

## Errata

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HP-IB Programming Guide (AN 401-17)

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# HP 8620C Sweep Oscillator

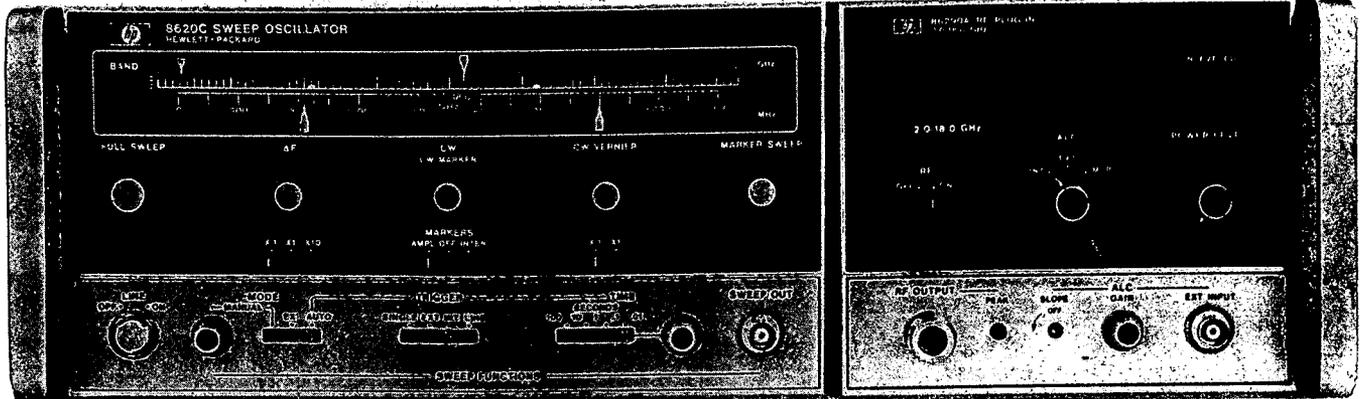


# HP 1000 Computer



## Programming Guide

Application Note 401-17



### Device Introduction

The HP 8620C Solid State Sweep Oscillator is an ideal source for characterizing devices over a wide, continuous range of frequencies. It provides high power output with solid state reliability from 10 MHz to 22 GHz.

The system consists of an HP 8620C sweep oscillator mainframe, and the choice of a single-band, multi-band, straddle-band, or broad-band plug-in.

The HP 8620C mainframe provides a CW mode and three different sweep modes: full sweep, marker sweep and CW  $\Delta F$  sweep. Full sweep selects the entire frequency range of the plug-in band to be swept. Marker sweep covers the frequency range between the start and stop markers. The CW  $\Delta F$  mode sweeps symmetrically around the CW marker with calibrated frequency widths up to 100% of the band width. In CW mode, a selectable CW vernier allows a narrow, calibrated frequency offset. The 8620C mainframe also includes controls for sweep trigger modes, sweep time, and frequency markers (amplitude or intensity).

The plug-in modules are numbered with an 86200 series number. Each plug-in is distinguishable by its frequency range, output power, and frequency performance (harmonics, accuracy, etc). The broadband 86290A/B plug-ins cover their frequency range in one band. Each plug-in has AM and FM capability, power level control, and selectable modes of source leveling.

*The HP 8620C Sweep Oscillator Operating and Service Manual (part no. 08620-90002) contains complete information pertaining to the instrument. Also, see Application Note 401-1 (part no. 5953-2800).*

### Addressing

The 8620C mainframe is a listen-only device set to address 6 (octal) by the factory. This address is set on a switch package on the A12 printed circuit board. The address can be changed as follows:

- Disconnect power and HP-IB cables, and remove the top cover.
- Locate and remove the A12 printed circuit board, which is in the XA6 socket. (Refer to figure 17-1 for board placement.)
- Set the new address on switch A12SW1. The layout of the switch is in standard binary form. (Refer to figure 17-2.)
- Replace the A12 board in its socket, and re-install the top cover and cables.

### System Preparations

#### LU Assignment

One logical unit number (LU) should be assigned to the 8620C.

:SYLU,17,10,6B

will assign LU 17 to equipment table 10. The device address associated with LU 17 will be 6 octal.

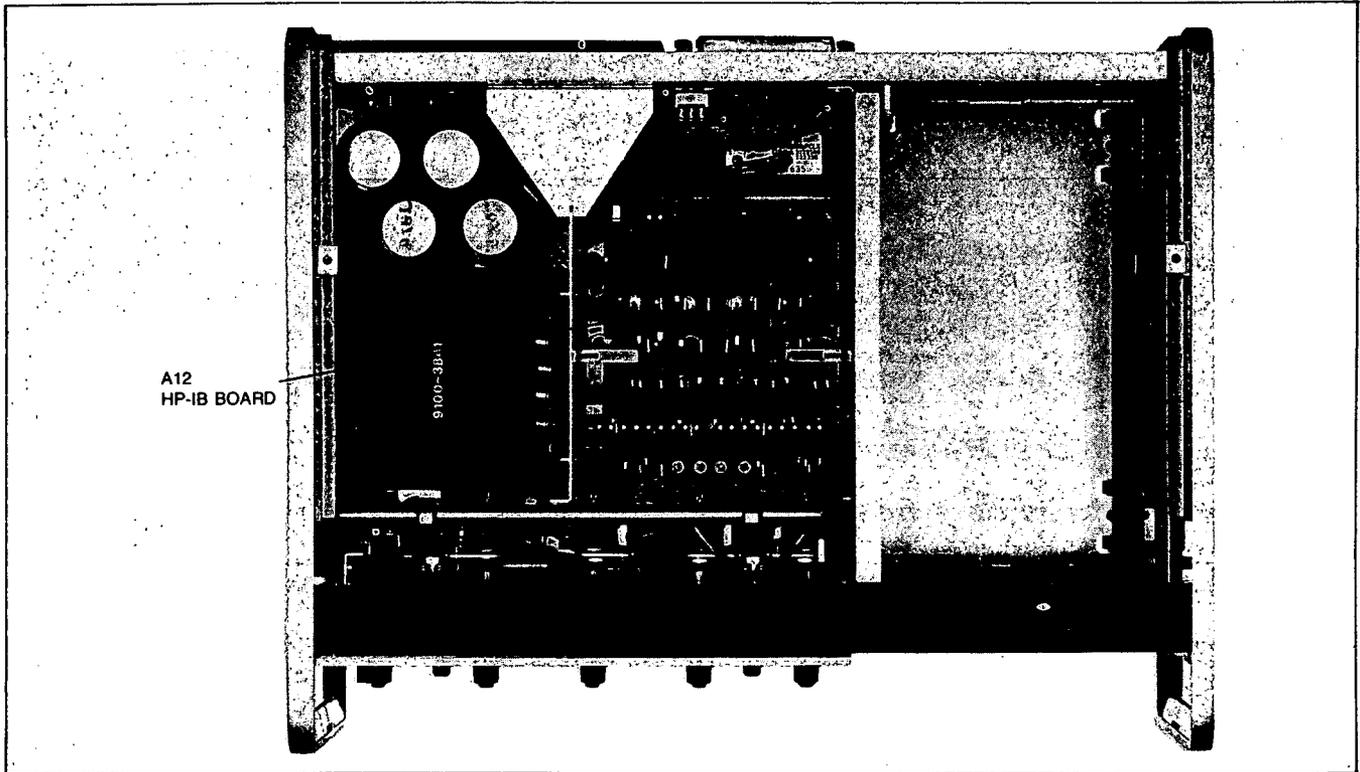


Figure 1. Front Panel Assembly

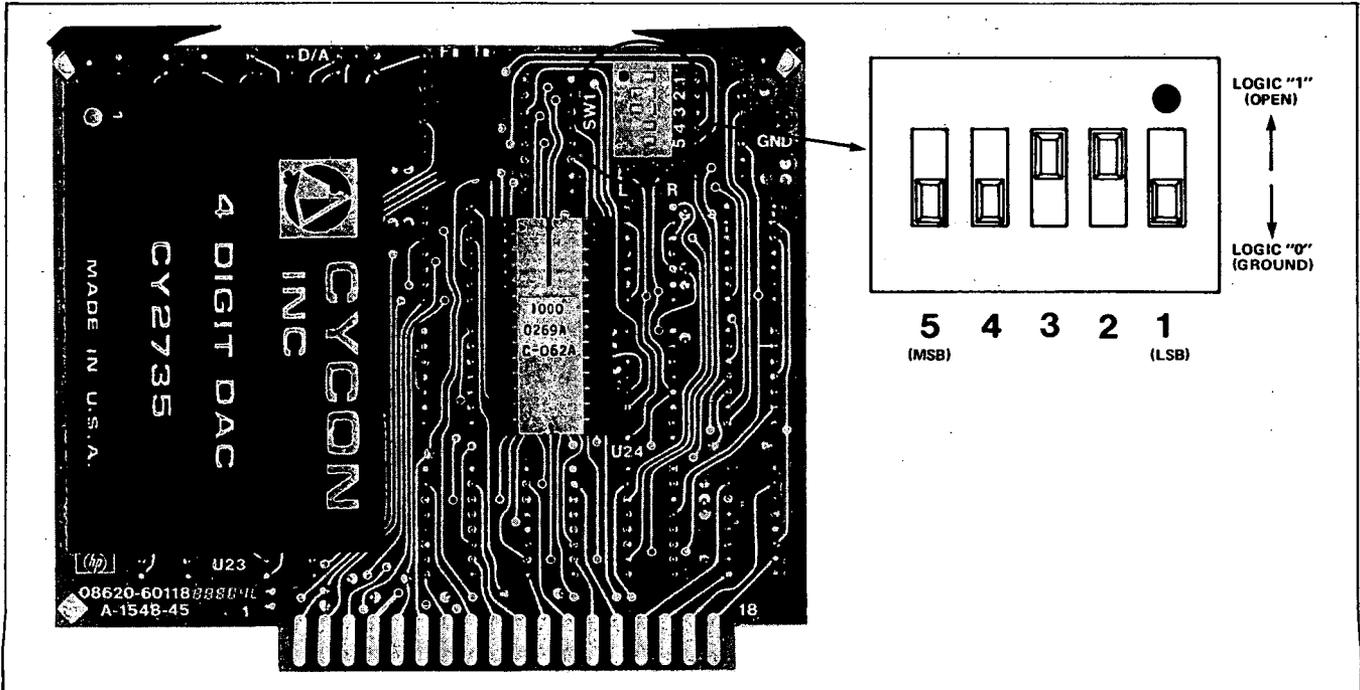


Figure 2. A12 HP-IB Interface Assembly

## Output Buffering

Buffering is normally used when large amounts of data are sent. Since the 8620C requires few characters, output buffering for the 8620C EQT is not necessary. The File Manager command,

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

will set equipment table 10 to the unbuffered mode. Remember, the bus must be unbuffered if the user program performs its own error checking.

## Time-out

In certain cases, the 8620C can delay a response for up to 50 milliseconds. Any longer delay from the 8620C should be considered as a time-out error. When selecting a time-out value, remember that the time-out value will affect all devices on the same EQT and should encompass the needs of all devices.

From File Manager, a system request may be used to set the time-out value.

```
:SYTO,10,5
```

will set the time-out value for EQT 10 to 50 milliseconds.

A time-out error will be handled through RTE by default. However, a user program may handle the time-out error by setting up the device configuration word.

## Configuration

When bit 6 (the E bit) of the device configuration word is zero, the operating system will set the logical unit of the 8620C down after a time-out, and put the user program into the general wait state. When the problem is corrected, the "UP" operator command is intended to restore the logical unit to the UP condition, and allow execution to resume.

When the E bit is configured to one, the time-out condition will not stop execution of the user program. The user program should check the current bus status (by calling the subroutine "IBERR") each time an I/O request is made to determine if a time-out has occurred. The user program can then determine how the time-out will be handled.

Two examples of the device configuration word are shown in figure 17-3. The first example shows the configuration for operating system processing of the time-out condition. The second example shows the configuration for user processing of a time-out condition.<sup>2</sup>

A File Manager command may be used to alter the E bit in the device configuration word. For LU 17,

```
:CN,17,25B,17400B
```

specifies that the time-out condition will be performed by the user program.

The device configuration word defaults to the correct value, and does not have to be changed. The 8620C does not generate SRQ, so the S and R bits, which are used for SRQ processing, do not need to be modified.

DMA is not usually allocated for the 8620C. Typically, the two DMA channels in the HP 1000 are used for the faster devices in the system, like magnetic tapes and discs. Because the 8620C receives short message strings, the interrupt technique is more effective.<sup>3</sup> The D bit (bit 13) defaults to zero, which disables DMA, and causes interrupt processing to be used.

The following example demonstrates a typical configuration request from File Manager for LU 17.

```
:CN,17,25B,17000B
```

This request represents the default condition of the device configuration word. The second example in figure 17-3 describes the meaning of each bit.

## Remote

The 8620C must be set to the remote state before programming operations can begin. Remote is one of the HP-IB management lines, and once asserted, will remain asserted until cleared. The remote enable command may be executed from the File Manager, or a user program. The File Manager command,

```
:CN,17,16B
```

may be entered or the FORTRAN statement,

```
CALL REMOTE (17)
```

may be used. For convenience, the remote statement can be included in the WELCOM file. Then, it will automatically be executed at boot-up.

<sup>2</sup>Application Note 401-1, Chapter 3, describes a utility program called BSCU that is used to observe the status of the HP-IB, including the configuration word.

<sup>3</sup>Application Note 201-4 presents a thorough discussion on evaluating the use of DMA versus the interrupt technique for HP-IB data transfers.

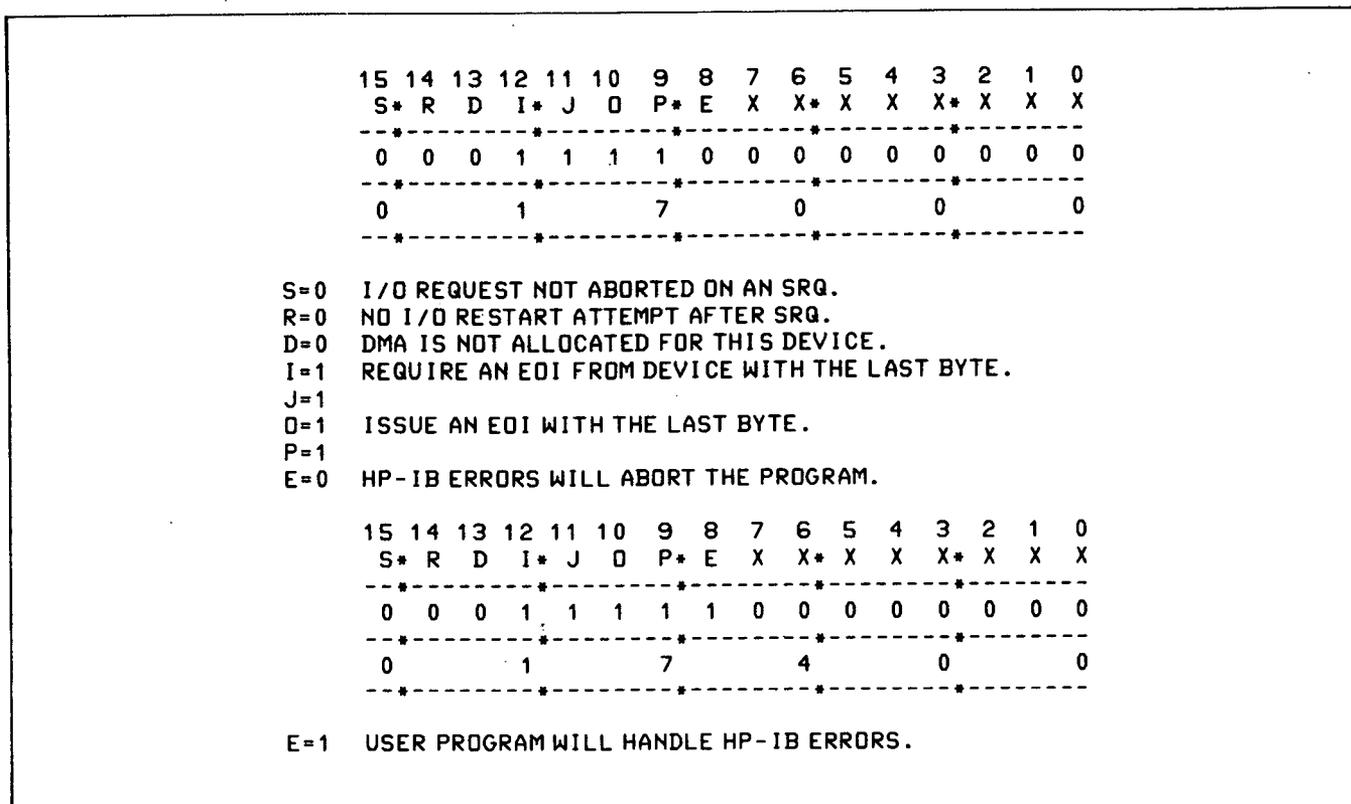


Figure 17-3. Example Device Configuration Words

When set to remote, the front panel of the 8620C is automatically locked out. Front panel operator control may be restored by returning the instrument to local. The File Manager request,

```
:CN,IBLU,17B
```

or the FORTRAN request,

```
CALL LOCAL (IBLU)
```

will return the bus to local. When returning the bus to local, special care must be taken to assure that other devices on the bus are not affected. The LOCAL request is not a device-specific command. When sent, the LOCAL command returns all devices on the same bus to local, and some devices respond by resetting themselves or going to a pre-determined state.

## Programming

The HP 8620C is a listen-only device that allows its operating mode, bandswitch, and frequency to be programmatically controlled. The operation of these functions can be verified by executing the program shown in figure 17-4. This program first tests the operating modes, cycling through them five times. Then the routine exercises the bandswitch, cycling through the bands five times. Finally, the oscillator is tested by sending the lowest frequency, highest frequency, and middle frequency for the plug-in being used. An oscilloscope or counter can be used to verify output.

There are eight operating modes in the 8620C which select analog or digital sweeping, or CW output. The different modes within analog or digital sweeping determine how the upper frequency bound (FU) and lower frequency bound (FL) are obtained. Table 17-1 illustrates the various modes, their ASCII codes, and how the upper (FU) and lower bounds (FL) to be swept are determined.

```
0001  FTN4,L
0002      PROGRAM VER20
0003      INTEGER IP(5)
0004      CALL RMPAR(IP)
0005      ITLU=IP
0006      IF(ITLU.EQ.0) ITLU=1
0007      IDLU=IP(2)
0008      IF(IDLU.NE.0) GO TO 44
0009      WRITE(ITLU,101)
0010  101  FORMAT("ENTER 8620C LU #")
0011      READ(ITLU,*) IDLU
0012  44   WRITE(ITLU,102)
0013  102  FORMAT("***CHECK MODES***")
0014      DO 81 J=1,5
0015      DO 81 I=1,4
0016      WRITE(IDLU,103) I
0017  103  FORMAT("M",I1)
0018      CALL EXEC(12,0,1,0,-50)
0019  81   CONTINUE
0020      WRITE(IDLU,104)
0021  104  FORMAT("M1")
0022      WRITE(ITLU,105)
0023  105  FORMAT("***CHECK BANDS***")
0024      DO 82 J=1,5
0025      DO 82 I=1,4
0026      WRITE(IDLU,106) I
0027  106  FORMAT("B",I1)
0028      CALL EXEC(12,0,1,0,-50)
0029  82   CONTINUE
0030      WRITE(IDLU,107)
0031  107  FORMAT("B1")
0032      WRITE(ITLU,108)
0033  108  FORMAT("***CHECK VOLTAGES***")
0034      WRITE(IDLU,109) 0.0
0035  109  FORMAT("V",1F5.3,"E")
0036      PAUSE
0037      WRITE(IDLU,109) 9.999
0038      PAUSE
0039      WRITE(IDLU,109) 5.000
0040      PAUSE
0041      WRITE(1,119)
0042  119  FORMAT("DONE")
0043      STOP
0044      END
0045  END$
```

Figure 17-4. Verification Program for 8620C

**Table 17-1. Program Modes**

	Description	ASCII Code
Digital Modes	0.000 Volts → Low End of Band Selected = $F_L$ 10.000 Volts → High End of Band Selected = $F_U$	M1
	0.000 Volts → Setting of Front Panel CW Control Minus $\frac{\Delta F \text{ Setting}}{2} = F_L$ 10.000 Volts → Setting of Front Panel CW Control Plus $\frac{\Delta F \text{ Setting}}{2} = F_U$	M2
	0.000 Volts → Setting of Front Panel Start Marker = $F_L$ 10.000 Volts → Setting of Front Panel Stop Marker = $F_U$	M4
Analog Sweep Modes	Analog Sweep of Full Band Selected	M5
	Analog $\Delta F$ Sweep Controlled by Front Panel $\Delta F$ and CW Controls	M6
	Analog Marker Sweep Controlled by Front Panel Start- and Stop-Marker Controls.	M8
Analog CW Mode	Output = Front Panel CW Control Setting	M3 or M7

**Band Programming (All Modes)**

Description	ASCII Code
Local Band (As Selected by Front Panel Lever)	B0
Band 1	B1
Band 2	B2
Band 3	B3
Band 4	B4

Sweep mode M1 is the most commonly used mode under program control. This mode allows the output frequency to be specified independent of the front panel settings. The low and high boundaries are the limits of the plug-in being used.

The 8620C can choose specific bands when a multiband plug-in is installed. Bands 1 through 4 are designed by the ASCII character "B1" through "B4." In addition, band selection control can be provided from the front panel by programming "B0." If a single band plug-in is used, the band programming instruction has no effect.

Frequencies are produced in the digital sweep modes by converting the frequency into a percentage of the difference between the high (FU) and low (FL) frequency bounds, and multiplying this percentage by 10 volts. The 8620C is programmed by voltage, with FL set to zero volts and FU set to 10 volts. There are 10,000 points of resolution between FL and FU. Therefore, the proper drive voltage can be obtained from the conversion equation,

$$V_x = \frac{F_x - FL}{FU - FL} \times 10$$

where  $F_x$  is the desired frequency

FL is the lower bound.

FU is the higher bound.

$V_x$  is the required voltage.

Once the proper voltage is computed, it can be sent to the sweeper. The 8620C requires the letter "V" to be sent followed by four digits, and the letter "E." The letter "E" indicates the end of the voltage string. A decimal point in the string will be ignored by the sweeper. It processes the four digits of information and assumes they represent millivolts. If more than four digits are sent, the 8620C processes the last four digits it receives immediately preceding the "E."

For example, assume that the range of a plug-in is 2 to 6.2 GHz, (86290A plug-in band 1), and 4.1 GHz is desired,

$$V_x = \frac{4.1 - 2.0}{6.2 - 2.0} \times 10 = 5.000$$

will produce,

M1B1V5.000E

Most applications deal with frequency, not voltage. To make this transition, a device subroutine can be created. Figure 17-5 illustrates the source language for a generalized device subroutine to convert frequency to the proper bandwidth and voltage for the 86290A and 86220A plug-ins. The calling program tells the device subroutine which plug-in is installed, the frequency desired, and the LU of the 8620C.

Since FU and FL are known beforehand, the equation for  $V_x$  can be factored to require only one subtraction and one multiplication. The values to be supplied are a scaling factor ( $10/(FU-FL)$ ), and an offset (FL). Line 17 in the device subroutine shows how the factors are used, since,

$$V_x = (FREQ - FL) * scaling\ factor.$$

The accuracy of any plug-in can be improved through the use of a counter-feedback scheme. Figure 17-6 shows an example using the 86290A plug-in and 5340A counter. The 86290A provides a unique advantage in this application because it has AUX output. The AUX output signal is sampled directly from the fundamental oscillator and therefore, removes the need of a coupler or power splitter.

The program first "calibrates" itself by producing a scaling factor according to frequencies obtained for 0 and 9.999 volts. Then, the user is instructed to enter a frequency. The program then iterates in a read/set loop until the actual frequency is within 350 KHz. It then requests the next frequency, keeping the previous value ( $\pm$  the drift of the sweeper) until a new value is entered.

This technique could be used with another plug-in by coupling a portion of the output signal with a coupler or power splitter. Change the routine to cover the proper number of bands, and the upper and lower frequency limits for error checking.

## Performance

Performance considerations for the 8620C Sweep Oscillator in remote operation include not only the data transfer rate, but the frequency settling time, drift, and repeatability of the plug-in module used. Since few bytes are sent to the 8620C, the time to send a message from the HP 1000 is approximately the RTE setup time (6 milliseconds).

The critical information to consider is the settling time for the plug-in module used. A measurement should not be taken until the oscillator has settled to insure that the proper frequency has been reached. Table 17-2 illustrates performance information for the 8620C including settling time, drift, and frequency repeatability.

```

&FREQ T=00003 IS ON CR UU USING 00005 BLKS R=0000

0001 FTN4,L
0002 SUBROUTINE FREQ(IDLU,IB,FRQ), 8620 FREQ SET NHK
0003 C THIS ROUTINE ACCEPTS A FREQUENCY FROM A CALLING PROGRAM AND
0004 C CONVERTS IT TO A FORM REQUIRED BY THE 8620C. THE ROUTINE FIRST
0005 C DETERMINES WHICH PLUG-IN MODULE THE 8620C IS USING(0=88222A,
0006 C 1=86290A). THEN, THE ROUTINE DETERMINES WHICH BAND TO BE ON.
0007 C FINALLY, THE FREQUENCY IS CONVERTED TO A PERCENTAGE OF THE BAND
0008 C AND OUTPUT TO THE 8620C. WHEN THE DATA HAS BEEN SENT, A WAIT
0009 C STATEMENT IS EXECUTED TO ALLOW THE 8620C ENOUGH TIME TO SETTLE ON
0010 C THE DESIRED FREQUENCY.
0011 C DIMENSION CAL(2,4)
0012 C INTEGER R,VCD
0013 C DATA CAL/10.0,4.18,2000.0,2.38095,6000.0,1.56250,12000.0,1.51515/
0014 C COMPUTE PROPER BAND
0015 C R=1
0016 C IF(IB.EQ.1) R=R+1
0017 C IF(FREQ.GT.6100.0) R=R+1
0018 C IF(FREQ.GT.12000.0) R=R+1
0019 C COMPUTE VCD INPUT
0020 C VCD=FIX((FREQ-CAL(1,R))*CAL(2,R))
0021 C IF(VCD.GT.9999.5) VCD=VCD-1
0022 C R=R-1
0023 C WRITE(IDLU,101) R,VCD
0024 101 FORMAT("M1B",I1,"V",I4,"E")
0025 C ALLOW SETTLING TIME
0026 C CALL EXEC(12,0,1,0,-4)
0027 C RETURN
0028 C END
0029 END$

```

Figure 17-5. Frequency or Voltage Conversion Routine

```

&SWPR T=00004 IS ON CR UU USING 00010 BLKS R=0022

0001 FTN4,L
0002 PROGRAM SWEEP(3),790306 SWEEPER ACCURACY ROUTINE
0003 C THIS ROUTINE COMBINES THE 8620C SWEEPER AND AN 86290A PLUG-IN
0004 C MODULE WITH THE 5340A COUNTER TO PRODUCE A SYSTEM GIVING
0005 C FREQUENCY OUTPUT WITHIN 350KHZ.
0006 INTEGER IP(5),B
0007 REAL F(3),G(3)
0008 C HOUSEKEEPING--GET THE LOGICAL UNITS NUMBERS OF THE USER TERMINAL,
0009 C THE SWEEPER, AND THE COUNTER.
0010 CALL RMPAR(IP)
0011 ITLU=IP
0012 IF(ITLU.EQ.0) ITLU =1
0013 ISWPR=IP(2)
0014 IF(ISWPR.NE.0) GO TO 41
0015 WRITE(ITLU,101)
0016 101 FORMAT("ENTER 8620C LU #")
0017 READ(ITLU,*) ISWPR
0018 41 ICNTR=IP(3)
0019 IF(ICNTR.NE.0) GO TO 42
0020 WRITE(ITLU,102)
0021 102 FORMAT("ENTER 5340 LU #")
0022 READ(ITLU,*) ICNTR
0023 C SET UP THE COUNTER
0024 42 WRITE(ICNTR,103)
0025 103 FORMAT("eTKMO")
0026 C CALIBRATE THE SYSTEM
0027 DO 81 B=1,3
0028 V=0.0
0029 WRITE(ISWPR,104) B,V
0030 104 FORMAT("M1B",I1,"V",F5.3,"E")
0031 CALL EXEC(13,0,1,0,-5)
0032 WRITE(ICNTR,105)
0033 105 FORMAT("H")
0034 READ(ICNTR,106) C
0035 106 FORMAT(2X,F12.6)
0036 F(B)=C*B/1000.0
0037 V=9.999
0038 WRITE(ISWPR,104) B,V
0039 CALL EXEC(12,0,1,0,-5)
0040 WRITE(ICNTR,105)
0041 READ(ICNTR,106) C
0042 C=C*B/1000.0
0043 81 G(B)=9.999/(C-F(B))
0044 C GET A FREQUENCY AND SET IT.
0045 43 V=0.0
0046 WRITE(ITLU,107)
0047 107 FORMAT("ENTER FREQUENCY IN GHZ (2<FREQ<18)")
0048 READ(ITLU,*) FREQ
0049 C CHECK LIMITS
0050 IF(FREQ.GT.18.0) GO TO 88
0051 IF(FREQ.LT.2.0) GO TO 88
0052 C COMPUTE PROPER BAND
0053 B=1
0054 IF (FREQ.GT.6.1) B=B+1
0055 IF (FREQ.GT.12.2) B=B+1

```

Figure 17-6. Operations Verification Program

```
0056      C=F(B)
0057 C    SET VOLTAGE FOR DAC (VCD IN SWEEPER)
0058 44   V=V+((FREQ-C)*G(B))
0059     IF(V.GT.9.9995) GO TO 87
0060     IF(V.LT.0.0) V=0.0
0061     WRITE(ISWPR,104) B,V
0062     CALL EXEC(12,0,1,0,-5)
0063 C    CHECK FREQUENCY
0064     WRITE(ICNTR,105)
0065     READ(ICNTR,106) C
0066     C=C+B/1000.0
0067 C    CHECK TO SEE IF FREQ IS WITH 350 KHZ.
0068     IF(ABS(C-FREQ).GT.0.00035.AND.V.GT.0.0) GO TO 44
0069 C    IF YES --DONE
0070 46   WRITE(ITLU,108)
0071 108  FORMAT("FREQ SET -REPEAT?")
0072     READ(ITLU,109) J
0073 109  FORMAT(1A2)
0074     IF(J.EQ.2HYES) GO TO 43
0075     STOP
0076 87   WRITE(ISWPR,110) B
0077 110  FORMAT("M1B" I1,"V:000E")
0078     GO TO 46
0079 88   WRITE(ITLU,111)
0080 111  FORMAT("BAD VALUE--TRY AGAIN")
0081     GO TO 43
0082     END
0083 END$
```

Figure 17-6. Operations Verification Program (continued)

Table 17-2. Performance of 86200 Series Plug-ins Under Programming<sup>1</sup>

Plug-in Model Number	Frequency Range (GHz)	Frequency Accuracy (MHz)		Frequency Repeatability (kHz)		Frequency Settling Time Typical (msec)	Freq. Drift w/Time (kHz/10 min) Typical after warmup of	
		Typical	Max	Typical	Max		1/2 hr	1 hr
86220A	0.01-1.3	± 7.5	± 9.5	± 400	± 1100	60	± 250	± 50
86222A/B	0.01-2.4	± 1.5	± 5.5	± 200	± 900	7	± 400	± 100
86230B	1.8-4.2	± 2.5	± 4.5	—	—	15	± 150	± 100
86235A	1.7-4.3	± 2.5	± 3.5	± 400	± 1300	15	± 150	± 100
86240A/B	2.0-8.4	± 3.5	± 8.5	± 200	± 700	10	± 450	± 150
86240C	3.6-8.6	± 3.5	± 8.5	± 200	± 700	10	± 450	± 150
86241A	3.2-6.5	± 10.5	± 23.5	± 200	± 600	10	± 300	± 200
86242C/D	5.9-9.0	± 5.5	± 15.5	± 300	± 2600	15	± 550	± 200
86245A	5.9-12.4	± 10.5	± 19.5	± 300	± 2000	15	± 650	± 200
86250C/D	8.0-12.4	± 8.5	± 24.5	± 800	± 1500	15	± 800	± 400
86260A	12.4-18.0	± 5.5	± 9.5	± 800	± 3000	5	± 550	± 450
86290A/B								
Band #1	2.0-6.2	± 2.5	± 3.5	± 100	± 300	<sup>2</sup> 5	± 250	± 100
Band #2	6.0-12.4	± 2.5	± 4.5	± 200	± 500	<sup>2</sup> 5	± 500	± 200
Band #3	12-18/18.6	± 3.5	± 8.5	± 300	± 900	<sup>2</sup> 5	± 750	± 300

<sup>1</sup> These Performance Characteristics are intended to provide information useful in applying the instrument by giving typical, but non-warranted, performance parameters.

<sup>2</sup> Approximately 6 msec should be added if switching from one band to another.

