# Assembly Instructions CT-L Parallel Interface Board

## Introduction

There are two interfaces available for transfering digital data to and from the CT-1024 terminal system. The simplest is the Serial Interface (CT-S) which uses the RS 232 data format. It is the best system for transfering data over communications systems and in noisy environments but is limited to a maximum data transfer rate of 120 characters per second. Some applications of the CT-1024 terminal system may require faster transfer of data to avoid slowing a system such as a parallel bus oriented computer system. For these applications the Parallel interface (CT-L) may be the best choice. Although the parallel structure is inherent in the design of the CT-1024, the parallel interface provides the handshaking, buffering, and timing necessary to transfer data properly.

For high noise immunity, the interface has been provided with Tri-State outputs, line rejection/noise discriminators on the strobe lines, and heavy duty diode clamping on all inputs from the data bus. For maximum flexibility all data and strobe lines from the I/O bus(es) can be selectively inverted by programming jumpers on the P.C. card. The keyboard can be directed to just print data on the screen, to print the data on the screen and load it on the output bus, or just load it on the output bus. This is especially nice when you want to have all typed information echoed back by a computer for verification. The interface input and output bus lines can be used seperately, or if selected, may be paralleled for applications where a bi-directional bus system is used. To make interfacing really simple, the data flow control lines can be either strobed or operated in a demand/response mode, here again, selectable.

## PC Board Assembly

NOTE: Since all of the holes on the PC board have been plated thru, it is only necessary to solder the components from the bottom side of the board. The plating provides the electrical connection from the "BOTTOM" to the "TOP" foil of each hole. It is important that none of the connections be soldered until <u>all</u> of the components of each group have been installed on the board. This makes it much easier to interchange components if a mistake is made during assembly. Be sure to use a low wattage iron (not a gun) with a small tip. Do not use acid core solder or any type of paste flux. We will not guarantee or repair any kit on which either product has been used. Use only the solder supplied with the kit or a 60/40 alloy resin core equivalent. Remember all of the connections are soldered on the bottom side of the board <u>only</u>. The plated-thru holes provide the electrical connection to the top foil.

( ) Attach all of the resistors to the board. As with all other components unless noted, use the parts list and component layout drawing to locate each part and install from the "TOP" side of the board bending the leads along the "BOTTOM" side of the board and trimming so that 1/16" to 1/8" of wire remains. Solder.

( ) Install all of the capacitors on the board. Be sure to orient the electrolytic capacitors correctly. The polarity is indicated on the component layout drawing. Solder. NOTE: When installing capacitor C7 it may be necessary on some boards to run a short jumper from the right hand side of C7 to the vacant pad 1/4" to its right. This vacant pad is directly between J1-1 and J1-2 and is about 1/3" above the connector. This jumper is necessary if the land is missing on the board. Install this jumper on the top side of the board.

( ) Install the diodes on the board. The diodes must be turned so the banded end corresponds with that shown on the component layout drawing. Solder.

( ) Install all of the integrated circuits on the board being very careful to install each in its correct position. Do not bend the leads on the back side of the board. Doing so makes it very difficult to remove the integrated circuits should replacement ever be necessary. The semi-circle notch on the end of the package is used for reference and should match with that shown on the component layout drawing for each of the IC's. Make sure the intergrated circuits are down firmly against the board and solder.

( ) Now attach the two fifteen pin female connectors J1 and J2, to the board. These must be installed from the "TOP" side of the board and pressed down so the connectors seat firmly against the board. If the connector does not readily fit the board, carefully compress each of the connector pins with pliers until the connector pins fit the holes. Solder.

( ) Assemble connector JL-1 by inserting the 3 female pins into holes 3, 7 and 12 and the 9 male pins into the remaining holes of the nylon female connector. Insert the pins from the back of the connector (the side with the stamped numbers) so that the thin pointed end sticks out the back of the connector. Attach this assembled connector to the circuit board from the "BOTTOM" side making sure to turn it exactly as shown in the component layout drawing. Make sure the connector sets flush against the board. Solder.

( ) On the "BOTTOM" side of the board notice that the pads for I/O 1 pin 7 and I/O 2 pin 6 are slightly tear drop shaped. On the edge of the board mark the location of these two pins with a pen or pencil. Insert the two fifteen pin male connectors from the "BOTTOM" side of the board into the holes provided for I/O 1 and I/O 2. These connectors should be inserted so that the long section of the male pins is pointed away from the bottom side of the board. Solder.

( ) The appropiate "keypressed" strobe jumper should be installed. If your keyboard's strobe is negative, solder a jumper wire between pads J and -. Our KBD unit will work in this configuration. Jumpering pad J to + instead is used for positive "keypressed" strobes where the pulse is clean and there is no ringing. The board must not be wired for a negative "Keypressed" strobe (J to -) unless the keyboard strobe is truly negative going.

( ) If the screen read board will not be used, solder a jumper wire from J2 pin 13 to J2 pin 5 on the interface board.

( ) Now that all components have been installed on the board, double check to make sure that all have been installed correctly in their proper location.

( ) Now check very carefully to make sure that all components have been soldered. It is very easy to miss some connections when soldering which can really cause some hard to find problems later during use. Also

check for solder "bridges" and "cold" solder joints which are also a common problem.

( ) Press the nylon indexing plug into J2 pin 2.

( ) In order to complete the interface assembly, it will be necessary to configure the board with jumpers as described in the following sections of the instructions. Upon completion take note that this board should not be plugged on to the main terminal board until the main board itself is working and has been completely checked out according to the checkout phase of the terminal assembly instructions.

## Using The Interface

Since there is no universal standard for the operation of parallel interfaces, our interface is an attempt to build one compatable with several types of commonly used interface systems. It is up to you the user to configure the interface for whatever mode of operation you prefer. We are providing a detailed description ofoperation of each of the I/O bus lines along with a description of a simple uni-directional handshake system. Take note when attaching the wires from the external device to the interface, to keep the wires as short as possible to avoid ringing.

## System Configurations

Although external devices can interface to the terminal in several ways, try to select the simplest method. The most basic is to use a separate uni-directional input/output bus.

This system will have the receiver selected at all times (Jumper H-H1) I/O bus 1, pins 2 and 3 open. The transmitter will always be selected by jumpering X to Y and leaving I/O bus 2 pin 5 open. The device interfacing to the terminal should monitor the "Ready to Receive Data" output pin 8 looking for a high. When it has data to load it should present data to the inputs and generate a strobe signal on the "DATA READY FOR INPUT" input (I/O bus 1 pin 5). To make things really simple we may provide either a positive or negative strobe, jumper programmable. A positive strobe is preferred however, since a data settling time delay is provided. Approximately 150 nanoseconds after the leading edge of this strobe, the "READY TO RECEIVE DATA" line (I/O bus 1 pin 8) will go low. At this time the data and strobe have done their job, but you should continue to hold data for 100 nanoseconds to guarantee that data is loaded correctly. The "READY TO RECEIVE DATA" line is ready to accept new data. If you do not want to load data faster than one character every 16 ms, this "READY TO RECEIVE DATA" LINE I/O bus 1 pin 8, need not be used.

To receive data the device interfaced to the terminal should present a high level to the "READY FOR OUTPUT" input I/O bus 2 pin 7 (Jumper L to + installed) to signify that it is ready to accept data and should hold this level until it gets a positive strobe pulse back from "OUTPUT READY" (TTL), I/O bus 2 pin 11. As soon as it sees this strobe pulse, it should lower its "READY FOR OUTPUT" signal on I/O bus 2 pin 7 and approximatly 100 nanoseconds later terminal data will be removed. This seperate input/output system is the simplest hand shake routine that can be set up and is the preferred mode of operation.

For interrupt systems, or those where you want the terminal to tell the device to which it is interfaced when it has a character to be sent out, the wire "OR" able "SERVICE REQUEST" line I/O bus 2 pin 10, may be used. It goes low when terminal data is available to be transmitted. When this data is accepted, it is the responsibility of the interfaced device to strobe the "READY FOR OUTPUT" input I/O bus 2 pin 7 to acknowledge acceptance and allow the "SERVICE REQUEST" line to return high again.

In polled systems where two or more terminals outputs are paralleled and operated in a Tri-State mode, the "OUTPUT READY" (Tri-State), I/O bus 2 pin 12 can be polled and tested using the "TRANSMIT SELECT" input, I/O bus 2 pin 5 to enable both the data outputs and the "OUTPUT READY" (Tri-State) line, I/O bus 2 pin 12. If and when terminal data is presented and accepted, it must be acknowledged by strobing the "READY FOR OUTPUT" input, I/O bus 2 pin 7.

A single bus (common input/output data lines) system may be used by paralleling the input/output data lines, (installing jumpers A thru G) however, this approach, like the polling system makes the system more complicated since it generally involves proper control of the "TRANSMIT SELECT" input, I/O bus 2 pin 5 and often times requires external address decoding which has not been provided on the parallel interface board.

## INPUT/OUTPUT CONNECTOR PIN ASSIGNMENTS

I/O BUS 1 - PIN 1 — Disables keyboard data to screen when grounded. This may be switch selected.

PIN 2 — Totally disables input data from the system when grounded. This may be switch selected.

PIN 3 — Same as pin 2 but disables on a positive level. Jumper H-H1 must be installed if not used or may be switch selectable.

PIN 4 — Disables keyboard data to the output bus when grounded. This may be switch selected.

PIN 5 — The "DATA READY FOR INPUT" input signal should be a signal to let the terminal interface know that you have input data ready for it. This signal can be a level change, but need be only a pulse of no less that 250 nanoseconds duration. Jumper M to + will trigger the interface on a low to high transition. Jumper M to - will trigger on a high to low transition. Positive going pulses (M TO +) are given a 150 nanosecond delay before loading data for increased noise immunity.

PIN 6 — Ground point.

PIN 7 — Not used, except for indexing. Install the nylon plug in the female connector and cut the pin off the male connector.

PIN 8 — The "READY TO RECEIVE DATA" output is a line to let

the sending device know that the terminal is ready to accept data. It is high when ready and low when busy. This output cannot be wire "OR"ed and is not Tri-State.

* ALL INPUT AND OUTPUT LINES ARE INVERTED UNLESS JUMPER N - N1 IS INSTALLED.

PIN 9 Bit 2 input data *

PIN 10 Bit 1 input data *

PIN 11 Bit 3 input data *

PIN 12 Bit 4 input data *

PIN 13 Bit 5 input data *

PIN 14 Bit 6 input data *

PIN 15 Bit 7 input data *

I/O BUS 2 - PIN 1 Bit 4 output data* (TRI-STATE)

PIN 2 Bit 3 output data* (TRI-STATE)

PIN 3 Bit 1 output data* (TRI-STATE)

PIN 4 Bit 2 output data* (TRI-STATE)

PIN 5 The "TRANSMIT SELECT" input activates the Tri-State data outputs which are capable of sinking 16 MA on low level and sourcing 5 MA at high level output. When not selected the output lines look like very high impedence loads. Jumpering X to Y enables the Tri-State outputs when the "TRANSMIT SELECT" input is held high and jumpering X to Z inables the outputs when the "TRANSMIT SELECT" input is held low. Jumpering X to Y and leaving pin 5 disconnected will leave the Tri-State outputs active at all times as would be done in separate I/O bus systems.

PIN 6 Not used except for indexing. Install the nylon plug in the female connector and cut the pin off of the male connector.

PIN 7 The "READY FOR OUTPUT" is an input signal from the device receiving terminal data to the interface letting it know that it is in the process of reading data from the interface's output bus. This line may be strobed by the receiving device and treated as a "I HAVE GOT YOUR DATA SIGNAL". The strobe or level should be at least 250 nanoseconds minimum duration and is trailing edge triggered meaning data will be

held steady on the output bus until the trailing edge of the strobe pulse. The "READY FOR OUTPUT" may be also used as a "I AM READY TO ACCEPT YOUR OUTPUT - GIVE ME A STROBE PULSE". This makes the terminal's output similar to that of a keyboard. The strobe requested in this case will come from I/O bus 2 pin 11, and will be a positive pulse. The "READY FOR OUTPUT" line is also polarity programmable. L to + selects a positive going strobe or level and is best for noise immunity. (L TO -) selects a negative going strobe or level.

PIN 8 Not used. May be jumpered to JS-2 pin 9 and used as a "START READ" command if desired.

PIN 9 Ground point.

PIN 10 The "SERVICE REQUEST" line is a heavy duty wire "OR" able output, which can function as an interrupt, or it can be used as a "READY OUTPUT DATA" signal, going low when ever data is ready. It functions independent of the "TRANSMIT SELECT" input and goes low whenever data is available for output. A pull-up resistor (1K ohm typical) must be provided by the external equipment or on the connector. This output is capable of sinking at least 500 MA of current.

PIN 11 The "OUTPUT READY" (TTL) is an output designed to function as a keyboard type strobe from the interface to the equipment receiving data. It goes positive when data is stable on the bus and the device has requested it by enabling the "READY FOR OUTPUT" input. It should be used either by equipment capable of leaving "READY FOR OUTPUT" enabled until the "OUTPUT READY" (TTL) strobe is generated, or a computer with an interrupt scheme.

PIN 12 The "OUTPUT READY" (TRI-STATE) is an output ready signal that may be tested as in polled systems. The line is Tri-State and is open until the "TRANSMIT SELECT" input is activated, at which time the proper data level is output. The signal can be either HIGH = READY or LOW = READY. For HIGH = READY install jumper P to P1, for LOW = READY, omit the jumper. The "OUTPUT READY" (TRI-STATE) signal resets within 150 nanoseconds of the trailing edge of "READY FOR OUTPUT" input signal.

PIN 13 Bit 7 output data* (TRI-STATE)

PIN 14 Bit 6 output data* (TRI-STATE)

PIN 15 Bit 5 output data* (TRI-STATE)

## Final Note

Note that when the interface is used the keyboard must be plugged into JL-1 on the interface board rather than J9 on the main board. If you will be using the parallel interface board along with the screen read board it will be necessary to attach a jumper from J1 pin 2 of the main board to J4 pin 10 of the main board. It is best to use a 3" piece of #24 wire soldered from the bottom side of the board. This is necessary to make the START READ pin functional when the keyboard is plugged into the serial interface board.

## In Case of Problems

If you have problems on some phase of operation of the parallel interface, the best recommendation is to remove power and recheck your assembly over very carefully with the instructions. If you still cannot find the problem and feel secure in your understanding of digital circuits, you can troubleshoot the unit with an oscillioscope. This does, however, require a thorough understanding of how the unit works as is described in the "how it works" section. If you are still not able to locate the problem or prefer not to service the unit yourself, please consult us before sending the unit in for repair.

The following is a checkout procedure to allow one to checkout the parallel interface independent of a peripheral device. It will verify that the entire interface functions as it should. Do not proceed to the next step until proper operation is observed in preceeding step.

( ) Install jumper M to +

( ) Install correct jumper for keypress strobe (J to - for the KBD). Also check the keyboard jumper on CT-1024 main board and be certain that it is (1 TO 3).

( ) Remove screen read board from CT-1024 (if applicable).

( ) Install a jumper from J2-13 to J2-5 on the bottom of the CT-L board (needed when using parallel interface without screen read board installed).

( ) Remove H to H1 jumper if it is installed.

( ) Install the interface and type in data.

A. If there is no data printed, check to see if point J goes positive on a keypress strobe. If it goes negative you have the wrong jumper installed for keypress strobe.

B. Check to see if C3 and R8 are installed correctly.

C. Check for a negative 200 nanosecond strobe at J1 - pin 13. If there is no strobe troubleshoot the circuit to find the problem before proceeding.

D. Look at the data on J1 Pins 8 through 15. The data should be stable for the duration of keyboard strobe on these points. Type a ? mark

and look for high's on all bits except for bit 7. @ is the reverse of ?. A space is all lows except for bit 6.

( ) If characters are printed on the screen correctly, then jumper I/O bus 1 pin 1 to pin 6. Check to see that keyboard to screen is disabled. Leave the jumper connected for next portion of test.

( ) Install jumpers A through G.

( ) Install X to Y jumper.

( ) Install a temporary jumper from J to H1.

( ) Install L to + jumper.

( ) Connect I/O bus 2 pin 7 to I/O bus 1 pin 8.

( ) Connect I/O bus 2 pin 11 to I/O bus 1 pin 5.

( ) Type data to see if it loops from output to input correctly. Note that data may not appear until after the key is lifted depending on the width of the keyboard strobe.

A. If data is not transfered correctly look at data on pads A through G. It should be inverted and stable for the duration of keypressed strobe. If present, look for a positive going strobe at I/O bus 2 pin 11. If either of above conditions are not correct, look for problems in the transmit section. If OK look for problems in the receive section.

( ) Ground I/O bus 2 pin 5 and type a letter. The letter should not be printed until the ground is removed.

( ) Install a jumper from P to P1 to select output ready as a high.

( ) Remove jumper from I/O bus 2 pin 11 to I/O bus 1 pin 5.

( ) Install a jumper from I/O bus 1 pin 5 to I/O bus 2 pin 12.

( ) Type data to see if it prints correctly.

( ) Install a jumper from N to N1. The terminal should work the same but as before the data at pads A through G will no longer be inverted.

( ) Check service request line by attaching 1 K resistor from + 5 V to I/O bus 2 pin 10. (IC-7 pin 14 is good point to get + 5V). It should be inverted from I/O bus 2 pin 12. (also pin 11). I/O bus 2 pin 10 should go low when a key is pressed.

( ) If the interface works correctly, remove jumpers H to H1 and if you plan to use screen read board remove jumper from J2 - 13 to J2 -5.

( ) Remove all jumpers that you do not need for your system and install the jumpers that you plan to use.

( ) Make up the appropriate cables to connect to the plugs for the I/O busses. Twisted pairs are recommended. Remember that the reliability of the system depends on good transfer of data over these I/O lines. Terminate the lines if necessary, but do not exceed the 16 m.a. sink capability (500 ohm to +5V or 300 pfd in series with 100 ohms to ground).

## How It Works

### Input Circuits

Input data from I/O bus 1 pins 9 through 15 is presented to IC-4 and IC-5 and inverted if selected and then passed to the data selectors IC-12 and IC-13 as true data. The keyboard data from keyboard connector JS-2 is also presented to the data selectors, but not passed by the selectors unless there is a keyboard "keypressed" strobe. The outputs of data selectors, IC-12 and IC-13, go out J1 to the CT-1024 mainframe. "INPUT READY TO RECEIVE DATA", I/O bus 1 pin 8, goes high when the interface is ready to receive data. The equipment sending data seeing the "READY TO RECEIVE DATA" can at any time, change data on the inputs and after the data is stable can either strobe "DATA READY FOR INPUT" I/O bus 1 pin 5, or present a level change to it. The strobe is presented to IC-10 pin 4, a schmitt trigger with a delay to a rising edge. Although the strobe is programmable for either polarity, a low to high transition provides the best noise immunity. IC-2 pin 2 provides this polarity inversion selected and presents a positive strobe signal to IC-1 pin 5. This signal can be inhibited by either a ground on "INPUT OFF", I/O bus 1 pin 2 or a high on I/O bus 1 pin 3. This inhibit strobe is then wire "OR"ed with the keyboard "keypressed" strobe at IC-1 pin 6 and 8, which then triggers IC-11 at pin 1. The output at IC-11 pin 4, is a narrow negative pulse which clears IC-14, removing the "READY TO RECEIVE DATA" flag from I/O bus 1 pin 8. IC-11's output also goes out J1 pin 13 as a negative "keypressed" strobe to the CT-1024 main frame. As soon as the CT-1024 has stored the data (16.6 milliseconds max. delay) a 1 microsecond pulse for "DATA ACCEPTED" is presented at J2-6 by the CT-1024 main frame. This pulse toggles IC-14 at pin 3 and it again raises "READY TO RECEIVE DATA" flag at I/O bus 1 pin 8, making it ready for the next character.

The previously mentioned keyboard "keypressed" strobe, comes in at JS-2 pin 10, and is presented to IC-10 pin 1. It is then inverted if selected and passed onto IC-12 and IC-13 as a keyboard select command. It also goes to IC-1 pin 9 and can be prohibited from being loaded to the screen memory by a "INPUT OFF" state. Leaving IC-1 at pin 8 it is ORed with the "DATA READY FOR INPUT" strobe, I/O bus 1 pin 5. One final note, the keyboard "keypressed" strobe must be selected for the correct polarity of it will block incoming input data. A narrow strobe is preferred.

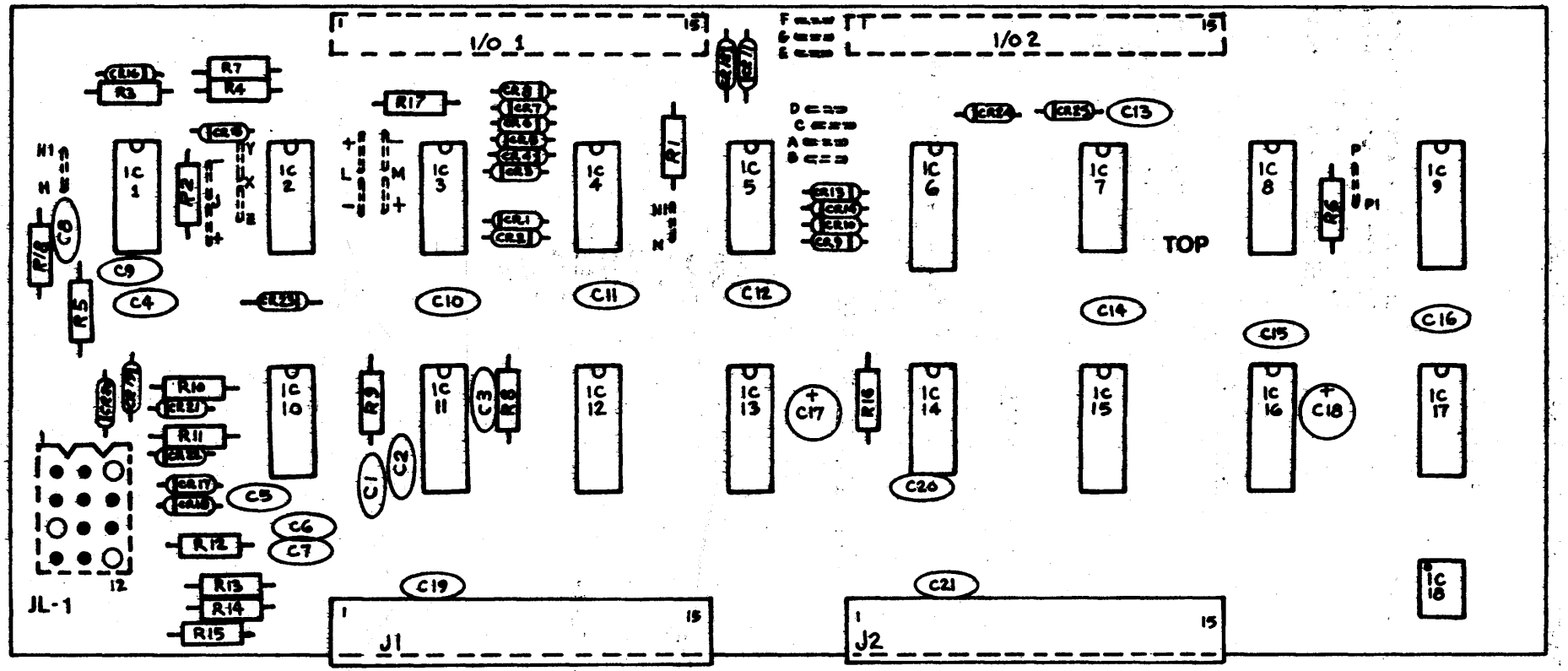
### Output Data

Data to be output from the interface can be either from the screen read board (CT-E) or the keyboard. Keyboard data to the output is inhibited by a low on I/O bus 1 pin 4. Both keyboard and screen read (if applicable) data are presented to data selectors IC-15 and IC-16 and the selected data is passed as true data to the signal correctors, IC-7 and IC-8 where it can be inverted if selected. The data of the desired form, true or inverted, is presented to

the inputs of IC-6 and IC-9 which is a Tri-State latch. The output ready data is also presented to IC-9 pin 11 and its polarity is selectable by jumper P to P1. A strobe generated by either a ready from the screen read board or a keyboard strobe exits IC-16 pin 12 and toggles a latch made up of three sections of IC-3. The strobe will be high and trigger the latch at IC-3 pin 12. IC-3 pin 8 will go high toggling IC-14 at pin 11 and IC-14 pin 9 will go high, forcing IC-17 pin 1 low blocking the latch from accepting any more input pulses. At the same time IC-3 goes low, an accepted command is sent to the screen read board and a load Tri-State latch strobe is sent from IC-10 pin 8 to IC-6 and IC-9.

At this point the Tri-State latch is loaded and waiting for the external equipment to accept it. The "SERVICE REQUEST", I/O bus 2 pin 10, line goes low and can function as an interrupt to the external external equipment. With the "OUTPUT READY" (Tri-State) loaded in the Tri-State latch, the (TRANSMIT SELECT) may be enabled and this signal tested at I/O bus 2 pin 11. In those systems not requiring a Tri-State "OUTPUT READY" the "SERVICE REQUEST" one itself may be used as an output ready line. In either case, a strobe on the "READY FOR OUTPUT" line, I/O bus 2 pin 7 will remove the "SERVICE REQUEST", I/O 2 pin 10, the "OUTPUT READY" (Tri-State) signal, I/O bus 2 pin 12, and will prepare the system for loading the next character to be output. One other mode of output is available and that is to present a signal to "READY FOR OUTPUT", I/O bus 2 pin 7 which is a level indicating that you are ready for output and using "OUTPUT READY TTL", I/O bus 2 pin 7, as a strobe signal telling you when a characteris being presented by the interface. In this last case "TRANSMIT SELECT", I/O bus 2 pin 5 can be used to inhibit the Tri-State data output until you are ready for it.

The important thing to remember in any of the operating modes is that removal of "READY FOR OUTPUT" signal. I/O bux 2 pin 7 clears all ready lines and allows new data to be fed into latches IC-6 and IC-9. It does this by toggling IC-11 at pin 10 which is turn clears IC-14 at pin 13 removing the ready signals and the lock on input latch IC-3 at pin 13.




Component Layout Drawing - CT-L Parallel Interface Board

# PARTS LIST CT-L PARALLEL INTERFACE

## Resistors

| | |
|---|---|
| R1 - R6, R10, R11, R16 - R18 | 1K ohm 1/4 watt resistor |
| R7 | 10K ohm 1/4 watt resistor |
| R8, R9 | 5.6K ohm 1/4 watt resistor |
| R12 - R15 | 3.3K ohm 1/4 watt resistor |

## Capacitors

| | |
|---|---|
| C1 - C8 | 270 pfd disc capacitor |
| C9 - C16, C19 - C21 | 0.1 mfd disc capacitor |
| C17, C18 | 47 mfd 16 VDC electrolytic capacitor |

## Diodes

| | |
|---|---|
| CR1 - CR25 | IN4148 silicon diode |

## Integrated Circuits

| | |
|---|---|
| IC-1 | 7403 |
| IC-2 | 7404 |
| IC-3 | 7400 |
| IC-4, IC-5, IC-7, IC-8 | 7486 |
| IC-6, IC-9 | 74173 |
| IC-10 | 74132 |
| IC-11 | 74123 |
| IC-12, IC-13, IC-15, IC-16 | 74L157 |
| IC-14 | 7474 |
| IC-17 | 7402 |
| IC-18 | 75452 |