog. gain/auto zero)* . . . . . 40,000 samples/sec., max.

**Acquisition Time** . . . . . 6 microseconds

**A/D Conversion Time** . . 7.3 microseconds

**Aperture Time** . . . . . 50 nanoseconds

**Sample/Hold Switch Feedthrough** . . . . . .01% max.

**MUX Crosstalk from OFF Channels** . . . . . .01% @ 1 kHz

#### DIGITAL OUTPUTS

**Output Coding** *(prewired jumpers)* . . . . . Straight Binary (unipolar)
Offset Binary (bipolar)
2's complement (bipolar)

**Output Format** *(prewired jumpers)* . . . . . Buffered output electrically compatible to the Nova bidirectional bus. Sign extension is provided on Bits 12-15.

**Channel Addressing** . . . . . RANDOM - Under program control
SEQUENTIAL - Under program control or under interface DMA control using preloaded start channel, final channel, number of channels and next memory address registers.

**DMA Frame Clock** . . . . . Selectable period up to 1 second per channel (specify with order)

#### INTERFACE ADDRESSING

*NOVA SineTraces are supplied with addressing shown below. Contact Datel if other addressing is required.*

**A/D System Device Address** . . . . . 21

**Assembler Mnemonic** . . . . ADCV

**D/A System Device Address** . . . . . 23

**Assembler Mnemonic** . . . . DACV

**A/D Interrupt Location** . . . . . LOC 21

**POWER CONSUMPTION** . . . 2.5 Amps typical @ +5VDC supplied by DEC backplane connector power bus. On-board ±15V DC/DC converter powers linear circuits.

#### PHYSICAL

**Operating Temperature Range** . . . . . 0°C to +70°C

**Storage Temperature Range** . . . . . −25°C to +85°C

**Card Size** . . . . . 15" x 15" x 0.375" (not including PC card fingers).

**Card Connection** . . . . . One peripheral I/O slot in Nova Series backplane connector

**Humidity** . . . . . 20% to 90% (no condensation)

#### DATA DISTRIBUTION SECTION (D/A Analog Outputs)

#### ANALOG OUTPUTS

**Number of Channels** . . . . 4 single-ended

**Channel Expansion**. . . . . 256 channels addressable using Datel's System 256 (separate housing)

**Output Voltage Ranges** . . 0 to +5 Volts
0 to +10 Volts
−5V to +5 Volts*
−10V to +10 Volts*
*(*specify offset binary or 2's complement output coding)*

**Output Impedance** . . . . . 50 milliohms

**Output Current** . . . . . ±5mA, min., short circuit proof to ground

#### PERFORMANCE

**Nonlinearity** . . . . . ±1/2 LSB, max.

**Differential Nonlinearity** . . . . . ±1/2 LSB, max.

**Gain Error** . . . . . Adj. to zero using pot for each each channel

**Zero Error** . . . . . Adj. to zero using pot for each channel

**Gain Temperature Drift** . . . . . ±30ppm of output/°C

**Zero Temperature Drift** *(unipolar output)* . . . . . ±5ppm of full scale range/°C

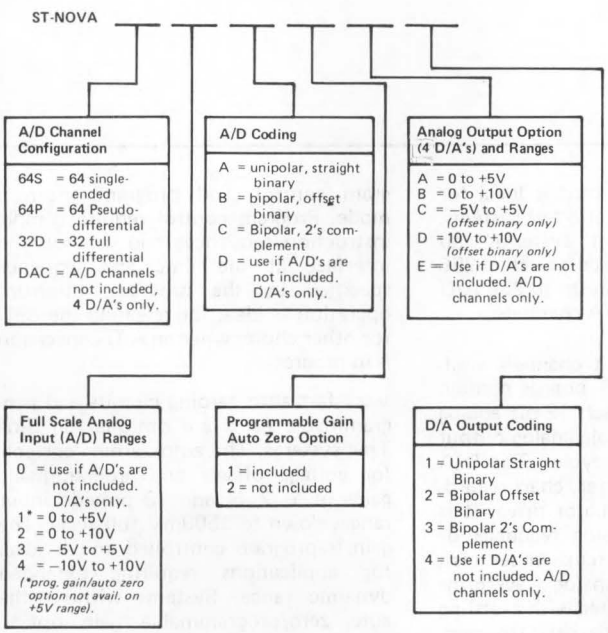
**Offset Temperature Drift** *(bipolar output)* . . . . ±15ppm of full scale range/°C

**Settling Time** . . . . . 4 microseconds to ±1/2 LSB

**Power Supply Rejection** . . . . . ±0.02% of full scale range 1% supply variation

**Power Requirements** . . . ±15VDC @ ±40mA full load per D/A channel. Furnished by on-board DC/DC converter for A/D-D/A card. ±15VDC externally supplied for expanded D/A channels.

### ORDERING GUIDE
**Nova SineTrac Series**




*Specify DMA Frame Clock period up to 1 second maximum.*

### PRICES (Single Quantity)

**ST-NOVA-64S (or −64P or −32D)**
(All A/D input channels and no D/A output channels) . . . . . $1445.

**ST-NOVA-64S (or −64P or −32D)**
(All A/D channels plus 4 D/A channels). . . . . $1795.

**ST-NOVA-DAC**
(No A/D channels but including 4 D/A channels). . . . . $1345.

**ADD $250 FOR THE PROGRAMMABLE GAIN/AUTO ZERO OPTION**


DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
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# ANALOG DATA PERIPHERALS FOR DEC LSI-11 MICROCOMPUTERS

## SINETRAC LSI SERIES

### FEATURES

- 64-channel analog input (A/D) and 2 output (D/A) channels fit directly inside DEC's LSI-11 series minicomputer.
- Data acquisition rates up to 75,000 samples per second.
- Two modes of programming.
  - Program-controlled mode
  - Program-interrupt mode
- Expandable up to 256 A/D and/or 256 D/A channels.
- 12-bit analog resolution with choice of coding and voltage ranges.

### DESCRIPTION

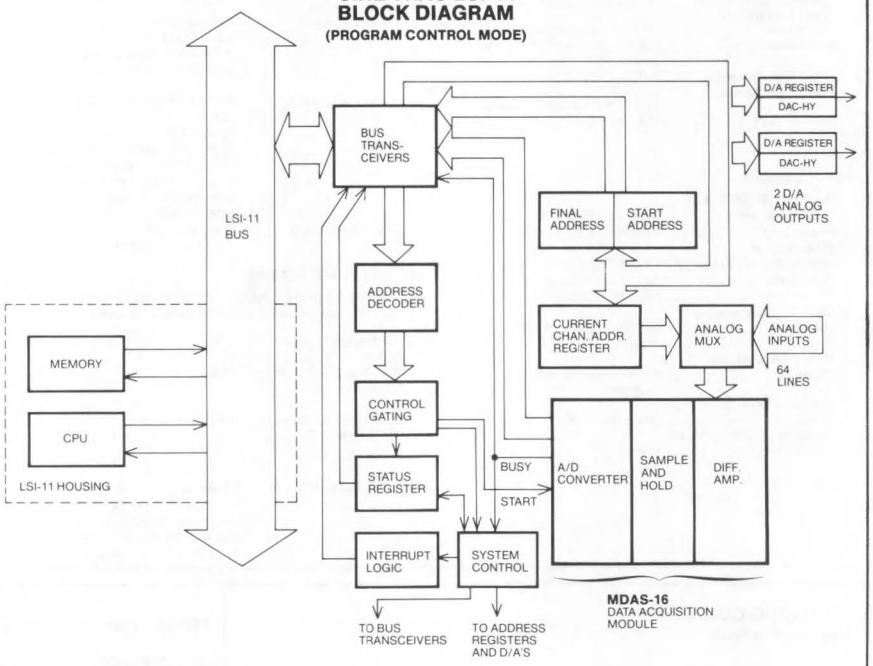
Datel offers a simple approach to providing analog signal inputs and outputs to DEC's popular LSI-11 (PDP-11/03) series microcomputers. Datel's Sine Trac analog peripheral I/O module plugs directly into the card guides in LSI-11 housings or H9270 backplanes. The Sine Trac module accepts up to 64 analog input (A/D) channels and 2 analog output (D/A) channels on the same interface card.

The Sine Trac analog I/O card communicates directly with the LSI-11 bus, thereby, eliminating all CPU cabling. Sine Trac is handled as an addressable peripheral I/O device. Analog connections are made through PC board connectors on the Sine Trac card.

Assembly language or high level languages completely control all activities of the Sine Trac analog I/O card. These include random or sequential analog channel addressing with automatic reset on program-specified first and last channels. By using the appropriate I/O instructions, Sine Trac analog channels may be transferred to a teletypewriter, paper or magnetic tape, tape cassettes, CRT terminal or other peripherals.

The Sine Trac board is organized around Datel's MDAS-16, a high density data acquisition module employing a hybrid successive approximation A/D converter, FET multiplexer switches, integrated circuit Sample/Hold amplifier, and Tri-state TTL output buffer/registers. Address decoders, bidirectional bus transceivers, status and address registers, a ±15V DC/DC converter and control logic complete the rest of the Sine Trac system.

**SINE TRAC LSI-11 BLOCK DIAGRAM**
**(PROGRAM CONTROL MODE)**




The Sine Trac LSI-11 card is ideal for process control, automatic test systems, laboratory measurment systems and similar applications. Datel's System 256 will allow for expansion up to 256 A/D channels and/or 256 D/A channels.

The D/A analog output channels available on Sine Trac A/D boards contain storage registers for each 12-bit analog word to maintain a stable analog output between CPU output cycles. The D/A option is ideal for plotter, chart recorder, oscilloscope or actuator drive. It is also excellent for analog feedback or test waveforms to systems under test. Digitally synthesized analog waveforms may be program-generated with a settling time of 4 microseconds per D/A step.

The Sine Trac analog system can accept two modes of operation including program control, and program interrupt mode. Program control requires simple instruction sequences and controls the interface at the time and sequence specified by the program. Interrupt operation is ideal for releasing the CPU for other chores while an A/D conversion is in progress.

Very fast auto zeroing circuits and programmable gains are optional on Sine Trac systems. The auto zeroing corrects for voltage offsets and programmable gains of 1, 2, 5, and 10 provide input ranges down to ±500mV full scale. The gain is program controlled and is ideal for applications requiring extended dynamic range. Systems without the auto zero/programmable gain option have A/D data throughput of 75,000 samples per second. Throughput for systems with the option is 40,000 samples per second.

# SPECIFICATIONS (Typical @ +25°C, dynamic conditions unless otherwise specified.)

## ANALOG DATA SYSTEMS

### SPECIFICATIONS

(Typical @ +25°C, dynamic conditions unless otherwise specified.)

### DATA ACQUISITION SECTION (A/D Analog Inputs)

#### ANALOG INPUTS

| | |
|---|---|
| **Number of Channels** | 64 single-ended<br>64 Pseudo-differential<br>32 full differential |
| **Channel Expansion** *(using Datel's System 256 in an external housing)* | up to 256 single-ended channels or 128 full differential channels |
| **Input Voltage Ranges** | 0 to +5 Volts<br>0 to +10 Volts<br>−5 to +5 Volts<br>−10 to +10 Volts |
| **Programmable Gains and Autozero** *(optional)* | x1, x2, x5, x10 (not avail. 0 to +5V range) |
| **Common Mode Range** | ±10V Volts guaranteed max. |
| **Input Overvoltage,** *(no damage)* | ±15V, max. sustained |
| **Input Impedance** | 100 megohms differential or to ground |
| **Input Bias Current** | 3nA typical, 10nA max. |
| **Input Capacitance** *(to ground)* | 10pF, OFF channel, 100pF ON channel |

#### PERFORMANCE

| | |
|---|---|
| **Accuracy @ +25°C and 75kHz Sampling** | Within ±.025% of full scale |
| **Resolution** | 12 Binary Bits |
| **Nonlinearity** | ±1/2 LSB, max. |
| **Differential Nonlinearity** | ±1/2 LSB, max. |
| **Gain Error** | Adjustable to zero |
| **Offset Error** | Adjustable to zero |
| **Gain Temperature Drift** | Within ±30ppm of full scale/°C |
| **Offset Temperature Drift** | With ±7ppm of full scale/°C |
| **Common Mode Rejection** *(with 1 kilohm unbalance)* | 70 dB min., DC to 1 kHz |
| **Power Supply Rejection** *(to +5 V bus)* | 100 dB |

#### DYNAMIC CHARACTERISTICS

| | |
|---|---|
| **Throughput Rate** *(without prog. gain/auto zero)* | 75,000 samples/sec., max. |
| **Throughput Rate** *(with prog. gain/auto zero)* | 40,000 samples/sec., max. |
| **Acquisition Time** | 6 microseconds |
| **A/D Conversion Time** | 7.3 microseconds |
| **Aperture Time** | 50 nanoseconds |
| **Sample/Hold Switch Feedthrough** | .01% max. |
| **MUX Crosstalk from OFF Channels** | .01% @ 1 kHz |

#### DIGITAL OUTPUTS

| | |
|---|---|
| **Output Coding** *(prewired jumpers)* | Straight Binary (unipolar)<br>Offset Binary (bipolar)<br>2's complement (bipolar) |
| **Output Format** *(prewired jumpers)* | Buffered output electrically compatible to DEC's bi-directional bus. Sign extension is provided on Bits 12-15. |
| **Channel Addressing** | RANDOM - Under program control<br>SEQUENTIAL - Under program control |

#### POWER CONSUMPTION

2.5 Amps typical @ +5VDC supplied by DEC backplane connector power bus. On-board ±15V DC/DC converter powers linear circuits.

#### PHYSICAL

| | |
|---|---|
| **Operating Temperature Range** | 0°C to +70°C |
| **Storage Temperature Range** | −25°C to +85°C |
| **Card Size** | 8.5" x 10" x 0.375" (not including PC card fingers). Card area covers one extended length quad module. |
| **Card Connection** | One module slot in the PDP-11/03 Housing or H9270 backplane card cage. |
| **Humidity** | 20% to 90% (no condensation) |

### DATA DISTRIBUTION (D/A Analog Outputs)

#### ANALOG OUTPUTS

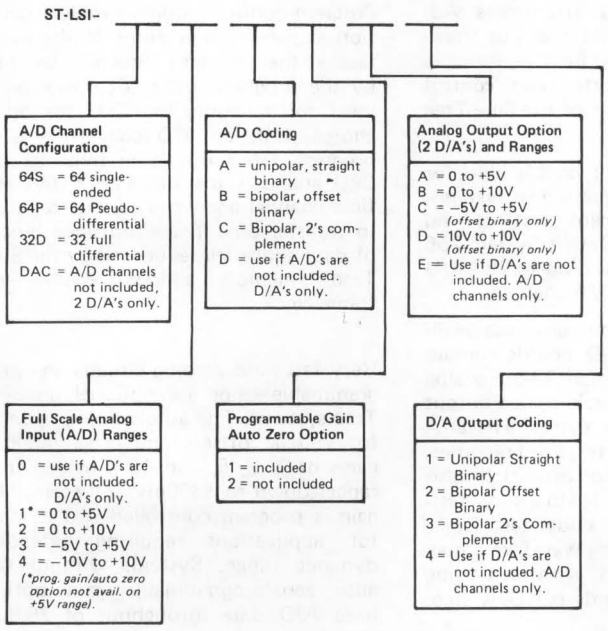
| | |
|---|---|
| **Number of Channels** | 2-single-ended |
| **Channel Expansion** | 256 channels addressable using Datel's System 256 (separate housing) |
| **Output Voltage Ranges** | 0 to +5 Volts<br>0 to +10 Volts<br>−5V to +5 Volts*<br>−10V to +10 Volts*<br>*(*offset binary or 2's complement, specify when ordering)* |
| **Output Impedance** | 50 milliohms |
| **Output Current** | ±5mA, min., short circuit proof to ground |

#### PERFORMANCE

| | |
|---|---|
| **Nonlinearity** | ±1/2 LSB, max. |
| **Differential Nonlinearity** | ±1/2 LSB, max. |
| **Gain Error** | Adj. to zero using pot for each channel |
| **Zero Error** | Adj. to zero using pot for each channel |
| **Gain Temperature Drift** | ±30ppm of output/°C |
| **Zero Temperature Drift** *(unipolar output)* | ±5ppm of full scale range/°C |
| **Offset Temperature Drift** *(bipolar output)* | ±15ppm of full scale range 1% |
| **Settling Time** | 4 microseconds to ±1/2 LSB |
| **Power Supply Rejection** | ±0.02% of full scale range 1% supply variation |
| **Power Requirements** | ±15VDC @ ±40mA full load per D/A channel. Furnished by on-board DC/DC converter for A/D-D/A card. ±15VDC externally supplied for expanded D/A channels. |

## ORDERING GUIDE

**LSI-11 SineTrac Series**




### PRICES (Single Quantity)

**ST-LSI-64S (or −64P or −32D)**
(A/D analog input cards without D/A outputs. . . . . $ 895.

**ST-LSI-64S (or −64P or −32D)**
(A/D analog input card including 2 D/A outputs) . . . . . $1045.

**ST-LSI-DAC**
(No A/D inputs but with 2 D/A outputs) . . . . . $ 545.

**ADD $250 FOR THE PROGRAMMABLE GAIN/AUTO ZERO OPTION**

**Model ST-LSI-DA8**
Optional 8 channel single-ended analog output (D/A)
(Specify +5V, +10V, ±5V, ±10V full scale outputs.
Requires A/D section for control. Uses ±15V power
from DEC power supply or from external source) . . . . . $ 750.

**Model ST-LSI-DA4**
4 channel analog output.
Same as −DA8 but includes ±15V DC/DC converter . . . . . $ 595.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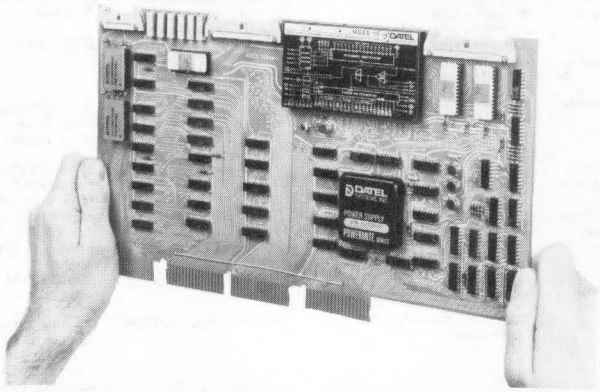
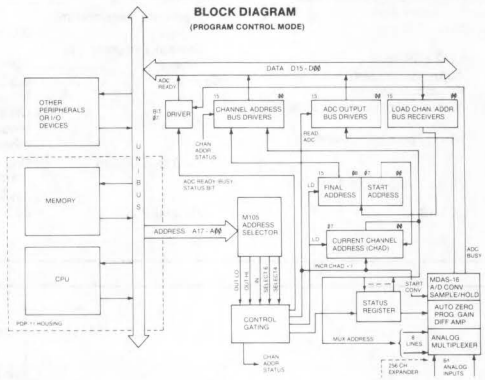
# ANALOG DATA PERIPHERALS FOR DEC PDP-11 MINICOMPUTERS

## SINETRAC PDP SERIES

### FEATURES

- 64-channel analog input (A/D) and 2 output (D/A) channels fit directly inside DEC's PDP-11 series minicomputers.
- Data acquisition rates up to 75,000 samples per second.
- Three modes of programming.
  - Program-controlled mode
  - Program-interrupt mode
  - Direct Memory Access
- Expandaple up to 256 A/D and/or 256 D/A channels. 12-bit analog resolution with choice of coding and voltage ranges.
- Optional auto-zeroing and programmable gain.
- Includes on-board control for block transfer and automatic channel sequencing and for random channels.






### DESCRIPTION

Datel offers a simple approach to providing analog signal inputs and outputs to DEC's popular PDP-11 series minicomputers. Datel's Sine Trac analog peripheral I/O module plugs directly into the card guides and connector slots inside PDP-11 housings. The Sine Trac module accepts up to 64 analog input (A/D) channels and 2 analog output (D/A) channels on the same interface card.

The Sine Trac analog I/O card communicates directly with the PDP-11 unibus, thereby, eliminating all CPU cabling. Sine Trac is handled as an addressable peripheral I/O device. Analog connections are made through the rear cable clamps on the PDP-11 housing.

Assembly or high level languages completely control all activities of the Sine Trac analog I/O card. These include random or sequential analog channel addressing with automatic reset on program-specified first and last channels. By using the appropriate I/O instructions, Sine Trac analog channels may be transferred to a teletypewriter, paper or magnetic tape, tape cassettes, CRT terminal or other peripals.

The Sine Trac board is organized around Datel's MDAS-16, a high density data acquisition module employing a hybrid successive approximation A/D converter, FET multiplexer switches, integrated circuit Sample/Hold amplifier, and tri-state TTL output buffer/registers. Address decoders, bidirectional bus transceivers, status and address registers, a ±15V DC/DC converter and control logic complete the rest of the Sine Trac system.

The Sine Trac PDP-11 card is ideal for process control, automatic test systems, laboratory measurement systems and similar applications. Datel's System 256 will allow for expansion up to 256 A/D channels and/or 256 D/A channels.

The D/A analog output channels available on Sine Trac A/D boards contain storage registers for each 12-bit analog word to maintain a stable analog output between CPU output cycles. The D/A option is ideal for plotter, chart recorder, oscilloscope or actuator drive. It is also excellent for analog feedback or test-waveforms to systems under test. Digitally synthesized analog waveforms may be program-generated with a settling time of 4 microseconds per D/A step.

The Sine Trac analog system can accept three modes of operation including program control, program interrupt mode and direct memory access (DMA). Program control requires simple instruction sequences and controls the interface at the time and sequence specified by the program. Interrupt operation is ideal for releasing the CPU for other chores while an A/D conversion is in progress. DMA operation bypasses the CPU and uses the Sine Trac's start and final channel and word counter registers to transfer Sine Trac-Controlled blocks of data addresses sequenced by the Sine Trac's memory address register and frame clock.

Very fast auto zeroing circuits and programmable gains are optional on Sine Trac systems. The auto zeroing corrects for voltage offsets and programmable gains of 1, 2, 5, and 10 provide input ranges down to ±500mV full scale. The gain is program controlled and is ideal for applications requiring extended dynamic range. Systems without the auto zero/programmable gain option have A/D data throughput of 75,000 samples per second. Throughput for systems with the option is 40,000 samples per second.

## SPECIFICATIONS (Typical @ +25°C, dynamic conditions unless otherwise specified.)

### DATA ACQUISITION SECTION (A/D Analog Inputs)

#### ANALOG INPUTS

**Number of Channels** . . . . 64 single-ended
64 pseudo-differential
32 full differential

**Channel Expansion** . . . . . up to 256 single-ended channels or 128 full differential channels
*(using Datel's System 256 in an external housing)*

**Input Voltage Ranges** . . . . 0 to +5 Volts
0 to +10 Volts
−5 to +5 Volts
−10 to +10 Volts

**Programmable Gains and Autozero** *(optional)* . . . . x1, x2, x5, x10 (not available 0 to +5V range)

**Common Mode Range** . . . ±10V Volts guaranteed maximum

**Input Overvoltage,** *(no damage)* . . . . . ±15V, max. sustained

**Input Impedance** . . . . . 100 megohms differential or to ground

**Input Bias Current** . . . . . 3nA typical, 10nA max.

**Input Capacitance** *(to ground)* . . . . . 10pF, OFF channel, 100pF, ON channel

#### PERFORMANCE

**Accuracy @ +25°C and 75kHz Sampling** . . . . . Within ± 025% of full scale

**Resolution** . . . . . 12 Binary Bits

**Nonlinearity** . . . . . ± 1/2 LSB, max.

**Differential Nonlinearity** . ±1/2 LSB, max.

**Gain Error** . . . . . Adjustable to zero

**Offset Error** . . . . . Adjustable to zero

**Gain Temperature Drift** . . Within ±30ppm of full scale/°C

**Offset Temperature Drift** Within ±7ppm of full scale/°C

**Common Mode Rejection** *(with 1 kilohm unbalance)* . . 70 dB min., DC to 1 kHz

**Power Supply Rejection** *(to +5V bus)* . . . . . 100 dB

#### DYNAMIC CHARACTERISTICS

**Throughput Rate** *(without prog. gain/auto zero)* . . . . . 75,000 samples/sec., max.

**Throughput Rate** *(with prog. gain/auto zero)* . . . . . 40,000 samples/sec., max.

**Acquisition Time** . . . . . 6 microseconds

**A/D Conversion Time** . . 7.3 microseconds

**Aperture Time** . . . . . 50 nanoseconds

**Sample/Hold Switch Feedthrough** . . . . . .01% max.

**MUX Crosstalk from OFF Channels** . . . . . .01% @ 1 kHz

### DIGITAL OUTPUTS

**Output Coding** *(prewired jumpers)* . . . . . Straight Binary (unipolar
Offset Binary (bipolar)
2's complement (bipolar)

**Output Format** *(prewired jumpers)* . . . . . Buffered output electrically compatible to DEC's bidirectional bus. Sign extension is provided on Bits 12-15.

**Channel Addressing** . . . . RANDOM - Under program control
SEQUENTIAL - Under program control or under interface DMA control using preloaded start channel, final channel, number of channels and next memory address registers.

**DMA Frame Clock** . . . . . Selectable period up to 1 second per channel (specify with order).

### INTERFACE ADDRESSING

**PDP-11 Sinetracs are supplied with addressing shown below. Contact Datel if other addressing is required.**

**M105** *(Address Selector)*
**Address** . . . . . 762000 thru 762006 with jumper 10 cut.

**DMA Address** . . . . . 762010 thru 762016 with jumpers 10 and 3 cut.

**Vector Address-Interrupt Interface** *(Program Interrupt)*
**M7821** *(VECTOR BIT 2L)* 770 (no jumper cuts)

**Vector Address** *(DMA Mode)*
**M7821** *(VECTOR BIT 2H)* 774 (no jumper cuts)

**Bus Request Level** . . . . . 7

**Bus Grant Level** . . . . . 7

### POWER CONSUMPTION

**2.5 Amps typical @ +5VDC supplied by DEC backplane connector power bus. On-board ±15V DC/DC converter powers linear circuits.**

### PHYSICAL

**Operating Temperature Range** . . . . . 0°C to +70°C

**Storage Temperature Range** . . . . . −25°C to +85°C

**Card Size** . . . . . 7.69" x 15.5" x 0.375" (not including PC card fingers). Card area covers 6 BB11 card slots.

**Card Connection** . . . . . Four BB11 card slots (C thru F). Wire wrapped BB11, power and I/O connectors supplied on full systems (see ordering).

**Humidity** . . . . . 20% to 90% (no condensation)

### DATA DISTRIBUTION SECTION (D/A Analog Outputs)

#### ANALOG OUTPUTS

**Number of Channels** . . . . 2 single-ended

**Channel Expansion** . . . . . 256 channels addressable using Datel's System 256 (separate housing)

**Output Voltage Ranges** . . 0 to +5 Volts
0 to +10 Volts
−5V to +5 Volts*
−10V to +10 Volts*
*(*offset binary or 2's complement specify when ordering)*

**Output Impedance** . . . . . 50 milliohms

**Output Current** . . . . . ±5mA, min., short circuit proof to ground

#### PERFORMANCE

**Nonlinearity** . . . . . ±1/2 LSB, max.

**Differential Nonlinearity** ±1/2 LSB, max.

**Gain Error** . . . . . Adj. to zero using pot for each channel

**Zero Error** . . . . . Adj. to zero using pot for each channel

**Gain Temperature Drift** ±30ppm of output/°C

**Zero Temperature Drift** *(unipolar output)* . . ±5ppm of full scale range/°C

**Offset Temperature Drift** *(bipolar output)* . . . . ± 15ppm of full scale range/°C

**Settling Time** . . . . . 4 microseconds to +1/2 LSB

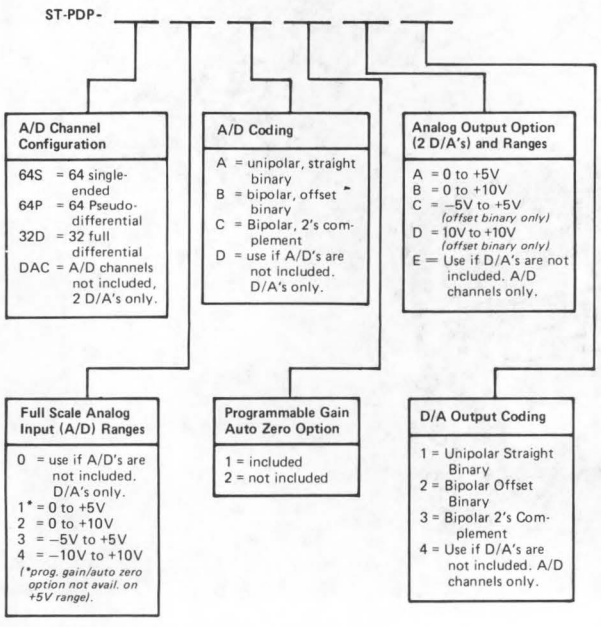
**Power Supply Rejection** . . . . . ±0.02% of full scale range 1% supply variation

**Power Requirements** . . . ±15VDC @ ±40mA full load per D/A channel. Furnished by on-board DC/DC converter for A/D-D/A card. ±15VDC externally supplied for expanded D/A channels.

DATEL

## ORDERING GUIDE
PDP-11 Sinetrac Series

**CONTACT DATEL FOR LATEST ORDERING INFORMATION**




*Specify DMA Frame Clock period up to 1 second maximum.*

### PRICES (Single Quantity)

**ST-PDP-64S, −64P or −32D A/D Section** (less 2 D/A's, less prog. gain/auto zero) . . . . . $ 795.

**Add for programmable gain/auto zero option** (see specifier in A/D Section Model Number) . . . . . $ 250.

**Add for two analog output (D/A) channels mounted on A/D Section** (see specifier in A/D Section Model Number . . $ 150.

**Model 11175, DMA Board, 3 Backplane slots** (see full system description below) . . . . . $ 250.

**Model ST-PDP-DA8 optional eight channel single-ended analog output (D/A)** (specify +5V, +10V, ±10V. Requires A/D section for control. Uses ±15V power from DEC power supply or from external source) . . . . . $750.

**Model ST-PDP-DA4 - 4 channel analog output.** Same as −DA8 but includes ±15V DC/DC converters . . . . . $ 595.

### FULL SYSTEMS

*(Analog output D/A and programmable gain/auto zero options may be added to any of these systems.)*

**PROGRAM CONTROL** (includes the following:)

| Model | Description | Manufacturer |
|---|---|---|
| **M920B** | Bus Extender | DEC |
| **M105C** | Address Selector | DEC |
| **BB11** | Connector Block (wire-wrapped by Datel for analog I/O systems) | DEC |
| **11180** | +5V Jumper Card | DATEL |
| **ST-PDP-** | 64 channel A/D Section | DATEL |

Total Price $2295.

**PROGRAM INTERRUPT** (includes the above, plus the following:)

| | | |
|---|---|---|
| **M7821B** | Interrupt Control | DEC |

Total Price $2495.

**DIRECT MEMORY ACCESS** (includes the above, plus the following:)

| | | |
|---|---|---|
| **11175** | DMA Board | DATEL |

Total Price $2775.

DATEL
SYSTEMS, INC.
1020G Turnpike Street, Building S
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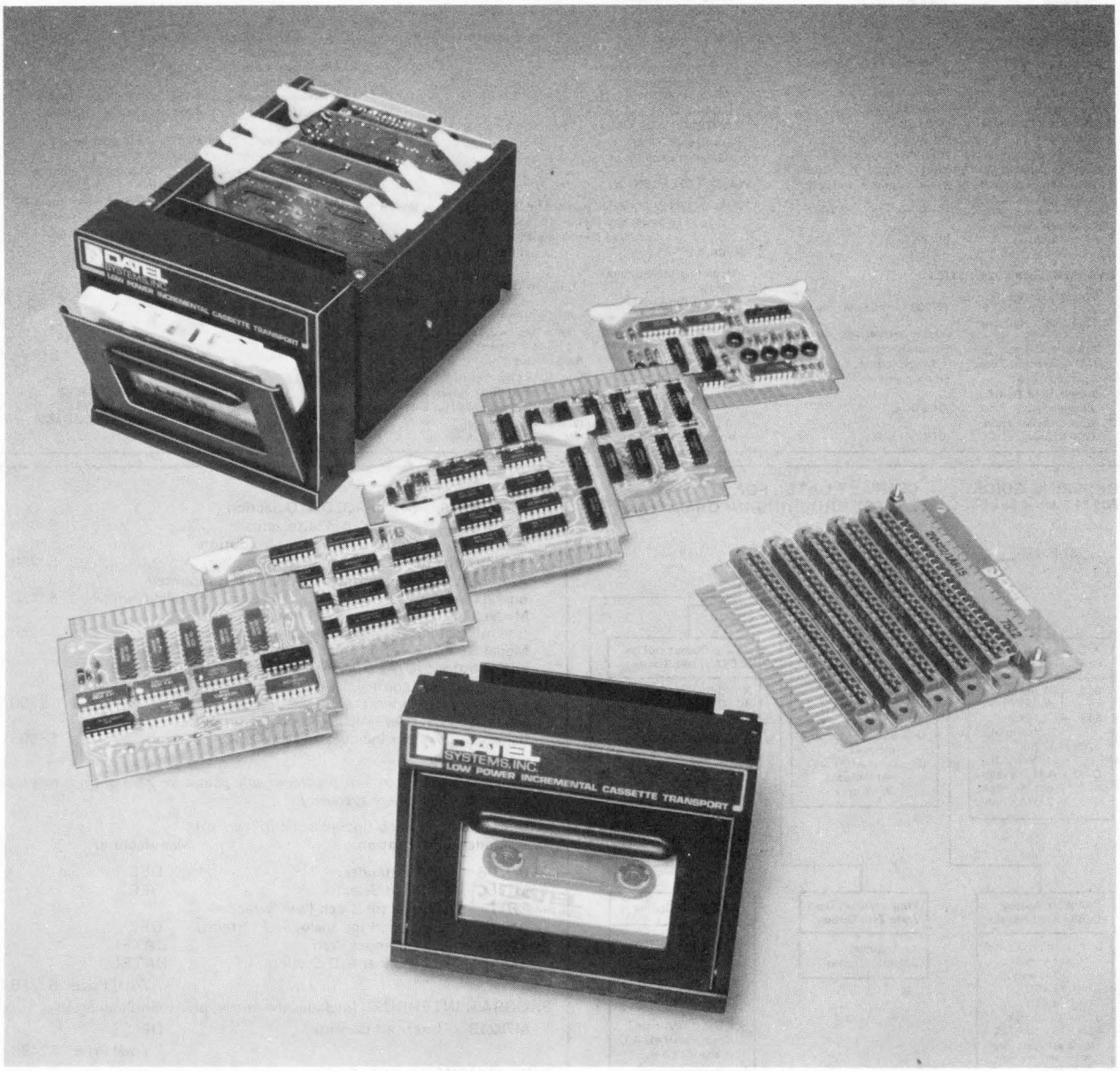
# Digital Cassette Recorders & Systems



DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
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# WRITE-ONLY, ULTRA LOW POWER INCREMENTAL DIGITAL CASSETTE TRANSPORTS AND RECORDER SYSTEMS

# ICT-SERIES

### TRANSPORT FEATURES

- Simple, reliable capstan/pinch roller stepping motor drive
- Ultra-low power (700 milliwatts while writing) using CMOS electronics
- True standby incremental performance starts writing within 20 milliseconds
- Choice of complementary NRZ or ANSI/ECMA/ISO phase-encoding formats
- High data capacity: Up to 2.2 million bits per 300 foot cassette

### RECORDER SYSTEM FEATURES

- Accepts digitized analog, serial or parallel digital inputs
- Ideal for +12VDC battery portable digital data recorders
- ANSI/ECMA/ISO systems automatically record preamble, postamble, CRC, CR, NULL, LF ASCII characters
- Optional A/D converter, 16 channel analog multiplexer, sample/hold and channel sequencer available
- Reader Systems available to interface most computer terminals, RS-232-C CRT displays, modems and teleprinters (TTY)


### INTRODUCTION

Datel presents its ICT-series digital incremental cassette tape transport systems. These unique data recorders and reader systems offer a new concept to the instrument designer—miniature, removable ultra-low power, digital data storage. Using a Philips data tape cassette, low power incremental stepping motor and CMOS electronics, these recorders are ideal for portable-battery-powered data collection instruments.

Datel's cassette systems form the nucleus of your data recorder. They complement your selection of input transducers, signal conditioners and your computer system. Inputs to the optional A/D converter analog section have been standardized to 5 and 10 Volt levels commonly available from many sensors.

Reader/interface systems which are separate from the data recorder provide several output forms (full parallel, TTY/RS-232-C ASCII, 1/2" mag. tape) to adapt to different computers and printout devices.

Datel also offers a new concept to the engineer or scientist interested in data recording with tape systems. The ICT-series offers a simplified approach with circuit card modules which are specified in terms familiar to circuit designers who know digital logic. Data entry, retrieval and power-up, power-down considerations are simplified to the point of providing and accepting logic levels at the required times. For a complete system design, details of the transport's flux levels and motor drive are transparent to the designer, requiring only a knowledge of ultimate word size, bit rate and data capacity. Yet Datel's transport and individual card modules are fully specified so that customized systems may be created at any level from transports alone up to fully packaged systems.

With very fast power turn on, the tape moves only when actually recording data or creating a gap. At all other times when not recording data, the transport and power-multiplexed electronics remain turned off to save tape and batteries.

The fast turn-on, turn-off feature means that tape is up to writing speed within 10 milliseconds with no coasting when turned off. Data systems such as seismic recorders may be designed to record only when data is actually present, providing a very large data capacity per cassette. Hand-held stock inventory recorders move the tape only when keyboard data has been entered.

### MODELS AVAILABLE

Datel offers these cassette recorders and companion readers as complete systems or as general purpose component modules for the widest range of applications. The basic ICT-series transports are available with a family of printed circuit cards, parallel-to-serial/formatter cards, A/D converter, multiplexer and sample/holds for analog inputs. Transport and PC cards may be purchased separately at any time to build complete customized low power digital recording systems.

### APPLICATIONS

Complete Cassette Data Logging Systems from Datel are available to record up to 16 or 64 analog channels, both as user-mounted modular systems and as stand-alone, weatherproof automatic data acquisition/logging systems (refer to Datel Models LPS-16 and DL-2). Applications include oceanographic buoys and submersible probes, portable air and water quality environmental monitors, traffic and noise loggers, natural resources exploration, vehicular testing, seismic and geophysical measurements, RF field strength and transmission loggers, unmanned weather stations and biomedical loggers.

## RECORDING FORMATS

Datel uses two cassette digital recording methods. A dual-track complementary NRZ (CNRZ) method is used for high noise immunity and self-clocking on playback. This high capacity method uses both tracks of the tape simultaneously and records in only one direction. Using separate 1's and 0's tracks and very small gaps, one cassette can hold up to 2.2 million bits, or 120,000 A/D samples.

Datel also uses a single-track phase-encoding serial method fully compatible with widely accepted ANSI/ECMA/ISO standards. Both sides of the cassette may be written. The ANSI/ECMA/ISO format is 8-bit oriented with optional parity as the 8th bit or fixed at one or zero. This format is ideal for interfacing to ASCII encoded data or to the IEEE-488 instrument interface bus. The proper preamble, cyclic redundancy check characters and post-amble are recorded for playback synchronization, start of data recognition and error detection. Datel's ANSI/ECMA/ISO transports are unique from those of other manufacturers in that full incremental operation is a standard feature (rapid start and stop with each byte). Yet the transport retains its ultra low-power stepping motor design. Tapes prepared on Datel's cassette transport may be used on any reader which is fully ANSI/ECMA/ISO compatible. This includes a variety of CRT terminals and computers accepting ASCII coding using a serial interface with EIA RS-232-C electrical specifications.

## CASSETTE TRANSPORT FEATURES

Datel's incremental cassette transport features a design simplicity not found in other mechanisms. An elegantly simple tape speed control is provided using a four-winding stepping motor with 48 rotor steps per revolution and geared down capstan drive. The stepping motor relies on electronically rotating the stator field around permanent magnet multi-pole rotors instead of mechanical brushes and a commutator. A CMOS clock sequences the stepping motor drivers. This avoids the usual methold found in continuous recorders employing slotted strobe discs, tachometers or pre-recorded clock tracks. All of these methods require some servo slewing time to reach accurate speed, thereby adding a delay in true incremental applications. The stepping motor drive features high electrical to mechanical efficiency since there is no brush friction drag. The complete transport and electronics are optimized for ultra-low power (one watt while stepping) making it ideal for battery-operated portable systems.

Further mechanical simplicity and ultra-low power is enhanced by the single-motor write-only transport. Instead of a second motor to maintain take-up tape tension, a spring-belt and friction clutch takeoff from the capstan drive maintain constant take-up hub torque and tape tension.

The ICT-series write-only transports are optimized for ultra-low battery power with bit writing rates within bytes or words of 50 or 100 bits/second. These bit rates are adequate for a wide variety of portable and long term instrumentation applications. These include hand-held keyboard inventory recorders and field data logging of slowly varying analog parameters such as temperature, pressure, RF field strength, etc. However, on playback, ICT-recorder cassettes may be read at the full speed of most computer cassette readers, typically several thousand bits per second. Playback bit rates within blocks or files at a tape speed of 2.5 inches per second are 2 Kilo bits per second or 250 bytes per second.

Special reader transports with appropriate heads and drives available from several manufacturers allow data search speeds up to 30 inches per second or more.

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## RECORDING TECHNIQUES TO CONSERVE POWER AND TAPE

Datel's ICT recorder systems use several methods to save available battery energy and to record a maximum amount of data on tape.

The stepping motor drive allows immediate access (with 10 milliseconds) from data input to writing on tape unless the system is within a gap. This fast turn-on saves time, tape, and battery energy normally required to establish higher tape speeds typical of continuous or constant-speed incremental transports.

The second factor which saves time, tape and batteries is the incremental operating mode. Since tape can be stopped or started at any time except within a byte, word or gap, the transport can be shut off any time data is not ready to record. The tape is moved only when actually recording data or generating gaps.

The fast turn-off and turn-on are controlled by logic levels generated on the ICT-series circuit cards. Extensive use of digital integrated circuits means that no warm-up time is required. The logic family chosen was CMOS (Complementary Metal Oxide Semiconductor) because of the exceptionally low power required, high reliability and high noise immunity.

For these reasons, Datel's ICT incremental cassette systems comprise one of the more energy-efficient data storage systems that are commercially available.

# DIGITAL CASSETTE TRANSPORT SPECIFICATIONS (Typical over 0° to +70°C unless noted)

| | Model ICT-Wa Biphase-Level ANSI/ECMA/ISO Format | Model ICT-WZ Complementary Format |
|---|---|---|
| **GENERAL** | | |
| Recording Medium | Philips magnetic tape cassette, certified for digital operation by using a bit-error check for dropouts. The transport is designed to accept cassettes complying with ANSIX3. 48, ECMA-34 and ISO/DIS3407 specs. | |
| Number of Tracks | One half-width track | Two half-width tracks, recorded simultaneously |
| Recording Direction | Two directions by flipping cassette over | One direction only |
| **TAPE MOTION** | | |
| Motor | 4-winding 24 pole, permanent magnet stepping motor | |
| Equivalent Tape Speed Range | Zero to 0.063 inches per second (1,59 mm/sec) | Zero to 0.163 inches per second (4, 13 mm/sec) |
| Nominal Tape Speed | 0.063 in./sec. (1,59 mm/sec) at 100 steps/sec. | 0.163 in./sec. (4, 13mm/sec) at 100 steps/sec. |
| Bit Density | 800 bits per inch (1600 FRPI) 32 bits per mm | 615 bit per inch (615 FRPI) 24 bits per mm |
| Bit Cell Spacing | 0.00125 inches per bit 0,0318 mm per bit | 0.00163 inches per bit 0,0414 mm per bit |
| Bit Writing Rate | Zero to 50 bits/second, asynchronous | Zero to 100 bits/second, asynchronous |
| **STEPPING MOTOR CHARACTERISTICS** | | |
| Tape Drive Capstan Diameter | 0.118 inches 3,0 mm | 0.1246 inches 3,16 mm |
| Capstan Rotation Step Angle | 0.6° | 1.5° |
| Stepping Rate | Zero to 100 steps per second, asynchronous | Zero to 100 steps per second, asynchronous |
| Number of Stator Windings | 4 | |
| Winding Resistance | 450 ohms per winding, ± 20% | |
| Winding Inductance | 335 millihenries per winding, ± 20% | |
| Motor Steps per Bit Cell | 2 | 1 |
| Winding Voltage | ± 10V min. to ± 24V max. | |
| Hub and Capstan Torques and Tape Tension | Suitable for cassettes within ANSI/ECMA/ISO specifications | |
| **TAPE HEAD CHARACTERISTICS** | | |
| Tape Saturation Current | 5mA typ. | |
| Suggested Write Current | 7.5mA typ. | |
| D.C. Resistance | 50 ohms ± 20% | |
| Effective Track Width | 0.057 inches (1, 45 mm) | |
| Nominal Space Between Tracks | 0.035 inches (0,88 mm) (Tracks are symmetrically spaced) | |
| **DATA CHARACTERISTICS USING DATEL'S ELECTRONICS** | | |
| Recording Format | Single track full serial, externally clocked using 8-bit bytes phase-encoded per ANSI/ECMA/ISO standards | 2-track serial complementary NRZ 1's on Track 1, 0's on Track 2 |
| Character Record Length | 8-bit bytes | 8, 10, 12, 14 or 16 bit characters or words |
| File or Block Length | Blocks consisting of 2 min. up to 256 max. usable data bytes per block | Files consisting of 1, 2, 4, 8, 16, 32 or 64 characters or words per block |
| Gaps | 0.8" (20, 3mm) nominal noiseless gap written between each block. No gaps within blocks. One-half gap generated before each data block and the other half after the data block. | 2-bit intercharacter, or inter-word gaps added before each character. 12-bit end-of-file gap written after each file. |
| Gap Stepping Rate | 250 steps/sec. | 100 steps/sec. |
| Time to General Full Gap Length | 5.1 sec. | 0.12 sec. |
| Power Consumption *(Transport & Tapehead only)* | 700 mW typ. @ 100 steps/sec. (+12VDC @ 60 mA) | |
| **DATA CAPACITY** (Assuming 64 8-bit characters per block or file, plus non-data characters and 282 feet (86 m) usable recording area) | | |
| Block or File Length including Controls and Gaps | 1.48 inches (37, 6 mm) | 1.06 inches (26, 9 mm) |
| Block or Files per Cassette | 2260 blocks (recording one side) | 3200 files |
| Bit Cells per Block or File (including Gaps and Control Characters) | 1200 | 652 |
| Time per Block or File (not including gaps) | 11.2 seconds | 6.4 seconds |
| Time to Fill a Cassette (continuous running at max. step rate) | 10.2 hours per side | 5.8 hours |
| Bit Writing Rate | 50 bits/sec. | 100 bits/sec. |
| Playback Speed, typical | 250 bytes/sec. (2.5 ips) (TI 733 ASR) or higher | 1700 bits/sec. (LPR-16 Reader, 2.75 ips |
| Time to Generate Full Gap* Length | 5.1 sec. @ 250 steps/sec. | 0.12 sec. @ 100 steps/sec. |
| Gear backlash, tape creep and slack is taken up by load forward and gapping operations. | | |
| **2.55 second half-gap generated before and after each data block.* | | |
| **PHYSICAL** | | |
| Weight | 1.25 pounds (0,567 kilogram) | |
| Dimensions | 3.91" High x 4.5" Wide x 4.2" Deep (99,3 x 114,3 x 106,7 mm) | |
| Maximum Extension in Front of Mounting Panel * (door closed) (door open) | 1.40" (35,6 mm) 2.26" (57,4 mm) | |
| Maximum Depth Behind Mounting Panel | 1.94" (49,3 mm) from panel front surface | |
| Mounting Method | Front insertion into a panel cutout, secured by (4) 4-40 bolts inserted from the rear into tapped Helicoil thread inserts, 0.187" (4,76 mm) deep | |
| Mounting Position | Horizontal or vertical. Recommended with cassette vertical, tapehead at top for easy cassette insertion. | |
| Temperature Range (Operating and Storage) | –20°C to +70°C standard (–40°C to +70°C available on special order) | |
| Power Consumption (Auxiliary Cards and EOT/BOT Detector) | Phase Board, ANSI Formatter, Block Formatter, and Expander consume approximately 120 microwatts each (+12VDC @ 10 microamps). The EOT/BOT Lamp and detector consume 900 mW (+12VDC @ 75 mA). | |

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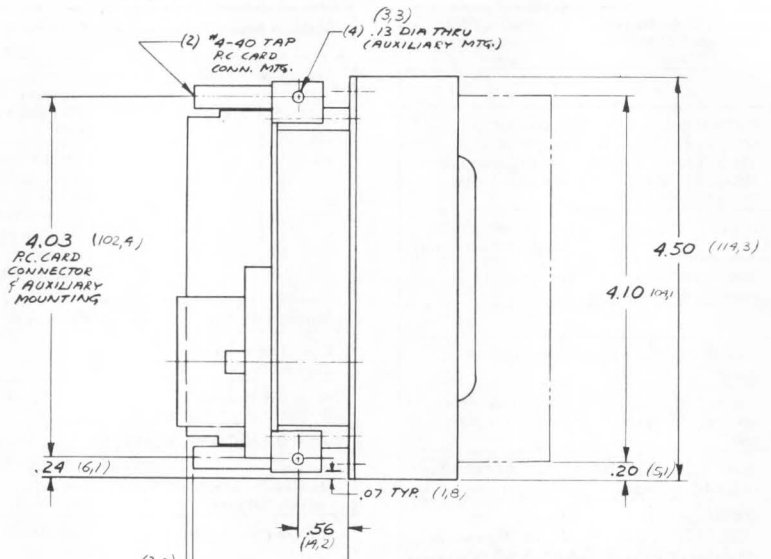
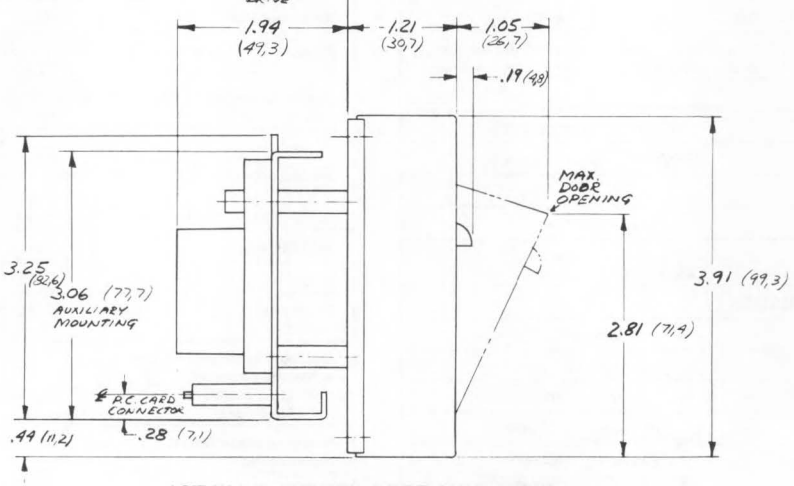
*Prices and specifications subject to change without notice.*

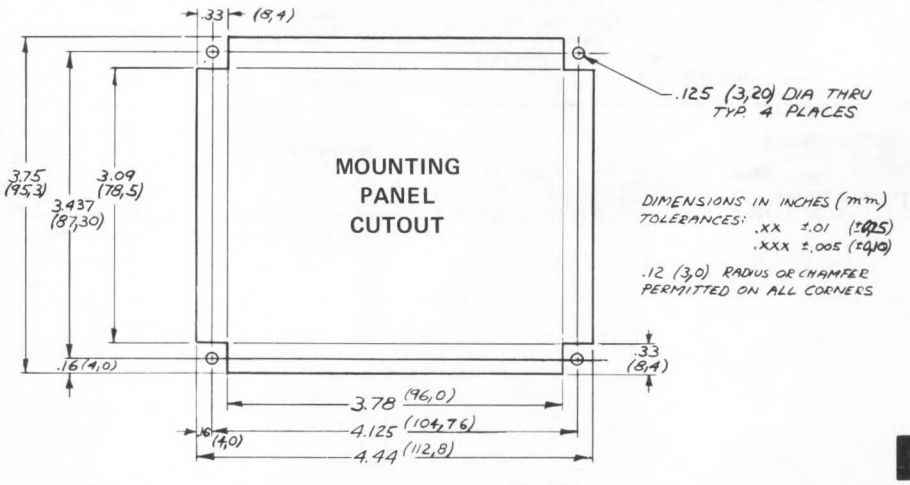
## MECHANICAL DIMENSIONS




ICT-WA & ICT-WZ: TOP VIEW




ICT-WA & ICT-WZ: LEFT SIDE VIEW



# RECORDER SYSTEMS CARD CAGE OUTLINE DIMENSIONS – INCHES (MM)

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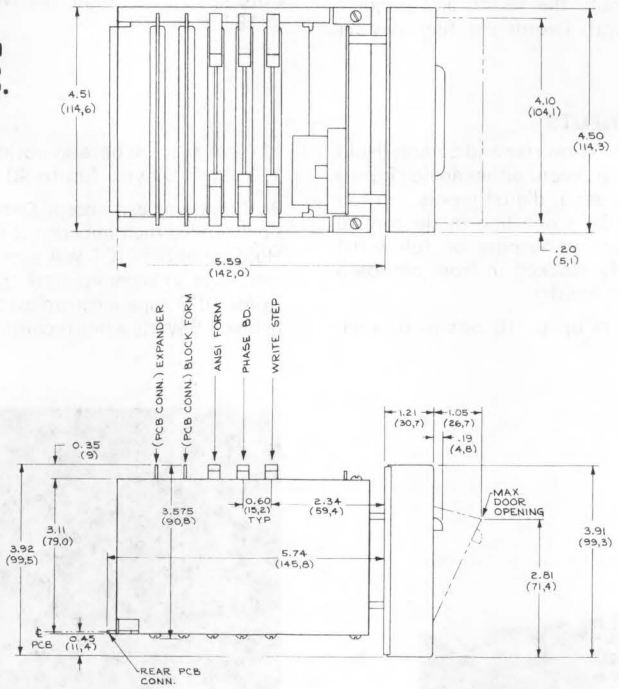



## CASSETTE RECORDER SYSTEM MODELS AVAILABLE

Both ICT series write-only recorders are available in many configurations , from transport-only to stand-alone recorders.

The basic ICT transport is a panel mounting assembly which fits through a front panel cutout. The transport includes the stepping motor, tape head, both hub assemblies and optional EOT/BOT photodetector.

All electronics for the ICT systems are mounted in an optional five-slot PC card cage which attaches to the rear of the transport. The entire assembly consisting of the cage, PC cards and transport are firmly supported when the transport is mounted to the user's front panel. The five optional cards slide into card guides in the card cage and mate with PC edgeboard connectors mounted on a motherboard on the bottom of the card cage. All signals and power voltages are transferred along a bus on this motherboard which terminates at a rear PC connector for all I/O signals.

## WHICH DATA FORMAT? CNRZ or ANSI/ECMA/ISO PHASE-ENCODING?

Both CNRZ and ANSI/ECMA/ISO phase-encoding formats have been optimized for ultra-low power incremental recording, yet each has its particular advantages.

CRNZ formatting should be used for noise-immunity and shortest gaps for data logging applications. ANSI/ECMA/ISO phase-encoded formatting should be selected where interchangeability with other makes of writers and readers and most computer terminals is a consideration.

Phase encoded cassettes from Datel's ICT-WA series systems are available with first level (octal or hexadecimal) ASCII printout formatting recorded directly on the write-only system. ICT-WA cassettes may be played back immediately on any ANSI/ECMA/ISO compatible CRT display terminal or computer teleprinter.

Both formats are readily available with code conversion to ASCII 8-bit formats for later storage or transmission of the data. ANSI/ECMA/ISO recording may be used for all slowly-varying analog data logging applications except those which cannot wait the 2.55 seconds to generate the half-gap preceding each data block.

Code conversion to ASCII is performed in the write-only system for ANSI/ECMA/ISO formats and in the reader for Datel's CNRZ format. This contributes to tape storage efficiency on CNRZ systems, but also to preformatted interchangeable cassettes on ANSI/ECMA/ISO systems, for playback on many types of Readers. ICT-WZ CNRZ cassettes must use a CNRZ-compatible Reader such as Datel's model LPR-16 (refer to the LPR-16 Reader in the Data Logging section).

Both formats can accept varied block or file length and both require similar cost in electronics to perform the same functions. Datel's ICT-WZ CNRZ systems have room in a single 5-slot card cage for an optional 12-bit analog/digital converter and 16-channel multiplexer (see Model LPS-16). ICT-WA systems require additional area to accommodate an A/D section.

The minimum 5.1 second, 0.8 inch (20,3 mm) gaps required of ANSI/ECMA/ISO formatting become a serious data capacity consideration if blocks cannot contain substantial numbers of bytes. Short blocks waste excessive tape in writing gaps and ANSI/ECMA/ISO data systems frequently use external semiconductor memory storage to produce efficiently-long blocks.

ANSI/ECMA/ISO formatting relies on regulated speed control while writing and reading single-track phase-encoded data with two motor steps per bit cell. Data is recorded in blocks ranging from two to 256 bytes with no gaps within the blocks. Noiseless gaps of specified minimum length are required before and after each block and these are automatically generated by Datel's circuit card modules.

## FILE OR BLOCK LENGTH

In ANSI/ECMA/ISO formatting, the number of bytes per block is selected using an externally supplied 8-bit block length code which must be stored before writing the block.

The CNRZ format allows for variable file length and jumper-selected bits per word. The file length (words per file) may be internally or externally controlled. An internal word counter may be jumper-programmed to end the file at 1, 2, 4, 8, 16, 32 or 64 words. An external word counter can also end the file at any word count. Bit length per word is jumper selected at 8, 12, 14, or 16 bits.

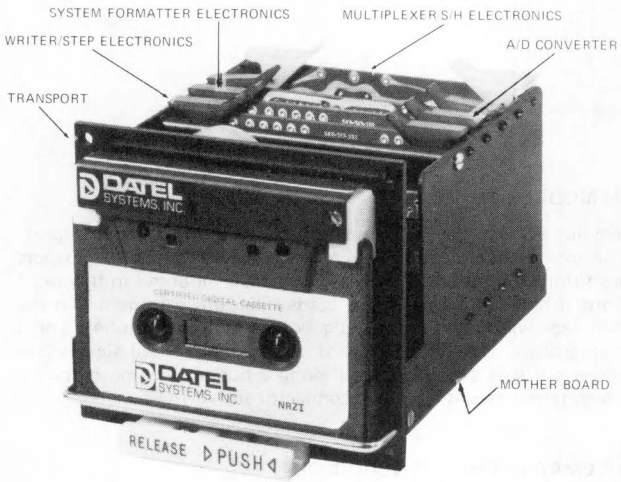
## MIXED ANALOG AND DIGITAL INPUTS

By the simple addition of Datel's A/D converter and Sample/Hold Amplifier PC cards, the ICT-series can record either analog inputs (up to 12 binary bits) or parallel or serial digital inputs. On full data logging systems (model LPS-16), a one line mode control accepts A/D converter parallel binary outputs or full serial external digital inputs synchronously clocked in from outboard serial sources or parallel-to-serial shift registers.

ICT-WZ systems accept digital inputs up to 16 bits in parallel.

ICT-WA systems have an optional Expander Board accommodating 1, 2, 3, 4, 5 bytes (up to 40 bits total) of parallel digital inputs.

Both systems can accept Datel's optional 16 channel, high speed, single ended high impedance FET analog multiplexer and Sample/Hold amplifier. ICT-WA systems require a second short (4-card) card cage to accommodate the analog section plus all the ANSI/ECMA/ISO tape electronics. System power consumption remains below 1.5 Watts while recording and in the microwatts in standby.




16-CHANNEL
ULTRA LOW POWER
ANALOG DATA
LOGGER

**MODEL LPS-16**

BATTERY POWERED
WEATHERPROOF
AUTOMATIC ANALOG
DATA LOGGER FOR
64 CHANNELS. INCLUDES
ONE YEAR
CALENDAR CLOCK
**MODEL DL-2**

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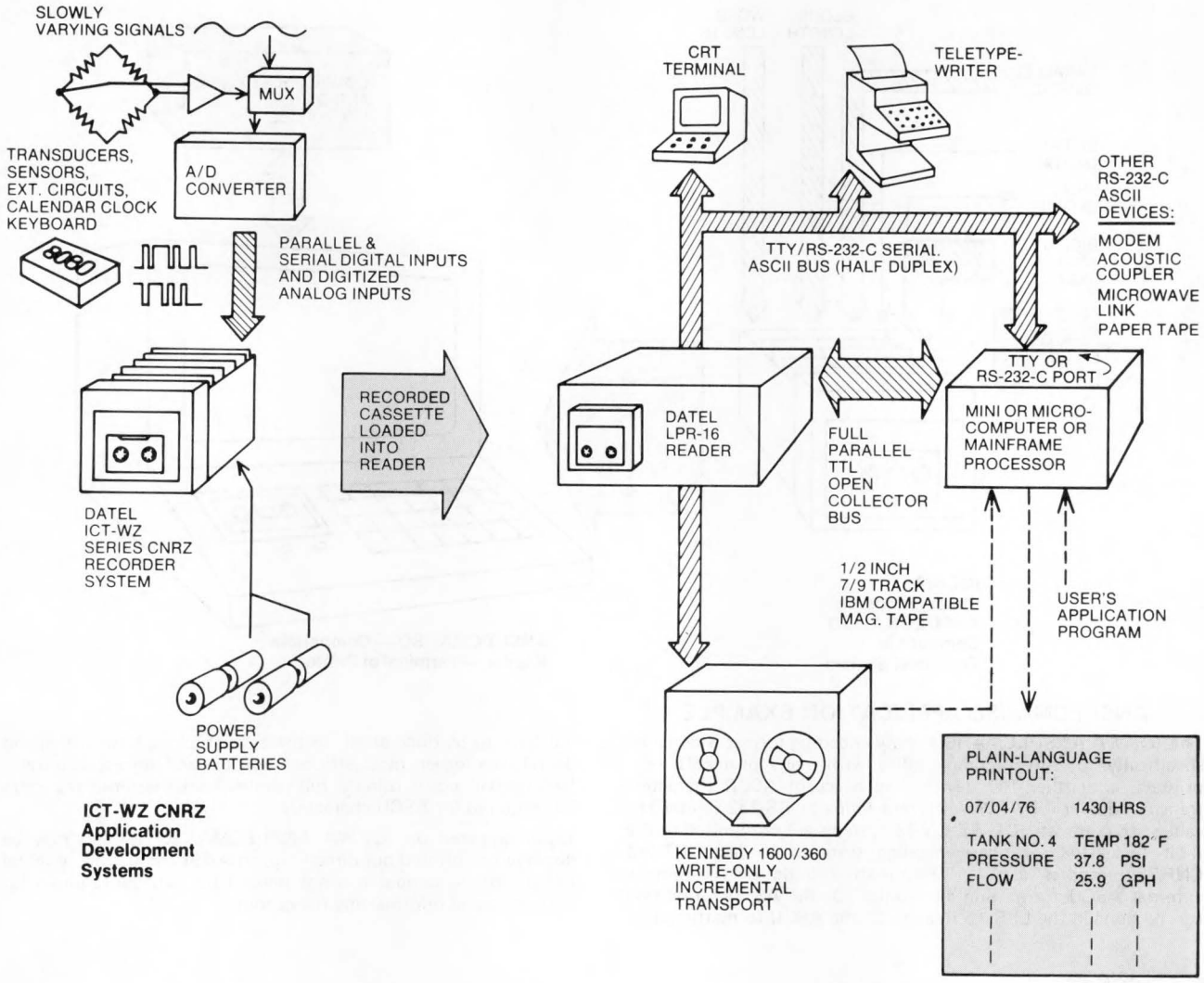



**ICT-WZ CNRZ Application Development Systems**

## COMPLEMENTARY NRZ APPLICATION SYSTEM EXAMPLE

The block diagram shown indicates the types of input sources used with the ICT Transport System. Also shown are computer system output devices used when reading cassettes. This particular example shows an analog signal from an input bridge used to measure strain, temperature, etc. The ICT system cannot directly record this analog signal so it must first be digitized using an A/D converter. Datel supplies modular encapsulated 12-bit CMOS A/D converters mounted on cards which slide directly into the ICT series card cage. The digitized analog signals may then be recorded on the cassette.

The block diagram also shows digital signal sources. These can include parallel and serial TTL or CMOS inputs. The TTL signals should be buffered through open collector level shifters to be compatible with the ICT's +12V CMOS logic levels. Serial digital inputs may be shifted into the ICT systems by using the shift clock output.

Not shown in this application diagram are 8-bit bytes in ASCII format externally encoded from portable hand-held keyboards and other sources.

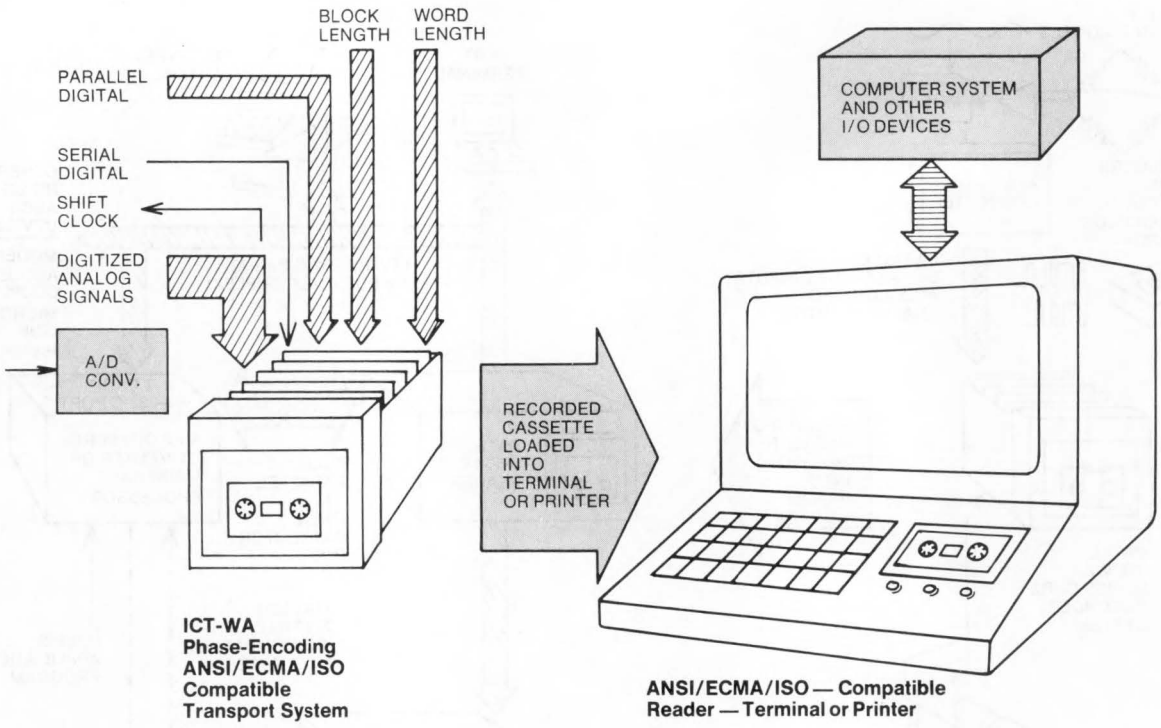
The ICT Transport Systems using CNRZ format must use a CNRZ-compatible Reader such as Datel's model LPR-16 shown here. Refer to the Data Logging section for more information on the LPR-16.

The LPR-16 Reader is available with 3 types of outputs to feed computers and various output and display devices. These outputs are full parallel, full serial or half-inch magnetic tape. Between them, practically every current computer-compatible device can easily by interfaced to.

For example, if you have access to a powerful high speed mainframe computer with BASIC or FORTRAN languages but without convenient electrical input, transcribing cassettes off line onto half-inch magnetic tape is the logical route to follow.

Half-inch tapes are then loaded into mainframe memory and a complete printout is available with user-controlled output formatting, variable labeling and arithmetic functions. The high density tapes can be retained by the user if they ever need to be run again or analyzed differently.

A computer is shown in this block diagram and it will be required in practically all situations needing arithmetic on the data or output formatting. However, the LPR-16 Reader can be operated off-line directly to a local teletypewriter or CRT terminal to get a quick look at the data in hexadecimal output. Simple TTY printout formatting presents A/D samples and digital words as hexadecimal characters with optional channel identification for analog channels. Spacing, carriage returns and line feeds help identify individual words and data files.




**ICT-WA Phase-Encoding ANSI/ECMA/ISO Compatible Transport System**

**ANSI/ECMA/ISO — Compatible Reader — Terminal or Printer**

## ANSI/ECMA/ISO APPLICATION EXAMPLE

The ICT-WA ANSI/ECMA/ISO phase-encoding format is designed specifically for direct compatibility with many terminals, teleprinters, and other I/O devices which accept ASCII characters transferred over TTY 20mA current loops or RS-232-C interface cables. In contrast, ICT-WZ CNRZ systems are not limited to the 8-bit formatting of phase-encoding systems. In fact, ICT-WZ CNRZ transports can be preformatted using the customer's external ASCII formatting electronics. Or the ASCII formatting can be done in the LPR-16 Reader. Or the ASCII formatting does not have to be done at all. In the case of a long-term analog and digital data logger, most efficient tape use and highest data transfer rate will occur using a full parallel reader without the extra bits required for ASCII characters.

Tapes prepared on ICT-WA ANSI/ECMA/ISO systems may be displayed or printed out directly on an ANSI-compatible terminal I/O device. A computer is not needed but will be required for arithmetic and reformatting the output.

### ELECTRONICS

Both cassette systems accept serial and parallel digital inputs. These are presented to input terminals at the proper times and are internally stored. DATA ACCEPTED flag signals appear, allowing the user's external electronics to clear and load the input bus with the next group of data. This can occur in parallel or bit by bit in full serial by using the shift clock output.

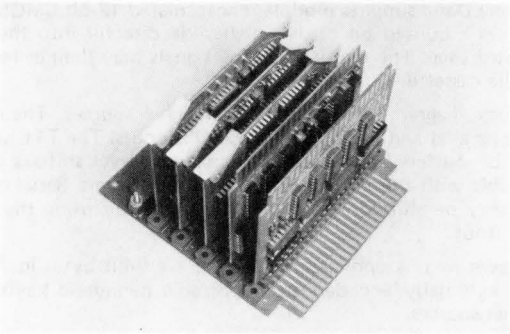
Since the transport must run at a given tape speed, data bits must be ready fast enough for input to the write electronics. However, the transport is truly character or word incremental so that the tape can stop within a block or file and wait after writing one word for new data that isn't ready yet.

### ICT-WZ COMPLEMENTARY NRZ BOARDS

In addition to the Write Step Board, ICT-WZ Recorder systems have the Formatter Board available. An optional A/D Converter Board, and Sample/Hold, Multiplexer, Channel Sequencer are also available for analog inputs. Refer to complete analog systems specifications under Datel's LPS-16 series.

The ICT-WZ Formatter Board accepts parallel CMOS digital words from 8 to 16 bits long, stores them and shifts them over serially to the Write Step Board. The Formatter also supplies a 2-step bitless gap beginning each word to the Write Step Board and a longer 12 step gap at the end of a file or from external command. Word length from 8 to 16 bits is jumper programmed as is a word counter which automatically generates the 12-step file gap after the jumper-selected number of words per file. File length can also be externally controlled.

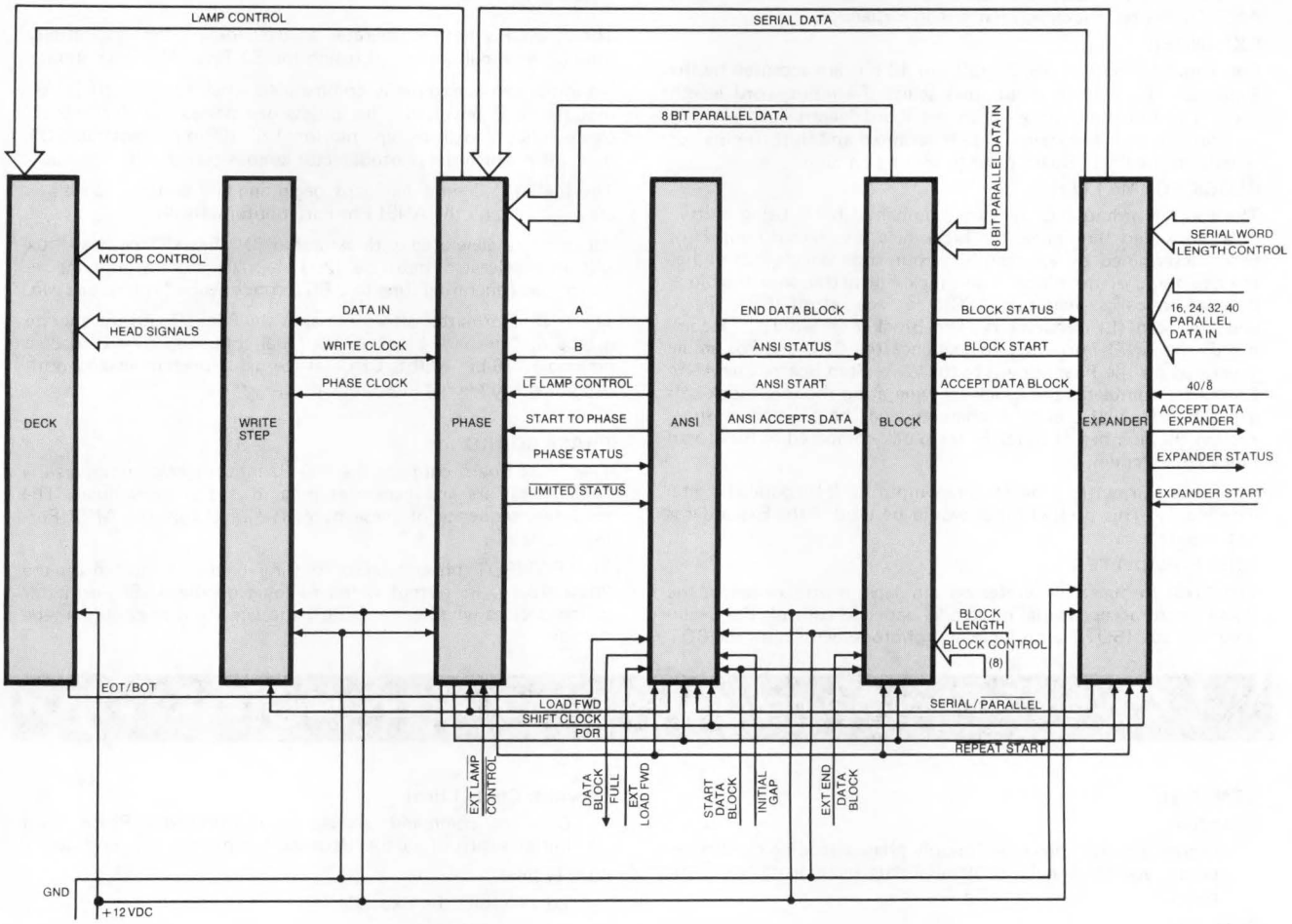
Several circuit boards with similar functions are used on ICT-WA and -WZ systems. The Write Step board drives the 4-phase windings of the stepping motor. The 100 Hz motor clock pulses are also used to sequence input bits which drive the tape head through the Write Step board. Flip flops for the tape head keep track of the present drive state of the head and apply the proper flux change. CNRZ systems route zero and one bits to alternate tracks and phase-encoding systems orient the single-track flux change direction for zeroes and ones. The basic motor clock serves as a master clock for all the remaining logic in either ICT system.



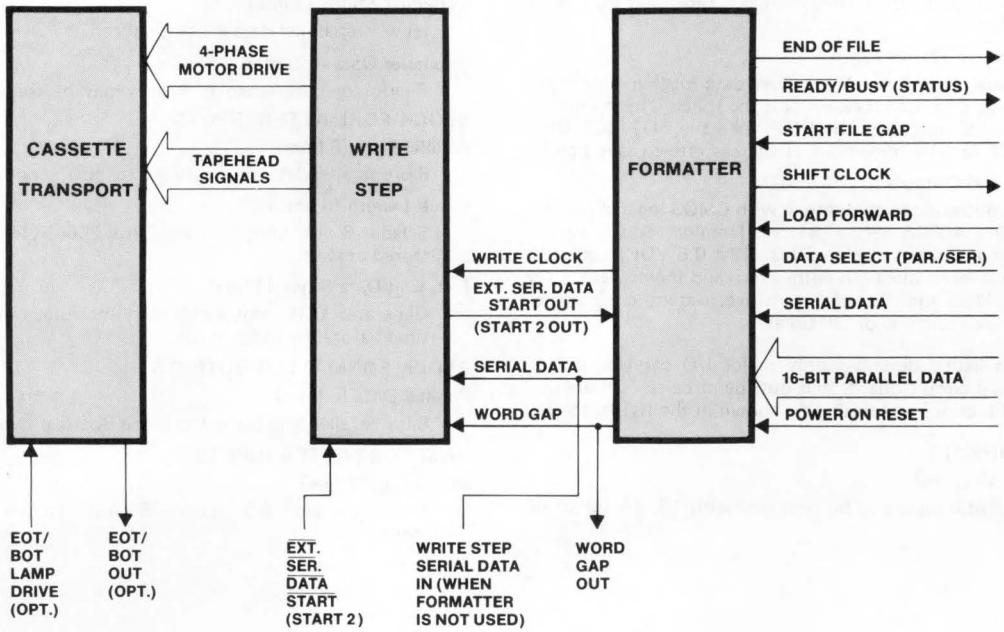
**ICT-WA CARDS LESS TRANSPORT (SEE BLOCK DIAGRAM)**

# ANSI/ECMA/ISO

ICT-WA Recorder Block Diagram




# Complementary NRZ ICT-WZ Recorder System Block Diagram



## ICT-WA PHASE-ENCODING PC BOARDS

ANSI/ECMA/ISO ICT-WA Recorders employ several more boards besides the Write Step Board, These include the Phase Board, ANSI Formatter, Block Formatter and Expander.

### EXPANDER

Full Parallel inputs of 16, 24, 32, or 40 bits are accepted by the Expander. Two other input lines select the input word length code. The Expander stores both the word length code and full parallel inputs. It flags when data is accepted and shifts inputs out serially to the Phase Board prior to writing on tape.

### BLOCK FORMATTER

The Block Formatter Counts the number of bytes being written in a block and terminates the block at a preselected number of bytes determined by an eight-bit input code which is stored at the beginning of the block. The Block Formatter ends the block by automatically generating ASCII carriage return (CR), NULL and line feed (LF) characters. The Block Formatter then commands the ANSI Formatter to sequence the CRC and Postamble generated on the Phase Board to the Write Step Board. The ANSI Formatter completes the block by generating the interblock half gap. The CR, NULL and LF characters can be omitted by short cycling the number of bytes in the block compared to the stored block length code.

The block Formatter provides direct input for 8-bit parallel digital words only. This parallel input would be used if the Expander is not required.

### ANSI FORMATTER

The ANSI formatter generates certain gaps, controls whether the Phase Board accepts serial or parallel data and controls the Beginning of Tape (BOT) lamp logic and photodetector until the BOT tape hole is passed. The ANSI Board directs the sequence of bytes generated on the Phase Board including Preamble, Postamble, Data and CRC.

The ANSI Formatter generates an overriding bitless gap at any time on external command (using the EXT. LOAD FWD. input).

An initial gap is externally commanded when the cassette is first mounted and rewound. This bitless gap passes the clear leader/oxide splice and stops tape motion 1.5" (38 mm) past the BOT hole, after which the photodetector lamp is turned off.

The 0.4" (11,6 mm) half-gaps beginning and ending each block are generated by the ANSI Formatter automatically.

All gaps are generated with saturated (DC Erase) tape head flux and an accelerated step rate (250 steps/second) to limit the required gap-generating time to 2.55 seconds per half interblock gap.

The ANSI Formatter also commands the Phase Board to generate a tape or file mark block on external command consisting of a preamble, 16-bit NULL CRC (all zeros) a postamble and both beginning and ending interblock gaps.

### PHASE BOARD

The Phase Board contains the 100 Hz motor clock, computes the CRC characters and generates preambles and postambles. The recording sequence of these bytes is directed by the ANSI Formatted Board.

The EOT/BOT photodetector sensing circuit is located on the Phase Board. Its output is fed to logic on the ANSI Formatter which decides whether to shutoff the lamp and/or continue tape motion.

## ANSI/ECMA/150 ICT-WA RECORDER SYSTEM SPECIFICATIONS

### GENERAL

**Function**

Digital ultra-low power write-only phase-encoding cassette recorder accepting serial or parallel data incrementally in 8-bit bytes.

**Data Rate**

Writing rate is 50 bits per second within blocks. Parallel inputs may be stored. Input data bus must be valid 100 microseconds minimum at time of start command.

**EOT/BOT Photodetector**

Optional lamp and photodetector to sense passage of clear leader/oxide splice, BOT (Beginning of Tape) and EOT (End of Tape) holes.

Lamp requires 12V @ 75mA.

For optional long term, low power data logging, automatic circuits provide a load forward past the splice. This continues 1.5 inches (38 mm) past the BOT, then the EOT/BOT lamp is shut off for the remainder of the cassette to save power.

**Digital Inputs and Outputs**

All input/outputs are compatible with CMOS logic characteristics, using 4000A series devices. Nominal power supply voltage for ICT series electronics is +12 ± 0.5 VDC, regulated. Logic input levels must fall within zero and the power supply voltage. CMOS logic is edge sensitive, requiring 15 microseconds maximum rise or fall times.

The following listing describes only major I/O connections between individual circuit boards and outside circuits. Full descriptions of line functions and timing are shown in the ICT brochure.

### EXPANDER INPUTS

**Parallel Data (40 Lines)**

Accepts digital inputs to be recorded with 16, 24, 32, or 40 bits.

**Expander Start (1 line)**

Data and commands are stored on rising edge. Phase board initiates shift of parallel data and begins recording on tape.

**40/8 (1 line)**

Low disables the Expander

**Word Length (2 lines)**

Selects parallel input length of 16, 24, 32, or 40 bits.

### EXPANDER OUTPUTS

**Serial Data (1 line)**

Parallel data shifted out to phase board.

**Expander Status (1 line)**

HI when parallel data is being shifted.

**Expander Data Accepted**

Ready for data when high. Bus may be changed when low.

### BLOCK FORMATTER INPUTS

**Parallel Data (8 lines)**

8-bit parallel data input when Expander is not used.

**Block Length (8 lines)**

Selects Block Length from 2 to 256 Bytes. This code is stored at start.

**Ext. End Data Block (1 line)**

Generates CRC, Postamble and interblock half-gap at any time before the block is full.

### BLOCK FORMATTER OUTPUTS

**Parallel Data (8 lines)**

8-bit parallel data bussed to Phase Board as bytes are counted.

### ANSI FORMATTER INPUTS

**Initial Gap (1 line)**

Moves the tape 1.5 inches (38 mm) past the BOT hole and stops.

**Start Data Block (1 line)**

Generates interblock half-gap, preamble and stops tape, waiting for additional data.

**Ext. Load Forward (1 line)**

Overriding command to generate a bitless gap at 250 steps/second at any time.

ANSI FORMATTER OUTPUT

**Data Block Full (1 line)**

HI flag indicates maximum allowable bytes recorded in a block.

PHASE BOARD INPUTS

**Parallel Data (8 lines)**

8-bit data bussed from Block formatter.

**Serial Data (1 line)**

Shifted from Expander

**External Lamp Control (1 line)**

LO turns EOT/BOT lamp on, HI turns it off. Used for incremental applications.

POWER REQUIREMENTS

**Transport and Tapehead**

700mW typical @ 100 steps/second (+12VDC @ 60mA)

**EOT/BOT Lamp (optional)**

900mW typical (+12VDC @ 75mA)

**Auxiliary Boards**

120 microwatts per board (+12VDC @ 10 microamps)

PHYSICAL

**Outline Dimensions (Transport plus Card Cage)**

3.91-in. high, 4.50-in. wide, 7.20-in. deep. (99,3 x 114,3 x 182,9 mm). 126.7 cu. in. (2076 cu. cm)

**Weight**

2 pounds (0,9 kg)

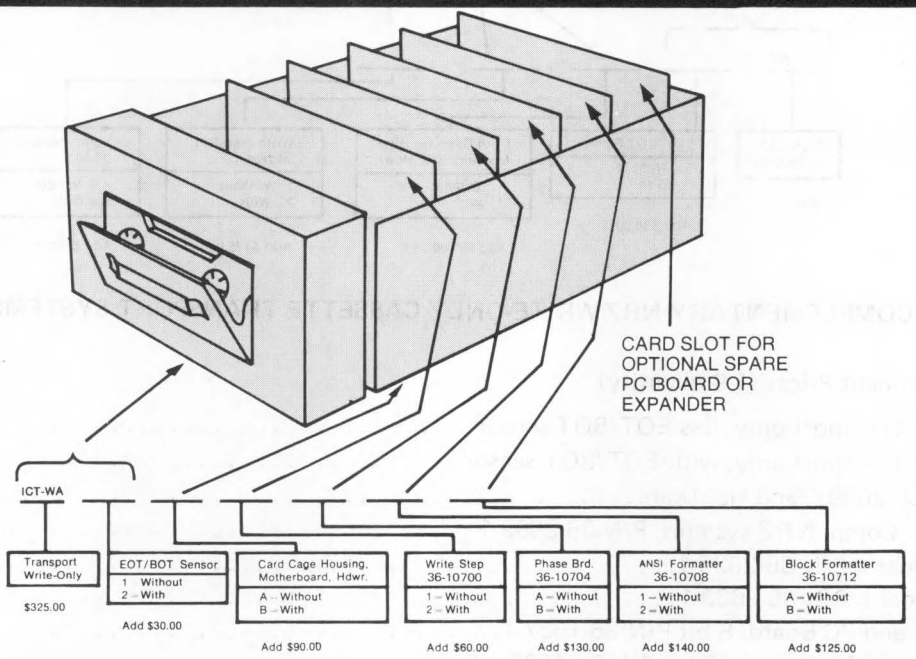
**Connectors**

3 sets of dual-readout 44-pin PC edgeboard fingers (male) are used for external connections. The fingers are spaced on 0.156-inch centers on the BLOCK FORMATTER, EXPANDER and rear of the MOTHERBOARD. Each PC jack mates to Cinch #251-22-30-160 connector or Viking 2VH-22/1AN or equivalent (Datel #2075060)

**Temperature Range (Operating and Storage)**

-20°C to +70°C (-40°C to +70°C optional)

## MODEL NUMBERING AND ORDERING GUIDE



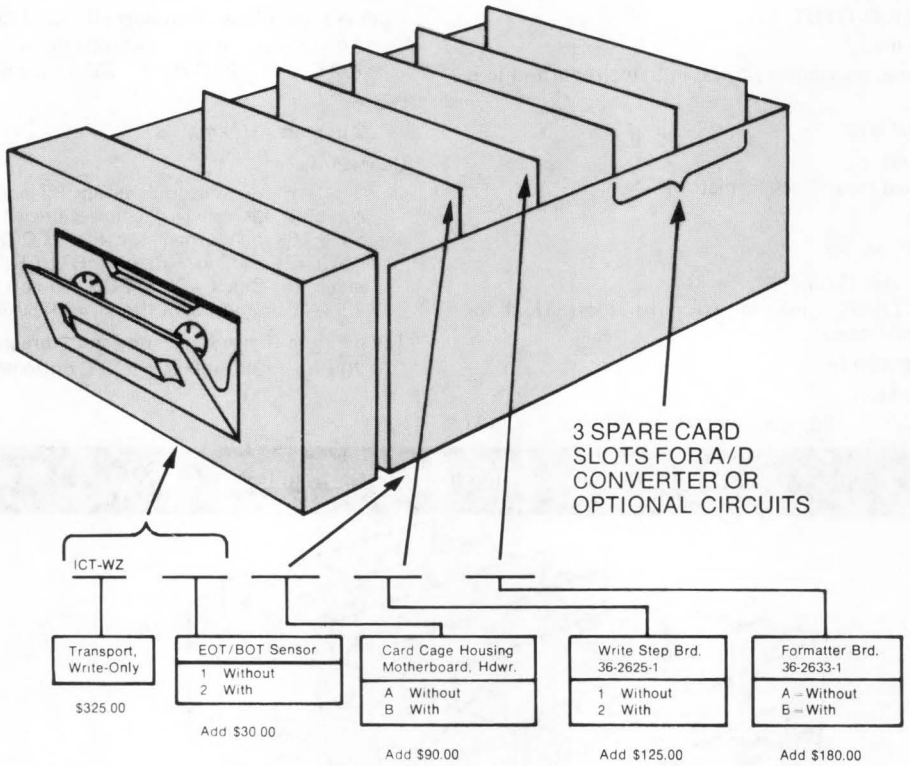

### ANSI/ECMA/150 WRITE-ONLY CASSETTE TRANSPORT SYSTEMS

**Individual Component Prices (1-9 quantity)**

Model ICT-WA1 Transport only, less EOT/BOT sensor ..... $325.
Model ICT-WA2 Transport only, with EOT/BOT sensor ..... $355.
Card Cage P/N 36-2669-1 and Hardware ..... $ 35.
Motherboard for ANSI/ECMA/ISO Systems, P/N 36-10720
with 5 card slots and connectors ..... $ 55.
Write Step, Motor Clock and Head Drive PC Board, P/N 36-10700..... $ 60.
Phase Board, Parallel/Serial Input, Preamble, Postamble, CRC generators, P/N 36-10704..... $130.
Formatter Board, Gap Control, EOT/BOT spacing, Block counter full flag, P/N 36-10708..... $140.
Block Formatter Board, Generates ASCII CR, LF Chars., Block length short-cycling
(stored 8-bit input) P/N 36-10712 ..... $125.
Expanded Board, Accepts 16, 24, 32 or 40 bit full parallel inputs for ANSI/ECMA recording, number of bits controlled by 2-bit modified gray code. Both controls and inputs are stored (strobable) P/N 36-10716..... $125.

# Model Numbering and Ordering Guide

COMPLEMENTARY NRZ WRITE-ONLY CASSETTE TRANSPORT SYSTEMS




COMPLEMENTARY NRZ WRITE-ONLY CASSETTE TRANSPORT SYSTEMS

**Individual Component Prices (1-9 quantity)**

Model ICT-WZ1 Transport only, less EOT/BOT sensor . . . . . $325.
Model ICT-WZ2 Transport only, with EOT/BOT sensor . . . . . $355.
Card Cage P/N 36-2669-1 and Hardware . . . . . $ 35.
Motherboard for Comp. NRZ systems, P/N 36-2699-1 . . . . . $ 55.
Write Step PC Board, P/N 36-2625-1. . . . . $125.
Formatter PC Board, P/N 36-2633-1. . . . . $180.
A/D Converter* and PC Board, 8-bit P/N 36-1637-1. . . . . $385.
A/D Converter* and PC Board, 12-bit P/N 36-1637-1-2 . . . . . $405.
Sample/Hold and 16-channel single-ended analog multiplexer, P/N 36-1711. . . . . $375.
plus channel sequencer.

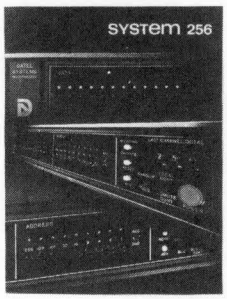
*Specify input voltage range and output coding when ordering A/D converters.

For full analog 16-channel data logging systems (includes A/D converter, mux, sample/hold and channel sequencer), refer to the model LPS-16 numbering and order guide.

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

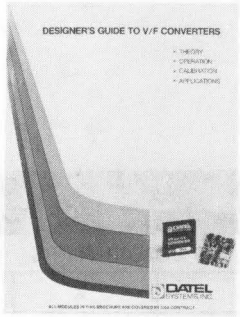
# Other Datel Brochures

**MINI-COMPUTER COMPATIBLE DATA ACQUISTION SYSTEM**

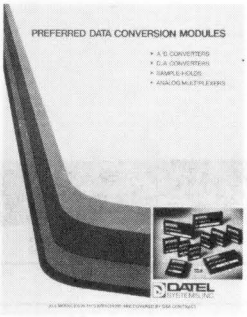



**LOW POWER CASSETTE DATA LOGGING SYSTEM**


**V/F CONVERTERS**

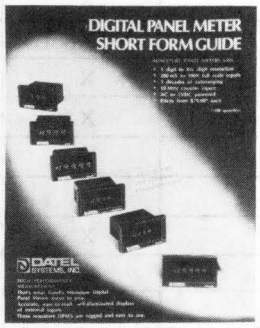



**DATA CONVERSION PRODUCTS**

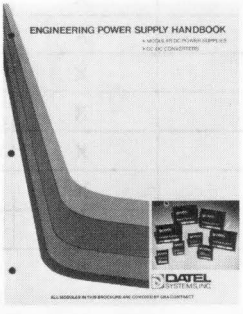



**HIGH PERFORMANCE AMPLIFIERS**

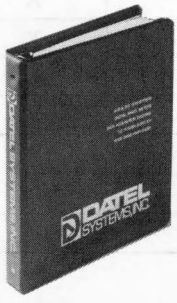

**DIGITAL PANEL METERS**




**DC POWER SUPPLIES AND DC-DC CONVERTERS**




**THREE RING BINDER CONTAINING ALL PRODUCT LITERATURE (1)**




**(1) Available upon written request**

# Extended Performance Modules

| MODEL/SERIES | EX | EXX-HS |
|---|---|---|
| D/A CONVERTERS | | |
| DAC-9 | X | X |
| DAC-19 | X | X |
| DAC-29 | X | X |
| DAC-49 | X | X |
| DAC-69 | X | |
| DAC-169 | X | |
| DAC-CM | X | X |
| DAC-DG | X | X |
| DAC-FI | X | X |
| DAC-GI | X | X |
| DAC-HB | X | |
| DAC-HI | X | X |
| DAC-HR | X | X |
| DAC-HV | X | X |
| DAC-I | X | X |
| DAC-MI | X | X |
| DAC-MV | X | X |
| DAC-R | X | X |
| DAC-TR | X | X |
| DAC-V | X | X |
| DAC-VR | X | X |

| MODEL/SERIES | EX | EXX-HS |
|---|---|---|
| A/D CONVERTERS | | |
| ADC-Econov. | X | X |
| ADC-89A | X | X |
| ADC-149-14B | X | X |
| ADC-CM | X | X |
| ADC-D | X | X |
| ADC-E | X | |
| ADC-EH | X | X |
| ADC-EP | X | |
| ADC-ER | X | X |
| ADC-G | X | X |
| ADC-H | X | X |
| ADC-K | X | X |
| ADC-L | X | X |
| ADC-M | X | X |
| ADC-MA | X | X |
| ADC-N | X | X |
| ADC-P | X | X |
| ADC-SH4B | X | X |
| ADC-UH | X | X |
| ADC-VH | X | X |
| | | |


| MODEL/SERIES | EX | EXX-HS |
|---|---|---|
| CONVERTER ACCESSORY MODULES | | |
| SHM-1 | X | X |
| SHM-2 | X | X |
| SHM-2E | X | X |
| SHM-3 | X | X |
| SHM-4 | X | X |
| SHM-5 | X | |
| SHM-CM | X | X |
| SHM-CMI | X | X |
| SHM-UH | X | X |
| MM-8 | X | X |
| MMD-8 | X | X |
| MM-16 | X | X |
| MM-16-1 | X | X |
| AM-100 | X | |
| AM-201 | X | |
| AM-303 | X | |
| VFV-10K | X | X |
| VFV-100K | X | |
| SCL | X | X |
| | | |
| | | |

Most of Datel Systems' products are specified over the operating temperature range of 0°C to 70°C (32°F to 158°F) with a storage temperature range of −55°C to +85°C (−67°F to +185°F). While this operating temperature range is satisfactory for most applications encountered in industrial environments or research laboratories, there are some applications which may require a wider temperature range and/or the additional reliability of hermetically sealed semiconductor components. Datel Systems can supply extended performance versions of most of its modular products in accordance with the following suffix designation:

EX = Extended operating temperature range of -25°C to +85°C.

EXX-HS = Extended operating temperature range of -55°C to +85°C with all hermetically sealed semiconductor components.

In the following table an "X" indicates availability of the above described options. In addition to the extended performance options Datel Systems also offers standard burn-in options for any of these modules. The burn-in options are indicated by the following add-on suffixes:

| | |
|---|---|
| BU01 | 96 hours at +25°C |
| BU02 | 96 hours at +85°C |
| BU03 | 168 hours at +25°C |
| BU04 | 168 hours at +85°C |

For pricing and delivery time of any of these options please contact the factory or Datel Systems' local sales office.

# Accessory Products

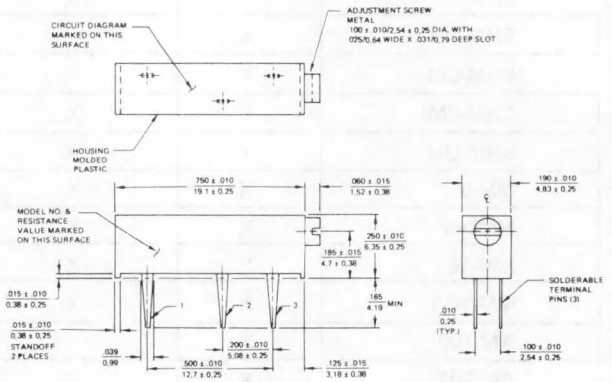
## TRIMMING POTENTIOMETERS

- 15 Turn, 200 cycle rotational life
- Virtually infinite resolution
- 3/4 Watt rating, 25°C (derated to zero at +105°C)
- -55°C to +105°C operating temperature range
- 100ppm/°C CERMET element
- Clutch action stops, no damage
- Sealed against flux solvents and potting compounds

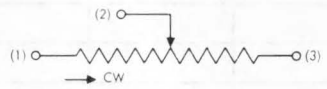
Datel Systems stocks a variety of trimming potentiometers which are used for external adjustment of zero and gain for our A/D & D/A converters, sample-holds, operational amplifiers, etc. We have chosen the Beckman Model 89P for this purpose because of its excellent characteristics. Please refer to the appropriate data sheet for the trimming potentiometer required for a given Datel Systems product.

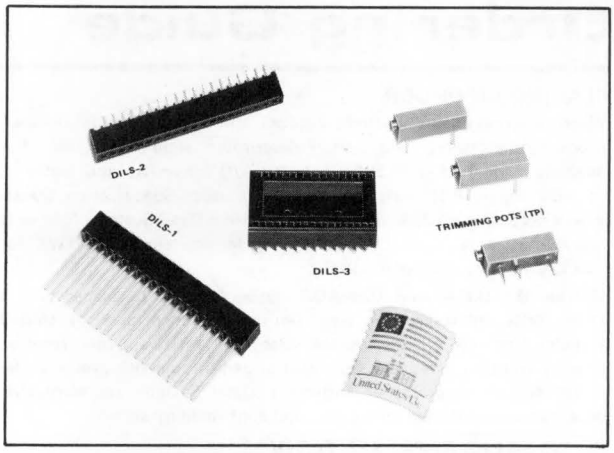
| MODEL | RESISTANCE (±10%) | PRICE |
|---|---|---|
| TP20 | 20 ohms | $3.00 |
| TP50 | 50 ohms | $3.00 |
| TP100 | 100 ohms | $3.00 |
| TP200 | 200 ohms | $3.00 |
| TP500 | 500 ohms | $3.00 |
| TP1K | 1K ohms | $3.00 |
| TP2K | 2K ohms | $3.00 |
| TP5K | 5K ohms | $3.00 |
| TP10K | 10K ohms | $3.00 |
| TP20K | 20K ohms | $3.00 |
| TP50K | 50K ohms | $3.00 |
| TP100K | 100K ohms | $3.00 |

DIMENSIONS — INCHES / MM




CIRCUIT DIAGRAM






## DUAL-IN-LINE SOCKETS

| | | |
|---|---|---|
| DILS-1 | 20 Contact Strip, wire wrap | $ 2.50 |
| DILS-2 | 20 Contact Strip, dip solder | $ 2.50 |
| DILS-3 | 24 Pin Socket, dip solder | $ 1.95 |

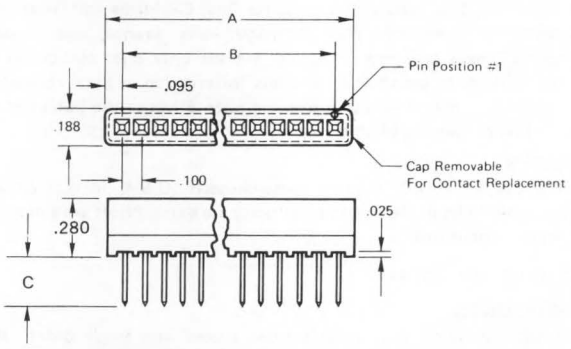
## MODULE SOCKETS

| | | |
|---|---|---|
| MS-1 | Socket for 2" x 1" module | $25.00 |
| MS-2 | Socket for 2" x 1.5" module | $25.00 |
| MS-3 | Socket for 2" x 2" module | $25.00 |
| MS-4 | Socket for 2" x 3" module | $25.00 |
| MS-5 | Socket for 2" x 4" module | $25.00 |
| MS-6 | Socket for AM-100 amplifiers | $ 3.50 |
| MS-7 | Socket for 2.5" x 3.5" power supply | $ 3.50 |
| MS-9 | Socket for AM-201 amplifiers | $ 3.50 |
| MS-11 | Socket for AM-303 amplifier | $ 3.50 |
| MS-12 | Socket for FLT series active filters | $ 5.00 |
| MS-13 | Socket for triple output power supply | $ 3.50 |

## PRINTED CIRCUIT BOARDS

| | | |
|---|---|---|
| PCB-1 & 2 | Printed circuit board for mounting one ADC-D, ADC-K, ADC-M, ADC-E, ADC-89, ADC-L, ADC-H, ADC-N, ADC-P | $35.00 |
| PCB-3 | Printed circuit board for mounting three DAC-I | $40.00 |
| PCB-4 | Printed circuit board for mounting two DAC-I and one BPM-15/50 | $35.00 |
| PCB-5 | Printed circuit board for mounting two DAC-V, VR, DAC-HI, DAC-FI, DAC-GI | $35.00 |
| PCB-6 | Printed circuit board for mounting two DAC-HB and one BPM-15/50 | $35.00 |
| PCB-7 | Printed circuit board for mounting two UPM-5/300 and two BPM-15/50 | $20.00 |
| PCB-9 | Printed circuit board for mounting two DAC-19, DAC-29, DAC-49, DAC-69 | $35.00 |
| PCB-EX | Printed circuit board extender. | $25.00 |
| PCB-CN | 2VK22D/1-3 or equiv. 44 solder pin connector for PCB series | $ 3.50 |

## DILS MECHANICAL DIMENSIONS – INCHES




| Model | No. of Contacts | A | B | C |
|---|---|---|---|---|
| DILS-1 | 20 | 2.090 | 1.900 | .645 |
| DILS-2 | 20 | 2.090 | 1.900 | .145 |

## DIGITAL PANEL METER CONNECTORS

These connectors are dual 18 pin PC edgeboard types with 0.1" finger spacing on .062" thick boards.

| Connector For DPM Model | Solder Tab Connector Model | Wire Wrap Connector Model |
|---|---|---|
| DM-2115 | 2335-3 | 2335-4 |
| All Other Models | 2335-1 | 2335-2 |

# Ordering Guide

## PLACING AN ORDER

When ordering a Datel Systems product, the complete model number, product description, and option description should be given. For example: Model ADC-M12D1A2, 12 bit A/D converter, input buffer, 0 to +5V input, BCD outputs. Use the product Specification Guides where necessary. Orders may be placed with a Datel Systems field sales representative or with the factory by letter, telephone, TWX, or TELEX. Minimum order is $30.00.

**Outside the U.S.A. and CANADA:** Orders should be placed with a Datel Sales Subsidiary (in West Germany, France, and the United Kingdom) or with a Datel overseas sales representative. Orders received directly will be treated the same as if placed through our overseas sales representative. In countries without a Datel Systems representative, orders should be placed by TELEX and confirmed by air mail.

## FIELD SALES REPRESENTATIVES

Datel Systems employs field sales representatives throughout the United States, Canada, Europe, and the Far East. In addition, it has a Western Regional Sales Office in Santa Ana, California and Datel Sales Subsidiaries in Munich, West Germany; Paris, France; and London, England. These sales representatives are the only ones authorized by Datel Systems to solicit sales, and any information or data received by sources other than these authorized representatives or the Datel factory cannot be considered binding.

## PRICES

All prices are F.O.B. Canton, Massachusetts, U.S.A. in U.S. dollars. Applicable federal, state, and local taxes are extra. Prices are subject to change without notice.

**TERMS:** Net 30 Days

## DISCOUNTS

Quantity discounts are available when placed in a single order. OEM discounts are available on an order or contract basis. Corporate discount plans are available for all catalog items. Consult the factory for details on any of these plans. Most Datel products are covered by GSA contracts for which an appropriate Federal Government discount applies. Price lists with government discounts are available upon request.

## QUOTATIONS

Price and delivery quotations made by Datel Systems or its authorized field sales representatives are valid for 60 days.

## DELIVERY

Datel uses an IBM System 3, Model 10, for efficient processing of orders. All orders placed with Datel Systems are acknowledged within a few days by an acknowledgement copy of our sales order form. This copy will indicate pertinent information including estimated delivery date. This date has preference over all other agreed upon dates unless otherwise specified.

All products are shipped in rugged commercial containers suitable for insuring safe delivery under normal shipping conditions. Unless shipping method is specified, the best available method will be used. UPS, UPS Blue Label, Parcel Post, and Air Parcel Post are among the methods normally used. Datel recommends insurance on Parcel Post and Air Parcel Post shipments for tracing purposes. Shipping charges are normally prepaid and billed to the customer except for Air Freight charges which are sent collect. The appropriate data sheet and/or instruction manual is packed with each product shipped.

## ORDER CANCELLATION

All orders entered with Datel Systems are binding and are subject to a cancellation charge if cancelled before or after the scheduled shipping date on the acknowledgement copy of the sales order form. The normal cancellation charge is 20% but may be higher depending on expenses already incurred and commitments made by Datel Systems.

## WARRANTY

Datel Systems warrants that its products are free from defects in material and workmanship under normal use and service for a period of one year from date of shipment for module products and digital panel meters. For systems and subsystems products, the applicable period is 90 days. Datel Systems' obligations under this warranty are limited to replacing or repairing, at its option, at its factory or facility, any of the products which shall within the applicable period after shipment be returned to Datel Systems' facility, transportation charges prepaid, and which are after examination disclosed to the satisfaction of Datel Systems to be thus defective. This warranty shall not apply to any such equipment which shall have been repaired or altered except by Datel Systems or which shall have been subjected to misuse, negligence, or accident. In no case shall Datel Systems' liability exceed the original purchase price. The aforementioned provisions do not extend the original warranty period of any product which has either been repaired or replaced by Datel Systems, Inc.

## SERVICE POLICY

During the warranty period, non-catastrophic failures resulting from misuse, negligence, accident, or improper application or installation of modular converter products, modular power supplies, amplifiers, or digital panel meters will be repaired for a flat charge as follows:

| PRODUCT PRICE RANGE | FLAT CHARGE |
|---|---|
| $20-$70 | $20.00 |
| $71-$150 | $30.00 |
| $151-$300 | $40.00 |
| $301-$500 | $55.00 |
| $501-Up | $75.00 min. |

## RETURNING PRODUCTS FOR REPAIR

If a Datel Systems product malfunctions during the warranty period, the unit should be carefully checked to determine that the unit is in fact at fault. Then call the factory or field sales representative for authorization to return the unit. The product should be carefully packaged and shipped prepaid with original purchase order number and date and an explanation of the malfunction. Allow 3 to 4 weeks for repair and return of the unit. For out of warranty period repairs, the customer will be invoiced for repair charges. If an estimate of repair charge is required first, the following additional items should be furnished with the return unit.

1. A new purchase order number for the estimated repair charge.
2. Name of project engineer or other technical person and telephone number for contact reference.

When returning products for any reason, contact the factory first for authorization and shipping instructions. Items should not be returned air freight collect as they cannot be accepted.

**Returns Outside the U.S.A. and CANADA:** Contact the local sales representative or factory for authorization and shipping instructions first.

## EVALUATION SAMPLES

In cases where it is necessary to evaluate the performance of a product before purchasing, a 30 day no charge evaluation model may be obtained by contacting the factory or local Datel Systems sales representative. The request must be accompanied by a purchase order stating "no charge 30 day evaluation unit." At the end of the 30 day period the customer should return the unit in operating condition. Note: module pins should not be soldered on these units. If the customer decides to keep the unit or does not return it at the end of 30 days, the no charge purchase order is converted into a normal purchase order and invoicing is sent out.

## CERTIFICATE OF COMPLIANCE

Datel Systems will provide a standard Certificate of Compliance with all shipments when requested by the customer. This request must be specified on the purchase order.

DATEL SYSTEMS, INC.
1020G Turnpike Street, Building S
Canton, Massachusetts 02021 U.S.A.
TEL: (617) 828-8000
TWX: 710-348-0135 TELEX: 924461

# FIELD SALES REPRESENTATIVES

**FOR DIRECT FACTORY CALL Canton, Mass. (617) 828-8000**

## NORTHEAST

Metropolitan New York
Long Island, New York
Northern New Jersey

**EASTERN INSTRUMENTATION**
(516) 466-9505 — Great Neck, LI, NY
(201) 661-2000 — New Jersey Exchange

**New England States**
Contact Factory
(617) 828-8000

Upstate New York
**R & D ASSOCIATES, INC.**
(315) 622-2350 — Liverpool, N.Y.

## MIDDLE ATLANTIC

Southern New Jersey
Eastern Pennsylvania
Delaware
Maryland
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