DELTA 1
VIDEO DISPLAY TERMINAL
REFERENCE MANUAL

September 1969
DELTA 1

VIDEO DISPLAY TERMINAL
# TABLE OF CONTENTS

1.0 Introduction

1.1 Selective Blink

1.2 Editing Package

1.3 Remote Programming

1.4 Cursor Controls

2.0 Systems Configuration

2.1 Display Control

2.2 Display

2.3 Read-Only Memory

2.4 Memory Control

2.5 Refresh Memory

2.6 Edit Control

2.7 Serial I/O Control

2.8 Parallel I/O Controller

2.9 Keyboard

3.0 Modes of Operation

3.1 Conversation Mode

3.2 Format Mode

3.3 Normal Mode

3.4 Graphic Mode

3.4.1 Light Pen Tracking

4.0 TV Compatibility

4.1 Use with CCTV Equipment

4.2 Raster Scan

4.3 Sync Signal and Composite Video

5.0 Input-Output Transfer

5.1 Party Line I/O Bus

5.2 Commands

5.3 Transmit Commands

5.3.1 Transmit Message

5.3.2 Transmit Display Command

5.3.3 Transmit Line Command

5.3.4 Transmit X Address Counter

5.3.5 Transmit Y Address Counter

5.4 Clear Commands

5.4.1 Clear Message Command

5.4.2 Clear Display Command

5.4.3 Clear Line Command

5.5 Enter Commands

5.5.1 Enter
5.5.2 Enter Addressed Line
5.5.3 Enter Addressed Position
5.6 Edit Commands
8.1 Insert Command
5.6.2 Insert Line Command
5.6.3 Delete Command
5.6.4 Delete Line Command
5.7 Display Controls
   7.1 Set Blink
   5.7.2 Clear Blink
   5.7.3 Cursor Left
   5.7.4 Cursor Right
   5.7.5 Cursor Up
   5.7.6 Cursor Down
   5.7.7 Return
   5.7.8 New Line
   5.7.9 Home
   5.7.10 Backspace
   5.7.11 Tab
5.8 Party Line Signals
      5.9 Interrupt System

6.0 Serial Communications
6.0.1 Communication Interface
6.0.2 Synchronous Interface
6.1 Serial Controller - IBM Compatible
6.1.1 ASCII Communication Control Characters
6.1.2 Addressing Sequences
6.1.3 Sequence/Response Dialogue
6.1.4 Transmit Data Commands
6.1.4.1 Enter Data Commands
6.1.4.2 Error Control
6.1.5 Teletype Compatibility Serial Controller
6.2 Echoplex Mode
6.2.1 Normal Mode
6.2.2
6.3 Serial Interface (RS-232B)
6.3.1 Grounds
6.3.2 Data Signals
6.3.3 Control Signals
6.3.4 Additional Control Signals
6.3.5 Electrical Signal Characteristics

7.0 Parallel Interface Controller
7.1 Parallel Controller I/O Bus
FIGURES

DELTA 1 USASCII CODE

3.0 DELTA 1 System Configuration
5.1 Input/Output Party Line Schematic
5.2 Party Line Data Input Timing
5.3 Party Line Output Timing
5.4 Party Line Timing
5.5 Sequential Priority Interrupt Schematic Diagram
6.1 Sequence/Response Diagram for Transmit Data Commands from the Computer
6.2 Sequence/Response Diagram for Enter Data Commands from the Computer
7.1 Sequence/Response Diagram for Transmit Data Commands from the Computer via a Parallel Interface
7.2 Sequence/Response Diagram for Enter Data Commands from the Computer via a Parallel Interface
8.0 Bits and DELTA 1 Control Codes
9.0 Keyboard

TABLES

5.1 Party Line I/O Connector
7.1 Parallel Interface Connector
1.0 INTRODUCTION

The DELTA 1 VIDEO DISPLAY TERMINAL is a complete stand alone computer terminal for rapid entry, transmission, and retrieval of digital information. It consists of a controller, an alpha-numeric keyboard and a CRT display. A standard T.V. monitor is used for display of an EIA-TV compatible signal. This makes possible the operation of many T.V. monitors in a room or building to display information to many users.

The DELTA 1 has a capacity of 960 characters, 40 on each of 24 lines. A graphics mode provides display of graphic information on a 128 by 64 matrix. Complete capability for editing, formatting and transmitting data is included to provide data manipulation heretofore unavailable with a terminal in this price class.

Communications with the DELTA 1 is provided through an EIA compatible serial communications interface. The serial interface provides ASCII communications capability to make the DELTA 1 compatible with the Model 2701 communications controller of the IBM software. A parallel interface is also available with DTL electrical compatibility. Data is transferred through the parallel interface using a REQUEST-ACKNOWLEDGE control sequence providing compatibility with computer input/output.

The most complete set of editing and format controls are provided to simplify operator manipulation and preparation of data. The character insert and delete keys open or close a space on a line and the line insert or delete keys open or close a line space. The format control permits entering and protecting fixed information while the operator enters variable information. Transmission and clearing of the variable information provides a high level of efficiency of operation.

The selective blink feature permits any characters at selected positions to blink to call the operator's attention to the data.

Complete cursor control from the keyboard as well as the computer is provided by cursor controls to position the cursor anywhere on the screen. Variable transmission and erase data commands provide the ability to handle either the entire screen, a single line, or a message.
Options offered for the DELTA 1 include a light pen, hard copy devices for printing what is on the screen, closed circuit T.V. equipment for use in conjunction with the DELTA 1, and various interfaces for communication and direct connection to other computers.

A. Options also include a 96 character set where the 32 additional characters are either:

1. Lower case.
2. Line drawing characters.
3. ASCII control code graphic symbols.

(The use of any of these options requires that the blink capability be deleted.)

1.1 SELECTIVE BLINK

The SELECTIVE BLINK feature permits the computer to call attention to important information displayed on the screen. Such information blinks on and off at approximately a once per second rate. The operator's eye is captured by the blinking and he can take appropriate action to acknowledge receipt of such information.

Blink will cause any field of characters to be in the BLINK condition. When BLINK is established for a given character position, any displayable characters stored in that position will blink on and off on the screen. Clearing the position to a space or changing the character will not stop the blink function. To stop a field from blinking, the appropriate command must be entered for each position for which the blink function should be terminated. In this way, each position may be separately and independently programmed to blink or to stop blinking as required.

BLINK is independent of the format function and will be affected by whether a given position is FIXED or VARIABLE data in the FORMAT MODE. Edit commands will change the location of the blink field as well as data.

1.2 EDITING PACKAGE

The DELTA 1 has a complete set of data editing features. Because an important characteristic of a CRT terminal is the ability to receive data from a computer, manipulate the data and then transmit back to the computer, the edit features provided by the DELTA 1 are essential. These are as follows:
A. Insert

The Insert Command causes a character space to be opened up at the position of the Cursor and all characters at that position and to the right are moved over one place. The last character on the line is discarded. The Cursor remains in its same position and repeated operation of this key will open up a multi-position space. The data to be inserted can then be typed directly in without affecting subsequent lines of data. This is used to add a letter or a number in the middle of another group of numbers or letters.

B. Insert Line

This command takes the entire line of data on which the Cursor is located and moves it and all lower lines down one line. The bottom line of data is discarded. This opens up an entire line of data for insertion into the body of the text.

C. Delete

This command causes the character at the position of the Cursor to be replaced by the one immediately on its right and all characters to the right of the Cursor position to be moved to the left one position. A space is brought into the last position on the line. It is used to remove a word or character from a line without replacing it with something else. It differs from the normal typing operation where any new characters typed over an old one will simply replace the old character with the new one.

D. Delete Line

This command causes all characters on the same line as the Cursor to be replaced by all the characters on the next lower line. All lines below that are moved up one line and spaces are brought into the bottom line from a text without replacing it with a different line.

E. Roll and Crawl

One of the important capabilities of the DELTA 1 Terminal through the edit functions is the ability to ROLL data up and down by the use of the deletion or insertion command. New lines of data can then be entered so that a continuously moving text
can appear on the screen of the terminal. The same thing can be true for a single row of characters, CRAWLING from left to right or right to left. In each case the appropriate characters or lines to be entered can be displayed and moved up, down, left or right.

1.3 REMOTE PROGRAMMING

The DELTA 1 display is capable of responding to a variety of commands to provide for remote operation of the various function controls. These include all of the format controls, the erase controls, and the transmit control. In addition, the remote computer can cause the Cursor to be set at any fixed position on the screen by providing an absolute address to the terminal.

1.4 CURSOR CONTROLS

An extensive set of Cursor Controls is provided on the DELTA 1. These are designed with two points of view; for operator convenience, and to provide complete flexibility to the computer programmer.

At the keyboard, there are 7 Cursor Commands. These include UP, DOWN, LEFT, and RIGHT. Also provided is the HOME command which moves the Cursor to the first position of the first line, the RETURN command which moves the Cursor to the first position of the following line, and the BACKSPACE command which moves the Cursor back one position.

All of the above Cursor Commands are programmable from the computer which also has the capability for absolute positioning the Cursor any where on the screen with the POSITION CURSOR COMMAND. The Cursor command, given with a line and position number, will automatically move to the position addressed. This provides the ultimate in manipulative capability from the computer.
2.0 SYSTEMS CONFIGURATION

The DELTA 1 display station consists of a number of modular components described in the following paragraphs:

2.1 DISPLAY CONTROL

The function of display control is to generate master timing, integrate the refresh memory, generate the character font, and convert the digital character information into a signal capable of being recognized by a standard T.V. monitor. It also contains an EIA RS170 compatible sync generator which produces composite sync and composite video signals. Optionally available is a source of control signals necessary to permit the Display Controller to be the source of synchronization for any closed circuit T.V. facility.

2.2 DISPLAY

The technique used for generation and display of data employs a scanned raster approach. The display is a standard CRT T.V. monitor mounted in a desk top housing. The 12" screen will display 960 characters in 24 rows of 40 characters each. Mounted on the side of the display station are three control knobs, for brightness, contrast, and horizontal hold. At the users option, other displays may be attached to the same controller providing the opportunity to monitor the contents of the screen in several different locations. These monitors can be additional DELTA 12" display screens, or large screen remote monitors can be used.

2.3 READ-ONLY MEMORY

The read-only memory is a permanent storage device. It is programmed to contain a pattern of one's and zero's which represent the shape of each of the standard 64 characters which can be displayed on the screen. Since each character is made up of seven rows of five dots each, the memory is broken up into 64 x 7 words of five bits each.

2.4 MEMORY CONTROL

Memory control serves the purpose of addressing the refresh memory and controlling the source and destination of the data. During that portion of the raster
scan in which the display is active, memory access is controlled by a real time clock counter which defines character position along the line and character line on the page. During this time the data is transferred from core memory to the Display Control.

If new characters are to be entered into the refresh memory or if some other form of an edit is pending, during the period of time in which the raster is re-tracing, the memory address is the cursor address. Data is either extracted from the memory or entered into the memory during the retrace time, as defined by Edit Control.

2.5 REFRESH MEMORY

The refresh memory is a high speed, random access magnetic core storage. This unit contains 1024 eight-bit words. In the DELTA 1, six bits are used for storage of which of the 64 characters in the set is to be displayed. The other two bits are used to store blink and format information. In a 96 character-set display or in a color terminal, one or the other of the remaining two bits may be used for other information.

2.6 EDIT CONTROL

The function of Edit Control is to perform all editing operations for the data received from either the computer or the keyboard, and for sending all data to the computer.

The basic edit functions include control of transmission to and from a computer, clearing all or sections of the display, entering data into the display, controlling the cursor on the display, or manipulating data via the insert, insert line, delete, or delete line commands.

2.7 SERIAL I/O CONTROL

The function of the Serial I/O Controller is to permit the display system to communicate with a computer via a communications line. The Serial I/O Controller transmits and receives serial ASCII Coded data via a telephone company supplied modem and converts it to edit, transmit, or control commands for the display.

The Serial I/O Controller also performs the handshaking operation required to establish communications.
2.8 PARALLEL I/O CONTROLLER

The function of the Parallel I/O Controller is to permit direct communications between the display system and other I/O devices. Such devices include small general purpose computers, paper tape readers or punches, card readers or punches, magnetic tape controllers, line printers, and the keyboard.

The parallel I/O Controller contains a party line data bus permitting the display controller and other peripheral devices to share common information. To insure proper direction of information flowing into or out of the data lines, an interrupt structure is used. Thus, any device requiring service will make a request which is stored in the Parallel I/O Controller, and when the Controller completes the processing associated with some other I/O device control is transferred to the requesting peripheral. During the time that this peripheral is using the data bus, all other requests are stored and only the peripheral presently using the I/O data bus can control the flow of data to or from the display controller.

2.9 KEYBOARD

The keyboard, as shown in figure 9, contains a standard typewriter keyboard, a display edit keyboard, and a display control keyboard all in one package. The standard typewriter keyboard permits entry of 26 characters, ten numbers, and 24 special symbols.

The edit keyboard permits relative motion control of the cursor (up, down, left, and right), homes the cursor, permits the establishment of formats and blink fields, and permits the operator to enter or delete characters or lines.

The control keyboard permits the operator to request transmissions, to clear a message, display, line, to reset the display, to select the mode of operation, and the mode of display, and permits a limited number of special controls which will cause actions on external I/O devices (up to ten can be supplied).
3.0 MODES OF OPERATION

There are three modes of operation for display of alphanumeric information. These are 1) conversation mode, 2) format mode, and 3) normal mode.

3.1 CONVERSATION MODE

The Conversation Mode is provided to facilitate conversational dialogue between the computer and the DELTA 1 terminal. The purpose is to simplify operator actions in communicating with the computer and to permit the past conversation with the computer to be left displayed on the screen.

After Activation of the Conversation Mode Key, the Mode Light will go on. The address of the cursor is stored in a register and the operator types his inquiry to the computer. The last character of the message will be an End Of Message (EOM) symbol. The terminal transmits all information between the cursor locations stored in the register and the End Of Message symbol. The computer begins its reply on the next line leaving displayed the inquiry to the computer. When the computer has completed transmission of its message, it sends a Return and returns control to the terminal. The terminal again stores the address of the cursor in the address register and the operator can type in the next inquiry.

In the Conversation Mode it is not necessary to constantly reposition the cursor to the beginning of a message in order to transmit. Furthermore, the entire dialogue between computer and operator remains displayed on the screen instead of being cleared after each communication.

The Conversation Mode is an important factor in the man-machine interface problem by simplifying communications with the computer. It, therefore, simplifies operator intervention and training.

3.2 FORMAT MODE

The Format Mode is designed to simplify man-machine interaction. It is used when a pre-established format is placed on the screen in the Normal Mode and requested information (variable data) is typed in Format Mode.
An example of a format would be:

NAME: 
ADDRESS: 
CITY: STATE: ZIP: 
S. S. #: 
EMPLOYER: 

The computer would transmit data in the Normal Mode to establish such a format. Now, operating in the Format Mode, the operator would be unable to erase the format information. Operation of the tab control would move the cursor to the start of the first variable data field. The operator would then type (TAB) Richard M. Nixon (TAB) 1600 Pennsylvania Ave (TAB) WASHINGTON (TAB) D.C. (TAB) 21111 (TAB) 333-333-3333 (TAB) U.S. GOVERNMENT (END OF MESSAGE).

The screen would then look like this:

NAME: RICHARD M. NIXON 
ADDRESS: 1600 PENNSYLVANIA AVE 
CITY: WASHINGTON STATE: D.C. ZIP: 21111 
S. S. #: 333-333-3333 
EMPLOYER: U.S. GOVERNMENT 

Now the operator is ready to transmit the variable data to the computer. Since the computer established the format in the first place, it knows what the format information is. The transmit button is pushed and the terminal sends only the variable data. Now, the clear screen command is activated. This will clear the variable data and bring the screen back to just the format information, ready for a new entry.

When a delete or insert character editing function is operated in the Format Mode, it only operates on the field from the cursor to the end of the line or the end of the variable data field, whichever shall occur first.

3.3 NORMAL MODE

The Normal Mode is the usual operating condition of the DELTA 1 terminal. It provides unrestricted use of the editing functions. Clear commands will operate on all character positions and all data specified will be transmitted in a send operation.

3.4 GRAPHIC MODE

An alternate mode of operation from that of ALPHA-NUMERIC display is for GRAPHIC DATA DISPLAY. In this mode the
screen is divided up into 8192 spots on the face of the screen. Each eight bit character in the refresh memory of the terminal describes an on-off condition for any one of a corresponding eight spots on the face of the screen. The computer can then transmit data to the memory to provide a pattern of lit and unlit spots that will draw lines, circles, and curves and generate characters on the face of the screen. In this way graphic data may be displayed and annotated using the DELTA 1.

No relationship exists between the positioning of the alpha-numeric data on the screen and the graphic data.

3.4.1 LIGHT PEN TRACKING (OPTIONAL)

Light Pen Tracking permits use of the light pen to draw lines and curves on the face of the screen. When the light pen tracking control has been operated, the movement of the pen across the face of the screen will cause dots along the path of the pen to be turned on. This pattern becomes stored in the refresh memory and can be interrogated by the computer to provide input data.
4.0 T.V. COMPATIBILITY

The DELTA 1 Terminal is a T.V. compatible display. This means the signal generated to drive the display portion of the terminal is compatible with the television signal generated in any closed circuit television system. This opens up a broad avenue of applications for the DELTA 1 Terminal. Because of T.V. COMPATIBILITY, we are able to make use of a standard solid state 12" T.V. set in our terminal at an accompanying savings to the user. This savings is in the form of initial cost as well as maintainability because the operation of the circuits within the display are identical to those of part of a standard commercial television set.

4.1 USE WITH CCTV EQUIPMENT

The T.V. compatible signal drives a standard 525 line T.V. monitor or modified T.V. set. The display associated with each keyboard can be monitored remotely through a closed circuit television system. A single television distribution amplifier can be used to drive several remote monitors in different locations.

A standard commercially available Video Tape Recorder may be used to record the data being displayed for later retrieval and display. The output of a closed circuit television camera can be combined with the signal from the DELTA 1 terminal to superimpose computer generated information onto a T.V. signal for display or recording. This is useful in many applications where existing closed circuit television systems can be combined with the output data generated by a computer. Graphic data such as pictures from slides or art work can be scanned by a T.V. camera and annotated by the signal from DELTA 1 terminal.

4.2 RASTER SCAN

Characters are created on the screen in the TV raster mode by blanking and unblanking of the TV beam as it moves laterally across the screen. The beam moves across the screen 525 times to create a normal TV picture. Successive sweeps skip every other line creating two fields of scan of 262 and 263 lines equally spaced up and down the screen. This is known as an interlace. In the DELTA 1 terminal, the information on each field is refreshed identically so that in effect we have 262 lines on the screen rather than 525. Since each is written 30 times per second, an equivalent refresh rate of 60 per second assures a flicker free display.
The display characters are formed in the middle 212 T.V. lines which made up of seven lines per character and two lines between rows on each of 24 rows of characters. The cursor is written on the 8th line of each character row and the 9th line is always used as a separation to row below.

It takes approximately 52 microseconds for the beam to sweep from one side of the screen to the other and approximately 12 microseconds for it to return back to the left hand side. During the 52 microsecond period as it sweeps the screen, the beam is turned on and off to generate one line of the character. However, the first 5 microseconds of the sweep are not used in order to assure a placement of the characters in the center of the screen and reduce maintenance problems from drift of the characters to the left or right of the visible area of the screen.

4.3 **SYNC SIGNAL AND COMPOSITE VIDEO**

The output signal from the Delta 1 generator to the display station and to remote monitors is a standard EIA Video signal as per specification RS 170 of the Electrical Industries Association. This specification provides the exact timing and characteristics of the synchronization signal for the TV receiver and the composite video signal.

The sync signal must have a pulse at the beginning of each line of video data to cause the beam to return from the right hand side of the screen to the left hand side. When the proper number of these pulse signals have been generated at 60 microsecond intervals, a horizontal synchronization sequence is generated. These provide the triggering necessary for the TV receiver to cause return of the beam from the bottom of the screen on the right to the top of the screen on the left. The receiver is now ready to receive a new vertical sync pulse and video data for the next field of display.

Standard synchronization signals are available as outputs from the generator to be used to trigger T.V. cameras and other closed circuit television equipment used in conjunction with the DELTA 1 terminal. Sync signal is mixed with the digital data to provide a composite video signal. This is the type of signal normally received from the output of a television camera and required by distribution amplifiers and monitors in a closed circuit TV
system. The compatibility with EIA standard RS 170 assures operation with closed circuit or broadcast TV equipment.

When operating in conjunction with TV equipment, it is necessary to provide the synchronization signals to the equipment from the Delta 1 display in order to provide for compatibility in operation.
5.0 **INPUT-OUTPUT TRANSFER**

All data transferred to and from the DELTA 1 passes through the party line input/output bus. This consists of eight bi-directional data lines and a series of control lines. These control lines provide for transfer of data through the data register. Data is transferred to and from the memory via the data register.

A priority input/output structure is provided through the party line I/O to permit various devices to gain exclusive access.

The single input/output port provided by the party line I/O is used by the serial communications interface, the parallel communications interface as well as other I/O devices. All data exchanged with the external world is passed to the memory through the party line I/O.

5.1 **PARTY LINE I/O BUS**

The DELTA 1 controller employs a "Party Line" I/O bus to communicate with peripheral equipment.

The party line at the last device must be terminated with a resistor whose value is the characteristic impedance of the signal line. This is done to minimize reflections. Since the data lines are bilateral, i.e. they can be driven from either end, a termination is required at each end. The control lines, which are unilateral, are required to be terminated only at the receiving end of the line. Figure 5.1 shows the circuit schematics of both types lines. Signal lines should be twisted pairs. Peripheral design should try to minimize the length of the line. While the controller can operate at long distances an effort should be make to keep the party line cable under 12 feet long.

5.2 **COMMANDS**

All commands described in the following paragraphs may be initiated from a remote source. To initiate them the controller expects the first input word to be the code for the command and the COMEN signal to be true during the transfer. If the command is a XMIT the XMITEN signal must also be true during the transfer.
The DATAVL signal will be turned off from the time the command data transfer is initiated until the command has been completed. At the conclusion of the command the controller will place an ACK code (for receive data commands) or an STX character (for send data commands) into the data register. Data is then transferred from the party line to the peripheral controller or other peripheral device under external control.

5.3 TRANSMIT COMMANDS

The transmit commands provide for transmission of data to a computer. Information to the right of a new line symbol on any transmitted line will not be transmitted. This conserves transmission time.

When the display is in the Format mode, only those characters located in "Variable" field positions are transmitted to the I/O device.

5.3.1 TRANSMIT MESSAGE (0100000)

This command causes the contents of the display from the present location of the cursor to an end of message symbol to be transmitted to some I/O device at a rate compatible with that device. At the end of the command, the cursor is located at the character position following the end of message symbol.

In the Conversational mode the cursor is backed up automatically to the first character after the last end of message indicator before executing the transmission sequence.

5.3.2 TRANSMIT DISPLAY COMMAND (0110000)

This command causes the cursor to reset to the origin location on the display and transmit the contents of every location on the display to the input/output device. At the conclusion of the transmission, the cursor is returned to the origin location.
5.3.3 TRANSMIT LINE COMMAND (0100001)

This command transmits to the requesting I/O device all information from the present location of the cursor to the end of the line. At the conclusion of the command, the cursor is located at the first location on the next line.

5.3.4 TRANSMIT X ADDRESS COUNTER (01000010)

This command causes the contents of the X address counter to be transmitted. The X address is the position of the cursor on the line. It varies from zero to 39.

5.3.5. TRANSMIT Y ADDRESS COUNTER (0100011)

This command causes the contents of the Y address counter to be transmitted. The Y address is the line address of the cursor.

5.4 CLEAR COMMANDS

5.4.1 CLEAR MESSAGE COMMAND (1100001)

This command will reset to a space character code the contents of all display locations from the present position of the cursor to but not including the end of message (EOM) symbol on the screen. At the conclusion of this command the cursor will be located at the character position following the EOM symbol.

5.4.2 CLEAR DISPLAY COMMAND (1100000)

The execution of this command causes the cursor to reset to the origin position and causes the replacement with a space character code of all character positions on the display screen. At the conclusion of the command the cursor is reset to the origin position.

5.4.3. CLEAR LINE COMMAND (1100010)

This command causes the replacement with a space character code all display positions from the present position of the cursor to the end of a line. At the conclusion of this command the cursor is returned to the position it had before execution of the command.
5.5 ENTER COMMANDS

There are three enter commands acknowledged by the terminal to permit display of data from the computer.

5.5.1 ENTER (1000000)

This command causes data received to be displayed beginning at the present cursor position. If more than forty characters are entered on a line of the display, an automatic over-flow to the next line of the display will occur. No return command need be entered when it is desired to display more than forty characters before a return symbol occurs. If 50 characters are transmitted followed by a return, the first forty will occur on a line and the next ten will occur on the following line. Subsequent data will begin at the start of the third line.

5.5.2 ENTER ADDRESSED LINE (1010000)

Data will be entered on a line whose number is specified by the first character after the STX in the message. The X address counter will be reset to zero so that the message begins at the first position of the addressed line. If a Y address is entered which is greater than 23, the cursor will be positioned in an imaginary place below the screen. Line addresses greater than 32 will cause entry on a line specified by the line address modulo 32.

5.5.3 ENTER ADDRESSED POSITION (1010001)

This command provides for entering of data on the screen beginning in a specified position of a line. The first character after the STX command specifies the position on the line. Data following the X position address will be displayed beginning at the position specified and continue across the line and on subsequent lines. The Y address counter is unaffected by this instruction.

NOTE: On all enter commands, the terminal will treat the first line as if it were immediately after the last line of the display. For example, a return command given on the bottom line of the display will cause the cursor to go to the home position.

5.6 EDIT COMMANDS

5.6.1 INSERT COMMAND (1110000)
This command causes a space character code to be inserted onto a display line at the location of the cursor and causes all remaining characters to the right of this location to be moved one character to the right. The character in the right most position is discarded. At the conclusion of this command the cursor is returned to the location of the space character code to permit the operator or computer to enter a new character. In the format mode the space character is inserted and all characters moved right one place until the end of the variable field.

5.6.2 INSERT LINE COMMAND (1110001)

This command causes a line of space code characters to be inserted on the line where the cursor is presently located and causes all subsequent lines below this line to be pushed down one line. The last line on the display is deleted from memory. At the conclusion of this command the cursor is located at the start of the new inserted line. In the format mode this command is invalid.

5.6.3 DELETE COMMAND (1110010)

This command causes the character located at the preset location of the cursor to be deleted from the display and all subsequent characters to the right of the cursor to be moved one position to the left. At the conclusion of this command the cursor is returned to the location at which the delete occurred. A space coded character is inserted as the last character on this line. In the format mode only variable data may be deleted and all characters in the variable field up to the cursor are moved to the left.

5.6.4 DELETE LINE COMMAND (1110011)

This command causes the erasure of all characters on the line signified by the cursor. All lines below this line are pushed up one line. At the conclusion of this command the cursor is located at the starting position on the line just deleted. This command is invalid in format mode.

5.7 DISPLAY CONTROLS

These characters can be contained as part of any text.
5.7.1 **SET BLINK** (0010010)

This command causes the present cursor location to be designated as a blink position so data will blink any time a character is located at this position. At the conclusion of the command the cursor is incremented one character position.

5.7.2 **CLEAR BLINK** (0010011)

This command resets the blink control for the present cursor location. At the conclusion of this command the cursor is incremented one character location.

5.7.3 **CURSOR LEFT** (0011101)

This causes the cursor to move one position to the left. Data is unaffected. If the cursor was on the leftmost position on the line before the key was operated, the cursor will go to the last position on that line. Data is unaffected.

5.7.4 **CURSOR RIGHT** (0011100)

This causes the cursor to move one position to the right. Data is unaffected. If the cursor was on the rightmost position of the line before the key was operated, the cursor will go to the first position of the same line. Data is unaffected.

5.7.5 **CURSOR UP** (0010110)

Moves the cursor to the same position on the preceding line. Data is unaffected.

5.7.6 **CURSOR DOWN** (0010111)

Moves the cursor to the same position on the next line down. Data is unaffected. If the cursor was on the bottom line, it will go to the first line on the screen.

5.7.7 **RETURN** (0001010)

Moves the cursor to the first position on the next line.
5.7.8 **NEW LINE (1111111)**

The character is entered on the screen. This character defines the end of a line during transmit commands, and the end of a field if in the format mode.

5.7.9 **HOME (0011011)**

Moves cursor to the first position of the first line on the screen. Data is unaffected.

5.7.10 **BACKSPACE (0001000)**

Moves cursor back one position. Data is unaffected. If cursor is in the first position of the line, it will go to the last position of the same line.

5.7.11 **TAB (0001001)**

The Tab Command is used when the display is in the Format Mode to facilitate the location of Variable Fields. Execution of the Tab Command causes the cursor to move to the first position of the next variable data field.

5.8 **PARTY LINE SIGNALS**

Data Bus - IDIBON to IDIB7N - eight bidirectional lines that transmit data between peripheral devices and the DELTA 1 controller. IDIB7N is the most significant bit, IDIB1N is the least significant bit and IDIBON is the parity bit (ignored by the controller unless longitudinal parity check (LRCC) is utilized).

Control Bus - ten lines that transmit or receive control signals between the DELTA 1 and I/O devices. The signals are described as follows:

- **INCKIN** Input clock. This signal is received by the Delta 1 and defines the period of time that new data is available to be entered into the controller. This signal must be true until a CKRN is received at the peripheral.

- **INDKOTN** Output clock. This signal is received by the Delta 1 and causes the controller to place a word on the Data Bus. Information to be sent to the peripheral is valid for that period of time from CKRN true until the INCKOTN is removed.
| **CKRN** | Clock response. This signal is sent by the DELTA I and defines to a peripheral when input data has been received and when output data is available. This signal goes true 250 nanoseconds after the INCKIN or INCKOTN goes true and lasts for 250 nanoseconds. |
| **SENDEN** | Send/Receive. This signal is transmitted by the DELTA I and defines to a peripheral whether the next data transfer is to be from or to controller. The signal will change state about 500 nanoseconds after the INCKIN or INCKOTN signal becomes true if a change is expected. |
| **COMEN** | Command Enable. The DELTA I expects that the first word of every transmission sequence be a command. The command enable signal must be true from just prior to the first INCKIN signal at least until a CKRN is received by the peripheral. It may stay true until the next INCKIN or INCKOTN. |
| **XMITEN** | Transmit enable. This signal has characteristics similar to COMEN and is required in addition if the command is a transmit. |
| **DATAVLN** | Data Available. This signal is transmitted by the DELTA I and defines to a peripheral when the data bus is available for the next INCKIN or INCKOTN. This signal goes false as either clock goes true and remains false until the controller has completed the operation associated with the data transfer. |
| **INTRN** | Interrupt Reset. This signal is transmitted by the DELTA I and defines to a peripheral when in time the message has been completed. This signal occurs at the leading edge of the last CKRN of a message transfer and is 250 nanoseconds long. |
| **VRCERN** | Parity Error. This signal is received by the DELTA I controller at any time during a message transfer and causes the controller to retransmit a message (transmit screen only) at the completion of the message or respond with a NAK for received messages. (This signal is normally used with the serial communications controllers only.) |
RESETN  Reset. This signal is transmitted by the DELTA 1 controller to peripherals when an operator depresses the RESET Key on the Keyboard. It may also be received from the peripheral. This signal causes the controller to reset all control flags to an initial state.

IREQ  Interrupt request. This signal is generated by the interface controller and when true indicates that a request for service is being made.

IACK  Interrupt Acknowledge. This signal is generated by the Input/Output unit in response to an IREQ and indicates that the I/O unit is ready to respond to the interface controller.

ICL  Interrupt clock. This signal is generated by the I/O unit and is used to clock the request FF's in the interface controller. When the IACK is true, this signal is not present.

ICP  Interrupt complete. This signal is generated by the interface controller when its operation is complete. It is used to reset all request FF's in all interface controllers. The serviced unit must reset its request storage FF at the same time. This pulse must be $>1<2$ times the ICL time.

**Function Bus** - Three lines that transmit pulses to a peripheral to initiate some action. All these lines are related to keys on the keyboard. (While three are available up to 10 can optionally be added.)

XMITSWN  Transmit Switch. This signal is transmitted to a peripheral when an operator depresses the XMIT key. The signal produced is true for 2 microsecond.

PRINTSWN  Print Switch. Same as above only initiated by operation of Print Key.

READSWN  Read Switch. Same as above only initiated by operation of the Read Key.

Table 5.1 defines the connector pin assignment for connecting external peripherals or their controllers to the DELTA 1. Figures 5-1, 5-2, 5-3 describe the timing of control and data symbols for the party line.
5.9 INTERRUPT SYSTEM

The interface controllers employ a unit sequential interrupt system which permits several interface devices to communicate with the display. To accomplish this, each interface controller must provide a signal to all subsequent controllers (INTERN) to indicate that it is not using the DELTA 1. It can only provide this signal if no other higher priority device has previously generated it (INTKN). Figure 5.5 shows a schematic of the interrupt structure.

Each interface controller is prohibited from generating party line clocks until it has received priority.

As shown in Figure 5.5 and INTEN signal is the INTKN of the next controller.

OPERATION OF INTERRUPT SYSTEM

The interrupt system shown schematically in Figure 5.5, operates as follows. When a request is determined by the interface controller, the request storage FF ($S_1 \ldots S_N$) is set. On the next trailing edge of the interrupt clock (ICL), the request FF is set for each device where the request storage FF is set. Since the IACK and each INTEN is high at this time, the IREQ is brought low. The interrupt FF (I) is set causing IACK to go low and the ICL to be removed from the bus. When INTKEN of the first controller goes low indicating that priority is available, the common input of gates A and C are enabled. If $R_1$ is set only gate A will have an output which transfers priority to the next controller in the chain.

When the interface controller finishes its operation, it generates an ICP which resets all request FF's (even those in other controllers) and its own request storage FF. Since all request FF's are reset, there will be no IREQ. The interrupt FF will then be reset, by the CL during ICP, allowing the ICL to return to the bus and to set any request FF where there is a corresponding request storage FF set. Thus, multiple requests will be serviced in their order of priority.
6.0 SERIAL COMMUNICATIONS

Communications between a peripheral and the display controller is always half duplex (except echoplex). For serial communications this takes the form of either a two-wire or four-wire system. For parallel communications it takes the form of eight-wire communication plus a number of control signals.

An unpollled system is one in which operator requests for transmission to or from a computer are initiated upon his action.

For DELTA 1 displays a polled system permits the use of a single communication line to address a large number of display controllers. The polled system is under the control of the data processor and requires that the data processor elicit communications traffic from the display controller by means of a polling message which identifies the polling command and specifies the address of a display controller which it is asking, "Are there any messages available for transmission?"

Because of the nature of the display command, two seven-bit words can specify the controller address (this stimulates an IBM 2848 Display Controller and a 2260 Display Station). The total number of display controllers accessible via this mode is in excess of 16,000.

A polled system allows the display controller to non-simultaneously transmit and receive data to and from the processor. If the control computer employs a full duplex communication channel, the communications from multi-display terminals to the computer permits transmitting data or polling messages to one station while receiving information from another even though at the display controller stations themselves, only half duplex operation is permitted.

6.0.1 COMMUNICATION INTERFACE

The display controller will operate using either synchronous or asynchronous modes of communication.

Asynchronous Modems. The display controller is compatible with Bell data sets Model 103A or Model 202C or 202D to permit asynchronous communication over either private line or direct dial switching networks.
The Model 202C Modem permits asynchronous information to be transferred on the dial-up networks at rates up to 1,800 baud, and the Model 202D modem permits asynchronous communication on the private line network up 1,800 baud. The Model 103A permits communication on either of these networks at rates up to 150 baud.

The display controller also has available an option to remove the modem interface for providing serial communication over a direct connection.

6.0.2 SYNCHRONOUS INTERFACE

The display controller also permits operation of a serial interface using synchronous modems permitting transmission speeds of up to 9,600 baud using private line connections.

For synchronous communications at 2,400 baud, the Bell Model 201A Modem can be used. This modem can be used in either a two-wire or four-wire system on either the dial-up or private line networks.

When a synchronous Modem is used in a polling environment, the message must also contain a synchronization code which is the ASCII SYNC command repeated four times prior to the message normally required with the use of an asynchronous modem.

6.1 SERIAL CONTROLLER - IBM COMPATIBLE

The DELTA 1 terminal with this controller operates with the same communications dialogue and features as the IBM 2265 Display with a (2845) Controller. This means that the IBM Display may be replaced on a plug to plug compatible basis with the DELTA 1 terminal. To provide this compatibility, the terminal is capable of responding to a four-character polling sequence that is identical to that which the IBM terminal expects. This sequence consists of a communications command character (EOT or SOH Command), two address characters which the terminal is capable of recognizing and decoding for operation on a shared line, and the fourth character is a command. These commands are the communications commands and are listed in section 5. They provide for transmission of the terminal data to the computer, entering data from the computer onto the terminal screen, erasing portions of the screen, and absolute positioning of the cursor.
If the transmit button has been depressed and the unit is in the transmit condition when the terminal is requested to transmit, it will respond with a start of text symbol (STX) and the message followed by an ETX and an LRC code. The unit will respond with an EOT character if the XMIT key has not been pressed indicating there is nothing to be transmitted.

When the unit transmits its message, the computer will respond either with an ACK (indicating the message was received without error) or an NAK (indicating the message was received with errors). If the NAK is received, the terminal will retransmit the entire message (XMIT screen only). If the ACK is received, the terminal will send an EOT character and unlock the keyboard.

6.1.2 ASCII COMMUNICATION CONTROL CHARACTERS

To establish and maintain an orderly flow of traffic over communication lines, particularly in multidrop applications (where more than one device is attached directly to the lines), a method of controlling line traffic is necessary. Line traffic between the computers and the remote display system is controlled by the use of six of the ASCII communication control characters. These six codes, used singly or in sequences, perform all the control functions necessary to establish and maintain an orderly flow of traffic between the channel and I/O devices attached to the communication lines.

The definition of each of these six ASCII characters is given below. The code structure for each is given in Figure 6.1

A. **STX (Start Of Text)** - A communication control characters that is to be treated as an entity. This entity will usually be terminated by ETX.

B. **ETX (End Of Text)** - A communication control character used to terminate a sequence of characters started with STX and transmitted as an entity.

C. **ACK (Acknowledge)** - A communication control character transmitted by a receiver as an affirmative response to a sender.

D. **NAK (Negative Acknowledge)** - A communication control character transmitted by a receiver as a negative responder to a sender.
E. **SOH (Start Of Heading)** - A communication control character used at the beginning of a sequence of characters which constitute a machine-sensible address.

F. **EOT (End Of Transmission)** - A communication control character used to indicate the start or conclusion of a transmission which may have contained one or more texts and any associated heading (addresses).

EOT is also used, instead of SOH, as the first byte of the addressing sequences in the transmit command operations.

### 6.1.3 ADDRESSING SEQUENCES

Each command issued by the computer to the remote display is transmitted in four sequential bytes of a definite format called an addressing sequence. The addressing sequence prepares the display to accept a command, defines the address, and specifies the operation to be performed. The following describes the specific function of each of the four bytes of the addressing sequences.

A. **First Byte** - The first byte of an addressing sequence must be either an SOH or EOT communication control character.

B. **Second Byte** - The second byte in the addressing sequence contains an address.

C. **Third Byte** - The third byte contains the second address character of the display to be selected.

D. **Fourth Byte** - The fourth byte of an addressing sequence specifies the command to be executed by the selected display.

Each of the four bytes of every addressing sequence is parity-checked by the DELTA 1 as it is received (as is every character).

### 6.1.4 SEQUENCE/RESPONSE DIALOGUE

### 6.1.4.1 TRANSMIT DATA COMMANDS

Figure 6.1 is a sequence/response diagram for transmit data commands from the computer. These are required in
a polling environment.

An EOT (or SOH) command will cause the terminal to treat the next two characters (TA1 and TA2) as a terminal address. These two characters will be coded and checked and if the proper address sequence is received, the fourth character received will be decoded as a command to the terminal. This four character sequence is present for all communications commands. The fourth character could be any of the several transmit commands.

The terminal will respond dependent upon whether the transmit button has been pressed putting the machine in the transmit mode. If it has not, the terminal will send an EOT character back to the computer indicating the fact that the terminal has no data to transmit. If the operator has pressed the transmit button, then the terminal will transmit a STX command (indicating the start of text), TA2 (the second of the two terminal addresses that were transmitted to it by the computer in the fourth character command sequence), and the text of the message that the terminal has to send. This will be followed by an ETX (indicating the end of text) and an LRC (longitudinal redundancy check character) for parity checking by the computer.

The terminal remains in the transmit mode until the response is received from the computer. If an error was detected in transmission, the computer will send back an NAK which will cause the terminal to send STX and begin the transmission of the text again. If no ACK command and the terminal will respond with an EOT which will then unlatch both the computer and the terminal from the communications. The on line light on the terminal will be turned off and the machine will return to its previous mode.

6.1.4.2 ENTER DATA COMMANDS

Figure 6.2 is a sequence response diagram for Enter Data Commands from the computer. The first character communications sequence will be either an SOH or EOT. The terminal will see a two character terminal address which it will decode to determine if it is being addressed. If so, it will decode the fourth character, the command character. Upon receipt of an Enter Data Command and detection of the correct address, the terminal will send to the computer an ACK character. The computer will transmit an STX character which would be used in those commands which involve entering data on a specific line
or character position on the line followed by the text to be displayed. An ETX command follows the text and then an LRC. The terminal will respond with an ACK (acknowledge) indicating receipt of the message and the computer should respond to that with an EOT which will remove the keyboard and the terminal from the Enter Data condition. If an error was detected by the controller it will respond with an NAK and the computer may (via software) retransmit or terminate.

6.1.5 ERROR CONTROL

Vertical Parity

As each character is received from the modem it is checked for even parity. If a parity error is detected an error flag is set and the character replaced by a CAN (\) character. As each character is sent to the modem an even parity is generated.

Longitudinal Parity

An accumulator is used to keep account of all input and output data from the first character after an STX to an ETX. This longitudinal accumulator is compared with the first received character after an ETX (LRCC) and any difference sets an error flag. During data transmission the contents of the accumulator is transmitted as the first character after an ETX.

Error Retransmission

If the error flag is set during receipt of data the controller will respond with an NAK character after the message is complete. The computer may be programmed to cause retransmission upon detection of the NAK.

If the computer responds to the receipt of a message with an NAK the controller causes the message to be transmitted. (This is only valid if the transmit command is a XMIT SCREEN.)
6.2 TELETYPe COMPATIBILITY SERIAL CONTROLLER

The DELTA 1 terminal with this controller operates with the same communications dialogue as a TTY. It can operate with either of two options -- Normal or Echo-plex. It is designed to communicate with a remote computer via a 103 series Dataphone using either a private line or the dial-up network. It may also be connected to an acoustic coupler. The communications are full duplex at 110 baud. (Up to 300 baud optionally available.)

6.2.1 ECHOPLEX MODE

In this mode the communications line is the only source of data to be entered on the CRT. As each character is typed on the keyboard it is transmitted to the computer. The computer returns either the same character or an error character (CAN, if a transmission error is detected) and displays it. The display advances the cursor one position. If a vertical parity error is detected on receipt of a word the CAN character is also displayed.

For TTY compatible communications initiation of commands from a remote source is not permitted.

6.2.2 NORMAL MODE

While the controller operates with a full duplex modem in this mode data cannot be sent and received simultaneously. Received data is displayed (except control characters) as it is received. The operator may create a display and then after editing it transmit it as a block to the remote computer. This action is initiated by the operator depression of the XMIT key.

If the operator has selected the Conversational mode the transmit command is a XMIT MESSAGE and the information transmitted is that information from the previous EOM symbol to the latest EOM symbol (typed by the operator after creating the display).

If the operator has not selected Conversational mode the transmit command is a XMIT SCREEN and all information on the screen is transmitted (if also in a format mode only variable data and new line characters are transmitted).
For all transmissions the transmitted data is bracketed by an STX character and an ETX character.

For all receptions of data the detection of a parity error (even parity) cause a CAN symbol (\) to replace the normal character.

6.3 SERIAL INTERFACE (RS-232B)

6.3.1 GROUNDS

Circuit AA -- Protective Ground

This conductor shall be electrically bonded to the terminal frame. It may be further connected to external grounds as required by applicable regulations.

Circuit AB -- Signal Ground

This conductor establishes the common ground reference potential for all interchange circuits except circuit AA (Protective Ground). In the data communication equipment this circuit shall be brought to one point, and it shall be possible to connect this point to circuit AA by means of a wire strap.

This wire strap can be connected or removed at the installation, as may be required to meet applicable regulations or to minimize the introduction of noise into electronic circuitry.

6.3.2 DATA SIGNALS

Circuit BA -- Transmitted Data

Direction: From Terminal

Signals on this circuit are generated by the terminal and are connected to the transmitting signal converter for transmission to remote data processing equipment.

The terminal equipment holds Circuit BA in marking condition during any time interval between characters or words, or at such other times when no signals are to be transmitted.

The marking or spacing signal condition is held for the total duration of each signal element.
Circuit BB -- Received Data

Direction: To Terminal Computer

Signals on this circuit are generated by the receiving signal converter in response to data signals received from remote equipment.

In half-duplex service, the receiving data set shall hold marking condition on Circuit CA (Request to Send in the OFF condition. Alternatively, in half-duplex service, the Received Data circuit may be used to monitor transmitted signals (e.g., for local copy).

A data set equipped for Transmit-Only service shall hold Circuit BB in the marking condition at all times.

The marking or spacing signal condition shall be held for the total duration of each signal element.

6.3.3 CONTROL SIGNALS

Circuit CA -- Request to Send

Direction: From Terminal

Signals on this circuit are generated by the terminal equipment to condition the local data set to transmit. For example, if the data set contains a modulator, the carrier signal shall be transmitted during the ON condition of Circuit CA.

The ON condition is maintained whenever the terminal equipment has information ready for transmission or being transmitted. The signal converter shall transmit all data on Circuit BA (Transmitted Data), while the ON condition is maintained on Circuit CA, Circuit CB (Clear to Send), and Circuit CC (Data Set Ready).

In half-duplex service, the OFF condition shall hold the data set in the receive-data condition, and the ON condition shall hold the data set in the transmit-data condition. The above conditions shall be established without regard to signals on Circuits BA (Transmitted Data) and BB (Received Data).

On a multipoint communication channel which may successively carry data signals transmitted by several data communication equipment stations, Circuit CA shall be used by each data processing terminal to condition its local data set to transmit.
Circuit CB -- Clear to Send
Direction: To Terminal

Signals on this circuit are generated by the transmitting data set to indicate that it is prepared to transmit data. The ON condition is a response to the ON condition on Circuit CA (Request to Send), delayed as may be appropriate to the data communication equipment for establishing a communication channel to a remote data processing terminal. When Circuit CA is turned OFF, Circuit CB shall be also turned OFF.

In Receive-Only service, the data set shall hold Circuit CB OFF at all times.

In Transmit-Only or Full-Duplex service, if the data communication equipment is arranged to be in transmit condition at all times, then Circuit CB shall be held in the ON condition at all times.

Circuit CC -- Data Set Ready
Direction: To Terminal

Signals on this circuit are generated by the local data set to indicate that it is ready to operate.

The OFF condition shall be used to indicate either:

A. Any abnormal or test condition which disables or impairs any normal function associated with the class of service being furnished.

B. That the communication channel is switched to an alternate means of communication (e.g., alternate voice telephone).

C. That the local data set is not connected to a communication channel (i.e., the data set is "on hook").

The ON condition shall appear at all other times.

This circuit shall be used only to indicate the status of the local data set. The ON condition shall not be interpreted either as an indication that a communication channel has been established to a remote station or the status of any remote station or equipment.
6.3.4 ADDITIONAL CONTROL SIGNALS

Additional interchange circuits may be required in some systems:

Circuit CD -- Terminal Ready

Direction: From Terminal

Signals on this circuit are used to control switching of the signal converter to the communication channel. The ON condition causes the signal converter to be connected to the communication channel. However, if the station is equipped only for call origination by means external to this interface (e.g., manually or an automatic call origination unit), then the ON condition serves only to maintain the connection established by these external means. When the station is equipped for automatic answering of received calls, connection to the line may be arranged to occur only in response to a ringing signal.

The OFF condition removes the signal converter from the communication channel, for such reasons as:

A. Freeing the line for alternate use (e.g., voice or use by other terminal stations).

B. Permitting use of the data processing terminal equipment for an alternate function.

C. Terminating a call (i.e., going "on hook").

The OFF condition shall not disable the operation of Circuit CE (Ring Indicator).

Circuit CF -- Data Carrier Detector

Direction: To Terminal

Signals on this circuit are used to provide an indication that the data carrier is being received. When the data carrier is lost because the transmitting signal converter is turned OFF or because of a fault condition, the OFF condition follows after an appropriate guard time delay.

In Half-Duplex service where the signal converter is arranged for local copy (see Circuit BB, Received Data), Circuit CF may respond to carrier signals from either the local or remote transmitting signal converter.

The ON condition indicates reception of the data carrier. The OFF condition provides an indication of the end of present transmission activity or a fault condition.
6.3.5 ELECTRICAL SIGNAL CHARACTERISTICS

The maximum open-circuit voltage to either Circuit AA (Protective Ground) or Circuit AB (Signal Ground) on any interchange circuit shall not exceed 25 volts, and the maximum short-circuit current flow between any two conductors (including grounds) shall not exceed one-half ampere.

For Circuit BA (Transmitted Data) and Circuit BB (Received Data), the signal shall be considered in the marking condition when the voltage on the circuit is more negative than minus three volts with respect to Circuit AB (Signal Ground), and the signal shall be considered in the spacing condition when the voltage is more positive than plus three volts with respect to Circuit AB (Signal Ground). During transmission of data, the marking condition shall be used to denote the binary state ONE (e.g., hole punched in paper tape), and the spacing condition shall be used to denote the binary state ZERO. Note that marking is the normal condition on a data circuit when no signals are present.

**SUMMARY OF DATA CIRCUIT INTERFACE TERMS**

<table>
<thead>
<tr>
<th>Binary state</th>
<th>ONE</th>
<th>ZERO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal condition</td>
<td>Marking</td>
<td>Spacing</td>
</tr>
<tr>
<td>Voltage</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Paper tape</td>
<td>Hole</td>
<td>No hole</td>
</tr>
</tbody>
</table>

The control function shall be considered ON when the voltage on the circuit is more positive than plus three volts with respect to Circuit AB (Signal Ground), and shall be considered OFF when the voltage on the circuit is more negative than minus three volts with respect to Circuit AB (Signal Ground).

**SUMMARY OF CONTROL CIRCUIT INTERFACE TERMS**

<table>
<thead>
<tr>
<th>Control function</th>
<th>OFF</th>
<th>ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>Negative</td>
<td>Positive</td>
</tr>
</tbody>
</table>

The operation of the circuitry that receives signals from an interchange circuit shall be dependent only on the signal voltage, as specified above, and should, therefore, be insensitive to the rise time, fall time, presence of signal overshoot, etc. The design of this
circuitry shall minimize the effects of any circuit time constants which would delay the circuit response, thus introducing time distortion in the signals.

The terminating impedance at the receiving end of an interchange circuit shall have a DC resistance of not less than 3000 ohms or more than 7000 ohms, and the voltage in open-circuited condition shall not exceed two volts. The effective shunt capacitance at the receiving end of a signal interchange circuit, measured at the interchange point and including any connecting cable, shall not exceed 2500 picofarads.

The source impedance of the sending end of an interchange circuit is not specified.

For both data circuits and timing signal circuits (Circuits BA, BB, DA, DB, DC, and DD), neither the rise time nor the fall time, through the six volt range in which the signal condition is not defined, shall exceed three per cent of the nominal duration of a signal element. The circuitry used to generate a signal voltage on an interchange circuit shall meet this specification with any receiving termination which complies with the preceding section.
7.0 PARALLEL INTERFACE CONTROLLER

The DELTA 1 can be provided with a parallel interface controller which permits connection of a number of different types of parallel devices (mini computers) to the DELTA 1. It provides a means of receiving input data, sending output data, interpreting a device address, and generating an interrupt address all on separate lines. It is organized to permit all of these functions to be separate or "or'd" together to permit the controller to accept and transmit data directly from the party line of a peripheral computer.

The data, address, and control signals are designed to have the characteristics of the DELTA 1 controller party line. Figures 7.1 and 7.2 describe the word parallel, character serial communications flow.

7.1 PARALLEL CONTROLLER I/O BUS

The parallel controller I/O cable consists of a number of lines grouped according to function.

Data Bus

DIOXN -- Input Data Lines. These lines are used to transfer data from a peripheral to the DELTA 1. These lines can be jumpered to the DOLOXN lines if the peripheral has a party line data bus. They may also be connected to the ADROXN and/or interrupt address data on its party line data bus. DIO0N is parity, DIO1N and DIO7N is MSB.

DOLOXN -- Output Data Lines. These lines are used to transfer data from the DELTA 1 to the peripheral. (x = 0 to 7 where 0 is parity, 1 is LSB and 7 is MSB)

Address Bus

ADROXN -- Device address. These lines are interrogated by the parallel controller (a specific code) at the time an ADRSYN signal is available.

IADROXN - Interrupt address. These lines are transmitted to the peripheral (a specific code) when an IUACKN is true.
Control Bus

INCKN --- Input Clock. This signal causes the data on the DILOXN to be transferred to the controller.

OUTCKN -- Output Clock. This signal causes the data on the DELTA 1 party line to be transferred to the DOLOXN lines.

ADRSYN -- Address sync clock. This signal causes the contents of the ADROXN lines to be interrogated for a specific code.

INST ---- Input Strobe. This signal is "and" ed with the INCKN and OUTCKN to permit synchronization for data transfers.

IURN ---- Interrupt request. This signal is transmitted by the controller upon operator action and causes the generation of an INTEN if the INTKN is not true.

IUACKN -- Interrupt acknowledge. This signal is received by the controller when the peripheral has responded to an interrupt.

IARN ---- Interrupt address request. This signal is received by the controller and causes the wire selected interrupt address to appear on the IADROXN lines.

Since the use of this parallel interface controller will cover many peripherals, it is suggested that to obtain a specific interface for a peripheral the user contact a DELTA sales engineer.
### DELTA 1 USASCII CODE

<table>
<thead>
<tr>
<th>b7</th>
<th>b6</th>
<th>b5</th>
<th>b4 b3 b2 b1</th>
<th>0 0 0 0 0</th>
<th>NUL</th>
<th>DCO</th>
<th>0 0</th>
<th>P</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>COL</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ROW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b6</td>
<td></td>
<td></td>
<td></td>
<td>0 0 0 0 0 1 0 0 0 0</td>
<td>!</td>
<td></td>
<td>A Q</td>
<td>A Q</td>
<td></td>
</tr>
<tr>
<td>b5</td>
<td></td>
<td></td>
<td></td>
<td>0 0 0 0 0 1 1 0 0 0</td>
<td>2</td>
<td>B</td>
<td>R</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>b4</td>
<td>b3</td>
<td>b2</td>
<td>b1</td>
<td>0 0 0 0 0 1 0 0 0 0</td>
<td>#</td>
<td>3</td>
<td>C</td>
<td>C</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>$</td>
<td>4</td>
<td>D</td>
<td>T</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 0 0 0 0 0 0 0 1 1 1</td>
<td>%</td>
<td>5</td>
<td>E</td>
<td>U</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 0 0 0 0 0 1 1 1 1 1</td>
<td>&amp;</td>
<td>6</td>
<td>F</td>
<td>V</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 0 0 0 0 1 1 1 1 1 1</td>
<td>'</td>
<td>7</td>
<td>G</td>
<td>W</td>
<td>G</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 0 0 0 0 0 0 0 0 0 0</td>
<td>)</td>
<td>8</td>
<td>H</td>
<td>X</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 0 0 0 0 1 0 0 0 0 0</td>
<td>)</td>
<td>9</td>
<td>I</td>
<td>Y</td>
<td>I</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 0 0 0 0 1 1 0 0 0 0 0</td>
<td>*</td>
<td>10</td>
<td>:</td>
<td>J</td>
<td>Z</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 0 0 0 0 1 1 1 1 1 1 1</td>
<td>+</td>
<td>11</td>
<td>;</td>
<td>K</td>
<td>[</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 0 0 0 0 1 1 1 1 1 1 1 1</td>
<td>,</td>
<td>12</td>
<td>&lt;</td>
<td>L</td>
<td>\</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 0 0 0 0 1 1 1 1 1 1 1 1 1 1</td>
<td>-</td>
<td>13</td>
<td>=</td>
<td>M</td>
<td>]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1</td>
<td>&gt;</td>
<td>14</td>
<td>N</td>
<td>EOM</td>
<td>NEW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1</td>
<td>/</td>
<td>15</td>
<td>?</td>
<td>O</td>
<td>LINE</td>
</tr>
</tbody>
</table>

( ) with Teletype Keyboard
FIGURE 3
DELTA I SYSTEM CONFIGURATION

DISPLAY

R.O.M. → MASTER TIMING

CHARACTER GENERATOR
BLINK

REFRESH MEMORY → INPUT OUTPUT

GRAPHICS → FORMAT CONTROL

1. ASR-33
2. NCR PRINTER
3. CARD READER

OPTIONAL I/O DEVICE CONTROLLER

PARALLEL COMMUNICATIONS INTERFACE

SERIAL COMMUNICATIONS INTERFACE

EIA RS232B INTERFACE

Party Line I/O Bus
FIGURE 5.1

INPUT/OUTPUT
PARTY LINE SCHEMATIC
FIGURE 5.2
PARTY LINE DATA INPUT TIMING

NOTE: See figure 5.4 for proper relationship of sequential clock signals
FIGURE 5.3
PARTY LINE OUTPUT TIMING

<table>
<thead>
<tr>
<th>Signal</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCKOTN</td>
<td>4 usec max</td>
</tr>
<tr>
<td>CKRN</td>
<td>250 nsec</td>
</tr>
<tr>
<td>DATA BUS</td>
<td></td>
</tr>
<tr>
<td>DATAVLN</td>
<td>63.5 usec max</td>
</tr>
</tbody>
</table>
FIGURE 5.4
PARTY LINE TIMING

OUTPUT CLOCK (INCHON) IDS

INPUT CLOCK (INCHON) IDS

COMMAND ENABLE (COMEN)

CLOCK RESPONSE (CHRN)

SEND/RECEIVE (SENDEN) S

DATA AVAILABLE (DATAVLN)

DATA BUSS

interrupt reset (intrn)

Output Clock (INCHON)

Input Clock (INCHON)

Command Enable (COMEN)

Clock Response (CHRN)

Send/Receive (SENDEN) S

Data Available (DATAVLN)

Data BUSS

Interrupt Response (INTRN)

Xmit Enable (XMITEN)
Interrupt request from interface

Request

Bus connections

FIGURE 5.5
SEQUENTIAL PRIORITY INTERRUPT SCHEMATIC DIAGRAM
FIGURE 6.1

SEQUENCE/RESPONSE DIAGRAM FOR TRANSMIT DATA COMMANDS FROM THE COMPUTER

TERMINAL IS IN THE TRANSMIT MODE

EOT
TERMINAL ADDRESS (TA-1)
TERMINAL ADDRESS (TA-2)
COMMAND

YES

NO

STX
TA-2

TEXT

ETX
LRC

ACK

NAK

EOT

COMPUTER

TERMINAL

TRANSMISSION ERROR?

NO

YES
FIGURE 6.2

SEQUENCE/RESPONSE DIAGRAM FOR ENTER DATA COMMANDS FROM THE COMPUTER

SOH
TERMINAL ADDRESS (TA-1)
TERMINAL ADDRESS (TA-2)
COMMAND

ACK

STX
ADDRESS *
TEXT
ETX
LRC

ACK

EOT

* Where applicable

COMPUTER | TERMINAL
FIGURE 7.1
SEQUENCE/RESPONSE DIAGRAM FOR TRANSMIT DATA COMMANDS FROM THE COMPUTER VIA A PARALLEL INTERFACE

TERMINAL IS IN THE TRANSMIT MODE

COMMAND

YES

NO

STX
TA-2
TEXT
ETX
LRC

TRANS ERROR

NO

YES

ACK

NAK

EOT

EOT

COMPUTER

TERMINAL
FIGURE 7.2

SEQUENCE/RESPONSE DIAGRAM FOR ENTER DATA COMMANDS FROM THE COMPUTER VIA A PARALLEL INTERFACE

COMMAND

ACK

STX
ADDRESS *

TEXT

ETX
LRC

ACK

EOT

* Where applicable

COMPUTER

TERMINAL
<table>
<thead>
<tr>
<th>Bits</th>
<th>Delta 1 Control Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>00000000</td>
<td>NUL Control Character</td>
</tr>
<tr>
<td>00000001</td>
<td>SOH Control Character</td>
</tr>
<tr>
<td>00000100</td>
<td>STX Control Character</td>
</tr>
<tr>
<td>00000110</td>
<td>ETX Control Character</td>
</tr>
<tr>
<td>00000111</td>
<td>EOT Control Character</td>
</tr>
<tr>
<td>00001010</td>
<td>ACK Control Character</td>
</tr>
<tr>
<td>00001110</td>
<td>BS</td>
</tr>
<tr>
<td>00001111</td>
<td>TAB</td>
</tr>
<tr>
<td>00010000</td>
<td>RETURN</td>
</tr>
<tr>
<td>00010001</td>
<td>SO DISPEN</td>
</tr>
<tr>
<td>00010010</td>
<td>SI DISP DN</td>
</tr>
<tr>
<td>00010011</td>
<td>DCO</td>
</tr>
<tr>
<td>00010100</td>
<td>SET BLINK</td>
</tr>
<tr>
<td>00010101</td>
<td>CLEAR BLINK</td>
</tr>
<tr>
<td>00011010</td>
<td>NAK Control Character</td>
</tr>
<tr>
<td>00011011</td>
<td>CURSOR UP</td>
</tr>
<tr>
<td>00011100</td>
<td>CURSOR DOWN</td>
</tr>
<tr>
<td>00011101</td>
<td>NORMAL MODE</td>
</tr>
<tr>
<td>00011110</td>
<td>FORMAT MODE</td>
</tr>
<tr>
<td>00100000</td>
<td>HOME</td>
</tr>
<tr>
<td>00100001</td>
<td>CURSOR RIGHT</td>
</tr>
<tr>
<td>00100010</td>
<td>CURSOR LEFT</td>
</tr>
<tr>
<td>00100100</td>
<td>A/N</td>
</tr>
<tr>
<td>00100101</td>
<td>GR</td>
</tr>
<tr>
<td>00101000</td>
<td>TRANSMIT MESSAGE COMMAND</td>
</tr>
<tr>
<td>00101001</td>
<td>TRANSMIT LINE COMMAND</td>
</tr>
<tr>
<td>00101010</td>
<td>TRANSMIT X ADDRESS COMMAND</td>
</tr>
<tr>
<td>00101011</td>
<td>TRANSMIT Y ADDRESS COMMAND</td>
</tr>
<tr>
<td>00110000</td>
<td>TRANSMIT DISPLAY COMMAND</td>
</tr>
<tr>
<td>10000000</td>
<td>ENTER COMMAND</td>
</tr>
<tr>
<td>10010000</td>
<td>ENTER Y ADDRESS COMMAND --</td>
</tr>
<tr>
<td>10100001</td>
<td>RESET X ADDRESS COMMAND</td>
</tr>
<tr>
<td>10100010</td>
<td>ENTER X ADDRESS</td>
</tr>
<tr>
<td>11000000</td>
<td>CLEAR DISPLAY COMMAND</td>
</tr>
<tr>
<td>11000001</td>
<td>CLEAR MESSAGE COMMAND</td>
</tr>
<tr>
<td>11000100</td>
<td>CLEAR LINE COMMAND</td>
</tr>
<tr>
<td>11100000</td>
<td>INSERT COMMAND</td>
</tr>
<tr>
<td>11100001</td>
<td>INSERT LINE COMMAND</td>
</tr>
<tr>
<td>11100100</td>
<td>DELETE COMMAND</td>
</tr>
<tr>
<td>11100101</td>
<td>DELETE LINE COMMAND</td>
</tr>
<tr>
<td>NAME</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------------</td>
</tr>
<tr>
<td>IDIB0N</td>
<td>DATA BIT 0 (parity)</td>
</tr>
<tr>
<td>IDIB0N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>IDIB1N</td>
<td>DATA BIT 1 (LSB)</td>
</tr>
<tr>
<td>IDIB1N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>IDIB2N</td>
<td>DATA BIT 2</td>
</tr>
<tr>
<td>IDIB2N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>IDIB3N</td>
<td>DATA BIT 3</td>
</tr>
<tr>
<td>IDIB3N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>IDIB4N</td>
<td>DATA BIT 4</td>
</tr>
<tr>
<td>IDIB4N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>IDIB5N</td>
<td>DATA BIT 5</td>
</tr>
<tr>
<td>IDIB5N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>IDIB6N</td>
<td>DATA BIT 6</td>
</tr>
<tr>
<td>IDIB6N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>IDIB7N</td>
<td>DATA BIT 7 (MSB)</td>
</tr>
<tr>
<td>IDIB7N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>VRCERN</td>
<td>ERROR</td>
</tr>
<tr>
<td>VRCERN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>INCKIN</td>
<td>INPUT CLOCK</td>
</tr>
<tr>
<td>INCKIN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>INCKOTN</td>
<td>OUTPUT CLOCK</td>
</tr>
<tr>
<td>INCKOTN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DATAVLN</td>
<td>DATA AVAILABLE</td>
</tr>
<tr>
<td>DATAVLN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>INTRN</td>
<td>INTERRUPT RESET</td>
</tr>
<tr>
<td>INTRN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>CKRN</td>
<td>CLOCK RESPONSE</td>
</tr>
<tr>
<td>CKRN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>XMITEN</td>
<td>XMIT ENABLE</td>
</tr>
<tr>
<td>XMITEN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>COMEN</td>
<td>COMMAND ENABLE</td>
</tr>
<tr>
<td>COMEN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>RESETN</td>
<td>RESET</td>
</tr>
<tr>
<td>RESETN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>NAME</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>--------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>XMITSWN</td>
<td>XMIT SWITCH</td>
</tr>
<tr>
<td>XMITSWN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>PRINTSWN</td>
<td>PRINT SWITCH</td>
</tr>
<tr>
<td>PRINTSWN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>READSWN</td>
<td>READ SWITCH</td>
</tr>
<tr>
<td>READSWN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>SENDEN</td>
<td>SEND/RECEIVE</td>
</tr>
<tr>
<td>SENDEN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>VCCPL</td>
<td>+5 VOLTS</td>
</tr>
<tr>
<td>GNDPL</td>
<td>0 VOLTS POWER RETURN</td>
</tr>
<tr>
<td>NAME</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>DIL00N</td>
<td>DATA INPUT BIT 0 (parity)</td>
</tr>
<tr>
<td>DIL00N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DIL01N</td>
<td>DATA INPUT BIT 1 (LSB)</td>
</tr>
<tr>
<td>DIL01N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DIL02N</td>
<td>DATA INPUT BIT 2</td>
</tr>
<tr>
<td>DIL02N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DIL03N</td>
<td>DATA INPUT BIT 3</td>
</tr>
<tr>
<td>DIL03N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DIL04N</td>
<td>DATA INPUT BIT 4</td>
</tr>
<tr>
<td>DIL04N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DIL05N</td>
<td>DATA INPUT BIT 5</td>
</tr>
<tr>
<td>DIL05N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DIL06N</td>
<td>DATA INPUT BIT 6</td>
</tr>
<tr>
<td>DIL06N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DIL07N</td>
<td>DATA INPUT BIT 7</td>
</tr>
<tr>
<td>DIL07N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DLO00N</td>
<td>DATA OUTPUT BIT 0 (parity)</td>
</tr>
<tr>
<td>DLO00N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DLO01N</td>
<td>DATA OUTPUT BIT 1 (LSB)</td>
</tr>
<tr>
<td>DLO01N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DLO02N</td>
<td>DATA OUTPUT BIT 2</td>
</tr>
<tr>
<td>DLO02N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DLO03N</td>
<td>DATA OUTPUT BIT 3</td>
</tr>
<tr>
<td>DLO03N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DLO04N</td>
<td>DATA OUTPUT BIT 4</td>
</tr>
<tr>
<td>DLO04N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DLO05N</td>
<td>DATA OUTPUT BIT 5</td>
</tr>
<tr>
<td>DLO05N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DLO06N</td>
<td>DATA OUTPUT BIT 6</td>
</tr>
<tr>
<td>DLO06N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DLO07N</td>
<td>DATA OUTPUT BIT 7 (MSB)</td>
</tr>
<tr>
<td>DLO07N-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>INCKN</td>
<td>INPUT CLOCK</td>
</tr>
<tr>
<td>INCKN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>NAME</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>OUTCKN</td>
<td>OUTPUT CLOCK</td>
</tr>
<tr>
<td>OUTCKN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>DATAVLN</td>
<td>DATA AVAILABLE SENSE LINE</td>
</tr>
<tr>
<td>DATAVLN-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>INST</td>
<td>INPUT STROBE</td>
</tr>
<tr>
<td>INST-R</td>
<td>RETURN</td>
</tr>
<tr>
<td>VCCPI</td>
<td>+5 VOLTS</td>
</tr>
<tr>
<td>GNDPI</td>
<td>GROUND</td>
</tr>
</tbody>
</table>
TABLE 7.1 (CONT.)
PARALLEL INTERFACE CONNECTOR

<table>
<thead>
<tr>
<th>NAME</th>
<th>DESCRIPTION</th>
<th>CONNECTOR</th>
<th>PIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADRO0N</td>
<td>ADDRESS DATA BIT 0 (LSB)</td>
<td>PI2</td>
<td>A</td>
</tr>
<tr>
<td>ADRO0N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>L</td>
</tr>
<tr>
<td>ADRO1N</td>
<td>ADDRESS DATA BIT 1</td>
<td>PI2</td>
<td>B</td>
</tr>
<tr>
<td>ADRO1N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>M</td>
</tr>
<tr>
<td>ADRO2N</td>
<td>ADDRESS DATA BIT 2</td>
<td>PI2</td>
<td>C</td>
</tr>
<tr>
<td>ADRO2N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>N</td>
</tr>
<tr>
<td>ADRO3N</td>
<td>ADDRESS DATA BIT 3</td>
<td>PI2</td>
<td>D</td>
</tr>
<tr>
<td>ADRO3N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>P</td>
</tr>
<tr>
<td>ADRO4N</td>
<td>ADDRESS DATA BIT 4</td>
<td>PI2</td>
<td>E</td>
</tr>
<tr>
<td>ADRO4N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>R</td>
</tr>
<tr>
<td>ADRO5N</td>
<td>ADDRESS DATA BIT 5</td>
<td>PI2</td>
<td>F</td>
</tr>
<tr>
<td>ADRO5N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>S</td>
</tr>
<tr>
<td>ADRO6N</td>
<td>ADDRESS DATA BIT 6</td>
<td>PI2</td>
<td>H</td>
</tr>
<tr>
<td>ADRO6N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>T</td>
</tr>
<tr>
<td>ADRO7N</td>
<td>ADDRESS DATA BIT 7</td>
<td>PI2</td>
<td>J</td>
</tr>
<tr>
<td>ADRO7N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>U</td>
</tr>
<tr>
<td>IADRO0N</td>
<td>INTERRUPT ADDRESS BIT 0</td>
<td>PI2</td>
<td>K</td>
</tr>
<tr>
<td>IADRO0N-R</td>
<td>RETURN (LSB)</td>
<td>PI2</td>
<td>V</td>
</tr>
<tr>
<td>IADRO1N</td>
<td>INTERRUPT ADDRESS BIT 1</td>
<td>PI2</td>
<td>W</td>
</tr>
<tr>
<td>IADRO1N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>a</td>
</tr>
<tr>
<td>IADRO2N</td>
<td>INTERRUPT ADDRESS BIT 2</td>
<td>PI2</td>
<td>X</td>
</tr>
<tr>
<td>IADRO2N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>b</td>
</tr>
<tr>
<td>IADRO3N</td>
<td>INTERRUPT ADDRESS BIT 3</td>
<td>PI2</td>
<td>Y</td>
</tr>
<tr>
<td>IADRO3N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>c</td>
</tr>
<tr>
<td>IADRO4N</td>
<td>INTERRUPT ADDRESS BIT 4</td>
<td>PI2</td>
<td>Z</td>
</tr>
<tr>
<td>IADRO4N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>d</td>
</tr>
<tr>
<td>IADRO5N</td>
<td>INTERRUPT ADDRESS BIT 5</td>
<td>PI2</td>
<td>e</td>
</tr>
<tr>
<td>IADRO5N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>h</td>
</tr>
<tr>
<td>IADRO6N</td>
<td>INTERRUPT ADDRESS BIT 6</td>
<td>PI2</td>
<td>f</td>
</tr>
<tr>
<td>IADRO6N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>j</td>
</tr>
<tr>
<td>IADRO7N</td>
<td>INTERRUPT ADDRESS BIT 7</td>
<td>PI2</td>
<td>k</td>
</tr>
<tr>
<td>IADRO7N-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>p</td>
</tr>
<tr>
<td>ADRSYN</td>
<td>ADDRESS SYNC CLOCK</td>
<td>PI2</td>
<td>l</td>
</tr>
<tr>
<td>ADRSYN-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>r</td>
</tr>
<tr>
<td>NAME</td>
<td>DESCRIPTION</td>
<td>CONNECTOR</td>
<td>PIN</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------------</td>
<td>-----------</td>
<td>-----</td>
</tr>
<tr>
<td>IURN</td>
<td>INTERRUPT REQUEST</td>
<td>PI2</td>
<td>m</td>
</tr>
<tr>
<td>IURN-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>s</td>
</tr>
<tr>
<td>IUACKN</td>
<td>INTERRUPT ACKNOWLEDGE</td>
<td>PI2</td>
<td>n</td>
</tr>
<tr>
<td>IUACKN-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>t</td>
</tr>
<tr>
<td>IARN</td>
<td>INTERRUPT ADDRESS REQUEST</td>
<td>PI2</td>
<td>DD</td>
</tr>
<tr>
<td>IARN-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>u</td>
</tr>
<tr>
<td>INTKN</td>
<td>INTERRUPT ENABLE REQUEST</td>
<td>PI2</td>
<td>EE</td>
</tr>
<tr>
<td>INTKN-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>v</td>
</tr>
<tr>
<td>INTEN</td>
<td>INTERRUPT ENABLE TRANSMIT</td>
<td>PI2</td>
<td>FF</td>
</tr>
<tr>
<td>INTEN-R</td>
<td>RETURN</td>
<td>PI2</td>
<td>w</td>
</tr>
</tbody>
</table>