LARGE SCREEN DISPLAY

CHARACTRON® Shaped Beam Tube Projection System

A Technical Proposal
Submitted to

NAVAL AIR DEVELOPMENT CENTER

10 OCTOBER 1969
P69-412

Stromberg DatagraphiX, Inc.

POST OFFICE BOX 2449 SAN DIEGO, CALIFORNIA 92112

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ILLUSTRATIONS

FOREWORD

The equipment presented in this proposal is the result of Stromberg DatagraphiX continuing effort to provide military and industrial users with the finest direct view and projection display systems available. In-house funded programs have consistently upgraded the CHARACTRON® shaped beam tube and associated magnetic and electronic control units to surpass any other similar display systems in resolution and readibility. The experience gained in producing a full line of military command and control systems, micromation equipment, and basic displays and proprietary display components has been applied to the display equipment discussed in this proposal.

1. INTRODUCTION

Stromberg DatagraphiX is pleased to submit this proposal, describing a Large Screen Display System, to the Naval Air Development Center, Johnsville, Pennsylvania.

The Large Screen Display System proposed by Stromberg DatagraphiX is a prototype model of the CHARACTRON shaped beam tube Projection System which can be used to display alphanumerics, conics, vectors and special symbols onto a projection screen. Four assemblies comprise the system. They are the CHARACTRON shaped beam tube Projection Head, the Analog Controller, the Interface Controller, and the eight by eight foot portable screen. These units are connected as shown in Figure 1. The equipment interfaces with and operates directly from a UNIVAC 1206 computer.

The Interface and Analog Controllers are mounted in standard 19-inch racks while the Projection Head is mounted in a small portable cabinet for ease of placement. The Projection Head contains the CHARACTRON shaped beam tube, high voltage power supply, magnetic deflection and selection components, Schmidt optics and shielding. The Analog Controller contains low voltage power supplies, deflection, selection and unblank drivers and function generators. The Interface Controller contains the interface logic circuits, core memory and power supplies. A majority of the modules used in this equipment are off-the-shelf designs developed for the Navy's A-NEW Mod. 5.0 and ASA-70 display systems.

A description of the projection and interface hardware is covered in Section 2; a system and functional description is given in Section 3 of this proposal. A work statement and capabilities/facilities is given in Sections 4 and 5 respectively.

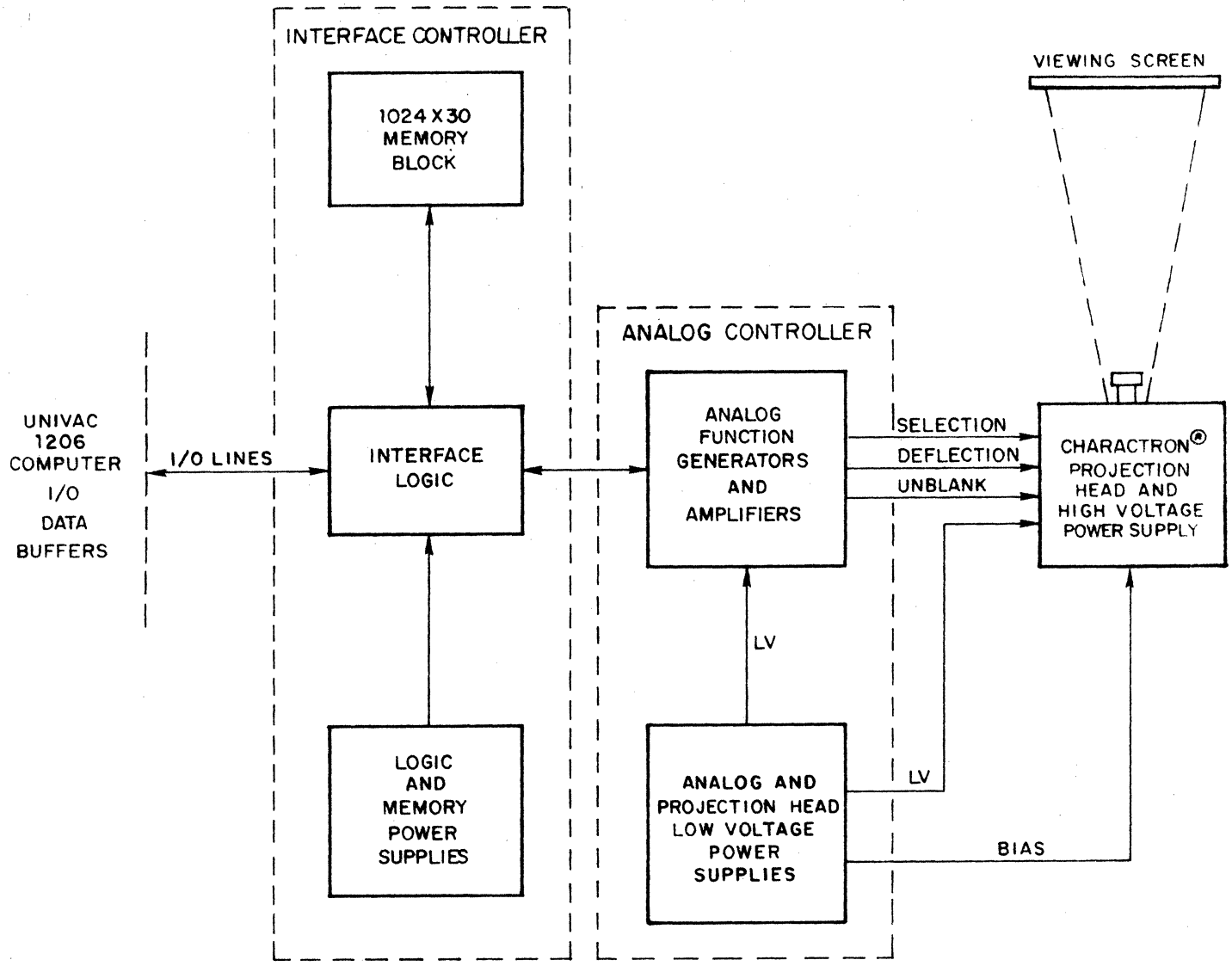


Figure 1. CHARACTRON® Projection System Functional Block Diagram

Stromberg DatagraphiX has demonstrated exceptional technical competence and manufacturing capability in designing and producing a large variety of military and industrail types of ground based and airborne display equipments. Stromberg DatagraphiX is the direct-view display team member for the Navy's A-NEW P-3C program and participated from the start of the program in the development of the A-NEW concept.

The proposed Large Screen Display System is another step in providing the Navy with the finest display equipment obtainable.

2. HARDWARE DESCRIPTION

2.1 GENERAL

The physical arrangement of the Large Screen Display System is shown in Figure 2. The CHARACTRON shaped beam tube is mounted in the Projection Head positioned on top of the Interface Controller. The Analog Controller and Interface Controller are mounted in castered cabinets which allows the equipment to be moved to different locations. Standard 19-inch removable panels are used to hold the component assemblies in the equipment cabinets for ease of maintenance and adjustment.

2.2 PROJECTION HEAD (See Figure 3)

The Projection Head is a non-modular unit containing frame, projection CHARACTRON shaped beam tube with associated magnetic components, and a Schmidt optical system consisting of a spherical reflector and aspheric corrector lens. Optical adjustments are provided to properly align the projection system.

2.3 INTERFACE CONTROLLER

The Interface Controller unit is comprised of the following panel mounted assemblies:

- Logic power supply
- Logic chassis
- Memory unit with power supply
- Control panel

A detailed functional description of the various assemblies is given in Section 3, System Description.

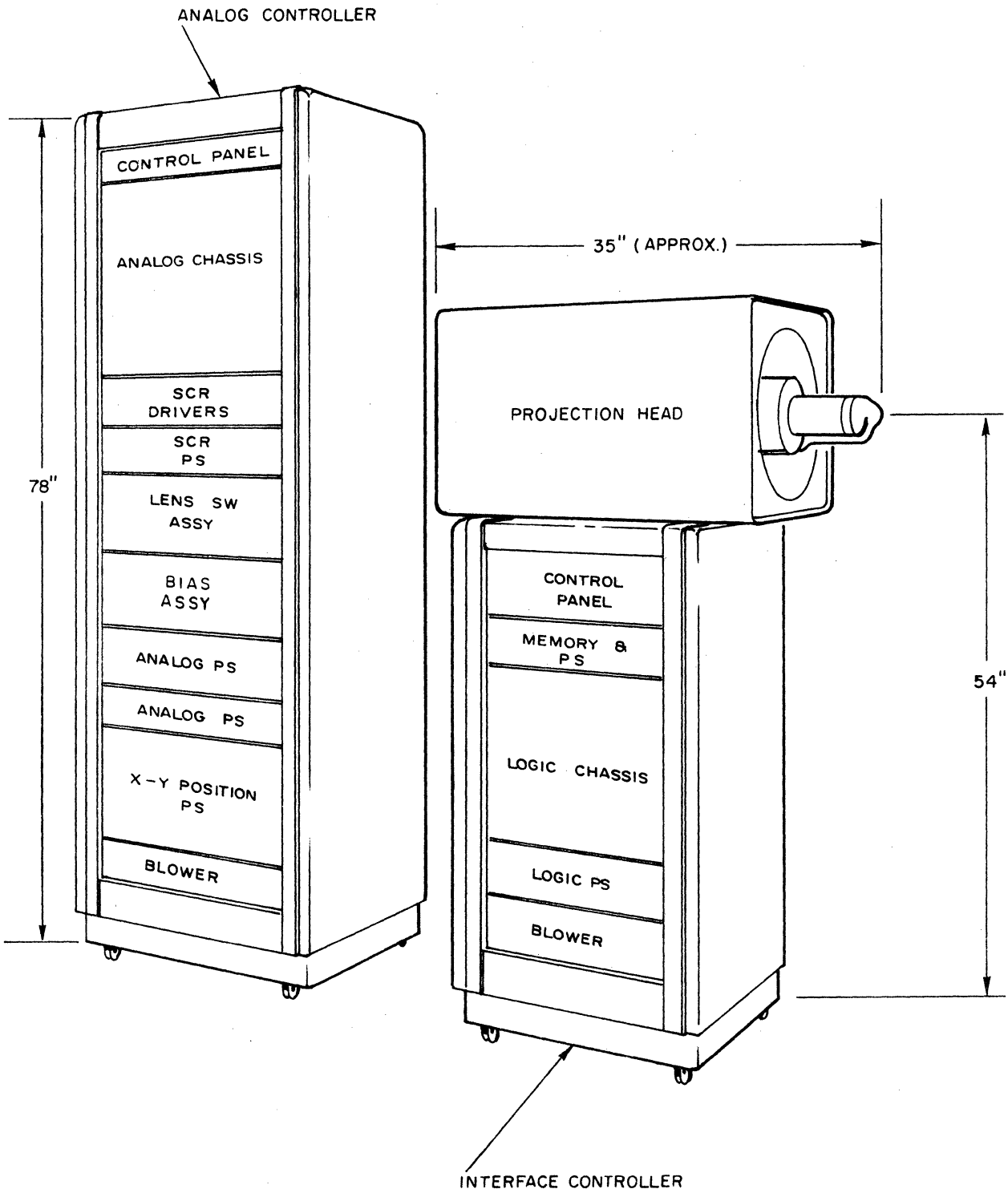


Figure 2. Large Screen Display Configuration

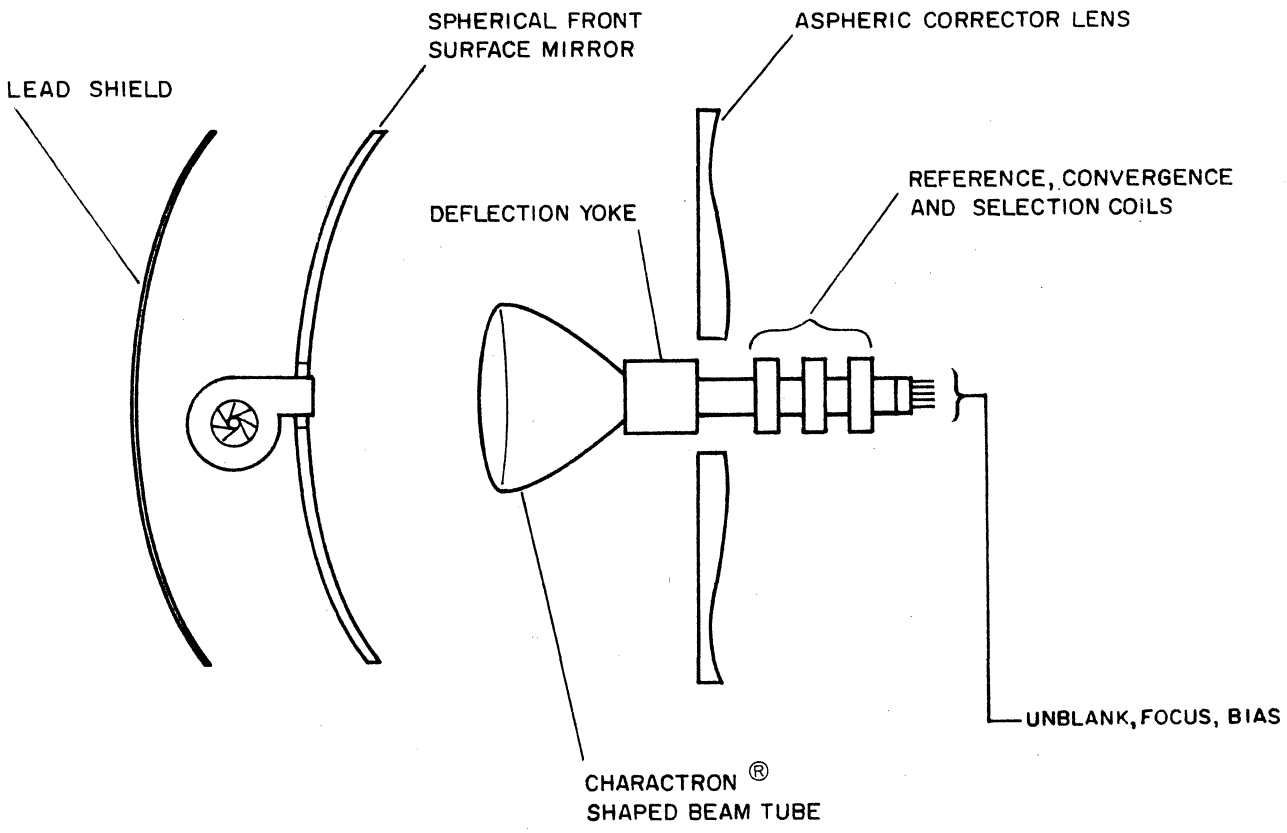


Figure 3. Projection Head

2.4 ANALOG CONTROLLER

The Analog Controller supplies the basic drive information to the Projection Head in accordance with the digital information supplied by the Interface Controller. The Analog Controller cabinet is approximately six and one-half feet high and two feet deep. Standard 19-inch panel mounted chasses are used to mount the various assemblies in the cabinet. Cooling air inputs from the blower in the base of the cabinet and exhausts at the top of the cabinet.

The following assemblies are panel mounted in the Analog Controller cabinet:

- X-Y deflection position power supply
- Analog voltage power supply chassis (2)
- Bias Assembly
- Lens switch assembly
- Selection, convergence and reference power supply
- Selection, convergence and reference amplifiers
- Analog function generator chassis
- Control panel

In addition to the above, the X-Y deflection system is internally mounted within the cabinet frame and is accessible from the rear cabinet door.

A detailed functional description of the various assemblies are given in Section 3, System Description

2.5 ENVIRONMENTAL SPECIFICATIONS

Primary Power -

The large screen display system uses 115 vac, 60 Hz primary power. The system operates with the following range of values.

Voltage:	108 - 125 vac
Frequency:	58 - 62 Hz

Power Consumption -

Maximum power input: 2000 VA

115 vac, 17 amps

Temperature -

Room ambient: 25 ± 10°C

3. SYSTEM DESCRIPTION

3.1 GENERAL

The Large Screen Display System is intended for a situation plot capable of displaying processed computer information consisting of alphanumerics, symbols, vectors and conics (ellipses and circles). The overall system is under computer control by means of a dedicated I/O channel. Information from the computer is received by the Interface Controller (I/F Controller) which stores and processes the digital data. The I/F controller outputs through the display control logic directly to the Analog Controller unit where digital-to-analog conversion is accomplished. The majority of output signals from the Analog Controller consists of intensity, character selection and beam position levels necessary for controlling the CHARACTRON shaped beam tube in the projection system. The desired computer information present on the CHARACTRON shaped beam tube is magnified by a Schmidt optical system for large screen viewing. The overall system block diagram is shown in Figure 4.

3.2 INTERFACE CONTROLLER UNIT (I/F Controller)

The interface between the UNIVAC 1206 computer and the I/F Controller is as follows:

30 Output Data Lines

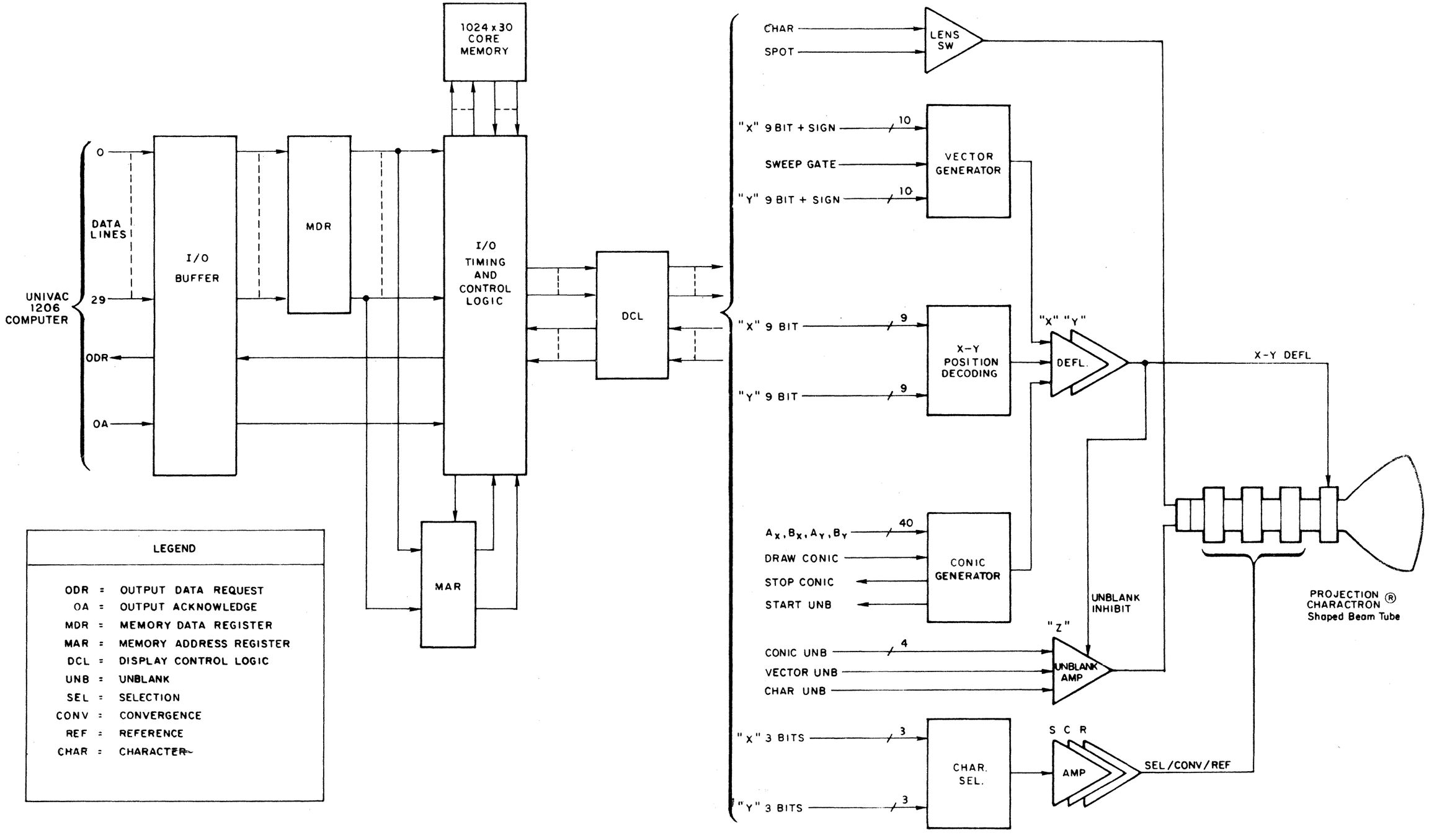
1 Output Data Request

1 Output Acknowledge

3.2.1 Data Levels - The I/F Controller signal voltage levels are compatible with the slow interface of the UNIVAC 1206 computer and are nominally as follows:

Logic "1" = 0 vdc

Logic "0" = -15 vdc



LEGEND	
ODR	= OUTPUT DATA REQUEST
OA	= OUTPUT ACKNOWLEDGE
MDR	= MEMORY DATA REGISTER
MAR	= MEMORY ADDRESS REGISTER
DCL	= DISPLAY CONTROL LOGIC
UNB	= UNBLANK
SEL	= SELECTION
CONV	= CONVERGENCE
REF	= REFERENCE
CHAR	= CHARACTER

Figure 4. Large Screen Display System Block Diagram

3.2.2 I/O Buffer - The I/O Buffer receives and transmits signal information over twisted pair cables using line receiver/line driver circuitry. Cable lengths up to 50 feet may be employed.

3.2.3 Memory Data and Address Registers - Computer data is temporarily stored in the Data Register for transfer to the Memory Unit. The Address Register detects the start address location contained in the computer load word.

3.2.4 Core Memory - The Core Memory is capable of storing 1024 30-bit words. Computer words are stored at the designated computer address, and the memory is capable of operating in read/restore or clear/write mode. The Memory Unit with its associated control and timing logic supplies the required display refresh signals.

3.2.5 I/O Timing and Control Logic - This logic unit supplies the circuitry necessary for display refresh, flash function, Master Logic Clock, and I/O control of the Core Memory unit.

3.2.5.1 Display Refresh - The CHARACTRON shaped beam tube is refreshed at approximately 40 Hz to insure operation above the flicker fusion frequency.

3.2.5.2 Flash Function - When specified in the computer word, flashing of a character is accomplished at 0.5 second on/off rate.

3.2.5.3 Master Logic Clock - Logic executions within the Interface Controller unit are controlled by the Master Logic Clock which operates at 4 MHz. Frequency accuracy and stability is better than 0.01%.

3.2.6 Display Control Logic - The Display Control Logic produces the digital commands necessary for proper operation of the analog function generators. This includes character, vector, and conic generators. All interfacing between the Analog Controller and Interface Controller occurs through the display control logic.

3.3 WORD FORMATS

3.3.1 Computer Word Structure - Data from the computer is in the form of 30 bit parallel words. The word structure is shown in Figure 5.

3.3.2 Function Code - The function code designation is located in bit positions 3 and 4. Function code 01 designates the PLOT function. Similarly, function code 10 specifies SET POSITION function.

3.3.3 X and Y Position - The display is capable of random plotting within a 511 by 511 coordinate grid. These positions are represented by 9-bit binary numbers in the PLOT and SET POSITION word. The octal code of positive binary numbers range from 000 to 377 representing zero to maximum positive. Negative numbers are expressed in one's compliment form extending from octal 777 (zero) to 400 (most negative).

3.3.4 Inhibit Control - In the PLOT or SET POSITION word the inhibit control, bit 1, provides for either displaying or not displaying the display element commanded. A logical "1" indicates an inhibit operation, and a logical "0" indicates normal operation.

3.3.5 Flash Control - In both the PLOT and SET POSITION words bit 2 provides for flashing either the plot character, or the first character of a typed sequence. The flashing rate is 1-Hz; one-half second on, one-half second off. The code "0" calls for a steady presentation, whereas code "1" causes the proper character to flash at the prescribed rate.

3.3.6 Plot Character - The plotting of an alphanumeric or symbol is accomplished by a 6-bit binary code in the PLOT word, located in positions 15 through 20. The code for character selection is shown in Figure 6.

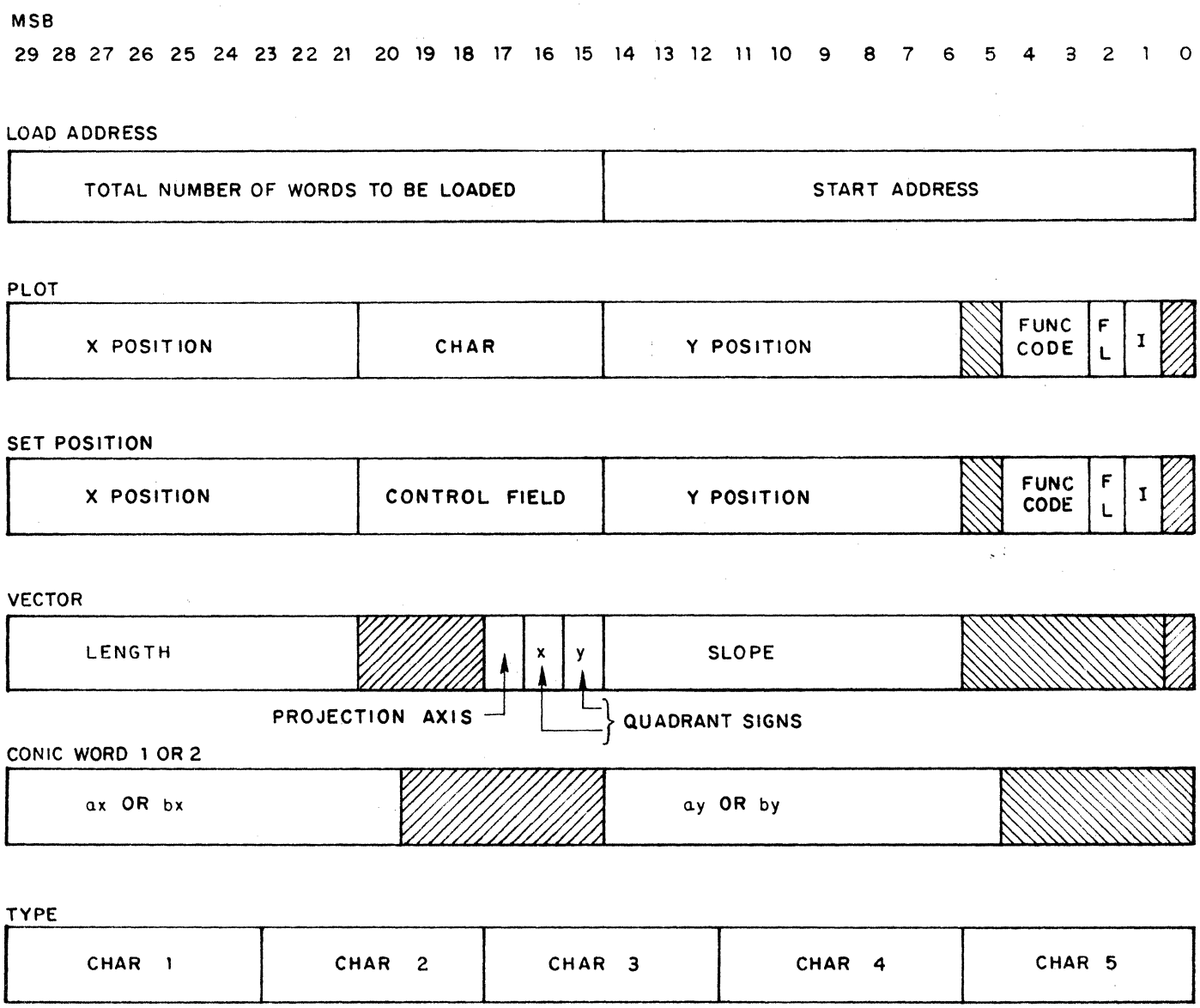


Figure 5. Computer Word Structure

OCTAL CODE	CHARACTER
00	SPOT
01	1
02	2
03	3
04	4
05	5
06	6
07	7
10	8
11	9
12	0
13	-
14	T
15	V
16	E
17	M
20	R
21	BLANK
22	P
23	C
24	L

OCTAL CODE	CHARACTER
25	J
26	D
27	
30	S
31	B
32	
33	
34	
35	
36	
37	
40	D
41	BLANK
42	N
43	
44	BLANK
45	
46	
47	
50	R
51	S

OCTAL CODE	CHARACTER
52	A
53	B
54	C
55	E
56	F
57	G
60	H
61	I
62	J
63	K
64	L
65	M
66	P
67	Q
70	T
71	U
72	V
73	W
74	X
75	Y
76	Z
77	+

Figure 6. Character Set and Corresponding Octal Codes

3.3.7 Set Position Word Control Field - The SET POSITION word control field is composed of the six bits from positions 15 through 20 inclusive. The control field codes and associated display operations are shown below:

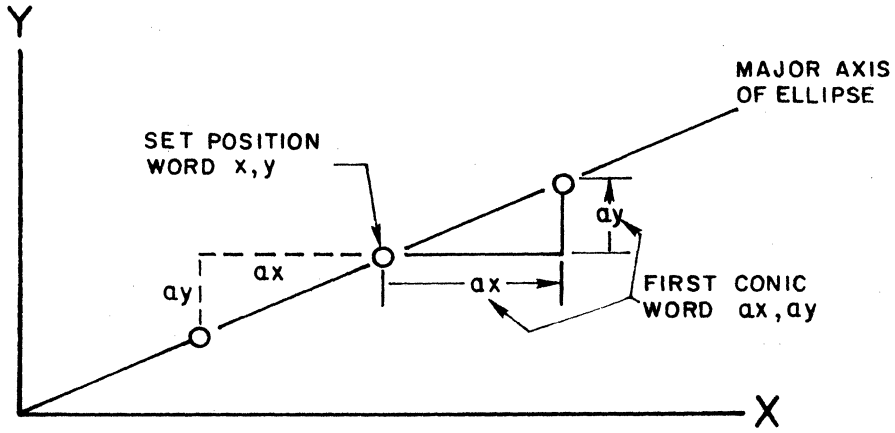
Control Field Code (Octal)	Display Operation
04	Display Conic Generator Output
05	Display Vector Generator Output
06	Display Normal Type Sequence
07	Display Short Type Sequence
10	EOD

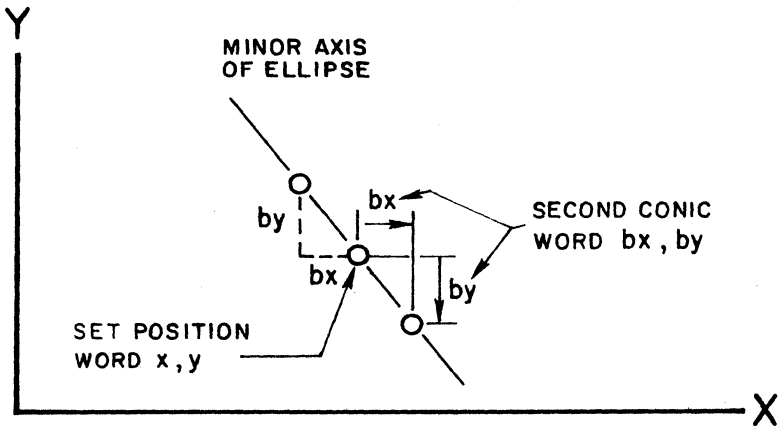
3.3.7.1 Control Field Code 04 - SET POSITION word control field code 04 commands the Conic Generator in such a manner that a conic in the form of an ellipse or a circle is generated, centered about the X and Y positions specified in the SET POSITION word containing the control field code 04. The next two digital words immediately following the SET POSITION word are shown in Figure 5.

3.3.7.2 Conic Format - Figure 7 illustrates the manner in which an ellipse is specified. Circles result when "ax" equals "by" and "ay" and "bx" are zero.

3.3.7.3 Control Field Code 05 - SET POSITION word control field code 05 causes the vector generator to prepare to generate a vector with the origin specified by the X and Y position fields. Additional information concerning the vector to be generated is given in the succeeding VECTOR word which specifies the slope, length and quadrant signs for the vector.

3.3.7.4 Vector Format - A vector is described in terms of its projections along the X and Y axes (ΔX and ΔY). The longer projected length is identified by the binary digits in bit positions 21 through 29 inclusive. The axis along which the longer projection lies is the major axis and identified in bit position 17 where the X and Y axes are identified





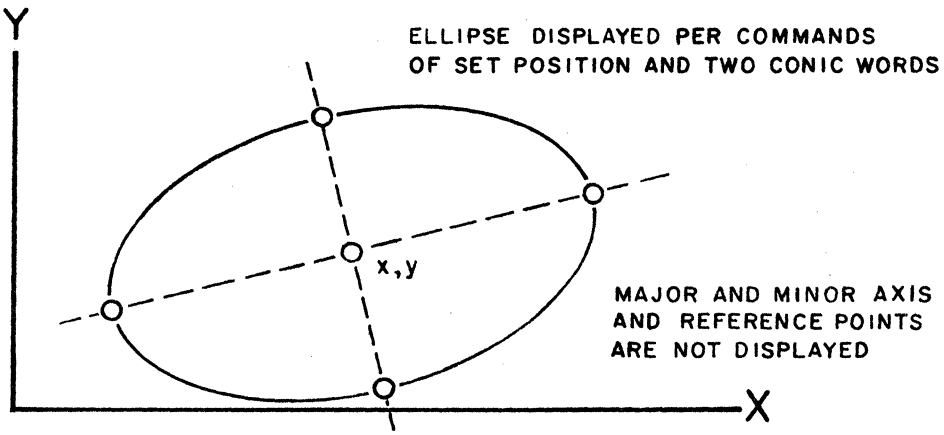


Figure 7. Conic Generation

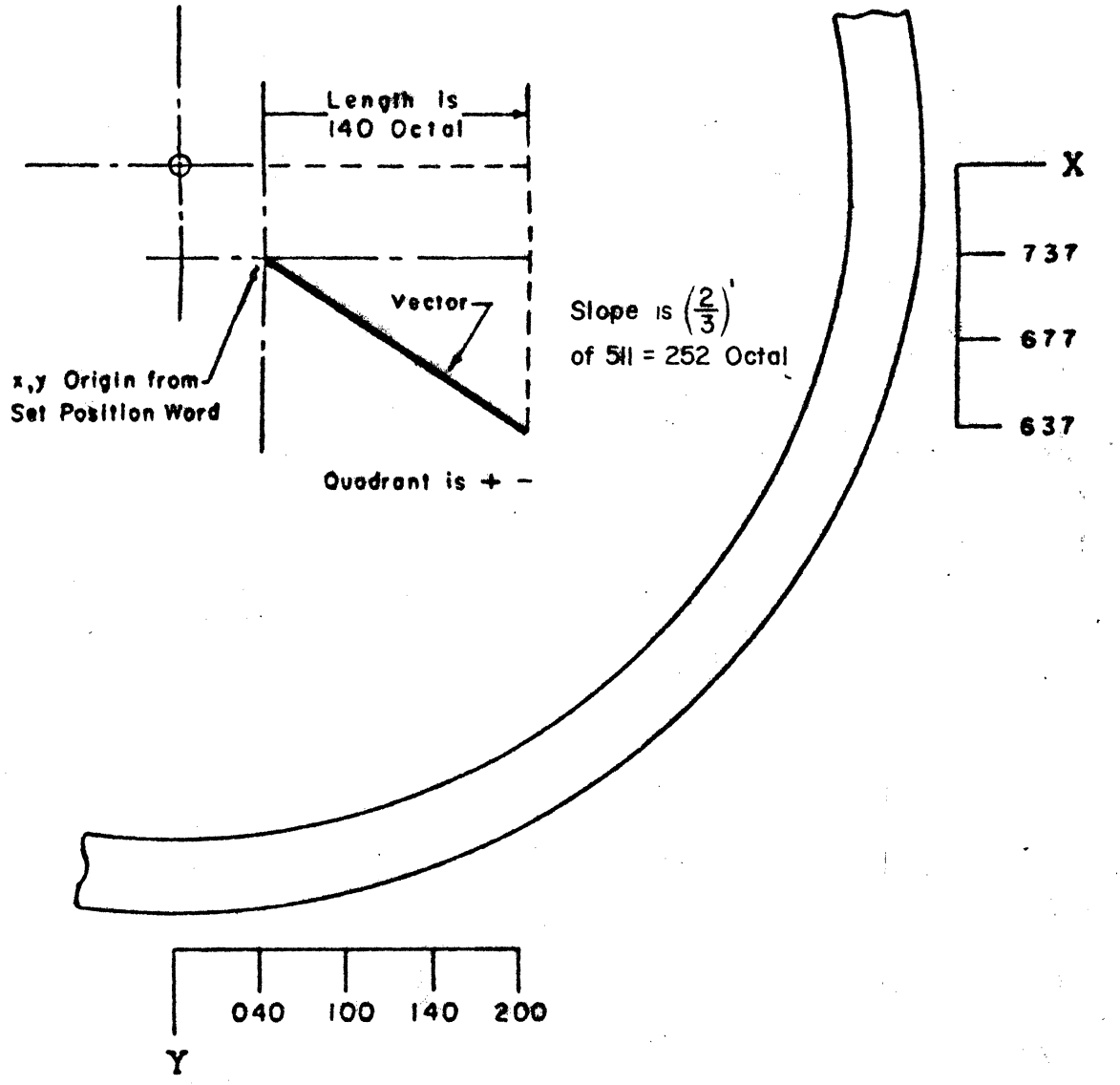
by 1 and 0 respectively. The direction of the vector extension from its origin is identified by the signs located in bit positions 16 and 15, the X and Y quadrant signs respectively. A 0 represents "+" and a 1 represents "-". The slope of the vector, identified by the binary digits in bit positions 6 through 14 inclusive, is defined as the ratio of the smaller to the larger of the absolute values of ΔX and ΔY multiplied by 511. Vector generation is shown in Figure 8 where the vector origin is the X and Y coordinates given in the SET POSITION word. The vector extension, as specified by the 0 and 1 in bits 16 and 15 of the VECTOR word, is into the +X and -Y quadrant of a cartesian coordinate system assumed to originate at the specified X, Y vector origin. The length is specified along the X axis by the 1 in bit 17 and the octal 140 in the length segment, bits 29 through 21 inclusive. The angle made with the larger projection on the X axis is determined by the slope of 2/3 times 511 which is octal 525 (complemented to octal 252, because the minor axis is negative) as specified in bits 14 through 6 inclusive.

As shown in this example the slope word must be expressed in one's compliment format whenever the minor axis is negative.

3.3.7.5 Control Field Code 06 - SET POSITION word control code 06 commands the logic to present a sequence of characters beginning at the X and Y position specified in the position fields. The characters to be typed are specified in the following series of TYPE words, each containing five character symbols identical to those of Figure 6, except that the code 36 calls for carriage return/line feed instead of symbol ⊙ , code 41 calls for end of message (EOM) instead of blank, and code 00 calls for a blank. Carriage return/line feed is to the left index as indicated in the SET POSITION word position fields. Upon receipt of EOM the logic calls for a new instruction word.

Character spacing is approximately 40% of character size. This allows a maximum of 30 characters per line in Type Mode.

3.3.7.6 Control Field Code 07 - SET POSITION word control field code 07 commands the logic to present a sequence of five characters beginning at the position specified by



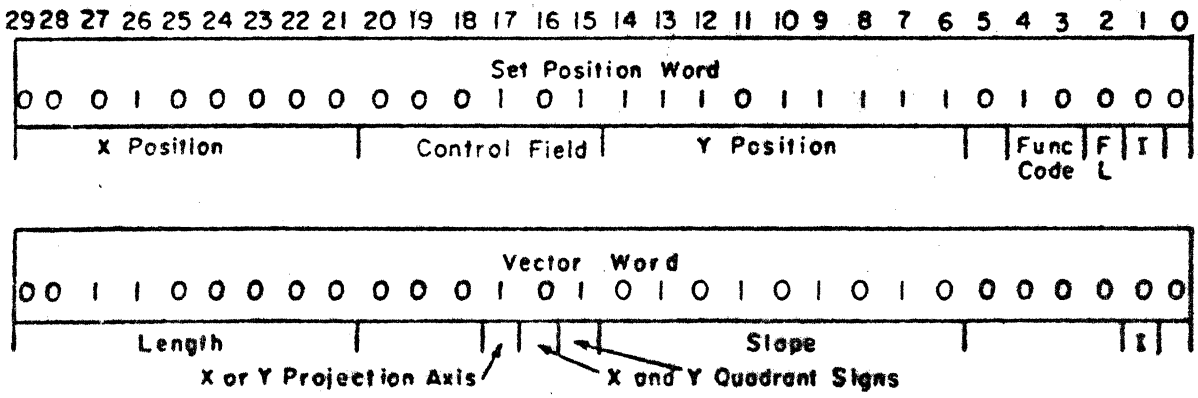


Figure 8. Vector Generation

the X and Y fields. The five characters to be presented are defined in the next instruction word. At the end of the fifth character the logic responds as though an EOM code had been presented.

3.3.7.3 Control Field Code 10 - END OF DATA Control Field Code 10 causes the interface unit to suspend operations pending the arrival of the next frame synchronization pulse. If the frame sync pulse is received prior to the control code 10, the overflow indicator on the console illuminates, and the frame time increases to accommodate the increased data. When the data period decreases to less than the normal frame time, the frame time decreases to normal.

3.3.7.8 Load Address - The I/F controller unit requests new computer data after the active frame interval. The first word detected in response to this request is treated as Load Address. The least significant 15 bits specify Start Address. Succeeding computer words are addressed sequentially until the total word count is reached as specified by the most significant 15 bits of the Load Address word. The next frame sync pulse is ignored if it occurs prior to completion of memory loading.

3.3.8 Data Load Density - The display system is capable of accepting and displaying in one frame period a situation plot consisting of the data shown below. The actual time to execute the particular display operation is determined by the I/O timing and control logic.

Display Operation	Number Per Frame
Conic (Circles and Ellipses)	14
Long Vector (50 inches average length)	24
Short Vector (2 inch)	80
Long Type (20 character line)	10
Short Type (5 character line)	20
Random Characters (PLOT)	90

3.3.9 Data Transfer Rates - The core memory within the I/F controller unit has a full cycle time of approximately 3.2 microseconds. This allows transfer rates up to the maximum allowed by the UNIVAC 1206 computer.

3.4 ANALOG CONTROLLER UNIT

Digital commands received from the display control logic are processed and converted to a form suitable for controlling the information displayed on the CHARACTRON shaped beam tube. These include vector, character, conic and unblank signal operation.

3.4.1 Analog Vector Generator - This unit consists of a Sweep Gate, Sweep Generator, and two 10-bit D/A converters.

3.4.1.1 Sweep Generator - The Sweep Generator supplies a voltage ramp, linear within 1%, and of sufficient magnitude to draw full diameter vectors. The sweep output is clamped to zero in the off state by the sweep gate which is under control of the display control logic.

3.4.1.2 D/A Converters - The output of the Sweep Generator is supplied as a reference voltage to the two 10-bit D/A converters. The output of the converters is proportional to the reference voltage multiplied by the binary number applied to its input. This binary number is the result of the length or slope information within the vector word. Each converter contains a divider network which supplies one-half of the voltage reference. This method provides a push-pull output signal from the converter.

3.4.2 X-Y Position Decoding - This unit consists of two 9-bit D/A converters and two precision voltage reference supplies. The purpose of this unit is to decode the X and Y position bits contained in the PLOT and SET POSITION computer words. A maximum of 511 discrete levels are outputed in push-pull form as explained in the previous paragraph, D/A Converters. The accuracy of the D/A converters is within 0.2% of full scale output.

3.4.3 Conic Generator - A Circle Generator, Buffer Amplifier, Summing Amplifier, and four 10-bit converters comprise the Conic Generator. The logic command (draw conic) causes the Circle Generator to output both a Sin and Cos voltage waveform. These signals are supplied to the 10-bit D/A converters as voltage references and the corresponding outputs are proportional to their binary inputs. In this case the binary inputs

represent X and Y resolved major and minor axis information. The push-pull outputs from the converters are coupled to the Summing Amplifier which produces an X and Y voltage output whose total harmonic distortion is less than 1%. The resulting outputs are of proper magnitude to produce a maximum two diameter conic.

3.4.4 X - Y Deflection - The X-Y Deflection unit consists of a Preamplifier, Power Amplifier, and control circuits capable of driving the magnetic deflection yoke located on the CHARACTRON shaped beam tube. The preamplifier input sums the analog signal outputs produced by the vector and conic generators, and X-Y position decoders. The resultant output signal to the deflection yoke positions the electron beam and draws vectors and conics as per original command. The preamplifier exhibits large open loop gain and signal bandwidth which is required for accurate presentation of the situation plots.

Although "off screen" operation is possible, e.g., two diameter conics, the magnetic deflection current is limited to a safe value. This is accomplished by a peripheral clamp circuit located within the deflection control circuitry.

3.4.5 Character Selection - Decoding of the six bit character code in the PLOT and TYPE computer words is accomplished by D/A converters in the Character/Selection unit. The push-pull signals are amplified by the Selection, Convergence and Reference amplifiers to a level suitable for driving three independent deflection yokes on the CHARACTRON shaped beam tube.

The circuit assemblies within the Character/Selection unit contain the controls required for character alignment, parallelogram correction, centering.

3.4.6 Unblank Amplifier - Intensity or "Z" axis signals are amplified by the Unblank Amplifier for purposes of controlling the intensity of the electron beam in the CHARACTRON display tube. Inputs to the Unblank Amplifier are vector, character, and conic unblank signals.

Controls are provided to adjust the intensity level of each mode of operation. Conic unblank consists of four adjustable levels to compensate for the various beam velocities inherent in conic function generation.

3.4.7 Lens Switch Assembly - The Lens Switch Assembly contains the necessary circuitry and controls to provide the appropriate voltage levels to the electron optical system of the CHARACTRON shaped beam tube. The lens voltages are automatically adjusted for optimum character and spot modes by digital command received from the Display Control Logic.

3.5 PROJECTION SYSTEM

The overall projection system consists of a Projection Head assembly and a projection screen. Signal voltages processed by the Analog Controller unit are coupled directly to the Projection Head assembly for purposes of displaying and controlling information on a CHARACTRON shaped beam tube. This information is magnified by a reflective optics system and displayed on the projection screen.

3.5.1 Display Tube - The display tube is a CHARACTRON shaped beam tube consisting of an internally mounted electron gun and character matrix plate. The matrix contains 61 character positions. The special spot writing symbol utilizes four character positions to insure sufficient brightness is available in the spot writing mode.

The character selection, convergence, and reference coils are driven in such a manner that the electron beam is shaped by the character matrix into the desired character. The deflection yoke positions the selected character on the six-inch faceplate of the CHARACTRON shaped beam tube as determined by the output of the deflection amplifier. The electron gun controls are connected to the lens switch assembly and Unblank Amplifier to allow beam size, focus, and intensity control.

3.5.2 Projection Optics - Information present on the face of the display tube is projected onto a spherical mirror, optically corrected by an aspheric corrector lens and projected onto an eight foot by eight foot screen (see Figure 1). The usable viewing

area is 84-inches by 84-inches resulting in displayed characters adjustable in size to two inches maximum. The display throw distance from Projection Head to viewing screen is in the range of 12 to 16 feet.

4. WORK STATEMENT

Stromberg DatagraphiX will provide to the Naval Air Development Center (NADC) the following services and end item equipment. (Refer to Figure 9, Work Schedule.)

a. Deliver one prototype model of the CHARACTRON Projection Display System.

b. Deliver one set of engineering documentation consisting of schematics, wiring diagrams and logic equations.

c. Provide installation and system integration of the display system at NADC.

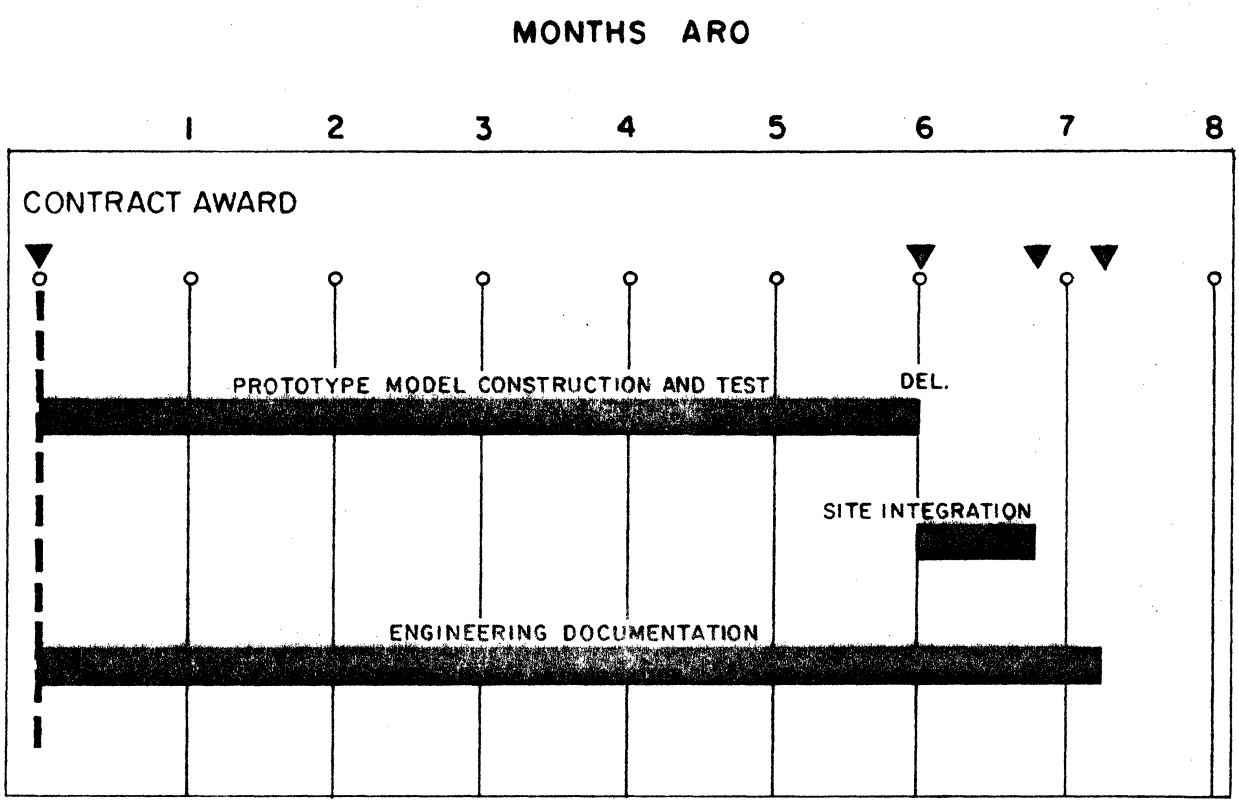


Figure 9. Work Schedule

5. CAPABILITIES AND FACILITIES

The following pages summarize the capabilities and facilities of Stromberg DatagraphiX, a wholly-owned subsidiary of General Dynamics Corporation.