DVA SYSTEM MANUAL FOR OPTICAL VIDEODISC PLAYERS

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For Model PR-7820 and PR-7820-2 Videodisc Players

DISCOVISION™
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Chapter 1. PR-7820-2 BIDIRECTIONAL DATA LINK PROTOCOL

1. INTRODUCTION AND SCOPE

1.1 The PR-7820-2 bidirectional data link feature allows the user to transmit commands/data to a PR-7820-2 player, hereinafter referred to as the 7820-2, for control of 7820-2 operation. The bidirectional data link also enables specific data retrieval from a 7820-2, e.g., player status, programs loaded from the videodisc, and current video frame numbers for the purpose of monitoring 7820-2 processes.

As shown in Figure 1, the host processor can control/monitor the operation of a 7820-2 in two ways:

1) The host processor can be linked directly to the 7820-2 via a parallel input/output (I/O) bus. A 7820-2 nonstandard communications protocol provides a simple SEND/RECEIVE/ACKNOWLEDGE interface, allowing host processor/7820-2 interaction.

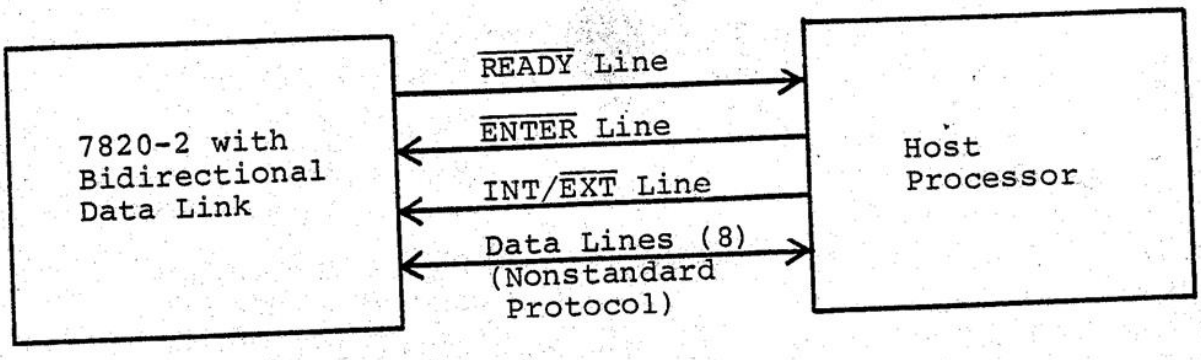
2) The host processor can control or monitor 7820-2 operation via an indirect link. A universal external interface (UEI) controller provides an interface between a host processor and the 7820-2. The UEI controller contains the necessary hardware and software to communicate with a host processor using standard RS232 or IEEE 488 communications protocol. Additionally, the UEI supports 7820-2 nonstandard communications protocol, providing a complete host processor/7820-2 link.

1.2 The bidirectional bus operates through the standard external connect receptacle on the 7820's rear panel. The link provides a bidirectional data path between a 7820-2 and a host processor, allowing transfer of data presently not accessible from the 7820-2 (e.g., player mode, current frame number and RAM program dumps).

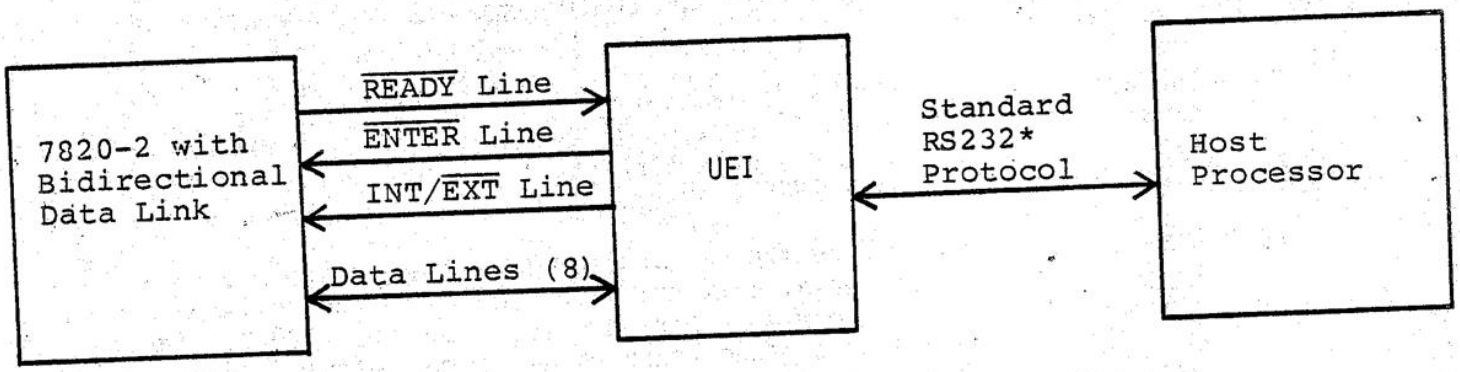
1.3 The 7820-2 operating system provides the following functional capabilities:

1) Communications link control
2) Host processor data requests
3) 7820-2 operational control from an external processor
4) User program control

OPTION 1



OPTION 2



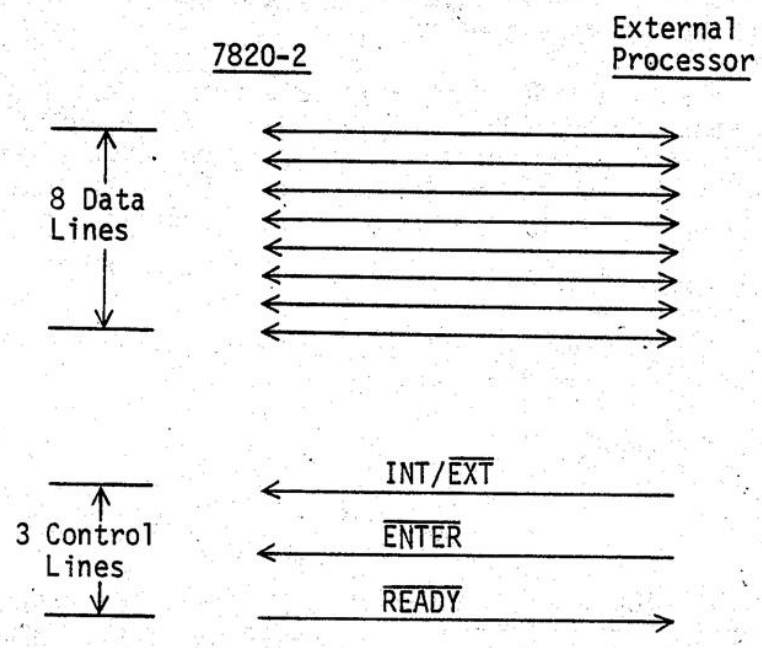
*Interface described in Chapter 2.

Figure 1. PR-7820-2 Bidirectional Data Link

2. FUNCTIONAL DESCRIPTION

2.1 COMMUNICATIONS LINK CONTROL

The 7820-2 external I/O interface consists of 11 lines linking the 7820-2 to an external processor:



The three 7820-2 control lines and eight data lines provide the capability to activate/deactivate the communications link, send/receive data or commands, and determine I/O status.

2.1.1 Link Activation/Deactivation A host processor or UEI controller can activate/deactivate or reset communications with a 7820-2 player by raising or lowering the INT/$\overline{\text{EXT}}$ line. Lowering the INT/$\overline{\text{EXT}}$ line and $\overline{\text{ENTER}}$ line signifies to the 7820-2 that 7820-2/external processor communications are now active. The converse is true when the host processor or UEI raises the INT/$\overline{\text{EXT}}$ line.

The 7820-2 resets all communications flags and buffers when the INT/$\overline{\text{EXT}}$ line is lowered. Any data request commands in process are aborted. Line resetting does not affect the current mode of the player.

2.1.2 Send/Receive Data or Commands An external processor can send qualifying data (e.g., storage or register addresses, frame numbers), or 7820-2 player commands (e.g., SEARCH, AUTOSTOP, STOP) to a 7820-2 via bidirectional link protocol. Frame numbers, player status or stored command sequences can also be requested from a 7820-2 player and transmitted to an external processor.

The eight data lines are used for bidirectional data transfer between a 7820-2 and an external processor. The three I/O control lines provide a full handshake protocol, ensuring data integrity. After communications link activation by an external processor, data transfer is coordinated by means of the two remaining control lines, $\overline{\text{READY}}$ and $\overline{\text{ENTER}}$.

NOTE: Communication is always initiated by the external processor since the 7820-2 is slaved to it.

The $\overline{\text{ENTER}}$ line signifies readiness to receive data from a 7820-2 player or that data is ready to be sent to the 7820-2. The 7820-2 uses the $\overline{\text{READY}}$ control line in a similar fashion, i.e., ready to receive or data received successfully. The $\overline{\text{READY}}$ line is also used to indicate to the external processor that the 7820-2 has data ready to send to the host in response to a data request command.

2.2 COMMUNICATION PROTOCOLS

The following paragraphs outline typical external processor/7820-2 communication sequences for the three communication mode options.

2.2.1 Initialization Protocol

External Processor		7820-2	Comments
	Lower INT/$\overline{\text{EXT}}$ Line →		Start link initialization or reset process. 7820-2 resets all communications flags and waits for $\overline{\text{ENTER}}$ signal to be lowered.
	← Raise $\overline{\text{READY}}$ Line		Occurs only if $\overline{\text{READY}}$ is low.
	Lower $\overline{\text{ENTER}}$ Line →		7820-2 does not read data bus.
	← Lower $\overline{\text{READY}}$ Line		
	Raise ENTER Line →		--
	← Raise $\overline{\text{READY}}$ Line		7820-2 ready to read data from external bus.
(Line Initialized)			The 7820-2 reads the I/O bus any time the $\overline{\text{ENTER}}$ signal line is subsequently lowered.

2.2.2 Inbound Protocol (Assumes Active Link)

External Processor	7820-2	Comments
Lower $\overline{\text{ENTER}}$ Line	→	Host ready to send.
Lower $\overline{\text{READY}}$ Line	←	7820-2 ready to receive.
Data Put on Bus	→	7820-2 delays 40 μsec before preparing data bus.
Raise $\overline{\text{READY}}$ Line	←	7820-2 acknowledges receipt of data byte. (Max. time = 26 msec.)
Raise $\overline{\text{ENTER}}$ Line	→	Data byte transfer complete. 7820-2 resumes scanning for lowered $\overline{\text{ENTER}}$ line. The 7820-2 lowers $\overline{\text{READY}}$ line now if data is to be sent to host in response to a data request.

2.2.3 Outbound Protocol (Assumes Active Link)

External Processor	7820-2	Comments*
Lower Data Direction	←	--
Place data byte on bus	←	7820-2 places data byte on bus prior to lowering $\overline{\text{READY}}$ line.
Lower $\overline{\text{READY}}$ Line	←	
Lower $\overline{\text{ENTER}}$ Line	→	Host has read data byte.
Raise $\overline{\text{READY}}$ Line	←	7820-2 detected $\overline{\text{ENTER}}$ line low.
Raise $\overline{\text{ENTER}}$ Line	→	Data byte transfer completed. Link ready for next Inbound/ Outbound data transfer.

*Both $\overline{\text{ENTER}}$ and $\overline{\text{READY}}$ lines are assumed to be in the raised state.

2.3 DATA INTEGRITY

Data integrity, the successful transfer of data between two devices, is under external processor control. The $\overline{\text{READY}}$ line is used by the external processor to determine if the 7820-2 has successfully received a data/command byte at the

link level. Communications processor logic in the external processor determines if data transfer from the 7820-2 is successful. In both cases the external processor oversees the initiation and control of error recovery procedures. Error recovery may consist of retransmitting a command or data byte to the 7820-2 player, retransmitting a request for 7820-2 status/data or resetting the link. It is the user's responsibility to determine what level of error recovery is required for each eventuality.

The external processor can monitor the execution of individual 7820-2 player commands by requesting player status after any command transmission by the external processor. The following paragraphs provide examples of external processor/7820-2 error recovery protocols.

2.3.1 Inbound Error (Link Level) Recovery Protocol

External Processor		7820-2	Comments
	Lower $\overline{\text{ENTER}}$ Line →		Host ready to send.
		← Lower $\overline{\text{READY}}$ Line	7820-2 ready to receive.
	Data Byte Available →		--
	(Host timeout; waiting for 7820-2 to raise $\overline{\text{READY}}$ signal)		
	Raise INT/$\overline{\text{EXT}}$ Line →		7820-2 link reset; host can reinitialize 7820-2 link.
	. . .		
	Initialization Process (see 2.2.1)		

2.3.2 Outbound Error (Link Level) Recovery Protocol

External Processor		7820-2	Comments
	. . .		
	Host timeout; waiting for requested data.		
	Raise INT/$\overline{\text{EXT}}$ Line →		7820-2 link reset.
	(Host can reinitialize link and retransmit data request.)		

2.4 HOST PROCESSOR DATA REQUESTS

The following types of 7820-2 data may be requested by an external processor:

1) Current frame number
2) Player operational status
3) Stored command sequences (program dump)

Data from the 7820-2 is requested by transmitting a data request command to the 7820-2. Currently, three data request commands are supported by the 7820-2 operating system. The commands cannot be sent as part of a RAM program load.

Command	Description
X 'EA'	Transmit current frame number.
X 'EB'	Transmit player operational status byte.
X 'E9'	Transmit stored command sequences.

2.4.1 Frame Numbers The 7820-2 videodisc frame number most recently read from the disc may be accessed by an external processor by sending the appropriate data request command. The frame number is transmitted to the external processor in the following format. N1 and N2 are binary digits representing the player frame number:

Frame Number

LSB	MSB
N1	N2
1st Byte	2nd Byte

2.4.2 Player Status Current player operational status may be requested by an external processor to monitor or control 7820-2 player operation. This information is encoded in a single byte according to Appendix A, Table 1.

2.4.3 Stored Command Sequences (Program Dump) The 7820-2 stores and executes user-written player command sequences. The command sequences are loaded into the 7820-2 RAM area from the videodisc, frame Ø, the remote control unit, or from an external processor via the communications link. To read a stored command sequence, an external processor accesses commands in 7820-2 RAM storage by sending a data request command to the 7820-2 player. The format of the data request is 'E9'. The dump will consist of 1024 RAM bytes and a checksum byte.

2.5 7820-2 OPERATIONAL CONTROL FROM AN EXTERNAL PROCESSOR

The general operation of the 7820-2 player can be controlled from four different environments:

1) The 7820-2 player's front panel.
2) A remote control unit.
3) Stored control sequences loaded from a videodisc or external processor.
4) External processor commands.

The following describes the external processor control mode.

2.5.1 Basic Operation The baseline external processor/7820-2 player interface functions as follows:

1) The external processor sends a player command to the 7820-2.

2) The 7820-2 acts upon the command to alter its mode.

3) The external processor requests player status to ensure command execution.

2.5.2 Player Command Transfer Protocol The communications protocol interface process is outlined below.

External Processor		7820-2	Comments
	Lower $\overline{\text{ENTER}}$ Line →		Host ready to send command (player status may be requested first).
	← Lower $\overline{\text{READY}}$ Line		7820-2 ready to receive command.
	Command Transfer →		Command available to 7820-2.
	← Raise $\overline{\text{READY}}$ Line		7820-2 accepted command at link level.
	Raise $\overline{\text{ENTER}}$ Line →		Host may request 7820-2 player status to ensure command execution. Current mode should match last received command.

The above describes the communications protocol for a single byte command. Multiple byte commands are handled by repeating the same process until all command bytes have been sent to the 7820-2.

2.5.3 New Audio/Display Commands The following new commands allow a host system to explicitly control Audio 1, Audio 2, and frame display states in the 7820-2. These commands cannot be downloaded as part of a RAM program:

Command Code	Function
E8	Audio 1 ON
E7	Audio 1 OFF
E6	Audio 2 ON
E5	Audio 2 OFF
E4	Digital Display ON
E3	Digital Display OFF

Original audio/display toggle commands are supported to ensure compatibility.

2.6 USER PROGRAM CONTROL (LOADING, EXECUTING)

With the exception of the new audio and display commands and data requests, commands may be transmitted to the player and loaded into the 7820-2 RAM area. These command sequences only affect player operation after a RUN command is received by the player. See Chapter 3 for a full description of program entry from a host processor.

Program loading is executed by sending a program load command, data location, and program commands to the 7820-2. The 7820-2 loads the program into the appropriate RAM location for later execution. Paragraph 2.3.1 describes the communications sequence required to accomplish program loading from the host.

The syntax of the program load request is: (RAM address) X'DF'; the RAM address is the starting location in RAM storage where the program is to be loaded. Default RAM location is Ø.

NOTE: The 7820-2 display state is unchanged from its previous state during program load processing, i.e., the display is not automatically enabled during program loading.

An end of program command, X'EF', signifies to the 7820-2 that all program bytes have been received. In addition to the program load command and the commands described in Table 19, Appendix C, the following commands may be inputted to the 7820-2 as part of a program:

	Command	Description
(Address)	CF	Branch
(Ø/1)	FØ	Decrement Register
(1-9)	F8	Input

To activate the program the external processor sends a RUN command to the 7820-2 along with the appropriate program RAM location.

3. ELECTRICAL REQUIREMENTS

3.1 7820-2 PLAYER LINK ELECTRICAL REQUIREMENTS

The modified player link uses three control lines and an 8-bit bidirectional data bus, all LSTTL compatible. Link signals are as follows:

Control lines

INT/$\overline{\text{EXT}}$: Host output to the player. Used to activate, deactivate or reset communications with the player.

$\overline{\text{ENTER}}$: Host output to the player indicates that there is data ready for player to receive, or that host is ready to accept data requested from player.

$\overline{\text{READY}}$: Host input produced by the player. Used to indicate that player is prepared to receive data, or that data has been successfully inputted.

Data lines

D0 through D7: This byte-wide bidirectional bus is the channel which carries data between the host and the player.

3.2 7820-2 INTERFACE CONNECTIONS

Connection through the rear panel of the player is made with an IEEE-488 style 24-pin Microribbon connector (e.g., Amphenol #57-40240, AMP #552930-1). Refer to Table 5 in Appendix A.

3.3 7820-2 CABLING REQUIREMENTS

Standard laminated flat cable exhibits a capacitance of approximately 7.7 pF/ft; bundled IEEE-488 cable capacitance is approximately 35 pF/ft. The limiting signal is the one LS drive accessible to $\overline{\text{READY}}$: a 2 foot bundled cable or an 8 foot flat cable can be driven. Monolithic buffers such as the LS242 quad transceiver perform well; certain peripheral interface circuits will also provide adequate capacitance drive.

4. FAST SEARCH SUPPORT

4.1 FAST SEARCH

Modifications have been made to the Search μcode to increase the forward and reverse search rates. Figure 2 shows the significant improvement made in search time across varying search distances. Variations between times for searches of equal distance are greatly reduced. For example, the search rate for one thousand frames using the standard player can vary between one and three seconds. The fast search varies between one-half and one second.

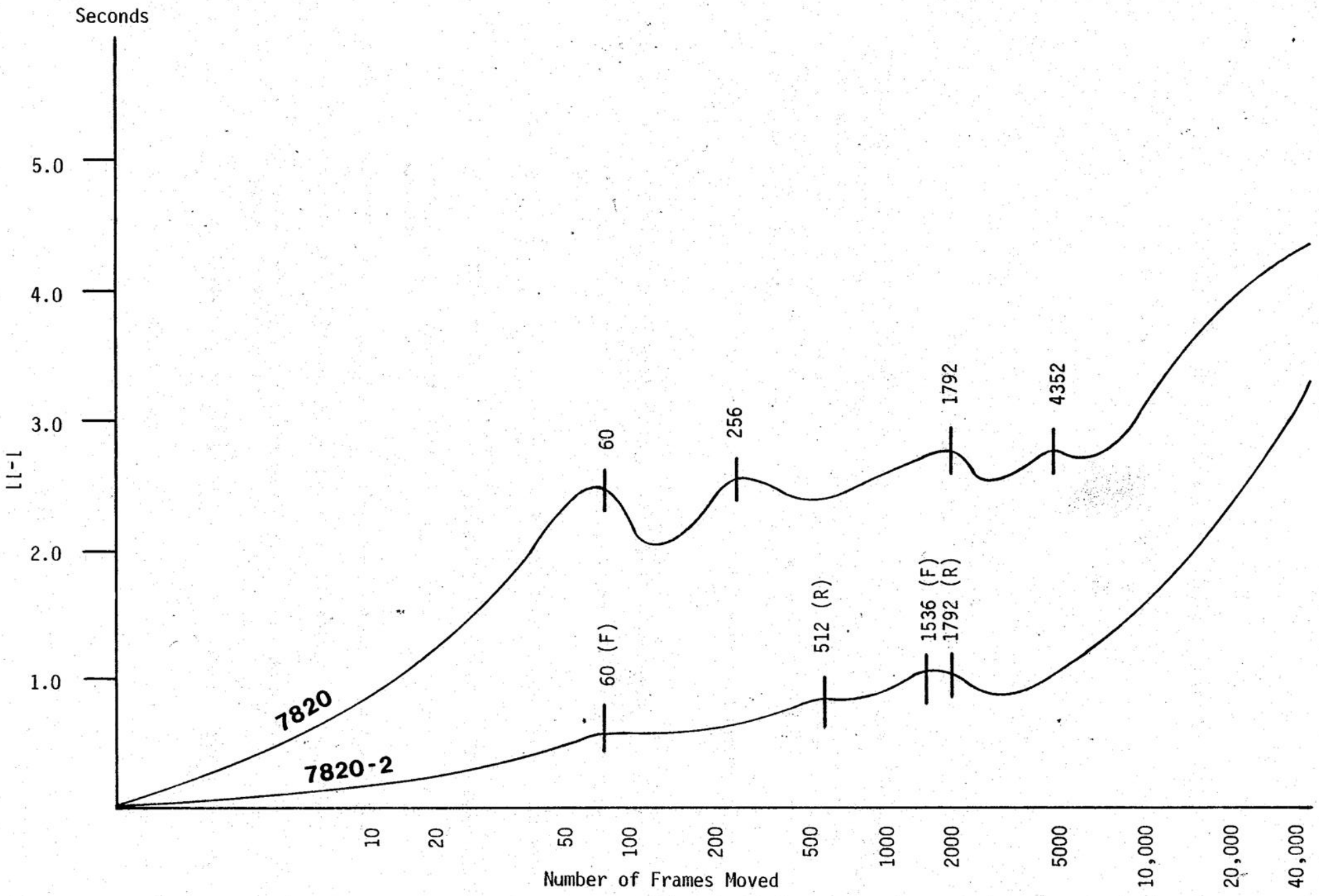


Figure 2. 7820,7820-2 Access Time Comparison Chart (Average)

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Chapter 2. UNIVERSAL EXTERNAL INTERFACE EXECUTIVE CONTROL PROGRAM

1. SYSTEM OVERVIEW

1.1 INTRODUCTION

The Universal External Interface (UEI) Executive Control Program provides a standard interface, (RS232 or IEEE 488), between a videodisc player, PR-7820-2, hereinafter referred to as the 7820-2, and an external processor or terminal. The UEI controller contains the necessary hardware and software to support a standard link (RS232 or IEEE 488) as well as the 7820-2 player 8-bit parallel bidirectional communications link shown in Figure 3.

The UEI Executive Control Program (see Figure 4 for overview) provides the following features:

1) RS232C support to a host computer or autonomous terminal, including auto-answer, half or full-duplex support.

2) 8-bit parallel bidirectional communications link support for one 7820-2 player.

3) Standard 8-bit ASCII communication with a host computer or autonomous terminal with odd, even, or no parity.

4) 7820-2 command buffering (up to 12 commands and associated operands).

5) Conversion of two byte ASCII to single byte hex player commands and operands.

6) Conversion of single byte hex player responses to two-byte ASCII.

7) Communication link fault isolation and exception status reporting.

8) Optional echo mode for communications with an autonomous terminal (RS232C only).

9) Activation/deactivation of player link from external processor or terminal.

10) UEI internal ROM/RAM check.

11) Buffering of player RAM dump data.

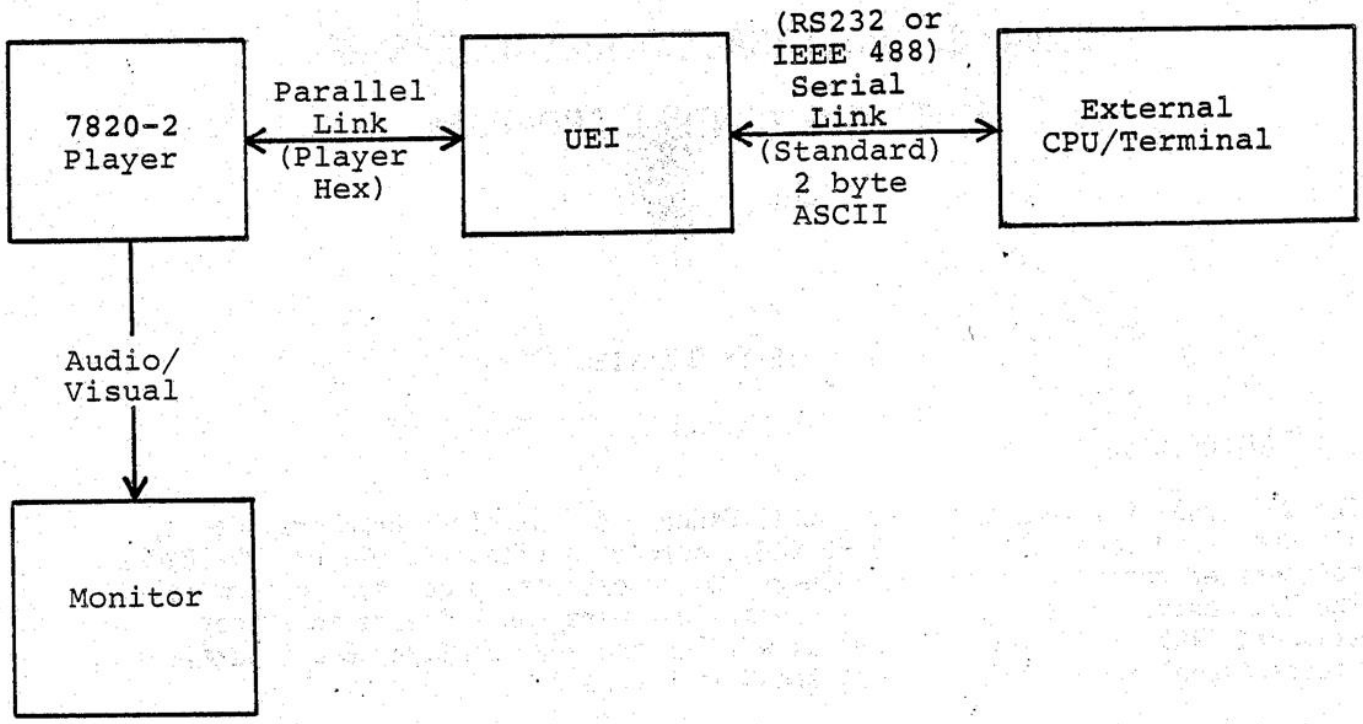


Figure 3. System Overview

2. HOST LINK

2.1 RS232 HOST SUPPORT

Refer to Appendix B, Table 14, for electrical characteristics.

2.2 RS232 OPTIONS

The UEI supports a standard interface (RS232 or IEEE 488) for the attachment of a host Central Processing Unit (CPU) or autonomous terminal. The following interface options are supported by the UEI:

1) Half or full duplex
2) Baud rates (4800, 2400, 1200, 600, 300)
3) Parity (odd, even, none)
4) Stop bits (one, two)
5) Auto answer.

Interface options are read by the UEI μcode during power-on reset. If RS232 options are changed the UEI must be reset before the new options are implemented.

The UEI μcode obtains the interface options by reading data from Port B, address 2ØØ6. Port B bits 2, 3 and 4 are transferred directly to the ACIA contol register bits 2, 3 and 4, respectively. The ACIA formats serial words according to the UEI serial data format found in Table 4, Appendix A.

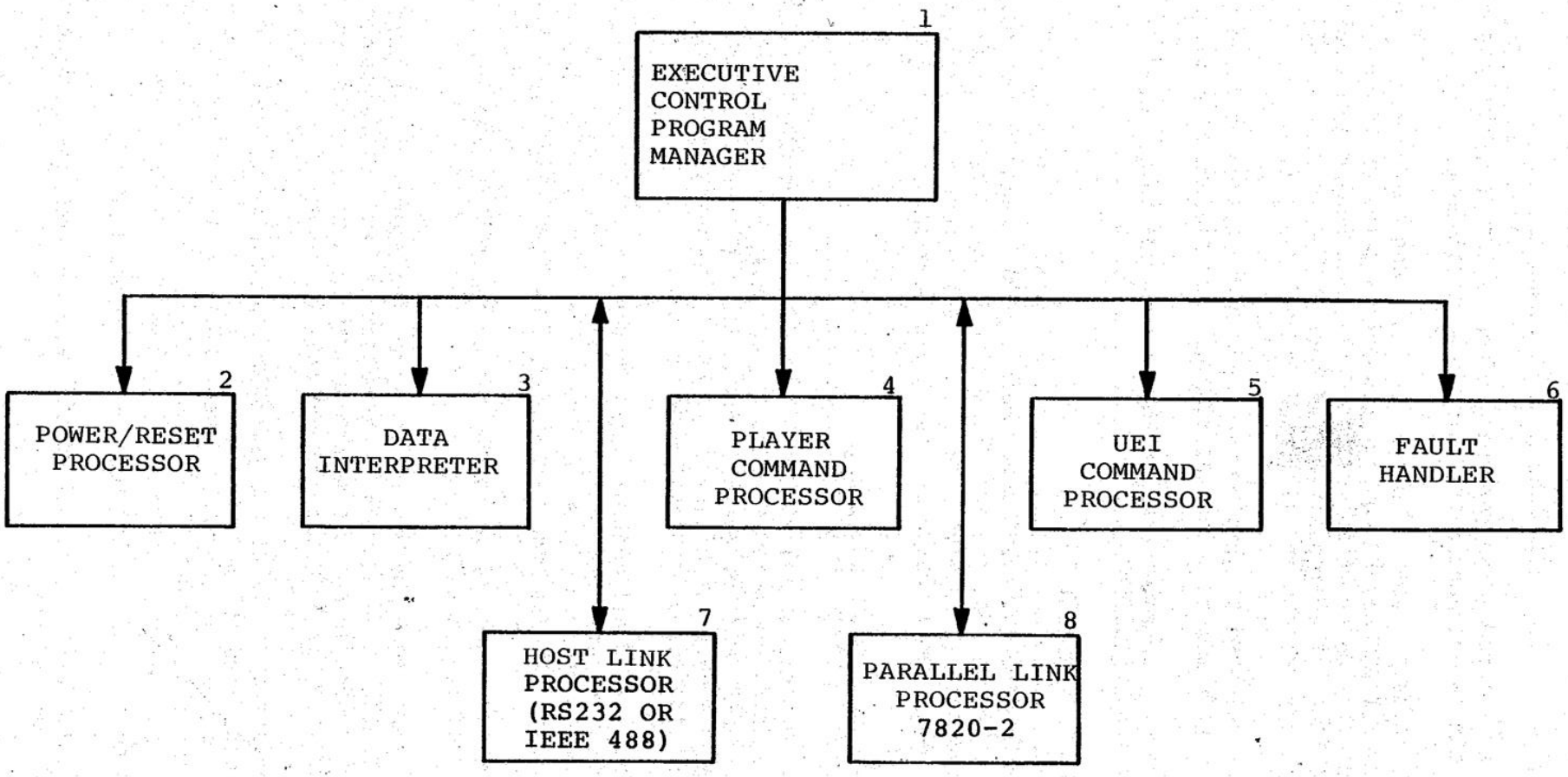


Figure 4. UEI Executive Control Program Overview

The RS232 options are stored in an internal options byte and are used by the UEI μcode when communicating across the interface serial port.

Setting baud rate and data format: Port B bits 2, 3 and 4 are reset by placing jumpers on header positions E1, E2 and E3, respectively (refer to Appendix A). Putting a jumper on the header makes the bit Ø; leaving the position open sets the bit to 1. The fourth header position (nearest to pin 40 of the 6821 PIA) is reserved for factory testing and is linked to port B bit 5.

The baud rate is established by jumping the appropriate header position (near the 74LS193 baud rate dividers); only one position can be selected at a time.

NOTE: Setting of baud rates and the auto answer option do not affect the UEI μcode.

2.3 UEI/MODEM LINK INITIALIZATION

Upon entry to the UEI power-on reset code, Data Terminal Ready is set to OFF. At the end of the power-on sequence the UEI activates the Data Terminal line to indicate its readiness to receive data from a host computer or autonomous terminal. The UEI then continues to monitor the communications line for incoming data.

2.4 INBOUND/OUTBOUND INTERFACE PROTOCOLS

The UEI supports a complete serial RS232C primary channel suitable for use with terminals, printers, standard computer outputs, and most Bell compatible modems. The following paragraphs describe general connection and operating considerations, the various interface signals, and typical functioning of the serial interface. Several possible operational modes exist:

1) Full duplex, with all control lines present; with partial set of control lines; or data leads only. See Figure 5.

2) Half duplex, with all required control lines present. See Figure 6.

When connected to a modem the UEI is configured to function as the answering station, not as a call originator.

The UEI continuously monitors the functionality of the modem path as part of its regular operating procedure; diagnostic information is sent to the remote host device as necessary. Certain non-modem devices may require a null modem cable, or other special cabling, as described in Appendix B, Figure 16.

The nine-line interface consists of the two data lines, five control lines, and two passive lines described below:

Data lines

Transmitted data (Tx): Information UEI is sending.

Received data (Rx): Information UEI receives from any attached device (terminal, modem, etc.).

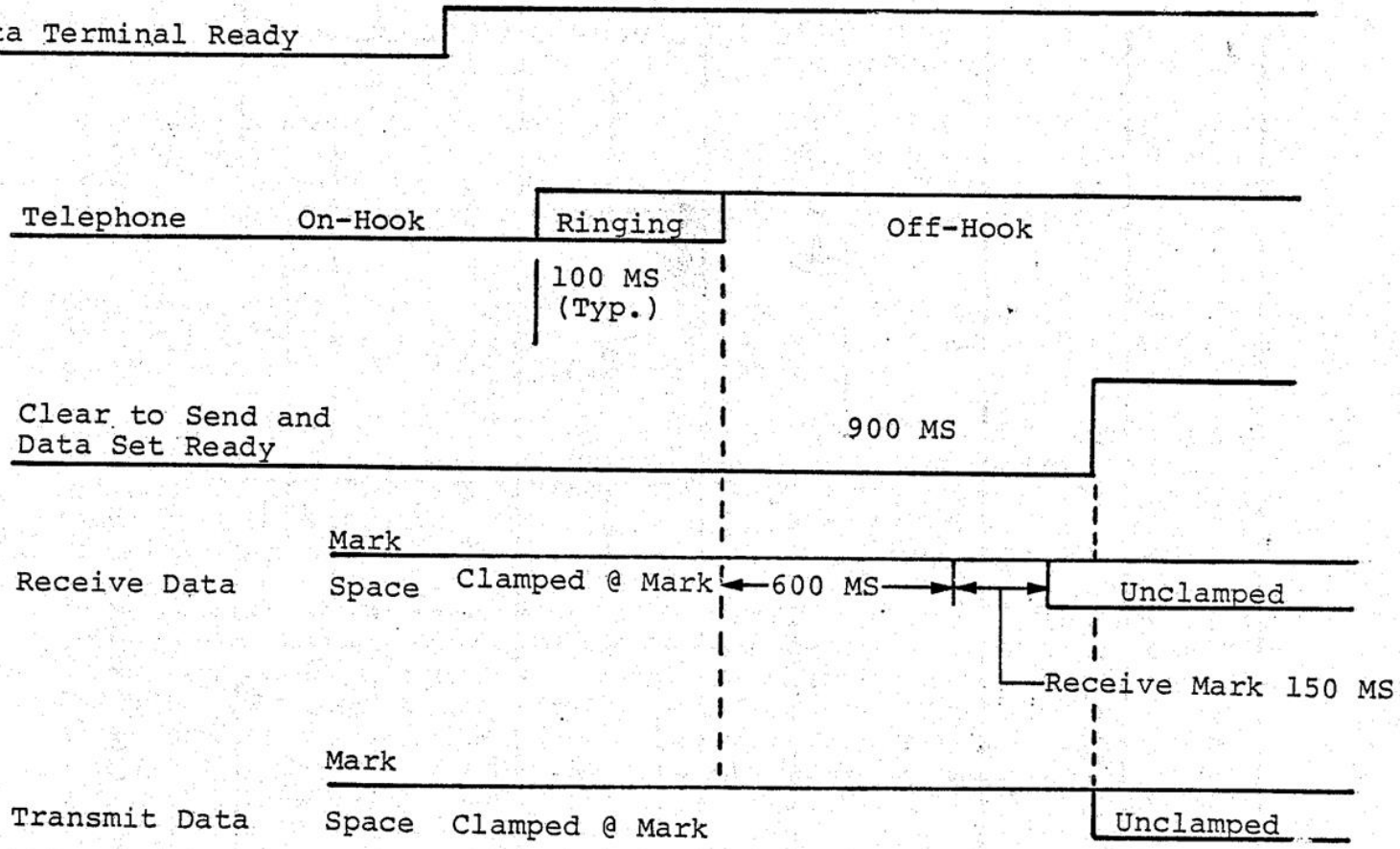


Figure 5. Duplex - Answer Mode Protocol

Control lines

Data Terminal Ready (DTR): UEI output indicating UEI has successfully completed all self-testing and is ready to communicate (DTR tells an auto-answering modem to respond when phone rings).

Request to Send (RTS): UEI output indicating UEI has information to be sent (line controls direction in half-duplex systems).

Data Set Ready (DSR): UEI input indicating modem has completed self-testing and is linked to a phone line; distant modem link may not be fully established.

Data Carrier Detect (DCD): UEI input indicating modem is receiving signal suitable for demodulation.

Clear to Send (CTS): UEI input indicating information presented on Tx will be sent to distant modem. CTS responds to RTS in half-duplex systems; may serve as BUSY signal if printer requires.

Passive lines

Signal Ground

Chassis Ground

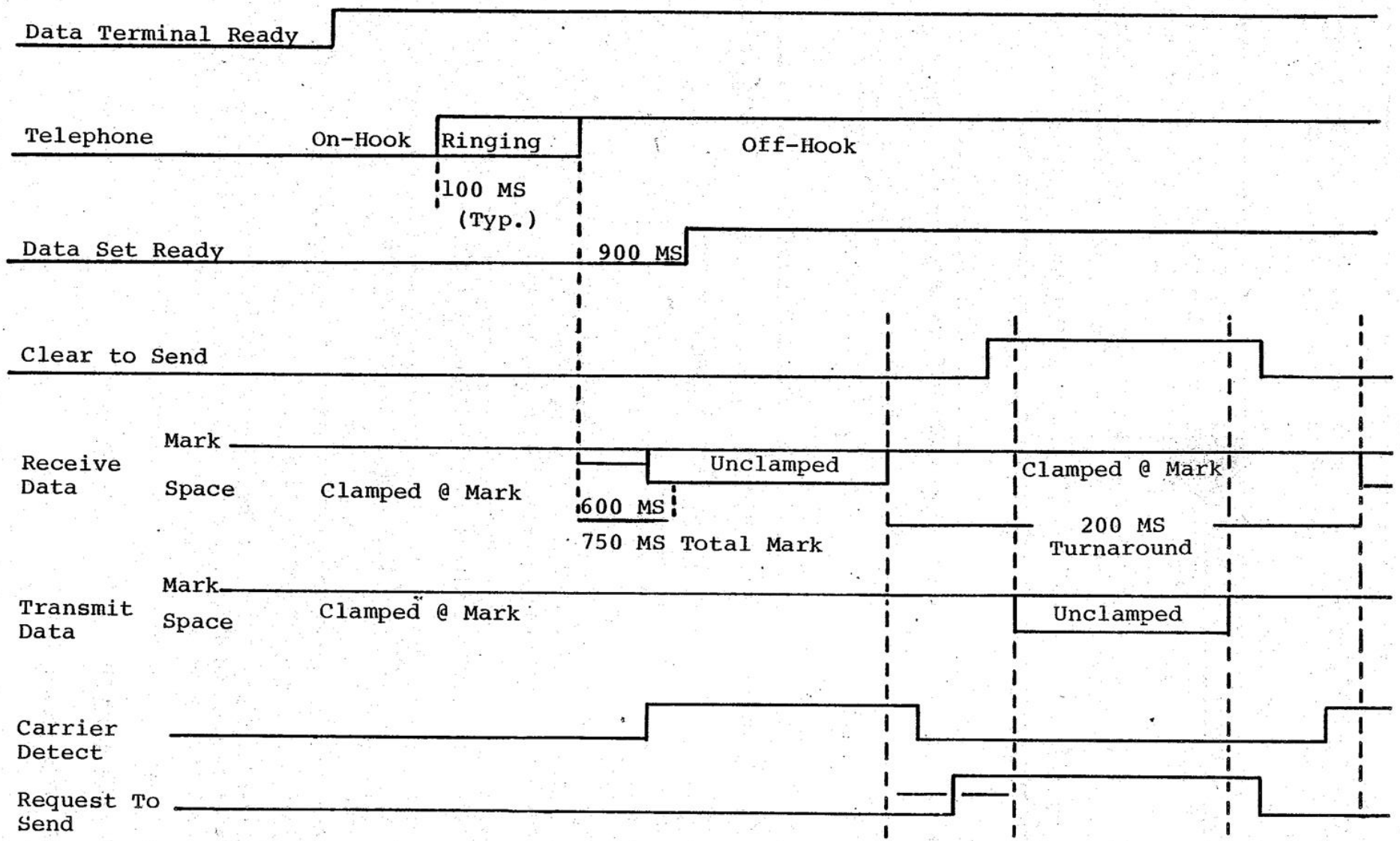


Figure 6. Half Duplex - Answer Mode Protocol

All control lines are assigned a default value of ON inside the UEI. No special external jumpers are required for operation with a partial set of signals.

Upon power-on reset the UEI turns DTR and RTS to OFF. After successfully completing RAM and ROM tests and general internal housekeeping the UEI will turn DTR to ON. If the modem has an auto-answer capability it will await, and answer, an incoming call from the host processor. Otherwise an equipment operator must establish the phone link.

Once the modem is linked to an off-hook telephone it will turn DSR to ON. In the case of a terminal or other event where no connection is made to DSR, an ON condition is automatically established inside the UEI.

Before the UEI may transmit, CTS must be ON. CTS is ON in a full-duplex modem (Bell 103, 113, 212) whenever a complete link to the distant modem has been established. In a half-duplex modem (Bell 202) the UEI must wait for the distant modem to stop transmitting (indicated by DCD going OFF), then request clearance to send by turning RTS to ON; the attached modem will turn CTS to ON when ready.

In half-duplex systems when the UEI has a character to send it will ignore data received while waiting for CTS to turn ON. In normal operation such a condition should never develop, since the host handles all arbitration. The UEI will turn RTS to OFF at transmission terminus. The default condition of DCD and CTS is established as ON inside the UEI. Consequently, data leads only devices are intrinsically treated as full-duplex. Because of the transmission-inhibiting effect of CTS described above, the CTS input may be used as a BUSY signal with terminals requiring such a control.

When the host has finished its entire communication with the UEI it will dissolve the phone link. The modem attached to the UEI will indicate that it has dissolved the link by turning DSR to OFF. The UEI responds by relinquishing control of the player (if the host has failed to do so) and waits for DSR to turn ON again; this provides a safe transition in the event that the telephone transmission was accidentally "cut off" instead of being intentionally terminated.

2.5 FAULT DETECTION

The UEI continuously monitors the interface link for the following fault conditions:

1) Framing error
2) Overrun*
3) Parity error.

If any of the above fault conditions is detected, the UEI sets the corresponding exception status, as defined in Section 7, and transmits the fault information to the host.

*The UEI RS232 hardware buffers one incoming data byte. If the input byte is not read by the UEI before the next byte is received, an overrun condition is set by the hardware.

All fault conditions are reset at the beginning of the next read or write operation.

2.6 IEEE 488 UEI/HOST LINK

For UEI units configured for the GPIB bus in place of the RS232 serial data link, the IEEE 488 UEI/host link is implemented in the manner of the Hewlett-Packard bus. The UEI address is switch-selectable.

The UEI supports the instrument interface bus that was developed by Hewlett-Packard and is now sanctioned by the Institute of Electrical and Electronic Engineers (IEEE-488 1978), American National Standards Institute (ANSI MC1.1), and International Electrotechnical Commission (IEC 625-1).

The IEEE 488 bus uses eight data and eight control lines for communication rates up to 1 megabyte/second between the host computer and the slaved equipment.

The UEI utilizes the MC68488 General Purpose Interface Adapter (GPIA). The MC68488 LSI Device automatically performs many interface tasks such as transfer/receive handshake, and provides a simplified interface to the UEI μcode.

2.7 GENERAL DESCRIPTION OF IEEE 488

The IEEE 488 instrument interface bus employs eight bidirectional data and eight control lines to form a parallel communication interface between controller and equipment. Three of the eight control lines are used for handshaking between the controller (host) and the UEI when data is sent. The interfacing connector (shown in Figure 7) is 24-pin to provide eight additional ground connections to allow for twisted pairs on the eight control lines, thus reducing noise coupling. 15 pieces of equipment (1 host and 14 slaves) can be placed on the IEEE 488 bus at once, with a total cable length of up to 20 meters.

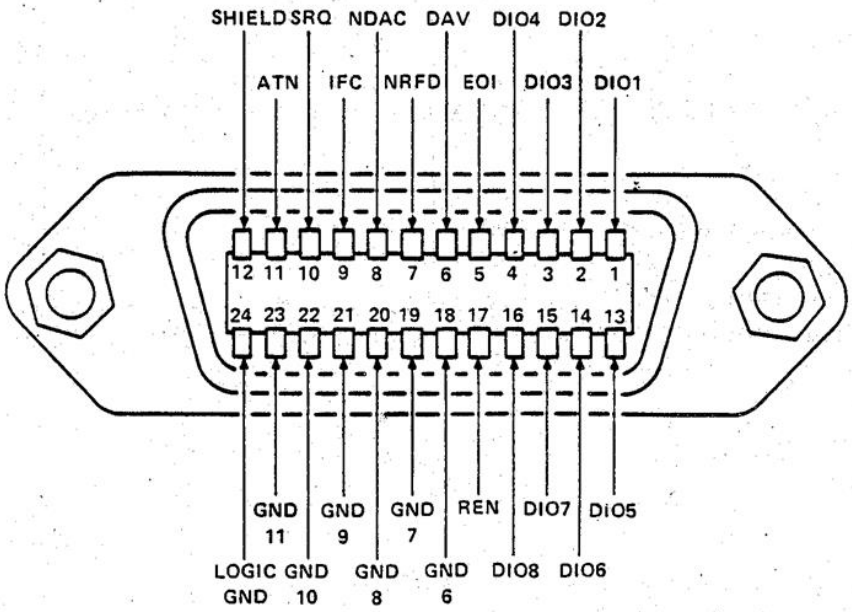


Figure 7. Interface Connector

2.8 TYPE OF DEVICE

The UEI is equipped with an IEEE 488 interface which can perform one or all of the following functions:

Talker: Device capable of sending data to other instruments, e.g., digital voltmeters outputting data, counters outputting data or paper tape readers.

Listener: Device capable of receiving data from other instruments, e.g., line printers, programmable signal generators, programmable power sources, or paper tape punches.

2.9 IEEE 488 COMMANDS

Data transmitted over the IEEE 488 bus is in a 7-bit ASCII (American Standard Code for Information Interchange) code. When a command is transmitted, certain letters from the ASCII table have been given special meaning, as follows:

(ATN line is held true (low) for the command mode.)

TYPE	COMMAND	MNEMONIC	ASCII	HEX	COMMENTS
Unaddress Commands	Unlisten	UNL	?	3F	Clears bus of all listeners.
	Untalk	UNT		5F	Unaddresses current talker; no talker remains on bus.
Universal Commands	Device Clear	DCL	DC4	14	Returns all devices to cleared state, whether they are addressed or not.
	Serial Poll Enable	SPE	CAN	18	Enables Serial Poll mode.
	Serial Poll Disable	SPD	EM	19	Disables Serial Poll mode.
	Parallel Poll Unconfigure	PPU	NAK	15	Sets all devices on bus with parallel poll capability to a predefined condition.
Addressed Commands	Selective Device Clear	SDC	EOT	ϕ4	Clears only one device on bus.
	Parallel Poll Configure	PPC	ENQ	ϕ5	Command permits data line assignment to bus device for "PPU" response.

TYPE	COMMAND	MNEMONIC	ASCII	HEX	COMMENTS
Secondary Commands	Parallel Poll Enable	PPE			
	Parallel Poll Disable	PPD			

NOTE: The UEI bypasses the following commands: GO TO LOCAL, Mx SECONDARY ADDRESS, OTHER SECONDARY ADDRESS, OTHER TALK ADDRESS, SECONDARY GROUP COMMAND, TAKE CONTROL. The UEI transmits an exception status, Invalid Command, if any of the above commands are received.

NOTE: The MC68488 does not automatically support parallel poll commands. Parallel poll is supported in the UEI μcode.

2.9.1 Universal Commands UEI response to these controller commands is not inhibited by either address or unaddress mode.

2.9.2 Addressed Commands These commands are similar to universal commands; however, they are recognized by the UEI only when addressed as a listener.

2.10 SIGNAL LINES

Sixteen signal lines are used on the IEEE 488 bus for communication. Negative logic levels are used, so True = Low, False = High.

2.11 TIMING

Three handshaking lines are used for sending data: 1) NRFD, 2), DAV and 3) NDAC. The sequence of the signals on these lines is critical for correct IEEE 488 operation. Data transfer rate is limited to the rate of the slowest device. (Data rates up to 500 kilobytes/second are not uncommon.)

2.12 UEI/HOST 488 SIGNALS

The 16 standard interface lines are identified as:

Handshake lines

Data Valid (DAV): Used by talker in data transfer. Indicates bus data is valid for listener to read.

Not Ready for Data (NRFD): Used by listener in data transfer. Indicates ability to input further data from talker.

Not Data Accepted (NDAC): Used by listener in data transfer. Indicates acceptance of data talker has placed on bus.

Control lines

Interface Clear (IFC): Used to set interface system in a known state.

Attention (ATN): Specifies bus transfer of command information or data.

Service Request (SRQ): Interrupt line from talker/listener to bus controller.

Remote Enable (REN): Used by controller to select source of device programming input.

End or Identify (EOI): Used to signal end of multiple byte data transfer or enable a parallel polling sequence.

Data lines

DIO1 thru DIO8: The byte-wide bus over which command and data codes are sent.

Refer to Table 16, Appendix B for electrical characteristics.

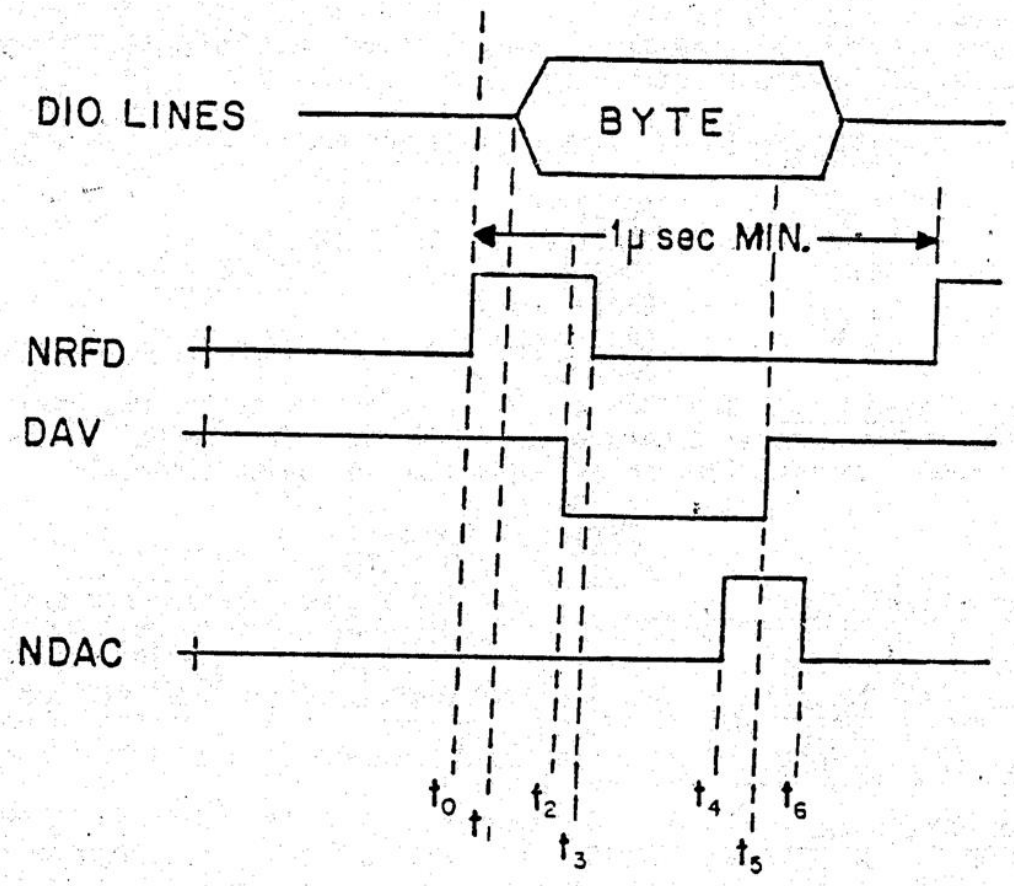


Figure 8. Handshake Timing

3. UEI COMMANDS

3.1 HOST COMMANDS

Commands which can be sent to the UEI from a host CPU or autonomous terminal fall into two groups:

1) UEI Executive Control Program Commands
2) 7820-2 Player Commands and Arguments

Valid commands and arguments are composed entirely of hexadecimal characteristics (0...9, A...F). The UEI translates lower-case characters to their upper case equivalent to facilitate operation with a terminal lacking a "caps lock" function.

Mixing hexadecimal characters which are not valid commands results in flagging by the UEI and a status value of X'22' to be returned to the external processor. All other ASCII byte configurations, except a carriage return, are flagged and a status value of X'21' returned to the host. Carriage return is ignored by the UEI.

3.2 UEI EXECUTIVE CONTROL PROGRAM COMMANDS

The five commands that can be transmitted by a host to request the UEI to perform a limited set of functions are:

HEX		ASCII	Description
DØ		C4 BØ	ACTIVATE PLAYER LINK
D1		C4 B1	DEACTIVATE PLAYER LINK
D2	±	C4 B2	TOGGLE ECHO MODE
D3		C4 B3	BEGIN STACK
D4		C4 B4	END STACK
ESC			SOFTWARE RESET

3.2.1 Activate Player Link The 7820-2 link is activated by the UEI when the host CPU or autonomous terminal transmits an X'DØ' command. The UEI initializes the UEI/player communications link according to the following protocol:

UEI		7820-2	Comments
	Lower INT/$\overline{\text{EXT}}$ Line →		7820-2 communication buffers, flags reset.
	← Raise $\overline{\text{READY}}$ Line		Occurs only if $\overline{\text{READY}}$ is low.
	Lower $\overline{\text{ENTER}}$ Line →		--
	← Lower $\overline{\text{READY}}$ Line		--
	Raise $\overline{\text{ENTER}}$ Line →		--
	← Raise $\overline{\text{READY}}$ Line		Player link initialized.

NOTE: Player mode is unaffected by link initialization.

An exception status, X'13', is transmitted to the external processor if the link cannot be initialized.

3.2.2 DEACTIVATE PLAYER LINK Internal control of the player is initiated if the UEI receives a DEACTIVATE PLAYER LINK command, X'D1', from the host. The UEI deactivates the player link by raising the INT/EXT line, allowing player control via the front panel buttons or a remote control unit (RCU).

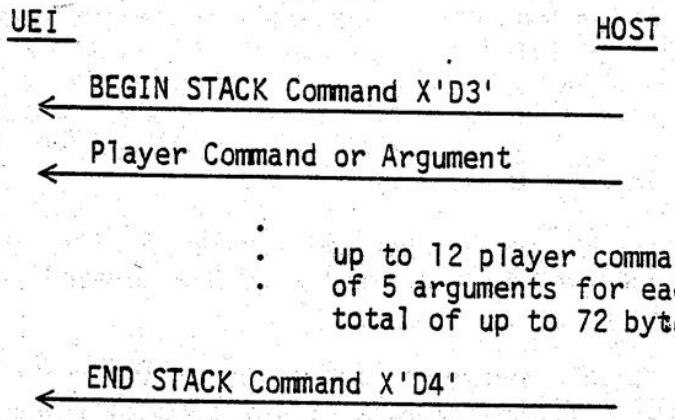
NOTE: Player link deactivation does not affect player mode.

3.2.3 TOGGLE ECHO MODE Many autonomous terminals require the echoing of data entered at the terminal, and transmitted to the UEI to facilitate data display on the CRT. TOGGLE ECHO MODE causes the UEI to echo each byte received from the terminal across the interface link, including carriage returns and non-hex characters in the same format as transmitted (ASCII) immediately after receipt at the UEI. At power-on reset the echo mode will be switched OFF.

This mode should only be used when the UEI is linked to an unintelligent terminal to prevent communications link deterioration as a result of line turnaround and byte transfer delays.

3.2.4 BEGIN STACK The UEI supports the stacking of up to 12 7820-2 commands and associated arguments. This feature is especially useful when the host has several players to control/monitor. Stacking allows the host to download up to 12 commands in a UEI and then handle other tasks. The UEI services each command and argument in the stack in the order dictated by the host.

To use the stack feature, the host follows the protocol outlined.



All bytes received between the BEGIN STACK and END STACK commands are loaded into the stack buffer. If stack buffer terminus is reached prior to receiving an END STACK command, an exception status byte, X'2Ø', Stack Buffer Overflow, is set and exception status is sent to the host. Player commands frozen in the stack buffer can be executed by entering an END STACK command.

3.2.5 END STACK The END STACK command, X'D4', delimits a series of player arguments/commands. If the 7820-2 link is initialized, the UEI automatically begins player command execution from the stack when the END STACK command is

received. If the 7820-2 link is not initialized an exception status, X'14', is transmitted. The stack will not be processed until an ACTIVATE LINK command is received. Subsequent END STACK transmissions will cause the UEI to again execute the stacked commands.

NOTE: Host commands are not accepted during stack processing.

4. PLAYER COMMANDS

4.1 7820-2 PLAYER COMMANDS

Player commands can be separated into four categories:

1) Immediate commands
2) Delayed commands
3) Stacked commands
4) Data request commands.

4.1.1 Immediate Player Commands These are player commands executed as received by the UEI. They have an immediate effect on the player, e.g., PLAY, STOP, REJECT, AUDIO 1, AUDIO 2. Any command requiring argument must send the argument prior to the command.

4.1.1.1 Player Status Constraint. In the immediate mode the UEI can process data no faster than the player can execute the commands (100 ms); in addition, the time delays listed after the following special commands should be observed (due to player characteristics).

Run program - 1 second
Search - 7 seconds
Play - (when player is in Park mode) 15-20 seconds

An exception status, X'14', player link not initialized, is returned to the external processor if the link is not initialized when a 7820-2 command is received.

4.1.2 Delayed Commands Player command sequences can be downloaded to the player for later execution. A WRITE PROGRAM command begins command sequence downloading and an END PROGRAM command delimits the sequence. Loaded sequence execution can be initiated by the host transmitting a RUN command.

The following commands cannot be loaded into RAM for delayed execution:

FRAME DISPLAY OFF
FRAME DISPLAY ON
AUDIO 2 OFF
AUDIO 2 ON
AUDIO 1 OFF
AUDIO 1 ON
DUMP RAM
DUMP FRAME NUMBER
DUMP PLAYER STATUS

4.1.3 Stacked Commands Paragraphs 3.2.4 and 3.2.5 describe the UEI stack feature.

4.1.4 Data Request Commands Several player commands require player-to-host data transmittal after the data request command is received. These commands can be incorporated in the UEI stack*.

4.1.4.1 DUMP PLAYER STATUS. This command instructs the player to transmit one status byte back through the UEI to the host. The UEI converts the player hex byte to two standard ASCII bytes, based on the status returned, before transmitting to the host. See Table 18, Appendix B, for 7820-2 status byte definitions.

4.1.4.2 DUMP CURRENT FRAME NUMBER. The player returns two binary bytes containing the current player frame number to the UEI. The first binary byte contains the least significant digits of the frame number. The UEI converts the hex digits to four ASCII bytes before transmitting to the host.

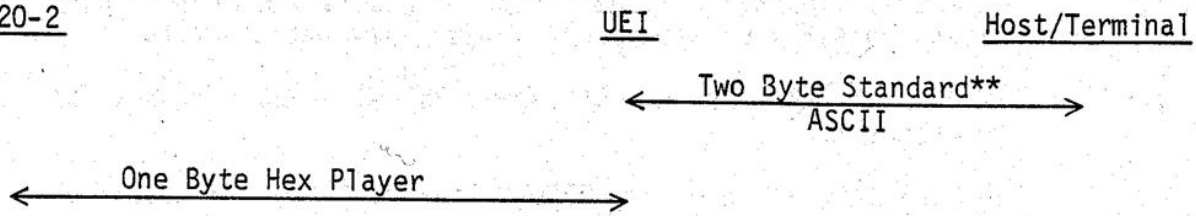
4.1.4.3 DUMP RAM. A DUMP RAM command is accepted by a player in the Park or Play modes. A total of 1024 bytes of RAM are returned to the UEI. The last byte, byte 1Ø25, contains the check sum computed by the player μcode by totaling all 1024 RAM byte values and bypassing any carry bits. The bytes are stored in a UEI buffer until the entire dump is received from the player. Each RAM byte is then converted to two ASCII bytes and sent to the host. The check sum value provided by the player is checked by the UEI. If an error is detected, the RAM bytes and original checksum are sent to the host, followed by exception status X'12'. The UEI transmits a total of 2052 ASCII characters to the host.

If a RAM dump is requested while the player is in Park mode, byte transfer occurs in approximately 300 to 400 μs. The 7820-2 disables all player interrupts until all RAM dump data has been transmitted to the UEI. If a DUMP RAM command is received while the player is in any mode other than Park, interrupts are not disabled. The 7820-2 transmits eight bytes of RAM during the end of each 16 ms vertical synch interrupt. The UEI must be able to process eight bytes of data within approximately 3 ms. The UEI has access to each eight-byte set at approximately 16 ms intervals.

5. DATA CONVERSIONS

5.1 CONVERSION ROUTINES

The following describes data formats required for communications among a host, UEI and 7820-2 player.



*A <carriage return><line feed> is transmitted after data return on all data request commands.

**Includes odd, even or no parity as specified by interface option flags.

The UEI Executive Control Program contains two routines which convert standard ASCII to player hex and vice versa, according to Tables 9 through 12 in Appendix B.

6. SELF-CHECK

6.1 UEI SELF-CHECK

As part of the power-on reset process, the UEI code ensures UEI hardware operational status by internally checking all ROM and RAM. If a malfunctioning ROM or RAM is detected, the UEI continuously flashes the POWER ON indicator (approximately 1.0 second ON/1.0 second OFF). The UEI initialization process is terminated by a faulty ROM or RAM, and Data Terminal Ready remains off.

7. EXCEPTION STATUS

7.1 UEI EXCEPTION STATUS

The UEI Executive Control Program monitors both communication links for failures. If a failure is detected the UEI transmits an exception status byte to the host. The following failure conditions may be set in the byte:

Value	Definition
Ø1	ASCII parity error detected in data sent from host. Interface options determine parity type being used (RS232 only).
Ø2	Overrun condition detected on interface/host link (RS232 only).
Ø3	Interface framing error detected on interface/host link(RS232 only).
	Failure conditions for Ø1 - Ø3 can be detected through UEI μcode by reading UART control/status byte, location 2008 as follows: Bit 4 - Framing error Bit 5 - Receiver Overrun Bit 6 - Parity Error.
1Ø	UEI/7820-2 linking fault detected. Transmission of last host command possibly unsuccessful. Player link deactivated.
12	RAM dump checksum error. Different value computed by UEI for RAM checksum.
13	Link initialization error; 7820-2 link could not be activated.
14	Player link not initialized. 7820-2 command received but 7820-2/UEI link not activated.

Value	Definition
2Ø	Player command stack overflow. UEI player command buffer filled before END STACK command was received from host.
21	ASCII character not representing a hexadecimal digit (0...9A...F) was received.
22	Invalid player command.

The exception status byte is sent to the host as five ASCII bytes in standard format as follows:

ASCII byte 1	21	(!) Status Delimiter
ASCII bytes 2,3		Status Value
ASCII bytes 4,5		<Carriage Return> <Line Feed>

The ! ASCII character signals an external processor that the two ASCII bytes which follow are status information, aiding the host in distinguishing between unsolicited exception status and expected player data.

The UEI sends <carriage return> <line feed> after the last character of all sequences transmitted to the host.

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Chapter 3. COMPUTER CONTROL INTERFACE FOR MODEL 7820 DISCOVISION PLAYER

1. INTRODUCTION

The PR-7820 Industrial Videodisc Player asserts control through the medium of an internal microprocessor. The microprocessor contains the basic operating system of the player and provides one kilobyte of memory and an instruction set, permitting the user to create and store a program which exploits the player's motion controls. A user's motion control program can be entered manually from the keypad, bit serially from the disc on Audio Channel 2, or bit parallel, byte serial through a computer port located on the rear of the player. This document specifies this computer interface.

2. CONTROL SIGNALS

Available player signal lines consist of an 8-bit data bus and three control lines. The control lines are:

$\overline{\text{READY}}$. Signal is player-produced and indicates that the microprocessor is ready to execute another operation. Note that this is a 10 μs (nominal) pulse occurring within a 16 ms (nominal) period. A circuit to transform the periodically occurring pulses into a steady signal is shown in the appendix.

$\overline{\text{ENTER}}$. Signal is host computer-produced and indicates that the player should encode input port data.

INT/$\overline{\text{EXT}}$. Signal indicates whether input port data is being issued by an internal or external source.

3. TRANSFER SEQUENCE

The data transfer sequence is illustrated in Figure 9. Note that the sum of the ENTER pulse duration (T_{ent}) and the OFF delay (T_{off}) must be at least 100 ms to guarantee data transfer. Transfer rate is thus approximately 100 ms/byte (or 80 bits/second).

Pre-data transfer requires the INT/$\overline{\text{EXT}}$ signal to be lowered, enabling the external host to place command information on the internal microprocessor bus. Software must then acknowledge that two consecutive ready pulses have been transmitted before placing data on the bus (by observation of the conditioned $\overline{\text{READY}}$ signal). A data byte (8 bits wide) is then loaded on the data bus and

the $\overline{\text{ENTER}}$ control line is lowered for 50 ms. The $\overline{\text{ENTER}}$ signal is then raised for an additional 50 ms before a new operation can be initiated. This cycle may be repeated for multiple byte transfers. Also note that after the last byte is transferred the INT/$\overline{\text{EXT}}$ must be raised to resume normal player operation.

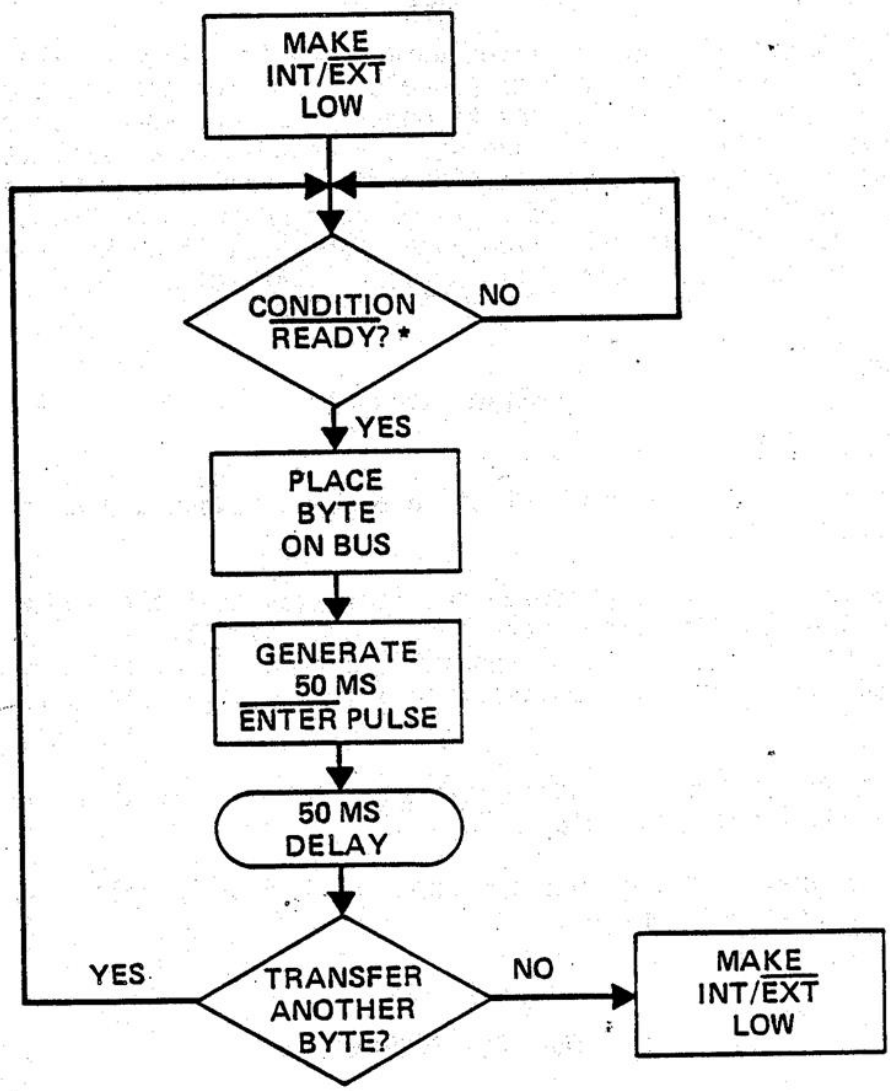

Figure 9. Transfer Sequence

4. FUNCTIONAL SPECIFICATIONS

4.1 REMOTE MESSAGE CODING TABLE

Table 19 in Appendix C is constructed to reflect each remote message received and corresponding remote control function. Each remote message simulates a button function with the identical name.

Level assignment:

1 = High state signal

Ø = Low state signal

Symbols:

HEX = Hexadecimal code equivalent of input function

4.2 REMOTE/LOCAL INTERFACE

INT/$\overline{\text{EXT}}$ (REN) is set to Ø for external control during data entry, and may be disconnected for internal control.

4.3 TRANSFER OF REMOTE MESSAGES

Messages are transferred when the $\overline{\text{ENTER}}$ (ATN) is low. There should be only one $\overline{\text{ENTER}}$ (ATN) command per input function. $\overline{\text{ENTER}}$ (ATN) is independent of $\overline{\text{READY}}$ (NRFD). Therefore a command may be entered when the player is not ready, overriding computer control mode. Normal computer control mode requires one or more READY (NRFD) pulses prior to command entry.

5. ELECTRICAL SPECIFICATIONS

5.1 APPLICATION

This section defines the electrical specification for interface systems to be used in environments where:

1) Physical distance between devices is short.

2) Electrical noise is relatively low.

All electrical specifications for driver and receiver circuits are based on the use of low-power Schottky transistor-transistor logic (TTL) technology.

5.2 LOGICAL AND ELECTRICAL STATE RELATIONSHIPS

The relationship between the logic states defined in Appendix B, Table 8, and the electrical state levels of the signal lines are as follows:

Coding Logical State	Electrical Signal Levels
Ø	Corresponds to +0.8V Called low state
1	Corresponds to +2.0V Called high state

The high and low states are based on standard low-power Schottky TTL levels for which supply does not exceed +5.25 Vdc and is referenced to ground.

5.3 CAPACITIVE LOAD LIMIT

The external capacitance load on each signal line shall not exceed 100 pF within the controlling device.

6. DATA TRANSFER

6.1 TIMING AND SEQUENCING FOR COMPUTER CONTROL

Figure 10 below and Table 20 in Appendix C define polarity and pulse duration of data and controlling signals needed to effect external control. Figure 11 shows a typical timing sequence during computer control.

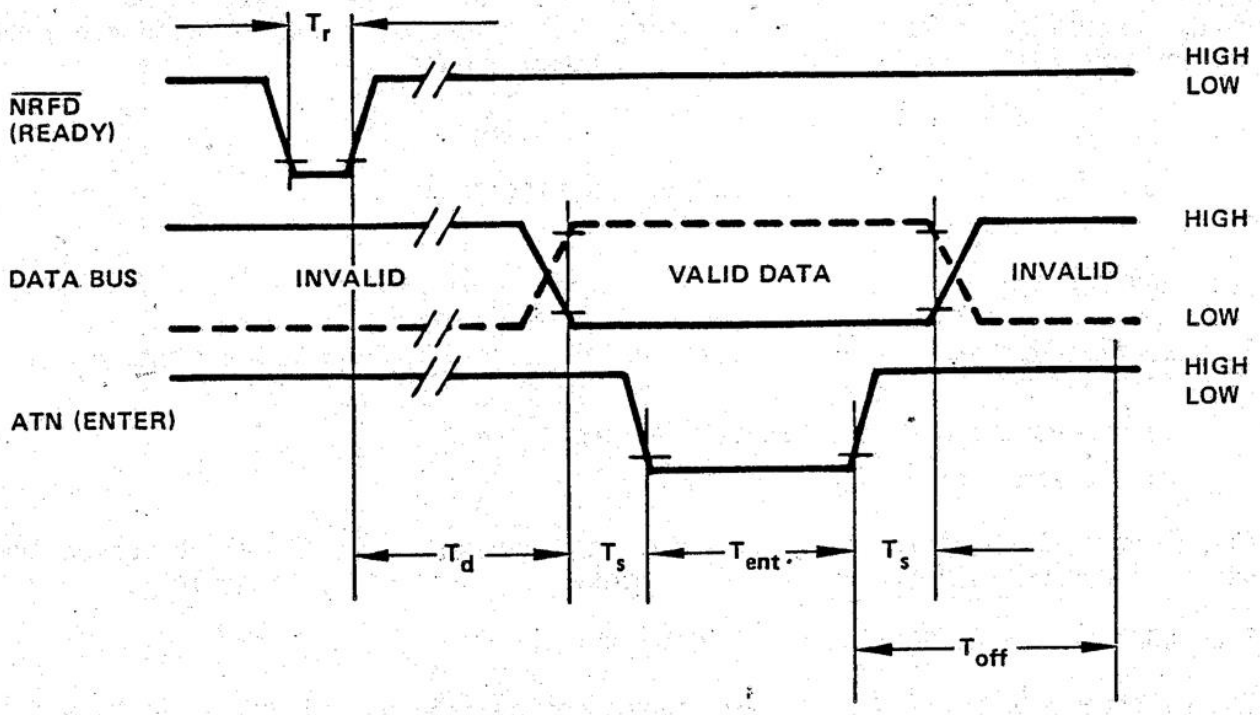

Figure 10. Timing Diagram

7. MODEL PR-7820 PLAYER MECHANICAL SPECIFICATIONS

This section defines the mechanical specification for interface systems to be used in environments where physical distances between devices are limited.

7.1 CONNECTOR TYPE

A 24-pin Microribbon (Amphenol or Cinch Series 57) or Champ (AMP) connector may be used for this application as specified in IEEE 488. Refer to Table 21 in Appendix C for contact assignment.

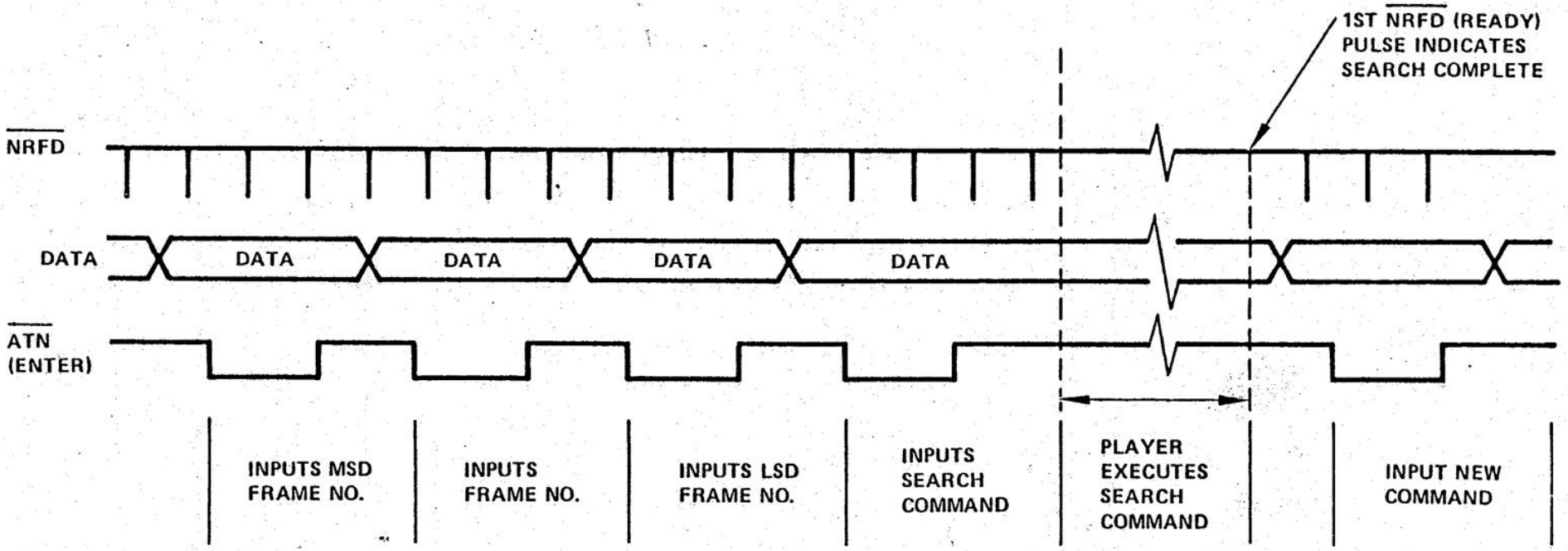

Figure 11. Sequence Diagram

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APPENDIX A

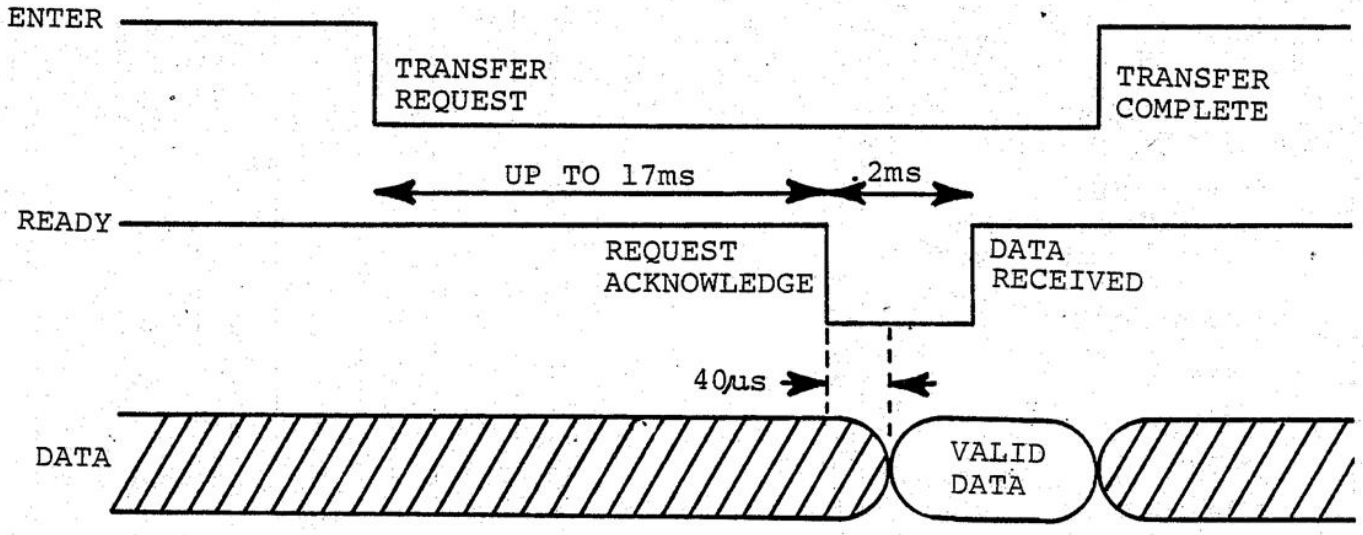

Figure 12. Host Writes To 7820-2

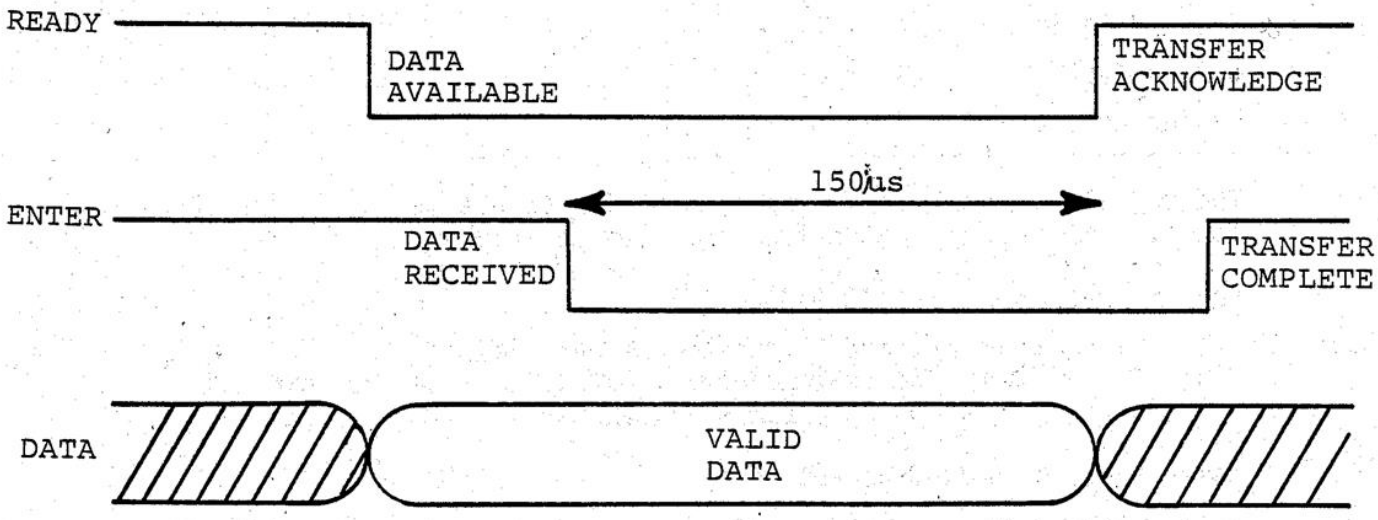

Figure 13. Host Reads From 7820-2

Table 1. Status 7820-2 Status Code

Status	DIO 7	6	5	4	3	2	1	Ø	HEX NIBBLE
1. Audio 2 (1 = ON, Ø = OFF)	X								N/A
2. Audio 1 (1 = ON, Ø = OFF)		X							N/A
3. Frame Display (1 = ON, Ø = OFF)			X						N/A
4. Current Mode Bit definitions are as follows:				X	X	X	X	X	X
Transient[1]				0	0	0	0	0	0
Park				0	0	0	0	1	1
Play				0	0	0	1	0	2
Stop				0	0	0	1	1	3
Slow Forward				0	0	1	0	0	4
Slow Reverse				0	0	1	0	1	5
Out of Focus				0	0	1	1	0	6
Search Finished				0	0	1	1	1	7
Auto Stop				0	1	0	0	0	8
Input (Stop Mode)				0	1	0	0	1	9
Input (Play Mode)				0	1	0	1	0	A
Write Program				0	1	0	1	1	B
Soft Reject[2]				0	1	1	0	0	C
Medium Reject[3]				0	1	1	0	1	D

[1] The transient state occurs when the player is not in any of the above modes, e.g., in transition from one mode to another.

[2] Mode is set equal to Soft Reject if:

a) Button = Reject and Player Mode = Hard Reject, or
b) Player Mode = Search, Autostop, Autoslow, Play, or Scan while Outside Limit is reached.

[3] Mode is set to Medium Reject if:

a) Player mode is illegal, or
b) Player mode = Soft Reject and In-Focus Flag = Clear.

The following external processor commands may be sent to control immediate 7820-2 player operation:

Table 2. Player Commands

Argument	Command Code	Description
	F4	AUDIO 1 (Toggle)
	FC	AUDIO 1 (Toggle)
Frame No.	F2	SLOW FORWARD
Frame No.	FA	SLOW REVERSE
	F6	STEP FORWARD
	FE	STEP REVERSE
	F9	REJECT
No.	F5	STORE
	FD	PLAY
	FØ	SCAN FORWARD
	F8	SCAN REVERSE
Frame No.	F3	AUTO STOP
Wait Time	FB	STOP
Frame No.	F7	SEARCH
Reg. No.	7F	RECALL
	BF	CLR
Starting Loc.	CF	RUN PROGRAM
	F1	FRAME DISPLAY (Toggle)
Starting Loc.	DF	WRITE PROGRAM

Decimal digits Ø-9 may also be sent as registers, frame numbers, wait times, etc. Input codes for Ø-9 are:

Decimal	Hex
Ø	3F
1	ØF
2	8F
3	4F
4	2F
5	AF
6	6F
7	1F
8	9F
9	5F

Table 3. 7820-2 Electrical Characteristics

Inputs and outputs are to be LSTTL compatible, in accordance with the following:

Parameter	Condition	Min	Max	Unit
V_{OH} output high	I_{OH} = -400 uA	2.7		V
V_{OL} output low	I_{OL} = 8 mA		0.5	V
V_{IH} high input voltage		2.0		V
V_{IL} low input voltage			0.8	V
I_{IH} high input current			20	uA
I_{IL} low input current			-0.4	mA

In addition, the following must be considered:

1) $\overline{\text{READY}}$ is driven in player by one LS device; should present a maximum load less than 20 LS inputs, including cable effects.

2) $\overline{\text{ENTER}}$ presents a six (6) LS input load plus cabling.

3) INT/$\overline{\text{EXT}}$ presents a five (5) LS input load plus cabling.

4) D0 through D7 each present a five (5) LS input load plus cabling, and can drive terminated lines as low as 133 ohms.

Table 4. UEI Serial Data Format

BITS			SERIAL DATA FORMAT		
4	3	2	Bits/Character	Parity	Stop Bits
0	0	0	7	Even	2
0	0	1	7	Odd	2
0	1	0	7	Even	1
0	1	1	7	Odd	1
1	0	0	8	--	2
1	0	1	8	--	1
1	1	0	8	Even	1
1	1	1	8	Odd	1

Table 5. Pin Assignment

Pin #	488 Label	Description
1	DIO1	Data bit 0
2	DIO2	Data bit 1
3	DIO3	Data bit 2
4	DIO4	Data bit 3
7	NRFD	$\overline{\text{READY}}$
11	ATN	$\overline{\text{ENTER}}$
12	Shield	GND
13	DIO5	Data bit 4
14	DIO6	Data bit 5
15	DIO7	Data bit 6
16	DIO8	Data bit 7
17	REN	INT/$\overline{\text{EXT}}$
18	GND	GND
.		
.		
.		
24	GND	GND

Note: Pins 5, 6, 8, 9 and 10 have no connections.

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APPENDIX B

Table 6. Pin/Function Assignment 488 Interface

Name	Pin	Function
DIO 1	1	Bidirectional data line, LSB
2	2	" " "
3	3	" " "
4	4	" " "
5	13	" " "
6	14	" " "
7	15	" " "
8	16	Bidirectional data line, MSB
NRFD	7	Not Ready For Data. NRFD line will be high when UEI is ready to receive data. (Source can check to see if both NRFD and NDAC lines are high before sending data since that would be an error -- "No listener"?)
DAV	6	Data Valid. Goes low when data is stable and NRFD is high.
NDAC	8	Not Data Accepted. This signal stays low after DAV until UEI has accepted data and then goes high until DAV goes false.

Table 7. IEEE 488 Pin Function Table

Name	Pin	Function
IFC	9	Interface Clear. Line activated by controller only. When signal is set true, all talkers, listeners or active controllers go to their inactive states.
ATN	11	Attention. Goes low during command transmission. Line is high when instrument data is being transmitted.
REN	17	Remote Enable. Controller sets signal low, then addresses devices to listen prior to commencement of remote control operation.
EOI	5	End Or Identity. Line used to indicate multiple byte transfer end, or, in conjunction with ATN, to execute a parallel polling sequence.
SRQ	10	Service Request. Line goes low when UEI requests service from controller.

Table 8. IEEE 488 Remote Message Coding

Signal Flow	Mnemonic	Message Name	Bus Signal Line(s) and Coding That Assert Message True																	Message Type	Message Class	Notes
			Data I/O								Handshake			Bus Management								
			DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1	DAV	NRFD	NDAC	ATN	EOI	RSQ	IFC	REN				
Control → UEI	ACG	Addressed Command Group	X	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X	M	AC	10
Control → UEI	ATN	Attention	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	U	UC	–
Control ↔ UEI	DAB	Data Byte	D8	D7	D6	D5	D4	D3	D2	D1	X	X	X	X	X	X	X	X	M	DD	1, 9
Control ↔ UEI	DAC	Data Accepted	X	X	X	X	X	X	X	X	X	X	0	X	X	X	X	X	U	HS	–
Control ↔ UEI	DAV	Data Valid	X	X	X	X	X	X	X	X	1	X	X	X	X	X	X	X	U	HS	–
Control → UEI	DCL	Device Clear	X	0	0	1	0	1	0	0	X	X	X	X	X	X	X	X	M	UC	10
Control ↔ UEI	END	End	X	X	X	X	X	X	X	X	X	X	X	X	1	X	X	X	U	ST	9, 11
Control → UEI	EOS	End of String	E8	E7	E6	E5	E4	E3	E2	E1	X	X	X	X	X	X	X	X	M	DD	2, 9
Control → UEI	GET	Group Execute Trigger	X	0	0	0	1	0	0	0	X	X	X	X	X	X	X	X	M	AC	10
Control → UEI	GTL	Go To Local	X	0	0	0	0	0	0	1	X	X	X	X	X	X	X	X	U	AC	10
Control → UEI	IDY	Identify	X	X	X	X	X	X	X	X	X	X	X	X	1	X	X	X	U	UC	10, 11
Control → UEI	IFC	Interface Clear	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1	X	U	UC	–
Control → UEI	LAG	Listen Address Group	X	0	1	X	X	X	X	X	X	X	X	X	X	X	X	X	M	AD	10
Control → UEI	LLO	Local Lock Out	X	0	0	1	0	0	0	1	X	X	X	X	X	X	X	X	M	UC	10
Control → UEI	MLA	My Listen Address	X	0	1	L5	L4	L3	L2	L1	X	X	X	X	X	X	X	X	M	AD	3, 10
Control → UEI	MTA	My Talk Address	X	1	0	T5	T4	T3	T2	T1	X	X	X	X	X	X	X	X	M	AD	4, 10
Control → UEI	MSA	My Secondary	X	1	1	S5	S4	S3	S2	S1	X	X	X	X	X	X	X	X	M	SE	5, 10
Control ↔ UEI	NUL	Null Byte	)	)	0	0	0	0	0	0	X	X	X	X	X	X	X	X	M	DD	–
Control → UEI	OSA	Other Secondary Address	(OSA=SCG ∧ MSA)																M	SE	10
Control → UEI	OTA	Other Talk Address	(OTA=TAG ∧ MTA)																M	AD	10
Control → UEI	PCG	Primary Command Group	(PCG=ACG v UCG v LAG v TAG)																M	–	10
Control → UEI	PPC	Parallel Poll Configure	X	0	0	0	0	1	0	1	X	X	X	X	X	X	X	X	M	AC	10
Control → UEI	PPE	Parallel Poll Enable	X	1	1	0	S	P3	P2	P1	X	X	X	X	X	X	X	X	M	SE	6, 10
Control → UEI	PPD	Parallel Poll Disable	X	1	1	1	D4	D3	D2	D1	X	X	X	X	X	X	X	X	M	SE	7, 10
	PPR1	Parallel Poll Response 1	X	X	X	X	X	X	X	1	X	X	X	X	X	X	X	X	U	ST	–
Control ← UEI	PPR2	Parallel Poll Response 2	X	X	X	X	X	X	1	X	X	X	X	X	X	X	X	X	U	ST	–
	PPR3	Parallel Poll Response 3	X	X	X	X	X	1	X	X	X	X	X	X	X	X	X	X	U	ST	–
	PPR4	Parallel Poll Response 4	X	X	X	X	1	X	X	X	X	X	X	X	X	X	X	X	U	ST	–
	PPR5	Parallel Poll Response 5	X	X	X	1	X	X	X	X	X	X	X	X	X	X	X	X	U	ST	–
	PPR6	Parallel Poll Response 6	X	X	1	X	X	X	X	X	X	X	X	X	X	X	X	X	U	ST	–
	PPR7	Parallel Poll Response 7	X	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	U	ST	–
	PPR8	Parallel Poll Response 8	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	U	ST	–
Control → UEI	PPU	Parallel Poll Unconfigure	X	0	0	1	0	1	0	1	X	X	X	X	X	X	X	X	M	UC	10
Control → UEI	REN	Remote Enable	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1	U	UC	–
Control ← UEI	RFD	Ready for Data	X	X	X	X	X	X	X	X	X	0	X	X	X	X	X	X	U	HS	–
Control → UEI	RQS	Request Service	X	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	U	ST	9
Control → UEI	SCG	Secondary Command Group	X	1	1	X	X	X	X	X	X	X	X	X	X	X	X	X	M	SE	10
Control → UEI	SDC	Selected Device Clear	X	0	0	0	0	1	0	0	X	X	X	X	X	X	X	X	M	AC	10
Control → UEI	SPD	Serial Poll Disable	X	0	0	1	1	0	0	1	X	X	X	X	X	X	X	X	M	UC	10
Control → UEI	SPE	Serial Poll Enable	X	0	0	1	1	0	0	0	X	X	X	X	X	X	X	X	M	UC	10
Control ← UEI	SRQ	Service Request	X	X	X	X	X	X	X	X	X	X	X	X	X	1	X	X	U	ST	–
Control ← UEI	STB	Status Byte	S8	X	S6	S5	S4	S3	S2	S1	X	X	X	X	X	X	X	X	M	ST	8, 9
	TCT	Take Control	X	0	0	0	1	0	0	1	X	X	X	X	X	X	X	X	M	AC	10
Control → UEI	TAG	Talk Address Group	X	1	0	X	X	X	X	X	X	X	X	X	X	X	X	X	M	AD	10
N/A	UCG	Universal Command Group	X	0	0	1	X	X	X	X	X	X	X	X	X	X	X	X	M	UC	10
Control → UEI	UNL	Unlisten	X	0	1	1	1	1	1	1	X	X	X	X	X	X	X	X	M	AD	10
Control → UEI	UNT	Untalk	X	1	0	1	1	1	1	1	X	X	X	X	X	X	X	X	M	AD	10

Symbols:

Type
- U = Uniline message
- M = Multiline message

Class
- AC = Addressed Command
- AD = Address (talk or listen)
- DD = Device Dependent
- HS = Handshake
- UC = Universal Command
- SE = Secondary
- ST = Status

- 0 = logical zero (HIGH Signal Level)
- 1 = logical one (LOW Signal Level)
- X = don't care (for the coding of a received message)
- X = must not drive (for the coding transmitted message)

Notes:

(1) D1-D8 specify the device dependent data bits.

(2) E1-E8 specify the device dependent code used to indicate the EOS message.

(3) L1-L5 specify the device dependent bits of the device listen address.

(4) T1-T5 specify the device dependent bits of the device talk address.

(5) S1-S5 specify the device dependent bits of the device secondary address.

(6) S specifies the sense of the PPR.

S	Response
0	0
1	1

P1-P3 specify the PPR message to be sent when a parallel poll is executed.

P3	P2	P1	PPR Message
0	0	0	PPR1
.	.	.	.
.	.	.	.
.	.	.	.
1	1	1	PPR8

(7) D1-D4 specify don't care bits that must be sent to all zeroes, but do not need to be decoded by the receiving device.

(8) S1-S6, S8 specify the device dependent status. (DIO7 is used for the RQS message.)

(9) The true message value must be ignored when received if the LACS is inactive.

(10) The true message value must be ignored when received if the ATN message is false.

(11) Interface protocol specifies that the IDY message is sent true, whereas the End message is sent only when the ATN message is sent false.

Table 9. Player Commands (Hex/ASCII Equivalents)

Command	Argument	Hex	ASCII
Recall	Register # (Ø-512)	7F	B7 C6
Clear		BF	C2 C6
Run/Branch	{Address (Ø-1Ø23)}	CF	C3 C6
Write Program	{Address (Ø-1Ø23)}	DF	C4 C6
Frame Display Off		E3	C5 B3
Frame Display On		E4	C5 B4
Audio 2 Off		E5	C5 B5
Audio 2 On		E6	C5 B6
Audio 1 Off		E7	C5 B7
Audio 1 On		E8	C5 B8
Dump RAM		E9	C5 B9
Dump Frame #		EA	C5 C1
Dump Player Status		EB	C5 C2
End Program		EF	C5 C6
Decrement Reg.		FØ	C6 BØ
Frame Display Toggle		F1	C6 B1
Slow Forward	{Frame # (Ø-5 bytes)}	F2	C6 B2
Auto Stop	{Frame # (Ø-5 bytes)}	F3	C6 B3
Audio 1 Toggle		F4	C6 B4
Store	{(# (Ø-5 bytes)}	F5	C6 B5
Step Forward		F6	C6 B6
Search	{Frame # (Ø-5 bytes)}	F7	C6 B7
Input	1-9 (1 byte)	F8	C6 B8
Reject		F9	C6 B9
Slow Reverse	{Frame # (Ø-5 bytes)}	FA	C6 C1
Stop	{Time (Ø-2 bytes)}	FB	C6 C2
Audio 2 Toggle		FC	C6 C3
Play		FD	C6 C4
Step Reverse		FE	C6 C5
Load		CC	C3 C3
{Optional}			

Table 10. Player Arguments (Hex/ASCII Equivalents)

Argument Digit	Hex	ASCII
Ø	3F	B3 C6
1	ØF	BØ C6
2	8F	B8 C8
3	4F	B4 C6
4	2F	B2 C6
5	AF	C1 C6
6	6F	B6 C6
7	1F	B1 C6
8	9F	B9 C6
9	5F	B5 C6

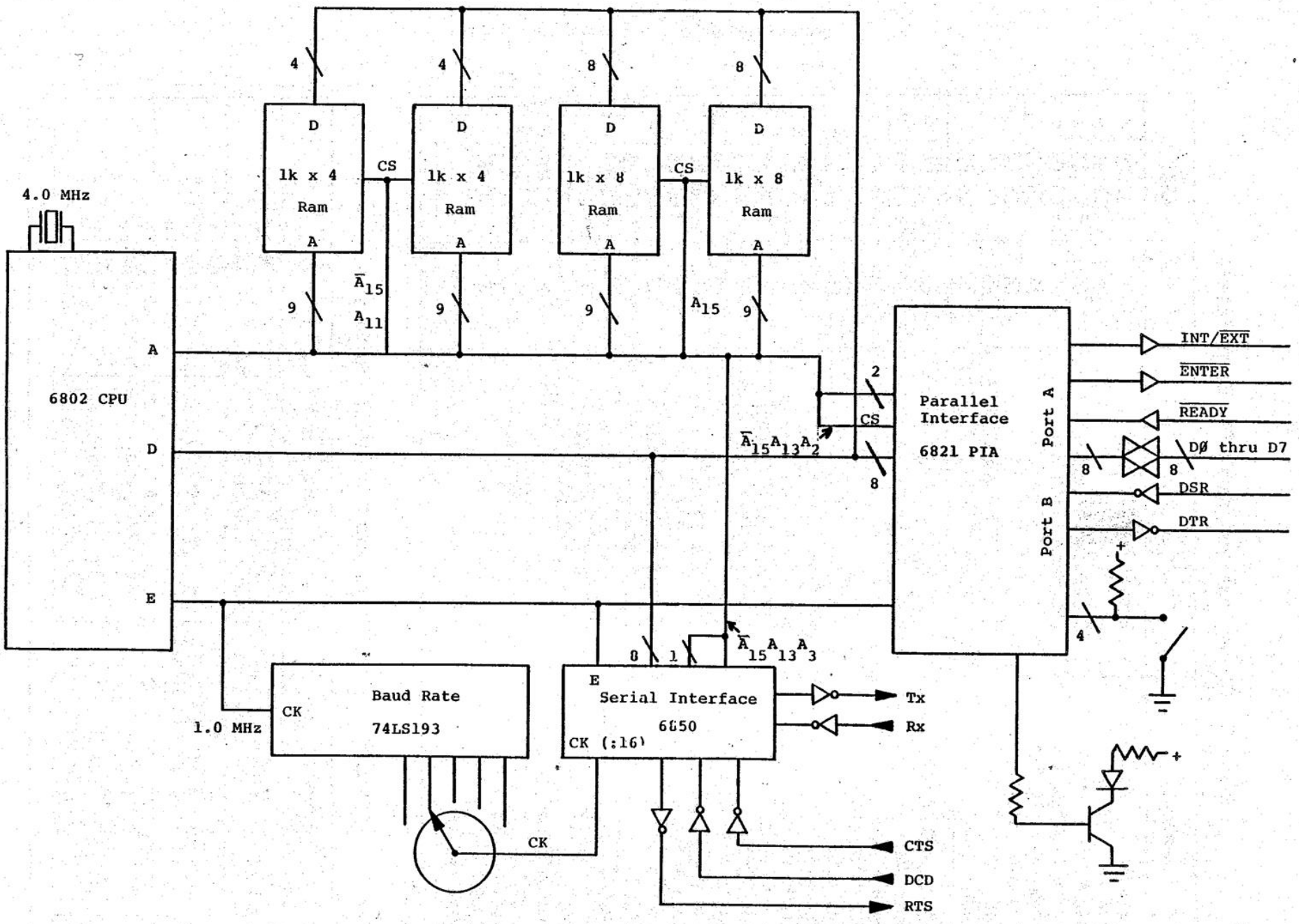


Figure 14. UEI Hardware Schematic

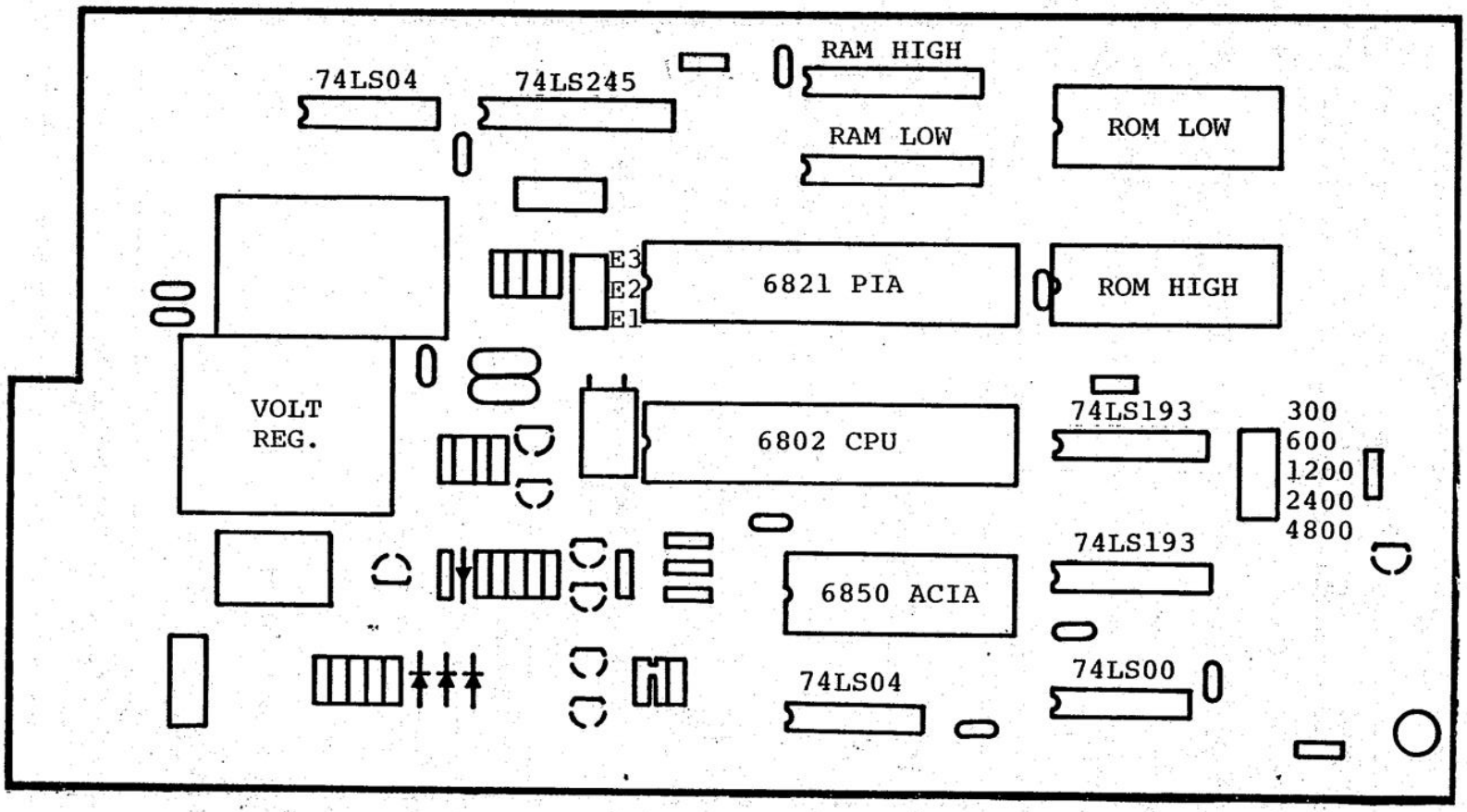


Figure 15. UEI Component Placement

Table 11. UEI Commands (HEX/ASCII Equivalents)

Command	Hex	ASCII
ACTIVATE PLAYER LINK	DØ	C4 BØ
DEACTIVATE PLAYER LINK	D1	C4 B1
SET ECHO MODE	D2	C4 B2
BEGIN STACK	D3	C4 B3
END STACK	D4	C4 B4

Table 12. Special Control Characters

Command	ASCII
Carriage Return	ØD
Line Feed	ØA
Status byte delimiter (!)	21
Software Reset (Esc)	1B
Exception status is terminated by <carriage return> <line feed>	

Table 13. UEI/Host 232C Signals

AA	Protective ground: chassis ground, power cord green wire
AB	Signal ground: zero reference for transmitted and received signals
BA	Transmitted data: outgoing data stream from UEI to host
BB	Received data: incoming data stream to UEI from host
CA	Request to send: output from UEI to modem controlling data direction
CB	Clear to send: input to UEI from modem indicating it will transmit
CC	Data set ready: input to UEI from modem indicating modem is active
CD	Data terminal ready: output from UEI to modem indicating UEI is ready to transmit
CI	Ring detect: input to UEI from modem indicating telephone is ringing
CF	Carrier detect: input to UEI from modem indicating carrier signal is suitable for demodulation

Table 14. UEI/Host RS232C Electrical Characteristics

EIA Standard RS 232C				
Parameter	Condition	Min	Max	Unit
V_{OH} output high	open circuit		25	V
	$3k \leq R_L \leq 7k$	3	15	V
V_{OL} output low	open circuit	-25		V
	$3k \leq R_L \leq 7k$	-15	-3	V
R_O output resistance	$-2V \leq V_O \leq 2V$		300	Ω
I_{OS} output short circuit current		-500	500	mA
dV/dt slew rate	all interchange circuits		30	V/uS
	controls	6		V/uS
	timings	6		V/uS
	% of unit interval	4		%
V_I open circuit input bias		-2	2	V
V_{IS} space input threshold (high, logic Ø)			3	V
V_{IM} mark input threshold (low, logic 1)		-3		V
R_I input resistance	$3V \leq /V/ \leq 25V$ in	3k	7k	Ω

Table 15. UEI/Host RS232C Interface Connections

The standard 25-pin miniature D connector (Cannon #DBC-25S, AMP #205207-1 or #206770-1) is used. Connector contract assignments are as follows:

Pin #	EIA Label	Description
1	AA	Protective ground
2	BA	Transmitted data
3	BB	Received data
4	CA	Request to send
5	CB	Clear to send
6	CC	Data set ready
7	AB	Signal ground
8	CF	Carrier detect
20	CD	Data terminal ready
22	CE	Ring detect

UEI/Host RS232C Cabling Requirements

Actual baud rates available on the UEI are: 4800, 2400, 1200, 600, and 300.

Maximum specified cable length is 50 feet. Maximum data rate is 20 kbaud (10 kHz). Suitable monolithic drivers and receivers: quad drivers MC1488 and DS1488 and quad receivers MC1489 and DS1489 are suitable for lines without external terminations and capacitance less than 1000 pF/line. Quad drivers MC3488A and SN75150 and quad receivers MC3486 and SN75154 are suitable for lines having $R_L > 450\Omega$ and $C_L < 2500$ pF. For typical cable of multiple twisted pairs C=30 pF/ft, giving a maximum run of 30 feet with the 1488 series drivers.

Refer to EIA Industrial Electronics Bulletin No. 9 for further data.

Table 16. UEI Host 488 Electrical Characteristics

Electrically the IEEE-488 bus is essentially an open-collector TTL bus with additional current drive and input hysteresis:

Parameter	Condition	Min	Max	Unit
V_{OH}	I_{OH} = -5.2mA	2.4		V
V_{OL}	I_{OL} = 48mA		0.4	V
I_{OZ} tri-state	V_O = 2.4V		±40	uA
I_{OH} open-collector	V_O = 5.25V		250	uA
V_{IH}		2.0		V
V_{IL} 0.4V hysteresis recommended			0.8	V
I_{IH}	V_I = 2.4V		40	uA
I_{IL}	V_I = 0.4V		-1.6	mA
Clamp current	V_I = -1.5V		12	mA
Bus terminations:				
R_H to V_{CC} = 5V(±5%)		2850	3150	Ω
R_L to GND = 0V		5890	6510	Ω

Table 17. UEI/Host 488 Interface Connections

Mechanical linkage is effected through the standard 24-pin type 57 Microribbon connector (eq. Amphenol 57-40240):

Pin #	Signal Line	Pin #	Signal Line
1	DIO1	13	DIO5
2	DIO2	14	DIO6
3	DIO3	15	DIO7
4	DIO4	16	DIO8
5	EOI	17	REN
6	DAV sig	18	DAV gnd
7	NRFD sig	19	NRFD gnd
8	NDAC sig	20	NDAC gnd
9	IFC sig	21	IFC gnd
10	SRQ sig	22	SRQ gnd
11	ATN sig	23	ATN gnd
12	shield - earth	24	signal ground

NOTE: Pins labeled SIG and GND are a twisted pair; all others are single-ended referenced to pin 24.

UEI/Host 488 Cabling Requirements

For more detailed information refer to "Condensed Description of the Hewlett-Packard Interface Bus", HP P/N 59401-90030.

Maximum specified cable length: 60 ft.

Suitable monolithic devices

Quad transceivers: MC3441A, SN75138

Octal transceivers: MC3447, DP8304B

Table 18. 7820-2 Status Byte Definitions

Status	DIO 7	6	5	4	3	2	1	Ø	HEX NIBBLE
1. Audio 2 (1 = ON, Ø = OFF)	X								N/A
2. Audio 1 (1 = ON, Ø = OFF)		X							N/A
3. Frame Display (1 = ON, Ø = OFF)			X						N/A
4. Current Mode Bit definitions are as follows:				X	X	X	X	X	X
Transient[1]				0	0	0	0	0	0
Park				0	0	0	0	1	1
Play				0	0	0	1	0	2
Stop				0	0	0	1	1	3
Slow Forward				0	0	1	0	0	4
Slow Reverse				0	0	1	0	1	5
Out of Focus				0	0	1	1	0	6
Search Finished				0	0	1	1	1	7
Auto Stop				0	1	0	0	0	8
Input (Stop Mode)				0	1	0	0	1	9
Input (Play Mode)				0	1	0	1	0	A
Write Program				0	1	0	1	1	B
Soft Reject[2]				0	1	1	0	0	C
Medium Reject[3]				0	1	1	0	1	D

[1] The transient state occurs when the player is not in any of the above modes, e.g., in transition from one mode to another.

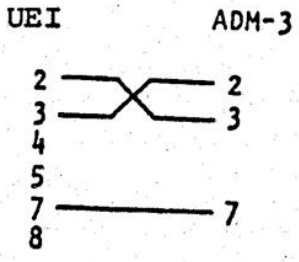
[2] Mode is set equal to Soft Reject if:

a) Button = Reject and Player Mode = Hard Reject, or
b) Player Mode = Search, Autostop, Autoslow, Play, or Scan while Outside Limit is reached.

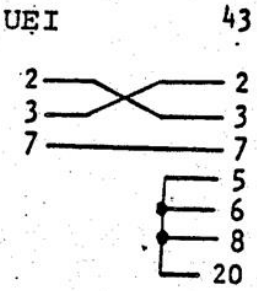
[3] Mode is set to Medium Reject if:

a) Player mode is illegal, or
b) Player mode = Soft Reject and In-focus Flag = clear.

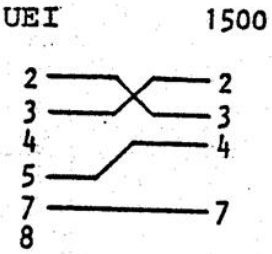
LEAR SIEGLER (ADM-3)



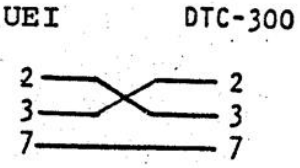
MODEL 43 PRINTER



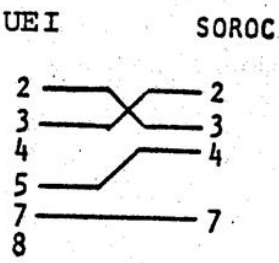
HAZELTINE (1500 SERIES)



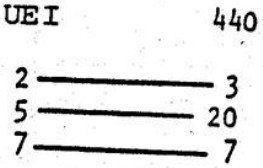
DTC-300 TERMINAL



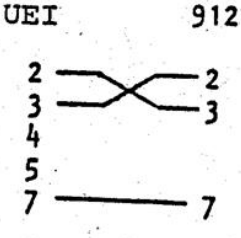
SOROC



IDS 440 (PAPER TIGER)



TELE VIDEO 912



Novation CAT

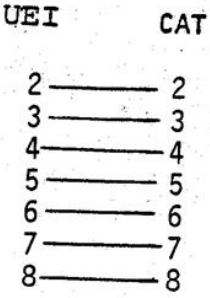


Figure 16. RS232 Serial Terminal Interconnections

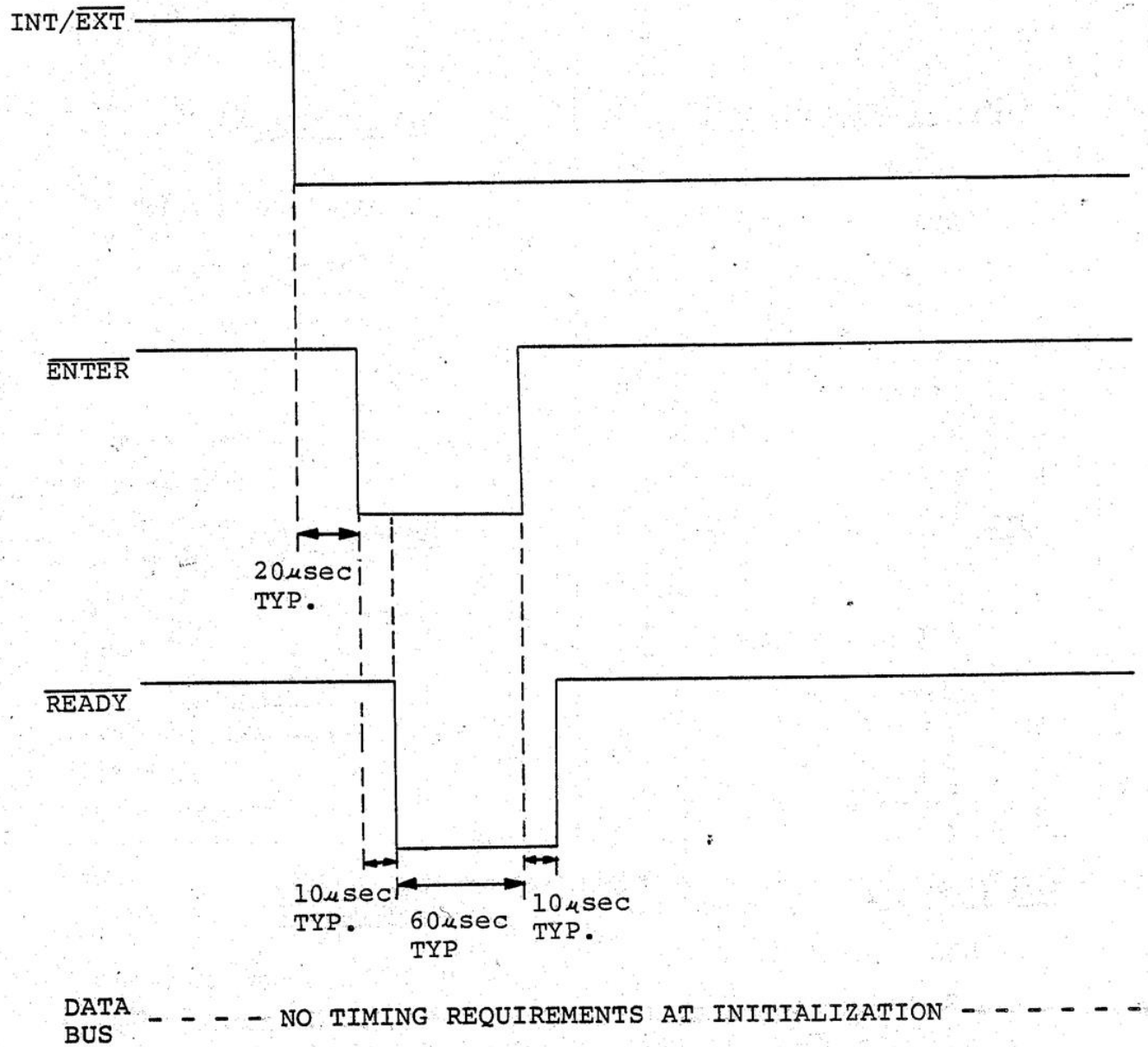


Figure 17. Typical Player Initialization

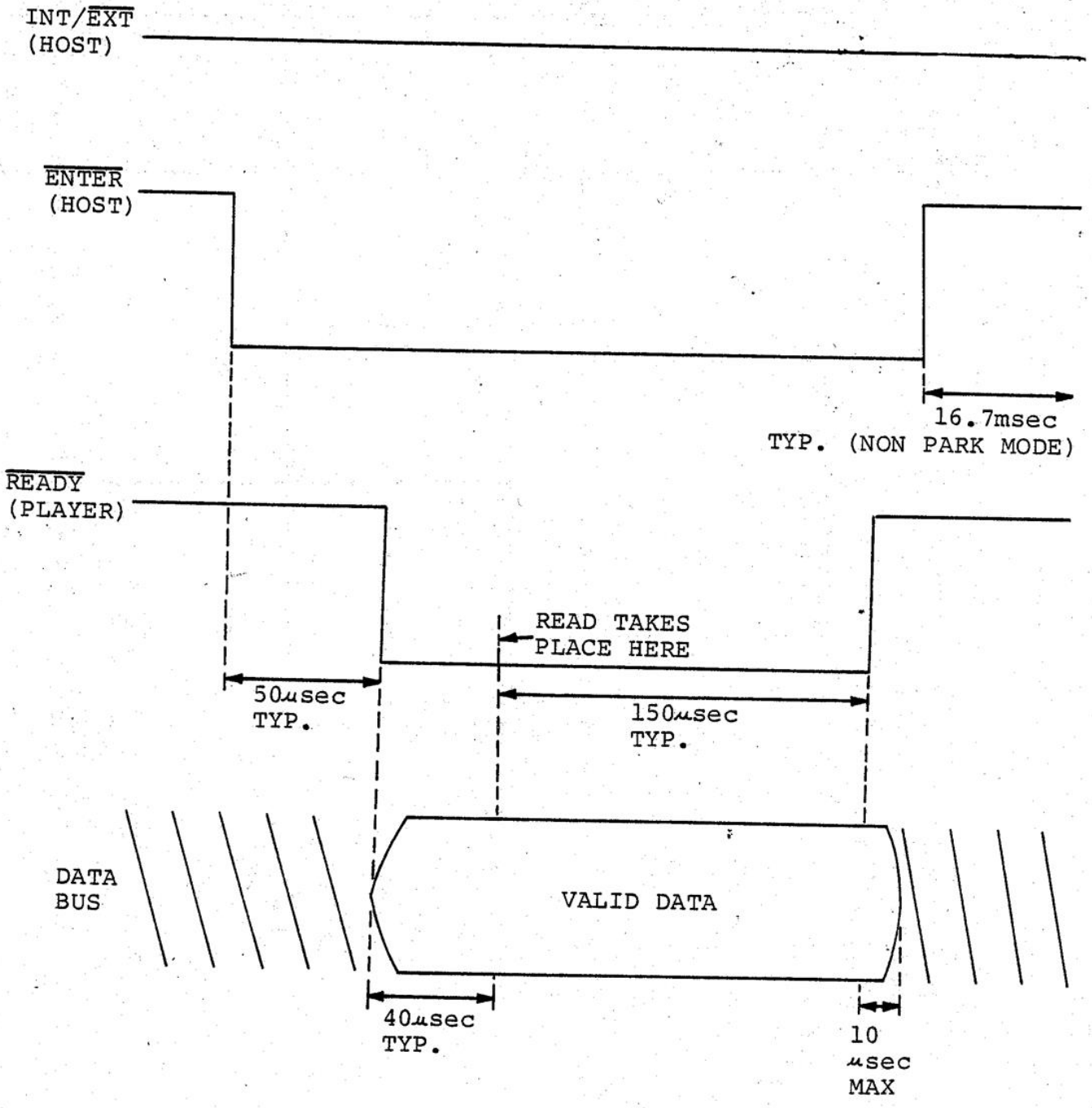


Figure 18. Typical Single Write Cycle

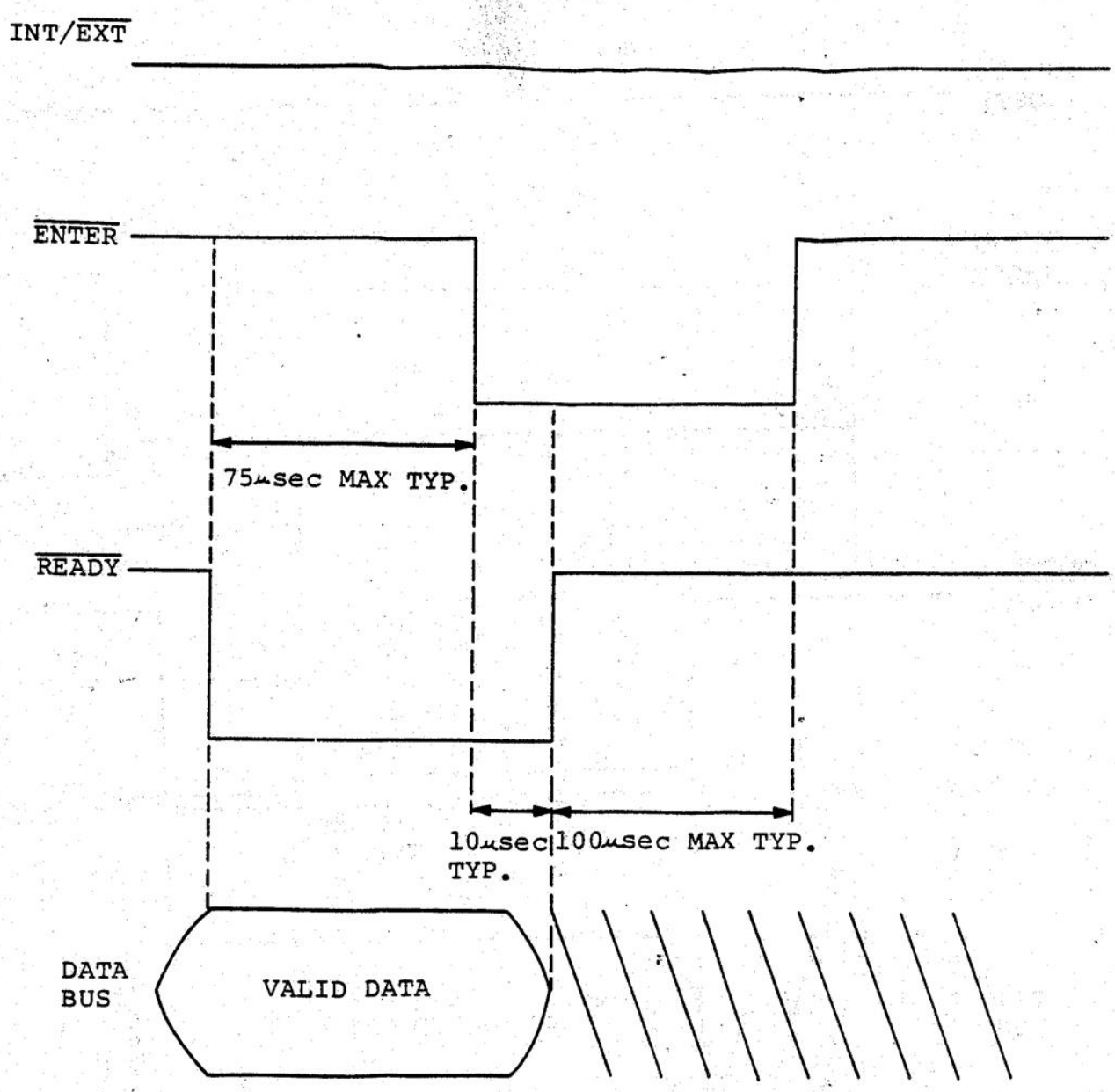


Figure 19. Typical Single Read Cycle

APPENDIX C

Table 19. Player Remote Message Coding

Message Name/Input Function	Input Hex Code	Data Bus							
		7	6	5	4	3	2	1	Ø
1	ØF	0	0	0	0	1	1	1	1
2	8F	1	0	0	0	1	1	1	1
3	4F	0	1	0	0	1	1	1	1
RUN/BRANCH*	CF	1	1	0	0	1	1	1	1
4	2F	0	0	1	0	1	1	1	1
5	AF	1	0	1	0	1	1	1	1
6	6F	0	1	1	0	1	1	1	1
END	EF	1	1	1	0	1	1	1	1
7	1F	0	0	0	1	1	1	1	1
8	9F	1	0	0	1	1	1	1	1
9	5F	0	1	0	1	1	1	1	1
PROGRAM	DF	1	1	0	1	1	1	1	1
0	3F	0	0	1	1	1	1	1	1
CLEAR/HALT*	BF	1	0	1	1	1	1	1	1
RECAL	7F	0	1	1	1	1	1	1	1
NO ENTRY	FF	1	1	1	1	1	1	1	1
DEC. REG.*	FØ	1	1	1	1	0	0	0	0
INPUT*	F8	1	1	1	1	0	0	0	0
AUDIO 1	F4	1	1	1	1	0	1	0	0
AUDIO 2	FC	1	1	1	1	0	1	0	0
SLOW FWD	F2	1	1	1	1	0	1	0	0
SLOW REV	FA	1	1	1	1	0	1	1	0
STEP FWD	F6	1	1	1	1	0	1	1	0
STEP REV	FE	1	1	1	1	0	1	1	0
DISPLAY	F1	1	1	1	1	0	0	0	1
REJECT	F9	1	1	1	1	0	0	0	1
STORE	F5	1	1	1	1	0	1	0	1
PLAY	FD	1	1	1	1	0	1	0	1
AUTOSTOP	F3	1	1	1	1	0	0	1	1
STOP	FB	1	1	1	1	0	0	1	1
SEARCH	F7	1	1	1	1	0	0	1	1
NOT USED	ØØ	0	0	0	0	0	0	0	0
LOAD	CC	1	1	0	0	0	0	0	0
SCAN FWD	FØ	1	1	1	1	0	0	0	0
SCAN REV	F8	1	1	1	1	1	0	0	0

*Programming mode only.

Table 20. Timing Table

Time Value Identifier	Description	Value
T_r	Ready pulse	10 μs ± μs Typical
T_d	Ready to enter delay	600 ns Minimum
T_s	Data overlap delay	600 ns Minimum
T_{ent}	Enter pulse	50 ms Minimum
T_{off}	Data off delay	50 ms Minimum

Table 21. Connector Contact Assignment

Contact	Signal Line	Description
1	D101	Data Bit 0
2	D102	Data Bit 1
3	D103	Data Bit 2
4	D104	Data Bit 3
7	NRFD	$\overline{\text{Ready}}$
11	ATTN	$\overline{\text{Enter}}$
12	Shield	GND
13	D105	Data Bit 4
14	D106	Data Bit 5
15	D107	Data Bit 6
16	D108	Data Bit 7
17	REN	Int/$\overline{\text{Ext}}$
18	GND	GND
19	GND	GND
20	GND	GND
21	GND	GND
22	GND	GND
23	GND	GND
24	GND	GND

Note: Contacts 5, 6, 8, 9 and 10 have no connections.

MODIFICATION OF READY CONTROL

The player-generated $\overline{\text{READY}}$ signal is a periodic signal generated whenever the player is not executing a command. The circuit illustrated below converts this to a fixed signal with appropriate delays to accomplish the previously illustrated flow chart. The $\overline{\text{READY}}$ signal is reset whenever data is entered.

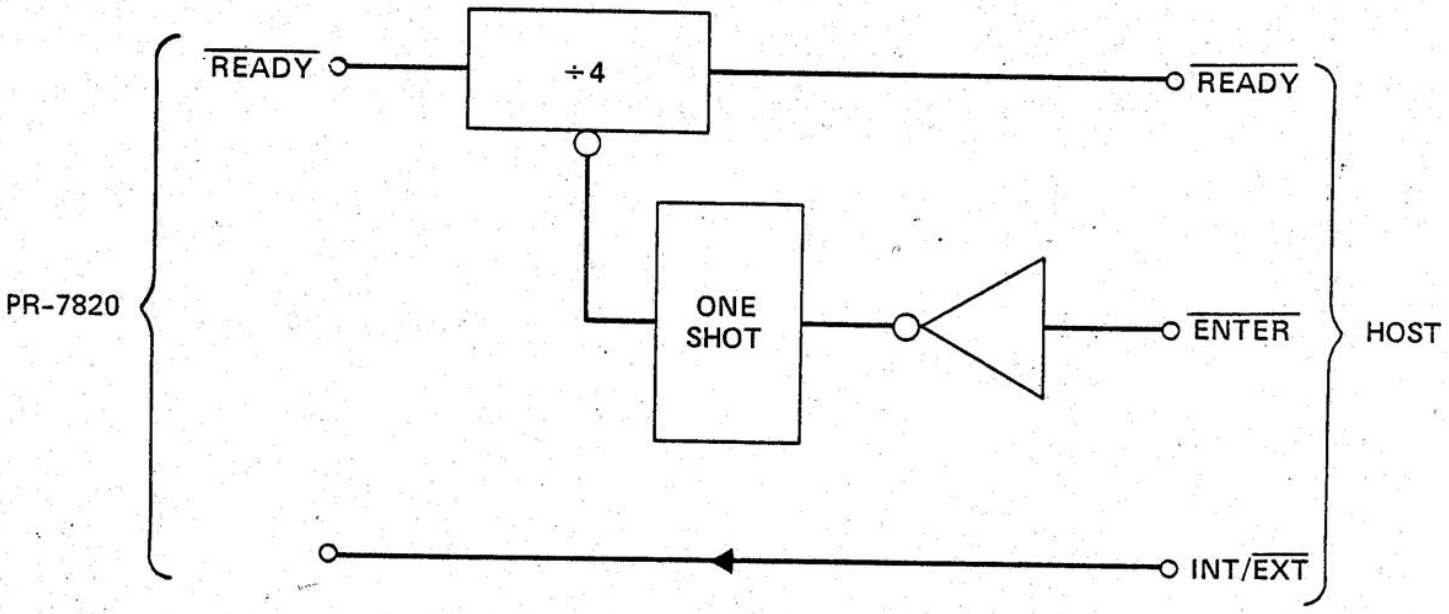


Figure 20. Ready Control

INITIALIZATION/REJECT MODE: CONTROL LOGIC

Upon initialization of a host REJECT command the ready pulses will disappear, though the player is still capable of processing host commands. This situation occurs in the player Park mode (i.e., carriage and disc are retracted from the optical read head). Raising the INT/$\overline{\text{EXT}}$ signal for a period of 100 ms (nominal) will override this condition, allowing the resumption of ready pulse generation to properly prepare the ready control package.

Player response to the REJECT command is from 5 to 7 seconds and should be considered in any software timeout loops related to REJECT command issuance.

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