HP 8660D
SYNTHESIZED SIGNAL GENERATOR
(Including Options 001, 002, 003, and 005)
Operation and Calibration Manual

SERIAL NUMBERS

This manual applies directly to instruments with
serial numbers prefixed:
3006A and all MAJOR changes that apply to your instrument.

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Valuetronics International, Inc.
1-800-552-8258
MASTER COPY

Operation and Calibration Manual HP Part 08660-90103
Other Documents Available:
Service Manual (Volume 2, 3) HP Part 08660-90104
Microfiche Operation and Calibration Manual HP Part 08660-90105
Microfiche Service Manual HP Part 08660-90106

Printed in U.S.A.: March 1993
CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

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Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.
SAFETY CONSIDERATIONS

GENERAL
This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).

BEFORE APPLYING POWER
Verify that the product is set to match the available line voltage and the correct fuse is installed.

SAFETY EARTH GROUND
An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

SAFETY SYMBOLS
⚠️ Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (refer to Table of Contents).

⚡ Indicates hazardous voltages.

🔌 Indicates earth (ground) terminal.

WARNING The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

WARNING
Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection).

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to the earth terminal of the power source.

Servicing instructions are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.

Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

For continued protection against fire hazard, replace the line fuse(s) only with 250V fuse(s) of the same current rating and type (for example, normal blow, time delay, etc.). Do not use repaired fuses or short circuited fuseholders.
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Section 1
GENERAL INFORMATION

1-1. DESCRIPTION

The HP 8660D Synthesized Signal Generator mainframe, pictured in Figure 1-1, requires two plug-in sections to provide a usable RF output. The plug-ins required are an RF Section and a Modulation (or Auxiliary) Section. These plug-in sections are inserted into the front of the HP 8660D; all operating controls are on the front panels of the plug-in sections or on the mainframe panel.

An internal plug-in unit, the Frequency Extension Module (HP 11661A) is required when any RF Section other than the HP Model 86601 is in use.

The HP 8660D is programmable using either HP-IB (Hewlett-Packard Interface Bus) or BCD (Binary Coded Decimal).

1-2. INTRODUCTION TO THE OPERATION AND CALIBRATION MANUAL

This manual contains information required for a qualified person to install, operate, test, adjust, and service the Hewlett-Packard Model 8660D Synthesized Signal Generator mainframe. The HP 8660D will generally be referred to as the Signal Generator throughout the manual.

The Operation and Calibration Manual is comprised of five sections as described below:

Volume I, Operation and Calibration Manual

Section I, General Information. General Information covers instrument specifications, options, equipment available, and recommended test equipment.

Section II, Installation. Installation covers initial inspection, preparation for use, and storage and shipment.

Section III, Operation. Operation provides HP-IB operating information and detailed operating information for either the beginning or experienced user.

Section IV, Performance Tests. Performance tests enable you to check the performance of the instrument against the specifications listed in Table 1-1.

Section V, Adjustments. Adjustment procedures provide information required to adjust and align the instrument after repairs are made.

1-3. WHERE TO FIND INSTRUMENT SPECIFICATIONS

Instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument can be tested.
1-4. WHERE TO FIND SAFETY CONSIDERATIONS

This product is a Safety Class I instrument; that is, one provided with a protective earth terminal. Before operating or servicing the Signal Generator, service personnel should familiarize themselves with the safety markings on the Signal Generator and the safety instructions in the manual. Safety information regarding installation, operation, performance testing, or adjusting of the HP 8660D is found throughout this manual. Refer to the Safety Considerations pages found at the beginning of this manual for a summary of that information.

1-5. HEWLETT-PACKARD INTERFACE BUS (HP-IB) ENABLES REMOTE CONTROL

The Signal Generator has a Hewlett-Packard Interface Bus (HP-IB) interface and can be used with an HP-IB compatible controller for test system applications. The Signal Generator is fully programmable via the Hewlett-Packard Interface Bus. Operation of the plug-in sections may also be remotely programmed through the mainframe circuits. Both BCD (Binary Coded Decimal) and HP-IB are available for use in programming the Signal Generator. An extended set of programming codes is used in the HP 8660D, although the codes found with the HP 8660A/C manual are completely compatible with the HP 8660D. HP-IB is Hewlett-Packard’s implementation of IEEE Standard 488 and the identical ANSI Standard MC1.1. (Refer to Section III for more complete details about programming the HP 8660D.)

Selecting the HP-IB Address

The Signal Generator’s HP-IB address is set to 19 at the factory in both internal memory. Refer to Remote Selection in Section 2 for information regarding changing the HP-IB address.

1-6. ACCESSORIES SUPPLIED WITH THE 8660D

- A detachable three-wire power cable. The type of power cord will be determined by the shipmen’s destination. For the part numbers of the power cables, refer to Table 2-1, AC Power Cables Available. Signal Generators shipped to countries using 115 volts are also supplied with a set of fuses for 230 volt operation.
- An accessory kit (08660-60417) consisting of the following:

| 1 | Connector, Type-N-to-BNC | 1250-0780 |
| 1 | Extender Board 20 contact | 5060-0256 |
| 1 | Extender Board 24 contact | 5060-0258 |
| 2 | Extender Boards 30 contact | 5060-0276 |
| 1 | Connector 36 pin with hood and clamp | 1251-0084 |
| 2 | Extenders | 08660-60406 |
| 1 | Extender | 08660-90102 |

- A BCD to HP-IB Adapter HP Part Number 08660-60187 (attached to rear panel).

1-7. EQUIPMENT REQUIRED BUT NOT SUPPLIED

An RF Section and Modulation or Auxiliary Section must be installed in the HP 8660D mainframe. In addition, when an RF section such as the HP 86602 or HP 86603 is used, the internal Frequency Extension Module (HP 11661) must be used.
1-8. OPTIONS AVAILABLE WITH THE INSTRUMENT

Electrical Options

Option 001: $\pm 3 \times 10^{-9}$/24 hours internal oscillator (Standard).

Option 003: Operation from 48 to 440 Hz line (Standard).

Option 005: Factory configured for HP-IB Operation.

NOTE
To connect an HP-IB cable to the rear panel requires an adapter HP Part Number 08660-60187. This adapter is shipped with instruments ordered with Option 005.

Option 100: HP 11661B factory installed.

Option W30: Extends hardware support three years.

Mechanical Options

Option 908: Adds a rack-mount kit. If the HP 8660D was purchased without the rack-mount option, the kit may be ordered from the nearest Hewlett-Packard office using HP part number 08660-60347.

Manual Options


Option 915: Adds Service Manual (1 copy).

1-9. GENERAL OPERATING PRINCIPLES

All of the signals generated in the HP 8660D are phase locked, directly or indirectly, to a 100 MHz master oscillator in the reference section. The 100 MHz master oscillator is phase locked to an internal temperature controlled oscillator or to an external standard. Provisions are made for the internal oscillator to be used as a reference signal for other equipment.

The HP 8660D uses synthesizer techniques to provide digitally controlled, precise RF signals which are used in the RF Section output plug-ins to produce the selected output frequency. The output frequencies are exactly those selected in 1 Hz or 2 Hz increments.

Six phase-locked loops, all phase locked to the 100 MHz master oscillator, are used to generate the RF signals used in the RF Section plug-ins to produce the final output signal.

The HP 8660D functions can be selected by front-panel controls or by a remote controller. RF plug-in functions can also be remotely programmed through the mainframe circuits.

Service information, descriptions, and operating instructions for the various plug-in sections are provided in separate manuals.

1-10. EQUIPMENT AVAILABLE

A service kit, HP 11672A, is recommended for servicing and adjusting the mainframe and the plug-in sections. Contents of the service kit are listed in Table 1–2. Individual items in the kit may be ordered separately if desired.
<table>
<thead>
<tr>
<th><strong>Electrical Characteristics</strong></th>
<th><strong>Description</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency Selection</strong></td>
<td>Keyboard control panel allows selection of CW (or center frequency) by entry keys or synthesized tuning dial. The least significant digit is 1 Hz*</td>
</tr>
<tr>
<td><strong>Reference Oscillator</strong></td>
<td>Internal: 10 MHz quartz oscillator. Aging rate less than ±3×10⁻⁹/24 hours after 30 day warmup (Standard).  &lt;br&gt;External: Rear panel switch allows operation from any 5 MHz or 10 MHz signal at a level between 0.5V and 2.5V rms into 170Ω. Stability and spectral purity will be partially determined by characteristics of external reference oscillator.</td>
</tr>
<tr>
<td><strong>Reference Output</strong></td>
<td>Rear panel BNC connector provides output of signal selected (INT. or EXT.) at the following levels into 170Ω:  &lt;br&gt;Internal Reference: 0.75V to 1.5 Vrms.  &lt;br&gt;External Reference: Nominally equal to external input.</td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td>Ten-digit numerical LED display of CW frequency is active in either local or remote mode unless the DISPLAY BLANK command has been programmed over the remote interface bus (HP-IB or BCD).</td>
</tr>
<tr>
<td><strong>Synthesized Search</strong></td>
<td>The Tuning dial increments the synthesized output frequency 60 steps per revolution (with the HP 86601A, the COARSE and STEP tuning are desensitized to 30 steps/revolution). Step sizes are 1 Hz, 1 kHz, 1 MHz, or any step size entered through the keyboard.</td>
</tr>
<tr>
<td><strong>Digital Sweep</strong></td>
<td>Type: Symmetrical about CW/center frequency. Sweep width is divided into 100 synthesized steps for fastest sweep speed or 1000 steps for slower speeds or Manual Sweep.  &lt;br&gt;Sweep Width: Continuously adjustable over range of RF section installed. Smallest step size is equal to frequency resolution of mainframe.  &lt;br&gt;Sweep End Point Accuracy: Same as reference oscillator accuracy.  &lt;br&gt;Sweep Speed: Selectable 0.1 sec, 1 sec, or 50 sec per sweep (Auto or Single)  &lt;br&gt;Sweep Output: 0 to +8V stepped ramp, 100 or 1000 equal steps depending on sweep speed.  &lt;br&gt;Manual Sweep: Synthesized search dial allows manual sweep over width selected in 1000 steps (LED display follows output frequency during manual sweep).  &lt;br&gt;Single Sweep: Initiated by momentary contact key.</td>
</tr>
<tr>
<td><strong>Frequency Stepping</strong></td>
<td>After a step size has been entered on the keyboard, depressing ↑ or ↓ button will increment frequency up or down by the desired step size. The knob can also be used to vary the frequency by that same step size.</td>
</tr>
<tr>
<td><strong>Step Accuracy</strong></td>
<td>Same as reference oscillator accuracy.</td>
</tr>
</tbody>
</table>

* When using 86603A RF section above 1300 MHz, least significant digit becomes 2 Hz.
**Table 1-1. HP 8660D Specifications (2 of 2)**

<table>
<thead>
<tr>
<th>Electrical Characteristics</th>
<th>Remote Programming *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>CW frequency is programmable over entire range with same resolution obtained in manual operation.</td>
</tr>
<tr>
<td>Frequency Step</td>
<td>↑ or ↓ may also be programmed to change the output frequency by a previously selected step size.</td>
</tr>
<tr>
<td>Output Level</td>
<td>Programmable in 1 dB steps over the output range of the RF section installed (for output level accuracy see RF section specifications).</td>
</tr>
<tr>
<td>Modulation</td>
<td>See specifications for modulation and RF section installed.</td>
</tr>
<tr>
<td>Programming Input</td>
<td>Mating Connector Types:</td>
</tr>
<tr>
<td></td>
<td>BCD interface: 36 pin Cinch type (supplied). HP-IB interface 24 pin Cinch type 57 (supplied with option 005).</td>
</tr>
<tr>
<td></td>
<td>Logic:</td>
</tr>
<tr>
<td></td>
<td>TTL compatible (negative true)</td>
</tr>
<tr>
<td></td>
<td>&quot;0&quot; logic state corresponds to +2V or higher.</td>
</tr>
<tr>
<td></td>
<td>&quot;1&quot; logic state corresponds to +0.8V or lower.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature Range</td>
<td>0° to 55° C.</td>
</tr>
<tr>
<td>Leakage</td>
<td>Meets radiated and conducted limits of MIL STD 461B at frequencies above 100 kHz.</td>
</tr>
<tr>
<td>Power</td>
<td>100 or 120 Vac, +5 –10% at 48 to 440 Hz.</td>
</tr>
<tr>
<td></td>
<td>200 or 240 Vac, +5 –10% at 48 to 65 Hz.</td>
</tr>
<tr>
<td></td>
<td>400 VA maximum.</td>
</tr>
<tr>
<td>Weight</td>
<td>Signal Generator only: Net, 23.2 kg (51 lb), shipping 28.6 kg (63 lb).</td>
</tr>
</tbody>
</table>

* All functions controlled from the front panel, with the exception of the power switch and the knob, are programmable with the same accuracy and resolution as in manual mode.
1-11. HOW TO USE THE RECOMMENDED TEST EQUIPMENT TABLE

Table 1-2 lists the test equipment and accessories required to test, adjust, and service the Signal Generator. The minimum specifications column describes the essential requirements for each piece of test equipment. Other equipment can be substituted if it meets or exceeds these minimum specifications.

<table>
<thead>
<tr>
<th>Item</th>
<th>Minimum Specifications</th>
<th>Suggested Model</th>
<th>Use*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Voltmeter</td>
<td>Voltage Accuracy ±0.02% 0.000V to ±40 Vdc</td>
<td>HP 3478A</td>
<td>A, S</td>
</tr>
<tr>
<td>AC RMS Voltmeter</td>
<td>1 μV Sensitivity 0.05% of reading + 3 μV accuracy</td>
<td>HP 3465A</td>
<td>A, S</td>
</tr>
<tr>
<td>Variable Voltage Transformer</td>
<td>Range 103 to 127 Vac Meter range 103-127-Vac ±1V</td>
<td>General Radio W4MT3A</td>
<td>A</td>
</tr>
<tr>
<td>Frequency Standard</td>
<td>Frequency 10 MHz Long Term Stability &lt; 1 × 10^-10/24 hours</td>
<td>HP 5065A</td>
<td>P, A</td>
</tr>
<tr>
<td>Oscilloscope</td>
<td>Frequency dc to 50 MHz Time base 10 ns to 1s Time base accuracy 3%</td>
<td>HP 54200A</td>
<td>P, A, S</td>
</tr>
<tr>
<td>10:1 Divider Probes</td>
<td>10:1 Divider 10 Megohm 10 pF</td>
<td>HP 10014A (2)</td>
<td></td>
</tr>
<tr>
<td>Spectrum Analyzer</td>
<td>Frequency Range 0.1 to 500 MHz</td>
<td>HP 8590A</td>
<td>A, S</td>
</tr>
<tr>
<td>Frequency Counter</td>
<td>Range 10 Hz to 500 MHz 1 Hz Resolution External Time Base Input</td>
<td>HP 5385A</td>
<td>A, S</td>
</tr>
<tr>
<td>Pulse Generator</td>
<td>Pulse Rate 100 kHz Pulse width 0.035 μsec Amplitude 0.5V Polarity-Selectible</td>
<td>HP 8011A</td>
<td>A</td>
</tr>
<tr>
<td>Sweep Generator/Test Oscillator</td>
<td>Frequency Range 10 Hz to 20 MHz Output Level -35 to +10 dBm</td>
<td>HP 3325A</td>
<td>A, S</td>
</tr>
<tr>
<td>RF Voltmeter</td>
<td>Range 0.1 to 2V Frequency Range 1 to 10 MHz</td>
<td>HP 3400A</td>
<td>P</td>
</tr>
<tr>
<td>50Ω Feedthru Termination</td>
<td></td>
<td>HP 10100C</td>
<td>P</td>
</tr>
</tbody>
</table>

* Use: A = Adjustments; P = Performance Tests; S = Service
### Table 1-2. Recommended Test Equipment and Accessories List (2 of 2)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Model or Part Number</th>
<th>Use*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Kit</td>
<td>Consisting of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adapter: BNC female to OSM male</td>
<td>HP 11672A</td>
<td>A, S</td>
</tr>
<tr>
<td></td>
<td>Adapter: BNC female, Sealectro female</td>
<td>HP 1250-1200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adapter: BNC female, Sealectro female</td>
<td>HP 1250-1236</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adapter: Right angle OSM male/female</td>
<td>HP 1250-1249</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sealectro jack (printed circuit mount)</td>
<td>HP 1250-1255</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adapter: Sealectro Tee</td>
<td>HP 1250-1391</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tool: Adjustment</td>
<td>HP 8330-0024</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cable: Extender, 66 pin, gray</td>
<td>HP 11672-60001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cable: Extender, 42 pin, gray</td>
<td>HP 11672-60002</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cable Assy: Sealectro male/female, 24&quot; long, gray</td>
<td>HP 11672-60005</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cable Assy: Sealectro male/female right angle connectors, 24&quot; long, red</td>
<td>HP 11672-60004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cable Assy: Sealectro right angle female, BNC male, 24&quot; long, gray</td>
<td>HP 11672-60003</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cable Assy: Sealectro male/female, 24&quot; long, gray with blue stripe</td>
<td>HP 11672-60006</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cable Assy: White</td>
<td>HP 11672-60008</td>
<td></td>
</tr>
</tbody>
</table>

* Use: A = Adjustments; P = Performance Tests; S = Service
Section 2
INSTALLATION

2-1. INTRODUCTION TO THIS SECTION

This section provides the information needed to install the Synthesized Signal Generator. Included is information pertinent to initial inspection, power requirements, line voltage selection, power cables, interconnections, operating environment, remote selection, rack mounting, storage and shipment.

2-2. INITIAL INSPECTION

**WARNING**

*To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, meters).*

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. Procedures for checking electrical performance are given in Section 4. If there is mechanical damage or defect, incompleteness, or if the instrument does not pass the electrical performance test, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection.

2-3. PREPARATION FOR USE

**Power Requirements**

The Synthesized Signal Generator requires a power source of 100, 120, 220, or 240 Vac (+5% to -10%), 48 to 400 Hz. Power consumption is 400 VA maximum.

**Line Voltage Selection**

**CAUTION**

*To prevent damage to the instrument make the line voltage selection BEFORE connecting the line power. Also, ensure the line power cord is connected to a line power circuit that is provided with a protective earth contact.*
A rear panel line power module (A7), permits operation from 100, 120, 220, or 240 Vac. The number visible in the window (located on the module) indicates the nominal line voltage to which the instrument must be connected.

To prepare the instrument for operation, slide the fuse compartment cover to the left (the line power cable must be disconnected). Pull the handle marked FUSE PULL and remove the fuse; rotate the handle to the left. Gently pull the printed circuit voltage selector card from its slot and orient it so that the desired operating voltage appears on the top-left side (see Figure 2-1). Firmly push the voltage selector card back in its slot. Rotate the FUSE PULL handle to the right, install a fuse of the correct rating, and slide the fuse compartment cover to the right.

**NOTE**

*For 110-120V line, use 4A slo-blo fuse, HP part number 2110-0635. For 220-240V line, use 2A slo-blo fuse, HP part number 2110-0303.*

**WARNING**

This is a Safety Class I product (that is, provided with a protective earth terminal). An uninterruptible safety earth ground must be provided from the Mains power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

**BEFORE CONNECTING THIS INSTRUMENT, the protective earth terminals of this instrument must be connected to the protective conductor of the (Mains) power cord. The Mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding).**

If this instrument is to be energized via an external autotransformer, make sure the autotransformer's common terminal is connected to the earthed pole of the power source.

**CAUTION**

*For protection against fire hazard, the line fuse should only be a 250V normal blow fuse with the correct current rating.*

**Power Cable**

This instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The type of power cable plug shipped with each instrument depends on the country of destination. Refer to Table 2-1 for the part numbers of the power cables available.
Selection of Operating Voltage and Fuse Replacement

1. Open cover door, pull the FUSE PULL lever and rotate to left. Remove the fuse.
2. Remove the Line Voltage Selection Card. Position the card so the line voltage appears at top-left corner. Push the card firmly into the slot.
3. Rotate the FUSE PULL lever to its normal position. Insert a fuse of the correct value in the holder. Close the cover door.

**Figure 2–1. Line Voltage and Fuse Selection**

Operating Environment

The operating environment should be within the following limitations:

- **Temperature**: $-0^\circ\text{C}$ to $+55^\circ\text{C}$
- **Humidity**: $<95\%$ relative
- **Altitude**: $< 4600$ meters (15 000 feet)

Clearances for airflow around the instrument should be as follows: 7.6 cm (3 in.) minimum clearance at the rear of the instrument and 2.5 cm (1 in.) minimum clearance on each side. The clearances provided by the plastic feet in bench stacking and the filler strip in rack mounting are adequate for the top and bottom cabinet surfaces.

Remote Selection

The HP 8660D is factory configured for BCD programming, or HP-IB programming (address=19) if option 005 is specified. If you are not sure what configuration the instrument is in, turn power on and press blue shift, 3 (display address). Either the letters "bcd" or the HP-IB address will be displayed.
The HP-IB address can be changed through front panel operation (see section 3) but upon power on or reset conditions it will always revert to the hardware setting on rocker switches found within the DCU module. The following procedure will allow you to change the HP-IB address or change programming format (HP-IB to BCD, or BCD to HP-IB).

**WARNING**

Setting of the HP-IB address should be performed only by service trained persons who are aware of the potential shock hazard of working on an instrument with protective covers removed.

To avoid hazardous electrical shock, the line (Mains) power cable should be disconnected before attempting to change the HP-IB address.

With the instrument in front of you, as if in operating position:

1. Make certain no power is connected to the instrument.
2. Remove the top cover.
3. Locate DCU module and trace power cable bundle (one black wire, one red/white wire, one white wire) from DCU module back to a connector mounted on the chassis. Remove the right side screw and pull the connector loose.
4. Remove the 2 ribbon cables from the DCU.
5. Rotate the instrument clockwise onto its right side.
6. Remove the bottom cover
7. To remove the DCU module, locate and remove 4 recessed screws fastening each corner of the DCU front to the chassis. (With the instrument up on its side screws are located on the right and left sides).
8. Slide the DCU out through the front of the instrument, and turn it upside down to further disassemble.
9. Remove 4 screws holding the DCU bottom cover and lift bottom cover up, exposing 3 circuit boards.
10. Remove the board furthest back, A1A5, by pulling straight up out of mounting connectors.

With the A1A5 board removed the HP-IB address can be changed, or the programming format can be changed by moving the blue jumper (to J3 for HP-IB or to J4 for BCD).

**Rack Mounting (Option 908)**

Rack mounting information is provided with the rack mounting kit. If the kit was not ordered with the instrument as an option, it may be ordered through the nearest Hewlett-Packard office. For rack-mount kit part numbers, refer to paragraph 1-8, "Options Available with the Instrument".

**2-4. STORAGE AND SHIPMENT**

**Environment**

The instrument should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

Temperature .................................................. \(-40^\circ\text{C to } +75^\circ\text{C}\)

Humidity ....................................................... \(<95\% \text{ relative}

Altitude ......................................................... \(<7600 \text{ meters (25 000 feet)\)}}
### Table 2-1. AC Power Cables Available

<table>
<thead>
<tr>
<th>Plug Type</th>
<th>Cable HP Part Number</th>
<th>C D</th>
<th>Plug Description</th>
<th>Cable Length (inches)</th>
<th>Cable Color</th>
<th>For Use In Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>250V</td>
<td>8120-1351 8120-1703</td>
<td>0 4</td>
<td>Straight*BS1363A 90°</td>
<td>90 90</td>
<td>Mint Gray</td>
<td>United Kingdom, Cyprus, Nigeria, Rhodesia, Singapore</td>
</tr>
<tr>
<td>250V</td>
<td>8120-1369 8120-0696</td>
<td>0 4</td>
<td>Straight*NZSS198/ASC112 90°</td>
<td>79 87</td>
<td>Gray  Mint Gray</td>
<td>Australia, New Zealand</td>
</tr>
<tr>
<td>250V</td>
<td>8120-1689 8120-1692</td>
<td>0 2</td>
<td>Straight*CEE7-Y11 90°</td>
<td>79 79</td>
<td>Mint Gray</td>
<td>East and West Europe, Saudi Arabia, Egypt, (unpolarized in many nations)</td>
</tr>
<tr>
<td>125V</td>
<td>8120-1376 8120-1398</td>
<td>0 5</td>
<td>Straight*NEMA5-15P 90°</td>
<td>80 80</td>
<td>Black</td>
<td>United States, Canada, Mexico, Japan (100V or 200V), Philippines, Taiwan</td>
</tr>
<tr>
<td>250V</td>
<td>8120-1521 8120-1676</td>
<td>0 6</td>
<td>Straight*NEMA5-15P 90°</td>
<td>80 80</td>
<td>Jade Gray</td>
<td>East and West Europe, Saudi Arabia, Egypt, (unpolarized in many nations)</td>
</tr>
<tr>
<td>250 V</td>
<td>8120-2104</td>
<td>0 3</td>
<td>Straight*SEV1011 1959-24507 Type 12</td>
<td>79</td>
<td>Gray</td>
<td>Switzerland</td>
</tr>
<tr>
<td>250V</td>
<td>8120-0698</td>
<td>0 6</td>
<td>Straight*NEMA6-15P</td>
<td>80 80</td>
<td>Black</td>
<td>United States, Canada</td>
</tr>
<tr>
<td>1220V</td>
<td>8120-1957 8120-2956</td>
<td>0 2</td>
<td>Straight*DHCK107 90°</td>
<td>79 79</td>
<td>Gray</td>
<td>Denmark</td>
</tr>
<tr>
<td>250V</td>
<td>8120-4211</td>
<td>0 7</td>
<td>Straight*IEC83-B1</td>
<td>79 79</td>
<td>Black</td>
<td>South Africa, India</td>
</tr>
<tr>
<td>250V</td>
<td>8120-1860</td>
<td>0 6</td>
<td>Straight*CEE22-VI (Systems Cabinet Use)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Part number shown for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable including plug.

E = Earth Ground;  L = Line;  N = Neutral
Packaging

Tagging for Service. If the instrument is being returned to Hewlett-Packard for service, please complete one of the blue repair tags located at the end of this manual and attach it to the instrument.

Original Packaging Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number and full serial number. Also mark the container FRAGILE to assure careful handling. In any correspondence refer to the instrument by model number and full serial number.

Other Packaging The following general instructions should be used for re-packaging with commercially available materials:

1. Wrap the instrument in heavy paper or plastic. (If shipping to a Hewlett-Packard office or service center, attach a tag indicating the service required, return address, model number, and full serial number.)

2. Use a strong shipping container. A double-wall carton made of 2.4 MPa (350 psi) test material is adequate.

3. Use enough shock-absorbing material (75 to 100 mm layer; 3 to 4 in. layer) around all sides of the instrument to provide firm cushion and prevent movement inside the container. Protect the front panel with cardboard.

4. Seal the shipping container securely.

5. Mark the shipping container FRAGILE to assure careful handling.
3-1. INTRODUCTION TO THIS SECTION

This section provides operating instructions for the Hewlett-Packard Model 8660D Synthesized Signal Generator mainframe for both the local and remote modes.

The Model 8660D is designed to be used with plug-in sections that provide the selected output frequency with the chosen modulation parameters. Having access to the operating manuals for the plug-in sections you are using might make it easier to learn complete instrument operation.

NOTE

If a Modulation Plug-In Section is not used, it will be necessary to have an HP 86631B Auxiliary Section in place of the Modulation Section. The Auxiliary Section completes a signal path from the mainframe to the RF Section Plug-In and also provides a means of modulating the RF Section from an external source.

3-2. PANEL FEATURES

Front and rear panel controls, indicators and connectors of the HP 8660D are shown in Figure 3-1, and their functions are described in the following table.

<table>
<thead>
<tr>
<th></th>
<th>SINGLE SWEEP key. In the SINGLE mode, when pressed, causes the RF output to be swept, one time only across the range stored in the sweep register, at a speed determined by the sweep RATE key.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>OUTPUT (0 to +8V). Provides a sweep ramp for use in external equipment (oscilloscopes, X-Y recorders, etc.) when operating in the swept mode.</td>
</tr>
<tr>
<td>3</td>
<td>SWEEP RATE key. Selects sweep rates as follows: FAST — 100 steps at 1 millisecond per step, MED — 1000 steps at 1 millisecond per step, SLOW — 1000 steps at 50 milliseconds per step (functional only when in Single or Auto Sweep modes).</td>
</tr>
<tr>
<td>4</td>
<td>POWER STBY-ON switch. In the STBY position, with the instrument connected to the ac line source, the reference oscillator oven temperature is maintained at the operating temperature to avoid the necessity of allowing for a warm-up period each time the instrument is used.</td>
</tr>
<tr>
<td>5</td>
<td>CENTER FREQUENCY readout. Displays the output center frequency of the RF Section (when a frequency units annunciator is lit and is not flashing).</td>
</tr>
<tr>
<td>6</td>
<td>ANNUNCIATORS. Provide a visual display of mode of operation, crystal oven temperature and out-of-range frequency selection. A frequency display annunciator flashes if a frequency value is not transferred to a register (by pressing CF, Sweep Width, or Step).</td>
</tr>
<tr>
<td>7</td>
<td>TUNING. Works as specified in the MANUAL MODE descriptions. May also be used to set the RF output to any point within the limits stored in the sweep register when the SWEEP MODE key is set to MANUAL.</td>
</tr>
</tbody>
</table>
### 8 MANUAL MODE
Works in conjunction with the TUNING control to step the RF output in steps of 1 Hz (FINE), 1 kHz (MED), and 1 MHz (COARSE). In the STEP position the TUNING control steps the RF output frequency by the step stored in the instrument.

### 9 DATA KEYS
Contains 20 keys which are used to enter data or instructions as follows:

- Numerals 0 through 9
- Decimal Point (. )
- $\Leftarrow$ Clears last data entry.
- GHz, MHz, kHz, and Hz select frequency in conjunction with numeric keys.
- CF transfers keyboard storage register data to the center frequency register.
- $\uparrow$ transfers keyboard storage register data to the step register or steps the center frequency up when keyboard data is not present on the display.
- $\downarrow$ Same as $\uparrow$ except that frequency is stepped down.
- SWEEP WIDTH transfers keyboard storage register data to sweep register.

### 10 SHIFT
Blue SHIFT key lights up amber annunciator when pressed. At this time any one of the following shifted functions (blue key labels) can be selected.

- RESET sets instrument to power up state.
  - CF = 1 MHz
  - Sweep Width = 2 MHz
  - Step = 5 MHz
  - HP-IB Addr = 19 (or value selected by internal dip switches)
  - Sweep Functions: Off
  - Manual Step Mode: Off

ERROR will redisplay error codes 01~05 (Refer to Error Codes.)
SET ADRS allows HP-IB address (0~30) to be entered into volatile memory. Power down or instrument reset will cause the address to revert back to the manually set switch address.
DISPLAY ADRS displays current HP-IB address or BCD if BCD is selected.
LOCAL allows keyboard entry of data during remote programming (returns instrument to the local mode).
CLEAR KYBD causes display to revert to center frequency.
DISPLAY $\uparrow$ or $\downarrow$ displays step size.
DISPLAY SWEEP WIDTH displays sweep width.

### 11 SWEEP MODE key
With the sweep mode switch in the AUTO position, sweep operation is automatic; the RF output is swept continuously about the center frequency by the data stored in the sweep register at the rate selected by the SWEEP RATE key. In the SINGLE mode, the RF output is swept once each time the SINGLE key is pressed. In the MANUAL mode, the sweep is controlled by the MANUAL TUNE control and the data stored in the sweep register.

### 12 LINE MODULE
Contains a means of switching input line voltage to 100/120/220/240 Vac $\pm 5\% - 10\%$, fuse, line cable connector and filtering. NOTE: The cabinet (earth) ground is also applied through the line module.

### 13 REFERENCE INPUT
Used when an external standard of 5 or 10 MHz is used.

### 14 REFERENCE OUTPUT
Provides the capability of using the internal reference as a time base in external equipment.

### 15 SELECTOR
Selects INT or EXT reference.

### 16 REMOTE INPUTS
When the instrument is operated in the remote mode, all functions of the instrument are controlled by the remote programming device. Front panel controls (except for LINE STBY-ON) have no effect on operation of the instrument.
Figure 3-1. Front and Rear Panel Features
3-3. OPERATOR'S MAINTENANCE

Operator's maintenance of the HP 8660D Synthesized Signal Generator mainframe is limited to fuse replacement.

3-4. OPERATING PRINCIPLES

The HP 8660D may be operated by front panel controls in the local mode or externally programmed in the remote mode. Allow the system to warm up for 15 minutes before operating.

WARNING

The power requirements and safety precautions listed throughout this manual must be observed to preserve the built-in safety features of the HP 8660D.

3-5. LOCAL OPERATION

In the local mode of operation, all functions of the mainframe are controlled by front panel controls, except when an external reference oscillator is used. When an external reference oscillator is used, the rear panel SELECTOR switch must be in the EXT position.

The 25-key keyboard may be used to:

1. Select any frequency within the range of the RF Section plug-in in 1 Hz increments (above 1300 MHz, 2 Hz increments).

NOTE

When a center frequency is keyed in on the HP 8660D, the frequency is displayed and the units (GHz, MHz, kHz, Hz) annunciator flashes. Upon keying in CF, the frequency is accepted or rejected. If the entered frequency is above the upper limit of the RF Section (plug-in) being used, the readout reverts back to the last valid entry. If the frequency being entered is below the minimum frequency limit, the frequency is displayed but the RANGE annunciator comes on, indicating that the output amplitude may be degraded.

2. When frequencies below the RF Section frequency range are selected, the RANGE lamp lights.

3. Select any desired sweep width within the frequency range of the RF Section in use.

4. Select any incremental step within the frequency range of the RF Section in use.

Sweep Functions

The sweep width is selected by entering a frequency, then pressing SWEEP WIDTH. The sweep width may be displayed on the CENTER FREQUENCY readout by pressing the blue SHIFT key and then the SWEEP WIDTH key.

When the SWEEP MODE key is in the AUTO mode the output signal of the RF Section is swept about the selected center frequency by the selected sweep width. (Example: With the center frequency at 50 MHz and the sweep width at 20 MHz, the RF output is swept from 40 to 60 MHz.) The sweep rate, selected by the SWEEP RATE key is as follows: FAST - 100 steps at 1 millisecond per step, MED - 1000 steps at 1 millisecond per step and SLOW - 1000 steps at 50 milliseconds per step.

When the SWEEP MODE key is in the SINGLE mode, pressing the SINGLE SWEEP key causes the output of the RF Section to be swept one time. When the single sweep is completed, the output of the RF Section returns to the selected center frequency. The sweep width and sweep rate are selected in the same manner as they are in the AUTO mode.
Manual Tuning

When the SWEEP MODE key is in the MANUAL position, the output frequency of the RF Section may be manually controlled by the TUNING knob. In this mode the sweep width is still controlled by the information in the sweep register. The selected sweep width in this mode is divided by 1000 and the output of the RF Section may be controlled in frequency steps that are 1/1000 of the sweep width. (Example: with a 50 MHz center frequency and a 20 MHz sweep width, output may be swept manually from 40 to 60 MHz in 20 kHz steps.)

The center frequency may be stepped up or down in any increment within the frequency range of the RF Section in use. Enter the desired increment and units, then press STEP † or STEP ‡. The increment entered into the step register remains in the register until changed (or the instrument is reset or placed in standby mode) and may be displayed on the readout by pressing the blue SHIFT key, then the STEP † or STEP ‡ key.

MANUAL MODE can be used for changing the center frequency. Choose STEP mode and the TUNING knob will increment the frequency by the same value stored in the STEP register.

The other increments selected by the MANUAL MODE key are 1 Hz (FINE), 1 kHz (MED), and 1 MHz (COARSE).

3-6. OPERATOR’S CHECKS

NOTE

If the instrument is returned for service, be sure to attach a blue repair tag (located at the end of this manual) with failure information.

During final checkout at the factory the HP 8660D Synthesized Signal Generator mainframe is adjusted for proper operation. No adjustments should be required when the instrument is received. The following operator’s checks are based on the assumption that properly operating RF Sections and Modulation Sections are in place during the tests. Refer to the manuals for the specific plug-ins for operating parameters.

The steps listed in the Operator’s Checks need not be followed in the sequence listed. Their purpose is to aid operators in familiarizing themselves with the instrument, and to provide assurance that all functions of the instrument are operating properly.

Many of the tests specified in the Operators checks do not apply specifically to an RF Section (plug-in). Those checks which do not refer to a specific RF Section apply equally to the HP 86601, HP 86602, and HP 86603. When procedures apply to specific RF Sections only, this information is conveyed in the procedure.

NOTE

Any operator’s checks specified in the plug-in manuals should also be performed.

Initial Turn-On Check

1. Set the rear panel line select switch in the line power module to be compatible with the available line power (refer to Section 2).

2. Connect the instrument to the power outlet; use ground pin adapter for electrical systems having no ground outlet.
NOTE

The instrument should remain connected to the power source in the STBY (standby) mode when not in use. This will maintain a constant temperature in the crystal oven and eliminate the need for a warmup period.

3. Place the POWER key (STBY/ON) in the ON position. Allow the system to warm up for 15 minutes before operating.

The cooling fan should start and the display should read 1.000000 MHz.

Keyboard Register and Readout Checks.

1. Enter 1.234567890. Note that readout input steps from right to left.

   Units annunciators (GHz, MHz, kHz, Hz) should be off and the display should read 1.234567890.

2. Press GHz key.

   The display should read: 1.234567890 GHz (Units annunciator flashing).

3. Press MHz key.

   The display should read: 1.234567 MHz (Units annunciator flashing).

4. Press kHz key.

   The display should read: 1.234 kHz (Units annunciator flashing).

5. Press Hz key.

   The display should read: 1 Hz (Units annunciator flashing).

6. Press the \leftarrow key.

   The display should read: 1.000000 MHz.


   a. Press the kHz key.

      The display should read: 1.000 kHz (Units annunciator flashing).

   b. Press the MHz key.

      The display should read: 1.000000 MHz (Units annunciator flashing).

   c. Press the GHz key.

      The display should read: 1.00000000 GHz (Units annunciator flashing).

   d. Press the \texttt{SHIFT} key and then the \leftarrow key.

      The display should read: 1.000000 MHz.

Step \uparrow \downarrow Register and RANGE Annunciator Check Using the HP 86601 RF Section.

1. Enter 109 MHz and press CF on the keyboard.

   The display should read: 109.000000 MHz.

2. Enter 111111 Hz and press \texttt{STEP} \uparrow key.

   The display should read: 109.000000 MHz.

3. Press the \texttt{SHIFT} key and then the \texttt{STEP} \downarrow key.

   The display should read: 111111 Hz, momentarily, then return to 109.000000 MHz.
4. Press the **STEP ↑** key until the readout shows 109.999999 MHz. Note that the readout increments in 11111 Hz steps.

5. Press the **STEP ↑** key one more time.

The RANGE annunciator should flash once.

6. Press the **MANUAL MODE** key four times to put manual tuning in **STEP** mode and turn the **TUNING** knob counterclockwise. The value in the display should decrement in 11111 Hz steps.

7. Enter 10 kHz and press the **CF** key.

The display should read: 10.000 kHz.

8. Enter 1 Hz and then press the **STEP ↑** key.

The display should read: 10.000 kHz.

9. Press the **STEP ↓**.

The display should read: 9.999 kHz.

10. With the Model 86601A RF Section the specified lower frequency limit is 10 kHz, therefore, the RANGE light should stay on.

**NOTE**

*The Model 86601A RF Section lower frequency limit is specified at 10 kHz. The output frequency is accurate down to 1 Hz and the output power level is typically accurate down to 3 kHz or less. However, the output signal should be considered unusable below 1.5 kHz.*

11. Enter 3 kHz **CF** on the keyboard.

The display should read: 3.000 kHz, the RANGE light should be on.

12. Enter 100 Hz **STEP ↓**.

The display should read: 3.000 kHz.

13. Repeatedly press the **STEP ↓** key. Note that the **CF** readout decreased in 100 Hz steps. The **RF** output level will typically start to drop when the frequency drops below 2 kHz. Also, the RANGE light will remain on.

**STEP ↑↓ Register and RANGE Annunciator Check with the 86602A RF Section.**

1. Enter 1200 MHz **CF** on the keyboard.

The display should read: 1.200000000 GHz.

Enter 11.111111 MHz **STEP ↑**

2. Press **STEP ↑** until display reads: 1.299999999 MHz.

3. Press the **STEP ↑** key one more time.

The display should read: 1.299999999 GHz and the RANGE light should flash once.

4. Repeatedly press the manual **MODE** key until manual tuning is in **STEP** mode, and turn the **TUNING CONTROL** counterclockwise.

The readout should decrease in 11.111111 MHz steps.
5. Enter 1 MHz CF on the keyboard.
   The display should read: 1.000000 MHz.

6. Enter 1 Hz STEP ‹ on the keyboard. Press SHIFT key. Press the STEP ‹ key.
   The display should read: 1 Hz, momentarily, then return to 1.000000 MHz.

7. Press STEP ‹ key. The RANGE light should come on.

**STEP ‹› Register and RANGE Annunciator Check with the 86603A RF Section.**

1. Enter 2500 MHz CF on the keyboard.
   The display should read: 2.50000000 GHz.

2. Enter 11.111111 MHz STEP ‹ on the keyboard.
   The display should read 2.50000000 GHz.

3. Press STEP ‹ until the readout displays: 2.599999998 GHz.

**NOTE**

*The frequency increase alternates between 11.111110 and 11.111112 MHz due to the 2 Hz resolution of center frequencies ≥1300 MHz.*

4. Press the STEP ‹ key one more time.
   The display should read: 2.599999998 MHz and the RANGE light should flash once.

5. Repeatedly press the manual MODE key until manual tuning is in STEP mode. Turn the TUNING CONTROL counterclockwise.
   The readout decrease is in 11.1111110 or 11.1111112 MHz steps down to 1300 MHz. When the frequency gets below 1300 MHz, it will decrease in 11.1111111 MHz steps (down to a minimum of 25 Hz).

6. Enter 1 MHz CF on the keyboard. Enter 1 Hz STEP ‹ on the keyboard.
   The display should read: 1.000000 MHz.

7. Press the STEP ‹ key.
   The display should read: 999.999 kHz and the RANGE light should stay on.

**Manual Mode - Manual Tuning Check (With 86601A)**

**NOTE**

*The upper frequency limit for 86602A/B RF Section is 129.999999 MHz; for 86603A, 2599.999998 MHz*

1. Set SWEEP MODE off (no annunciators lit) and enter 0 MHz CF.
   Display should read: 0 Hz and RANGE light is on.

2. Repeatedly press the manual MODE key until Manual Mode is set to COARSE and rotate the TUNING control clockwise until the readout indicates: 109.000000 MHz. Note that the readout steps in 1 MHz increments.

3. Repeatedly press the manual MODE key until Manual Mode is set to MED and rotate the TUNING control clockwise until the readout indicates: 109.999000 MHz. Note that the readout steps i. 1 kHz increments.
4. Repeatedly press the manual **MODE** key until Manual Mode is set to FINE, then rotate the TUNING control clockwise until the readout indicates: 109.999999 MHz. Note that the readout steps in 1 Hz increments.

**NOTE**

*The RANGE light flashes on if the RF Section upper frequency limit (109.999999 MHz) is passed. The system rejects overrange frequencies and the CF register retains the last valid entry.*

**Sweep Mode Checks with 86601A RF Section**

**NOTE**

*Proper operation of the instrument in the sweep mode is best verified with a spectrum analyzer. However, operation of the sweep function can be verified by front panel indications in steps 1 and 2. Also, when the RANGE light comes on during these checks, it is because the frequency has dropped below the lower frequency limit of 10 kHz.*

1. Set CF to 5 kHz. Enter 10 kHz and press SWEEP WIDTH. Place SWEEP MODE in the AUTO position and the SWEEP RATE in MED position. The SWEEP and RANGE lights should be on.

2. Set CF to 10 kHz. The SWEEP light should remain lit. RANGE light should flash every second.

3. Connect the RF output to the RF INPUT of the spectrum analyzer. Enter 10 MHz CF and 10 MHz SWEEP WIDTH and set the SWEEP MODE to AUTO. Set the SWEEP RATE to MED and adjust the spectrum analyzer for a clear display. Enter 5 MHz STEP and step the frequency across the RF range. The readout should increase in 5 MHz steps. Sweep should continue to be 5 MHz on each side of the CF.

**Sweep Mode Checks with 86602A, 86602B or 86603A RF Sections**

**NOTE**

*When the RANGE light comes on during the HP 86602/HP 86603 checks, it is because the frequency has dropped below the lower frequency limit of 1 MHz.*

1. Set CF to 5 MHz. Set SWEEP WIDTH to 10 MHz. Set SWEEP MODE to AUTO and SWEEP RATE to MED.

   Display should read: 5.000000 MHz, and the RANGE light will flash every second. RF Section meter also will dip, and SWEEP light will remain on.

2. Set SWEEP WIDTH to 2 MHz. Set CF to 1 MHz.

   The display should read: 1.000000 MHz with SWEEP light on. The RANGE light will flash every second.

3. Set CF to 5 MHz on the keyboard. Set SWEEP WIDTH to 10 MHz. Set SWEEP RATE to MED.

   Display should read: 5.000000 MHz, and the RANGE light will flash every second.
Manual Sweep Check

1. Enter 50 MHz CF and 10 MHz SWEEP WIDTH. Place the SWEEP MODE in the MANUA' position. Rotate the TUNING control knob through its range. Note that CF is tuneable from 4 to 55 MHz.

Single Sweep Check

1. Enter 50 MHz CF and 20 MHz SWEEP WIDTH and place the SWEEP MODE in the SINGLE position. Connect the RF output to the RF INPUT of the spectrum analyzer to display the 50 MHz signal. Press the SINGLE SWEEP key.

Display should read: 50.000000 MHz. The spectrum analyzer display is swept once from 40 to 60 MHz.

Modulation Plug-ins

Since the modulation plug-ins are not affected by the mainframe except for digital control signals, operator's checks for the modulation plug-ins are not included in the Operator's Checks. Refer to the individual manuals for the modulation plug-in operator's checks.

3-7. ERROR CODES

Table 3-1 explains the meaning of all error codes the HP 8660D Digital Control Unit (DCU) is programmed to output. Note that errors 01-05 can be redisplayed by pressing the blue SHIFT, ERROR.

3-8. HP-IB PROGRAMMING; "OLD" AND "NEW" CODES EXPLAINED

The HP 8660D features a new DCU section which recognizes two versions of HP-IB code. The version used by the HP 8660A, HP 8660B and HP 8660C is termed "OLD". It is the only code recognized by the HP 8660D after being powered up or reset, or when the command "OLD" is sent via HP-IB.

An extended version of HP-IB codes is termed "NEW", and these codes are the only ones that can be used after the command "NEW" is sent. The "NEW" codes can also be used when adding to existing programs which may contain "OLD" codes. Simply send the command "NEW" for code being added, and send the command "OLD" before the program goes back to a section of "OLD" code.

The advantages of the "NEW" over the "OLD" programming code includes:

- Frequency units of GHz, MHz, kHz, and Hz are used. No conversion to Hz necessary.
- No digit reversal required.
- Desired output level is entered directly in +dBm or -dBm. No adjustment is needed to compensate for a +13 dBm reference level.
- Programming syntax is consistent with other HP signal generators currently being manufactured.
### Table 3-1. Error Codes

<table>
<thead>
<tr>
<th>Error</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>This error occurs when an error is detected during power-up RAM TEST (can be redisplayed by pressing the blue SHIFT, ERROR).</td>
</tr>
<tr>
<td>02</td>
<td>This error occurs when an error is detected in ROM Checksum during power-up (can be redisplayed by pressing the blue SHIFT, ERROR).</td>
</tr>
<tr>
<td>03</td>
<td>This error occurs when a Read error occurs during the Read/Write test of the instrument interface PIA (A1A3U8) ports during the power-up Self Test (can be redisplayed by pressing the blue SHIFT, ERROR).</td>
</tr>
<tr>
<td>04</td>
<td>This error occurs when a Read error is detected during the Read/Write check of the BCD Interface PIA (A1A5U7) during the power-up Self Test (can be redisplayed by pressing the blue SHIFT, ERROR).</td>
</tr>
<tr>
<td>05</td>
<td>This error occurs when in the Sweep Mode and the Sweep Width has been selected such that it will cause the CW to sweep to a Frequency below 0 Hz or above the maximum output frequency of the RF plug-in. (can be redisplayed by pressing the blue SHIFT, ERROR).</td>
</tr>
<tr>
<td>06</td>
<td>This error occurs when an HP-IB address that is &gt; 30 is input via the keyboard.</td>
</tr>
<tr>
<td>07</td>
<td>This error occurs when an unrecognized command or ASCII character is received over the GPIB while in the &quot;OLD&quot; programming format.</td>
</tr>
<tr>
<td>08</td>
<td>This error occurs when an unrecognized command or ASCII character is received over the GPIB while in the &quot;NEW&quot; programming format.</td>
</tr>
</tbody>
</table>
| 09    | This error occurs only in the HP-IB "NEW" programming format when an output level which is out of the respective plug-in's output range is programmed over the GPIB. This error condition aborts the command.  

**NOTE**  
The Output Level is programmed with a maximum of three significant digits.

| 0A    | This error occurs only in the HP-IB "NEW" programming format when a modulation level which is out of range for the specified modulation type is programmed over the GPIB. (For example, AM > 99 PC, PM > 99 DG, FM > 990 KHz, or FM < 0.1 KHz.)  

**NOTE**  
Modulation is programmed with a maximum of three significant digits.
3-9. SIGNAL GENERATOR FUNCTION TO “NEW” HP-IB CODES

Table 3-2 organizes the HP 8660D operating functions to their corresponding HP-IB “NEW” programming codes.

<table>
<thead>
<tr>
<th>Function</th>
<th>Code</th>
<th>Function</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>FREQUENCY</td>
<td></td>
<td>MODULATION SOURCE</td>
<td></td>
</tr>
<tr>
<td>Center Frequency</td>
<td>FR</td>
<td>Internal 1 kHz</td>
<td>M1</td>
</tr>
<tr>
<td>Frequency Step Up</td>
<td>UP</td>
<td>Internal 400 Hz</td>
<td>M2</td>
</tr>
<tr>
<td>Frequency Step Down</td>
<td>DN</td>
<td>Internal dc-Coupled</td>
<td>M4</td>
</tr>
<tr>
<td>Increment Set</td>
<td>(FR)S</td>
<td>External ac-Coupled</td>
<td>M8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>External ac-Coupled Unleveled</td>
<td>M9</td>
</tr>
<tr>
<td>AMPLITUDE</td>
<td></td>
<td>SWEEP</td>
<td></td>
</tr>
<tr>
<td>Output Level</td>
<td>AP</td>
<td>Sweep Width</td>
<td>FS</td>
</tr>
<tr>
<td>MODULATION</td>
<td>FM$^1$</td>
<td>Sweep Mode:</td>
<td></td>
</tr>
<tr>
<td>FM Deviation</td>
<td>AM$^2$</td>
<td>Sweep Off</td>
<td>WO</td>
</tr>
<tr>
<td>AM Depth</td>
<td>PM$^3$</td>
<td>Auto Sweep</td>
<td>W1</td>
</tr>
<tr>
<td>FM Deviation</td>
<td>MO</td>
<td>Single Sweep</td>
<td>W2</td>
</tr>
<tr>
<td>Modulation Off</td>
<td>PC</td>
<td>Single Sweep Trigger</td>
<td>W3</td>
</tr>
<tr>
<td>Modulation Level</td>
<td>FC</td>
<td>Sweep Rate:</td>
<td></td>
</tr>
<tr>
<td>FM Calibration</td>
<td>DG</td>
<td>SL</td>
<td>T1</td>
</tr>
<tr>
<td>Modulation Degrees</td>
<td>CN$^4$</td>
<td>MED</td>
<td>T2</td>
</tr>
<tr>
<td>FM±2</td>
<td></td>
<td>FAST</td>
<td>T3</td>
</tr>
<tr>
<td>DISPLAY</td>
<td>DB</td>
<td>UNITS</td>
<td></td>
</tr>
<tr>
<td>Blank CF Display</td>
<td>DO</td>
<td>GHz</td>
<td>GZ</td>
</tr>
<tr>
<td>Output CF Display</td>
<td></td>
<td>MHz</td>
<td>MZ</td>
</tr>
<tr>
<td>MISCELLANEOUS</td>
<td>OLD</td>
<td>kHz</td>
<td>KZ</td>
</tr>
<tr>
<td>HP-IB “OLD” Mode</td>
<td>NEW</td>
<td>Hz</td>
<td>HZ</td>
</tr>
<tr>
<td>HP-IB “NEW” Mode</td>
<td></td>
<td>+dBm</td>
<td>+dm</td>
</tr>
<tr>
<td>Register Clear</td>
<td>/</td>
<td>−dBm</td>
<td>−dm</td>
</tr>
</tbody>
</table>

1 FM code must be followed by up to 3 digits of FM deviation, followed by the units. For example, FM150KZ.
2 AM depth must be programmed using PC (%).
3 PM depth must be programmed using DG (°).
4 If CN is not programmed in when the modulation section is 86632B, or 86635A, the FM or AM modulation will be twice the value programmed.
3-10. HP-IB CAPABILITIES

Refer to the following table for a synopsis of HP-IB operations the HP 8660D is capable of performing.

**Table 3-3. HP-IB Capabilities**

<table>
<thead>
<tr>
<th>HP-IB Capability</th>
<th>Applicable</th>
<th>Response</th>
<th>Related Commands and Controls*</th>
<th>Interface Functions*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>Yes</td>
<td>All Front-Panel functions and Remote only functions are programmable (except knob rotation and all shift key functions excluding LOCAL).</td>
<td>MLA, EOI</td>
<td>T6, AH1, SH1</td>
</tr>
<tr>
<td>Trigger</td>
<td>No</td>
<td>The Signal Generator does not have a device trigger capability.</td>
<td>GET</td>
<td>DT0</td>
</tr>
<tr>
<td>Clear</td>
<td>No</td>
<td>The Signal Generator does not respond to the DCL or SDC bus commands</td>
<td>DCL, SDC</td>
<td>DC1</td>
</tr>
<tr>
<td>Remote</td>
<td>Yes</td>
<td>The Signal Generator's Remote mode is enabled when the REN bus line is true. However, it remains in local (that is, the keyboard is active) until it is first addressed to listen. The RF output power level goes to its minimum level upon entering the remote mode. The front-panel REMOTE indicator turns on when in the remote mode.</td>
<td>RNA, MLA</td>
<td>RL1</td>
</tr>
<tr>
<td>Local Lockout</td>
<td>Yes</td>
<td>The Signal Generator responds to the LLO bus command.</td>
<td>LLO</td>
<td>RL1</td>
</tr>
<tr>
<td>Clear lockout/Set local</td>
<td>Yes</td>
<td>The Signal Generator returns to the local mode when the REN bus line goes false.</td>
<td>REN</td>
<td>RL1</td>
</tr>
<tr>
<td>Pass control/Take control</td>
<td>No</td>
<td>The Signal Generator does not pass or take control of the HP-IB bus.</td>
<td>ATN, IFC</td>
<td>C1, C2, C3, C28</td>
</tr>
<tr>
<td>Require Service</td>
<td>No</td>
<td>The Signal Generator does not activate the SRQ bus line.</td>
<td>SRQ</td>
<td>SR1</td>
</tr>
<tr>
<td>Status Byte</td>
<td>No</td>
<td>The Signal Generator does not respond to a serial poll enable.</td>
<td>SPE, SPD, MTA</td>
<td>T6</td>
</tr>
<tr>
<td>Status Bit</td>
<td>No</td>
<td>The Signal Generator does not respond to a parallel poll enable.</td>
<td>ATN, EOI</td>
<td>PPO</td>
</tr>
<tr>
<td>Abort</td>
<td>Yes</td>
<td>The Signal Generator stops listening.</td>
<td>IFC</td>
<td>T6, L3</td>
</tr>
</tbody>
</table>

* Commands, Control lines and Interface Functions are defined in IEEE Std 488 (and the identical ANSI Standard MC1.1). Knowledge of these might not be necessary if your controller's manual describes programming in terms of the twelve HP-IB Messages shown in the left column.

Complete HP-IB capability as defined in IEEE Std 488 (and the identical ANSI Standard MC1.1) is: SH1, AH1, T6, TEO, L3, LEO, SR1, RL1, PP0, DC1, DT0, C1, C2, C3, C28, E2.
3-11. EXAMPLE PROGRAM

This program is written in BASIC for the HP 9826 computer. The program will display a menu of softkey selections which allow you to enter frequency, modulation, amplitude, frequency step, and go to local or remote operation.

You must have a modulation plug-in (HP 86632B or HP 86635A) and any RF section plug-in to use all the features of the program.

Once the program is loaded and running, press remote to display softkey selection.

10 !
20 !
30 ! COMPUTER CONTROL OF THE
40 ! HP 8660D
50 ! USING THE 9826
60 !
70 ! RESTORE "TEST6MD"
80 !
90 DIM Input$, [6], Step_size$, [11]
100 DIM Center_freq$, [11], Rf_level$, [4]
110 DIM Modulation$, [6], Mod_source$, [1]
120 !
130 CLEAR 7
140 !
150 Local_operation: ! Enable local mode and give user choice of stopping
160 LOCAL 719 ! program or going into remote mode.
170 OFF KEY
180 ON KEY 3 LABEL "STOP" GOTO Stop_pgm
190 ON KEY 8 LABEL "REMOTE" GOTO Remote
200 GOTO 200
210 !
220 Remote: ! Enable remote mode and set 8660D to new programming
230 REMOTE 7 ! mode. Provide softkey selection of frequency, output
240 OUTPUT 719; "NEW" ! level, modulation, step size, step up, step down, and
250 OFF KEY ! local modes.
260 ON KEY 0 LABEL "FREQ" GOSUB Center_freq
270 ON KEY 1 LABEL "MOD" GOSUB Modulation
280 ON KEY 5 LABEL "LEVEL" GOSUB Rf_level
290 ON KEY 7 LABEL "S SIZE" GOSUB Set_step_size
300 ON KEY 3 LABEL "UP" GOSUB Step_up
310 ON KEY 4 LABEL "DOWN" GOSUB Step_down
320 ON KEY 8 LABEL "LOCAL" GOTO Local_operation
330 GOTO 330
340 !
350 Center_freq: ! Input and program center frequency.
360 DISP "Enter center frequency in MHz";
370 INPUT Center_freq$
380 GOSUB Set_center_freq
390 RETURN
400 !
410 Rf_level: ! Input and program RF level.
420 DISP "Enter Rf level in dBm";
430 INPUT Rf_level$
440 GOSUB Set_rf_level
450 RETURN
460 !
470 Modulation: ! Input type of modulation desired and enable
480 ! softkey selection.
490 DISP "Enter type of mod: AM, FM, PHASEM or none";
500 INPUT Modulation$
510 IF Modulation$="AM" THEN
520 ON KEY 6 LABEL "AM" GOSUB Am
530 GOSUB Am
540 RETURN
END IF
560 IF Modulation$="FM" THEN
570 ON KEY 6 LABEL "FM" GOSUB Fm
580 GOSUB Fm
590 RETURN
600 END IF
610 IF Modulation$="PHASEM" THEN
620 ON KEY 6 LABEL "PHASEM" GOSUB Phasem
630 GOSUB Phasem
640 RETURN
650 END IF
660 IF Modulation$="none" THEN
670 OUTPUT 719:"MO"
680 OFF KEY 6
690 RETURN
700 END IF
710 GOTO Modulation
720 Am:
730 DISP "Enter AM depth in percent";
740 INPUT Modulation$
750 GOSUB Set_mod_source
760 GOSUB Set_am_depth
770 RETURN
790 !
800 Fm:
810 DISP "Enter FM deviation in kHz";
820 INPUT Modulation$
830 GOSUB Set_mod_source
840 GOSUB Set_fm_dev
850 RETURN
860 !
870 Phase:
880 DISP "Enter phase deviation in degrees";
890 INPUT Modulation$
900 GOSUB Set_mod_source
910 GOSUB Set_ps_dev
920 RETURN
940 !
950 Stop_pgm:
960 STOP
970 !
980 Set_mod_source:
990 DISP "Enter the type of modulation source desired:
1000 internal 1000 Hz, internal 400 Hz, external DC, external AC, or external AC unlevelled.
1010 INPUT$
1020 Mod_source$="0"
1030 ENTER Source: DISP "Enter Source: I1000,I400,EDC,EAC,EACU";
1040 INPUT$
1050 IF Input$="I1000" THEN Mod_source$="1"
1060 IF Input$="I400" THEN Mod_source$="2"
1070 IF Input$="EDC" THEN Mod_source$="4"
1080 IF Input$="EAC" THEN Mod_source$="8"
1090 IF Input$="EACU" THEN Mod_source$="9"
1100 IF Mod_source$="0" THEN GOTO ENTER Source
1110 RETURN
1120 !
1130 Set_step_size:
1140 DISP "Enter step size in MHz";
1150 INPUT Step_size$
1160 OUTPUT 719:"IS";Step_size$;"Mz"
1170 RETURN
1180 !
1190 Step_up:
1200 OUTPUT 719:"UP"
Operation

1210 RETURN
1220 !
1230 Step_down: ! Program frequency step down.
1240 OUTPUT 719:"DN"
1250 RETURN
1260 !
1270 Set_center_freq: ! Output programmed center frequency to the 8660.
1280 OUTPUT 719:"FR";Center_freq$:"Mz"
1290 RETURN
1300 !
1310 Set_rf_level: ! Output programmed RF level to the 8660.
1320 OUTPUT 719:"AP";Rf_level$:"dm"
1330 RETURN
1340 !
1350 Set_am_depth: ! Output programmed AM depth to the 8660.
1360 OUTPUT 719:"M";Mod_source$:"AM";Modulation$:"PC"
1370 RETURN
1380 !
1390 Set_fm_dev: ! Output programmed FM deviation to the 8660.
1400 OUTPUT 719:"M";Mod_source$:"FM";Modulation$:"KZ"
1410 RETURN
1420 !
1430 Set_pm_dev: ! Output programmed Phase deviation to the 8660.
1440 OUTPUT 719:"M";Mod_source$:"PM";Modulation$:"DG"
1450 RETURN
1460 END

HP-IB Address Selection

The Signal Generator's address is set to 19 at the factory by an internal switch located inside the instrument. This address can be locally changed using either the front-panel function, SET ADRS, or the internal switch. The HP-IB address cannot be changed by remote command.

It is simpler to change the address from the front panel than from the internal switch. However, it is a more permanent change to change the address using the internal switch. The address set from the front panel reverts to the address set by the internal switch whenever the instrument is turned off, then on again.

Changing the Address from the Front Panel

Available addresses are from 00 to 30.

Example of changing the address to 15:

1 5 SET ADRS (SHIFT 1)

Changing the Address Using the Internal Switch

For a procedure for changing the address using the internal switch, refer to Remote Selection in Section 2 of this manual.

Further HP-IB Programming Information

For more information about HP-IB, refer to one or all of the following documents:

IEEE Standard 488-1978

ANSI Standard MC1.1

"Improving Measurements in Engineering and Manufacturing" (HP part number 5952-0058)(the Hewlett-Packard catalog of Electronic Systems and Instruments)

"Tutorial Description of the Hewlett-Packard Interface Bus" (HP part number 5952-0156)
Figure 3-3. HP 8660D Data Input and Error Output Timing
Data Inputs

Data inputs (logic 1=0V) must be referenced to the command pulse as shown in Figure 3-3. The data inputs may be terminated after the command pulse trailing edge.

The command pulse causes the input data to be stored in the temporary storage register or, if the data input is an address, to be stored in one of the final storage registers. These pulses are logic 1 (0V) pulses of 100 nanoseconds minimum width, maximum frequency of 500 kHz. Pulses for low transfer frequencies may be wider if consistent with the duty cycle. The trailing edge must have a rise time of 100 nanoseconds or less. Transfer occurs on the trailing edge of the pulse. Note that data must be held until the command pulse terminates. The flag signal is also initiated by the falling (leading) edge of the command pulse.

Flag Signal

The flag signal indicates receipt and execution of the command pulse from the remote programming device. The flag signal will be logic 1 (0V). Duration of the signal will depend on the function programmed.

Reset

Controls the DCU circuits in the same manner as a front panel reset. Requires a logic 1 (0V) level which may be as short as 5 microseconds.

### Table 3-4. Storage Register Addresses

<table>
<thead>
<tr>
<th>Name of Register</th>
<th>Address 0=High, 1=Low</th>
<th>Location</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center Frequency</td>
<td>0000 (0)</td>
<td>Mainframe</td>
<td>To Set Frequency</td>
</tr>
<tr>
<td>Step ↑</td>
<td>0001 (1)</td>
<td></td>
<td>To step center frequency up in any increment</td>
</tr>
<tr>
<td>↓ Step</td>
<td>0010 (2)</td>
<td>Mainframe DCU</td>
<td>To step center frequency down in any increment</td>
</tr>
<tr>
<td>Attenuator</td>
<td>0011 (3)</td>
<td>RF Section plug-in</td>
<td>Controls level of RF OUTPUT</td>
</tr>
<tr>
<td>AM-FM Function</td>
<td>0100 (4)</td>
<td>Modulation Section plug-in</td>
<td>Selects Modulation Function</td>
</tr>
<tr>
<td>AM-FM%</td>
<td>0101 (5)</td>
<td>Modulation Section plug-in</td>
<td>*Selects AM% of Modulation or FM Deviation</td>
</tr>
<tr>
<td>FM CAL 86632 or 86635 only</td>
<td>0110 (6)</td>
<td>Modulation Section plug-in</td>
<td>Phase locks 20 MHz FM oscillator to the reference loop 20 MHz</td>
</tr>
</tbody>
</table>

* The HP 86632B and the HP 86635A require inputs of one-half of the desired deviation in remote mode.

### Example 1. Set 100.000000 MHz Center Frequency (CF)

<table>
<thead>
<tr>
<th>Input (0=High, 1=Low)</th>
<th>Temporary Register</th>
<th>CF Register</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data: D₁ 0001 (1) D₂ 0000(0)</td>
<td>00 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>01 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Address: D₁ 1111 (15) D₂ 0000(0)</td>
<td>01 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Transfer Command</td>
<td>00 00 00 00 00</td>
<td>01 00 00 00 00</td>
</tr>
</tbody>
</table>

3-20
For a detailed description of the Hewlett-Packard Interface Bus connector, refer to Figure 3-2.

For information regarding "OLD" HP-IB programming codes, refer to Programming Note HP part number 5953-8391, or the HP 8660 A, B, or C manuals.

3-12. BCD REMOTE OPERATION

NOTE

The following information pertaining to BCD programming, does not apply to HP-IB programming.

There are several conventions which must be observed when remotely controlling the 8660D using BCD code. Besides providing data with the least significant digit first, these conventions include:

1. All output levels are referenced to +13 dBm. This reference operation involves subtracting 13 from the desired output level.

2. There are three separate modulation parameters which may be programmed; source, type and %. Source and type are combined into one number (source is the least significant digit).

3. When in the remote mode, all front panel controls except the POWER and FM CAL controls and the SHIFT, POWER and LOCAL keys are inhibited.

4. Digital sweep may not be operated in the remote mode of operation.

5. When changing from the local to the remote mode of operation the temporary storage register should be cleared before a remote entry is made.

6. The data level inputs to the Model 8660D are as follows: approximately 0 volts TTL LOW = 1 and approximately 2.8 volts TTL HIGH = 0 (sometimes referred to as negative or ground true logic).

In BCD remote operation two four-bit parallel codes are applied to the instrument circuits through a rear panel connector (J3). These inputs, if numeric data, are converted to BCD digit serial information and clocked into a temporary storage register. If the inputs are address information they are used to direct a clock to strobe the data from the temporary storage register into the desired final storage register.

When all of the significant data entries have been stored in the temporary storage registers, the least significant digit is stored in a position to allow it to be the first digit strobed out, then the next least significant digit, etc, so that the information will be stored in the appropriate register in the same sequence in which it was received.

Operation of the storage registers not located in the HP 8660D mainframe is detailed in the manuals for the plug-in sections. Examples 1-7 provides examples of programming the registers which may be programmed when the HP 8660D mainframe is used.

Refer to Figure 3-3 for timing information and to Table 3-6 for interconnection information.

NOTE

Although it is not necessary to program frequency first, then modulation (if any), then attenuation, this sequence minimizes the time required for entering data.
Logic Levels
The Hewlett-Packard Interface Bus logic levels are TTL compatible, i.e., the true (1) state is 0.0 Vdc to +0.4 Vdc and the false (0) state is 2.5 Vdc to +5 Vdc.

Programming and Output Data Format
Refer to Section III, "Operation".

Mating Connector
HP 1251-0293; Amphenol 57-30240.

Mating Cables Available
HP 10631A, 1 metre (3.3 ft.), HP 10631B, 2 metres (6.6 ft.)
HP 10631C, 4 metres (13.2 ft.), HP 10631D, 0.5 metres (1.6 ft.)

Cabling Restrictions
1. A Hewlett-Packard Interface Bus system may contain no more than 2 metres (6.6 ft.) of connecting cable per instrument.
2. The maximum accumulative length of connecting cable for any Hewlett-Packard Interface Bus system is 20 metres (55.6 ft.).
EXAMPLE 2. Set 107.654321 MHz Center

<table>
<thead>
<tr>
<th>Input (0=High, 1=Low)</th>
<th>Temporary Register</th>
<th>CF Register</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data: D₁ 0001 (1) D₂ 0010(2)</td>
<td>00 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>21 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Data: D₁ 0011 (3) D₂ 0100(4)</td>
<td>21 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>43 21 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Data: D₁ 0101 (5) D₂ 0110(6)</td>
<td>43 21 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>65 43 21 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Data: D₁ 0111 (7) D₂ 0000(0)</td>
<td>65 43 21 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>07 65 43 21 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Data: D₁ 1111 (15) D₂ 0000(0)</td>
<td>01 07 65 43 21</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>00 00 00 00 00</td>
<td>01 07 65 43 21</td>
</tr>
</tbody>
</table>

EXAMPLE 3. Set 120 dB Attenuation (RF SECTION) Below +13 dBm (1 volt)

<table>
<thead>
<tr>
<th>Input (0=High, 1=Low)</th>
<th>Temporary Register</th>
<th>CF Register</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data: D₁ 0010 (2) D₂ 0001(1)</td>
<td>00 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>12 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Address: D₁ 1111 (15) D₂ 0011(3)</td>
<td>12 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Transfer Command</td>
<td>00 00 00 00 00</td>
<td>120</td>
</tr>
</tbody>
</table>

NOTE: The attenuator is a three-digit register; only the three most significant digits are retained.

EXAMPLE 4. Set 7 dB Attenuation (RF SECTION) Below +13 dBm (1 volt)

<table>
<thead>
<tr>
<th>Input (0=High, 1=Low)</th>
<th>Temporary Register</th>
<th>CF Register</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data: D₁ 0000 (0) D₂ 0111(7)</td>
<td>00 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>70 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Data: D₁ 0000 (0) D₂ 0000(0)</td>
<td>70 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>00 70 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Address: D₁ 1111 (15) D₂ 0011(3)</td>
<td>00 70 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Transfer Command</td>
<td>00 00 00 00 00</td>
<td>007</td>
</tr>
</tbody>
</table>

NOTE: The attenuator is a three-digit register; only the three most significant digits are retained.
### EXAMPLE 5. Shut off Modulation (MODULATION SECTION)

<table>
<thead>
<tr>
<th>Input (0=High, 1=Low)</th>
<th>Temporary Register</th>
<th>CF Register</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address: D1 1111 (15) D2 0100(4)</td>
<td>00 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Transfer Command</td>
<td>00 00 00 00 00</td>
<td>000</td>
</tr>
</tbody>
</table>

**NOTE:** All digits are zero - no modulation.

### EXAMPLE 6. Set 3% AM Modulation, Internal 1 kHz (MODULATION SECTION)

<table>
<thead>
<tr>
<th>Input (0=High, 1=Low)</th>
<th>Temporary Register</th>
<th>CF Register</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data: D1 0011 (3) D2 0000(0)</td>
<td>00 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>03 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Address: D1 1111 (15) D2 0101(5)</td>
<td>03 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Transfer Command</td>
<td>00 00 00 00 00</td>
<td>03 into % Storage</td>
</tr>
<tr>
<td>Data: D1 0001 (2) D2 1000(8)</td>
<td>00 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>81 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Address: D1 1111 (15) D2 0100(4)</td>
<td>81 00 00 00 00</td>
<td>81 into AM-FM Function Register Sets AM and 1 kHz</td>
</tr>
<tr>
<td>Transfer Command</td>
<td>00 00 00 00 00</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** See Table 3–5 for AM-FM Function Register Codes

### EXAMPLE 7. Set 10 MHz STEP ⬆

<table>
<thead>
<tr>
<th>Input (0=High, 1=Low)</th>
<th>Temporary Register</th>
<th>CF Register</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data: D1 0000 (0) D2 0001(1)</td>
<td>00 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>10 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Data: D1 0000 (0) D2 0000(0)</td>
<td>10 00 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Temporary Command</td>
<td>00 10 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Address: D1 1111 (15) D2 0001(1)</td>
<td>00 10 00 00 00</td>
<td>Last Input</td>
</tr>
<tr>
<td>Transfer Command</td>
<td>00 00 00 00 00</td>
<td>00 10 00 00</td>
</tr>
</tbody>
</table>
### Table 3-5. AM-FM Function Register Coding

<table>
<thead>
<tr>
<th>Function</th>
<th>Digit 2 ((D_2)) ((0=\text{High}, 1=\text{Low}))</th>
<th>Function</th>
<th>Digit 1 ((D_1)) ((0=\text{High}, 1=\text{Low}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\Phi M)</td>
<td>1100 (12)</td>
<td>EXT. AC (Unleveled)</td>
<td>1001 (9) ((\text{HP 86633 only}))</td>
</tr>
<tr>
<td>(\text{FM} \times 0.1)</td>
<td>0100 (4)</td>
<td>EXT. DC</td>
<td>0100 (4)</td>
</tr>
<tr>
<td>(\text{FM} \times 1)</td>
<td>0010 (2)</td>
<td>INT. 400 Hz</td>
<td>0010 (2)</td>
</tr>
<tr>
<td>(\text{FM} \times 1)</td>
<td>0001 (1)</td>
<td>INT. 1 kHz</td>
<td>0001 (1)</td>
</tr>
<tr>
<td>(\text{OFF})</td>
<td>0000 (0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 3-6. Programming Connections to A23J3 (Remote Inputs - Rear Panel)

<table>
<thead>
<tr>
<th>From A23J3</th>
<th>To A3XA5</th>
<th>Signal</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin 1</td>
<td>Pin 2</td>
<td>Error</td>
<td>To A23J3 Pin 18</td>
</tr>
<tr>
<td>Pin 3</td>
<td>Pin 5</td>
<td>LCL-RMT</td>
<td></td>
</tr>
<tr>
<td>Pin 5</td>
<td>Pin 11</td>
<td>Command</td>
<td></td>
</tr>
<tr>
<td>Pin 9</td>
<td>Pin 15</td>
<td>Digit 1-8</td>
<td></td>
</tr>
<tr>
<td>Pin 13</td>
<td>Pin 16</td>
<td>Digit 1-4</td>
<td></td>
</tr>
<tr>
<td>Pin 14</td>
<td>Pin 17</td>
<td>Digit 1-2</td>
<td></td>
</tr>
<tr>
<td>Pin 15</td>
<td>Pin 18</td>
<td>Digit 1-1</td>
<td></td>
</tr>
<tr>
<td>Pin 16</td>
<td>Pin A</td>
<td>Flag (Busy)</td>
<td></td>
</tr>
<tr>
<td>Pin 17</td>
<td>Pin J</td>
<td>Reset</td>
<td></td>
</tr>
<tr>
<td>Pin 24</td>
<td>Pin S</td>
<td>Digit 2-8</td>
<td></td>
</tr>
<tr>
<td>Pin 28</td>
<td>Pin T</td>
<td>Digit 2-4</td>
<td></td>
</tr>
<tr>
<td>Pin 29</td>
<td>Pin U</td>
<td>Digit 2-2</td>
<td></td>
</tr>
<tr>
<td>Pin 30</td>
<td>Pin V</td>
<td>Digit 2-1</td>
<td></td>
</tr>
<tr>
<td>Pin 31</td>
<td>Pin 36</td>
<td>To Ground</td>
<td></td>
</tr>
<tr>
<td>Pin 32</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A23J3 pins not listed are also wired to A3XA5. See the Rear Interface Assembly schematic diagram for wiring information.
Section 4
PERFORMANCE TESTS

4–1. INTRODUCTION

Most of the procedures in this section apply to verifying the instrument's electrical performance using the specifications of table 1–1 as the performance standards. Performance Test 3, Phase Locked Loops Test, verifies that the error voltage for each phase locked loop is within normal operating limits, but does not verify any instrument specifications.

The Operator's Checks in section 3 are useful for incoming inspections, routine maintenance, and general post-repair checks.

Other instrument performance specifications depend on the modulation and RF plug-in section installed. The service manual for the associated plug-in sections provide performance tests specific to the plug-in.

4–2. EQUIPMENT REQUIRED

Equipment required for the performance tests is listed in the Recommended Test Equipment table in Section 1. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

4–3. TEST RECORD

Results of the performance tests may be tabulated in the Performance Test Record, Table 4–1. It is located on the last page of this section, we suggest that you make several copies of the table for future use before the you perform the first performance test. Test results recorded at incoming inspection can then be used for comparison in periodic maintenance and troubleshooting and after repairs or adjustments.
Performance Test 1

INTERNAL CRYSTAL OSCILLATOR AGING RATE

Specifications
Reference Oscillator Internal: 10 MHz quartz oscillator. Aging rate less than (±3 parts in 10⁻⁹ per 24 hours after 30 day warmup.

Description
This test verifies the reference oscillator aging rate after the instrument has been connected to the ac line for 72 hours.

![Figure 4-1. Crystal Oscillator Aging Rate Test Setup](image)

Equipment
- Frequency Standard .................................................. HP 5065A
- Oscilloscope .......................................................... HP 54200A
- 50Ω Feedthru Termination ........................................ HP 10100C

Procedure
1. Set the rear panel REFERENCE switch to INT.
2. Connect the equipment as shown in Figure 4-1.
3. Adjust the oscilloscope controls for a stable display of the 10 MHz output.
4. Measure the time required for a phase change of 360°. Record the time (T₁) in seconds.

\[ T₁ = \text{_______ s} \]
5. Wait for a period of time (from 3 to 24 hours) and re-measure the phase change time \( T_2 \). Record the period of time between measurements \( T_3 \) in hours.

\[
T_2 = \underline{\quad} \text{s}
\]

\[
T_3 = \underline{\quad} \text{h}
\]

6. Calculate the aging rate from the following equation:

\[
Aging \ Rate = \left| \left( \frac{1 \text{ cycle}}{f} \right) \left( \frac{1}{T_1} - \frac{1}{T_2} \right) \left( \frac{T}{T_3} \right) \right|
\]

where:

1 cycle = the phase change reference for the time measurement (in this case 360°)

\( f \) = Synthesizer's reference output frequency (10 MHz)

\( T \) = specified time for aging rate (24 hours)

\( T_1 \) = initial time measurement(s) for a 360° (1 cycle) change

\( T_2 \) = final time measurement(s) for a 360° (1 cycle) change

\( T_3 \) = time between measurement(s) (hours)

For example if:

\[
T_1 = 351 \text{ seconds}
\]

\[
T_2 = 349 \text{ seconds}
\]

\[
T_3 = 3 \text{ hours}
\]

then:

\[
Aging \ Rate = \left| \left( \frac{1 \text{ cycle}}{10 \text{ MHz}} \right) \left( \frac{1}{351 \text{s}} - \frac{1}{349 \text{s}} \right) \left( \frac{24 \text{ hrs}}{3 \text{ hrs}} \right) \right| = 1.306 \times 10^{-11}
\]

7. Enter calculated Aging Rate in Table 4-1.
Performance Test 2

REFERENCE TEST

Specifications
At 5 or 10 MHz from 0.75 to 1.5 Vrms into 170 ohms.

Description
This test verifies proper operation of the reference amplifier and relay switching circuits.

Equipment
RF Voltmeter................................................................. HP 3400A

![Diagram of equipment setup]

Figure 4-2. Internal Reference Test Setup

Procedure
1. Connect the RMS Voltmeter to the REFERENCE OUTPUT (rear panel) jack and set the SELECTOR switch (rear panel) to the INT position.
2. The RF Voltmeter should display a voltage from 0.75 to 1.5 Vrms.
3. Enter measured voltage in Table 4-1.
Performance Test 3

PHASE LOCKED LOOPS TEST

Specifications

N1, N2, N3, SL1, and SL2 Loop error voltages must be 0V ± 500 mVdc. HF Loop error voltage must be 0V ± 100 mVdc.

Description

The Phase Locked Loops Test does not verify any instrument specifications. The purpose of this test is to determine if the error voltages for the phase locked loops require adjustment.

If the loops do not meet the limits of this test, then perform the abbreviated adjustment procedure (adjustment 1) for the Phase Locked Loops. The HP 8660D will function correctly with associated RF and modulation sections when the error voltages are within these limits. It is recommended that the abbreviated adjustment procedure be performed regularly (every six months) to insure trouble-free performance of the HP 8660D.

![Diagram of Phase Locked Loop Test Setup]

**Figure 4-3. Phase Locked Loop Test Setup**

Equipment

Oscilloscope (with 10:1 divider probes) ........................................ HP 54200A

Procedure

**NOTE**

*Set the HP 8660D Line switch to ON and allow the instrument to warm up with the covers on for at least six hours before starting the measurements. The warm-up period is required to stabilize the internal temperature.*

1. Set up the test equipment as shown in Figure 4-3.

2. Adjust the oscilloscope as follows:
   - VOLTS/DIV ......................................................... 0.01V
   - TIME/Div .......................................................... 10 μs
   - MODE ............................................................. DC COUPLED
   - GROUND POSITION ........................................ CENTER OF DISPLAY
NOTE
All of the test points except for the HF loop are located on the Low Frequency motherboard. Access to these test points is obtained by raising the A4 assembly and locking it in the up position (see Figure 4–3). Figure 5–23 shows the approximate location of all test points. The reference designators of the test points are etched on the pc board. Access to TP3 and TP8 is difficult because they are under the A3A1 and A3A2 assemblies. TP3 can be reached by using a piece of solid wire to probe down into the test point. TP8 is connected to XA12-1 pin 4, which is accessible.

3. Connect the oscilloscope probe to TP 17, the first test point specified in Table 4–1, N1 Loop. Set the HP 8660D CF to the corresponding frequency values, and record the measured DC offsets. If the DC offset exceeds 0.0V ±500mV, perform Adjustment 1 (abbreviated phase locked loops adjustment procedure). Repeat this procedure for all 6 loops in Table 4–1. Note that the HF Loop DC offset should not exceed 0.0V ±100 mV after thermal stability is reached. Typically, the HP 8660D will be thermally stable after six hours of warm-up with the covers on.

NOTE
The trace displayed on the oscilloscope should be a dc level. It is normal for some ac components to appear on the trace. However, if the peak-to-peak amplitude of the ac component is greater than 500 mV, the loop is probably not locked. Also, if the trace cannot be adjusted to 0 volts, the loop is probably not locked. In either case, the full adjustment procedure should be performed.
Table 4-1. Performance Test Record (1 of 2)

<table>
<thead>
<tr>
<th>Hewlett-Packard Model 8660D Synthesized Signal Generator</th>
<th>TestsPerformed by __________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial No. __________________________</td>
<td>Date __________________________</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crystal Oscillator Aging Rate:</th>
<th>Standard &lt; 3 × 10⁻⁹</th>
<th>Actual __________________________</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Output Reference Level:</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75 Vrms</td>
<td>1.5 Vrms</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase Locked Loops:</th>
<th>N1 Loop</th>
<th>N2 Loop</th>
<th>N3 Loop</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF (MHz)</td>
<td>Vdc @ TP17&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>CF (kHz)</td>
<td>Vdc @ TP10&lt;sup&gt;(1)&lt;/sup&gt;</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td></td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td></td>
<td>22.2</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td></td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td></td>
<td>44.4</td>
<td></td>
</tr>
<tr>
<td>5.5</td>
<td></td>
<td>55.5</td>
<td></td>
</tr>
<tr>
<td>6.6</td>
<td></td>
<td>66.6</td>
<td></td>
</tr>
<tr>
<td>7.7</td>
<td></td>
<td>77.7</td>
<td></td>
</tr>
<tr>
<td>8.8</td>
<td></td>
<td>88.8</td>
<td></td>
</tr>
<tr>
<td>9.9</td>
<td></td>
<td>99.9</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SL2 Loop</th>
<th>SL1 Loop</th>
<th>HF Loop</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF (kHz)</td>
<td>Vdc @ TP6&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>CF (MHz)</td>
</tr>
<tr>
<td>94.5</td>
<td></td>
<td>9.45</td>
</tr>
<tr>
<td>84.5</td>
<td></td>
<td>8.45</td>
</tr>
<tr>
<td>74.5</td>
<td></td>
<td>7.45</td>
</tr>
<tr>
<td>64.5</td>
<td></td>
<td>6.45</td>
</tr>
<tr>
<td>54.5</td>
<td></td>
<td>5.45</td>
</tr>
<tr>
<td>44.5</td>
<td></td>
<td>4.45</td>
</tr>
<tr>
<td>34.5</td>
<td></td>
<td>3.45</td>
</tr>
<tr>
<td>24.5</td>
<td></td>
<td>2.45</td>
</tr>
<tr>
<td>14.5</td>
<td></td>
<td>1.45</td>
</tr>
<tr>
<td>4.5</td>
<td></td>
<td>0.45</td>
</tr>
</tbody>
</table>

<sup>(1)</sup> ±500 mVdc.
<sup>(2)</sup> ±100 mVdc.
### Table 4–1. Performance Test Record (2 of 2)

<table>
<thead>
<tr>
<th>Hewlett-Packard Model 8650D Synthesized Signal Generator</th>
<th>Tests Performed by</th>
<th>Serial No.</th>
<th>Date</th>
<th>Crystal Oscillator Aging Rate: Standard $&lt; 3 \times 10^{-9}$</th>
<th>Actual</th>
<th>Output Reference Level: Minimum 0.75 Vrms</th>
<th>Maximum 1.5 Vrms</th>
<th>Actual</th>
</tr>
</thead>
</table>

**Phase Locked Loops:**

<table>
<thead>
<tr>
<th></th>
<th>N1 Loop</th>
<th>N2 Loop</th>
<th>N3 Loop</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF (MHz)</td>
<td>Vdc @ TP17(1)</td>
<td>CF (kHz)</td>
<td>Vdc @ TP10(1)</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td></td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td></td>
<td>22.2</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td></td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td></td>
<td>44.4</td>
<td></td>
</tr>
<tr>
<td>5.5</td>
<td></td>
<td>55.5</td>
<td></td>
</tr>
<tr>
<td>6.6</td>
<td></td>
<td>66.6</td>
<td></td>
</tr>
<tr>
<td>7.7</td>
<td></td>
<td>77.7</td>
<td></td>
</tr>
<tr>
<td>8.8</td>
<td></td>
<td>88.8</td>
<td></td>
</tr>
<tr>
<td>9.9</td>
<td></td>
<td>99.9</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SL2 Loop</th>
<th>SL1 Loop</th>
<th>HF Loop</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF (kHz)</td>
<td>Vdc @ TP8(1)</td>
<td>CF (MHz)</td>
<td>Vdc @ TP14(1)</td>
</tr>
<tr>
<td>94.5</td>
<td></td>
<td>9.45</td>
<td></td>
</tr>
<tr>
<td>84.5</td>
<td></td>
<td>8.45</td>
<td></td>
</tr>
<tr>
<td>74.5</td>
<td></td>
<td>7.45</td>
<td></td>
</tr>
<tr>
<td>64.5</td>
<td></td>
<td>6.45</td>
<td></td>
</tr>
<tr>
<td>54.5</td>
<td></td>
<td>5.45</td>
<td></td>
</tr>
<tr>
<td>44.5</td>
<td></td>
<td>4.45</td>
<td></td>
</tr>
<tr>
<td>34.5</td>
<td></td>
<td>3.45</td>
<td></td>
</tr>
<tr>
<td>24.5</td>
<td></td>
<td>2.45</td>
<td></td>
</tr>
<tr>
<td>14.5</td>
<td></td>
<td>1.45</td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td></td>
<td>0.45</td>
<td></td>
</tr>
</tbody>
</table>

(1) ±500 mVdc.  
(2) ±100 mVdc.
Section 5
ADJUSTMENTS

5–1. INTRODUCTION

This section describes adjustments and checks required to return the HP 8660D to peak operating capability when periodic adjustments are required or when repairs have been made. Included in this section are test setups and procedures.

Except for the Abbreviated Phase Locked Loops and Power Supply adjustment procedures, which should be performed before repairs are made to any part of the instrument, the adjustment procedures are arranged in the same sequence as the service sheets to which they refer.

5–2. PERIODIC ADJUSTMENTS REQUIRED

The following table shows adjustments that should be performed at recommended 6 month, but no longer than 1 year, intervals.

<table>
<thead>
<tr>
<th>Adjustment</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustment 1: Phase Locked Loops (Abbreviated)</td>
<td>All</td>
</tr>
<tr>
<td>Adjustment 2: Power Supply</td>
<td>All</td>
</tr>
<tr>
<td>Adjustment 3: Reference Section (100 MHz Output)</td>
<td>2</td>
</tr>
</tbody>
</table>

All other adjustments need only be performed after repair, or to correct instrument malfunction.

5–3. EQUIPMENT REQUIRED

Each adjustment procedure in this section contains a list of test equipment and accessories required to perform the procedure. Each test setup identifies test equipment and accessories by callouts.

Minimum specifications for test equipment used in the adjustment procedures are detailed in Table 1–2. Because the HP 8660D Synthesized Signal Generator is an extremely accurate instrument, minimum specifications in Table 1–2 are particularly important in performing these adjustment procedures.

5–4. ADJUSTMENT AIDS

The HP 11672A Service Kit is an accessory item available from Hewlett-Packard for use in maintaining the HP 8660D. Table 1–2 contains a detailed description of the Service Kit. Any item in the kit may be ordered separately.
5-5. FACTORY SELECTED COMPONENTS

Some component values are selected at the time of final checkout at the factory. Usually these values are not extremely critical; they are selected to provide optimum compatibility with associated components.

Factory selected components and suggested range of values are listed in Table 5-2.

The recommended procedure for replacing a factory selected component is as follows:

a. Try the original value, then perform the test specified in Section V of this manual for the circuit being repaired.

b. If the specified test cannot be satisfactorily performed, try the typical value shown in the parts list and repeat the test.

c. If the test results are still not satisfactory, substitute various values within the tolerances specified in Table 5-2 until the desired result is achieved.

5-6. RELATED ADJUSTMENTS

Most of the adjustments within any given phase lock loop are interrelated. This is especially true in digital-to-analog converters. Adjustments should be made in the order in which they appear for any given loop.

Generally, it will not be necessary to adjust any of the phase lock loops except the one in which the component failure occurred. An exception to this will be when adjustment to any phase lock loop has been attempted while the reference section is not functioning properly.

5-7. ADJUSTMENT LOCATIONS

Adjustment locations are identified pictorially on Section VIII foldout service sheets referred to in the individual procedures and in Figures listed in the individual procedures.

5-8. CHECKS AND ADJUSTMENTS

Data taken while following the adjustment procedures should be recorded in spaces provided. This information may then be used as reference in later tests.

5-9. SAFETY CONSIDERATIONS

Although this instrument has been designed in accordance with international safety standards, this manual contains information and warnings, which must be followed to ensure safe operation and to retain the instrument in a safe condition (see Section II). Service and adjustments should be performed only by qualified service personnel.

**WARNING**

Any interruption of the protective (grounding) conductor inside or outside the instrument or disconnection of the protective earth terminal is likely to make the apparatus dangerous. Intentional interruption is prohibited.

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazards involved. The opening of covers or removal of parts may expose live parts, and accessible terminals may be live.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.
Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

**NOTE**

_When repairs or adjustments to the instrument are required, such work should not be performed, even by a skilled technician, unless another person is in the same general area. This is not to be interpreted to mean that two persons are required to perform the necessary work, but only that another person should be available, should the need for assistance arise._

In Adjustments 1–12 it is assumed that:

a. At the start of the test the output frequency is set to 0.

b. An RF Section output plug-in section must be in place during the tests.

c. A Modulator Section or an Auxiliary Section must be in place in the modulator compartment.

d. All tests in which a counter is used should be made with the HP 8660D and the counter referenced to the same source. The HP 8660D internal reference may be used as the source.

---

**Table 5–2. Factory Selected Components (1 of 2)**

<table>
<thead>
<tr>
<th>Designation</th>
<th>Location</th>
<th>Purpose</th>
<th>Range of Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>A4A2C11</td>
<td>Reference Loop</td>
<td>A variable 10 MHz signal (at −45 dB) is connected in parallel with the 10 MHz reference signal to A4J5. The frequency is varied to show the 3 dB points. The capacitor is selected for the reference loop 3 dB bandwidth of 60 to 160 kHz (±30 to ±80 kHz) measured at the 100 MHz output.</td>
<td>38 to 72 pF</td>
</tr>
<tr>
<td>A4A2R42</td>
<td>Phase Detector</td>
<td>To achieve correct phase error signal level.</td>
<td>100 to 422 ohms</td>
</tr>
<tr>
<td>A4A4C10</td>
<td>Reference VCO</td>
<td>To set reference loop bandwidth and capture range. Interacts with A4A2C11.</td>
<td>10 to 56 pF</td>
</tr>
<tr>
<td>A4A4L12</td>
<td>Reference Loop</td>
<td>To control output level of 100 MHz</td>
<td>0.34 to 1.0 μH</td>
</tr>
<tr>
<td>A4A4Q7</td>
<td>Reference Loop</td>
<td>To optimize performance of 500 MHz tuned amplifier</td>
<td></td>
</tr>
<tr>
<td>A4A4Q8</td>
<td>Reference Loop</td>
<td>To optimize performance of 100 MHz tuned amplifier</td>
<td></td>
</tr>
<tr>
<td>A4A4R29</td>
<td>Reference VCO and Divider</td>
<td>To compensate for variations in the 100 MHz reference output level. Selected for an output level of +11 to +13 dBm into a 50 ohm load at the output of A4A8.</td>
<td>42.2 to 422 ohms</td>
</tr>
</tbody>
</table>
### Table 5-2. Factory Selected Components (2 of 2)

<table>
<thead>
<tr>
<th>Designation</th>
<th>Location</th>
<th>Purpose</th>
<th>Range of Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>A4A5C7, C8, C13, C14, C19, C20</td>
<td>HF Loop VCO</td>
<td>If one or more of the amplifiers in the 340 to 450 MHz tuned amplifier stages are overdriven, a one half frequency harmonic spur will track the output signal. Reduce the drive to the overdriven stage by decreasing the value of the appropriate capacitor. After selecting a capacitor, be sure there is sufficient output to drive the amplifier.</td>
<td>7.5 to 24 pF</td>
</tr>
<tr>
<td>A4A5R38, 40, and 42 (50 ohm pad)</td>
<td>HF VCO</td>
<td>To compensate for variations in the 350/450 MHz output level. Selected for a level of +10 to +13 dBm.</td>
<td>See Table 5-3.</td>
</tr>
<tr>
<td>A4A5R37, 39, and 41 (50 ohm pad)</td>
<td>HF Loop</td>
<td>To compensate for variations in the 350/450 MHz output level to the phase detector. Selected for a level of +10 to +12 dBm.</td>
<td>See Table 5-3.</td>
</tr>
<tr>
<td>A4A6C6</td>
<td>HF Loop</td>
<td>To ensure tuning range sufficient to trap the 10 MHz signal.</td>
<td>16 to 24 pF</td>
</tr>
<tr>
<td>A4A6R19</td>
<td>HF Loop</td>
<td>To center the travel of A4A6R20 Profile Adjust</td>
<td>215 to 422 ohms</td>
</tr>
<tr>
<td>A4A7R23</td>
<td>Sampling Phase Detector</td>
<td>To permit adjustment of A4A7R22. See paragraph 5-30 step 2b.</td>
<td>7.5k to 11k</td>
</tr>
<tr>
<td>A8R18</td>
<td>N3 Oscillator</td>
<td>To aid in balancing Summing loop for Varactor tuning</td>
<td>19.6k to 25k</td>
</tr>
<tr>
<td>A8R25</td>
<td>N3 Oscillator</td>
<td></td>
<td>4k to 6k</td>
</tr>
<tr>
<td>A13R30</td>
<td>N2 VCO</td>
<td>To center range of associated potentiometer.</td>
<td>5.62k to 8.25k</td>
</tr>
<tr>
<td>A13R36</td>
<td>N2 VCO</td>
<td>To center range of associated potentiometer.</td>
<td>12.1k to 17.4k</td>
</tr>
<tr>
<td>A13R60</td>
<td>N2 VCO</td>
<td>To compensate for variations in the Varactor diode by reducing phase error output of the N2 assembly. Selected for an output at A2TP10 phase monitor of 0.00 ±0.35 Vdc</td>
<td>68k to 120k</td>
</tr>
<tr>
<td>A13R81</td>
<td>N2 VCO</td>
<td>To produce the most symmetrical square wave at A14aTP1. See Service Sheet 9A and 10.</td>
<td>23.7 to 237 ohms</td>
</tr>
<tr>
<td>A16R2</td>
<td>N1 Phase Detector</td>
<td>To compensate for variations in U7A switching characteristics.</td>
<td>825 ohms to 1.21k</td>
</tr>
<tr>
<td>A17R29</td>
<td>N1 VCO</td>
<td>To center range of associated potentiometer.</td>
<td>12.1k to 17.4k</td>
</tr>
<tr>
<td>A17R32</td>
<td>N1 VCO</td>
<td>To center range of associated potentiometer.</td>
<td>5.11k to 7.5k</td>
</tr>
<tr>
<td>A19R55</td>
<td>SL1 Oscillator</td>
<td>To set the SL1 Oscillator output between −3 &amp; −5 dBm.</td>
<td>511 ohms to 1.47k</td>
</tr>
</tbody>
</table>

### Table 5-3. Range of Values

<table>
<thead>
<tr>
<th>Resistor</th>
<th>2 dB</th>
<th>3 dB</th>
<th>4 dB</th>
<th>5 dB</th>
<th>6 dB</th>
<th>7 dB</th>
<th>8 dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>R37, R38, (R41, R42)</td>
<td>422</td>
<td>287</td>
<td>315</td>
<td>178</td>
<td>147</td>
<td>133</td>
<td>115</td>
</tr>
<tr>
<td>R39, R40</td>
<td>12.1</td>
<td>17.8</td>
<td>23.7</td>
<td>28.7</td>
<td>34.8</td>
<td>46.4</td>
<td>51.1</td>
</tr>
</tbody>
</table>
Adjustment 1

PHASE LOCKED LOOPS (ABBREVIATED)

Description
This procedure specifies the adjustments for the phase locked loops which are most likely to change
due to aging or temperature effects and thus require periodic attention. This procedure can only be
used if a phase locked loop is locked. If it is not, the full adjustment procedure should be performed.

![Diagram](Figure 5-1. Abbreviated Phase Locked Loops Test Setup)

Test Equipment
Oscilloscope (with 10:1 divider probes) .................................................. HP 54200A

Procedure

NOTE
Set the HP 8660D line switch to ON and allow the instrument to warm up
with the covers on for at least six hours before starting the measurements.
The warm-up period is required to stabilize the internal temperature.

1. Set up the test equipment as shown in Figure 5-1.

2. Adjust the oscilloscope as follows:
   VOLTS/DIV .................................................. 0.01V (Actually 0.1V since 10:1 probes are used)
   TIME/DIV .................................................. 10 µs
   MODE .................................................. DC COUPLED
   GROUND POSITION .................................. CENTER OF DISPLAY
NOTE
All of the test points except for the HF loop are located on the A2 Motherboard. Access to these test points is obtained by raising the A4 assembly and locking it in the up position (see Figure 5–1). Figure 5–23 shows the approximate location of all test points. The reference designators of the test points are etched on the pc board. Access to TP3 and TP8 is difficult because they are under the A3A1 and A3A2 assemblies. TP3 can be reached by using a piece of solid wire to probe down into the test point. TP8 is connected to XA12-1 pin 4, which is accessible.

3. In Table 5–4, PLL Adjustment Points, connect the oscilloscope probe to the test point corresponding to the loop being adjusted (start with N1 Loop TP 17). Set the HP 8660D CF to the frequency value under the Adjustment 1 column, then the Adjustment 2 column, adjusting the corresponding potentiometer for 0V ±50 mVdc. Adjustments 1 and 2 are interactive. Repeat the adjustments until both measurements are correct.

NOTE
The trace displayed on the oscilloscope should be a dc level. It is normal for some ac components to appear on the trace. However, if the peak-to-peak amplitude of the ac component is greater than 200 mV, the loop is probably not locked. Also, if the trace cannot be adjusted to the required level, the loop is probably not locked. In either case, the full adjustment procedure should be performed.

<table>
<thead>
<tr>
<th>Loop</th>
<th>Test Point</th>
<th>Adjustment 1</th>
<th>Adjustment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CF</td>
<td>Adj Point</td>
</tr>
<tr>
<td>N1</td>
<td>TP17</td>
<td>9.5 MHz</td>
<td>A17R31</td>
</tr>
<tr>
<td>N2</td>
<td>TP10</td>
<td>95.5 MHz</td>
<td>A13R37</td>
</tr>
<tr>
<td>N3</td>
<td>TP3</td>
<td>95 Hz</td>
<td>A8R26</td>
</tr>
<tr>
<td>SL2</td>
<td>TP8</td>
<td>94.5 kHz</td>
<td>A11R19</td>
</tr>
<tr>
<td>SL1</td>
<td>TP14</td>
<td>9.45 MHz</td>
<td>A19R9</td>
</tr>
<tr>
<td>HF</td>
<td>PHASE ERROR</td>
<td>0 MHz</td>
<td>A4A6R20 “0”</td>
</tr>
</tbody>
</table>

(1) if an 86601A RF Section is installed, set CF to 100.0 MHz.

4. If the N1, N2, or N3 loop is being adjusted, continue with Step 5. If the SL1, SL2, or HF loop is being adjusted, jump to step 7.

5. Set the HP 8660D to the center frequencies in Table 5–5 for the loop that is being adjusted. At each frequency setting, record the voltage level displayed on the oscilloscope. Ensure that the loop remains locked at each of these settings.
6. When all voltages have been recorded for the loop being adjusted, do the following:

   Add all voltage readings and enter as the SUM value.

   Divide the Sum value by 10 and enter the average (AVG).

   Reverse the sign (polarity) of the AVG value and enter this figure as the Adjust value.

   Once again set the HP 8660D CF to the corresponding frequency value under the Adjustment 1 of Table 5-4 column for the loop being adjusted, and adjust the potentiometer in the Adj Point column to make the dc value of the oscilloscope trace equal to the calculated Adjust Value in Table 5-5.

   Return to Step 3 and repeat the procedures until the N1, N2, and N3 loops are adjusted.

7. In Table 5-5 locate the HP 8660D frequency values given for the loop that is being adjusted (SL2, SL1, or HF Loops). At each frequency setting adjust the potentiometer under the Adjustment 1 column for a level of 0V ± 100mVdc on the oscilloscope.

8. Return to Step 3 and repeat the procedures until the SL2, SL1, and HF Loops are adjusted.
### Table 5–5. PLL Adjustment Values

<table>
<thead>
<tr>
<th>CF (MHz)</th>
<th>Vdc @ TP17(1)</th>
<th>CF (kHz)</th>
<th>Vdc @ TP10(1)</th>
<th>CF (Hz)</th>
<th>Vdc @ TP3(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-5.0 mV</td>
<td>0</td>
<td>-100 mV</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>-5.0 mV</td>
<td>11.1</td>
<td>-100 mV</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>-10 mV</td>
<td>22.2</td>
<td>-90 mV</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>-20 mV</td>
<td>33.3</td>
<td>-90 mV</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>-30 mV</td>
<td>44.4</td>
<td>-90 mV</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>5.5</td>
<td>10 mV</td>
<td>55.5</td>
<td>-65 mV</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>6.6</td>
<td>25 mV</td>
<td>66.6</td>
<td>-55 mV</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>7.7</td>
<td>40 mV</td>
<td>77.7</td>
<td>-55 mV</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>8.8</td>
<td>50 mV</td>
<td>88.8</td>
<td>-78 mV</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>9.9</td>
<td>60 mV</td>
<td>99.9</td>
<td>-78 mV</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td>Sum</td>
<td></td>
<td>Sum</td>
<td></td>
</tr>
</tbody>
</table>

**Avg (Sum ÷ 10)**

<table>
<thead>
<tr>
<th>Adjust Value</th>
<th>Adjust Value</th>
<th>Adjust Value</th>
</tr>
</thead>
</table>

**SL2 Loop**

<table>
<thead>
<tr>
<th>CF (kHz)</th>
<th>Adj Point</th>
<th>CF (MHz)</th>
<th>Adj Point</th>
<th>CF (MHz)</th>
<th>Adj Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>64.5</td>
<td>A11R39 &quot;8&quot;</td>
<td>8.45</td>
<td>A18R35 &quot;8&quot;</td>
<td>10</td>
<td>A4A6R60 &quot;1&quot;</td>
</tr>
<tr>
<td>74.5</td>
<td>A11R54 &quot;7&quot;</td>
<td>7.45</td>
<td>A18R40 &quot;7&quot;</td>
<td>20</td>
<td>A4A6R55 &quot;2&quot;</td>
</tr>
<tr>
<td>64.5</td>
<td>A11R60 &quot;6&quot;</td>
<td>6.45</td>
<td>A18R44 &quot;6&quot;</td>
<td>30</td>
<td>A4A6R53 &quot;3&quot;</td>
</tr>
<tr>
<td>54.5</td>
<td>A11R67 &quot;5&quot;</td>
<td>5.45</td>
<td>A18R41 &quot;5&quot;</td>
<td>40</td>
<td>A4A6R58 &quot;4&quot;</td>
</tr>
<tr>
<td>44.5</td>
<td>A11R73 &quot;4&quot;</td>
<td>4.45</td>
<td>A18R55 &quot;4&quot;</td>
<td>50</td>
<td>A4A6R44 &quot;5&quot;</td>
</tr>
<tr>
<td>34.5</td>
<td>A11R77 &quot;3&quot;</td>
<td>3.45</td>
<td>A18R62 &quot;3&quot;</td>
<td>60</td>
<td>A4A6R40 &quot;6&quot;</td>
</tr>
<tr>
<td>24.5</td>
<td>A11R83 &quot;2&quot;</td>
<td>2.45</td>
<td>A18R57 &quot;2&quot;</td>
<td>70</td>
<td>A4A6R35 &quot;7&quot;</td>
</tr>
<tr>
<td>14.5</td>
<td>A11R90 &quot;1&quot;</td>
<td>1.45</td>
<td>A18R74 &quot;1&quot;</td>
<td>80</td>
<td>A4A6R28 &quot;8&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100(1)</td>
<td>A4A6R22 &quot;9&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) With 86601A only.

---

**SL1 Loop**

**HF Loop**
Adjustment 2

POWER SUPPLY

- Service Sheet 27

Description

The power supplies in the HP 8660D provide regulated outputs of $+20\text{V}$, $+5.25\text{V}$, $-10\text{V}$, and $-40\text{V}$. Unregulated supplies provide $+30\text{V}$, $+21\text{V}$, $+4\text{V}$ and $-21\text{V}$. The following procedure should be used to adjust the regulated output of each power supply.

![Diagram of test setup]

*Figure 5-2. Power Supply Test Setup*

Test Equipment

Digital Voltmeter ......................................................... HP 3478A
AC Voltmeter ................................................................. HP 3466A

Procedure

1. Set up test equipment as shown in Figure 5-2.
2. Remove the top and bottom covers of the HP 8660D.
3. Use the digital voltmeter and the ac microvoltmeter to check the voltages and ripple at A20 test points specified in Table 5-6.
4. Use the digital voltmeter to adjust each power supply voltage specified in Table 5-7 using the corresponding adjustment. Verify that the ripple does not exceed the limits indicated.
### Table 5–6. Unregulated Power Supplies

<table>
<thead>
<tr>
<th>Test Location</th>
<th>Voltage</th>
<th>Tolerance</th>
<th>Ripple (RMS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ side of A20C7</td>
<td>Typical +3.37V</td>
<td>Specified ±0.6V</td>
<td>Typical 0.31</td>
</tr>
<tr>
<td>+ side of A20C4</td>
<td>Typical +21V</td>
<td>Specified ±2.4V</td>
<td>Typical 1.1</td>
</tr>
<tr>
<td>- side of A20C5</td>
<td>Typical -21V</td>
<td>Specified ±2.4V</td>
<td>Typical 1.15</td>
</tr>
<tr>
<td>+ side of A20C1</td>
<td>Typical +33V</td>
<td>Specified ±4V</td>
<td>Typical 1.0</td>
</tr>
</tbody>
</table>

### Table 5–7. Regulated Power Supplies

<table>
<thead>
<tr>
<th>Test Point</th>
<th>Adjust Control</th>
<th>Voltage</th>
<th>Tolerance</th>
<th>Ripple (RMS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A5TP4</td>
<td>A5R24</td>
<td>+5.25V</td>
<td>±20 mV</td>
<td>125 µV</td>
</tr>
<tr>
<td></td>
<td>+5.25 ADJ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5TP2</td>
<td>A5R26</td>
<td>-10.0V</td>
<td>±5 mV</td>
<td>50 µV</td>
</tr>
<tr>
<td></td>
<td>-10 ADJ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5TP3</td>
<td>A5R21</td>
<td>+20.0V</td>
<td>±10 mV</td>
<td>50 µV</td>
</tr>
<tr>
<td></td>
<td>+20 ADJ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5TP1</td>
<td>A5R28</td>
<td>-40.0V</td>
<td>±20 mV</td>
<td>50 µV</td>
</tr>
<tr>
<td></td>
<td>-40 ADJ</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Adjustment 3

REFERENCE SECTION

- Service Sheets 2 and 3.

Description

The reference section contains a voltage controlled master oscillator from which all RF signals generated in the HP 8660D mainframe are derived. The master oscillator is phase locked to an internal temperature controlled crystal oscillator or to an external standard. The reference section provides outputs of 500 MHz, 100 MHz, 20 MHz, 10 MHz, 2 MHz, 400 kHz and 100 kHz. These checks verify proper operation of the circuits within the reference section.

![Reference Accuracy Adjustment Test Setup](image)

**Figure 5-3. Reference Accuracy Adjustment Test Setup**

Test Equipment

- Frequency Standard .............................................. HP 5065A
- Oscilloscope (with 10:1 divider probes) .................. HP 54200A
- Spectrum Analyzer .............................................. HP 8590A
- Frequency Counter ............................................. HP 5328B Option 031
- 50 Ohm Feedthru Termination ............................... HP 10100C

Procedure

1. Set up test equipment as shown in Figure 5-3.

2. Internal Reference Accuracy Adjustment (see Figure 5-3). (Allow adequate warmup time.)
   
   a. Use the signal source to trigger the oscilloscope at the SYNC INPUT and connect the reference output from the HP 8660D rear panel reference output to the oscilloscope vertical input.

   b. Observe the 10 MHz sine wave on the oscilloscope and adjust the A21 oscillator until the oscilloscope display stops drifting.

   c. Set the oscilloscope to sweep at 0.1 μSec/Division and the sweep magnifier to ×10. If drift is observed readjust the A21 oscillator.
NOTE

When the oscilloscope display drift is less than 1 division in 10 seconds the HP 8660D reference oscillator is set within 1 part in 10^9 of the signal source.

3. 100 MHz Output Adjustment.

a. Connect the frequency counter to the 100 MHz output on the A4A4 assembly (see Figure 5-4).

b. If the internal reference is being used, place the rear panel INT/EXT switch in the EXT position to open the 100 MHz phase lock loop. (If an external reference is being used, disconnect the source.)

c. Allow at least 15 minutes warmup time for the oscillator to stabilize and adjust A4A4C2 for a counter readout of 100,000 MHz ± 20 kHz. Disconnect the frequency counter.

d. Connect the Spectrum Analyzer RF INPUT to the 100 MHz output of the A4A4 assembly and tune the Spectrum Analyzer CENTER FREQUENCY to 100 MHz. The 100 MHz signal should be >+10 dBm (see Figure 5-5 and 5-6).

e. Disconnect the Spectrum Analyzer and enable the 100 MHz phase lock loop by returning the INT/EXT switch to INT or by reconnecting the external standard.

NOTE

Steps f through p need to be performed only if the 100 MHz output signal is low or if the total harmonic distortion in the FM mode is > 1%.

f. Use a standard flatblade screwdriver to loosen the fastener which locks the A4 assembly in place. Rotate A4 up and to the right until it locks into position.

g. Disconnect W6 and A23W9 from the A4A8 100 MHz Band-pass Filter Assembly. Connect W6 to A23W9.

h. Set the Synthesized Signal Generator controls for a center frequency of 100 MHz at +10 dBm.

i. Set the spectrum analyzer controls as follows:

- Center Frequency: 100 MHz
- Frequency Span Per Division: 5 MHz
- Resolution Bandwidth: 100 kHz
- Input Attenuation: 20 dB
- Vertical Sensitivity Per Division: 10 dB
- Reference Level: +10 dBm
- Sweep Time Per Division: 2 ms
Figure 5-4. 100 MHz Adjustment Test Setup

Figure 5-5. RF Level Checks Test Setup

Figure 5-6. RF Level Checks Typical Waveform
Figure 5–7. 100 MHz Band-pass Filter Adjustment Test Setup

j. Connect the equipment as shown in Figure 5–7. If necessary, readjust the analyzer controls to center the 100 MHz signal on the display.

k. With a non-conducting alignment tool, adjust A4A8C1 and C2 for peak output at 100 MHz.

l. Set the spectrum analyzer’s vertical sensitivity to 2 dB per division or linear.

m. Set the Synthesized Signal Generator sweep width to 50 MHz.

n. Verify that the flatness is 3 dB for a bandwidth of > 4 MHz.

o. Check that the insertion loss is <1 dB. Bypass the 100 MHz Band-pass Filter and measure the output directly from the signal source. Compare the direct signal with the signal level through the filter. To achieve the 1 dB maximum insertion loss, flatness may be compromised slightly.

p. Reconnect W6 to the A4A8 Assembly. Monitor the 100 MHz output level of the of the A4A8 Assembly with the RF voltmeter (into 50Ω).

q. Adjust A4C41 for the maximum output level. Verify that the level is between +11 and +13 dBm.

r. If the level is incorrect, change A4R29 to a lower value (42.2Ω minimum) and peak the output level. Continue until one output level is 12 ± 1 dBm.

s. Reconnect A23W9 to the output of the A4A8 Assembly. Unlock A4 and return it to the original position. Lock A4 into place.

3. 500 MHz Output Adjustment

a. Connect the Spectrum Analyzer RF INPUT to the 500 MHz output connector on the A4A4 assembly and tune the analyzer to 500 MHz. Set the analyzer scan width to 50 MHz per division and other analyzer controls for a clear display (see Figure 5–6).

b. Adjust A4A4C17, A4A4C23 and A4A4C31 for a peak amplitude of the 500 MHz signal. The 500 MHz signal amplitude should be > +3 dBm. The 400 MHz signal observed at the 500 MHz output is typically < −10 dBm. The 600 MHz signal observed at the 500 MHz output is typically < −20 dBm. Disconnect the analyzer.

\[\begin{align*}
500 \text{ MHz} & \quad \text{___________ dBm} \\
400 \text{ MHz} & \quad \text{___________ dBm} \\
600 \text{ MHz} & \quad \text{___________ dBm}
\end{align*}\]
4. 20 MHz Output Check
   a. Connect the Spectrum Analyzer RF INPUT to the 20 MHz output on the A4A4 assembly and tune the analyzer to 20 MHz. The 20 MHz signal should be \( > -6 \text{ dBm} \) and \( < -2 \text{ dBm} \). Disconnect the analyzer.
   
   \[
   20 \text{ MHz} \quad \underline{\text{-------------}} \text{ dBm}
   \]

5. Reference Section Outputs Not Previously Checked
   a. Check the outputs listed in Table 5-8 for the levels shown (see Figure 5-8).

   \[
   \begin{array}{|c|c|c|c|}
   \hline
   \text{Test Point} & \text{Frequency} & \text{Specified Level} & \text{Actual} \\
   \hline
   \text{A4J6} & 10 \text{ MHz} & >1 \text{ Vp-p} & \underline{\text{---------}} \\
   \text{A4J1} & 2 \text{ MHz} & >2.2 \text{ Vp-p} & \underline{\text{---------}} \\
   \text{A4J3} & 400 \text{ kHz} & 2.2<\text{Vp-p}<5.0 & \underline{\text{---------}} \\
   \text{A4J2} & 100 \text{ kHz} & 2.2<\text{Vp-p}<5.0 & \underline{\text{---------}} \\
   \text{A4J4} & 100 \text{ kHz} & 2.2<\text{Vp-p}<5.0 & \underline{\text{---------}} \\
   \hline
   \end{array}
   \]

   \[
   \text{Figure 5-8. Oscilloscope Level Checks Test Setup}
   \]
Adjustment 4

10 MHZ BANDPASS FILTER ADJUSTMENT (AFTER REPAIR)

NOTE

It is necessary to remove this assembly from the mainframe in order to perform the adjustments. Therefore, this adjustment is to be performed ONLY if the Reference Assembly is repaired.

Description

The 700 Hz sidebands are set at least 20 dB down from the 10 MHz reference oscillator signal.

Test Equipment

Synthesizer ......................................................... HP 8660 or 3325A
RF Voltmeter ....................................................... HP 3400A
50-ohm Feedthrough Termination ...................... HP 10100C

Figure 5–9. A22A1 Adjustment Test Setup (After Repair)

Procedure

1. Connect equipment as shown in Figure 5–9. The +5.25 Vdc source must be connected to the junction of the inductor and feedthrough capacitor. The ground return must be connected to the chassis and the feedthrough capacitor.

2. Release and rotate the A4 assembly up and out of the chassis. Locate A21 output cable J1 (white) and disconnect from reference oscillator A21. Connect external synthesizer to cable. Set Reference Synthesizer to 10.000000 MHz, +13 dBm.
3. Set the unit under test reference switch to INTERNAL.


5. Adjust A22A1R2 for an RF Voltmeter reading of 270 mVrms.

6. Set the Reference Synthesizer to 10.000700 MHz, record RF Voltmeter reading in dBm.

7. Set the Reference Synthesizer to 0.999300 MHz; record RF Voltmeter reading in dBm.

8. Establish the higher of the power levels in steps 6 and 7 as a reference. Reset the Reference Synthesizer to 10.000000 MHz. Adjust A22A1R6 for a voltmeter reading 20 dBm above the reference.

Example: Reference level
-18 dBm
+20 dBm
+ 2 dBm

9. Reinstall the A22 Assembly.

10. Perform Adjustment 5 (10 MHz Bandpass Filter Adjustment).
Adjustment 5

10 MHZ BANDPASS FILTER ADJUSTMENT

Description
The A22A1 sub-assembly is adjusted to the internal 10 MHz reference frequency. The assembly level is adjusted for 270 mV into 50 ohms.

Test Equipment

RF Voltmeter ............................................. HP 3400A
50 ohm Feedthrough Termination ...................... HP 10100C

![Diagram of test setup]

Figure 5–10. A22A1 Adjustment Test Setup

NOTE

Adjustment of the Reference Section (Adjustment 3) is recommended before performing this procedure.

Procedure

1. Set up test equipment as shown in Figure 5–10.

2. Remove HP 8660D left side cover and top cover. Turn power ON and allow HP 8660D to operate for 2 hours to ensure reference stability. Set INT/EXT reference switch to INT.

3. Remove 10 MHz Reference input cable from A4J5. Connect the cable to the RF Voltmeter as shown in Figure 5–10.

4. Adjust A22A1C3 (using a non-metallic tool) accessible through hole in A22 assembly for maximum reading on the RF Voltmeter.

5. Adjust A22A1R2 (accessible through a hole in the A22 assembly) for an RF Voltmeter reading of 270 mVrms.

6. Reconnect the Reference Input cable to A4J5.
Adjustment 6

HIGH FREQUENCY SECTION

- Service Sheets 4, 5 and 6.

Description

The High Frequency Section contains a voltage controlled oscillator which provides eleven discrete output frequencies from 350 to 450 MHz in 10 MHz steps. The output of the voltage controlled oscillator is phase locked to a 10 MHz reference derived from the master oscillator in the reference section. The output from the HF section is used in the RF Section plug-in or in the internal frequency extension plug-in module. These checks verify proper operation of the High Frequency Section circuits.

![Diagram](image)

*Figure 5-11. Phase Detector Response Adjustment Test Setup*

Test Equipment

- Frequency Counter .................................................. HP 5385A
- Digital Voltmeter ................................................... HP 3478A
- Pulse Generator ..................................................... HP 8011A
- Spectrum Analyzer ................................................... HP 8590A
- Oscilloscope (with 10:1 divider probes) ........................... HP 54200A
- Signal Generator/Test Oscillator .................................. HP 3325A

Procedure

1. Set up test equipment as shown in Figure 5-11.
   a. Disconnect the coaxial cable from VCO INPUT A4J11. Connect the PULSE OUTPUT of the pulse generator to A4J11. Set the pulse generator for 100 kHz pulse rate, 0.035 μsec pulse width, 0.5 volt amplitude and + polarity.
b. Remove the cover of the A4A6 assembly. Connect the spectrum analyzer RF INPUT to the test point marked “φ” on the A4A6 assembly. This test point should have a white wire and a resistor soldered to it. Set the analyzer controls as follows:

Center Frequency ......................................................... 5 MHz
Scan Width Per Division ........................................... 1 MHz
Scan Time Per Division ........................................... 1 ms
Gain and Attenuation .............................................. as required

c. Adjust efficiency control A4A7R18 for a flat response to approximately 5 MHz with very slight peaking (1 dB ± 1 dB). See the waveform in Figure 5–12 for typical response.

d. Disconnect the pulse generator and the spectrum analyzer.

![Figure 5–12. Phase Detector Response Waveform](image)

   a. Connect the digital voltmeter to “phase error” TP.
   b. Adjust the BALance control (A4A7R22) for a digital voltmeter reading of 0 volts ± 0.05 volt. Disconnect the digital voltmeter.

4. Voltage Controlled Oscillator Adjustment (see Figure 5–13).
   a. Remove the A4A6 cover. With the output cable of the A4A5 assembly disconnected from the VCO OUTPUT (A4J10), connect the digital voltmeter to the A4A6 Frequency Control output (white/black/violet lead).
   b. Adjust the A4A6 “0” CONTROL (A6A6R13) for a digital voltmeter reading of −34 Vdc (voltage should be adjustable from about −33 to −35 Vdc).
   c. Connect the frequency counter to the A4A5 voltage controlled oscillator output, A4J12. Replace the A4A6 assembly cover.
   d. The counter should display 450 MHz ± 1 MHz. If the correct reading is obtained proceed to step f. If the frequency reading is not correct, proceed to step e.
   e. Adjust A4A5C3 for a 450 MHz ± 1 MHz reading.
   f. Disconnect the frequency counter and reconnect the voltage controlled oscillator output to the phase detector.
Figure 5-13. Voltage Controlled Oscillator Adjustments Test Setup

g. Connect the digital voltmeter to the “phase error” test point. Connect the frequency counter to A4J12 (350-450 MHz OUTPUT, white-yellow cable).

h. Set the center frequencies as shown in Table 5-9 and set the digital-to-analog controls on the A4A6 assembly for 0 ± 0.1 volt for each frequency listed. Note that the counter displays the output frequency listed for each center frequency setting.

NOTE

When the 86602 or 86603 is installed in the mainframe the 350 MHz output of the High Frequency Section is not used. When this situation exists, the adjustment procedure for A4A6R15 "10" is not valid and the following procedure should be substituted:

1. Ground the collector of A4A6Q1.
3. Remove the ground from the collector of A4A6Q1.

Table 5-9. Pretune Adjustments

<table>
<thead>
<tr>
<th>Center Frequency</th>
<th>Adjust Control</th>
<th>Counter Readout</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 MHz</td>
<td>A4A6R13'0&quot;</td>
<td>450.000000 MHz</td>
</tr>
<tr>
<td>10 MHz</td>
<td>A4A6R60'1&quot;</td>
<td>440.000000 MHz</td>
</tr>
<tr>
<td>20 MHz</td>
<td>A4A6R56'2&quot;</td>
<td>430.000000 MHz</td>
</tr>
<tr>
<td>30 MHz</td>
<td>A4A6R52'3&quot;</td>
<td>420.000000 MHz</td>
</tr>
<tr>
<td>40 MHz</td>
<td>A4A6R48'4&quot;</td>
<td>410.000000 MHz</td>
</tr>
<tr>
<td>50 MHz</td>
<td>A4A6R44'5&quot;</td>
<td>400.000000 MHz</td>
</tr>
<tr>
<td>60 MHz</td>
<td>A4A6R40'6&quot;</td>
<td>390.000000 MHz</td>
</tr>
<tr>
<td>70 MHz</td>
<td>A4A6R35'7&quot;</td>
<td>380.000000 MHz</td>
</tr>
<tr>
<td>80 MHz</td>
<td>A4A6R28'8&quot;</td>
<td>370.000000 MHz</td>
</tr>
<tr>
<td>90 MHz</td>
<td>A4A6R22'9&quot;</td>
<td>360.000000 MHz</td>
</tr>
<tr>
<td>100 MHz</td>
<td>A4A6R15'10&quot;</td>
<td>350.000000 MHz</td>
</tr>
</tbody>
</table>
NOTE

The adjustments shown in Table 5-9 should be made with the counter time base connected to the synthesizer REFERENCE OUTPUT.

i. If any of the controls listed in Table 5-9 cannot be adjusted to 0 volts, adjust A4A6R20 "profile" to obtain additional range. Repeat all pretune adjustments until satisfactory results are obtained. Disconnect the digital voltmeter and the frequency counter.

5. Loop Gain Adjustment (see Figure 5-14).

a. With the center frequency set to 0 MHz connect the Spectrum Analyzer RF INPUT to A4J12 (350–450 MHz OUTPUT) and set the analyzer controls as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center Frequency</td>
<td>450 MHz</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>30 kHz</td>
</tr>
<tr>
<td>Scan Width Per Division</td>
<td>0.5 MHz</td>
</tr>
<tr>
<td>Scan Time Per Division</td>
<td>5 ms</td>
</tr>
</tbody>
</table>

b. Disconnect the reference input to A4J13 (10 MHz output from A4A4) and reconnect it together with the RF output of the Signal Generator/Sweeper.

c. Set the Signal Generator/Sweeper to 11.5 MHz CW at -35 dBm and symmetrical sweep width to 3 MHz. The analyzer display should be approximately as shown in the typical waveform shown in Figure 5-15. Adjust the A4A6 GAIN control (A4A6R2) for the response shown.

d. Disconnect the Analyzer and the Generator/Sweeper. Reconnect the reference signal to A4J13.

![Diagram showing test setup](image)

*Figure 5-14. Loop Gain Adjustment Test Setup*
6. 10 MHz Trap Adjustment (see Figure 5–16).

**NOTE**

*This adjustment is necessary only if the A4A6 10 MHz trap has been repaired.*

a. Disconnect the coaxial cable from A4J10 (350/450 MHz to \( \Phi \) detector).

b. Disconnect the 10 MHz reference signal from A4J13 and reconnect it using a TEE connector. Connect the 10 MHz reference signal from the other TEE port to the \( \Phi \) input of the A4A6 assembly (white wire from the A4A7 assembly).

c. Connect the Spectrum Analyzer RF INPUT to the A4A6 Frequency control output (white-black-violet wire). Set the analyzer controls as follows:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center Frequency</td>
<td>10 MHz</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>30 kHz</td>
</tr>
<tr>
<td>Scan Width Per Division</td>
<td>200 kHz</td>
</tr>
<tr>
<td>Video Filter</td>
<td>OFF</td>
</tr>
<tr>
<td>Input Attenuation</td>
<td>0 dB</td>
</tr>
<tr>
<td>Scan Time Per Division</td>
<td>1 msec</td>
</tr>
<tr>
<td>Ref Level</td>
<td>-30 dBm</td>
</tr>
</tbody>
</table>

d. Adjust A4A6C5 trap for minimum 10 MHz amplitude.

e. Reconnect \( \Phi \) input to A4A6.

f. Replace all High Frequency Section Covers.
7. Output Frequency and Amplitude Check (see Figure 5-17).
   a. Set the HP 8660D CF to 6 MHz.
   b. Connect the Spectrum Analyzer RF INPUT to A4J12. Set the analyzer controls as required to view the 450 MHz signal. The output should be +13 dBm to +15 dBm. To increase or decrease output, change resistors A4A5R38, R40, R42. See Table 5-2 for suggested sets of values.

   c. Switch digits 9 and 8 from 00 through 10. The frequency should decrease in 10 MHz steps (amplitude at +13 dBm minimum).

   440 MHz ________ dBm  430 MHz ________ dBm  420 ________ dBm
   410 MHz ________ dBm  400 MHz ________ dBm  390 ________ dBm
   380 MHz ________ dBm  370 MHz ________ dBm  360 ________ dBm
   350 MHz ________ dBm
Adjustment 7

N1 PHASE LOCK LOOP

- Service Sheets 7 and 8

Description

The N1 phase lock loop produces digitally controlled RF signals from 19.8 to 29.7 MHz in 100 kHz steps. The output frequency is controlled by changing the 1 MHz and 100 kHz digits of the front panel display. The following procedure adjusts the pre-tuning circuitry of the loop.

![Diagram of N1 Loop Test Setup]

Figure 5-18. N1 Loop Test Setup

Test Equipment

Digital Voltmeter ................................................................. HP 3478A
Frequency Counter ................................................................. HP 5385A

Procedure

1. Set up test equipment as shown in Figure 5-18.
2. Enter 0 MHz center frequency and ground A2 Motherboard test point A2TP16 with one of the jumper plugs provided. Connect the digital voltmeter to A2TP18.
3. Adjust A17R31 (or A17R28) for a voltmeter reading of −30 Vdc ±0.1 Vdc, and disconnect the digital voltmeter.
4. Connect the frequency counter to the N1 oscillator output on the A2 mother board and adjust A17C17 for a counter reading of 29.70 MHz ± 0.02 MHz.
5. Set the HP 8660D center frequency to 9.5 MHz. Adjust A17R31 for a counter reading of 20.2 MHz ± 0.02 MHz. (Hint: Set the Step Freq increment to 9 MHz).
6. Set the HP 8660D center frequency to 0.5 MHz. Adjust A17R28 for a counter reading of 29.2 MHz ± 0.02 MHz.
7. The adjustments in steps 5 and 6 are interactive. Repeat these adjustments until both counter readings are within tolerance.
8. Remove the ground jumper from A2TP16.

9. Disconnect the 400 kHz reference signal by disconnecting the cable from A4J3 and connect the digital voltmeter to A2TP17. Adjust A16R38 for a digital voltmeter readout of 0V ± 10 mV. Reconnect the 400 kHz reference signal.

10. Set the HP 8660D center frequency to 9.5 MHz. The frequency counter reading should be 20.200000 MHz. Adjust A17R31 for a DVM reading of 0V ± 100 mVdc at TP17.

11. Set the HP 8660D center frequency to 0.5 MHz. The frequency counter reading should be 29.200000 MHz. Adjust A17R28 for a DVM reading of 0V ± 100 mVdc at TP17.

12. The adjustments in steps 10 and 11 are interactive. Repeat these steps until the DVM reading is within tolerance at both frequency settings.

13. Enter the center frequencies shown in Table 5-10. The counter readings should be as shown in the table. (Hint: Set the Step Freq increment to 1.1 MHz).

<table>
<thead>
<tr>
<th>Center Frequency</th>
<th>Counter Readout</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>29.700000 MHz</td>
</tr>
<tr>
<td>1.1 MHz</td>
<td>28.600000 MHz</td>
</tr>
<tr>
<td>2.2 MHz</td>
<td>27.500000 MHz</td>
</tr>
<tr>
<td>3.3 MHz</td>
<td>26.400000 MHz</td>
</tr>
<tr>
<td>4.4 MHz</td>
<td>25.300000 MHz</td>
</tr>
<tr>
<td>5.5 MHz</td>
<td>24.200000 MHz</td>
</tr>
<tr>
<td>6.6 MHz</td>
<td>23.100000 MHz</td>
</tr>
<tr>
<td>7.7 MHz</td>
<td>22.000000 MHz</td>
</tr>
<tr>
<td>8.8 MHz</td>
<td>20.900000 MHz</td>
</tr>
<tr>
<td>9.9 MHz</td>
<td>19.800000 MHz</td>
</tr>
</tbody>
</table>

**NOTE**

The adjustments shown in Table 5-10 should be made with the counter time base connected to the synthesizer REFERENCE OUTPUT.
Adjustment 8

N2 PHASE LOCK LOOP

- Service Sheets 9 and 10

Description

The N2 phase lock loop produces digitally controlled RF signals from 19.80 to 29.79 MHz in 10 kHz increments. The output frequency is controlled by changing the 10 kHz, 1 kHz, and 100 Hz digits of the front panel display. The following procedure adjusts the pretuning circuitry of the loop.

![Diagram of N2 Loop Test Setup]

**Figure 5-19. N2 Loop Test Setup**

Test Equipment

- Digital Voltmeter ................................................................. HP 3478A
- Frequency Counter .............................................................. HP 5385A

Procedure

1. Set up test equipment as shown in Figure 5-19.
2. Set the center frequency to 0 MHz and ground A2TP12 on the A2 Motherboard with one of the jumper plugs provided.
3. Connect the digital voltmeter to A2TP9 and adjust A13R37 (or A13R39) to $-30V \pm 0.1\text{ Vdc}$. Disconnect the digital voltmeter.
4. Connect the frequency counter to the N2 oscillator output at XA13-14. Adjust A13C19 for a counter reading as close as possible to 29.79 MHz $\pm 0.02$ MHz.
5. Set the HP 8660D center frequency to 95.5 kHz. Adjust A13R37 for a counter reading of 20.24 MHz $\pm 0.020$ MHz. (Hint: Set the Step Freq increment to 90 kHz).
6. Set the HP 8660D center frequency to 5.5 kHz. Adjust A13R39 for a frequency counter reading of 29.24 MHz $\pm 0.020$ MHz.
7. The adjustments in steps 5 and 6 are interactive. Repeat these steps until both counter readings are within tolerance.
8. Remove the ground from A2TP12.
9. Connect the voltmeter to A2 Motherboard TP10.
10. Set the HP 8660D center frequency to 95.5 kHz. The frequency counter reading should be 20.24000 MHz. Adjust A13R37 for a DVM reading of 0V ± 100 mVdc.
11. Set the HP 8660D center frequency to 5.5 kHz. The frequency counter reading should be 29.24000 MHz. Adjust A13R39 for a DVM reading of 0V ± 100 mVdc.
12. The adjustments in steps 10 and 11 are interactive. Repeat these steps until the DVM reading is within tolerance at both frequency settings.

12. Set center frequency as shown in Table 5–11. The counter readings should be as shown in the table. (Hint: Set the Step Freq increment to 11.1 kHz).

<table>
<thead>
<tr>
<th>Center Frequency</th>
<th>Counter Readout N2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>29.790000 MHz</td>
</tr>
<tr>
<td>11.1 kHz</td>
<td>28.680000 MHz</td>
</tr>
<tr>
<td>22.2 kHz</td>
<td>27.570000 MHz</td>
</tr>
<tr>
<td>33.3 kHz</td>
<td>26.460000 MHz</td>
</tr>
<tr>
<td>44.4 kHz</td>
<td>25.350000 MHz</td>
</tr>
<tr>
<td>55.5 kHz</td>
<td>24.240000 MHz</td>
</tr>
<tr>
<td>66.6 kHz</td>
<td>23.130000 MHz</td>
</tr>
<tr>
<td>77.7 kHz</td>
<td>22.020000 MHz</td>
</tr>
<tr>
<td>88.8 kHz</td>
<td>20.910000 MHz</td>
</tr>
<tr>
<td>99.9 kHz</td>
<td>19.800000 MHz</td>
</tr>
</tbody>
</table>
Adjustment 9

N3 PHASE LOCK LOOP

- Service Sheets 11 and 12

Description

The N3 phase lock loop produces digitally controlled RF signals from 2.001 to 2.100 MHz in 1 kHz increments. The output frequency is controlled by changing the 1 Hz and 10 Hz digits of the display. The following procedure adjusts the pretuning circuitry of the loop.

![Diagram of N3 Loop Test Setup]

*Figure 5-20. N3 Loop Test Setup*

Test Equipment

Digital Voltmeter .................................................. HP 3478A
Frequency Counter .................................................. HP 5385A

NOTE

*The A2 Motherboard test points used in this procedure are covered up by the HP 8660D DCU. To access these test points, remove the 4 screws holding the DCU to the chassis and slide it forward. Refer to the Remote Selection procedure in Section 2 if needed.*

Procedure

1. Set up test equipment as shown in Figure 5-20.

2. Set the HP 8660D center frequency to 95 Hz. Ground A2TP4 on the A2 Motherboard with one of the jumpers provided.

3. Connect the frequency counter to the A2 Motherboard test point labeled N3 OSC, which is adjacent to XA8-1 pin 7. (The other test point labeled N3 OSC is the VCO output after the frequency is divided by 10). Adjust A8R26 for a counter reading of 20.05 ± 0.02 MHz.

4. Set the HP 8660D center frequency to 5 Hz. Adjust A8R24 for a counter reading of 20.95 ± 0.02 MHz.
5. The adjustments in steps 3 and 4 are interactive. Repeat these adjustments until both counter readings are within tolerance.

6. Connect the voltmeter to A2 Motherboard TP3.

7. Remove the ground from A2 TP4.

8. Set the HP 8660D center frequency to 95 Hz. The counter reading should be 20.050000 MHz. Adjust A8R26 for a DVM reading of 0V ± 100 mVdc.

9. Set the HP 8660D center frequency to 5 Hz. The counter reading should be 20.950000 MHz. Adjust A8R24 for a DVM reading of 0V ± 100 mVdc.

10. The adjustments in steps 8 and 9 are interactive. Repeat these steps until the DVM reading is within tolerance at both frequency settings.

11. Set center frequencies as shown in Table 5-12. The counter readings should be as shown in the table.

**Table 5-12. N3 Oscillator Output Frequency Checks**

<table>
<thead>
<tr>
<th>Center Frequency</th>
<th>Counter Readout</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>21.000000 MHz</td>
</tr>
<tr>
<td>11 Hz</td>
<td>20.890000 MHz</td>
</tr>
<tr>
<td>22 Hz</td>
<td>20.780000 MHz</td>
</tr>
<tr>
<td>33 Hz</td>
<td>20.670000 MHz</td>
</tr>
<tr>
<td>44 Hz</td>
<td>20.560000 MHz</td>
</tr>
<tr>
<td>55 Hz</td>
<td>20.450000 MHz</td>
</tr>
<tr>
<td>66 Hz</td>
<td>20.340000 MHz</td>
</tr>
<tr>
<td>77 Hz</td>
<td>20.230000 MHz</td>
</tr>
<tr>
<td>88 Hz</td>
<td>20.120000 MHz</td>
</tr>
<tr>
<td>99 Hz</td>
<td>20.010000 MHz</td>
</tr>
</tbody>
</table>
Adjustment 10

SUMMING LOOP 2 (SL2)
- Service Sheets 13 and 14

Description
SL2 is a phase lock loop that provides a digitally controlled RF output to Summing Loop 1. This output, which is from 20.0001 to 30.000 MHz in 100 Hz steps, is controlled by changing the frequency of the N2 and N3 phase locked loops. The following procedure adjusts the pretuning circuitry of the loop.

![Diagram of SL2 Test Setup]

**Figure 5-21. SL2 Test Setup**

Test Equipment

- Digital Voltmeter .................................................. HP 3478A
- Frequency Counter .................................................. HP 5385A
- Oscilloscope (10:1 divider probes) .............................. HP 54200A

Procedure

1. Set up the test equipment as shown in Figure 5-21.
2. Set the HP 8660D center frequency to 0 MHz. Ground A2TP8 on the A2 Motherboard.
NOTE

The A2 Motherboard test points used in this procedure are covered by the
interface boards, A3A1 and A3A2. The HP 8660D will not function with the
interface boards removed. The best way to access these test points is to use a
short piece of wire (#14 AWG) with one end filed to a point. The pointed end
of the wire can be forced into the test points located between the interface
boards. Then the oscilloscope or DVM probe can be connected to the other
end of the wire. Likewise, instead of using the plug-in jumper to short TP 8
to ground, insert the piece of wire into TP8 and connect a jumper from the
wire to ground. The HP 8660D DCU must be moved forward to gain access
to TP5. See Remote Selection in Section 2 for this procedure.

3. Connect the voltmeter to A2 Motherboard TP5. Adjust A11R19 for a DVM reading of
   −30V ± 0.1 Vdc. Remove the voltmeter from TP5.

4. Connect the counter to the A2 Motherboard TP6 (SL2 OSC). Adjust A11C17 for a counter reading
   of 30V ± 0.02 MHz.

5. Set the HP 8660D center frequency to 94.5 kHz. Adjust A11R19 for a counter reading
   of 20.55 ± 0.02 MHz.

6. Set the HP 8660D center frequency to 4.5 kHz. Adjust A11R15 for a counter reading of
   29.55 ± 0.02 MHz.

7. The adjustments in steps 4 and 5 are interactive. Repeat these steps until both counter readings
   are within tolerance.

8. Remove the ground from the A2 TP8.

9. Set the HP 8660D center frequency to 94.5 kHz. Connect the voltmeter to A2 Motherboard TP
    and adjust A11R19 for a DVM reading of 0V ± 5 mVdc.

10. Connect the oscilloscope to A2 Motherboard TP7. Adjust A12R37 for a square wave with 50/50
    symmetry. Remove the oscilloscope.

11. Set the HP 8660D center frequency to 4.5 kHz. Adjust A11R15 for a DVM reading of
    0V ± 100 mVdc at A2TP8.

NOTE

The voltage readings will drift immediately after a frequency change. Wait
until the reading stabilizes before making the adjustment.

12. Set the HP 8660D center frequency to 94.5 kHz. Adjust A11R19 for a DVM reading of
    0V ± 100 mVdc.

13. The adjustments in steps 11 and 12 are interactive. Repeat these steps until both DVM readings
    are within tolerance.

14. Set the HP 8660D center frequency to the values given in Table 5–13. At each frequency setting
    adjust the control listed in the table for a DVM reading of 0V ± 100 mVdc. The frequency at
    TP6 SL2 OSC should be as shown in the table.
Table 5–13. SL2 Oscillator Output Frequency Adjustments

<table>
<thead>
<tr>
<th>Center Frequency</th>
<th>Adjust</th>
<th>Counter Readout</th>
</tr>
</thead>
<tbody>
<tr>
<td>84.5 kHz</td>
<td>A11R39 &quot;8&quot;</td>
<td>21.55 MHz ± 20 kHz</td>
</tr>
<tr>
<td>74.5 kHz</td>
<td>A11R54 &quot;7&quot;</td>
<td>22.55 MHz ± 20 kHz</td>
</tr>
<tr>
<td>64.5 kHz</td>
<td>A11R60 &quot;6&quot;</td>
<td>23.55 MHz ± 20 kHz</td>
</tr>
<tr>
<td>54.5 kHz</td>
<td>A11R67 &quot;5&quot;</td>
<td>24.55 MHz ± 20 kHz</td>
</tr>
<tr>
<td>44.5 kHz</td>
<td>A11R73 &quot;4&quot;</td>
<td>25.55 MHz ± 20 kHz</td>
</tr>
<tr>
<td>34.5 kHz</td>
<td>A11R77 &quot;3&quot;</td>
<td>26.55 MHz ± 20 kHz</td>
</tr>
<tr>
<td>24.5 kHz</td>
<td>A11R83 &quot;2&quot;</td>
<td>27.55 MHz ± 20 kHz</td>
</tr>
<tr>
<td>14.5 kHz</td>
<td>A11R90 &quot;1&quot;</td>
<td>28.55 MHz ± 20 kHz</td>
</tr>
</tbody>
</table>
Adjustment 11

SUMMING LOOP 1 (SL1)

- Service Sheet 15, 16 and 17.

Description

SL1 is a phase lock loop that provides a digitally controlled RF output to the RF Section plug-in. This output, which is from 20.0000001 to 30.000000 MHz in 1 Hz steps is controlled by changing the N1 and SL2 phase locked loops. The following procedure adjusts the pretuning circuitry of the loop.

![Diagram of test setup]

*Figure 5-22. SL1 Test Setup*

Test Equipment

- Digital Voltmeter .......................................................... HP 3478A
- Frequency Counter .......................................................... HP 5385A
- Oscilloscope (10:1 divider probes) ...................................... HP 54200A

Procedure

1. Set up test equipment as shown in Figure 5-22.
2. Set the HP 8660D center frequency to 0 Hz. Connect a plug-in jumper on the A2 Motherboard between TP14 and GND.
3. Connect the voltmeter to A2TP21. Adjust A19R9 for 30V ± 0.1 Vdc. Remove the voltmeter cable from TP21.
4. Connect the frequency counter to the A2 Motherboard test point labeled SL1 OSC. Adjust A19C18 for a counter reading of 30 MHz ± 0.02 MHz.
5. Set the center frequency to 9.45 MHz. Adjust A19R9 for a counter reading of 20.55 MHz ± 0.02 MHz.
6. Set the HP 8660D center frequency to 0.45 MHz. Adjust A19R3 for a counter reading of 29.55 MHz ± 0.02 MHz.

7. The adjustments in steps 5 and 6 are interactive. Repeat these steps until both counter readings are within tolerance.

8. Remove the jumper from the A2 Motherboard.

9. Set the HP 8660D center frequency to 9.45 MHz. Connect the voltmeter to A2 Motherboard TP14.

10. Adjust A19R9 for a DVM reading of 0 mVdc ± 5 mVdc.

11. Connect the oscilloscope to A2 Motherboard TP13. Adjust A15R14 for a square wave with 50/50 symmetry. Remove the oscilloscope.

12. Set the HP 8660D center frequency to 0.45 MHz. Adjust A19R3 for a DVM reading of 0 mVdc ± 100 mVdc at A2 TP14.

**NOTE**

*The voltage reading will drift immediately after a frequency change. Wait until the reading stabilizes before making the adjustment.*

13. Set the HP 8660D center frequency to 9.45 MHz. Adjust A19R9 for a DVM reading of 0 mVdc ± 100 mVdc.

14. The adjustments in steps 12 and 13 are interactive. Repeat these steps until both DVM readings are within tolerance.

15. Set the HP 8660D center frequency to the values given in Table 5-14. At each frequency setting adjust the control listed in the table for a DVM reading of 0 mVdc ± 100 mVdc. The frequency counter reading at the test point called SL1 OSC should be as shown in the table.

**Table 5-14. SL1 Oscillator Output Frequency Adjustments**

<table>
<thead>
<tr>
<th>Center Frequency</th>
<th>Adjust</th>
<th>Counter Readout</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.45 MHz</td>
<td>A18R35 “8”</td>
<td>21.550 MHz ± 20 kHz</td>
</tr>
<tr>
<td>7.45 MHz</td>
<td>A18R40 “7”</td>
<td>22.550 MHz ± 20 kHz</td>
</tr>
<tr>
<td>6.45 MHz</td>
<td>A18R44 “6”</td>
<td>23.550 MHz ± 20 kHz</td>
</tr>
<tr>
<td>5.45 MHz</td>
<td>A18R51 “5”</td>
<td>24.550 MHz ± 20 kHz</td>
</tr>
<tr>
<td>4.45 MHz</td>
<td>A18R55 “4”</td>
<td>25.550 MHz ± 20 kHz</td>
</tr>
<tr>
<td>3.45 MHz</td>
<td>A18R62 “3”</td>
<td>26.550 MHz ± 20 kHz</td>
</tr>
<tr>
<td>2.45 MHz</td>
<td>A18R67 “2”</td>
<td>27.550 MHz ± 20 kHz</td>
</tr>
<tr>
<td>1.45 MHz</td>
<td>A18R74 “1”</td>
<td>28.550 MHz ± 20 kHz</td>
</tr>
</tbody>
</table>
Adjustment 12

DCU SWEEP OUTPUT

- Service Sheet 25

Description

The HP 8660D sweep output is used to drive the horizontal sweep of an oscilloscope while the RF output is used to determine the characteristics of a device being tested. This procedure properly adjusts the sweep ramp output.

Test Equipment

Digital Voltmeter ............................................................... HP 3478A

Procedure

1. Remove the bottom cover from the HP 8660D.
2. Connect the DVM to the 0 - 8V output on the front panel. Set the DVM to measure DC volts.
3. Enter 1.0005 MHz center frequency and 1 kHz sweep width.
5. Using the tuning knob, set frequencies shown in Table 5-15 and make the indicated adjustments. All adjustments must be ± 1 mVdc.

Table 5-15. Adjustments

<table>
<thead>
<tr>
<th>Step</th>
<th>Frequency</th>
<th>Adjust</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000799 MHz</td>
<td>Record DVM output reading (typically 6.392V)</td>
</tr>
<tr>
<td>2</td>
<td>1.000800 MHz</td>
<td>R29 for an output 8 mV greater than above. Reading is typically 6.4V</td>
</tr>
<tr>
<td>3</td>
<td>1.000999 MHz</td>
<td>R11 for an output of 7.992V</td>
</tr>
<tr>
<td>4</td>
<td>1.000000 MHz</td>
<td>R28 for an output of 0.000V</td>
</tr>
<tr>
<td>5</td>
<td>1.001000 MHz</td>
<td>Repeat steps 1 through 4</td>
</tr>
</tbody>
</table>

Table 5-16. Frequency Versus Exact Output Levels

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Output Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000000 MHz</td>
<td>0.000V</td>
</tr>
<tr>
<td>1.000799 MHz</td>
<td>6.392V</td>
</tr>
<tr>
<td>1.000800 MHz</td>
<td>6.400V</td>
</tr>
<tr>
<td>1.000999 MHz</td>
<td>7.992V</td>
</tr>
<tr>
<td>1.001000 MHz</td>
<td>8.000V</td>
</tr>
<tr>
<td>Nominal step size 8 mV/Hz</td>
<td></td>
</tr>
</tbody>
</table>

5-36 Adjustment 12
Figure 5-23. A2 Test Point Locator