Errata

Document Title:

Part Number:

Revision Date:

HP References in this Application Note

This application note may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this application note copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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Agilent Technologies

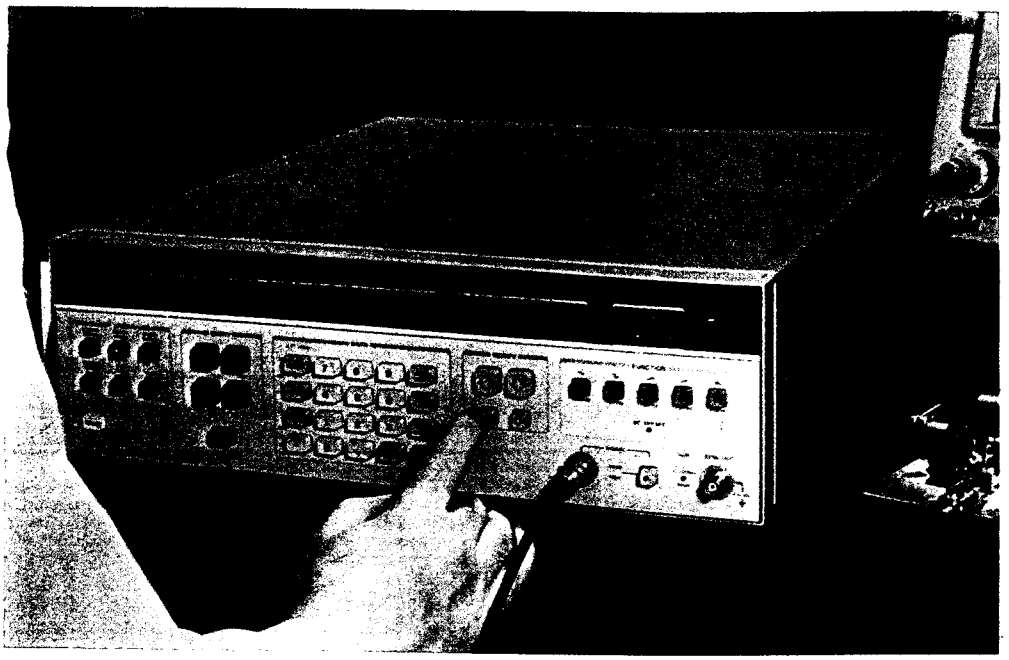
HP 3325A Synthesizer/ Function Generator

HP-IB

HP 1000 Computer

Programming Guide

Application Note 401-13



Device Introduction

The HP 3325A Synthesizer/Function Generator[1] produces the following signals from a minimum frequency of 1 μHz to a maximum frequency of:

Sine wave	20 MHz
Square wave	10 MHz
Triangle	10 kHz
Positive slope ramp	10 kHz
Negative slope ramp	10 kHz

Frequencies may be selected with up to 11 digits of resolution. Output amplitude is from 1 millivolt to 10 volts peak-to-peak. The output level may also be selected or displayed in RMS volts or in dBm (50 ohms). Any function may be DC offset up to + 5 volts. An optional high voltage output produces up to 40 volts peak-to-peak given that the load is more than 500 ohms.

For all functions, frequency sweep is provided in linear or log sweep, at sweep times of 10 milliseconds to 99.99 seconds. Minimum time is 2 seconds for single sweep and 0.1 seconds for continuous sweep. Single linear sweep may be up or down, while continuous sweep is up/down/up, etc., in the linear mode and up/up, etc., in log mode.

The 3325A can be programmed remotely in the same manner as it is programmed from the front panel. All of the HP-IB messages are available except "trigger," the "status bit" (also known as parallel poll), and "pass control". The 3325A has sophisticated error checking facilities which can be combined with SRQ functions to provide powerful diagnostic analysis of on-line problems.

All applicable functions are programmable using an organized mnemonic message structure. Various 3325A modes can be programmed and tested separately in subroutines, then combined for application-specific problems.

Addressing

The 3325A is normally shipped from the factory with the TALK/LISTEN address set to 21 octal (17 decimal). Its address switches are located inside the top cover near the center of the instrument. The possible HP-IB addresses are shown in figure 13-1.

---

[1] *The 3325A Operating and Service Manual (03325-90000) and Application Note 401-1 (5953-2800) should be used in conjunction with this note.*

ASCII Characters		Address Switches (Binary Code)					Equivalent Codes (To 5-Bit Binary Switches)		
Listen Address	Talk Address	5	4	3	2	1	Octal	Decimal	Hexadecimal
SP	@	0	0	0	0	0	00	00	00
!	A	0	0	0	0	1	01	01	01
"	B	0	0	0	1	0	02	02	02
#	C	0	0	0	1	1	03	03	03
$	D	0	0	1	0	0	04	04	04
%	E	0	0	1	0	1	05	05	05
&	F	0	0	1	1	0	06	06	06
'	G	0	0	1	1	1	07	07	07
(	H	0	1	0	0	0	10	08	08
)	I	0	1	0	0	1	11	09	09
*	J	0	1	0	1	0	12	10	0A
+	K	0	1	0	1	1	13	11	0B
,	L	0	1	1	0	0	14	12	0C
-	M	0	1	1	0	1	15	13	0D
.	N	0	1	1	1	0	16	14	0E
/	O	0	1	1	1	1	17	15	0F
Ø (Factory Selected Address)	P	1	0	0	0	0	20	16	10
1	Q	1	0	0	0	1	21	17	11
2	R	1	0	0	1	0	22	18	12
3	S	1	0	0	1	1	23	19	13
4	T	1	0	1	0	0	24	20	14
5	U	1	0	1	0	1	25	21	15
6	V	1	0	1	1	0	26	22	16
7	W	1	0	1	1	1	27	23	17
8	X	1	1	0	0	0	30	24	18
9	Y	1	1	0	0	1	31	25	19
:	Z	1	1	0	1	0	32	26	1A
;	[	1	1	0	1	1	33	27	1B
<	\	1	1	1	0	0	34	28	1C
=	]	1	1	1	0	1	35	29	1D
>	~	1	1	1	1	0	36	30	1E

NOTE: The Equivalent Codes shown correspond only to the 5-bit binary switch code. These bits are the same for both listen and talk addresses, and the sixth and seventh bits determine whether the address is listen (01) or talk (10). Some controllers distinguish between listen and talk automatically, requiring only the 5-bit code equivalent to designate a device.

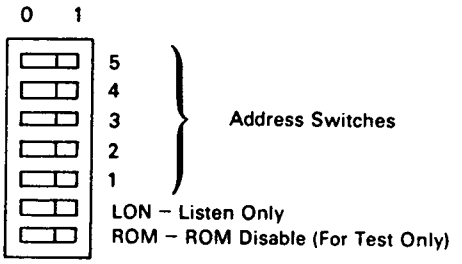


Figure 13-1. 3325A TALK/LISTEN Addresses

System Preparations

LU Assignment

One LU should be assigned to the 3325A's TALK/LISTEN address. Assuming the factory set address of 21B will be used, the File Manager command,

```
:SYLU,16,10,21B
```

will assign LU 16, mapped through EQT 10, to the 3325A.

Output Buffering

Buffering may be used on output from the HP 1000 to the 3325A once the instrument has been checked out and user software has been thoroughly verified. To unbuffer EQT 10 for hardware and software verification, a File Manager request may be used,

```
:SYEQ,10,UN
```

To buffer EQT 10,

```
:SYEQ,10,BU
```

Buffering affects all devices on the same EQT. Make sure that timing (on output from the HP 1000) will not be adversely changed for other HP-IB devices.

Time-Out

A time-out occurrence is considered to be an error condition within the 3325A. Triggering is not applicable, and the instrument does not return measurements to the computer. Time-outs may be handled by the operating system by allowing the device configuration word to default to its normal setting. The EQT time-out value may be set as short as one second, but other devices on the same bus must be considered also.

Configuration Word

DMA should not be allocated to the 3325A. The configuration word should be verified or set to reflect this condition. From File Manager,

```
:CN,16,25B,17000B
```

will set non-DMA and operating system processing of time-out errors. End-of-record processing is standard in the 3325A and will need no reconfiguration.

Remote

The 3325A must be programmed into remote before data messages will be recognized. The File Manager command,

```
:CN,16,16B
```

will set LU 16 into remote. The FORTRAN request,

```
CALL RMOTE(16)
```

will perform the same operation.

Programming

The 3325A communicates in ASCII only. Triggering and taking measurements are not applicable to the 3325A. The instrument may, however, be interrogated for internal status, so the essentials of programming are very simple.

Table 13-1 contains a list of 3325A programming commands. The documentation supplied in the 3325A Operating and Service Manual (03325-90000) is very good and should be read for instrument operation.

The 3325A recognizes programming strings (data messages) of the form shown in figure 13-2. Mnemonics, data, and delimiters are shown in their various columns in Table 13-1. EOS means "end of string" and is handled automatically by the HP 1000 as a carriage return linefeed (CRLF).

NOTE

Programming mode 2 should be used when operating the instrument with the HP 1000. The string "MD2" should be sent first.

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

Figure 13-2. 3325A Mneumonic Programming Structure

Table 13-1. 3325A Programming Commands

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 Rear Panel Front 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

*Program times are in addition to the data transfer time of 225 to 250 μs per byte.

Table 13-1. 3325A Programming Commands (Continued)

Parameter or Operation	Mnemonics ASCII Code	Data	ASCII Code Delimiters	Approximate Programming Time*
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.

The 3325A does not default to mode 2 on power up. For this reason, the instrument should be initialized programmatically before any other operations are attempted. Figure 13-3 shows an example File Manager sequence for 3325A programming.

The output waveform from the 3325A after the sequence should be a sine wave, of amplitude 10 volts, with a frequency of 1000 Hz.

Later in the "Service Requests" section, an SRQ program is introduced which analyzes errors in the 3325A. This program can be set up independently and will print error messages whenever an invalid sequence is entered from the user terminal or a user program.

Programming strings may be sent to the 3325A using FORTRAN "WRITE" statements. For example,

```
      WRITE(16,10)
   10 FORMAT("MD2FU1FR1000.0HZ")
```

will send the ASCII message "MD2FU1FR1000.0HZ" to LU 16. At completion, the 3325A should be set to Mode 2, sine wave function, and a frequency of 1000 Hz.

Figure 13-4 contains a FORTRAN program and several function subprograms which remotely program waveform type, frequency, and amplitude in the 3325A. The program uses an interesting method for sending programming strings to the 3325A. In figure 13-4, strings are concatenated and when complete information has been obtained, the entire set of programming commands is sent using a "CALL EXEC" request.

```
:LL,16 . . . . . .Output to the 3325A.
:AN,MD2. . . . . .Set Mode 2.
:AN,FU1. . . . . .Sine wave.
:AN,FR1000.0HZ . . . . . .Frequency 1000.0 hz.
:AN,AM10VO . . . . . .Amplitude 10 Volts.
:LL,0G . . . . . .Set output back to user's terminal.
```

Figure 13-3. Example File Manager Sequence

```
0001  FTN4,L
0002        PROGRAM A3325(3),02-08-79 (GWG) PROGRAM FUNCTIONS
0003        INTEGER     FUNC,YES,ISTR,FREQ,AMPL
0004        COMMON      ILU,ILST,IDLU,ISTR(8)
0005        DATA        NO/2HNO/,YES/2HYE/
0006        IF(INPRM(ID).EQ.NO)GO TO 999
0007     10 ISTRT=0
0008        WRITE(ILU,20)
0009     20 FORMAT("FINISHED? _")
0010        CALL REIO(1,ILU+400B,IANS,1)
0011        IF(IANS.EQ.YES)STOP
0012        IF(FUNC(LEN).EQ.YES) CALL ADSTR(ISTRT,LEN)
0013        IF(FREQ(LEN).EQ.YES) CALL ADSTR(ISTRT,LEN)
0014        IF(AMPL(LEN).EQ.YES) CALL ADSTR(ISTRT,LEN)
0015        CALL ADSTR(ISTRT,-1)
0016        GO TO 10
0017    999 WRITE(ILU,1000)
0018   1000 FORMAT(":RU,A3325,ILST,IDLU")
0019        END
0020  C
0021  C
0022        INTEGER FUNCTION FUNC(LNTH),02-08-79 (GWG) FUNCTION
0023        INTEGER     FTBL(2,6),DTBL(12),ISTR,YES,FVAL,FUN,FUNCT,IREG(2)
0024        EQUIVALENCE (DTBL,FTBL),(FUN,ISTR),(FVAL,ISTR(2)),
0025       &            (IA,IREG,REG),(IB,IREG(2))
0026        COMMON      ILU,ILST,IDLU,ISTR(8)
0027        DATA        DTBL/30040B,2HDC,30440B,2HSI,31040B,2HSQ,
0028       &                 31440B,2HTR,32040B,2HPS,32440B,2HNS/,
0029       &            NO/2HNO/,YES/2HYE/
0030        FUNC= YES
0031        FUN = 2HFU
0032        LNTH = 2
0033      5 WRITE(ILU,10)
0034     10 FORMAT(/"WAVEFORM FUNCTIONS. VALID ENTRIES ARE:",//,
0035       &        "   DC = FUNCTION OFF (DC ONLY)",/,
0036       &        "   SI = SINE",/,
0037       &        "   SQ = SQUARE",/,
0038       &        "   TR = TRIANGLE",/,
0039       &        "   PS = POSITIVE SLOPE RAMP",/,
0040       &        "   NS = NEGATIME SLOPE RAMP",//,
0041       &        "ENTER A FUNCTION: _")
0042        REG= EXEC(1,ILU+400B,FUNCT,1)
0043        FVAL=NO
0044        DO 20 I=1,6
0045     20 IF(FTBL(2,I).EQ.FUNCT)FVAL=FTBL(1,I)
0046        IF(FVAL.EQ.NO)FUNC=NO
0047        RETURN
0048        END
0049  C
0050  C
0051        INTEGER FUNCTION FREQ(LNTH),02-08-79 (GWG) FREQUENCY
0052  C MAY RETURN:
0053  C FREQ = YES WHEN VALUES ARE ENTERED
0054  C      = NO  WHEN NONE ENTERED OR JUST RETURN
0055  C LNTH = 0 WHEN FREQ = NO
0056  C      > 0 WHEN FREQ = YES
```

Figure 13-4. FORTRAN Program for the 3325A

```
0057  C
0058        INTEGER     HERTZ,DVAL(6),MNENM,ISTR,YES,IREG(2)
0059        EQUIVALENCE (ISTR,MNENM),(ISTR(2),DVAL),
0060       &            (IREG,IA,REG),(IREG(2),IB)
0061        COMMON      ILU,ILST,IDLU,ISTR(8)
0062        DATA NO/2HNO/,YES/2HYE/
0063        DO 20 I=1,8
0064     20 ISTR(I)=2H
0065        FREQ=NO
0066        MNENM=2HFR
0067        LNTH=0
0068        WRITE(ILU,5000)
0069   5000 FORMAT(/"FREQUENCY:"/,
0070       &        "              HZ = HERTZ"/,
0071       &        "              KH = KILOHERTZ"/,
0072       &        "              MH = MEGAHERTZ"//,
0073       &        "? _")
0074        REG= REIO(1,ILU+400B,HERTZ,1)
0075        IF(HERTZ.EQ.2HHZ.OR.
0076       &   HERTZ.EQ.2HKH.OR.
0077       &   HERTZ.EQ.2HMH) GO TO 10
0078        RETURN
0079  C
0080     10 WRITE(ILU,5020)
0081   5020 FORMAT(/"DECIMAL VALUE (12.34 for example) : _")
0082        REG= EXEC(1,ILU+400B,DVAL,6)
0083        WRITE(ILU,144)IB
0084    144 FORMAT(I6)
0085        IF(IB.EQ.6)DVAL(6)=IAND(DVAL(6),177400B)+40B
0086        IF(IB.EQ.0) RETURN
0087        LNTH=IB+2
0088        DVAL(IB+1)=HERTZ
0089        FREQ=YES
0090        CALL EXEC(2,ILU,ISTR,LNTH)
0091        RETURN
0092        END
0093  C
0094  C
0095        INTEGER FUNCTION AMPL(LNTH),02-08-79 (GWG) AMPLITUDE
0096        INTEGER     VOLTS,DVAL(2),MNENM,ISTR,YES,IREG(2)
0097        EQUIVALENCE (ISTR,MNENM),(ISTR(2),DVAL),(ISTR(4),VOLTS),
0098       &            (REG,IREG,IA),(IREG(2),IB)
0099        COMMON      ILU,ILST,IDLU,ISTR(8)
0100        DATA NO/2HNO/,YES/2HYE/
0101        DO 20 I=1,4
0102     20 ISTR(I)=2H
0103        AMPL=NO
0104        MNENM=2HAM
0105        LNTH=0
0106        WRITE(ILU,5000)
```

Figure 13-4. FORTRAN Program for the 3325A (Continued)

```
0107   5000 FORMAT(/"AMPLITUDE:"/,
0108      &        "                VO = VOLTS (p-p)"/,
0109      &        "                MV = MILLIVOLTS"/,
0110      &        "                VR = VOLTS (rms)"/,
0111      &        "                MR = MILLIVOLTS (rms)"/,
0112      &        "                DB = dBm"/,
0113      &        "? _")
0114       REG= REIO(1,ILU+400B,VOLTS,1)
0115       IF(VOLTS.EQ.2HVO.OR.
0116      &   VOLTS.EQ.2HMV.OR.
0117      &   VOLTS.EQ.2HVR.OR.
0118      &   VOLTS.EQ.2HMR.OR.
0119      &   VOLTS.EQ.2HDB)    GO TO 10
0120       RETURN
0121  C
0122     10 WRITE(ILU,5020)
0123   5020 FORMAT(/"DECIMAL VALUE (12.34 for example) : _")
0124       REG= EXEC(1,ILU+400B,DVAL,2)
0125       IF(IB.EQ.0)RETURN
0126       LNTH=IB+2
0127       DVAL(IB+2)=VOLTS
0128       AMPL=YES
0129       CALL EXEC(2,ILU,ISTR,LNTH)
0130       RETURN
0131       END
0132  C
0133  C
0134       SUBROUTINE ADSTR(INDX,LEN),02-08-79 (GWG) CONCATENATE
0135       INTEGER OSTR(24)
0136       COMMON ILU,ILST,IDLU,ISTR(8)
0137       IF(LEN.LT.0)GO TO 5
0138       IF(LEN.EQ.0)RETURN
0139       IA=0
0140       LENA=LEN
0141       DO 10 I = 1,LEN
0142       IA=IA+1
0143       IF(INDX+I.LT.24)GO TO 20
0144       CALL EXEC(2,IDLU,OSTR,24)
0145       INDX=0
0146       LENA=LEN-I+1
0147       IA=1
0148    20 OSTR(INDX+IA)=ISTR(I)
0149    10 CONTINUE
0150       INDX=INDX+LENA
0151       RETURN
0152     5 CALL EXEC(2,IDLU,OSTR,INDX)
0153       INDX=0
0154       RETURN
0155       END
0156       END$
```

Figure 13-4. FORTRAN Program for the 3325A (Continued)

Subroutines "FUNC", "FREQ", and "AMPL" request the waveform function, frequency, and amplitude, respectively, from the user at a CRT terminal. Each subroutine builds a programming string in "ISTR" (line 4). After each string of characters has been determined, the subroutine "ADSTR" is called which,

1. concatenates the last string received onto the current string "OSTR" (line 136 in subroutine "ADSTR"), or

2. sends the complete string "OSTR" to the 3325A.

A 3325A programming string can be output from subroutine "ADSTR" only when,

1. parameter "LEN" (line 134) is negative, or

2. the number of characters in "OSTR" reaches a length of 48.

In subroutine "FUNC" (lines 23 through 29 of figure 13-4), a correspondence is set up between the 3325A waveform numbers and mneumonic values for each waveform. For example,

0 = DC = DC
1 = SI = Sine
2 = SQ = Square
3 = TR = Triangle
4 = PS = Positive slope ramp
5 = NS = Negative slope ramp

Table "FTBL" creates a match for the ASCII translation of "DC" to "0", etc. If a user entered "DC" in answer to the prompt "ENTER A FUNCTION," the subroutine would create the string "FU0".

The programs and subroutines in figure 13-4 do not contain a significant amount of error checking. In fact, erroneous or unrecognizable 3325A program statements may be entered and sent to the instrument. Figure 13-4 should be used with the SRQ error processor program (figure 13-8) discussed under "Service Requests" in this section. The SRQ program will diagnose syntax errors and print the error message on the user's terminal when an input error occurs.

Status and Interrogation Features

Status may be obtained from the 3325A in two ways:

1. Serial Poll, which produces a status byte.

2. Interrogation, when the HP 1000 interrogates program errors, or entry parameters.

Artificial Status

A serial poll may be produced artificially or left to be handled automatically by the service request abilities of the HP 1000 system (discussed under "Service Request" in this section). Status can be produced artificially by calling the subroutine STATS.[2] In FORTRAN,

```
CALL STATS(IDLU,ISTAT)
```

will conduct a serial poll, obtain the instrument status byte, and return the value in ISTAT. A simple program which performs this function is shown in figure 13-5. The format of the 3325A status byte is shown in figure 13-6.

```
0001  FTN4,L
0002        PROGRAM TDYN(3),03-29-79 (GWG) DYNAMIC STATUS
0003        INTEGER DYNS,YES
0004        COMMON ILU,ILST,IDLU
0005        DATA NO/2HNO/,YES/2HYE/
0006        IF(INPRM(ID).EQ.NO) STOP          Obtain input parameters.
0007        CALL STATS(IDLU,ISTAT)            Request status.
0008        WRITE(ILU,10)ISTAT
0009     10 FORMAT(K6)
0010        END
```

Figure 13-5. Obtaining 3325A Status Manually

[2]*Subroutine "STATS" is documented in the HP-IB User's Manual (part number 59310-90064).*

Some 3325A status byte information does not cause an SRQ. "Sweep in progress" is one such example. The sweep flag can be monitored by the HP 1000 to determine when the end of a sweep occurs. The 3325A will dynamically output status while internal processing is in progress.

Interrogation

When the "program string error" occurs and is detected within the 3325A status byte, further interrogation may be performed by requesting more error information from the instrument. Table 13-2 shows the numeric values returned when the 3325A is interrogated using the mnemonic "IER" (see "Service Requests").

In figure 13-8, the subroutine PCHCK performs a WRITE request in line 63 to send the message "IER". The READ statement in line 65 with format "A2,I1" then obtains the error information from the 3325A. The remainder of subroutine PCHCK evaluates possible errors.

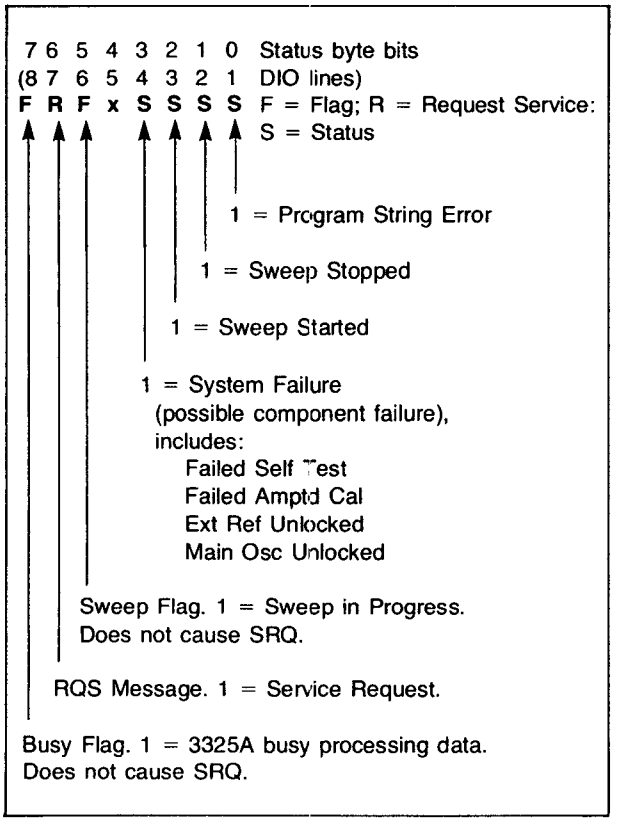


Figure 13-6. 3325A Status Byte Format

Table 13-2. 3325A Request "IER"

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); tart 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).

Subroutine STATS [3] can also be used with "S3325" (figure 13-8) to perform a complete 3325A status check.

Interrogating Past Programming Parameters

Entry parameters indicating the current frequency, amplitude, phase, etc., may also be interrogated from the 3325A. A typical FORTRAN sequence may be used. The FORTRAN example in figure 13-7 requests the current frequency setting and prints the result on the user's terminal.

Using this feature, a simple application program can be written which will actually learn various states in the 3325A. For example, a user can program the 3325A for various functions from the front panel. A user program is then executed which interrogates the instrument and saves its state in an FMP

[3] *An interesting program which performs a similar function for the 3582A Spectrum Analyzer is shown in AN 401-12 (5953-2811).*

disc file. Later this state could be restored using the subroutines documented earlier in this application note. This application may find use in test beds and assembly lines where many different devices are being tested.

The functions and programs in this section can be combined to satisfy this application.

Service Requests

The 3325A is capable of generating SRQ's for up to four conditions:

1. Program Error
2. Sweep Stop
3. Sweep Start
4. System Failure

Any combination of these may also be configured to generate the request for service (see Table 13-3).

When the 3325A is turned on, all service requests are masked out. This means that none of the above conditions will generate a service request. Different configurations can be enabled by sending the mask request "MS" and the corresponding ASCII character representing the status options desired. Table 13-3 shows the correspondence between the ASCII characters and the available mask options.

A feature known as "automatic program scheduling" may be used in the HP 1000 to process SRQ occurrences from the 3325A. When a 3325A SRQ occurs, the HP 1000 automatically does a serial poll and reads the 3325A status byte into memory. The operating system then schedules a user program previously designed and configured for processing 3325A service requests. One such program is shown in figure 13-8. This program, when scheduled, retrieves the 3325A status byte from system memory and analyzes it. Analysis is performed using subroutine "S3325" which sequentially checks each bit. When bit zero has been enabled, a programming error has occured and further 3325A interrogation is required. Subroutine "PCHCK" is then called to do the required processing.

In program C3325 (figure 13-8), the message "MS0" is sent to the 3325A in line 28. This enables the instrument to generate SRQ's for all potential service request situations.

Program C3325 is scheduled once from a user terminal to prepare the HP 1000 for further automatic SRQ program scheduling. It is during this first run sequence that the 3325A mask is enabled for all SRQ situations. Program C3325 then finishes execution, saving the values of the input terminal LU (ILU) and the 3325A LU (IDLU) on the HP 1000 mass storage system disc. (This is called "termination saving resources" by most programmers.)

```
      INTEGER IBFR(20),IREG)20
      EQUIVALENCE (IREG,REG,IA),(IREG(2),IB)
         :
         :
         :
      WRITE(IDLU,10)
   10 FORMAT ("IFR")
      REG=EXEC(I,IDLU,IBFR,20)
      CALL EXEC(2,ILU,IBFR,IB)
      NCHAR=IB2
         :
         :
         :
      END
```

Figure 13-7. Interrogating Entry Parameters in FORTRAN

Table 13-3. SRQ Mask Configurations

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 program C3325 can be used in applications when 3325A program development is being done and on-line error checking is needed. Any error messages will be printed on "ILST".

Performance

Performance data for the 3325A instrument is shown in Table 13-4.

Within the device, a quantum of time is required for each mneumonic and/or ASCII digit. Time is also required for processing the data once received. These times, when combined with setup times in the HP 1000,[4] will approximate transfer rates. The time required per byte for the 3325A should be compared to the time per byte for the HP 1000. The value which is larger should be used in the equation.

More sophisticated operations using the 3325A become very cumbersome to analyze. The performance information, equations, and programs in Chapters 4 and 5 of Application Note 401-1 (part no. 5953-2800) can be used when a detailed analysis is required.

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[4]*See Application Note 201-4, "Performance Evaluation of HP-IB Using RTE Operating Systems." Setup times and performance equations can be found in this document.*

Table 13-4. 3325A Performance Information

Function	Mnemonic	Input Data Transfer Time	Device Time	Output Data Transfer Time
Function (Waveform) 1 Digit	FU	450-500 µs 225-250 µs	1600 ms 2.8 ms	450-500 µs 225-250 µs
Frequency ≤ 11 Digits + Decimal Delimiters	FR HZ, KH, or MH	450-500 µs 225-250 µs each 450-500 µs	7.0 ms 2.8 ms each 12.5 ms	450-500 µs 225-250 µs each 450-500 µs
Amplitude ≤ 4 Digits + Decimal Delimiters	AM VO or MV VR or MR DB	450-500 µs 225-250 µs each 450-500 µs 450-500 µs 450-500 µs	6.8 ms 2.8 ms each 90 ms 130 ms 250 ms	450-500 µs 225-250 µs each 450-500 µs 450-500 µs 450-500 µs
DC Offset ≤ 4 Digits + Decimal Delimiters	OF VO or MV	450-500 µs 225-250 µs each 450-500 µs	6.8 ms 2.8 ms each 82 ms	450-500 µs 225-250 µs each 450-500 µs
Phase ≤ 4 Digits + Decimal Delimiter	PH DE	450-500 µs 225-250 µs each 450-500 µs	5 ms 2.8 ms each 28 ms	450-500 µs 225-250 µs each 450-500 µs
Sweep Start Frequency ≤ 11 Digits + Decimal Delimiters	ST HZ, KH, or MH	450-500 µs 225-250 µs each 450-500 µs	7.0 ms 2.8 ms each 10.3 ms	450-500 µs 225-250 µs each 450-500 µs
Sweep Stop Frequency ≤ 11 Digits + Decimal Delimiters	SP HZ, KH or MH	450-500 µs 225-250 µs each 450-500 µs	7.0 ms 2.8 ms each 10.3 ms	450-500 µs 225-250 µs each 450-500 µs
Sweep Marker Frequency ≤ 11 Digits + Decimal Delimiters	MF HZ, KH or MH	450-500 µs 225-250 µs each 450-500 µs	7.0 ms 2.8 ms each 10.3 ms	450-500 µs 225-250 µs each 450-500 µs
Sweep Time ≤ 4 Digits + Decimal Delimiter	T1 SE	450-500 µs 225-250 µs each 450-500 µs	5.5 ms 2.8 ms each 7.0 ms	450-500 µs 225-250 µs each 450-500 µs
Store	SR	450-500 µs	11 ms	
Recall	RE	450-500 µs	1700 ms	
Assign Zero Phase	AP	450-500 µs	5.2 ms	
Amptd Cal	AC	450-500 µs	1500 ms	
Start Single Sweep	SS	450-500 µs	300 ms	
Start Continuous Sweep	SC	450-500 µs	300 ms	
Interrogate (Add Parameter Mnemonic Time)	I	225-250 µs	3 ms	
Mask Service Request	MS	450-500 µs	4.5 ms	
High Voltage Output	HV	450-500 µs	48 ms	
Rear/Front Output	RF	450-500 µs	44.5 ms	
Self Test	TE	450-500 µs	10,000 ms	
Sweep Mode	SM	450-500 µs	4.5 ms	
Data Transfer Mode	MD	450-500 µs	4.5 ms	
Interrogate Function	IFU	675-750 µs	1603 ms	
Interrogate Error	IER	675-750 µs	11.5 ms	
Universal Commands		~225 µs per byte		
Amplitude Modulation	MA	450-500 µs	7.0 ms	
Phase Modulation	MP	450-500 µs	7.0 ms	

```
0001  FTN4,L
0002        PROGRAM C3325(3),02-08-79 (GWG) SRQ PROGRAM
0003  C
0004  C SYSTEM PREPARATIONS:
0005  C SET THE E BIT IN THE DEVICE CONFIGURATION WORD
0006  C UNBUFFER THE EQT
0007  C
0008  C THE RTE SAVE RESOURCES OPTION HAS BEEN
0009  C USED IN THIS PROGRAM. IT IS SCHEDULED
0010  C ONCE MANUALLY FOR SETUP, THEN N TIMES
0011  C BY 3325A INTERRUPTS.
0012  C
0013  C RMPAR IS CALLED N TIMES.
0014  C
0015  C
0016        INTEGER IPM(5),IPRG(4),ISTT(2)
0017        COMMON  ILU,ILST,IDLU
0018        DATA    NO/2HNO/
0019        DATA    IPRG/5,2HC3,2H32,2H5 /,LOOP/0/
0020  C
0021        IF(INPRM(ID).EQ.NO)  GO TO 999
0022        WRITE(ILU,100)IDLU
0023    100 FORMAT(" 3325A: SRQ PROGRAM SETUP",
0024       &" IN PROGRESS FOR FOR LU "I2"."/)
0025        CALL SRQ(IDLU,17)
0026        CALL SRQ(IDLU,16,IPRG)
0027        IF(IERR(NN).LT.0) GO TO 20
0028        WRITE(IDLU,5)
0029      5 FORMAT("MSO")
0030     10 CALL EXEC(6,0,1)
0031        CALL RMPAR(IPM)
0032        CALL S3325(IPM)
0033        GO TO 10
0034    999 WRITE(ILU,130)
0035    130 FORMAT(" :RU,A3325,ILST,IDLU"/)
0036        STOP
0037    20  END
0038  C
0039  C
0040        SUBROUTINE S3325(ISTAT),02-08-79 (GWG) SRQ FUNCTIONS
0041        COMMON ILU,ILST,IDLU
0042        IF(IAND(ISTAT,1).EQ.1)CALL PCHCK
0043        IF(IAND(ISTAT,2).EQ.2)WRITE(ILST,10)
0044        IF(IAND(ISTAT,4).EQ.4)WRITE(ILST,20)
0045        IF(IAND(ISTAT,8).EQ.8)WRITE(ILST,30)
0046        IF(IAND(ISTAT,32).EQ.32)WRITE(ILST,40)
0047        IF(IAND(ISTAT,128).EQ.128)WRITE(ILST,50)
0048     10 FORMAT(" 3325A SWEEP STOPPED."/)
0049     20 FORMAT(" 3325A SWEEP STARTED."/)
0050     30 FORMAT(" 3325A SYSTEM FAILURE. POSSIBILITIES INCLUDE:"/
0051       &       "      FAILED SELF TEST."/,
0052       &       "      FAILED AMPLITUDE CALIBRATE."/,
0053       &       "      EXTERNAL REFERENCE UNLOCKED."/,
0054       &       "      MAIN OSCILLATOR UNLOCKED."//)
```

Figure 13-8. SRQ Program to Diagnose Errors

```
0055      40 FORMAT(" 3325A SWEEP IN PROGRESS."/)
0056      50 FORMAT(" 3325A BUSY PROCESSING DATA."/)
0057         RETURN
0058         END
0059   C
0060   C
0061         SUBROUTINE PCHCK,02-08-79 (GWG) PROGRAM ERRORS
0062         COMMON ILU,ILST,IDLU
0063         WRITE(IDLU,10)
0064      10 FORMAT("IER")
0065         READ(IDLU,50)IEER,IVAL
0066      50 FORMAT(A2,I1)
0067         IF(IVAL.EQ.1)WRITE(ILST,1)
0068         IF(IVAL.EQ.2)WRITE(ILST,2)
0069         IF(IVAL.EQ.3)WRITE(ILST,3)
0070         IF(IVAL.EQ.4)WRITE(ILST,4)
0071         IF(IVAL.EQ.5)WRITE(ILST,5)
0072         IF(IVAL.EQ.6)WRITE(ILST,6)
0073         IF(IVAL.EQ.7)WRITE(ILST,7)
0074         IF(IVAL.EQ.8)WRITE(ILST,8)
0075         IF(IVAL.EQ.9)WRITE(ILST,9)
0076       1 FORMAT(" ENTRY PARAMETER OUT OF BOUNDS."/)
0077       2 FORMAT(" INVALID PROGRAM DELIMITER."/)
0078       3 FORMAT(" FREQUENCY TO LARGE FOR FUNCTION."/)
0079       4 FORMAT(" SWEEP TIME TOO SMALL OR TOO LARGE."/)
0080       5 FORMAT(" OFFSET INCOMPATIBLE WITH AMPLITUDE."/)
0081       6 FORMAT(" SWEEP FREQUENCY OUT OF RANGE FOR FUNCTION."/)
0082       7 FORMAT(" UNRECOGNIZABLE MNEMONIC RECEIVED."/)
0083       8 FORMAT(" UNRECOGNIZABLE DATA CHARACTER RECEIVED."/)
0084       9 FORMAT(" OPTION DOES NOT EXIST."/)
0085         RETURN
0086         END
0087   C
0088   C
0089         FUNCTION IERR(N),07-26-78 (GWG) HANDLE BUS ERRORS
0090         COMMON ILU,ILST,IDLU
0091         I=IBERR(IDLU)
0092         IERR=0
0093         IF(I.EQ.0)GO TO 10
0094         IERR=-I
0095         WRITE(ILU,30)I,IDLU
0096   30    FORMAT(" 3437A: BUS ERROR "I2" ON LU ",
0097        &I2," (HP-IB USERS GUIDE).")
0098   10    RETURN
0099         END
0100   C
0101   C
0102   C
0103         INTEGER FUNCTION INPRM(ID),11-29-78 (GWG) RUN PRM FOR HP-IB
0104         INTEGER         ISTRNG(40),OSTRNG(10),STRT
0105         COMMON          ILU,ILST,IDLU
0106   C
```

Figure 13-8. SRQ Program to Diagnose Errors (Continued)

```
0107  C 'INPRM' GETS:
0108  C
0109  C   A. THE INPUT LOGICAL UNIT (INTERACTIVE TERMINAL).
0110  C   B. THE LIST LOGICAL UNIT FROM PARAMETER ONE (IT
0111  C      SETS THE LIST LU EQUAL TO THE INPUT LU IF THE
0112  C      LIST LU IS 0).
0113  C   C. THE DEVICE LOGICAL UNIT(INPRM CHECKS TO SEE
0114  C      IF IDLU IS NON-ZERO. IF NOT INPRM IS SET TO
0115  C      '2HNO').
0116  C
0117        INPRM=2HNO
0118        ILU=LOGLU(ID)
0119        CALL GETST(ISTRNG,-80,RTNCLN)
0120        STRT=1
0121        DO 600 I=1,2
0122        IF(NAMR(OSTRNG,ISTRNG,RTNCLN,STRT))700,100
0123   100  ITYP=IAND(OSTRNG(4),3B)
0124        IF(I.EQ.1)GO TO 200
0125        IF(ITYP.NE.1) RETURN
0126        IDLU=OSTRNG
0127        GO TO 600
0128   200  ILST=OSTRNG
0129        IF(ITYP.EQ.0) ILST=ILU
0130   600  CONTINUE
0131   700  IF(IDLU.GT.0)INPRM=2HYE
0132        RETURN
0133        END
```

Figure 13-8. SRQ Program to Diagnose Errors (Continued)