d. Select square wave, triangle, positive slope ramp, and negative slope ramp and verify that each function indicates the same frequency and peak-to-peak amplitude.

AMPLITUDE AND DC OFFSET

e. Set the 3325A as follows:

FUNCTION.....Square
FREQUENCY.....2 kHz
AMPLITUDE.....10 V p-p

f. Set the oscilloscope controls as follows:

Vertical.....2 V/div
Horizontal.....0.5 ms/div
Trigger.....Auto

g. Oscilloscope display should show one square wave per division, 5 divisions peak-to-peak vertical. This checks the output with no attenuation. Actual display will depend greatly upon the accuracy of the oscilloscope amplifiers and display.

h. Change 3325A amplitude to 1 V p-p, and change oscilloscope vertical to .2 V/div. Oscilloscope display should again be 5 divisions peak-to-peak. This checks the ÷ 3 attenuator section.

i. Change 3325A amplitude to 500 mV p-p, and change oscilloscope vertical to .1 V/div. Oscilloscope display should be 5 divisions peak-to-peak. This checks the ÷ 10 attenuator section.

j. Change 3325A amplitude to 50 mV p-p, and change oscilloscope vertical to .01 V/div. The square wave display should be 5 divisions peak-to-peak. This checks the ÷ 100 attenuator section.

k. Press the 3325A SQUARE WAVE FUNCTION key to remove the square wave output. The indicator in the DC OFFSET Entry key should light and the 3325A display should show 0.0 mV.

l. Set the oscilloscope vertical control to 2 V/div. Ground the input and set the trace to the center line. Set input to dc coupled.

m. Enter 5 V offset in the 3325A. The oscilloscope trace should be 2.5 divisions above the center line. Enter – 5 V offset in the 3325A. The oscilloscope trace should go to 2.5 divisions below the center line.

n. Enter Ø V offset in the 3325A. Trace should be on the center line.

FREQUENCY

o. Set the 3325A as follows:

FUNCTION.....Sine
FREQUENCY.....100 Hz
AMPLITUDE.....10 V p-p

p. Set the oscilloscope controls as follows:

Vertical.....2 V/div
Horizontal.....1 ms/div

q. Oscilloscope display should show one cycle of sine wave, which should be free of any apparent irregularities.

r. Enter 20 MHz in the 3325A. Change oscilloscope horizontal to .05 μs/div. Oscilloscope should display one cycle of sine wave per division.

HIGH VOLTAGE OUTPUT (OPTION 002)

s. Remove the 50-ohm feedthru termination between the 3325A output and the oscilloscope input. Press the key in the lower right corner of the 3325A front panel to select the High Voltage output.

t. Set the 3325A as follows:

FUNCTION.....Sine
FREQUENCY.....2 kHz
AMPLITUDE.....40 V p-p

u. Set the oscilloscope controls as follows:

Vertical.....10 V/div
Horizontal.....0.5 ms/div

v. The oscilloscope display should show a sine wave four divisions peak-to-peak, one cycle per division. This checks the high voltage output amplifier.

3-78. OPERATOR'S MAINTENANCE.

3-79. Maintenance by the operator is limited to cleaning or replacing the rear panel fan filter, or replacing the ac line fuse on the rear panel. Generally, if the ac line fuse requires replacement there is a failure within the instrument, which should be referred to qualified service personnel. Disconnect the ac line cord before replacing the fuse. Be sure to use the correct replacement fuse:

Nominal Line Voltage	Fuse	-hp- Part No.
100/120 V	1 A	2110-0001
220/240 V	0.5 A	2110-0012

3-80. The fan filter should be inspected frequently and cleaned or replaced as necessary to allow free flow of air. To remove the filter, disconnect ac power from the instrument and remove the four nuts that secure the filter retainer. Remove the filter and wash thoroughly with soapy water, rinse clean, and air dry.

3-81. HP-IB OPERATION.

3-82. The Model 3325A is remotely controlled by means of the Hewlett-Packard Interface Bus (HP-IB).

The following information gives a general description of the HP-IB and defines the terms, concepts, and messages used in an HP-IB system. It also lists the capabilities and requirements for programming the 3325A. Program examples using a specific Hewlett-Packard calculator as the system controller may be found in the Supplemental Programming Information, Appendix 3-A at the rear of this section.

NOTE

HP-IB is Hewlett-Packard Company's implementation of IEEE Standard 488-1978, "Standard Digital Interface for Programmable Instrumentation.

3-83. General HP-IB Description.

3-84. The HP-IB is a parallel bus of 16 active signal lines grouped into three sets according to function, to interconnect up to 15 instruments. Figure 3-3 is a diagram of the interface connections and bus structure.

3-85. Eight signal lines form the first set and are termed "data" lines. The data lines carry coded messages which represent addresses, program data, measurements, and status bytes. The same data lines are used for input and output messages in bit-parallel, byte-serial form. Normally, a seven-bit ASCII code represents each piece (byte) of data, leaving the eighth bit available for parity checking.

3-86. Data transfer is controlled by means of an interlocked "handshake" technique which permits data transfer (asynchronously) at the rate of the slowest device participating in that particular conversation. The three data byte transfer control lines which implement the handshake form the second set of lines.

3-87. The remaining five general interface management lines form the third set and are used in such ways as activating all the connected devices at once, clearing the interface, etc. Table 3-5 defines each of the management lines.

3-88. Definition of HP-IB Terms and Concepts.

Byte - A unit of information consisting of eight binary digits (bits).

Device - Any unit that is compatible with the IEEE Standard 488-1978.

Device Dependent - 1. An action a device performs in response to information sent on the HP-IB. The action is characteristic of an individual device and may vary from device to device. 2. The data required to communicate with a particular device.

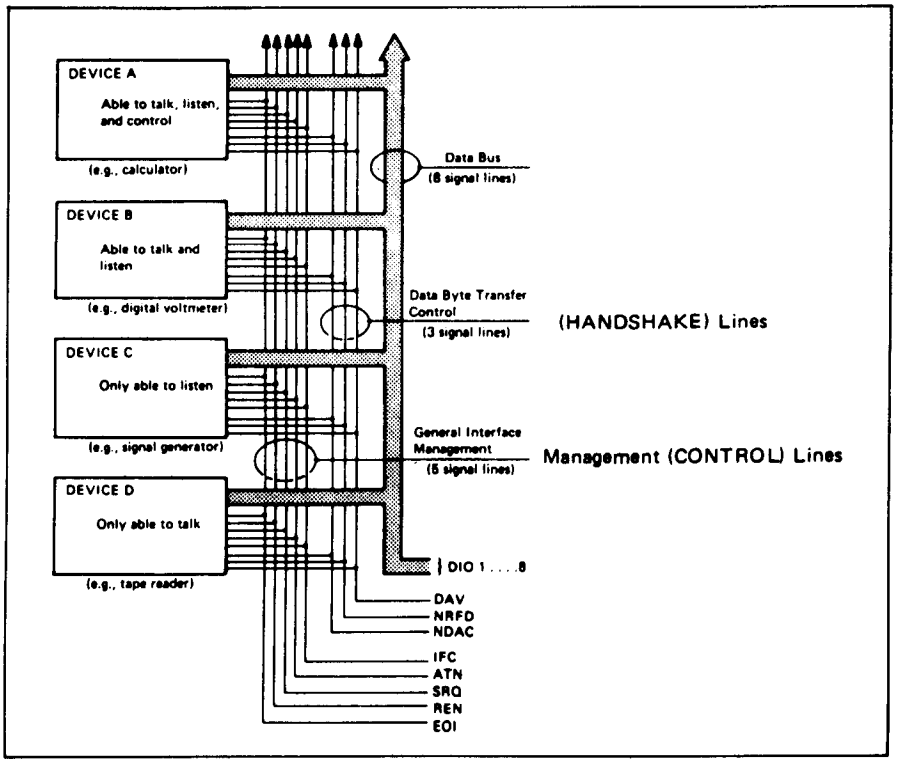


Figure 3-3. Interface Connections and Bus Structure.

Table 3-5. General Interface Management Lines.

Name	Mnemonic	Description
Attention	ATN	Enables a device to interpret data on the bus as a controller command (command mode) or data transfer (Data Mode).
Interface Clear	IFC	Initializes the HP-IB system to an idle state (no activity on the bus.)
Service Request	SRQ	Alerts the controller to a need for communication.
Remote Enable	REN	Places instruments under remote program control.
End Or Identify	EOI	Indicates last data transmission during a data transfer sequence; used with ATN to poll devices for their status.

Operator - The person that operates either the system or any device in the system.

Address - The characters sent by a controller to specify which device will send information on the bus and which device(s) will receive information. A device may also have its address fixed so that it may only receive information (listen only) or only send information (talk only).

Polling - Polling is a means by which a controller can identify a device that needs interaction with it. The controller may poll devices for their operational condition one at a time, which is termed a serial poll, or as groups of devices simultaneously, which is termed a parallel poll.

3-89. Basic Device Communication Capability.

3-90. Devices which communicate along the interface bus fall into three basic categories.

Talkers - Devices which send information on the bus when they have been addressed.

Listeners - Devices which receive information sent on the bus when they have been addressed.

Controllers - Devices that can specify the talker and listener(s) for an information transfer. The controller can be an active controller or a system controller. The active controller is defined as the current controlling device on the bus. The system controller can take control of the bus even if it is not the active controller. Each system can have only one system controller, even if several controllers have system control capability.

3-91. Message Definitions.

3-92. Information is transferred on the HP-IB from one device to one or more other devices in quantities called "messages". Some of the messages consist of two basic parts, the address portion and the information portion. Others are general messages to all devices. Messages can be classified into twelve types, which are referred to as "meta messages". These are defined in Table 3-6. A block diagram presentation of meta messages and their implementation will be found in Appendix A-3 at the rear of this section.

NOTE

The meta message in itself is not a program code or an HP-IB command. It is only intended as a tool to translate a program written as an algorithm into the controller's code.

3-93. 3325A Response to Messages.

3-94. The 3325A is capable of implementing only those messages indicated in Table 3-7. In order for those messages to be implemented, certain bus actions are required, which are shown in the Interface Functions column.

3-95. HP-IB Work Sheet.

3-96. A work sheet is provided at the end of this section for listing the address and message capabilities of each instrument in your HP-IB system. When this sheet is filled out, it will provide a summary of the system capabilities.

3-97. HP-IB Addressing.

3-98. Certain messages require that a specific talker and listener be designated. Each instrument on the bus has its own distinctive listen and/or talk address which distinguishes it from other devices. The 3325A receives programming instructions when addressed to listen. When addressed to talk, it will respond to the instructions it received prior to being addressed to talk, such as an interrogation or serial poll.

3-99. Addressing usually takes the form of "universal unlisten, device talk, device(s) listen". The universal unlisten command removes all listeners from the bus, allowing only the listener(s) designated by the device(s) listen parameter to receive information. The information is sent by the talker designated by the device talk parameter. The system controller may designate itself as either talker or listener.

3-100. 3325A REMOTE PROGRAMMING.

3-101. 3325A HP-IB Capabilities.

3-102. Table 3-8 lists the HP-IB capabilities of the 3325A, which are compatible with IEEE Standard 488-1978.

Table 3-6. Definition of Meta Messages.

Message	Definition
Data	The actual information (binary bytes) which is sent from a talker to one or more listeners. The information or data can be in a numeric form or a string of characters.
Trigger	The trigger message causes the listening device(s) to perform a device-dependent action.
Clear	A clear message will cause a device(s) to return to a predefined device-dependent state.
Remote	The remote message causes the listening device(s) to switch from local front panel control, to remote program control. This message remains in effect so that devices subsequently addressed to listen will go into remote operation.
Local	This message clears the remote message from the listening device(s) and returns the device(s) to local front panel control.
Local Lockout	The local lockout message is implemented to prevent the device operator from manually inhibiting remote program control.
Clear Lockout and Set Local	This message causes all devices to be removed from the local lockout mode and revert to local. It will also clear the remote message for all devices.
Require Service	A device can send this message at any time to signify that it needs some type of interaction with the controller. The message is cleared by the device's status byte message if it no longer requires service.
Status Byte	A byte that represents the status of a single device. One bit indicates whether the device sent the required service message and the remaining 7 bits indicate operational conditions defined by the device. This byte is sent from the talking device in response to a "Serial Poll" operation performed by a controller.
Status Bit	A byte that represents the operational conditions of a group of devices on the bus. Each device responds on a particular bit of the byte thus identifying a device dependent condition. This bit is typically sent by devices in response to a parallel poll operation. The status bit message can also be used by a controller to specify the particular bit and logic level that a device will respond with when a parallel poll operation is performed. Thus, more than one device may respond on the same bit.
Pass Control	This message transfers the bus management responsibilities from the active controller to another controller.
Abort	The system controller sends the abort message to unconditionally assume control of the bus from the active controller. The message will terminate all bus communications but does not implement the clear message.

3-103. Developing an HP-IB Program.

3-104. Basically, the 3325A is programmed remotely in the same manner as it is programmed manually. The sequence in which the various parameters are programmed is not important. At the end of this section (III) there is a summary of the HP-IB Programming Codes. This chart may be removed from the manual and/or copied to be used as a programming reference.

NOTE

It may be necessary to refer to some paragraphs on manual operation for descriptions of certain signals and requirements.

3-105. Several steps are needed to develop an HP-IB program.

a. Completely define the operation(s) the system is required to perform.

b. Write the program in flowchart or algorithm form. (An algorithm may be defined as a fixed step-by-step procedure for finding a solution to a problem.) Use the key words for meta messages shown in Table 3-6 in developing the program. The twelve key words are repeated here for reference.

Data
*Trigger
Clear
Remote
Local
Local Lockout
Clear Lockout and Set Local
Require Service

Table 3-7. 3325A Implementation of Messages.

Message	Implementation*	Interface Functions** Sender	Interface Functions** Receiver	3325A Response
Data	SR	T, SH	L^n, AH	Will send or receive as instructed
Trigger	NA	T, SH	L^n, AH	None
Clear-ID	R	C, SH	DC^n, L, AH	Device Clear sets 3325A to initial turn-on conditions. See Para. 3-8.
Clear-All	R	C, SH	DC^h, AH	
Remote	R	C_s, SH	RL^n, L, AH RL, AH	Goes to Remote. Can be set to Local by LOCAL key.
Local	R	C_s, SH	RL^n, L, AH	Goes to Local.
Local Lockout	R	C, SH	RL, AH	Goes to Remote. Cannot be set to Local by LOCAL key.
Clear Lockout and Set Local	R	C_s	RL	Goes to Local from Local Lockout.
Require Service	S	SR^n	C	Sets SRQ True.
Status Byte	S	SR^n, T, SH	L^n, AH	Sends byte which indicates if service required and reason.
Status Bit	NA	pp^h	C	None
Pass Control	NA	C_A, SH	C_B, T, AH	None
Abort	R	C_s		Unaddress

*S = Send Only
R = Receive Only
SR = Send and Receive
NA = Not Applicable

**SH = Source Handshake
AH = Acceptor Handshake
T = Talker (includes TE = Extended Talker)
L = Listener (includes LE = Extended Listener)
SR = Service Request
RL = Remote/Local
PP = Parallel Poll
DC = Device Clear
DT = Device Trigger
C = Any Controller
C_N = A specific controller (for example, C_A, C_B)
C_S = The System Controller
X^n = Indicates message can be sent to/by one or more devices simultaneously

Status Byte
*Status Bit
*Pass Control
Abort

*Not implemented by the 3325A

NOTE

The meta message in itself is not a program code or an HP-IB command. It is only intended as a tool to translate a program written as an algorithm into the controller's code.

Table 3-8. Interface Functions.

Code	Function
SH1	Source handshake capability
AH1	Acceptor handshake capability
T6	Basic talker; Serial Poll; Unaddressed to talk if addressed to listen
L3	Basic listener; Listen Only; Unaddressed to listen if addressed to talk
SR1	Service Request capability
RL1	Remote/Local capability
PP0	No parallel poll capability
DC1	Device clear capability
DT0	No device trigger capability
C0	No controller capability
E1	Open collector bus drivers

c. Define the operation in program codes that the instrument can use. Each instrument has its own set of program codes which are ASCII characters. The 3325A program codes are shown beginning with Paragraph 3-120 or Table 3-9.

d. Convert the program into the controller's language. The conversion information is supplied with each controller. For example, the -hp- 9825A Calculator Extended I/O Manual provides a chart for program code conversion.

NOTE

Examples for controlling the 3325A with a specific Hewlett-Packard calculator are provided in the Supplemental Programming Information, Appendix B-3 at the rear of this section.

3-106. Block diagrams and explanations of the meta messages that apply to the 3325A are shown in Appendix A-3 at the rear of this section.

3-107. Universal and Addressed Commands.

3-108. The 3325A will respond to the following universal and addressed commands, which are sent in the command mode (ATN true).

Mnemonic	Command	ASCII Code
Universal:		
*DCL	Device Clear	DC4
LLO	Local Lockout	DC1
MLA	My Listen Address	(selectable)
MTA	My Talk Address	(selectable)
SPD	Serial Poll Disable	EM
SPE	Serial Poll Enable	CAN
UNL	Unlisten	?
UNT	Untalk	–
Addressed:		
GTL	Go to Local	SOH
*SDC	Selected Device Clear	EOT

*DCL and SDC commands set the 3325A to its initial turn-on conditions (see Paragraph 3-8) and cause an AMPTD CAL operation. Any data in the HP-IB input buffer is lost. The storage registers, SRQ masking, and the status byte are not affected.

3-109. Placing the 3325A in Remote.

3-110. The 3325A will go to Remote when ATN is true, REN is true, and it receives its listen address.

3-111. The 3325A Address.

3-112. The 3325A address is normally set at the factory to:

	ASCII Character	5-Bit Octal	(5-Bit Octal Equivalent) Decimal	Hexadecimal
Listen	1	21	17	11
Talk	Q	21	17	11

The 3325A can be made to display its address in decimal code by pressing the blue prefix key and the BUS ADRS (LOCAL) key.

NOTES

1. All programming is shown in ASCII code.

2. Table 3-9 is a summary of the 3325A program data messages and program times. Table 3-10 lists program codes in binary, octal, decimal, and hexadecimal. At the end of this section (III) there is also a summary of the HP-IB programming codes. This chart may be removed from the manual and/or copied to be used as a programming reference.

3. The following front panel key actions cannot be remotely programmed:

Modify group
Sweep bandwidth × 2
Sweep bandwidth ÷ 2
Set sweep center frequency to marker frequency
Display bus address
Clear display

4. The 3325A must be set to REMOTE and addressed to LISTEN before it will accept device dependent data messages.

3-113. 3325A Data Message Formats.

3-114. The following are valid programming strings (data messages) for the 3325A:

Mnemonic, Data, Delimiter, EOS
Mnemonic, Data, EOS
Mnemonic, EOS
I, Mnemonic, EOS

Where I is the ASCII character I and EOS is the end-of-string character, which is required for Data Transfer Mode 2 (see following paragraphs). Valid EOS characters are:

LF = Line Feed = 12 octal
* = Asterisk = 52 octal

Table 3-9. Summary of 3325A Programming (ASCII Characters).**

Parameter or Operation	Mnemonics ASCII Code	Data	ASCII Code Delimiters	Approximate Programming Time*
Data Transfer Mode Data Mode 1 Data Mode 2	 =MD =MD	 1 2	NA	MD=4.5 ms
Function	=FU	0=DC Only 1=Sine 2=Square 3=Triangle 4=Positive Ramp 5=Negative Ramp	NA	FU=1500 ms
Frequency	=FR	≤ 11 Digits and Decimal	HZ=Hertz KH=Kilohertz MH=Megahertz	FR=7.0 ms Each digit or decimal=2.8 ms HZ, KH, or MH=12.5 ms
Amplitude	=AM	≤ 4 Digits and Decimal. Also − sign if negative dBm. + sign is valid but not required.	VO=Volts (p-p) MV=Millivolts (p-p) VR=Volts rms MR=Millivolts rms DB=dBm	AM=6.8 ms Each digit, decimal or decimal=2.8 ms VO or MV=90 ms VR or MR=130 ms DB=250 ms
DC Offset	=OF	≤ 4 Digits and Decimal. Also − sign if negative dc offset. + sign is valid but not required.	VO=Volts MV=Millivolts	OF=6.8 ms Each digit, decimal, or − sign=2.8 ms VO or MV=82 ms
Phase	=PH	≤ 4 Digits − minus sign	DE=Degrees	PH=5 ms; DE=28 ms Each digit and − sign=2.8 ms
Sweep Start Frequency Sweep Stop Frequency Sweep Marker Frequency	=ST =SP =MF	≤ 11 Digits and Decimal	HZ=Hertz KH=Kilohertz MH=Megahertz	ST, SP, or MF=7.0 ms Each digit or decimal=2.8 ms HZ, KH, or MH=10.3 ms
Sweep Time	=TI	≤ 4 Digits and Decimal	SE=Seconds	TI=5.5 ms; SE=7.0 ms Each digit and decimal=2.8 ms
Sweep Mode Linear Logarithmic	=SM	 1 2	NA	SM=4.5 ms
Rear or Front Panel Output Front Panel Rear Panel	=RF	 1 2	NA	RF=44.5 ms
Store Program Recall Program	=SR =RE	1 Digit, 0-9	NA	SR=11 ms; RE=1700 ms
Execution Functions Assign Zero Phase Perform Auto-Cal Start Single Sweep Start Continuous Sweep Perform Self-Test	 =AP =AC =SS =SC =TE	NA NA	NA NA	 AP=5.2 ms AC=1500 ms SS=300 ms SC=300 ms TE=10,000 ms
Interrogate Program Error	=IER	NA	NA	IER=11.5 ms
Interrogate Entry Parameters Frequency Amplitude Offset Phase Sweep Start Frequency Sweep Stop Frequency Sweep Marker Frequency Sweep Time	 =IFR =IAM =IOF =IPH =IST =ISP =IMF =ITI	NA	NA	 IFR=10 ms IAM=9.8 ms IOF=9.8 ms IPH=8 ms IST=10 ms ISP=10 ms IMF=10 ms ITI=8.5 ms
Interrogate Function	=IFU	NA	NA	IFU=1603 ms
Mask Service Requests	=MS	See Para. 3-144	NA	MS=4.5 ms
Binary (ON/OFF) Functions High Voltage Output Amplitude Modulation Phase Modulation	 =HV =MA =MP	 OFF=0 ON=1	NA	HV=48 ms MA=7.0 ms MP=7.0 ms

*Program times are in addition to the data transfer time of 225 to 250 μs per byte.
**See Note 2 following Paragraph 3-112.

Table 3-10. Programming Codes.

Instruction	ASCII Characters	Binary Code	Octal Code	Decimal Code	Hexadecimal Code
Entry					
Frequency	F	1000110	106	70	46
	R	1010010	122	82	52
Amplitude	A	1000001	101	65	41
	M	1001101	115	77	4D
Offset	O	1001111	117	79	4F
	F	1000110	106	70	46
Phase	P	1010000	120	80	50
	H	1001000	110	72	48
Sweep					
Start Frequency	S	1010011	123	83	53
	T	1010100	124	84	54
Stop Frequency	S	1010011	123	83	53
	P	1010000	120	80	50
Marker Frequency	M	1001101	115	77	4D
	F	1000110	106	70	46
Time	T	1010100	124	84	54
	I	1001001	111	73	49
Start Continuous	S	1010011	123	83	53
	C	1000011	103	67	43
Start Single (must be sent twice)	S	1010011	123	83	53
	S	1010011	123	83	53
Sweep Mode	S	1010011	123	83	53
	M	1001101	115	77	4D
Numerical Data					
0	0	0110000	060	48	30
1	1	0110001	061	49	31
2	2	0110010	062	50	32
3	3	0110011	063	51	33
4	4	0110100	064	52	34
5	5	0110101	065	53	35
6	6	0110110	066	54	36
7	7	0110111	067	55	37
8	8	0111000	070	56	38
9	9	0111001	071	57	39
.(decimal)	.	0101110	056	46	2E
– (minus)	–	0101101	055	45	2D
Data Suffix (Delimiter)					
Hertz	H	1001000	110	72	48
	Z	1011010	132	90	5A
Kilohertz	K	1001011	113	75	4B
	H	1001000	110	72	48
Megahertz	M	1001101	115	77	4D
	H	1001000	110	72	4A
Volts (p-p or dc)	V	1010110	126	86	56
	O	1001111	117	79	4F
Millivolts (p-p or dc)	M	1001101	115	77	4D
	V	1010110	126	86	56
Volts rms	V	1010110	126	86	56
	R	1010010	122	82	52
Millivolts rms	M	1001101	115	77	4D
	R	1010010	122	82	52
dBm	D	1000100	104	68	44
	B	1000010	102	66	42
Degrees	D	1000100	104	68	44
	E	1000101	105	69	45
Seconds	S	1010011	123	83	53
	E	1000101	105	69	45
Store	S	1010011	123	83	53
	R	1010010	122	82	52
Recall	R	1010010	122	82	52
	E	1000101	105	69	45

Table 3-10. Programming Codes (Cont'd).

Instruction	ASCII Characters	Binary Code	Octal Code	Decimal Code	Hexadecimal Code
High Voltage Output	H	1 0 0 1 0 0 0	110	72	48
	V	1 0 1 0 1 1 0	126	86	56
Modulation-Amplitude	M	1 0 0 1 1 0 1	115	77	4D
	A	1 0 0 0 0 0 1	101	65	41
Modulation-Phase	M	1 0 0 1 1 0 1	115	77	4D
	P	1 0 1 0 0 0 0	120	80	50
Rear or Front Output	R	1 0 1 0 0 1 0	122	82	52
	F	1 0 0 0 1 1 0	106	70	46
Data Transfer Mode	M	1 0 0 1 1 0 1	115	77	4D
	D	1 0 0 0 1 0 0	104	68	44
Assign Zero Phase Reference	A	1 0 0 0 0 0 1	101	65	41
	P	1 0 1 0 0 0 0	120	80	50
Perform Auto Cal.	A	1 0 0 0 0 0 1	101	65	41
	C	1 0 0 0 0 1 1	103	67	43
Perform Self Test	T	1 0 1 0 1 0 0	124	84	54
	E	1 0 0 0 1 0 1	105	69	45
Mask SRQ	M	1 0 0 1 1 0 1	115	77	4D
	S	1 0 1 0 0 1 1	123	83	53
Interrogate (Parameter)	I	1 0 0 1 0 0 1	111	73	49
Interrogate Error	I	1 0 0 1 0 0 1	111	73	49
	E	1 0 0 0 1 0 1	105	69	45
	R	1 0 1 0 0 1 0	122	82	52
EOS (End of String)					
Line Feed	LF	0 0 0 1 0 1 0	12	10	A
Asterisk	*	0 1 0 1 0 1 0	52	42	2A

All spaces (40 octal), carriage returns (15 octal), commas (54 octal), and all lower case alphabetics are ignored by the 3325A.

NOTE

A program string may program one parameter or all parameters. For example, the string "FU2FR10KHAM3V0" programs the following:

FU2 = Square wave function
FR10KH = 10 kHz
AM3V0 = 3 V p-p

The EOS character should follow the complete string, or a maximum of 48 characters (see Paragraphs 3-115 through 3-118).

3-115. Data Transfer Mode.

3-116. The 3325A accepts data from the HP-IB in either of two modes. If speed of communication is a critical factor on your HP-IB system, Mode 2 is preferrable. The characteristics of the two modes are:

Data Mode 1. The 3325A turns on in Data Mode 1. In this mode, each device dependent character (byte) is processed when received. Line feeds and Asterisks (EOS characters) are ignored. No other device dependent data communications are permitted on the bus until the entire 3325A program string has been accepted and all but the last character processed.

Data Mode 2. Device dependent characters are accepted and stored in an internal buffer and not processed until the EOS character is received or the buffer is filled (48 bytes). Consequently, other communications on the bus are permitted after the program string has been accepted (at the rate of approximately 150 to 200 microseconds per character). If the program string contains 48 characters or more, the 3325A will hold up the bus while it processes the 48 characters before accepting and storing the rest of the string. Because the instrument turns on in Data Mode 1, Mode 2 must be programmed remotely. It will then remain in Mode 2 until Mode 1 is programmed or until the POWER switch is set to STBY.

3-117. While the 3325A is processing data it will accept and respond to universal commands. For this reason, when operating in Mode 2, the controller can send a program string (48 characters or less) to the 3325A, and

while this data is being processed the controller can unaddress the 3325A to listen and then communicate with another device. However, if the string is more than 48 characters, the bus will be held up until the first 48 characters have been processed and the remaining characters accepted. In order for the bus to be used during 3325A processing time for communication between other devices, a program string greater than 48 characters should be divided and an EOS character sent after (or at a convenient place before) the 48th byte. The remaining program can then constitute a second string. While the 3325A is processing input information, a "Busy" flag is set in the status byte (see Paragraph 3-136). This flag can be used to determine when the 3325A has finished processing.

NOTE

The 3325A will handshake bus communications even though the POWER switch is set to STBY. This will not interfere with the operation of the bus unless it was set to STBY while addressed to talk. Before it is set to STBY, make sure it is not addressed to talk, or else disconnect the HP-IB cable from the 3325A. The addressed to talk condition can be cleared by an IFC command, even when the 3325A is in Standby.

3-118. Programming Data Transfer Mode.

3-119. Instructions for programming Data Transfer Mode are included in Paragraph 3-126.

3-120. Programming Entry Parameters.

3-121. The 3325A entry parameters are:

Frequency
Amplitude
Offset
Phase
Sweep Start Frequency
Sweep Stop Frequency
Sweep Marker Frequency
Sweep Time

The programming syntax for these parameters is:

Mnemonic, Data, Delimiter, EOS

NOTE

All program codes are shown in ASCII characters.

Valid mnemonics:

FR = Frequency
AM = Amplitude
OF = Offset
PH = Phase
ST = Sweep Start Frequency
SP = Sweep Stop Frequency
MF = Sweep Marker Frequency
TI = Sweep Time

Valid data:

0 thru 9 = ASCII numerics (if too many digits are sent, the extra digits will be ignored or rounded)

\+ = ASCII plus sign (plus sign is accepted but not required)

– = ASCII minus sign (minus sign will be ignored if sent for parameters that cannot be negative)

. = ASCII decimal (floating decimal entries not valid)

Valid delimiters:

HZ = Hertz
KH = Kilohertz
MH = Megahertz
VO = Volts (peak-to-peak or dc)
MV = Millivolts (peak-to-peak or dc)
VR = Volts rms
MR = Millivolts rms
DB = dBm
DE = Degrees
SE = Seconds

NOTE

When operating in Data Mode 1, an EOS character is not required. When in Mode 2, the EOS character should not be sent until the end of the program string (or after 48 bytes; see Paragraph 3-117).

3-122. Programming Waveform Function.

3-123. The selectable functions are:

DC only
Sine wave
Square wave
Triangle wave
Positive Slope Ramp
Negative Slope Ramp

The programming syntax for selecting function is:

Mnemonic, Data, EOS

Valid mnemonic:

FU = Function

Valid data:

Ø = Function off (dc only)
1 = Sine
2 = Square
3 = Triangle
4 = Positive Slope Ramp
5 = Negative Slope Ramp

3-124. Programming Binary (On or Off) Functions.

3-125. The programmable binary functions are:

High Voltage Output (Option 002)
Amplitude Modulation
Phase Modulation

The programming syntax for binary functions is:

Mnemonic, Data, EOS

Valid mnemonics:

HV = High Voltage Output (If the 3325A receives the HV mnemonic but does not have the high voltage option, SRQ (if enabled) and an error code will be generated. See Paragraph 3-134.)
MA = Modulation – Amplitude
MP = Modulation – Phase

Valid data:

Ø = Off
1 = On

NOTE

The rear panel signal output is inactive (no internal signal connection) if the instrument has the High Voltage Output Option 002 installed. Instructions are given in the Operating and Service Manual, Section VIII, Service Group M, for activating the rear panel signal output in one of two ways: 1) Placing the standard/high voltage output on the rear panel only, disconnecting the front panel signal output, or 2) Disabling the high voltage output and enabling the standard front/rear output configuration.

3-126. Programming Selection Functions.

NOTE

The selection functions are similar to binary functions, but instead of ON or OFF states, selection is made between two mutually exclusive operations.

3-127. The programmable selection functions are:

Rear Output/Front Output
Linear Sweep/Logarithmic Sweep
Data Transfer Mode

The programming syntax for the selection functions is:

Mnemonic, Data, EOS

Valid mnemonics:

RF = Rear or Front Output
SM = Sweep Mode
MD = Data Transfer Mode

Valid data for RF is:

1 = Select Rear Output

2 = Select Front Output (If the 3325A receives the RF mnemonic but does not have rear output capability (Option 002, for example) SRQ (if enabled) and an error code will be generated. See Paragraph 3-134.)

Valid data for SM is:

1 = Linear Sweep (The 3325A turns on in Linear Sweep function. This function need not be programmed except to change from Linear to Log Sweep or to return to Linear.)

2 = Logarithmic Sweep

Valid data for MD is:

1 = Data Mode 1 (The 3325A turns on in Data Mode 1. This function need not be programmed if it is desired to remain in Data Mode 1.)
2 = Data Mode 2

3-128. Programming Execution Functions.

3-129. The programmable execution functions are:

Assign Zero Phase Reference
Perform Amplitude Calibration
Start Single Sweep
Start Continuous Sweep
Perform Self Test

The programming syntax for execution functions is:

Mnemonic, EOS

Valid mnemonics:

AP = Assign Zero Phase Reference
AC = Perform Amplitude Calibration
SS = Start Single Sweep

SC = Start Continuous Sweep
TE = Perform Self Test

NOTES

1. The Start Single mnemonic must be sent twice (SSSS). The first SS sets the output (and display) to the start frequency, and the second SS starts the sweep.

2. While the 3325A is in Continuous Sweep mode, if it receives the mnemonics SC, SS, FR, PH, AC, AP, or TE, it will stop sweeping. It must receive SC again in order to resume continuous sweeping; or if a single sweep is to be programmed, SSSS is required.

3. The "Busy" flag (bit 7 in the status byte, see Paragraph 3-138) will be "1" for the duration of a Self Test operation. After Self Test, the 3325A returns to the previously programmed conditions, except that if a sweep was in progress the sweep will remain stopped.

3-130. Programming Amplitude Units Conversion.

3-131. The programming syntax for converting amplitude units (Vp-p, Vrms, dBm) is:

Mnemonic, Delimiter, EOS

Mnemonic = AM = Amplitude

Delimiter = The units to which you want to convert:

VO = Vp-p
MV = mVp-p
VR = Vrms
MR = mVrms
DB = dBm

Example: If amplitude was programmed in Vp-p, it may be converted to dBm by programming "AMDB". If amplitude was the last parameter programmed and is shown in the display, only the delimiter "DB" needs to be programmed.

3-132. Programming Storage Registers.

3-133. The data that will be stored includes the current program of Entry Parameters, Function (Waveform), Binary Functions, and Selection Functions. The storage register functions are:

Store Data in Register N
Recall Data from Register N

The programming syntax for storage register functions is:

Mnemonic, Data, EOS

Valid mnemonics:

SR = Store
RE = Recall

Valid data:

Ø thru 9 = ASCII numerics specifying register number

NOTES

1. If no data has been stored in a register, the recall command for that register will be ignored.

2. An amplitude calibration is performed when a register is recalled.

3. The numeric value for the phase is stored, but the phase of the output is not changed when the register is recalled. (Phase may need to be reprogrammed.)

4. DCL (Device Clear) and SDC (Selected Device Clear) commands do not affect the storage registers.

3-134. Service Requests.

3-135. The 3325A will set the SRQ line true for any of the following reasons, if enabled by the SRQ mask (see Paragraph 3-144):

Program String Error
Sweep Started or Sweep Stopped
System Failure (Possible component problem)
  Failed Self Test
  Failed Amplitude Calibration
  External Reference Unlocked
  Main Oscillator Unlocked

3-136. Serial Poll.

3-137. When the system controller determines that the SRQ line is true, it may conduct either a Serial Poll or a Parallel Poll to determine which device(s) initiated the Service Request, and the reason(s) for the request. The 3325A responds to a Serial Poll, which is conducted in the following manner:

Controller places ATN true (command mode)
Controller sends Serial Poll Enable (SPE) on lines DIO1-8 (ASCII CAN, binary code ×0011000)

Controller sends 3325A Talk address, controller Listen address
Controller places ATN false (data mode)
3325A responds by sending status byte on DIO1-8
Controller places ATN true (after each device has been polled)
Controller sends Serial Poll Disable (SPD) on DIO1-8 (ASCII EM, binary code ×0011001)

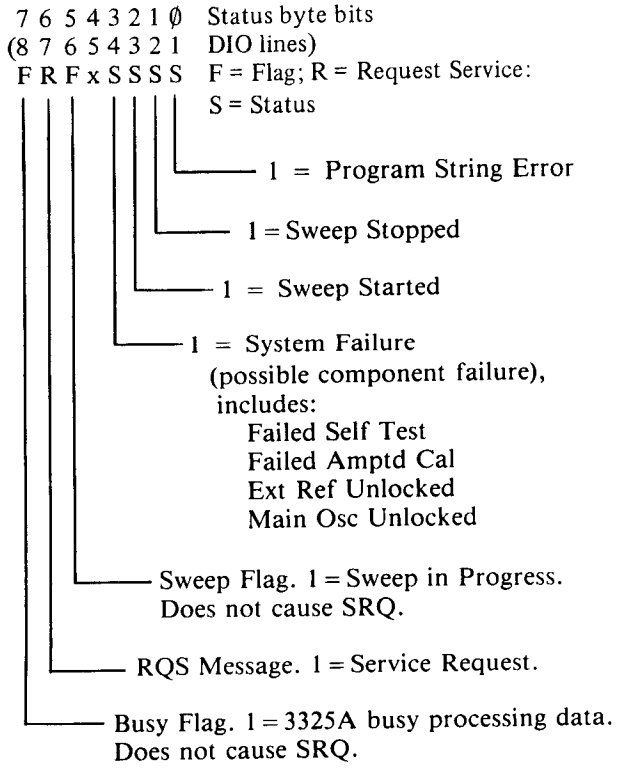
Serial Poll Disable clears the SRQ message originated by the 3325A, resetting bits Ø through 3 and bit 6 in the status byte.

NOTE

Some of the above Serial Poll operations are performed automatically by some controllers in response to certain programming statements. Refer to the programming instructions for your particular controller.

3-138. Status Byte.

3-139. A status byte consists of one 8-bit byte on the HP-IB data lines. A "1" in bit 6 indicates that the 3325A did request service (placed SRQ true), and a "Ø" in bit 6 indicates that it did not request service. The 3325A status byte contains the following information:



3-140. Busy Flag.

3-141. The Busy Flag (status byte bit 7) is high (1) while the 3325A is processing data. This bit can be monitored by the controller to determine when the 3325A is ready for more data.

3-142. Sweep Flag.

3-143. The Sweep Flag (bit 5 of the status byte) is high (1) while the 3325A is in the process of sweeping. This bit can be monitored by the controller to determine when the end of a sweep occurs.

3-144. Masking or Enabling Service Requests.

3-145. Bits 3 through Ø in the status byte can be masked so that the corresponding conditions will not cause a service request. However, a "1" will still appear in the status byte if the condition exists, and can be cleared only by a serial poll. At instrument turn-on all SRQ conditions are masked. The programming syntax for masking and enabling SRQ conditions is:

Mnemonic, Data, EOS

Mnemonic = MS

Valid Data is shown in Table 3-11.

3-146. Interrogating Program Errors.

3-147. The "Program Error" service request may result from the following Errors:

ASCII Numeric	Error
1	Entry parameter out of bounds (for example, Freq ≥ 61 MHz)
2	Invalid delimiter
3	Frequency too large for function (for example, Function = Triangle, Freq ≥ 11 kHz)
4	Sweep time too small or too large
5	Offset incompatible with amplitude, or amplitude incompatible with offset
6	Sweep frequency too large for function; Sweep bandwidth too small; Start frequency too small (log sweep); Start frequency greater than stop frequency (log sweep)
7	Unrecognizable mnemonic received
8	Unrecognizable data character received
9	Option does not exist (High Voltage or Rear/Front)

Table 3-11. SRQ Mask/Enable Data.

ASCII Character	Bits 3 thru 0	System Fail Bit 3	Sweep Start Bit 2	Sweep Stop Bit 1	Program Error Bit 0
@	*0000	Mask	Mask	Mask	Mask
A	0001	Mask	Mask	Mask	Enable
B	0010	Mask	Mask	Enable	Mask
C	0011	Mask	Mask	Enable	Enable
D	0100	Mask	Enable	Mask	Mask
E	0101	Mask	Enable	Mask	Enable
F	0110	Mask	Enable	Enable	Mask
G	0111	Mask	Enable	Enable	Enable
H	1000	Enable	Mask	Mask	Mask
I	1001	Enable	Mask	Mask	Enable
J	1010	Enable	Mask	Enable	Mask
K	1011	Enable	Mask	Enable	Enable
L	1100	Enable	Enable	Mask	Mask
M	1101	Enable	Enable	Mask	Enable
N	1110	Enable	Enable	Enable	Mask
O	1111	Enable	Enable	Enable	Enable

*Initial turn-on conditions

The programming syntax for interrogating error is:

Mnemonic, EOS

Mnemonic = IER

After receiving IER, the 3325A will send back the following the next time it is addressed to talk:

Mnemonic, Data, CR (ASCII carriage return), LF & EOI (ASCII line feed with EOI sent simultaneously)

Mnemonic = ER

Data = The ASCII numeric corresponding to the first error that occurred (see list above).

If no error occurred, the code returned is Ø. When more than one error has occurred, only the code for the first error will be returned. After interrogation, the error code is set to zero until the next error occurs.

3-148. Interrogating Entry Parameters.

3-149. Each entry parameter can be interrogated by the controller to determine its value. The programming syntax for interrogating entry parameters is:

I, Mnemonic, EOI

I = the ASCII character I and indicates interrogation desired.

Valid mnemonics (parameter to be interrogated):

FR = Frequency
AM = Amplitude
OF = Offset
PH = Phase
ST = Sweep Start Frequency
SP = Sweep Stop Frequency
MF = Sweep Marker Frequency
TI = Sweep Time

After receiving a parameter interrogation, the 3325A will send back the following the next time it is addressed to talk:

Mnemonic, Data, Delimiter, CR (ASCII Carriage Return), LF & EOI (ASCII Line Feed with EOI sent simultaneously)

Mnemonic = The mnemonic of the parameter being interrogated

Data = 11 digits of ASCII numerics equal to the value of the specified parameter plus decimal point. If the value is negative, the first digit is a minus sign.

Delimiter = The data suffix mnemonic denoting the parameter value (see Paragraph 3-120)

NOTE

Only one parameter can be interrogated by each interrogation message.

3-150. Interrogating Function (Waveform).

3-151. The 3325A may be interrogated by the controller to determine the current function programmed. The programming syntax for interrogating function is:

I, Mnemonic, EOS

I = The ASCII character I and indicates interrogation desired

Mnemonic = FU = Function

After receiving IFU, the 3325A will send back the following the next time it is addressed to talk:

Mnemonic, Data, CR (ASCII Carriage Return), LF & EOI (ASCII Line Feed with EOI sent simultaneously)

Mnemonic = FU

Data = One ASCII numeric indicating function as follows:

Ø = DC Only (Offset)
1 = Sine
2 = Square
3 = Triangle
4 = Positive Slope Ramp
5 = Negative Slope Ramp

3-152. Interrogating Miscellaneous Parameters.

3-153. The other parameters shown below can be interrogated by the controller to determine their present state. The programming syntax is:

I, Mnemonic, EOS

I = The ASCII character I and indicates interrogation desired

Valid Mnemonics (parameter to be interrogated):

SM = Sweep Mode
RF = Rear or Front Output*
HV = High Voltage Output*
MA = Amplitude Modulation
MP = Phase Modulation

*Rear/Front output and High Voltage Output (Option 002) are mutually exclusive. If either RF or HV is interrogated, the mnemonic and data returned will indicate the actual capability of the instrument and its state. For example, if the High Voltage option is present and OFF, HVØ will be returned in response to either IRF or IHV.

After receiving an interrogation, the 3325A will send back the following the next time it is addressed to talk:

Mnemonic, Data, CR (ASCII Carriage Return), LF & EOI (ASCII Line Feed with EOI sent simultaneously)

Mnemonic = The mnemonic of the parameter being interrogated

Data = 1 ASCII digit specifying the state of the parameter. This is the same digit that would be used to program the parameter to that state.

3-154. Using the Interrogate Capability.

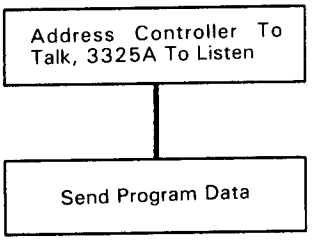
3-155. When the 3325A is changed from local to remote operation or vice versa, it retains its currently programmed state until this program is changed by the operator or controller. This feature can be useful in setting up a program string for HP-IB programming. For example, using the 3325A in local, the operator can determine experimentally the parameters required to perform the operation or test desired. Then the 3325A can be placed in remote and its function and entry parameters interrogated. Each item can be stored by the controller and then combined to form the 3325A program string to be incorporated into the total HP-IB program.

3-156. 3325A Programming Procedure.

3-157. The following examples are given to illustrate the basic procedure for developing a program. Program examples are shown in Appendix B-3, using the -hp- Model 9825A Calculator as the system controller. Appendix A-3 diagrams the required messages.

Example 1:
Address controller to talk, 3325A to listen

Send Program Data



Example 2:
Address controller to talk, 3325A to listen

Send Program Data

Check for Require Service message

If yes, determine reason from 3325A Status Byte

Take corrective action if necessary