WANG

MODEL 2254 INTERFACE USER MANUAL

SYSTEM 2200

MODEL 2254 INTERFACE USER MANUAL

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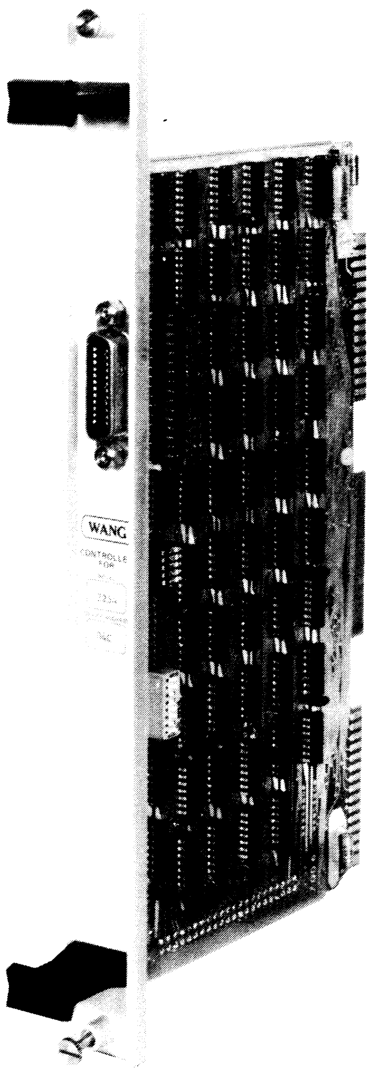
HOW TO USE THIS MANUAL

This manual provides answers to questions concerning the operation of the Model 2254 IEEE-488 Interface. Because the operation of the Model 2254 relies heavily on the use of the $GIO statement and special microcommands, it is recommended that the user become familiar with the General I/O Instruction Set Reference Manual before proceeding with this manual.

The manual has been divided into two chapters. Chapter 1 describes the features of the Model 2254 interface, installation procedure, and the I/O connector pin assignments. In addition, the use of Interface Messages for controlling the interface and Data Operations for transmitting and receiving data to and from external devices is explained. Chapter 2 describes the most typical programming techniques utilized with the $GIO statement for both Controller and Non-Controller configurations.



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CHAPTER 1
INTRODUCTION

1.1 GENERAL INFORMATION

The Model 2254 IEEE-488 Interface board plugs into one of the I/O slots of the System 2200 Central Processing Unit (CPU). A 24-pin female microribbon connector mounted on the face plate of the interface board facilitates direct connection of an external device to the System 2200.

Responsibility for wiring a cable from an external device is not assumed by Wang Laboratories.

Devices connected to the interface board may be one or more of the following:

CONTROLLER	A device which controls other devices on the interface signal line (bus) as to how and when information is to be transferred.
LISTENER	A device addressed by an interface message (originating in the CONTROLLER) to receive device dependent messages from another device. These messages sent via the Bus may pertain to information that is to be stored and printed on devices such as programmable power supplies and printers.
TALKER	A device addressed by an interface message to send device dependent messages to another device. Examples of devices which output information only are digital meters and thermocouples.
TALKER/LISTENER	A device which can both output and accept information from the Bus. Examples of this type of device are a programmable digital voltmeter and a counter.

With the Model 2254 Interface, the System 2200 can serve as either the controller (controlling, talking or listening) or as a non-controller (talking or listening). The Model 2254 is designed to operate with all Wang systems which have the $GIO capability as follows: 2200B or C with Option 2, 2200S with Option 23, 2200T, WCS/20, WCS/30, PCS series, WS, and 2200VP. The $GIO statement is necessary to properly control the 2254, however, once the protocol is established, other BASIC statements may be used to transfer information. For example, if a printer is on the bus it is possible to use a single $GIO statement to initialize (select, etc.) the interface board and the printer. For actual data transfer the PRINT statement may be used. The program may be concluded with another $GIO to reset the bus to a different state.

1.2 INSTALLATION

To install your Model 2254 Interface, your Wang Service Representative uses the following procedure:

1. Turn OFF all main power to the CPU and other devices being interfaced.

2. Wire the PC board for either controller or non-controller operation (see Appendix A); also set the following switches:

   a. Set the 8-bit address switch to the boards Primary Address. The normal Primary Address to be used is 4C, represented by FNFF NNFF. Assuming the switches are set to 4C, the board is addressed in BASIC as follows:

Address		Function
04C	Primary Address	Used by the 2200 to address a 2254 (wired either as a Controller or Non-Controller) for all input, output, status, and bus control (see Section 2.2).
04D	KEYIN Address	Used only in the input BUFFERED MODE when the 2200 is a LISTENER and subsequent KEYIN statements are used for data transfer.
04E	Service Request Address	Used in the Controller mode to detect Service Request from other devices.
04F	Reserved	An address currently received for diagnostic purposes.

> **NOTE:**
>
> If a second 2254 board is used, its address designation must be divisible by 4 and all four addresses (Primary, KEYIN, Service Request and Reserved) must be unique in the system. For instance if the 8-bit switch on the second board is set to 48, represented by FNFF NFFF, then the four addresses are 048, 049, 04A and 04B respectively.

b. Set the 5-bit switch for listener (MLA) and talker (MTA) addresses. The 2254 uses the 5-bit switch to select both addresses as follows:

Listen Address	Talk Address	Switch Setting	Listen Address	Talk Address	Switch Setting
20	40	NNNNN	30	50	FNNNN
21	41	NNNNF	31	51	FNNNF
22	42	NNNFN	32	52	FNNFN
23	43	NNNFF	33	53	FNNFF
24	44	NNFNN	34	54	FNFNN
25	45	NNFNF	35	55	FNFNF
26	46	NNFFN	36	56	FNFFN
27	47	NNFFF	37	57	FNFFF
28	48	NFNNN	38	58	FFNNN
29	49	NFNNF	39	59	FFNNF
2A	4A	NFNFN	3A	5A	FFNFN
2B	4B	NFNFF	3B	5B	FFNFF
2C	4C	NFFNN	3C	5C	FFFNN
2D	4D	NFFNF	3D	5D	FFFNF
2E	4E	NFFFN	3E	5E	FFFFN
2F	4F	NFFFF			

where: F means switch OFF
N means switch ON

These switch settings are represented with the component side of the mother board facing, and the connector up.

> **NOTE:**
>
> Addresses 3F and 5F are reserved. 3F is used to Unlisten and 5F is used to Untalk all devices on the bus (see Table 1-4). Therefore, switch positions FFFFF should not be used.

c. Set bit positions for Parallel Poll and RESET/ Interface Clear (IFC) capabilities (See Appendix A).

3. Mount the Interface Board in any available I/O slot in the CPU chassis, carefully fitting the three fingers on the PC board into the matching slots in the chassis. (For the PCS, insertion of the 2254 is made internally.)

4. When the face plate of the board is in contact with the chassis, tighten the screws at each end of the face plate.

5. Plug a user supplied connector cable into the 24-pin female Microribbon connector on the face plate of the interface board.

6. Tighten the hexagonal locking nuts on the connector.

7. Follow the Installation and Power-ON procedures for all other System 2200 peripherals (given in the System 2200 Reference Manual). Consult the manufacturer's manual for each instrument being interfaced to the System 2200.

1.3 SIGNAL SPECIFICATIONS

Voltage levels for the Model 2254 are as follows:

Coding Logical State	Signal Level
0 (High)	$\geq$ + 2.0V.
1 (Low)	$\leq$ + 0.8V.

1.4 INTERFACE AND BUS INTERACTIONS

1.4.1 Interface System

The interface system contains a set of sixteen signal lines used to carry all messages, both device dependent and interface messages, among interconnected devices (see Figure 1-1). The interface is organized into three sets of signal lines: DATA BUS CONTROL, GENERAL INTERFACE MANAGEMENT and DATA TRANSFER CONTROL.

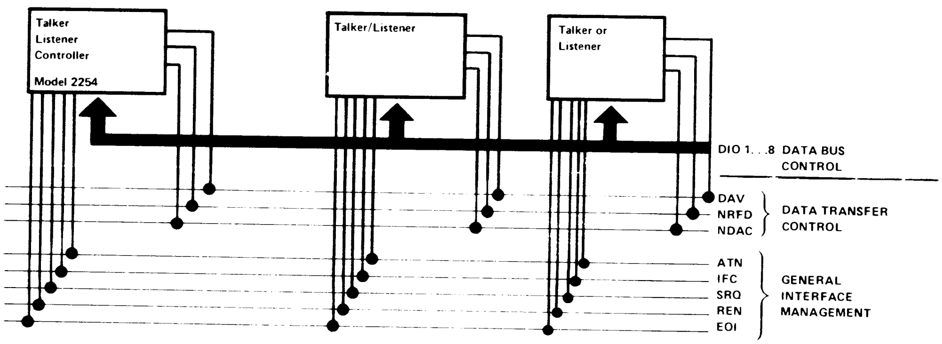

Figure 1-1. Interface Bus Structure

DATA BUS CONTROL - The eight Data Input/Output signal lines (DIO1 through DIO8) carry all 7-bit coded interface messages and all device dependent messages (1 to 8 bits). Device addresses for LISTENERS or TALKERS along with actual data bytes are transferred on these lines. The messages on these signal lines are carried in bit-parallel/byte-serial form. Information flow is bi-directional, i.e., an individual device can use the eight bit bus for two-way transmission of both input and output messages. Data can be transferred at rates in excess of 30,000 bytes per second. However, information flow on the Data Bus Control is asynchronous at the rate of the slowest device communicating over the interface at a given time.

GENERAL INTERFACE MANAGEMENT - Five interface signal lines are used to manage the orderly flow of information across the interface.

ATN (ATTENTION)	This signal from the CONTROLLER interrupts any data transfer and signals all devices to listen for bus commands.
IFC (INTERFACE CLEAR)	This signal resets all device interfaces on the BUS to a known state (similar to a RESET on the 2200).
SRQ (SERVICE REQUEST)	This signal is used by a particular device to notify the controller that the device needs servicing.
REN (REMOTE ENABLE)	This signal is used (in conjunction with other messages) to select whether operational parameters are to be derived from the front panel or from data messages.
EOI (END OR IDENTIFY)	This signal is used to end a multiple bytetransfer on the data lines or, with ATN, to identify a parallel polling sequence.

DATA TRANSFER CONTROL - This set of three interface signal lines is used to monitor the transfer of each byte of data on the Data Bus Control from one addressed device to another addressed device via the "handshake" procedure (see note on next page).

NRFD (NOT READY FOR DATA)	When high (logic 0), this signal from a LISTENER indicates that it is ready to receive a byte of information on the data lines.
DAV (DATA VALID)	When low (logic 1), this signal from a TALKER indicates that the information on the data lines is valid after all LISTENERS have indicated that they are ready.
NDAC (DATA NOT ACCEPTED)	When high (logic 0), this signal from a LISTENER indicates that it has accepted the current byte of information on the data lines.

NOTE:

The signals NRFD, DAV, and NDAC are used in a three wire "handshake" to transfer each byte along the data lines. When all devices are ready (NRFD high), DAV goes low indicating that the data is valid. After the data is accepted by all LISTENERS (NDAC high), DAV goes high indicating the data is no longer valid. After DAV goes high, NRFD goes low, followed by NDAC going low. This handshake process is repeated for each data byte to be transferred.

The functional assignments for the 24 pins in the microribbon connector are listed in Table 1-1. An open pin connection for an input circuit is equivalent to a high-level signal (logic "0").

Table 1-1. Model 2254 I/O Connector Pin Assignments

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	18	Ground, DAV
7	NRFD	19	Ground, NRFD
8	NDAC	20	Ground, NDAC
9	IFC	21	Ground, IFC
10	SRQ	22	Ground, SRQ
11	ATN	23	Ground, ATN
12	SHIELD	24	Ground, LOGIC

1.4.2 Interface Functions

An interface function is the system element which provides the basic operational facility through which a device can receive, process, and send messages. A number of interface functions are available in the 2254.

Interface Function	Description
C (CONTROLLER)	The C interface function provides a device with the capability to send device addresses, universal commands and addressed commands to other devices over the interface. It also provides the capability to conduct parallel and serial polls to determine which devices require service.

SR (SERVICE REQUEST)	The SR interface function provides a device with the capability to asynchronously request service from the controller in charge of the interface.
L (LISTENER)	The L interface function provides a device with the capability to receive device dependent data (including status data) over the interface from other devices. This capability exists only when the L interface function is addressed to listen.
T (TALKER)	The T interface function provides a device with the capability to send device dependent data (including status data) over the interface to other devices. This capability exists only when the T interface function is addressed to talk.
AH (ACCEPTOR HANDSHAKE)	The AH function provides a device with the capability to assure proper reception of remote multiline messages. An AH function may delay a multiline message transfer until prepared to continue with the transfer process.
SH (SOURCE HANDSHAKE)	The SH interface function provides a device with the capability to assure the proper transfer of multiline messages. The SH interface function controls the transfer of multiline message byte.
PP (PARALLEL POLL)	The PP interface function provides a device with the capability to present one bit of status to the controller in charge without being previously addressed.

Controller Subsets

As the system controller, the 2200 system via the 2254 Interface supports the following subsets of the IEEE 488-1975 Specifications:

Subset	Description
C1	System Controller
C2	Send IFC (Interface Clear)
C3	Send REN (Remote Enable)
C4	Recognize SRQ (Service Request)
C25	Send all standard multi-line interface messages and in addition . Serial Poll . Parallel Poll . Take Control Synchronously
SR1	Send Service Request

L2	Basic Listener
T4	Basic Talker
AH1	Full Listener Handshake
SH1	Full Talker Handshake

<u>Non-Controller Subsets</u>

As a non-controller, the 2200 system via the 2254 Interface supports the following subsets of the IEEE 488-1975 Specifications:

Subset	Description
C0	System Non-Controller
PP2	Respond to Parallel Poll (field-settable configuration)
SR1	Send Service Request
L2	Basic Listener
T4	Basic Talker
AH1	Full Acceptor Handshake
SH1	Full Source Handshake

1.4.3 Data Transfer

The most common use of the Interface Bus is to transfer data from a TALKER to a LISTENER or a group of LISTENERS. The sequence is described as follows:

1. ATN	Controller halts all bus activity in preparation for interface commands.
2. UNL (UNLISTEN)	All LISTENERS are put in an idle state.
3. LAD (LISTEN ADDRESS)	Specific LISTENER(S) is enabled.
4. TAD (TALK ADDRESS)	Specific TALKER is enabled.
5. Turn off ATTN	Controller allows TALKER to send data.
6. DAB (DTA BYTE)	Data is sent from the currently enabled TALKER to the currently enabled LISTENER(S). The TALKER may end the data transfer with an EOI or the CONTROLLER may assume control with ATN.

1.4.4 Serial Poll

The Serial Poll interface function allows a device to present one byte of status to the CONTROLLER when it is called upon to respond after other devices have responded in turn.

The sequence can be described as follows:

1. ATN	CONTROLLER halts all interaction and signals all devices to listen for commands.
2. UNL (UNLISTEN)	The CONTROLLER puts all current LISTENERS in the idle state.
3. SPE (SERIAL POLL ENABLE)	Instructs all devices to send status instead of data.
4. TAD	Controller enables each device in turn as a TALKER.
5. SBN or (SBA)	Status byte sent by each device on Bus. If SBN is sent, the loop is repeated. If SBA is sent, the device is identified as having sent SRQ over the interface.
6. SPD (SERIAL POLL DISABLE)	The CONTROLLER removes the Bus from the serial poll mode.

> NOTE:
>
> As a CONTROLLER, the 2254 can conduct a serial poll of other devices. However, the 2254 cannot be serial polled.

1.4.5 Parallel Poll

The Parallel Poll interface function allows a device to present one bit of status to the CONTROLLER without being previously addressed to talk. Signal lines DIO1 through DIO8 are used to convey the device status bits during the parallel poll. The sequence can be described as follows:

1. The CONTROLLER sends ATN and IDY, to indicate Parallel Poll.

2. Immediately, all devices (that are configured to respond to parallel poll) put their status signals on specific data lines. Generally, each device interface is assigned one line. The line to be used by a device may be set by jumpers for some devices, and by software on others.

> NOTE:
>
> In Parallel Poll the status of the DIO1 through DIO8 lines is taken (snapshot); there is no handshake involved.

1.5 BOARD COMMANDS

The System 2000/2254 interface configuration is made functional by a series of microcommand codes directed from the CPU to the interface board. These 4 hex-digit (2 byte) microcommands are sent by the CPU to the interface via the $GIO statement (see Chapter 2 for specific $GIO sequences).

The general form of the $GIO statement is as follows:

```
$GIO [comment] ⎡#n  ⎤ (microcommand sequence, error/status register) ARG3 data buffer
               ⎣/xyy⎦
```

Where:

Comment-	Represents an optional character string identifying the I/O operation (e.g., OUTPUT, PRINT, STATUS, IFC, POLL, etc.,); the comment is ignored by the system.
#n-	Represents an Indirect Address Specification: n = 1, 2, 3, 4, 5 or 6 being the file number currently assigned the three-hex-digit I/O code of the controller.
/xyy-	Represents an Absolute Address Specification: the value of x is "0" (zero) for $GIO operations; the value of yy must be the two-hex-digit code corresponding to the controller or non-controller of the interface.
microcommand sequence-	A series of one or more 4 hex-digit (2 byte) microcommands; a space is allowed between each microcommand.
error/status register-	An alphanumeric variable or array which represents ten to fifteen 8-bit error/status registers.
ARG 3 data buffer-	An alphanumeric variable or array designator which represents an optional I/O buffer, required by microcommand category. This variable type holds data to be sent or received.

NOTE:

If neither an Indirect nor Absolute address is specified, the address currently assigned to the SELECT statement parameter TAPE is the default address. (Avoid defaulting to a cassette drive address since cassette drives cannot be controlled by $GIO statements.)

In conformity with the syntax rules used for other general forms, the brackets [ ] in the $GIO statement indicate the enclosed information is optional.

Examples

```
:10  $GIO STATUS/04C (44D0 8601, A$)
                    or
:10  SELECT #1 04C
:20  $GIO STATUS #1 (44D0 8601, A$)
                    or
:10  SELECT TAPE 04C
:20  $GIO STATUS (44D0 8601, A$)
```

When the 2254 is wired as a controller , the microcommands shown in table 1-2 are used. Table 1-3 gives the microcommands when the 2254 is a non-controller.

TABLE 1-2

Board Commands
For Controller

$GIO Microcommand Code	Function
4480	Null operation
4481	Take control synchronously
4482	Turn off ATN (asynchronously)
4483	Turn on ATN (asynchronously)
4484	REN off
4485	REN on
4486	IFC
4487 8601	Parallel poll, accept poll status
4490	Turn on END (EOI bit)
44A0	*Turn off SRQ
44B0	*Turn on SRQ
44C0	2254 Clear (Board Clear)
44D0 8601	Status request, accept status
44E0	buffered mode OFF
44F0	buffered mode ON

*These commands are not normally used as a controller.

TABLE 1-3

Board Commands For Non-Controller	
$GIO Microcommand Code	Function
4490	Turn on END (EOI bit)
44A0	Turn off SRQ
44B0	Turn on SRQ
44C0	2254 Clear (board clear)
44D0 8601	Status request, accept OK
44E0	Buffered mode off
44F0	Buffered mode on

The first byte of the 2 byte microcommands in Tables 1-2 and 1-3 is a HEX(44). The HEX(44) code implies that the CPU waits for the 2254 Ready/Busy to go Ready. When the board is Ready the CPU sends out a CBS output strobe and the second byte of the microcommand. For instance, the HEX(83) in the microcommand 4483 turns on the ATN asynchronously (i.e., interrupts any data transfer between devices and signals all devices to listen for instructions).

Note that the microcommand for Status Request HEX(44D0) is paired with the microcommand for Accept Status, HEX(8601). The HEX(86) implies that the CPU is to accept a single character input. In this case the CPU sets its CPU Ready/Busy signal (CPB) to Ready and awaits an IBS input strobe with a character from the 2254. The character received with the input strobe is stored in Register 1 (specified by the hexdigit 1 in HEX(8601)). The IBS input strobe implied in HEX(8601) is also used following a parallel poll request HEX(4487).

NOTE:

In nearly every case a CBS output strobe (via HEX (44)) is sent only when the Ready/Busy of the interface board is ready. The normal exceptions to this rule can be the Status Request and IFC messages. In these cases use:

HEX(4586) for HEX(4486) IFC
HEX(45D0) for HEX(44D0) Status Request

The HEX(45) signifies that the CPU does not wait for the 2254 Ready/Busy to go Ready before sending out a CBS strobe.

The use of the HEX(45D0) Status Request code is especially useful in determining the immediate status of the interface. A snapshot of the latches and levels in the interface have the following status designations:

80	-	Reserved
40	-	Input buffer full
20	-	Output buffer full
10	-	DAV
08	-	DAC
04	-	RFD
02	-	Talk enabled
01	-	Listen enabled

The following examples illustrate the use of some board commands:

Example 1 - Interface Clear (IFC)

```
$GIO IFC #1 (4486, B$)
```

where 4486 - Generates an interface clear to stop all operations on the bus; unaddresses TALKER and LISTENER(S).

Example 2 - Request Status

```
$GIO STATUS #1 (44D0 8601, B$)
```

where 44D0 - Request status
8601 - Accept status

1.6 BUS COMMANDS

Bus Commands are the microcommands sent out by the System 2200 (as Controller) to the devices on the bus (via the $GIO statement). The first byte of the 2-byte microcommand is the HEX(44) and the second byte can be represented by any of the 7-bit codes shown in Table 1-3. The HEX(44) portion of the code directs a CBS strobe to be sent out only when Ready/Busy is Ready. In the normal sequence Ready/Busy is set to Busy, then ATN is turned on, and the interface command is latched into the output buffer of the 2254. The interface then proceeds to handshake the data onto the bus. When the data is accepted by the device(s), the buffer becomes empty, and Ready/Busy becomes Ready again. ATN remains on until turned off by subsequent 2200 operations.

> NOTE:
>
> Bus Commands may not be used unless the 2254 is wired as a controller.

A condensed version of the pertinent codes in Table 1-4 along with the standard $GIO Data Input/Output codes is presented below:

Mnemonic	Microcommand Code	Function
SPE	4418	Serial Poll Enable
SPD	4419	Serial Poll Disable
UNL	443F	Unlisten (all devices)
UNT	445F	Untalk (all devices)
TAD	4440-445E	Enable a specific talker
LAD	4420-443E	Enable a specific listener

4418	Waits for the board to go Ready, sends a CBS output strobe and the command HEX(18). The HEX(18) code in the table of bus commands is SPE (Serial poll enable).
4419	Waits for the board to go Ready, sends a CBS output strobe and the command HEX(19). The HEX(19) code in the table of bus commands represents SPD (Serial poll disable).
443F	Waits for the board to go Ready, sends a CBS output strobe and the command HEX(3F). The HEX(3F) code in the table of bus commands is interpreted as UNL (unlisten).
445F	Waits for the board to go Ready, sends a CBS output strobe and the command HEX(5F). The HEX(5F) code in the table of bus commands represents the command UNT (Untalk).
4440-445E	Waits for the board to go Ready, sends a CBS output strobe and the command HEX(XX). The HEX(XX) code in the table of bus commands enables a talker with device address 40 to 5E respectively.
4420-443E	Waits for the board to go Ready, sends a CBS output strobe and the command HEX(XX). The HEX(XX) code in the table of bus commands enables a listener with device address 20 to 3E respectively.

TABLE 1-4 BUS COMMANDS
(SENT AND RECEIVED WITH ATN=1)

Bits b7 b6 b5 →					0 0 0	MSG (1)	0 0 1	MSG	0 1 0	MSG	0 1 1	MSG	1 0 0	MSG	1 0 1	MSG	1 1 0	MSG	1 1 1	MSG
b4	b3	b2	b1	Col. → / Row ↓	0		1		2		3		4		5		6		7	
0	0	0	0	0	NUL		DLE		SP	MLA ASSIGNED TO DEVICE	0	MLA ASSIGNED TO DEVICE		MLA ASSIGNED TO DEVICE	P	MLA ASSIGNED TO DEVICE		MEANING DEFINED BY PCG CODE	p	MEANING DEFINED BY PCG CODE
0	0	0	1	1	SOH	GTL	DC1	LLO	!		1		A		Q		a		q	
0	0	1	0	2	STX		DC2		"		2		B		R		b		r	
0	0	1	1	3	ETX		DC3		#		3		C		S		c		s	
0	1	0	0	4	EOT	SDC	DC4	DCL	$		4		D		T		d		t	
0	1	0	1	5	ENQ	PPC (3)	NAK	PPU	%		5		E		U		e		u	
0	1	1	0	6	ACK		SYN		&		6		F		V		f		v	
0	1	1	1	7	BEL		ETB				7		G		W		g		w	
1	0	0	0	8	BS	GET	CAN	SPE	(		8		H		X		h		x	
1	0	0	1	9	HT	TCT	EM	SPD	)		9		I		Y		i		y	
1	0	1	0	A	LF		SUB		*		:		J		Z		j		z	
1	0	1	1	B	VT		ESC		+		;		K		[		k		{	
1	1	0	0	C	FF		FS		,		<		L				l		:	
1	1	0	1	D	CR		GS		-		=		M		[		m		}	
1	1	1	0	E	SO		RS		.		>		N		^		n		~	
1	1	1	1	F	S1		US		/		?	UNL	O		—	UNT	o		DEL	

ADDRESSED COMMAND GROUP (ACG)

UNIVERSAL COMMAND GROUP (UCG)

(4)

LISTEN ADDRESS GROUP (LAG)

TALK ADDRESS GROUP (TAG)

PRIMARY COMMAND GROUP (PCG)

SECONDARY COMMAND GROUP (SCG)

NOTES: (1) MSG = INTERFACE MESSAGE
(2) b1 = D010 ... b7 = D107
(3) REQUIRES SECONDARY COMMAND
(4) DENSE SUBSET (COLUMN 2 THROUGH 5)

Example 1 - Start Serial Poll

$GIO START SERIAL POLL #1 (443F 4418, B$)

where	443F	-	Unlisten
	4418	-	puts interface into serial poll mode

Example 2 - Go to Local (e.g., an instrument with front panel controls)

$GIO GO LOCAL #1 (4401, B$)

where	4401	-	returns all listening devices to local control (see Table 1-4, GTL)

Example 3 - Device Clear

$GIO SDC #1 (4404, B$)

where	4404	-	clears all devices currently selected to listen (see Table 1-4, SDC)

Example 4 - Trigger

$GIO GET #1 (4408, B$)

where	4408	-	triggers all devices currently selected to listen (see Table 1-4, GET)

1.7 DATA TRANSFER

The transfer of data along the interfac bus is accomplished by either of two programming procedures. In one technique the $GIO statement alone transfers data. In the second procedure, data transfer is accomplished by a combination of a $GIO statement and BASIC statements with PRINT, PRINTUSING, KEYIN or INPUT verbs.

Procedure 1 - $GIO Statement

In this procedure the Unlisten code is used, and the talker and listener(s) are enabled by their address microcodes (from Table 1-3) in the microcommand sequence of the $GIO statement. In addition, certain data input or data output microcommands must be specified in the mirocommand sequence which make use of the I/O data buffer.

The user is asked to refer to Table A-3 of the GENERAL I/O INSTRUCTION SET REFERENCE MANUAL for a complete listing of data input and data output microcommands for transferring multicharacter data. Depending on the particular devices on the bus the user may wish to employ certain microcommands that provide built-in time delays and special termination condition checks. However, for the purpose of this manual, only two simple microcommands for output and input are described:

C640 - Data Input

The CPU sets its READY/BUSY to ready. The CPU awaits an input strobe from the 2254. The received character from the 2254 is saved in the R$() data buffer. The sequence continues until the number of characters received is equal to the defined length of the R$() data buffer. The system then proceeds to the next microcommand.

A000 - Data Output

The CPU awaits a Ready signal from the 2254. The CPU sends out the next character in the ARG3 buffer along the bus with an OBS output strobe. The output sequence described above is repeated until all characters in the defined length of the ARG3 buffer are sent out.

Two examples of the $GIO statement used for data transfer are presented below. Both examples assume the 2254 5-bit bus address switch is set at ON OFF ON ON ON. Thus the 2254 LISTENER address is 28, and its talk address is 48.

Example 1 - Input to System 2200 from a TALKER with address (46)

```
$GIO INPUT #1 (443F 4428 4446 C640, B$) R$()

    where  443F  -  Unlisten
           4428  -  Enable listener 28 (the 2254)
           4446  -  Enable talker 46
           C640  -  Input the array R$() from talker 46
```

Example 2 - Output to a LISTENER with address (25)

```
$GIO OUTPUT #1 (443F 4425 4448 A000, B$) W$()

    where  443F  -  Unlisten
           4425  -  Enable listener 25
           4448  -  Enable talker 48 (the 2254)
           A000  -  Output the array W$() to listener 25
```

<u>Procedure 2 - $GIO with BASIC Statements</u>

In this procedure, the $GIO statement is used only to Unlisten the devices on the line and to enable the talker and the listener(s).

The actual data transfer is accomplished by subsequent statements in the program that use the verbs PRINT, PRINTUSING, KEYIN and INPUT. The user who is unfamiliar with these BASIC verbs is asked to refer to the Wang BASIC Language Reference Manual for a complete explanation of their use. Examples of the use of $GIO with BASIC statements are presented in Section 2.3.

CHAPTER 2: PROGRAMMING TECHNIQUES

2.1 INTRODUCTION

Some programming techniques for the Model 2254 applications are presented in this chapter. Because of the customized nature that the 2200/2254 interface may assume with special devices on the bus, the examples have been kept simple and generalized. It is also assumed that the reader is familiar with the Wang BASIC Language Reference Manual.

2.2 DEVICE SELECTION

When the System 2200 is Master Initialized (i.e., power is turned off and then on again), the primary devices are automatically selected for input/output operations. A primary device has one of the five default addresses for the System 2200.

The Model 2254 interface is not a primary device. Therefore, the 2254 must be properly addressed before data can be transferred over the interface. The 2254 has four board addresses:

Address	Function
04C - Primary Address	Used by the 2200 to address a 2254 (wired either as a Controller or Non-Controller) for all input, output, status, and bus control operations, except as specified below.

Examples

```
    :SELECT #1 04C
    :10 $GIO #1 (.....)
           or
:10 $GIO STATUS/04C (.....)
```

Address	Function
04D - KEYIN Address	Used only in the input BUFFERED MODE when the 2200 is a LISTENER and subsequent KEYIN statements are used for data transfer. This address is used for input only, with the 2254 READY/BUSY indicating the presence of a character in the input buffer. $IF ON may also be used to check for the presence of a character.

Examples

```
:10 SELECT INPUT 04D
:20 KEYIN A$,30,30

:SELECT #1 04D
:10 $IF ON #1,30
```

04E - SRQ Address

Used in the Controller mode to detect SRQ from other devices. The 2254 READY/BUSY at this address indicates the presence of an SRQ. Normal response would include a parallel or serial poll (using the primary address 04C).

Example

```
:10 SELECT #1 04E
       :
       :
:30 $IF ON #1,60
       :
       :
:60 $GIO PARALLEL POLL/04C (.....)
```

04F - Reserved Address

An address currently reserved for diagnostic purposes.

2.3 PROGRAMMING AS A CONTROLLER

The System 2200 in the role of controller has the ability to control all functions on the interface and to communicate with devices on the bus. When the user Master Initializes the 2200 and wishes to determine the status of devices on the interface he should proceed in the following manner:

1. Select the 2254 by using the primary address of the board with a SELECT statement.

   ```
   :SELECT #1 04C
   ```

2. Clear any operations on the bus with an Interface Clear.

   ```
   :10 $GIO IFC #1 (4586, B$)
   ```

> NOTE:
>
> The RESET switch on the 2200 keyboard can perform Interface Clear on a 2200/2254 interface that has been wired with this feature.

3. Conduct either a Parallel Poll or a Serial Poll to determine the status of the devices.

   Example: Parallel Poll

```
:20 $GIO PARALLEL POLL #1 (4487 8601, B$)
                       :
                       :
```

   (Status codes from each device on the interface are received via DIO1 through DIO8.)

   Example: Serial Poll of devices (45) and (46)

```
:20 $GIO START SERIAL POLL #1 (443F 4418, B$)
:30 REM POLL DEVICE (45)
:40 $GIO #1 (4445 8601, B$)
:50 IF ... (check status byte here)
  .
  .
  .
:130 REM POLL DEVICE (46)
:140 $GIO #1 (4446 8601, B$)
:150 IF ... (check status byte here)
  .
  .
  .
:230 REM END SERIAL POLL
:240 $GIO POLL END #1 (4419, B$)
```

4. After the status of the devices has been received the user may choose to talk to several devices or listen to a particular device. The following examples illustrate some typical TALKER/LISTENER interactions.

Example 1: Input from a TALKER (address 43) to the 2200 system (28) using KEYIN

```
:10 SELECT #1 04C, INPUT 04D
:20 $GIO SETUP #1 (443F 4428 4443 4482 44F0, B$)
:30 KEYIN A$, 80, 80 :GOTO 30
            :
            :
:80 PRINT A$; :GOTO 30
```

Example 2: Input N readings from a TALKER (41) to the 2200 (28), using INPUT, and PRINT the readings.

```
:10  SELECT #1 04C, INPUT 001
:20  REM ASK OPERATOR FOR NUMBER OF READINGS
:30  INPUT "NO OF READINGS", N
:40  REM SELECT ADDRESS OF PRINTER
:50  SELECT PRINT 215
:60  $GIO SETUP #1 (443F 4428 4441, B$)
:65  SELECT INPUT 04C
```

```
:70  FOR J=I TO N
:80  INPUT X
:90  PRINT "READING #", "VOLTAGE"
:100 PRINT J, X
:110 NEXT J
:120 $GIO IF #1 (4486, B$)
```

Example 3: Output to a LISTENER (25) from the 2200 system (48) using PRINT

```
:10  SELECT #1 04C, PRINT 04C, INPUT 001
:20  $GIO SETUP #1 (443F 4425 4448, B$)
:30  INPUT "ATTENUATION X", X
:40  IF X=999 THEN 100
:50  D=4.8 * EXP (-X)
:60  PRINT D :GOTO 30
:100 $GIO IFC #1 (4486, B$)
```

Example 4: Output to 2 LISTENERS with addresses (22) and (23) from the 2254 (47)

```
:10 SELECT #1 04C
:20 $GIO OUTPUT #1 (443F 4422 4423 4447 A000, B$) C$()
:30 $GIO GO LOCAL #1 (4401, B$)
```

Example 5: Output to 2 LISTENERS with addresses (24) and (26) from the 2254 (48)

```
:10  SELECT  PRINT 04C, INPUT 001
:20  $GIO OUTPUT 04C (443F 4424 4426 4448, B$)
:30  INPUT "RANGE", R
:40  IF R=1000 THEN 100
:50  S=1.69 * (1/R+2)
:60  PRINT S :GOTO 30
:100 REM CLEAR LISTENERS
:110 $GIO SDC /04C (4404, B$)
```

2.4 PROGRAMMING AS A NON-CONTROLLER

When the 2200/2254 Interface is wired as a Non-controller, another device (e.g., calculator) on the bus must be wired as a Controller. In this case the 2200 interacts with the interface as a TALKER or a LISTENER. In order to talk or listen, the 2200 must have been addressed by the Controller.

Example:

```
:SELECT #1 04C

:10 $GIO SRQ #1 (44A0, B$)
            :
            :
(Await Polling and respond)
```

Upon responding to the Controller with a particular talk or listen code, the 2200 is ready to be programmed as in Section 2.3.

> NOTE:
>
> As a non-controller, commands with a hex value below 90 may not be used, e.g. 4486, IFC is illegal.

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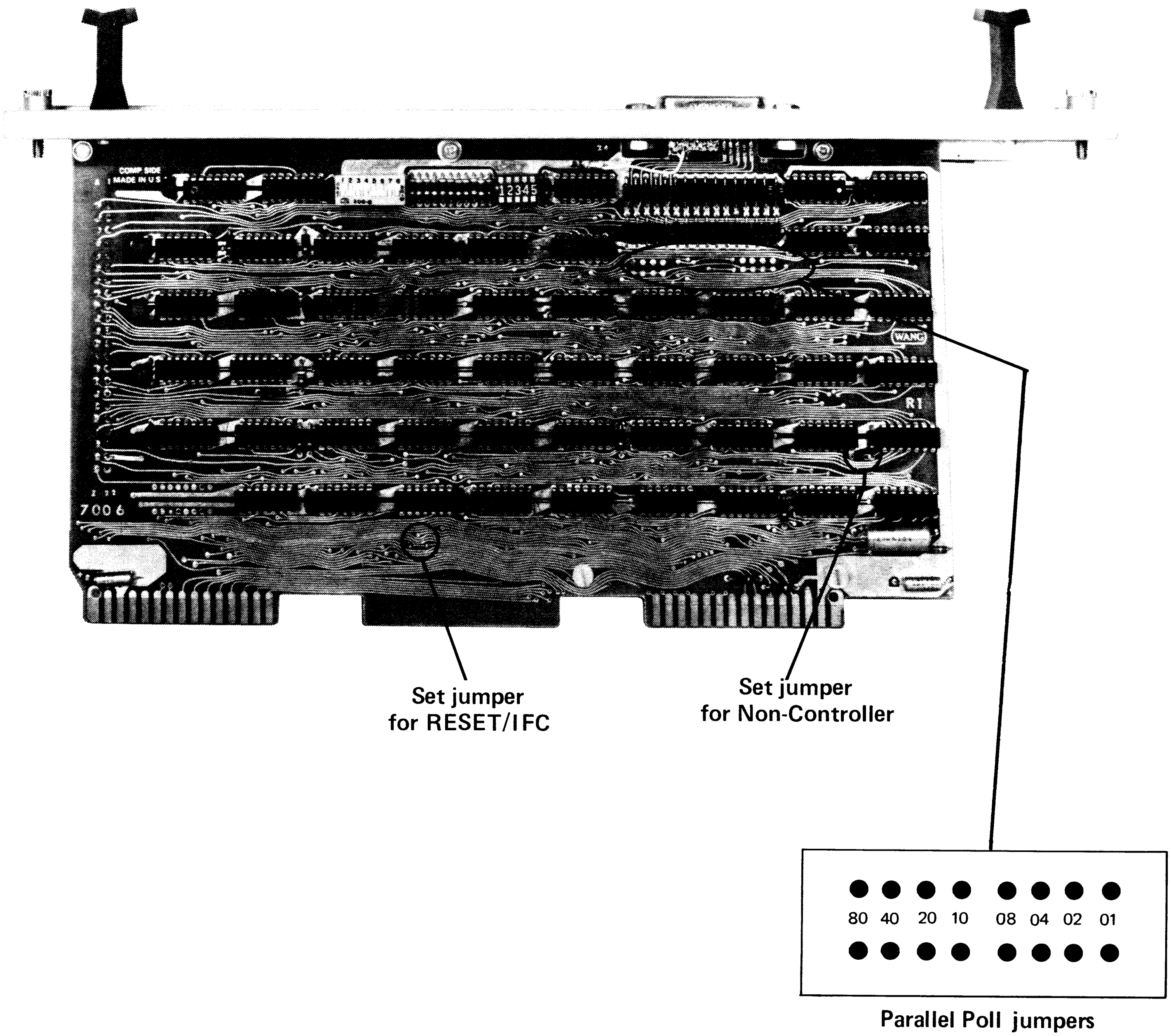
Appendix A: PC BOARD JUMPER LOCATIONS



Appendix B: SUMARY OF MICROCOMMANDS (Numerical Order)

4418 . . . . SPE - Serial Poll enable
4419 . . . . SPD - Serial Poll disable
4420-443E. . . . LAD - Enable specific listener
443F . . . . UNL - Unlisten (all devices)
4440-445E. . . . TAD - Enable specific talker
445F . . . . UNT - Untalk (all devices)
4480 . . . . Null operation
4481 . . . . Take control synchronously
4482 . . . . Turn off ATN (asynchronously)
4483 . . . . Turn on ATN (asynchronously)
4484 . . . . REN off
4485 . . . . REN on
4486 . . . . IFC
4487 8601. . . . Parallel Poll, accept poll status
4490 . . . . ▲Turn on END (EOI bit)
44A0 . . . . *Turn off SRQ
44B0 . . . . *Turn on SRQ
44C0 . . . . ▲Board Clear
44D0 8601. . . . ▲Status request, accept status
44E0 . . . . ▲buffered mode OFF
44F0 . . . . ▲buffered mode ON
4586 . . . . IFC (no wait for ready)
45D0 . . . . Status request (no wait for ready)
8601 . . . . Single character input
A000 . . . . Multi character output
C640 . . . . Multi character input

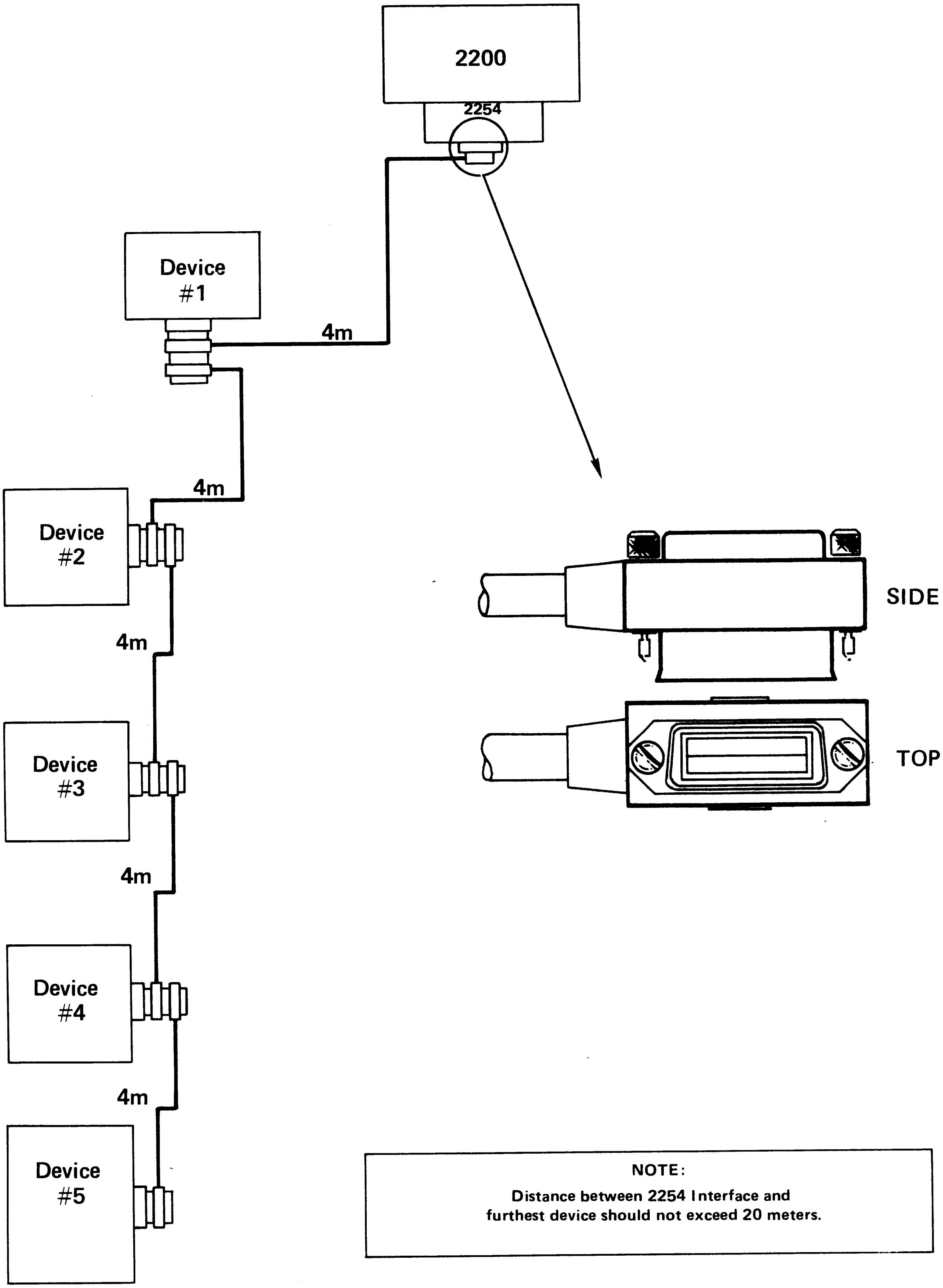
*These commands are not normally used as a controller
▲These commands used as controller or non-controller

Appendix C: SUMMARY OF MICROCOMMANDS (Alphabetical Order)

▲Board Clear	44C0
▲Buffered mode OFF	44E0
▲Buffered mode ON.	44F0
IFC	4486
IFC (no wait for ready)	4586
LAD - Enable specific listener. . . .	4420-443E
Multicharacter input.	C640
Multi-character output.	A000
Null operation.	4480
Parallel Poll, accept poll status . .	4487 8601
REN off	4484
REN on.	4485
Single character input.	8601
SPD - Serial Poll disable	4419
SPE - Serial Poll enable.	4418
▲Status request, accept status	44D0 8601
Status Request (no wait for ready). .	45D0
TAD - Enable specific talker.	4440-445E
Take control synchronously.	4481
Turn off ATN (asynchronously)	4482
*Turn off SRQ.	44A0
Turn on ATN (asynchronously).	4483
▲Turn on END (EOI bit)	4490
*Turn on SRQ	44B0
UNL - Unlisten (all devices).	443F
UNT - Untalk (all devices).	445F

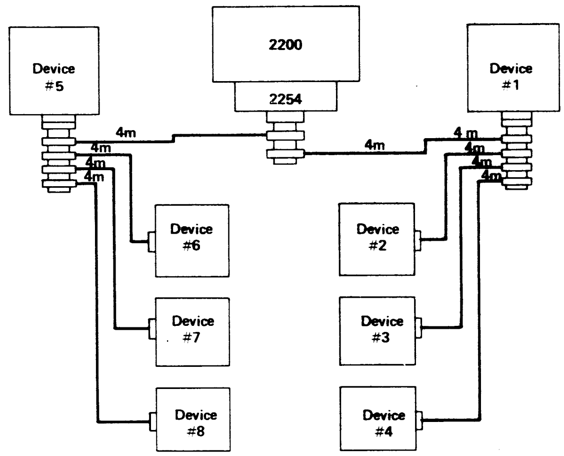
*These commands are not normally used as a controller
▲These commands used as controller or non-controller

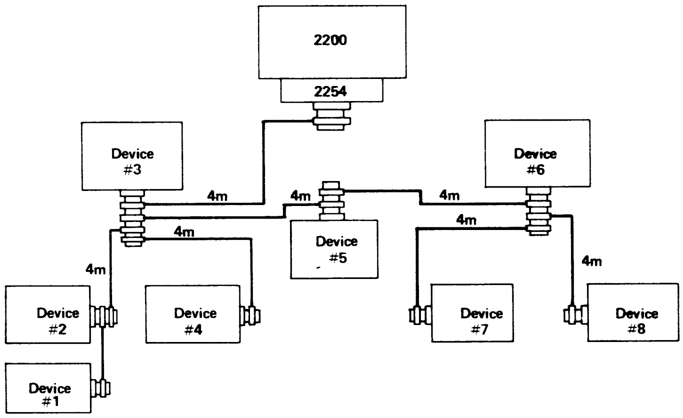
Appendix D: TYPICAL SYSTEM CONFIGURATIONS



NOTE:

Distance between 2254 Interface and furthest device should not exceed 20 meters.





Each device on the bus is assigned one or more listen and/or talk addresses. These addresses must generally be unique (i.e., two devices may not share the same address). Addresses for a listener range from HEX (20) to HEX (3E), and for a talker, from HEX (40) to HEX (5E).

Other IEEE devices use various methods to set their listen and talk addresses. They may use separate 5 bit switches, 4 bit switches, or jumpers, or they may not allow the addresses to be changed at all. Individual instruction manuals should be consulted. Frequently, an address is specified in the range of 00 to 1E. For listen devices, the actual listen address is obtained by ORing a HEX (20) with such an address. Similarly, a HEX (40) is used to generate a talk address. Some other devices use ASCII codes instead of HEX codes to specify addresses. For instance an ASCII "A" is the talk address 41.

It is recommended that stickers be affixed to each device (including the Model 2254) stating the present listen address and talk address.

Note:

The cable assembly is a standard 4 meter long IEEE cable constructed with both a plug and receptacle connector at each end of the cable. The cables are stacked plug side upon receptacle side and are secured with captive locking screws.

PREVENTIVE MAINTENANCE INFORMATION

MAINTENANCE

It is recommended that your equipment be serviced quarterly. A Maintenance Agreement is available to assure this servicing automatically. If no Maintenance Agreement is acquired, any servicing must be arranged for by the customer. A Maintenance Agreement protects your investment and offers the following benefits:

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