HP References in this Manual

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

About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

Support for Your Product

Agilent no longer sells or supports this product. You will find any other available product information on the Agilent Test & Measurement website:
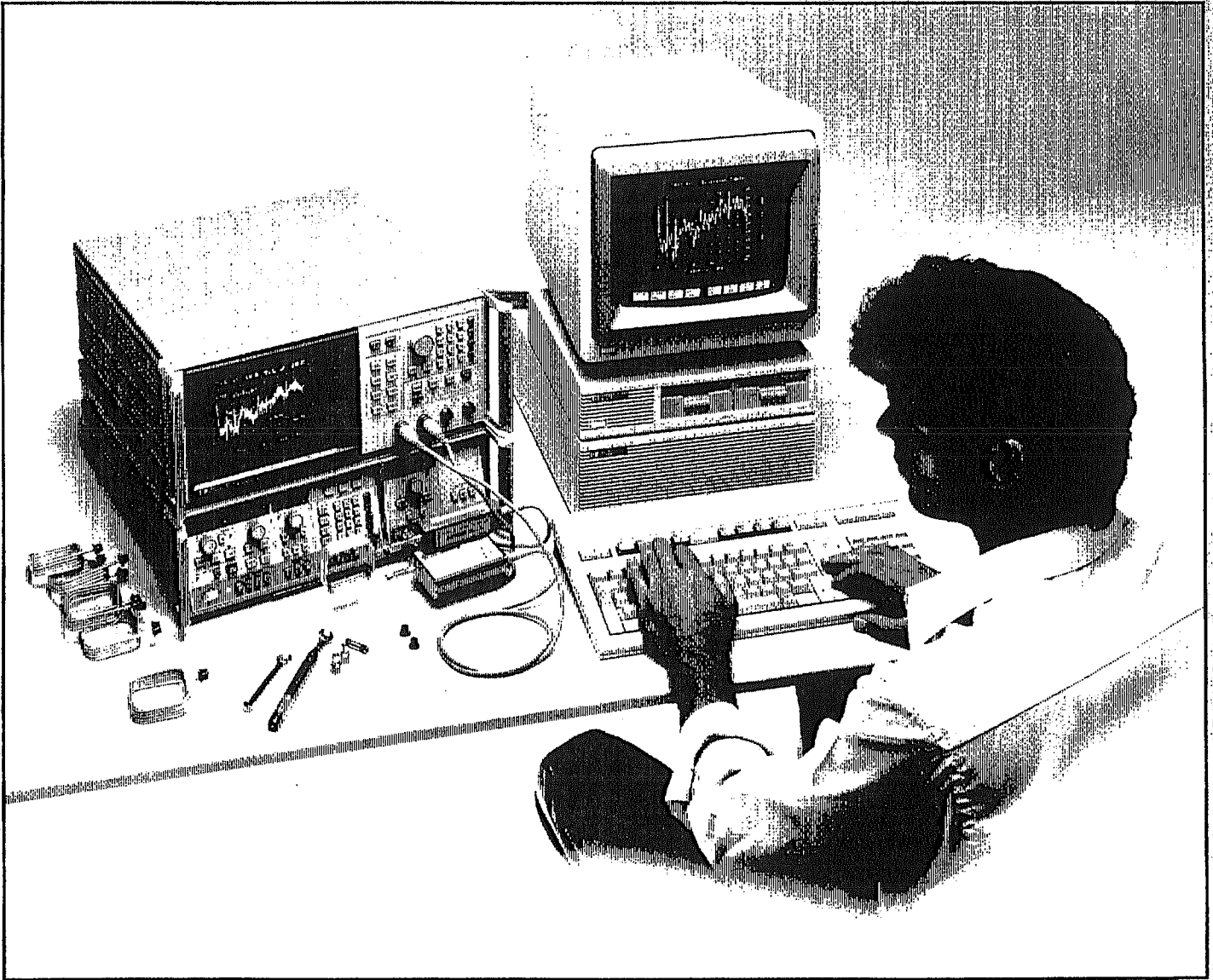
www.tm.agilent.com

Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

Agilent Technologies

HP 8757C/E
Scalar Network Analyzers

User's Guide

HEWLETT
PACKARD

This document is intended to provide an introduction to the operation of the HP 8757C/E scalar network analyzer. It is organized in a manner that will familiarize the user with many of the capabilities and features of the HP 8757C/E, illustrating actual operating sequences for various measurements.

Chapter 1 provides a basic introduction to the HP 8757C/E's front panel, then leads the user through the general measurement procedure for making scalar network measurements.

Chapters 2 and 3 describe the procedure for making transmission and reflection measurements. The examples have been selected to illustrate many of the operating modes of the HP 8757C/E, and the simplicity of their design. The bandpass filter (HP Part No. 0955-0446) utilized as the device under test in many of the examples, demonstrates the techniques for measuring most common devices.

Chapters 4 and 5 describe advanced features, such as limit testing for device evaluation and how to use the alternate sweep capabilities of the HP 8350B and HP 8340B/8341B sources.

Chapter 6 illustrates the HP 8757C's external disk save/recall capabilities, while chapter seven covers special functions such as color selection and frequency blanking. This document also includes an appendix, that describes the capabilities and advantages of the AC and DC detection modes.

The HP 8757C/E *Operating Manual* (HP Part No. 08757-90073) has more complete operating information. Use this reference for further information on any topic covered in this User's Guide. Programming information is provided in the *Quick Reference Guide* (HP Part No. 08757-90077), in the *Introductory Programming Guide* for *Microsoft® QuickBASIC 4.0* (HP Part No. 08757-90076) and for *Series 200/300 computers* (HP Part No. 08757-90075).

How to use this guide

To gain the most benefit from this User's Guide, it is recommended that you proceed sequentially through the guide, starting with chapter 1 and ending with chapter 7. Each chapter builds upon the information presented in previous chapters. Also, the examples provided within each chapter are written in procedural form. To follow the examples, start at the beginning of each chapter.

To simplify the execution of the measurements presented, the HP 8757C's front panel "hardkeys" are differentiated from the display "softkeys." The hardkeys are presented in **bold** capital letters (e.g. **[CAL]**) and the softkeys are *bold italic* capital letters (e.g. *[SHORT/OPEN]*).

Equipment utilized in this guide

HP 8350B Mainframe with HP 83592B Plug-in.

Bandpass Filter — HP Part No. 0955-0446.

HP 8447D Amplifier.

HP 85027E Directional Bridge.

> Includes 3.5 mm (f) to (f) adapter
> HP Part No. 85027-60005.
>
> and 3.5 mm (f) open/short
> HP Part No. 85027-60004.

HP 11664A Detector.

HP 11664E Detector.

HP 11667A Power Splitter.

HP 8491A 6 dB Attenuator.

HP 8491B 10 dB Attenuator.

Type N (m) to 3.5 mm (m) adapter
HP Part No. 1250-1743.

Type N (m) to 3.5 mm (f) adapter
HP Part No. 1250-1744.

HP 85022 Cable Kit.

C O N T E N T S

Operating the HP 8757C/E

Front panel tour

The front panel of the HP 8757C/E was designed to simplify measurement operations. Each "hardkey" accesses a CRT-displayed menu. These menus offer a list of possible selections for the completion of a particular operation. Each selection corresponds to one of the eight "softkeys" located to the right of the display. Using front panel keys to access softkey menus allows for the expansion of the analyzer's capabilities, without adding front panel complexity.
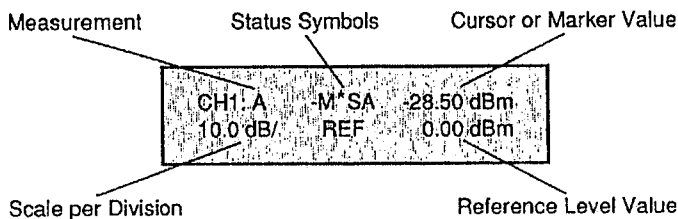
CRT display

With the selection of each hardkey or softkey, the HP 8757C/E's display is updated to exhibit the current measurement configuration and status information. For those parameters not continually shown on the display, select the appropriate key to exhibit the parameter in the active entry area.
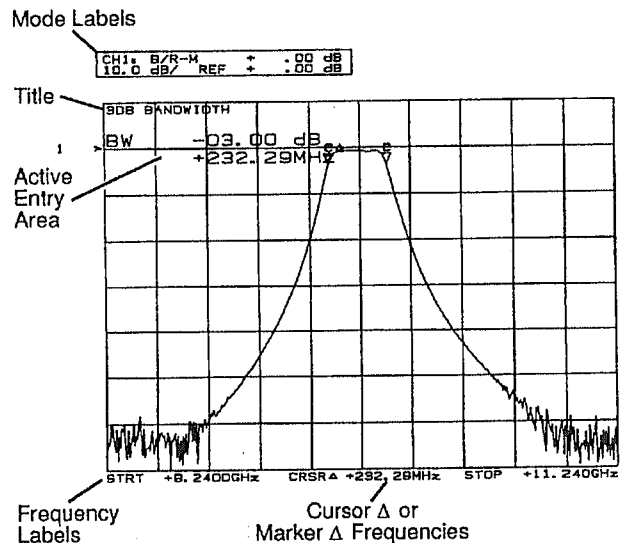
The HP 8757E utilizes a monochrome display. The HP 8757C offers a color display that may be customized to the user's particular color preferences. A monochrome display mode is also available at the touch of a softkey in the [DISPLAY] menu.

Mode labels

This area of the CRT is used to show the current status of various functions for the activated channels (an example is shown below). The following table lists the status symbol notations and their meanings.

Measurement   Status Symbols   Cursor or Marker Value

CH1: A   M*SA   -28.50 dBm
10.0 dB/   REF   0.00 dBm

Scale per Division   Reference Level Value

Notation	Definitions
—M	The trace displayed represents the subtraction of the stored data from measured data.
MEM	The trace displayed represents stored data.
S	Trace smoothing is on.
A	Trace averaging is on.
*	Adaptive Normalization is on (HP 8757C only).
U	Adaptive Normalization is on, but uncalibrated (the frequency span has been increased beyond the original calibration span).

Mode Labels

CH1: B/R-M   REF   ‡   .00 dB
10.0 dB/   REF   ‡   .00 dB

Title

3DB BANDWIDTH

BW   -03.00 dB
+232.29MHz

Active Entry Area

STRT +8.2400GHz   CRSR▲ +292.28MHz   STOP +11.2400GHz

Frequency Labels   Cursor ▲ or Marker ▲ Frequencies

Channel selection

Many measurement and display functions are independently selectable for each channel. To modify the parameters of a particular trace, first select that channel (making it the active channel), then make the desired measurement choices. The mode label area of the active channel is boxed to differentiate it from other enabled channels.

The HP 8757C may display as many as four channels at one time. Selecting one of the channel hardkeys will activate the CRT-displayed channel menu. The softkeys may then be utilized to activate or deactivate other channels. The HP 8757E has dual channel capabilities. The trace and labels of the active channel are displayed more brightly, selecting that channel again deactivates it.

CHANNEL
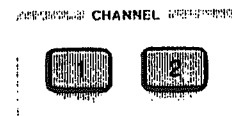
Function selection

There are eight function keys, which allow the user to select the measurement parameters, calibrate, and manipulate data presentation. [MEAS], [DISPLAY], and [CAL] access menus which provide the user with a choice of measurement and display configurations, and calibration sequences. The [SCALE], [REF], [CURSOR], [AVG], and [SPCL] keys allow the user to manipulate information in a manner that enhances usability of the measured data.
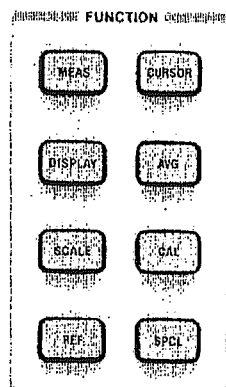

Data entry

The ten digit keypad is used to enter numeric values for a chosen parameter. Once the numbers have been selected, they need to be terminated with the appropriate units located on the right side of the keypad. Use [ENT] to terminate data that is unitless. In addition to entering data with the keypad, the knob may be used to make continuous adjustments, while the [▲] and [▼] keys allow the values to be changed in steps.
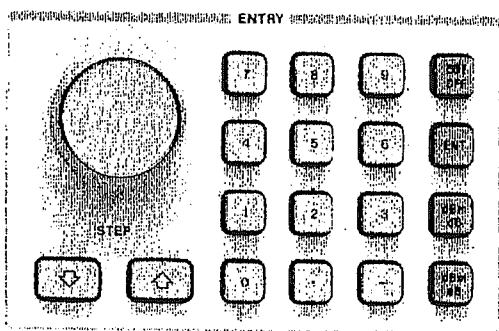
Instrument state selection

The Instrument State keys control system functions that apply to the entire instrument, they are not channel specific. [SYSTEM], [SAVE], [RECALL], [PRESET], and [LOCAL], implement such functions as: HP-IB plotter, printer, and disk controls, built-in diagnostic tests, front panel save/recall, instrument preset, and HP-IB instrument addresses.
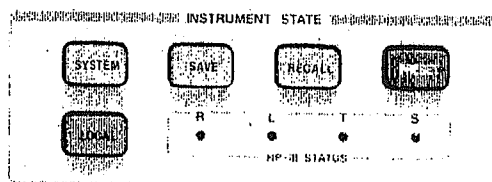
General measurement sequence

Even with its wide range of capabilities, the HP 8757C/E is easy to operate. Common measurements can be set up with only a few front panel selections. This section describes a general approach to performing network measurements with the HP 8757C/E.

The following sequence is used throughout this User's Guide to illustrate the use of the HP 8757C/E in its various operating modes. The individual steps are discussed in detail in the sections that follow.

Preset
Return to a known state.

Connections
Set up the test configuration for your particular device under test.

Controls
Set up the instrument with the following steps:
1. Select measurement input.
2. Set up source parameters.

Calibrate
Characterize the systematic errors and remove their effect from the displayed data.

Save
Save the instrument configuration and calibration to facilitate recalling measurement states.

Measurement
Measure the performance of the device under test. Utilize the cursor functions to extract key measurement information.

Output Results
Create a permanent record of your measurement data, by outputing the test results to a plotter or printer. Also, obtain virtually unlimited storage of test setups and measurement data with the HP 8757C and an external disk drive.

Step one: preset

Selecting [PRESET] activates a self test routine; when completed, the analyzer returns to a pre-determined state. [PRESET] also initializes all instruments attached to the 8757 System Interface. The major default conditions are listed in the table below.

Primary default conditions

Analyzer	
Channel	Channel 1 On, Active
	Channel 2 On
	Channel 3 Off*
	Channel 4 Off*
Measurement	A on Channel 1
	B on Channel 2
	C (Option 001) or B on
	Channel 3*
	R on Channel 4*
Display format	Displays the current
	measurement data
Colors*	Unchanged
Scale	20 dB/division
Reference	Reference Level equals 0 dBm
	Reference Position unchanged
	from previous setting
Number of points	401 trace points
Detection mode	AC
Trace memories	Unchanged
Save/Recall memories	Unchanged
Detector offsets	Unchanged
HP-IB addresses	Unchanged
Cursor	Off
	Search Value equals 3 dBm*
Modulation drive	On
Averaging	Off
Smoothing	Off
Adaptive normalization*	Off
Limit lines*	Unchanged
Source	
Frequency	Full span of source
Sweep time	200 ms
Mod	On
Plotter	Abort all activity
Printer	Abort all activity
Disk*	Abort all activity

* Applies only to the HP 8757C.

Step two: setup test connections

The device under test (DUT) determines the actual system configuration; the three (optionally four*) inputs offer the user a variety of possibilities. Simple insertion loss or gain measurements may be made with only a power splitter. Reflection measurements require a directional bridge or coupler.

The following figure presents a block diagram of a basic scalar coaxial system, configured for ratio reflection and transmission measurements. Adapters, attenuators, isolators, or other components may also be required depending on the actual DUT and the measurement parameters being characterized. Connector savers (high quality adapters) should be utilized whenever possible to preserve test ports of higher cost components (i.e. directional bridges), thus minimizing damage from repeated connect/disconnect cycles.
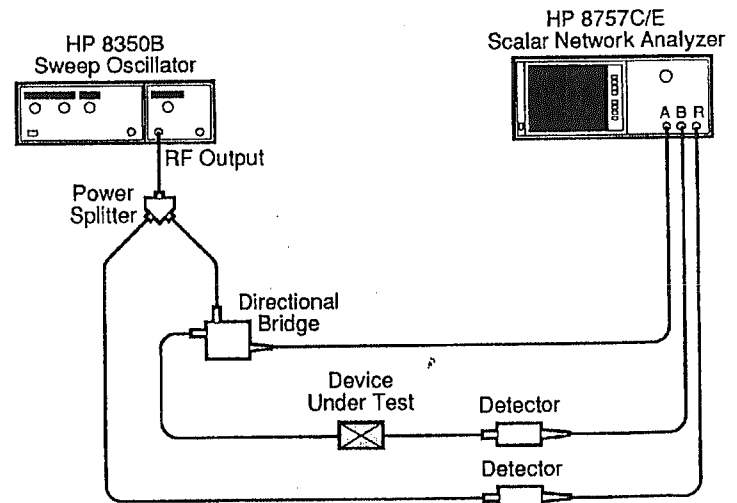
Step three: set system control settings

1. Select measurement input.
2. Set up source parameters.

Following preset, channel one is active and channel two is on. Use the [MEAS] key to select the appropriate single or ratioed measurement input for characterizing the desired parameters.

Use the controls of the source to set the start and stop frequencies that correspond to the frequency range of the device under test. The 8757 System Interface bus allows the HP 8757C/E to act as system controller, monitoring source functions. This interface provides frequency annotation on the CRT display, full use of all source marker modes, and control of the analyzer and source preset and save/recall functions. Also, it facilitates full use of the source sweep functions, such as CW (continuous wave), alternate and power sweep modes.

7

If the DUT is sensitive to the input power level, the power should be measured at the test port of the power splitter or directional bridge. To accomplish this, the device should be removed and the detector attached directly to the test port, then the power level on the source should be adjusted until the desired RF power level appears on the analyzer display. Typically, when the system is connected as in the previous figure, there is a 12 to 14 dB loss in power (from the power splitter and directional bridge) between the output of the source and the output of the test port. Once the power level has been set, reconnect the DUT.

Step four: perform calibration

Accuracy in network analysis is greatly influenced by factors external to the network analyzer. Parts of the measurement setup such as directional bridges, detectors and adapters all introduce variations that can distort the actual performance of the DUT. These errors are assumed to have a cummulative effect, thus increasing the overall uncertainty of the measured data.

Since scalar network analyzers measure the magnitude only response of the DUT (or calibration standard), it is impossible to completely eliminate the repeatable measurement (systematic) errors. Instead, these errors are minimized through a calibration process called normalization where the DUT is measured relative to the magnitude response of a known standard [MEAS–MEM]. Common systematic errors are:

- Frequency response   Removable
- Directivity
- Source and load match   Limited by quality of test setup

The accuracy of the calibration is dependent on the quality of the standards used for calibrating. Since calibration standards are very precise, excellent accuracy enhancement is acheived. Unless the Adaptive Normalization function is used (HP 8757C only), key measurement parameters such as the frequency may not be changed following calibration. Power may be changed if the system is configured for ratio measurements. When new parameters are required, the previous calibration becomes invalid and recalibration must occur.

For testing one or more devices, each calibration sequence may be saved in separate storage registers. When the source is connected to the 8757 System Interface, the front panel states of both the analyzer and the source are saved.

Transmission measurement calibration

For a transmission measurement, a "thru" is the calibration standard. It is accomplished by removing the DUT and directly connecting the measurement test port to the detector, thus establishing a 0 dB loss (or gain) reference.

Calibration sequence:

[CAL]	Accesses calibration menu
[THRU]	Sets up calibration; remove DUT, connect thru.
[STORE THRU]	Stores calibration in memory of active channel.
[DISPLAY]	Accesses display menu.
[MEAS–MEM]	Normalizes measurement trace; subtracts data stored in memory (calibration data) from current measurement data.

Reflection measurement calibration

Coaxial scalar systems commonly use a short and open as the calibration standards for a reflection measurement. Since either standard reflects all incident power, they provide a convenient 0 dB reference. Mismatches and directivity in the test setup cause calibration and measurement errors that vary as a function of frequency. A test setup with either a short circuit or a shielded open include the same calibration errors 180° out of phase with each other. Therefore, by averaging the responses of a short circuit and a shielded open circuit the mismatch and directivity effects will cancel during calibration, producing an accurate reflection reference. With waveguide scalar measurement systems only a fixed short may be utilized as the calibration standard, since it is impossible to create a full reflection open circuit.

Calibration sequence:

[CAL]	Accesses calibration menu.
[SHORT/OPEN]	Sets up calibration; connect short.
[STORE SHORT]	Connect open.
[STORE OPEN]	Stores calibration in memory of active channel.
[DISPLAY]	Accesses display menu.
[MEAS–MEM]	Normalizes measurement trace.

Step five: save instrument state

Utilize the HP 8757C/E's internal memory or an external disk drive (HP 8757C only) to save/recall the instrument configuration and calibration. This step will save time and effort when reconfiguring frequently used measurement set-ups or recalling a configuration that was lost after inadvertently pressing [PRESET] or cycling the line power.

Internal storage

The [SAVE] and [RECALL] keys are used to store and retrieve up to nine complete front panel states of the analyzer and the source (if the 8757 System Interface is connected). Color selections on the HP 8757C may not be saved internally, but may be stored on a disk. Only registers 1 through 4 may store the calibration memory, limit lines, and titles from channels 1 and 2 along with the instrument states. Information may be stored or retrieved internally by selecting [SAVE] or [RECALL], then the number of the storage register. The instrument states are saved in a non-volatile memory, and will not be erased until written over or until the [CLEAR SAV/RCL] softkey is utilized from the [SYSTEM] menu.

External storage (HP 8757C only)

A permanent copy of the instrument configuration and calibration may be made utilizing the external storage capabilities of the HP 8757C and an external disk drive. The [SAVE] and [RECALL] functions access the external storage menus as well as the internal storage registers. For more information refer to chapter 6, External disk Save/Recall. These external storage capabilities allow the user to increase productivity by concentrating on making measurements, as opposed to repeatedly setting up the same instrument configurations.

Step six: measure device under test

After the test setup is calibrated, and the device has been connected, the trace displayed will present a normalized measurement of the device being tested.

Optimizing trace display

To optimize the presentation of data, the scale per divisions, and/or reference level and position may be adjusted. Selecting [SCALE] displays the [AUTOSCALE] softkey which provides a quick convenient method for adjusting these functions. [SCALE] also allows the user to change the scale per divisions by utilizing the keypad, knob, or step keys on the front panel. Reference functions may be adjusted separately by selecting [REF LEVEL], or [REF POSN] from the [REF] menu. Changes may be entered via the keypad, knob, or step keys.

SWR and AUX display modes

The HP 8757C/E provides the user a choice of display formats. Reflection measurements may be displayed in standing wave ratio (SWR) or return loss (dB). The default format following preset is return loss. To make measurements in the SWR format select [TRC FMT SWR dB] from the [DISPLAY] menu. SWR is only available for channels 1 and 2 (channels 3 and 4 have to be turned off on the HP 8757C). The SWR measurement mode, also requires a ratioed or normalized measurement format with 401 points or fewer.

The [AUX] softkey allows the user to measure a voltage incident on the ADC IN connector on the rear panel of the analyzer. This input voltage must be in the −10 to +10 V range. The active channel displays this measurement as voltage versus frequency. This function provides a user with the means to measure voltage controlled devices such as attenuators and oscillators, enabling the analysis of the device's output power versus the control voltage. To access the AUX function, select the [MEAS] hardkey and press [MORE] until the [AUX] softkey appears.

Utilizing cursor and marker functions

The [CURSOR] key activates the cursor on all displayed channels. The cursor is identified by a "c" on an inverted triangle above each trace, it remains the active function until one of the other functions or instrument state keys is selected. The cursor value for each trace is presented in the mode label area above the grid. How power is presented is determined by the measurement and display mode selected for each channel; dB represents the difference between two inputs (ratio measurement or current measurement minus the stored reference), whereas dBm represents the absolute power at the chosen input. Use the front panel knob to move the cursor to the desired location on the trace. The measurement value (power and frequency) of the active trace will be displayed in the active entry area of the display.

The cursor menu contains several useful functions that can simplify many measurement procedures, thus reduce measurement times and increase productivity. These features are best illustrated in the transmission and reflection sections (chapters 2 and 3 respectively).

The HP 8757C/E also has the capability of displaying markers generated by the HP 8350B sweep oscillator and the HP 8340B/8341B synthesized sweepers. These sources, each have five independent, continuously variable markers, which may be adjusted via the knob, step keys, or data entry keyboard on the source. The active marker's number is presented on an inverted triangle on top of the displayed traces; other markers are displayed below the traces with their representative marker numbers beneath the triangle.

The markers may be manipulated while the cursor function is on, the cursor will remain active (identified by a "c") and accessable via the analyzer's front panel. If the cursor is turned off, the active marker's power and frequency will be presented in the mode and the frequency label areas respectively. When the cursor is on, the markers will be visable but without displaying any measurement data. The marker's utility is enhanced by several marker functions, such as marker sweep [MKR SWEEP] and marker to center frequency [MKR→CF]. A marker difference function [MKR Δ], computes and displays the difference between two markers.

Step seven: output results

Create a permanent record of the measurement by plotting the results to a plotter or a printer via HP-IB. The plotter/printer buffer facilitates efficient hardcopy outputs of your measurement data, by releasing the analyzer to the user within 5 seconds. Results may also be stored on an external disk; the HP 8757C/E allows the user to control these external peripherals without connecting an external controller.

To obtain a hard copy output of the current display, selecting [PRINT] or [PLOT] in the [SYSTEM] menu will offer a number of printing and plotting options (displayed in the menus below).

[SYSTEM] HP 8757C HP 8757E
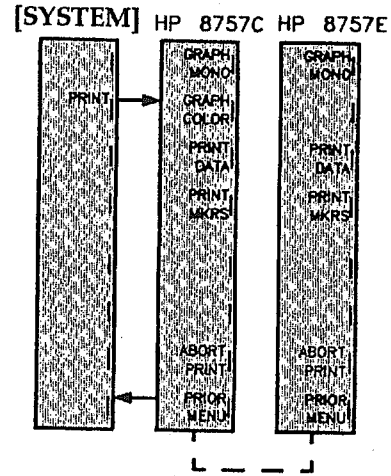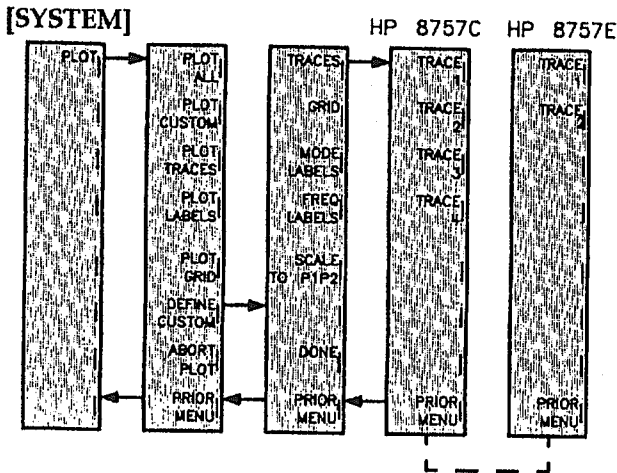
[PLOT ALL] plots everything currently displayed except for the softkey menu and the number of points. The user may also choose to plot only specific parameters (i.e. [PLOT TRACES] ...), or if repeated plots utilizing the same display parameters are necessary, a custom plot may be specified. [DEFINE CUSTOM] allows the user to select the display parameters for custom plots, then selecting [PLOT CUSTOM] will output the results with the same format each time. The [SCALE TO P1P2] option in the [DEFINE CUSTOM] menu allows the user to expand the plot to fill up the page, in this case the labels are plotted inside the grid.

In the HP 8757C/E's [PRINT] menu, [GRAPH MONO] allows the user to print the displayed information to any compatible printer in black and white. [GRAPH COLOR] which is available on the HP 8757C, may only be utilized with a HP PaintJet (color) printer. Both of these functions will output everything displayed except for any messages in the display's active entry area and the softkey menu.

Selecting [LABELS] in the [SYSTEM] menu offers the user the choice of turning on or off the labels or title of the current display prior to printing. [PRINT DATA] will output each point on the trace in tabular form. [PRINT MARKERS] will list just the information relating to markers and cursors currently displayed.

[SYSTEM]   HP 8757C   HP 8757E

Transmission measurements with the HP 8757C/E

This chapter demonstrates many of the features of the HP 8757C/E. A complete measurement setup is given for each example, following the same basic measurement sequence of chapter one. The examples provided in this document represent typical scalar network measurements. This section describes transmission measurements of insertion loss, 3 dB bandwidth, peak-to-peak ripple, and gain compression. Some of the features presented are: averaging, smoothing, adaptive normalization and power sweep.

Modify the instrument setups shown to suit your particular needs. For further information on any of the measurements shown, refer to the HP 8757C/E Operating Manual for the most complete description of the analyzer's operating modes, parameters, etc.

Basic system configuration

The HP 8757C/E analyzers can measure transmission using any of the four (three on the HP 8757E) display channels with either a single detector at input A, B, C (HP 8757C Option 001) or R, or two detectors in a ratio measurement (i.e. A/R, B/R, etc.). In the simplest transmission setup the device attaches directly to the source, and the detector to the output of the device. This configuration will produce accurate results when a leveled source is utilized with a low reflection test device. However, when source mismatches occur they can create power level variations which will produce system errors.

Ratioing provides an improvement in effective source match by eliminating the effects of source power variations common to both reference (R) and test inputs. This technique is particularly appropriate for measurement of devices with a low insertion loss, poor input match, or an unleveled source. Since active devices (devices with gain) usually require measurements with varying inputs, ratioing eliminates the need to recalibrate each time the power level is changed; also it reduces the ripple associated with source mismatches to which many active devices are particularly sensitive.
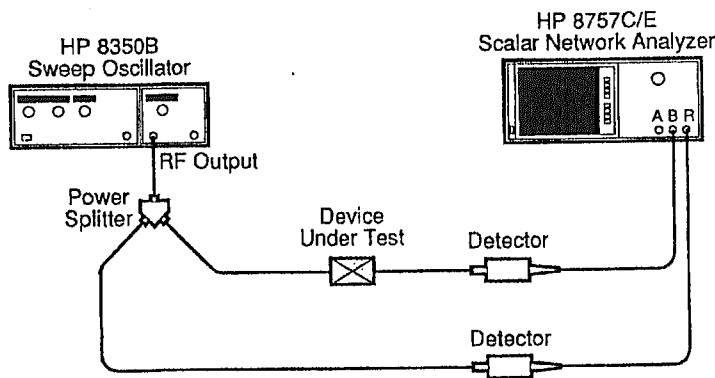
Measurement setup for insertion loss and gain

Insertion loss and gain are ratios of the output to input signals. When set up as shown below, the results can be read directly in decibels (dB).

Preset
Connections
Connect the DUT to the network analyzer as shown in the previous configuration.

Controls
Setup the measurement.

Measurement

CHANNEL [1]	Activates channel 1.
[CHAN 2 OFF]*	Turns channel 2 off.
[MEAS] [B/R]	Sets up ratio measurement.

Source parameters

[CF]	Activates the center frequency function.
[10.24] [GHz]	Sets center frequency to 10.24 GHz.
[ΔF]	Activates frequency span function.
[2] [GHz]	Sets frequency span to 2 GHz.
[POWER LEVEL]	Activates power level function.
[10] [dBm/dB]	Sets power level to + 10 dBm.

Calibrate
Perform thru calibration.

[CAL]	Accesses calibration menu.
[THRU]	Sets up calibration; remove DUT, connect thru.
[STORE THRU]	Stores calibration in active channel's memory.
[DISPLAY]	Accesses display menu.
[MEAS−MEM]	Normalizes measurement trace.

Save
Save the instrument states and calibration.

|	
[SAVE]	Presents "SAVE REG" in the display's active entry area.
[1]	Saves instrument state and calibration in register 1.

Measurement
Reconnect the DUT.

[SCALE]	Activates scale function.
[AUTOSCALE]	Provides quick, convenient scaling of the measurement data.

HP 8350B Sweep Oscillator / RF Output / Power Splitter / Device Under Test / Detector / HP 8757C/E Scalar Network Analyzer / A B R / Detector

---

* Available only on the HP 8757C. To deactivate a channel on the HP 8757E, press it's hardkey (once if it's the active channel, twice if it is on but not active) until the channel turns off.

Raising the reference position to the top half of the grid and adjusting the reference level to 0 dB sets the passband of the filter to the reference line, facilitating average insertion loss measurements and magnifying the passband region for flatness measurements without resetting the reference levels. The following sequence sets up the reference functions:

[REF]	Activates reference level function and displays menu.
[REF POSITON]	Allows the user to change the position of the reference line.
[▲] or [▼]	Steps the reference line up or down to any of the major graticules.
[REF LEVEL]	Allows the user to change the position of the trace relative to the position of the reference line.
[0] [dBm/dB]	Sets the reference level to 0 dB.

The following figure shows the complete transmission response of the bandpass filter under test. The display exhibits several important filter parameters. The cursor functions provide a powerful tool for measuring specific points or the difference between two points. Note that the cursor value is displayed in the mode label area above the reference level value; the negative value indicates loss, a positive value would indicate gain.
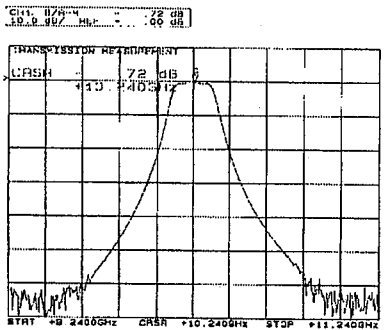

Insertion loss

Insertion loss can easily be determined to 0.01 dB resolution, by utilizing the cursor to measure the magnitude at any frequency of interest. When the cursor is active, the magnitude and frequency of that point will be presented in the active entry area of the display.

Average insertion loss is determined by utilizing the scale and reference level functions to magnify the passband, and making the ripple symmetrical about the reference line.

|	
[SCALE]	Activates the scale function.
[0.2] [dBm/dB]	Sets scale to 0.2 dB/division.
[REF]	Accesses reference menu.
[REF LEVEL]	Activates reference level function; use the front panel knob to move the trace such that the ripple is symmetrical about the reference line; read the average insertion loss in the active entry area of the display.
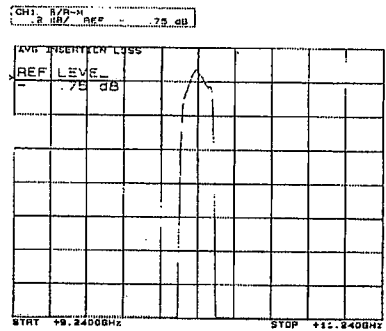
When finished, reset the reference level to 0 dB for the following measurements.

3 dB bandwidth

On the HP 8757C/E, bandwidth measurements are accomplished by selecting [MAX], [CURSOR Δ ON OFF], then moving the trace cursor to one side of the bandpass filter and locating the −3 dB point. Determine the frequency at that point, by turning [CURSOR Δ ON OFF] and noting the cursor value. Repeat the process to find the −3 dB point on the other side of the passband, then manually compute the bandwidth.

The HP 8757C's cursor search functions allow the user to determine the 3 dB bandwidth with only a few keystrokes.

[SCALE]	Activates scale function.
[AUTOSCALE]	Scales traces.
[CURSOR]	Turns cursor on, activates menu.
[SEARCH]	Activates search menu, displays current search value, default value equals −3 dB.
[BANDWIDTH]	Places cursor markers on the −3 dB points of trace, displays search value and bandwidth frequency span.

12
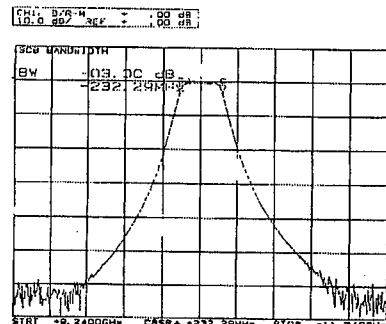
The search value and the bandwidth value are the same. To change the bandwidth value, select [SEARCH], [SEARCH VALUE], and enter the number on the keypad, followed by [ENT]. The user may also require frequency information at specific points. Selecting [MAX], then [CURSOR Δ ON OFF], [SEARCH], and [SEARCH RIGHT] or [SEARCH LEFT] will move the cursor to the "search value" previously set. Then selecting [CURSOR Δ ON OFF] will display the frequency at that point.

Peak-to-peak ripple

Measuring peak-to-peak ripple requires magnifying the passband such that the difference between the peaks can be determined.

[SCALE]	Activates scale function.
[0.2] [dBm/dB]	Sets scale to 0.2 dB/division.
[CURSOR]	Activates cursor function.
[MAX]	Moves cursor to maximum point on trace.
[CURSOR Δ ON OFF]	Marks the cursor position; use the front panel knob to move the cursor to the minimum point on the trace, the active entry area of the display will present the magnitude (and frequency) of the difference between the two points.
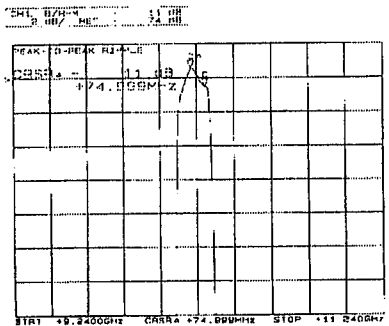
If more resolution is desired in the peak-to-peak measurement, the user may zoom in on the passband by selecting channel 2, then repeating the general measurement setup for channel 1, except replacing the [ΔF] with the span of the passband.

Out of band rejection

The wide dynamic range of the HP 8757C/E allows it to measure stopband rejection over 76 dB below the passband response. Maximum dynamic range requires proper selection of the measurement port power level and averaging factor. The [MAX] and [MIN] functions in the cursor menu allow the user to quickly determine the dynamic range of the device under test.

Usable dynamic range is the difference between the measurement port's output power and the HP 8757C/E's noise floor. Optimizing dynamic range therefore involves:

* choosing the optimum input and output power to the device.
* reducing the analyzer's noise floor.

Selecting the power level

The accompanying figures show how power test levels determine the available measurement range. In the first case, the output power of the source is −5 dBm. The device appears to have approximately 50 dB of rejection in the stopband. In the second case, the output power of the source is +10 dBm. Notice, this increases the measurable dynamic range to >65 dB. We have now demonstrated that the stopband rejection of this device is >65 dB.
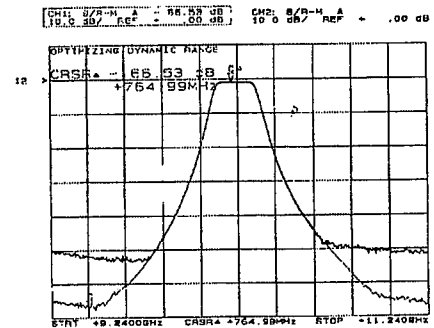
The user should ensure that the DUT's output power is within the measurement range of the analyzer. The analyzer can measure signals up to +20 dBm, but is only specified to +16 dBm with the HP 11664 and HP 85025 series detectors. On the low end, the analyzer can measure signals down to −60 dBm with the HP 11664 series and to −55 dBm (−50 dBm in DC mode) with the HP 85025 series detectors.

When >80 dBm of dynamic range is required, Application Note 327-1 describes how to utilize a HP 8349B Amplifier and an external leveling loop to extend the dynamic range of your measurement system.

Averaging

Averaging can reduce random noise measured by the HP 8757C/E, by applying weighted averaging to successive traces. The averaging factor *[AVG FACTOR]* determines the number of sweeps over which the traces are averaged. This function improves the accuracy and resolution of the calibration and measurement traces. When averaging is on, each successive sweep flattens the noise floor of the analyzer until the sweep count reaches the averaging factor value. Users must be careful to adjust the device under test only after the averaging of the traces has settled and the value of the averaging factor has been reached. An "A" will be displayed in the center of the channel's mode label area when averaging is in use.

Averaging keystrokes

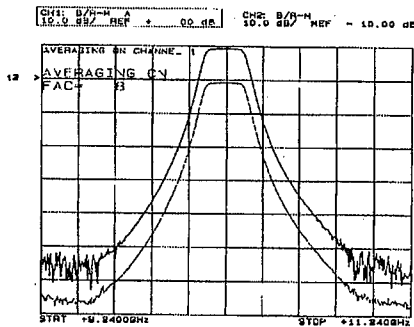|	
[AVG]	Accesses averaging menu.
[AVG ON OFF]	Turns averaging on.
[AVG FACTOR]	Displays current averaging factor value in active entry area, default value is 8; the value may be changed via the keypad, knob or step keys.
[RESTART AVERAGE]	Restarts the averaging algorithm.
[AVG ON OFF]	Turns off averaging function.

Smoothing

Although smoothing does not lower the noise floor, it can make noisy signals easier to interpret by reducing trace ripple. Smoothing is often likened to video filtering, and is different from averaging. Averaging computes each data point based on the average value during several sweeps. Smoothing computes each data point based on one sweep, but on the average of a window of several data points for the current sweep. The window or smoothing aperture is a percent of the swept frequency span, less than or equal to 20%.

Use smoothing with caution; too large a smoothing aperture may distort the data. The trace on channel 2 shows the response of a bandpass filter with no smoothing. The channel 1 trace shows the response with 1% smoothing. For this example, the 1% smoothing reduces the noise seen in the filter's reject band. Increasing smoothing beyond 1% will visably distort the passband response. Notice the "S" in the mode label area indicating that smoothing is active for channel 1.

Smoothing keystrokes

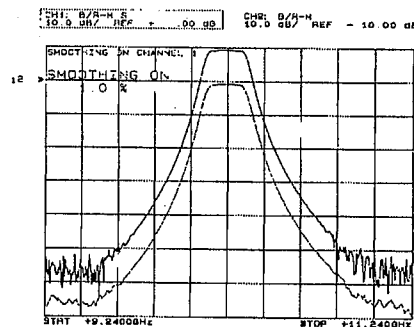|	
[SPCL]	Accesses the special functions menu.
[SMOOTH ON OFF]	Turns smoothing on.
[SMOOTH APERT]	Allows the smoothing aperture to be changed; the default value is 5%.
[SMOOTH ON OFF]	Turns smoothing off.

Adaptive normalization (HP 8757C only)

This feature allows the user to reduce the frequency span of a measurement without having to recalibrate. Note that the resolution (the number of points) of the narrower frequency span is not changed as the trace is expanded. This function utilizes the calibration data stored in memory and interpolates between the original calibration points.

Adaptive normalization is only available for normalized traces (MEAS–MEM) or if MEM is selected in the display menu. An asterisk (*) is displayed in the mode label area when adaptive normalization is active. If the frequency span is increased beyond the original calibration span, the measurement becomes uncalibrated and the * is replaced with a U in the mode label area.

The following sequence demonstrates how to use the adaptive normalization function of the HP 8757C, and the marker functions of the HP 8350B and HP 8340B/8341B sources to expand and display a selected portion of a calibrated trace.

[SYSTEM]	Displays system menu.
[ADPT NRM ON OFF]	Activates adaptive normalization function; select prior to changing the frequency settings.
[M1]	Activates marker 1; enter the start frequency on the source via the knob above the marker key or the keypad.
[M2]	Activates marker 2; enter the stop frequency on the source.
[SHIFT] [M1]	Activates the source's marker Δ function; displays the amplitude and frequency differences in the mode label area and beneath the grid respectively.
[MKR SWEEP]	Displays an expanded trace which is swept from marker 1 to marker 2; changes the source's front panel settings to reflect the new frequency span.
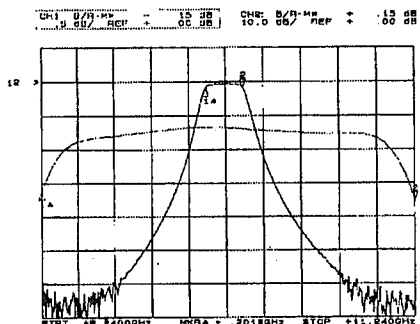
For other examples utilizing adaptive normalization, refer to the gain compression measurement section or chapter 5 (Alternate Sweep).

Measuring active devices

Active devices (devices with gain), usually require measurement at varying input power levels; a ratio configuration offers the best measurement results. Generally, the test setup for measuring gain and insertion loss are very similar. Although, it will be necessary to add attenuators to the measurement system if the input power to the detector exceeds +20 dBm (or damage may result). When an active device has a large gain, the input power needs to be appropriately attenuated during calibration and measurement.

When testing a modulation-sensitive device, the DC detection mode must be utilized. The HP 85025 series detectors operate in both AC and DC detection modes. The AC/DC mode softkey is located in the **[SYSTEM]** menu. Selecting *[MODE AC DC]* will turn off the square wave signal on the source and set the HP 85025 series detectors to DC mode. See the appendix for more information on AC versus DC detection.

Gain compression

Measurement of gain compression is useful for characterizing the power handling capability of active devices such as amplifiers. The 1 dB compression point of an amplifier is an indicator of the maximum output power possible before the gain non-linearity and it's associated distortion becomes excessive. Measurements to this point have all been made with a constant input amplitude and swept test frequency. Gain compression measurements may be made in CW (single frequency) or swept modes. For the most accurate measurement at a particular frequency the power sweep mode of the HP 8350B may be utilized. This allows the user to characterize a device at a CW frequency as a function of input power.

The following sequence is set up for the HP 8757C, it utilizes the power sweep function to measure gain compression. Since only two measurement channels are available on the HP 8757E, the gain compression measurement may be compared to absolute input or output power. Set up channel 2 accordingly.

Preset

Connection

Utilize the insertion loss measurement configuration. Add attenuation where appropriate.

Controls

Setup the measurement.

Measurement

CHANNEL [1]	Activates channel 1.
[MEAS] *[B/R]*	Sets up channel 1 for gain measurement.
CHANNEL [2]	Activates channel 2.
[MEAS] *[B]*	Sets up absolute output power measurement on channel 2.
[CHANNEL 1]	Accesses channel menu.*
*[CHANNEL 4]**	Activates channel 4.
[MEAS] *[R]*	Sets up absolute input power measurement.

Source parameters

[SHIFT] [CW]	Sets up display for gain and power versus input power at one frequency; set to desired frequency in amplifier range.
[POWER LEVEL]	Set start power.
[POWER SWEEP]	Enter the sweep range required to saturate the amp; e.g. 10 dB per sweep.

In the [SHIFT] [CW] mode, the source's SWEEP OUT drives the horizontal axis of the HP 8757C/E display to make this axis power instead of frequency.

Calibrate

The measurement will require a thru calibration on channel 1 for each CW test frequency when the HP 8757E is utilized. Whereas the HP 8757C will require a thru calibration (channel 1) only once for the full range of the amplifier under test, then the adaptive normalization function may be utilized to adjust the calibration data to the selected CW frequency. The thru calibration required is described in the insertion loss and gain measurement setup section. On the HP 8757C, the adaptive normalization function needs to be selected prior to the selection of the CW frequency, as shown below:

Source parameters

[SYSTEM]	Accesses system menu.
[ADPT NRM ON OFF]	Activates adaptive normalization function.
[SHIFT] [CW]	Enter desired frequency.
[POWER LEVEL]	Set start power.
[POWER SWEEP]	Enter sweep range.

Save

Save the instrument states and calibration as previously described.
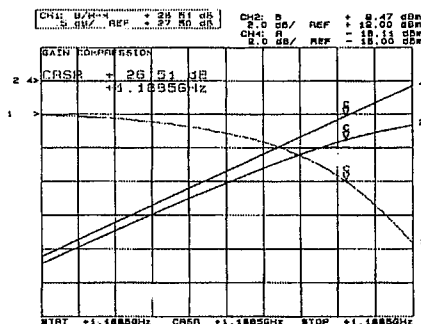
Measurement

Reconnect the DUT.

Select channel 1 if it is not active. The cursor function should be utilized to find the maximum point on the trace. Then by activating the cursorΔ function the 1 dB point may be located, either by rotating the front panel knob or by utilizing the search function of the HP 8757C and changing the search value to −1 dB. When the search function on the HP 8757C is used, and the 1 dB compression point has been located, selecting the cursor hardkey turns off the delta cursor function so that the absolute output and input power levels are presented in the mode label areas of channels 2 and 4 respectively. When using the HP 8757E, simply turn off the cursor delta function by pressing the softkey to read the power levels.

Most HP 8350B RF plug-ins in the power sweep mode can sweep up to 15 dB from the initial power set with [POWER LEVEL]. If the 1 dB compression point cannot be found, increase the power sweep setting or the start power. Remember not to exceed the maximum input power of the detector (+20 dBm), use attenuators where appropriate.

Once the measurement has been completed, a new frequency may be chosen. A convenient way to accomplish this is to set a step size in GHz, and increment the frequency by selecting [SHIFT] [CW] [▲]. It is not normally necessary to adjust the power sweep parameters once they are set up. However, the sweeper must remain in CW mode.

The following figure displays gain and the absolute input and output power at 1 dB compression for a HP 8447D Amplifier. Channel 1 was calibrated across the 100 MHz to 1.5 GHz frequency range. The plug-in power level was set to −4 dBm, with a 10 dB and 6 dB pad attached to the output. The other measurement parameters may be determined from the figure.

For more information on scalar analysis of amplifiers and mixers, refer to Application Notes 345-1 and 345-2 respectively.

---

* Available only on the HP 8757C.

Reflection measurements with the HP 8757C/E

The transmission measurements discussed in chapter 2 are only part of the network measurements picture. Measuring the return loss or SWR completes the device characterization. This chapter demonstrates how to perform reflection measurements with the HP 8757C/E.

Signal separation

Reflection measurements require the separation of the signal incident upon the input of the device from the device's reflected power. A signal separator such as a directional bridge or coupler provides a sample of the power traveling in only one direction; when it is connected as shown in the figure below, the reflected power is separated and measured independently of the incident power. Many types of directional bridges and couplers are available. They are differentiated by frequency range, directivity and connector type.

Device termination

Reflection measurements involve only one port of a test device. When a device has more then one port, it is critical that all of the unused ports are properly terminated in their characteristic impedance (e.g. 50 or 75 ohms). High quality loads or detectors with excellent return loss (such as the HP 85025D/E) should be used whenever possible, particularly with low loss devices. Otherwise, reflections off the unused ports will cause measurement errors.

Measurement accuracy

In reflection measurements, the accuracy of the final result is highly dependent on the signal separation devices, adapters, and the DUT terminations. Systematic errors such as the frequency response of the test setup, directivity, and mismatches degrade overall measurement accuracy. The HP 8757C/E's calibration routines can significantly reduce these measurement errors.
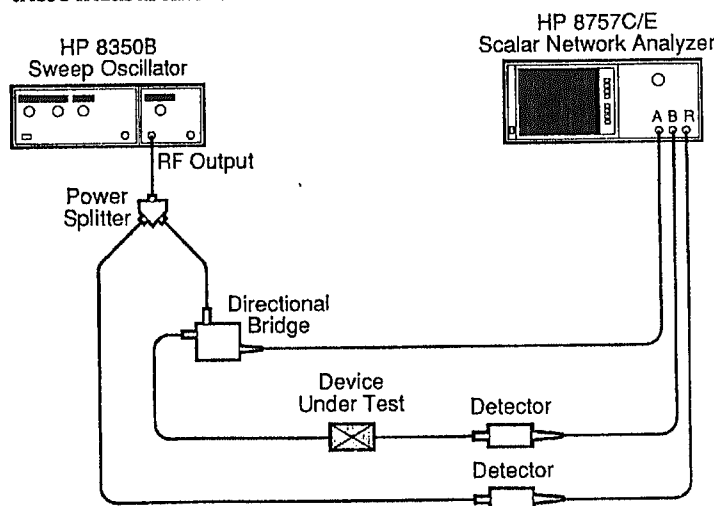
Measurement setup for return loss and SWR

The signal reflected from the DUT is most often measured as a ratio with the incident signal and can be expressed as return loss or SWR (standing wave ratio). These measurements are mathematically defined as:

reflection loss $=$ reflected/incident $= \rho$.

return loss (dB) $= -20 \log \rho$.

SWR $= (1+\rho)/(1-\rho)$.

Preset

Connections
Connect DUT as shown in figure.

Controls
Setup instrument.

Measurement

CHANNEL [1]	Activates channel 1.
*[CHAN 2 OFF]**	
[MEAS] *[A/R]*	Sets up reflection measurement.

Source parameters
[CF] [10.24] [GHz]
[ΔF] [2] [GHz]
[POWER LEVEL] [10] [dBm/dB]

Calibrate
Perform reflection calibration.

[CAL]	Accesses calibration menu.
[SHORT /OPEN]	Sets up calibration; connect short.
[STORE SHORT]	Connect open.
[STORE OPEN]	Stores calibration in memory of active channel.
[DISPLAY]	Accesses display menu.
[MEAS–MEM]	Normalizes measurement trace.

Save [2]
Save instrument state and calibration in register 2.

Measurement
Reconnect DUT and adjust parameters to enhance useability of measurement data.

HP 8350B
Sweep Oscillator

HP 8757C/E
Scalar Network Analyzer

RF Output

Power Splitter

Directional Bridge

Device Under Test   Detector

Detector

---

* Available only on the HP 8757C. To deactivate a channel on the HP 8757E, press it's hardkey until the channel turns off.

17

Return loss

The following figure displays the return loss of the bandpass filter. Since the return loss is high in the passband of the filter, only a small portion of the incident signal is being reflected off the filter. This indicates a good match between the filter and the test system impedance. The return loss in the filter's reject band is approximately 0 dB, which corresponds to an almost full reflection of the incident signal. A good passband filter should transmit the signal in the passband (i.e. small reflection, high return loss), while rejecting all signals outside of the passband (i.e. high reflection, low return loss).
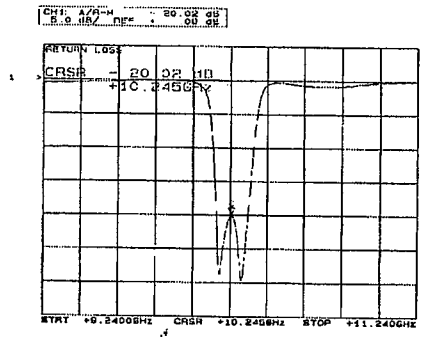
SWR

To display reflection data in terms of SWR, select **[DISPLAY]** then the *[TRC FMT SWR dB]* softkey. SWR is a unitless value, a SWR=1 corresponds to no reflection (perfect match), while an infinite SWR corresponds to 100% reflection (poor match). SWR is only available for channels 1 and 2, and for ratioed or normalized measurements with 401 points or fewer.

Simultaneous transmission and reflection measurements

Simultaneous insertion loss and return loss measurements are useful when adjusting the impedance match of a device for maximum power transfer. With the HP 8757C/E these measurements are easily accomplished. The following sequence demonstrates this feature.

Preset

Connections
Connect DUT as shown.

Controls

Measurement

CHANNEL [1]	Activates channel 1.
[MEAS] *[A/R]*	Sets up channel 1 for reflection measurement.
CHANNEL [2]	Activates channel 2.
[MEAS] *[B/R]*	Sets up channel 2 for transmission measurements.

Source parameters
[CF] [10.24] [GHz]
[ΔF] [2] [GHz]
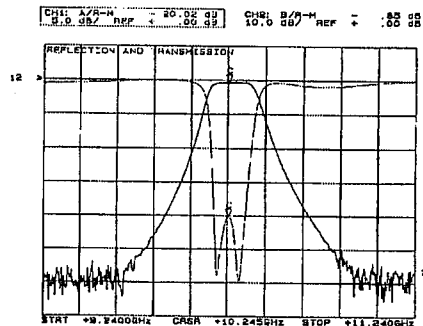[POWER LEVEL] [10] [dBm/dB]

Calibrate
Perform an open/short calibration on channel 1 and a thru calibration on channel 2.

Save

Measurement
Reconnect the DUT.

Adjust traces for the best data presentation with function keys.

Limit lines (HP 8757C only)

Limit testing is a measurement technique that compares measurement data to user defined constraints. Depending on the results of this comparison, the HP 8757C will display either pass or fail above the grid. Limit testing facilitates objective evaluation of your device's performance. Determining whether a filter meets its passband and stopband specifications or an amplifier meets its minimum gain specification is easily achieved utilizing limit lines that provide quick, convenient, and repeatable results. Limit testing also ensures that all devices are aligned and tested to the same specifications at each measurement station.

Limit testing is implemented by creating any combination of flat, sloping, and/or single point limit lines on the HP 8757C's display. Limit lines are defined in terms of upper and lower specifications for a particular frequency or band of frequencies. When combined, these lines represent the performance constraints of the device under test. Up to 12 limit segments are available for channels 1 and 2, for traces with 401 points or fewer. They may be stored in the analyzer's internal save/recall registers 1 through 4. The following sequences will describe how to create each type of limit line and the sequence for the measurement of the passband filter previously shown.

Accessing the limit menu

| [SPCL] | Accesses the special functions menu. |
| [LIM LNS ON OFF] | Turns on the limit line function. |
| [ENTER LIM LNS] | Accesses the limit line menu. |

Creating flat limit lines

[FLAT LIMIT]	Sets up the flat limit function.
[10.1] [GHz]	Enters start frequency for first segment.
[1] [dBm/dB]	Enters upper limit.
[−2] [dBm/dB]	Enters lower limit.
[10.3] [GHz]	Enters stop frequency.
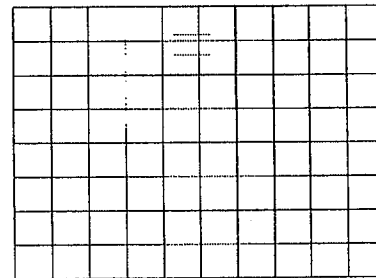
Flat limit lines are useful for testing insertion loss and passband ripple. The limit lines of the first segment should be displayed as soon as the stop frequency is entered. Once the first segment has been entered, the user may choose to start another segment by selecting the limit line type or terminate the limit line selection process by selecting [DONE]; the [SPCL] menu will reappear.

Creating sloped limit lines

[SLOPE LIMIT]	Sets up the slope limit function.
[9.25] [GHz]	Enters start frequency of segment.
[−44] [dBm/dB]	Enters start position of upper limit.
[−50] [dBm/dB]	Enters start position of lower limit.
[10.1] [GHz]	Enters stop frequency of segment.
[1] [dBm/dB]	Terminates the upper limit line.
[−5] [dBm/dB]	Terminates the lower limit line.
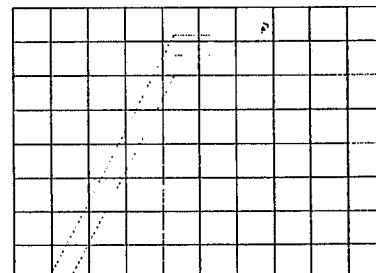
The user may find it difficult to span the entire side of a bandpass filter with one segment since the slope is not constant from the passband to the noise floor. It may be easier to set up the limit lines for one side with two segments (shortening the span) or, the user has the option of entering the limit lines for the entire span as two separate segments, one upper and one lower. To produce just an upper limit, the user may select [ENT] for the lower limit values of the start and stop frequencies.

Creating point limits

[POINT LIMIT]	Sets up the point limit function.
[10.4] *[GHz]*	Enters the point's frequency.
[1] [dBm/dB]	Enters upper point position.
[−2] [dBm/dB]	Enters lower point position.
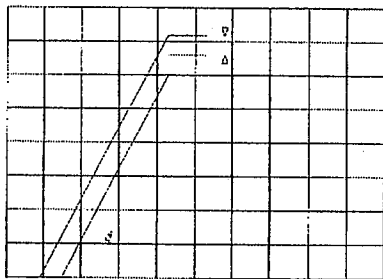
A single point limit is designated by two pointers. The upper limit points down, while the lower limit points up. The point limits are useful for testing the response of a device at specific test frequencies.

Editing limit segments

To edit a segment, select *[EDIT SEGMENT]* from the limit line menu and enter the segment number, the segment will be cleared erasing any data. A segment may not be modified; mistakes may only be corrected if the units (i.e. GHz or dB) for that particular entry have not been selected yet, then the [BK SP] (backspace) key may be utilized to erase the entry. To delete segments, select *[DELETE SEGMENT]* or *[DELETE ALL LNS]* from the limit line menu.

Creating limit lines for a bandpass filter
Preset
Connections
Connect DUT as for insertion loss measurement.

Controls
Measurement
   [CHAN 2 OFF]*
   [MEAS] [B/R]

Source parameters
   [CF] [10.24] [GHz]
   [ΔF] [2] [GHz]
   [POWER LEVEL] [10] [dBm/dB]

Calibrate
Perform thru calibration.

Save
After the limit lines have been created the setup should be saved again.

### Measure
Adjust trace for best data presentation.

   [SPCL]
      [LIM LNS ON OFF]
      [ENTER LIM LNS]
      [FLAT LIMIT]
        [8.24] *[GHz]*
        [−55] [dBm/dB]   Enters the first segment from
        [ENT]   the table below.
        [9.6] *[GHz]*
      [SLOPE LIMIT]

The following table supplies the entries necessary to create the limit lines shown in the figure.

Seg	Type	Freq. (GHz)	Upper (dB)	Lower (dB)	Freq. (GHz)	Upper (dB)	Lower (dB)
1	FL	8.24	−55		9.6		
2	SL	9.6	−55		10.05	−1	
3	FL	10.17	0	−2	10.3		
4	SL	10.42	−1		10.9	−55	
5	FL	10.9	−55		12.24		
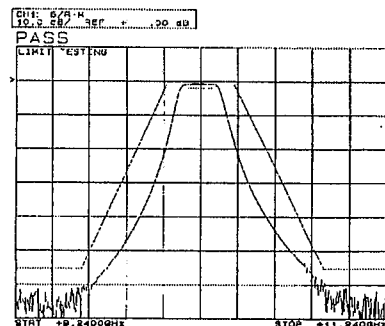
Alternate sweep

The alternate sweep function of the HP 8350B sweep oscillator and HP 8340B/8341B synthesized sweepers was designed for use with HP scalar analyzers, utilizing the 8757 System Interface. This function provides the ability to make real-time measurements, alternating on successive sweeps between the source's current front panel state and any of the states stored in memory. Simultaneously, the device's response may be displayed over two independent frequency ranges or two different power levels.

When tuning a filter, there is an alignment tradeoff between passband ripple and out of band rejection. Real-time adjustments may be made by displaying the passband on one channel and the full filter response on another channel, as shown in the figure below. Amplifier manufacturers may compare small signal gain to large signal gain for real time 1 dB gain compression measurements.

The following lists important considerations for setting up alternate sweep measurements:

- Only the source settings (frequency and power) of channels 1 and 2 are successively changed, the current analyzer settings remain the same.

- The active channel is swept over the source's current front panel settings, while the other channel is swept over the alternate register's source settings.

- The measurement parameters (the information in the mode label area) of channels 1 and 2 in the active register, should be set up the same as that in channels 1 and 2 in the register with which the active register will be alternated.

- The analyzer settings, such as the number of points, AC/DC detection mode, adaptive normalization (HP 8757C), etc. of the active register, must be the same as the analyzer settings of the register that will be alternated.

- To change the source or measurement parameters of a trace, select the desired channel to make it active. The source's front panel settings for that channel will now be displayed. Changing the source parameters of a calibrated trace will cause it to become uncalibrated unless adaptive normalization (HP 8757C) is activated prior to reducing the frequency span.

- Channel 1 should be the active channel of one storage register, channel 2 should be active in the other register.

The following sequence presents a simultaneous measurement of a filter's passband ripple and out-of-band rejection.

Preset

Connections
Connect DUT as for insertion loss measurement.

Controls 1
Set up storage register 1.

Measurement
    CHANNEL [1] [MEAS] *[B/R]*
    CHANNEL [2] [MEAS] *[B/R]*

Source parameters
    [CF] [10.24] [GHz]
    [ΔF] [2] [GHz]
    [POWER LEVEL] [10] [dBm/dB]

Calibrate
With the HP 8757C, perform a thru calibration on channels 1 and 2, then follow the sequence below utilizing adaptive normalization.

On the HP 8757E, channel 2 will require a thru calibration at the narrower frequency, since the adaptive normalization function is not available.

    CHANNEL [1] *[CHAN 2 OFF]**
    [SYSTEM] *[ADPT NRM ON OFF]* (HP 8757C only)
    [SAVE] [1]

Controls 2
Set up storage register 2.

Adaptive normalization is still on.

Measurement
    CHANNEL [2]   Still set for B/R measurement.
    *[CHAN 1 OFF]**

Source parameters
    [ΔF] [250] [MHz]
    [SAVE] [2]
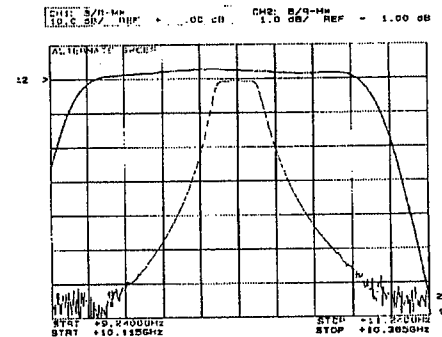
Measurement
Connect DUT.

    [ALT n] [1]   Alternates current display
                                   data stored in register 2,
                                   with the source parameters stored
                                   in register 1.

The traces should be scaled for optimal presentation of data. When the measurement is completed, pressing the [ALT n] hardkey again, will deactivate the alternate sweep function.

---

* Available only on the HP 8757C. To deactivate a channel on the HP 8757E, press it's hardkey until the channel turns off.

External disk Save/Recall

Using the external storage capabilities of the HP 8757C facilitates greater productivity by allowing the user unlimited storage of measurement setups and data. Frequently used test setups may be easily recalled for use by numerous test station operators, ensuring consistent device measurement.

When secure measurement environments are necessary, the measurement may be stored externally without displaying any frequency annotation (frequency blanking is described in the following chapter). Test station operators may then utilize the prepared measurement parameters without requiring direct knowledge of the frequency settings.

This chapter describes how to set up the disk drive, initialize the disk, and utilize the external disk store and recall functions of the HP 8757C.

Setting up the disk drive

When utilizing an external disk drive, the user must first set up the disk drive's HP-IB address, volume (for a hard disk drive), and unit number (for a floppy disk drive). Note that the HP 8757C can only access one drive at a time. The following sequence demonstrates the setup procedure.

Setting the disk's HP-IB address

[LOCAL]	Accesses the address menu.
[DISK]	Displays the disk's current HP-IB address in the active entry area of the display; default address is 0.
[#] [ENT]	Sets the new address to #.

Setting the disk's unit and volume numbers

|	
[SAVE]	Accesses the storage menu.
[SET UP DISK]	Accesses the disk menu.
[DISK UNIT]	Displays the current disk number in the active entry area; usually 0 is the default value for the hard disk or the left-hand drive on multiple disk units.
[#] [ENT]	Sets the disk unit to #.
[DISK VOLUME]	Displays the current volume number; floppy disk drives should have a volume number of 0, the default value.
[#] [ENT]	Sets the volume number to #.

Initializing a blank disk

The HP 8757C provides the ability to initialize either a 3.5 inch floppy disk or a hard disk from the front panel. If the disk you wish to initialize is a 3.5 inch floppy, insert the disk into the appropriate disk drive prior to beginning this procedure.

Note: the following sequence will erase any information currently stored on the disk.

[SAVE]	Accesses storage menu.
[SET UP DISK]	Accesses disk menu.
[INIT DISK]	Sets up initialization.
[INIT YES]	Starts initialization.

Save/Recall functions

The user may store parts or all of the information currently displayed, on an external disk. The [SAVE] and [RECALL] hardkeys offer a number of choices for saving or retrieving data (as shown in the following menus).

[SAVE] HP 8757C

[RECALL] HP 8757C
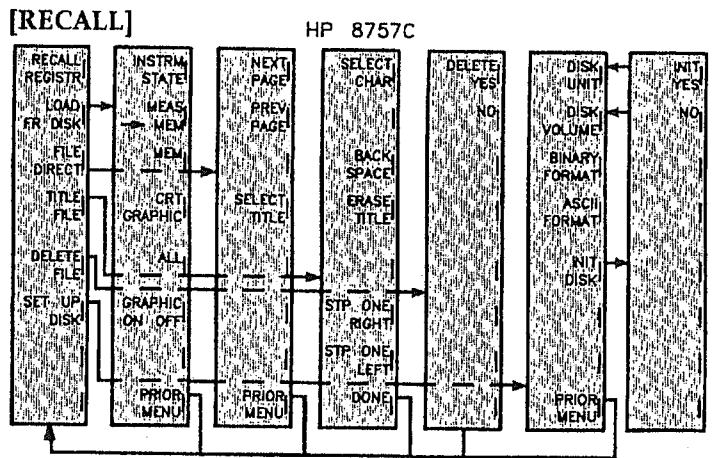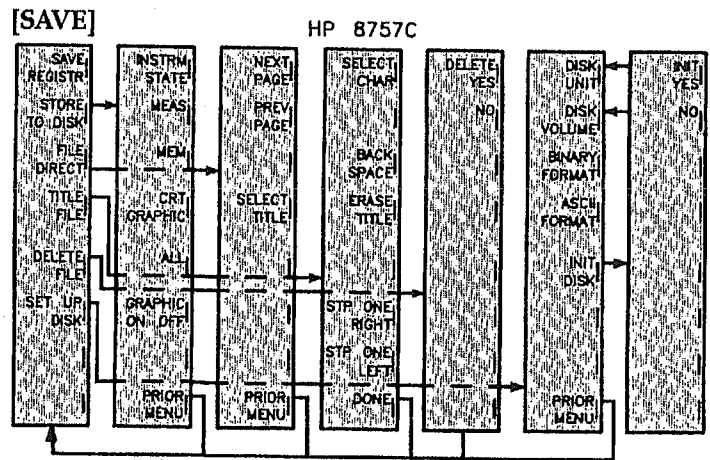
To store information on an external disk, each file must have a title with 8 characters or less. The *[TITLE FILE]* softkey is located in the **[SAVE]** and **[RECALL]** menus and uses the same title space as measurement titles. When selected, the name of the last file stored will be displayed in the title area. Following preset, the file title defaults to "FILE1."

When the file name has been entered, selecting *[STORE TO DISK]* allows the user to store all or part of the information currently displayed. Once stored, the information may be recalled at any time by selecting **[RECALL]** and *[LOAD FR DISK]*. If a title identifying the measurement was present prior to selecting the file name, when the file is recalled from the disk, the measurement title will reappear in the title area.

If a different file is required, the *[FILE DIRECT]* softkey displays a directory of all the files that have been stored on that particular disk. The HP 8757C displays the contents of each file by creating sub-files for the instrument state, trace data, trace memory, and CRT graphics. The file name associated with each of the sub-files is displayed on the left side of the screen (as shown in the example below). Selecting any of the sub-files accesses all or part of the file depending on what option is chosen from the *[LOAD FR DISK]* menu.

TEST2A - ACTIVE FILE TITLE

FILE TITLE	DESCRIPTION	NUM. OF POINTS
TEST1A	BINARY Instrum State	
TEST1A	BINARY Measurement Chan 1	401
TEST1A	BINARY Measurement Chan 2	401
TEST1A	BINARY Memory Chan 1	401
TEST1A	BINARY Memory Chan 2	401
TEST1B	BINARY Instrum State	.
TEST1B	BINARY Measurement Chan 1	801
TEST1B	BINARY Measurement Chan 2	801
TEST1B	BINARY Memory Chan 1	801
TEST1B	BINARY Memory Chan 2	801
--▶TEST2A	BINARY Instrum State	
TEST2A	BINARY Measurement Chan 1	1601
TEST2A	BINARY Memory Chan 1	1601
	END OF DIRECTORY	

NEXT PAGE

PREV PAGE

SELECT TITLE

PRIOR MENU

Sample file directory

The following sequence demonstrates how to store and retrieve data using and external disk drive.

|	
[SAVE]	Accesses the storage menu.
[TITLE FILE]	Accesses the title file menu.
[ERASE TITLE]	Allows the entry of a new file name.
[SELECT CHAR]	Selects the letter at the cursor on the display; use the front panel knob to move the cursor up and down the alphabet.
[DONE]	Terminates the title selection process; returns the user to the save menu.
[STORE TO DISK]	Initiates the external storage function.
[ALL]	Stores all the displayed information; the user may choose to store only a portion of the current information by selecting one of the other options.
[RECALL]	Accesses the recall menu.
[FILE DIRECT]	Displays a directory of files stored on the disk.
[SELECT FILE]	Selects the file title at the cursor; use the front panel knob to move the cursor up and down the file directory.
[LOAD FR DISK]	Initiates the external recall function.
[ALL]	Retrieves all of the file information; the user may choose to retrieve only a portion of the file by selecting another option.

Special functions

Color selection (HP 8757C only)

One of the notable characteristics of the color selection function is the flexibility afforded the user to match his or her personal preferences. Each of the displayed notations such as the channel information, warnings and labels, as well as the grid and background may be adjusted individually. For those desiring a monochrome display, that is also available by the selection of a softkey.

Color selection is a global function, it is not affected by preset, or recalling a measurement from an internal storage register. When a file is retrieved from an external disk, the color selections stored in that file will be retrieved.

The display colors have been optimized to present the most pleasing and effective display. If the color selection must be changed, the HP 8757C allows quick modification via a color list menu. The color list provides access to 7 default colors (white, black, yellow, blue, salmon, red, and green).

All the color selection menus are accessed via the *[ADJUST DISPLAY]* softkey in the **[DISPLAY]** menu, as shown in the following layout of the color menus.
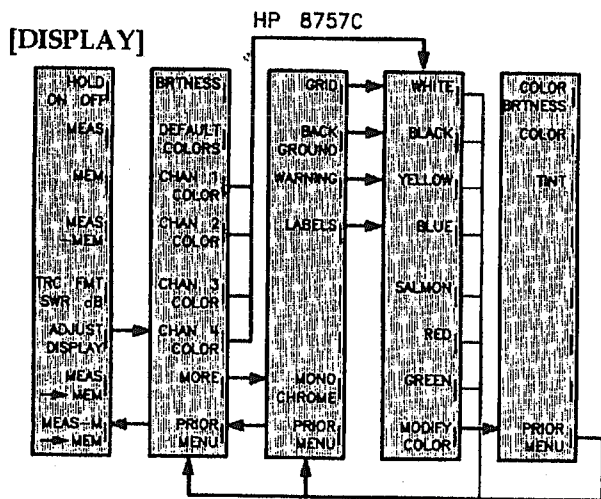
If the modification of the default colors is necessary, the user may select the *[MODIFY COLOR]* softkey at the bottom of the color list menu. It allows the user to change the color of a particular item (e.g. channel 1) by adjusting the tint, color and/or brightness.

In monochrome mode, the active trace is displayed with greater intensity then other traces. Once in monochrome mode, select *[ADJUST DISPLAY]*, then *[DEFAULT COLORS]* to reactivate the color mode.

Frequency blanking

The frequency blanking function in conjunction with the 8757 System Interface, allows the user to operate the analyzer in a secure mode by deleting all frequency annotation on the analyzer and the source. Once the *[FRQ LBL OFF]* softkey has been selected from the **[SYSTEM]** menu, frequency annotation may not be reactivated until the instrument is preset. Storing information in the internal registers or on an external disk with frequency blanking enabled, guarantees that frequency blanking will still be active when it is retrieved, even if the analyzer was preset prior to the recall operation. The following sequence activates the frequency blanking function.

|	
[SYSTEM]	Accesses system menu.
[LABELS]	Accesses labels menu.
[FRQ LBL OFF]	Deactivates frequency annotation on the analyzer and the source.

To disable the frequency blanking function, select **[PRESET]**.

AC versus DC detection

There are two methods used to detect microwave signals for display and measurement with scalar network analyzers. AC detection uses a modulated RF signal, providing accurate and stable measurements by minimizing unwanted signals. DC detection, which utilizes an unmodulated RF signal is most useful for modulation-sensitive devices. This section describes the capabilities and advantages of each mode. For further information on AC/DC detection with scalar analyzers, refer to: Product Note 8757-1, "Using AC detection with the HP 8757 scalar network analyzers."

The AC detection mode uses a 27.778 kHz square-wave modulated source. The square wave is demodulated by the detector and only the modulated envelope is passed to the scalar analyzer. At the analyzer, the demodulated signal is AC coupled into the log amplifiers then digitized. There are four main benefits of AC detection in scalar network measurements: 1) high-leveled broadband noise is rejected, 2) undesired RF signals are not detected, 3) thermal effects are minimized, and 4) fast sweep times are possible even at low power levels.

The DC detection mode does not require any source modulation, the detectors respond to all the signals present. The HP 85025 and 85026 series detectors operate in AC or DC mode. When the analyzer is in DC mode, the detectors chop the signal after detection to provide the 27.778 kHz signal that the analyzer processes. The receiver circuitry is identical in both modes. The HP 8757 DC detection process offers the speed advantage of AC detection, since the receiver is not limited by the settling time of the log amplifiers at low power levels. The following figure presents a comparison of the detection processes for AC and DC modes (1. AC detection, 2. DC detection).

(1)

Source

(2)

HP 85025B Detector
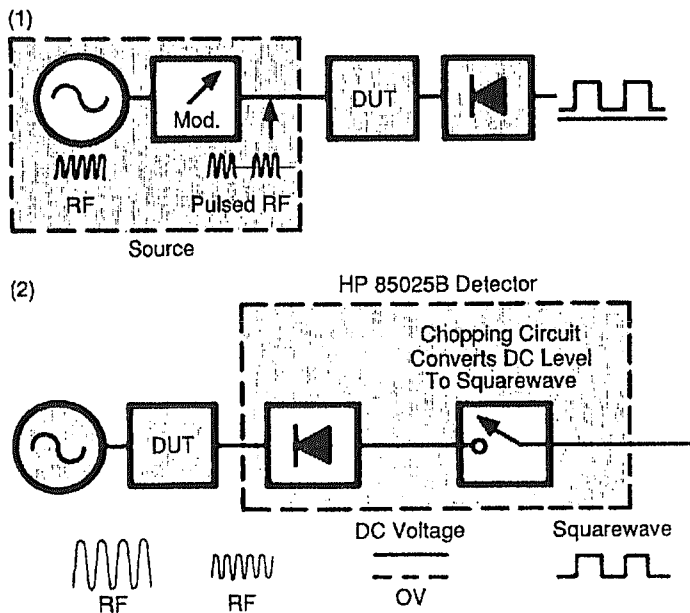
Using AC detection

The HP 8757C/E receiver (the log amplifiers in the analyzer) effectively functions like a tuned AC voltmeter operating at 27.778 kHz. In many applications, such as measurement of high-gain limiting amplifiers, noise will be present along with the desired signal being measured. This type of interference can reduce the effective dynamic range of the measurement system by raising the noise floor. In AC detection mode the analyzer is sensitive only to the signals that have the appropriate square wave modulation. Since only the desired signal is modulated at the source, the noise and other non-modulated RF signals are ignored, resulting with a true representation of the performance of the device under test.

Temperature changes can have a dramatic effect on measurements in DC mode, since they may induce a DC voltage offset at the diode's output. AC detection minimizes this problem by measuring only the modulated RF signal, thus ignoring the DC offset. Detector sensitivity to thermal change is a primary concern when measuring device performance as a function of temperature, particularly at low power levels (less than −40 dBm).

AC detection is the best broadband measurement technique for mixer testing. The presence of high-level LO feedthrough at the IF port of the mixer under test will impact the accuracy and dynamic range of the scalar analyzer, if DC detection is used. When the analyzer is operated in AC detection mode, the effect of the LO feedthrough is minimized by modulating the RF signal and leaving the LO signal un-modulated, thus the detector will respond only to the modulated IF.

Using DC detection

Certain devices require DC detection mode for the best results. Amplifiers with automatic gain control (AGC) are adversely affected by the modulation in AC detection mode. The leveling circuitry unsuccessfully tries to adjust the gain to track the modulation, the resulting square wave is distorted, degrading the scalar analyzer response. Other modulation sensitive devices include: amplifiers with slow responding self bias, devices with high gain at very low frequencies (<1 MHz), and devices with very narrow bandwidths (<1 MHz).

Absolute power (dBm) measurements may be more accurate in DC detection mode, since the measurement is not subject to variations in source modulation. Also, DC mode is more easily referenced to a power meter; in AC mode the power meter reading would be nominally 3 dB lower than the scalar analyzer reading, due to the square wave modulation of the source.

I N D E X

For more information, call your local HP sales office listed in your telephone directory or an HP regional office listed below for the location of your nearest sales office.

United States:
Hewlett-Packard Company
4 Choke Cherry Road
Rockville, MD 20850
(301) 670-4300

Hewlett-Packard Company
5201 Tollview Drive
Rolling Meadows, IL 60008
(312) 255-9800

Hewlett-Packard Company
5161 Lankershim Blvd.
No. Hollywood, CA 91601
(818) 505-5600

Hewlett-Packard Company
2015 South Park Place
Atlanta, GA 30339
(404) 955-1500

Canada:
Hewlett-Packard Ltd.
6877 Goreway Drive
Mississauga, Ontario L4V1M8
(416) 678-9430

Australia/New Zealand:
Hewlett-Packard Australia Ltd.
31-41 Joseph Street,
Blackburn, Victoria 3130
Melbourne, Australia
(03) 895-2895

Europe/Africa/Middle East:
Hewlett-Packard S.A.
Central Mailing Department,
P.O. Box 529
1180 AM Amstelveen,
The Netherlands
(31) 20/547 9999

Far East:
Hewlett-Packard Asia Ltd.
22/F Bond Centre
West Tower
89 Queensway
Central, Hong Kong
(5) 8487777

Japan:
Yokogawa-Hewlett-Packard Ltd.
29-21, Takaido-Higashi 3-chome
Suginami-ku, Tokyo 168
(03) 331-6111

Latin America:
Latin American Region Headquarters
Monte Pelvoux Nbr. 111
Lomas de Chapultepec
11000 Mexico, D.F. Mexico
(905) 596-79-33

HEWLETT PACKARD

CONVERTING EXISTING HP 8757A SOFTWARE TO THE HP 8757C/E

Programs written for the HP 8757A with firmware revision 2.0 or higher should require minimal or no changes to work on the HP 8757C/E. The majority of the differences are involved with the graphics commands, These commands are documented in the introductory programming guides and the quick reference guide. However, to assist in upgrading existing software, review the following list when using programs written for the HP 8757A.

Display Graphics (HP-GL Commands)

1. The DEFAULT command (DF) sets default values. This command is equivalent to: ("DI 1,0; SI 0.14,0.17;"), and places the HP 8757C in monochrome mode, as opposed to color.

2. The LINE TYPE command, (LTy,z) is no longer available on the HP 8757C/E.

3. The OUTPUT P1 and P2 POSITION command, (OP) is used to output the current P1 and P2 positions. P1 is the lower left position and P2 is the upper right position. The graphics display units (GDU's) define the plotting area on the CRT. The coordinates of the full page have changed to reflect the new displays used in the HP 8757C/E. The coordinates are shown in table 1:

Table 1. Full Page Coordinates of the HP 8757C/E Display

	Lower Left P1(LL)	Upper Right P2(UR)	Trace Graticule	
			(LL)	(UR)
HP 8757A	(0,0)	(2698,2047)	(198,150)	(2307,1814)
HP 8757C/E	(0,0)	(2924,2047)	(214,150)	(2500,1814)

4. The SELECT PEN command, (SP n) is used to select the beam intensity and color to be displayed on the CRT. The SELECT PEN command operates in three different modes:

- Monochrome display.
- Color (HP 8757C only).
- HP 9000 series 200/300 BASIC color (HP 8757C only).

The monochrome display mode, set by the (DF) command, uses the (SP n) command to select between three different beam intensities and beam off.

The color mode is selected, if it is not already on, by using the HP 8757C DEFAULT COLORS command (DEC). To determine the colors associated with the different pen numbers, see table 4 of the quick reference guide.

The third mode is the color mode used in HP BASIC and is set by using the HP 8757C BASIC COLORS command (BC). For a list of the colors available, see table 4 of the quick reference guide or the *BASIC 5.0 Condensed Reference*.

Unknown Commands

The HP 8757A has some commands available that are not found on the HP 8757E. These commands are handled in the same manner as an unknown command. An unrecognized command will simply be disregarded by the HP 8757E. However, with each occurrence of an unknown command, the analyzer will stop and display a message on the CRT before continuing on to the next command. The message will be displayed for about 2 seconds to make the user aware that the analyzer had received an unknown command.

Softkey Locations

If an existing program bases any part of its operation on the menu structure (softkey placement) of the HP 8757A, then the program must be updated to reflect the new menu structure in the HP 8757C/E.
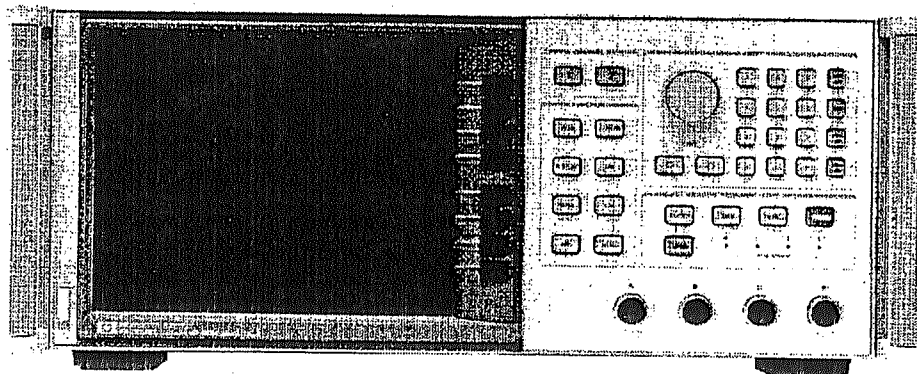
Learn Strings

There should be no difficulties in using the learn string from the HP 8757A on the HP 8757C/E.

Preset Timeout

Allow a minimum of 20 seconds after an instrument preset on the HP 8757C/E for internal diagnostics to be completed.

HP-IB Programming Note

Quick Reference Guide
For the HP 8757C/E Scalar Network Analyzer

Introduction

This programming note is a reference guide for the remote operation of the HP 8757C/E Scalar Network Analyzer with firmware revision 3.0 or greater. This note is intended for use by those familiar with HP-IB programming and the basic functions of the HP 8757C/E. For operation information for the analyzer, refer to the *Operating Reference* in the operating manual.

Note: Remote operation of the HP 8757C/E applies to operation with the HP Interface Bus (HP-IB) connector on the rear panel of the analyzer. Do not connect an HP-IB controller to the 8757 SYSTEM INTERFACE connector; HP-IB control of the instruments connected to this port is described in the "Passthrough" portion of this document.

HP-IB capabilities

The following codes describe the HP-IB electrical capabilities of the HP 8757C/E, using IEEE Std 488-1978 mnemonics (HP-IB, GP-IB, IEEE 488, and IEC-625 are all electrically equivalent). The mnemonics briefly translate as follows:

SH1: Source Handshake, complete capability.

AH1: Acceptor Handshake, complete capability.

T6: Talker, capable of basic talker, serial poll, and unaddress if MLA.

TE0: Talker, Extended address; no capability.

L4: Listener, capable of basic listener, and unaddress if MTA.

LE0: Listener, Extended address; no capability.

SR1: Service Request, complete capability.

RL1: Remote Local, complete capability.

PP0: Parallel Poll, no capability.

DC1: Device Clear, complete capability.

DT0: Device Trigger, no capability.

C0: Controller, no capability.

E1: Electrical specification indicating open collector outputs.

These codes are completely explained in the IEEE Std 488-1978 document, published by the Institute of Electrical and Electronic Engineers, Inc., 345 East 47th Street, New York, New York 11017.

Input data

The HP 8757C/E Scalar Network Analyzer accepts specific programming commands for selecting front panel key functions, most softkey functions and special HP-IB only functions. Line switch control and HP-IB address setting are not programmable. The analyzer can pass through HP-IB commands to a compatible Hewlett-Packard swept source, graphics plotter, and printer, connected to the 8757 SYSTEM INTERFACE. A list of compatible instruments is given in "8757 System Interface". In addition, some Hewlett-Packard Graphics Language (HP-GL) commands may be passed through to the CRT.

Programming data consists of a string of ASCII coded characters composed of one or more of the following control fields:

- Select channel
- Measure power/ratio
- Display measured data/memory
- Select scale
- Select reference value/position

- Select averaging
- Cursor functions
- Plot functions
- HP-GL graphics commands
- Instrument state/registers
- Special HP-IB only functions

Input syntax

The analyzer responds to program commands in the order in which they are received. The commands can be upper or lower case ASCII characters, and must be sent without any intervening alphanumeric characters or digits (spaces are ignored).

There are two input command terminators which can be universally applied to all analyzer input commands: a line feed ([lf]) or a semicolon (;). It is best to terminate all input programming commands with either a line feed or a semicolon. However, there are alternate choices in the use of terminators. Listed below in the syntax diagrams are all of the possible terminators that can be used with the various input commands.

Input syntax #1: function code
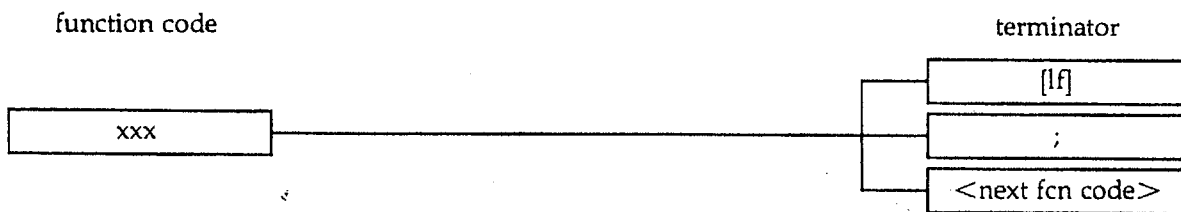
Example: "C1 IA;ME[lf]"

Select channel 1 (C1), measure the power at the A detector (IA), display the measured data (ME) on the CRT.

Input syntax #2: function code followed by a single digit numeric
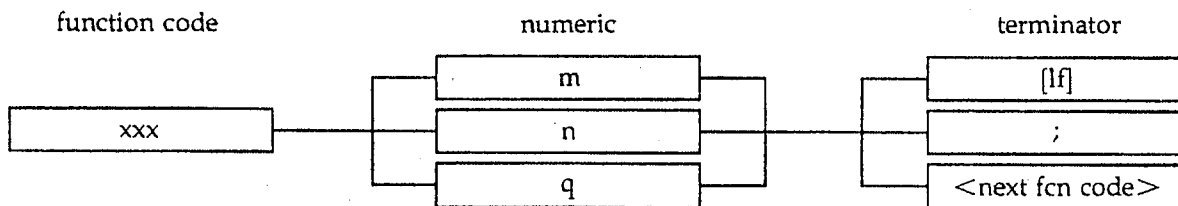
where: m = 0 function off
m = 1 function on
n = decimal integer 1 through 9
q = value unique to the particular function and explained under command description

Example: "MD1;RP4 SV9[lf]"

Turn the square wave modulation on (MD1), set the reference position to the 4th graticule (RP4), and then save the front panel setting into register 9 (SV9).

2

Input syntax #3: function code followed by a variable length numeric

function code	numeric	terminator
xxx	d	[lf]
		;
		<units>;
		<units>[lf]
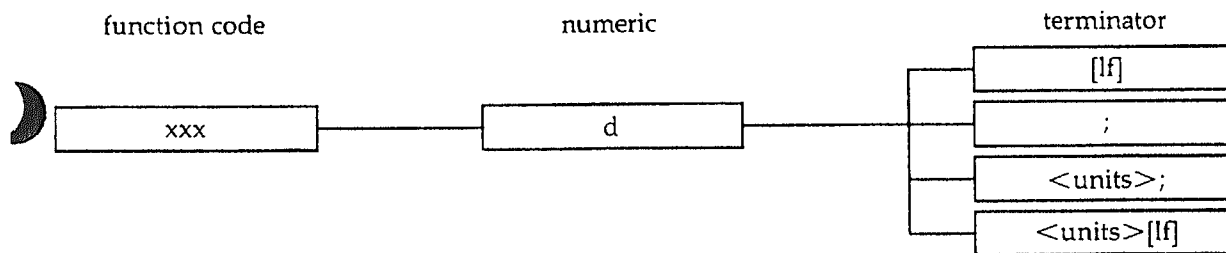
where: d = Variable length parameter, including sign, decimal point, and exponent, if desired. The general format is ± D.DDDDDE ± DD. Resolution or range of d is explained under the particular command description. When the value of d does not correspond to the function's resolution or range, d will be rounded and assigned the closest allowable value.

Example: "AF64;RL-10DB;SD0.5DB[lf]"
Set the averaging factor to 64 (AF64), set the reference level to − 10 dB (RL-10), and set the scale per division to 0.5 dB (SD0.5).

Input syntax #4: function code followed by a string of bytes or characters

function code	string	terminator
xxx	s	[lf]
		;

where: s = An ASCII string of characters or a sequence of 8-bit binary bytes, the length of which is unique to the particular function and is explained under the command description.

Example: "WK1 TEST1;WT PASSBAND INSERTION LOSS[lf]"

Write softkey 1 with the label "TEST1" (WK1 TEST1), and write a title onto the CRT which says "PASSBAND INSERTION LOSS" (WT PASSBAND INSERTION LOSS).

Valid characters

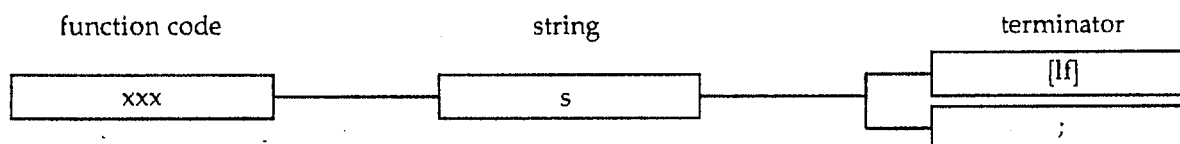Programming commands may be sent as upper or lower case ASCII characters. Spaces, unnecessary signs (+, −), leading zeros, carriage returns ([cr]) and unnecessary terminators are ignored by the analyzer. The parity bit (the eighth bit, MSB) of all ASCII coded characters will be ignored.

Any alphanumeric sequence which is not a recognized HP 8757C/E command will be noted on the CRT in the active entry area as "UNKNOWN CMD-" followed by the last one or two characters received by the analyzer over HP-IB. The analyzer will not lock out further HP-IB traffic, and will execute any subsequent valid command. Further, a syntax error service request (SRQ) will be output if that SRQ bit has been enabled in the request mask (see "Service Request" and "Status Byte"). If there are many errors in the alphanumeric sequence, only the last error is displayed in the active function area.

Programming data

See table 1 for HP-IB programming commands which control the analyzer.

Commands associated with the C detector are valid only for the HP 8757C Option 001 which has the fourth detector (C) input. If a command associated with the C detector is sent to a standard HP 8757C (not Option 001) or an HP 8757E, it will be treated as an unknown command.

Instrument preset

A self-test is first performed when the PRESET key is pressed or when the IP command is received by the analyzer. This is followed by presetting the analyzer and the instruments connected to the 8757 SYSTEM INTERFACE. All functions are turned off, then the following is set:

HP 8757C/E:

Channels 1 and 2 on. The channel menu appears in the softkey label area of the CRT.

- Measure power A on channel 1.
- Measure power B on channel 2.
- Measure power C[1] (or B[2]) on channel 3.
- Measure power R on channel 4[1].
- Display measurement data in log magnitude format.
- Scale = 20 dB/div.

- Reference level 0 dB for all channels.
- Reference level step size = 20 dB.
- Averaging off.
- Averaging factor = 8.
- Cursor off.
- All labels on.
- Channel 1 as the active channel.
- Modulation drive on.
- Number of points = 401.
- Detector mode set for AC detection.
- Smoothing set for 5.0% of span (off).
- Cursor format = log magnitude.
- Search value = −3 dB[1].
- Adaptive normalization off[1].
- Temperature compensation on.
- Repeat autozero off.

SOURCE (connected to the 8757 SYSTEM INTERFACE):

- Instrument preset.
- Sweep time set to 200 ms.
- HP 8350B square wave modulation on.
- HP 8340/41 SHIFT PULSE on; RF Output on.
- HP 8360 scalar modulation on; RF Output on; analyzer mode.

PLOTTER (connected to the 8757 SYSTEM INTERFACE):

- Abort plot if in progress.
- P1 and P2 scaling points unchanged.
- Selection of plotter pens unchanged.

PRINTER (connected to the 8757 SYSTEM INTERFACE):

- Abort plot if in progress.

DISKDRIVE (connected to the 8757 SYSTEM INTERFACE)[1]:

- Aborts any data transfers in progress.
- Unit number unchanged.
- Volume number unchanged.
- ASCII or binary mode unchanged.

The following analyzer conditions are not changed during a PRESET (IP) command execution:

- Reference position.
- Trace memory.
- Save/Recall registers.
- HP-IB addresses.
- Request mask.
- Limit lines[1].
- Title.
- Detector offset.
- User-defined plot.
- 8757 SYSTEM INTERFACE bus control on/off.
- Repeat autozero timer.
- Display intensity[1].
- Display colors[1].
- Plot buffer.

Passthrough

Programming commands and data may be sent to Hewlett-Packard instruments connected to the 8757 SYSTEM INTERFACE and the analyzer CRT. This is accomplished by first sending the PASSTHROUGH command (PTd), where d is the decimal address of the device being addressed. Subsequent addressing of the 8757 SYSTEM INTERFACE address will pass through commands to the selected device. The PTd command may be sent at any time. The default addresses for PASSTHROUGH commands are as follows:

HP 8757C/E Analyzer	16 decimal
8757 SYSTEM INTERFACE	17 decimal
HP 8757C/E CRT	15 decimal
Hewlett-Packard Source	19 decimal
Hewlett-Packard Plotter	05 decimal
Hewlett-Packard Printer	01 decimal
Hewlett-Packard Disk Drive	00 decimal

The following section explains how to pass through commands to instruments connected to the 8757 SYSTEM INTERFACE and the analyzer CRT.

8757 SYSTEM INTERFACE

This rear panel connector is physically similar to the HP-IB port, but is specifically used to control the following instruments:

Sources
HP 8350B Sweep Oscillator
HP 8340B Synthesized Sweeper
HP 8341B Synthesized Sweeper
HP 8360 Series Synthesized Sweeper

Plotters
HP 7470A Two-pen Plotter
HP 7475A Six-pen Plotter
HP 7550A Eight-pen Plotter

Printers
HP 2225A ThinkJet Printer
HP 3630A PaintJet Printer
HP 2227B QuietJet Plus Printer

Disk Drives
HP 9122 Dual 3.5 in. Disk Drive

The transfer of commands and data is performed by first sending a PASSTHROUGH command (PTd) to the analyzer, where d is the decimal address of the desired device. Subsequent addressing of the 8757 SYSTEM INTERFACE will pass through commands to the instrument selected.

The address of the 8757 SYSTEM INTERFACE is determined by complementing the least significant bit of the current analyzer address. For example, since the analyzer default address is 16 decimal (10000 binary), the default 8757 SYSTEM INTERFACE address is 17 decimal (10001 binary). As another example, if the analyzer address is set to 7 decimal (111 binary), then the 8757 SYSTEM INTERFACE address becomes 6 decimal (110 binary).

---

1. HP 8757C only.

This example shows how to pass through commands to the source, with address 19 decimal, using the analyzer default address (16 decimal):

1. Address device 16 (the HP-IB port on the analyzer) and send the command "PT19;".

2. Address device 17 (the 8757 SYSTEM INTERFACE) and send commands to the source.

3. Address device 16. This returns the analyzer to its normal HP-IB operation.

This example shows how to pass through commands to the plotter, with address 05 decimal, using the analyzer default address (16 decimal):

1. Address device 16 (the HP-IB port on the analyzer) and send the command "PT05;".

2. Address device 17 (the 8757 SYSTEM INTERFACE) and send commands to the plotter.

3. Address device 16. This returns the analyzer to its normal . HP-IB operation.

CRT graphics

The CRT screen of the analyzer may be used as if it were an external HP-IB graphics plotter. By defining the analyzer CRT as the plot device used by the computer, the operator may pass through graphics commands which will plot graphics on the CRT.

The graphics commands are mostly a subset of the Hewlett-Packard Graphics Language (HP-GL), shown in table 4. The analyzer graphics characters used for labeling are shown in table 5, "HP 8757C/E Modified ASCII Code Conversion Table". These modified ASCII characters are available only when explicitly using the (LB) command; many desktop computer plotter commands use different character sets.

The address of the CRT is the analyzer address minus 1. The default address of the analyzer is 16 decimal, therefore the default address of the CRT is 15 decimal.

This example shows how to pass through commands to the CRT, with address 15 decimal, using the analyzer default address (16 decimal):

1. Address device 16 (the HP-IB port of the analyzer) and send the command "PT15;".

2. Address device 17 (the 8757 SYSTEM INTERFACE) and send graphics commands to the CRT.

3. Address device 16. This returns the analyzer to its normal HP-IB operation.

Output data

The analyzer has several output modes that allow you to learn or interrogate the instrument state and to output data. The following output modes are available:

- Learn String
- Interrogate Function
- Status
- Error
- Data
- Identity

The program codes and syntax to enable each function are shown in table 3.

Learn string

Selected with the OL program code, the analyzer outputs a learn string of 150 bytes in length. This binary data string completely describes the present instrument state (excluding the storage registers, trace memory, title, limit line data, and source settings) of the analyzer. This information is packed and encoded for minimal storage requirements, thereby making data analysis difficult. When stored in an ASCII character data string, the learn string can later be input to the analyzer to restore that instrument state by using the INPUT LEARN STRING command. The length of the learn string is fixed at 150 bytes.

Interrogate function

The interrogate function is selected with the OP program code and followed immediately by the program code for the function to be interrogated. The analyzer will output the present value for the function that was selected to be interrogated. The units of the output value will be the same as the units available for setting the value, if it can be set. The functions valid for interrogation are: AF, BW, DA, DB, DC, DR, RL, RP, SD, SL, SO, SP, SR, SS, and ST.

Status

Selected with the OS program code, the analyzer will output 2 sequential 8-bit bytes giving the present instrument status. The first status byte is equivalent to the status byte of the serial poll; the second status byte is an extended status byte which provides additional information. See table 6 for a description of each status byte. The status bytes are cleared upon execution of either a serial poll, device clear (DCL), selective device clear (SDC), PRESET, or sending the CS or OS commands.

Error

Selected with the OE1 or OE2 program codes, the analyzer will output one 8-bit byte giving the present status of display channels 1 or 2, respectively. This can be used with the HP 8757C to determine which channel has failed the specified limit test, if limit lines were enabled.

Data

The analyzer outputs data from the designated display channel in one of three formats: ASCII formatted data, Extended ASCII formatted data, and binary formatted data. The two ASCII formats are the more general purpose formats and are the easiest to interpret the output values. Binary formatted data provides the fastest data transfer rates and is usually the choice when transfer speed is a major concern. The data format is selected by using the FDx commands. The data format must be selected before a data transfer is attempted.

Identity

Selected with the OI program code, the analyzer will output a message which identifies it from other scalar network analyzers. Both the model number and the software revision are provided. This is helpful in system applications where software is written to run on more than one scalar network analyzer.

Trigger

The HP 8757C/E does not respond to the group execute trigger (GET) message.

Clear

The device clear (DCL) and selective device clear (SDC) messages clear all status bytes, the request mask, the HP-IB of the analyzer, and the 8757 SYSTEM INTERFACE.

Remote/Local

The analyzer goes to remote when the remote enable (REN) line on the interface is low (true) and it receives its listen address. In remote, all front panel functions are disabled except the LINE switch and the [LOCAL] key. The [LOCAL] key can be disabled via the LOCAL LOCKOUT (LLO) command. The state of the REN line is also sensed by the 8757 SYSTEM INTERFACE. An instrument on the 8757 SYSTEM INTERFACE designated as the pass through instrument (with the PTd command) is placed in remote or local depending on the state of the REN line. When the analyzer is placed in local lockout, the HP-IB source is also placed in local lockout.

The analyzer goes to local when it receives the GO TO LOCAL (GTL) command or when the REN line goes high (false). It will also return to local when the [LOCAL] key is pressed unless the LOCAL LOCKOUT (LLO) command has been executed.

Service request

The analyzer can initiate a service request (SRQ) whenever one of the following conditions exist:

- HP-IB command syntax error.
- End of operation (sweep or plot completed).
- Self-test failed.
- Any front panel key pressed.
- Numeric entry completed (HP-IB or front panel).
- Softkey only pressed.
- Battery voltage low.
- Rotary knob activity.
- Requested action not possible.
- Limit test failed.

For further information, execute a serial poll or the OUTPUT STATUS (OS) command. A serial poll operation consists of sending the analyzer its talk address, sending the SERIAL POLL ENABLE (SPE) command, reading the status byte on the bus, and sending the SERIAL POLL DISABLE (SPD) command. The SRQ is cleared only by executing either a serial poll, device clear (DCL), selective device clear (SDC), PRESET, or sending the CS or OS commands.

The request mask function (RMd) is used to specify a particular set of conditions for initiating a service request (SRQ). The mask value is determined by summing the decimal values of each selected function or condition that is desired. If a bit in the request mask is set to zero, that bit in the status byte will be masked and an SRQ cannot be initiated. For example, the command (RM41) indicates an SRQ can be initiated by the functions of bits 0, 3, and 5. The default value of the request mask at power-on is 00000000 or 0 decimal (no SRQ's are initiated).

Status byte

The HP 8757C/E responds to a serial poll by sending the status byte (#1). Both the status byte (#1) and the extended status byte (#2) are obtained by sending the OUTPUT STATUS (OS) command and by immediately reading both byte values, respectively. The status bytes of the analyzer are described in table 6.

When bit 6 (request service) of the status byte (#1) is true (one), an SRQ has occurred. See "Service Request" for the conditions causing a service request. Bit number 2 of the status byte (#1) indicates whether a change has occurred in the extended status byte (#2). If bit number 2 is true, then the extended status byte (#2) should be accessed via the OUTPUT STATUS (OS) command to determine the cause of the status change. All other bits (7, 5, 4, 3, 1, 0) of the status byte (#1) indicate the present status of the noted function. The bits are true (one) only if the associated function or condition is true.

1. HP 8757C only.

6

Status bit

The HP 8757C/E does not respond to a parallel poll.

Controller capabilities

The HP 8757C/E does not have the ability to take or pass control.

Abort

The HP 8757C/E responds to the ABORT message (interface clear line, IFC true) by stopping all listener or talker functions.

Self-test

A self-test is performed at power-up and whenever the instrument PRESET (IP) command is received by the analyzer. This self-test routine includes a brief but thorough check that key parts of the instrument are functioning. At the conclusion of the self-test, the analyzer will be placed in its PRESET condition. The operator can check the outcome of the self-test by reading bit 0 of the extended status byte (#2) or by checking the front panel of the analyzer. For details on checking the front panel after the self-test, refer to the *Operating Reference*.

Address assignment information

The HP-IB address for the analyzer is set at the factory to decimal 16. The current address may be determined by pressing the [LOCAL] key on the front panel, then selecting the *[8757]* softkey, and observing the active entry area of the CRT. It may be changed, if desired, by entering the digits, range 00 to 29 decimal, followed by [ENT], using the keypad. Avoid the use of address 21 (most HP-IB controllers use this address) and any address used on the 8757 SYSTEM INTERFACE (analyzer CRT, source, plotter, printer, disk drive).

The new address is retained in non-volatile memory until changed by the operator. However, should battery power to the non-volatile memory be interrupted, the HP-IB address will default to 16 decimal.

The default addresses associated with the analyzer are listed in "Passthrough".

Secure frequency mode

The BL1 programming code blanks the frequency labels of the analyzer and source, and places the HP 8757C/E in secure frequency mode. Once in secure frequency mode, you cannot restore frequency labels for the existing configuration. Frequency labels can be restored with a PRESET (IP) command, however your frequency settings will be reset. Do not confuse this programming code with the BL5 programming code which blanks the entire screen and may be restored.

Table 1.   Function Select Commands (1 of 6)

Action	HP-IB Command	Syntax	Description
Channel Selection	C1	1	Channel 1 on and the active channel.
	C2	1	Channel 2 on and the active channel.
	C3	1	Channel 3 on and the active channel.
	C4	1	Channel 4 on and the active channel.
	C0	1	Turns the currently active channel off.
Measure Power/Voltage	IA	1	Input A absolute power measurement.
	IB	1	Input B absolute power measurement.
	IC	1	Input C absolute power measurement.[1]
	IR	1	Input R absolute power measurement.
	IX	1	External ADC Input ("AUX") voltage measurement.
Measure Ratio	AB	1	A/B ratio measurement.
	AC	1	A/C ratio measurement.[1]
	AR	1	A/R ratio measurement.
	BA	1	B/A ratio measurement.
	BC	1	B/C ratio measurement.[1]
	BR	1	B/R ratio measurement.
	CA	1	C/A ratio measurement.[1]
	CB	1	C/B ratio measurement.[1]
	CR	1	C/R ratio measurement.[1]
	R1	1	R/A ratio measurement.
	R2	1	R/B ratio measurement.
	R3	1	R/C ratio measurement.[1]
Display Trace Data	ME	1	Display measurement data.
	MY	1	Display memory data.
	M- or MN	1	Display normalized data (measurement – memory).
	DHm	2	Display hold on/off of the active trace.
	.SM	1	Store measurement data into memory.
	SN	1	Store normalized data (measurement – memory) into memory.
	DS0	1	Display trace data in a log magnitude format.
	DS1	1	Display trace data in a Standing Wave Ratio (SWR) format.
Scale	AS	1	Autoscale the trace on the CRT.
	SDd	3	Set scale per division to d; where d is
			for dB, dBm: 20, 10, 5, 2, 1, 0.5, 0.2, or 0.1
			for SWR: 10, 4, 2, 1, 0.4, 0.2, 0.1, 0.04, or 0.02
			for Volts: 5, 2.5, 1, 0.5, 0.25, 0.1, 0.05, or 0.025
Reference Level	MR	1	Marker = Reference Level. Moves the cursor (or active marker if no cursor) and trace to the reference line.
	RLd	3	Set Reference Level to d; d must be in the range of:
			ratio measurement: +90 to −90 dB
			normalized measurement: +90 to −90 dB
			power measurement: +20 to −70 dBm
			SWR measurement: 1.0 to 37.0 SWR
			voltage measurement: +10 to −10V
			normalized voltage measurement: +20 to −20V
	STd	3	Set Reference Level Step size to d; where d is
			for d, dBm: 0 to 60 dB
			for SWR: 1 to 37 SWR
			for Volts: 0 to 10V

1. HP 8757C Option 001 only (C detector)

Table 1. Function Select Commands (2 of 6)

Action	HP-IB Command	Syntax	Description
Reference Position	RPq	2	Set Reference Position; q has a value from 0 to 8 corresponding to the major horizontal graticule lines: 8 = top graticule line 4 = center graticule line 0 = bottom graticule line
Cursor	CUm	2	Cursor on/off.
	CDm	2	Cursor Delta on/off.
	CX	1	Cursor to maximum for the active channel.
	CN	1	Cursor to minimum for the active channel.
	SSd[1]	3	Set cursor search value to amplitude value of d; d must be in the range of: ratio measurement: +60 to −60 dB normalized measurement: +60 to −60 dB power measurement: +20 to −60 dBm Maximum resolution of d is 0.01 or dBm. Cursor search functions are not allowed in SWR or Voltage display modes.
	SL[1]	1	Cursor Search Left for the search value. Cursor will search left to the first frequency point (or interpolated point which equals the search value). If the value cannot be found, the message "SEARCH VALUE NOT FOUND" will appear in the ACTIVE ENTRY AREA.
	SR[1]	1	Cursor Search Right for the search value. Cursor will search right to the first frequency point (or interpolated point which equals the search value). If the value cannot be found, the message "SEARCH VALUE NOT FOUND" will appear in the ACTIVE ENTRY AREA.
	BW[1]	1	Cursor search for bandwidth representing the search value. If the value cannot be found, the message "BANDWIDTH VALUE NOT FOUND" will appear in the ACTIVE ENTRY AREA.
Cursor Format	FR0	1	Cursor format logarithmic (dB or dBm).[2,3]
	FR1	1	Cursor format SWR.[2]
Averaging	A0	1	Averaging off.
	AFd	3	Averaging on and factor set to d; d is 0 (enables previous factor), 1, 2, 4, 8, 16, 32, 64, 128, or 256.
	RS	1	Restart averaging process on the next sweep.
DC Detector Zero	MZ	1	Manual zero of the DC detectors. The operator must turn the source RF power off before sending this command.
	AZm	2	Auto Zero Repeat on/off of the DC detectors. The source RF power is automatically turned off at an interval determined by the Repeat Auto Zero Timer and the DC zero is performed each time.[4]
	AZ2	1	Auto Zero of the DC detectors. The source RF power is automaticaly turned off and the DC zero is performed once.[4]
	ZTd	3	Repeat Auto Zero Timer interval set to d; d is a decimal integer from 1 to 60 minutes.
Smoothing	SOd	3	Set Smoothing to d % of span; d must be in the range of 0.0 to 20.0%, with a maximum resolution of 0.1%. When d is set to 0, this is equivalent to smoothing off.
Step	UP	1	Step up; increment the active parameter.
	DN	1	Step down; decrement the active parameter.

1. HP 8757E only.
2. Revision 3.1 or above for an HP 8757C; revision 4.1 or above for an HP 8757C.
3. Available only if display trace data is in log magnitude format (see DS0).
4. This command is valid only when the operator is using a source which is connected to the 8757 SYSTEM INTERFACE.

Table 1. Function Select Commands (3 of 6)

Action	HP-IB Command	Syntax	Description
Plot	BFm	2	Plotter buffer on/off.[2]
	PA	1	Plot All; plots entire display (except user graphics) on an external plotter.
	P1	1	Plot channel 1 trace.
	P2	1	Plot channel 2 trace.
	P3	1	Plot channel 3 trace.
	P4	1	Plot channel 4 trace.
	PC	1	Plot only labels on a external plotter.
	PG	1	Plot only the grid on an external plotter.
	SUd	3	Specify custom plot; d is a decimal integer from 0 to 255 representing one byte. Each bit of this byte specifies what is to be plotted. If a bit is set to 1, that item will be plotted, else it will not be plotted.

bit #	decimal value	action	decimal value	bit #	action
0 (LSB)	1	Scale Trace (P1 and P2 define grid size)	4	16	Trace 4
			5	32	Grid
1	2	Trace 1	6	64	Mode Labels
2	4	Trace 2	7 (MSB)	128	Frequency Labels
3	8	Trace 3			

Action	HP-IB Command	Syntax	Description
	PD	1	Plot custom plot on an external plotter
Print	PR1	1	Print entire graphics display (except user graphics) on external graphics printer.
	PR2	1	Print tabular display data in monochrome.
	PR3	1	Print tabular marker/cursor data on external printer.
	PR4	1	Print all to color printer, except softkeys and CRT graphics.
Limit Lines[1]	LE	1	Erase limit lines for active channel (only channels 1 and 2 are valid).
	LPs	4	Limit is single point specified by s. The string s includes the segment number (1 to 12), in the x-axis value, the upper limit value, and the lower limit value in the following format: "LP [seg. no.], [x-value] [x-units], [upper limit] [y-units], [lower limit] [y-units];" where [x-value] is a frequency or value determined by the start/stop labels. [x-units] is "GZ" for GHz, "MZ" for MHz, "KZ" for kHz, "HZ" for Hz, or blank for no units. [y-units] is "DB" for dB/dbm, "SWR" for SWR, or "V" for volts. Entering no value for an upper or lower limit value means do not test this limit. An example: "LP 1, 2.5 GZ, 1.5 DB, −1 DB;"
	LFs	4	Limit is a flat line specified by s. The string s includes the segment number (1 to 12), the start x-axis value, upper limit value, lower limit value, and stop x-axis value in the following format: "LF [seg. no.], [x-start] [x-units], [upper limit] [y-units], [lower limit] [y-units], [x-stop] [x-units];" where [x-value], [x-units], and [y-units], are described above. An example: "LF 2, 750 MZ, −30 DB, −32 DB, 850 MZ;"
	LSs	4	Limit is sloped line specified by s. The string s includes the segment number (1 to 12), the start x-axis value, start upper limit value, start lower limit value, the stop x-axis value, the stop upper limit value and the stop lower limit value in the following format: "LS [seg. no.], [x-start] [x-units], [upper limit] [y-units], [lower limit] [y-units], [x-stop] [x-units], [upper limit] [y-units], [lower limit] [y-units];" where [x-value], [x-units], and [y-units] are described above. An example: "LS 4, 2 GZ, −3 DB, −4 DB, 3 GZ, 0 DB, −1 DB;"
	LTm	2	Limit line test on/off. If on, limit test status is designated by the CRT PASS/FAIL message and status bytes.
	LL	1	Store lower limit line into memory.
	LU	1	Store upper limit line into memory.

1. HP 8757C only.
2. Revision 3.1 or above for an HP 8757C; revision 4.1 or above for an HP 8757E.

Table 1. Function Select Commands (4 of 6)

Action	HP-IB Command	Syntax	Description
Graticule Start/Stop Labels	FAs	4	Start value for labeling x-axis graticule and entry of limit lines when System Interface control is off or no source is connected to the 8757 SYSTEM INTERFACE. s is a string in the following format: "FA [value] [x-units];" where [x-units] is "GZ" for GHz, "MZ" for MHz, "KZ" for kHz, "HZ" for Hz, or blank for no units. An example: "FA 6.55 GZ;"
	FBs	4	Stop value for labeling x-axis graticule and entry of limit lines when System Interface control is off or no source is connected to the 8757 SYSTEM INTERFACE. s is a string in the following format: "FB [value] [x-units];" where [x-units] is described above.
Number of Trace Points	SPd	3	Set the Number of Points displayed on the horizontal axis to d; d is 101, 201, 401, 801, or 1601. If source is connected to the 8757 SYSTEM INTERFACE, the sweep time may change if increasing the number of points.
Detector Offsets	DAd	3	Set Detector A offset to d; d must be in the range of +60 to −60 dB with a maximum resolution of 0.01 dB.
	DBd	3	Set Detector B offset to d; d must be in the range of +60 to −60 dB with a maximum resolution of 0.01 dB.
	DCd	3	Set Detector C offset to d; d must be in the range of +60 to −60 dB with a maximum resolution of 0.01 dB.[1]
	DRd	3	Set Detector R offset to d; d must be in the range of +60 to −60 dB with a maximum resolution of 0.01 dB.
External Detector Calibration	XAd XBd XCd[1] XRd	3 3 3 3	Enter external cal value for the specific detector input. d is the code number in the format of [DDDDDD;], read from the front panel after performing a calibration.
Detector Mode	DM0 DM1	1 1	Set Detector mode of all inputs for DC detection. Set Detector mode for all inputs for AC detection.
Adaptive Normalization	ANm	2	Adaptive Normalization on/off.
System Calibration	CL	1	Perform system configuration calibration of the detectors and channels.
	TCm	2	Continuous temperature compensation on/off.
	CTm	2	Auto System Calibration on/off. Performs a system calibration at an interval of every five minutes.
Sweep Mode	NSm	2	Non-standard sweep on/off. Allows the HP 8757C/E to track any sweep ramp in the range of 0 to 10 V, increasing in sweep voltage.
	CWm	2	CW mode (single point) on/off.[2]
	MSm	2	Manual sweep mode on/off.[2]
	PBm	2	System Interface control on/off.
	FSm	2	Step sweep mode on/off.[3,4]
Modulation	MDm	2	Rear panel square-wave modulation output on/off.

1. HP 8757C Option 001 only (C detector)
2. If source is connected to the 8757 SYSTEM INTERFACE and the interface control is on, the source is also set to this mode.
3. Revision 3.1 or above for an HP 8757C; revision 4.1 or above for an HP 8757E.
4. HP 8340, HP 8341, and HP 8360 only with 8757 SYSTEM INTERFACE connected and active.

Table 1. Function Select Commands (5 of 6)

Action	HP-IB Command	Syntax	Description
Save/Recall Registers	SVn	2	Save front panel settings in register n; n from 1 to 9. Note that registers 1 to 4 also retain title, channels 1 and 2 limit line information, and channels 1 and 2 trace memories.[2]
	RCn	2	Recall front panel settings from register n; n from 1 to 9.[2]
	ER0	1	Erase all save/recall registers.[2]
Instrument Preset	IP	1	Presets the HP 8757C/E and the instruments connected to the 8757 SYSTEM INTERFACE.
Front Panel Menus/ Softkeys	MM	1	Display the Channel Menu.
	MU0	1	Display the Measurement Menu.
	MU1	1	Display the Display Menu
	MU2	1	Display the Scale Menu.
	MU3	1	Display the Reference Menu.
	MU4	1	Display the Cursor Menu.
	MU5	1	Display the Average Menu.
	MU6	1	Display the Calibration Menu.
	MU7	1	Display the Special Menu.
	MU8	1	Display the System Menu.
	SKq	2	Select Softkey q; q is from 1 to 8. Equivalent to manually pressing the softkey.
Display/Color Control[1]	BTNd	3	Adjust the overall display brightness. Values for d can be defined by the user. See the *Operating Reference* for more information.
	DEC	1	Set default colors.
	MOC	1	Set monochrome mode.
	CCq	2	Selects channel q as the feature affected by color selection commands found under CLx. Valid values for q are 1 to 4.
	CGL	1	Set labels color.
	CGN	1	Selects background as the feature affected by color selections. For example: "CGN; CLB;" sets the background to black. Note: Select the feature to be changed before selecting the color. Define custom colors with COT, COB, and COC. These commands are used like the color list commands. For example: "CGN; COB100;COC75;COT100" defines all three parameters of a feature's color.
	CGR	1	Set grid color.
	CGW	1	Set warning label color.
	CLx	1	Selects a color from the color list for the feature previously selected. x represents colors from the color list. Valid values for x are: W — White Y — Yellow S — Salmon B — Black L — Blue R — Red G — Green
	COBd	3	Custom color brightness, affects the feature last selected. d ranges from 0 to 100.
	COCd	3	Custom color adjust, affects the feature last selected. d ranges from 0 to 100.
	COTd	3	Custom tint adjust, affects the feature last selected. d ranges from 0 to 100.

1. HP 8757C only.
2. Revision 3.1 or above for an HP 8757C; revision 4.1 or above for an HP 8757E.

Table 1. *Function Select Commands (6 of 6)*

Action	HP-IB Command	Syntax	Description
Disk Save/Recall[1]	DFA	1	The data sent after this command is stored in ASCII format. This is important for retrieving the data for use in another program.
	DFB	1	The data sent after this command is stored in fast binary format allowing quicker file access times.
	DIAd	3	Sets the HP-IB address for the disk drive on the bus. The valid range for d is 0 to 29.
	DIUd	3	Selects active disk unit. For example: With an HP 9122, select unit 0 or unit 1. The valid range for d is 0 to 15.
	DIVd	3	For hard drives with multiple partitions. The valid range for d is 0 to 15.
	DLF	1	Deletes the last file selected from the disk or, if no filename was selected, the default file, FILE1, is deleted (if FILE1 existed on the disk).
	IND	1	Formats the disk in the disk unit last selected.
	LFx	1	Loads from disk the items selected by x. All information is recalled from the last file specified by the "TIFs" command. If no filename was selected, then the default file, FILE1, is recalled from disk (if FILE1 exists.) Valid selections for x are: A — Load all information files from disk M — Memory trace only C — CRT graphics only D — Data trace only I — Instrument state only H — Load all information files from disk, hold display[2]
	SFx	1	Stores to disk the items selected by x. All information is stored into the last file selected by the "TIFs" command. If no filename was selected, then the default file, FILE1, is overwritten. Valid selections for x are: A — Store all information files to disk M — Memory trace only C — CRT graphics only D — Data trace only I — Instrument state only N — Measurement — Memory[2]
	TIFs	4	Defines the current active title for an existing or a new file. The strings can be up to eight characters in length and include only letters or numbers. For example: Select a file named SAMPLE with "TIFSAMPLE". Before storing to, loading from, or deleting files from disk, select a title.

1. HP 8757C only.
2. Revision 3.1 or above for an HP 8757C; revision 4.1 or above for an HP 8757E.

Table 2.   HP-IB Only Functions (1 of 2)

Action	HP-IB Command	Syntax	Description
Display Blanking	BL0	1	No blanking; restore CRT to normal mode.
	BL1	1	Blank only the frequency labels.
	BL2	1	Blank all labels on the CRT.
	BL3	1	Blank only the active channel trace.
	BL4	1	Blank only the softkey labels.
	BL5	1	Blank all of the CRT except user graphics.
	BL6	1	Blank only the user title.
	BL7	1	Blank only the mode labels.
	BL8	1	Blank only the active entry area.
	BL9	1	Blank only the limit lines.[1]
	BLA	1	Blank all of the CRT except user graphics and softkeys.
Status Bytes	CS	1	Clear Status bytes #1 and #2.
	RMd	3	Set Request Mask of status byte #1 to d; d is decimal integer from 0 to 255.
Format Data	FD0	1	Format Data ASCII; all successive data transfers are made in an ASCII format. Data is transferred in [± DD.DDD] format where D is an ASCII digit.
	FD2	1	Format Data Extended ASCII; all successive data transfers are made in an extended ASCII format. Data are transferred in [± DDD.DDD] format where D is an ASCII digit.
	FD1 FD3	1	Format Data Binary; all successive data transfers are made in a binary format. FD1 is for HP BASIC (MSB first); FD3 is for PC format files (LSB first). Two bytes are transferred, the value of which is scaled between the limits shown below:

	decimal value	ratio meas.	power meas.	normalized ratio meas.	normalized power meas.	SWR meas.	voltage meas.
$VP =$	0	−90 dB	−70 dBm	−180 dB	−90 dB	1.0	−11.25 V
	16384	0 dB	−25 dBm	0 dB	0 dB	19.0	0 V
$V1 =$	32767	+90 dB	+20 dBm	+180 dB	+90 dB	37.0	+11.25 V

Binary data can be unscaled using the following equation:

$$\text{real value} = \left[\text{binary value} \times \frac{(V1 - V0)}{32767} \right] + V0$$

Action	HP-IB Command	Syntax	Description
Pass Through Address	PTd	3	Set the Pass Through address of an instrument connected to the 8757 SYSTEM INTERFACE; d is a two digit ASCII integer which represents the HP-IB address of the instrument to be programmed.
Cursor Position	SCd	3	Set Cursor position to d; d is a decimal integer which represents a horizontal position on the CRT with a range of values shown below:

No. of trace points	range of d
101	0 to 100
201	0 to 200
401	0 to 400
801[1]	0 to 800
1601[1]	0 to 1600

Action	HP-IB Command	Syntax	Description
Control Outputs	OT1m	2	Rear panel control output #1 on/off.
	OT2m	2	Rear panel control output #2 on/off.

1. HP 8757C only.

Table 2. HP-IB Only Functions (2 of 2)

Action	HP-IB Command	Syntax	Description
Sweep Mode	SW0	1	Non-swept mode. Sweep off; hold data on the CRT.
	SW1	1	Swept mode. Sweep on; continuously track sweep ramp voltage and update trace data on the CRT.
	SW2	1	Sweep Hold mode. Sweep off; hold HP-IB bus activity until completion of TSd number of sweeps.
	TSd	3	Take d Sweeps, then hold trace data on the CRT. The HP 8757C/E must be in the Non-Swept (SWO)(or Sweep Hold (SW2) modes before executing. d is a decimal integer from 1 to 255. For certain operating modes, such as SWR trace mode, Alternate Sweep on, Averaging on, or Smoothing on, it is recommended that 2 successive sweeps be taken for accurate data.
Learn String	ILs	4	Input learn string; s is string of 150 binary bytes that were output by the output learn string command.

Write Softkey Label	WKs	4	Write softkey label for a particular softkey. s is an ASCII string; the first character is the softkey number (range 1 to 8) followed by the label. The label can be sent in the following forms:
			    one word label:
			      "[ASCII label] [term]"
			    two word label:
			      "[ASCII label], [ASCII label] [term]"
			where [ASCII label] is ⩽ 7 characters and [term] is a valid terminator.

Write Title	WTs	4	Write Title to the CRT; s is an ASCII string of up to 50 characters.
Write To Trace Memory	WMs	4	Write to the channel memory. Data is transferred from the computer to the channel memory of the analyzer. Several parameters must be properly set before the transfer is made: • data format must be set using the FDx command • the desired channel memory is selected by making that channel the active channel. • the number of points transferred must equal the present number of points/trace.

2. Revision 3.1 or above for an HP 8757C; revision 4.1 or above for an HP 8757C.
3. Available only if display trace data is in log magnitude format (see DS0).

Table 3. Output Modes (1 of 2)

Action	HP-IB Command	Description	Format
Output Learn String	OL	Outputs binary data string 150 bytes long which completely describes instrument state. Can be stored in ASCII character string and later input to restore that instrument state.	150 [B][EOI]
Output Interrogated Parameter Value	OPxx	Outputs the present numeric value of the function selected. xx is the function code to interrogate (AF, BW, DA, DB, DC, DR, RL, RP, SD, SL, SO, SP, SR, SS, ST).	$[\pm D.DDDDDE \pm DD][lf]$
Output Cursor Value	OC	Outputs cursor or cursor Δ amplitude and horizontal position. Format set by the FDx, FRx, and DSx commands.	ASCII Data: $[\pm DD.DDD,][DDDD][lf]$ Extended ASCII: $[\pm DDD.DDD,][DDDD][lf]$ Binary Data [BB][BB][EOI]
Output Measurement Data	OD	Output measurement data; no. of data points is the same as the no. of points/trace. Format set by "FDx" command. With the OD command, data is returned in units of dB or dBm unless in SWR trace format (units are SWR). In general, whenever a measurement is defined (dBm, dB, SWR), one or more sweeps must be taken before the data is valid.	ASCII Data: $(n-1)[\pm DD.DDD,]$ $[\pm DD.DDD][lf]$ Extended ASCII: $(n-1)[\pm DDD.DDD,]$ $[\pm DDD.DDD][lf]$ Binary Data: n [BB][EOI] n = no. of points per trace.
Output Memory Data	OM	Output memory data; no. of data points is the same as the no. of points/trace. Format set by "FDx" command.	ASCII Data: $(n-1)[\pm DD.DDD,]$ $[\pm DD.DDD][lf]$ Extended ASCII: $(n-1)[\pm DDD.DDD,]$ $[\pm DDD.DDD][lf]$ Binary Data: n[BB][EOI] n = no. of points per trace.
Output Normalized Data	ON	Output normalized data; (measurement − memory); no. of data points is the same as the no. of points/trace. Format set by "FDx" command. Not valid for SWR trace mode.	ASCII Data: $(n-1)[\pm DD.DDD,]$ $[\pm DD.DDD][lf]$ Extended ASCII: $(n-1)[\pm DDD.DDD,]$ $[\pm DDD.DDD][lf]$ Binary Data: n[BB][EOI] n = no. of points per trace.
Output CW Value	OV	Output CW value; Non-swept mode (SW0 or SW2) must be set. Format set by "FDx" command. Data is returned in dBm or dB, even if SWR trace format is used.	ASCII Data: $[\pm DD.DDD][lf]$ Extended ASCII: $[\pm DDD.DDD][lf]$ Binary Data: n[BB][EOI]

Table 3.   Output Modes (2 of 2)

Action	HP-IB Command	Description									Format
Output Error Status	OE1 OE2	Outputs error status of display channel 1 or 2. One byte is output, where each bit indicates:									[B][EOI]

Bit#	7	6	5	4	3	2	1	0
Decimal Value	128	64	32	16	8	4	2	1
Function	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Out of Limits

Action	HP-IB Command	Description	Format
Output Keycode	OK	Outpus keycode for the last front panel key pressed. Refer to table 7 for keycodes.	[DD][lf]
Output Knob Value	OR	Output Knob value; the value is between −32768 and +32767. It is reset to 0 after. Negative value = counterclockwise rotation, positive value = clockwise rotation.	[BB][EOI]
Output Status Bytes	OS	Output 2 bytes, the Status Byte (#1) and the Extendes Status Byte (#2). Both bytes are then cleared.	[bb][EOI]
Output Identity	OI	Outputs the HP 8757C/E identity string and the firmware revision number xx.x (i.e., 03.0 for revision 3.0)	"8757C REVxx.x" [cr][lf] or "8757E REVxx.x" [cr][lf]

NOTES: D   = ASCII digit
        B   = 8-bit byte
        ,   = comma
        EOI = End or Identity HP-IB line true
        cr = carriage return
        lf = line feed

Table 4. CRT Graphics Commands (1 of 2)

HP-GL Subset
Note: All Graphics Commands must be terminated with a semicolon ";" or a "[linefeed]" (the character [carriage return] is ignored).

HP-IB Command	Command Description
DF	Default; sets monochrome default values. ("DI 1,0;SI 0.14,0.17;")

DI run, rise	Absolute Character Direction; run rise allowable values are:
	   1, 0 = 0 degrees (default)
	   0, 1 = 90 degrees
	 −1, 0 = 180 degrees
	   0, −1 = 270 degrees

LB [text] [ETX]	Label text. Character set is shown in table 5, HP 8757C/E Modified ASCII Character Set. Before labeling text, move the pen to the appropriate (x,y) coordinate using the PU and PA commands. The text will be plotted with the lower left corner of the first character starting at the existing pen position. The pen stops at the lower left corner of the next character space.
OP	Output the current P1 and P2 positions. (P1 = 0,0; P2 = 2924, 2047). The graphics display units (GDU's) define the plotting area on the CRT. The coordinates of the full plotting are are (0,0) for lower left, (2924,2047) for upper right. The coordinates for the trace graticule are (214, 150) for lower left, (2500, 1814) for upper right.
PA x1, y1 (,x2,y2, ..., ..., xN, yN)	Plot Absolute; x and y are integers and are in Graphics Display Units (GDU's). Moves the pen to the specified (x,y) coordinates. Both the x and y coordinates must be specified. Any number of coordinate pairs can be specified when separated by commas. Use of the PD and PU commands determines whether a line is drawn or the pen is just moved. If an (x,y) coordinate is specified outside of the plotting area, only that portion of the line within the plotting area is drawn.
PD	Pen Down.
PU	Pen Up.
SI, w, h	Absolute Character Size; w = width; h = height. Values allowed are: 0.14, 0.17 Smallest size (Mode labels, softkey labels) 0.21, 0.25 (Active Entry Area) 0.28, 0.34 0.35, 0.42 Largest size

SP n	For monochrome display: select pen; n = 0 to 4;
	  0 Pen up (Beam off)
	  1 Bright Green
	  2 Half-Bright Green
	  3 Dim Green

Table 4. CRT Graphics Commands (2 of 2)

Non-HP-GL Commands

The following HP-GL commands will be accepted but their functions are not implemented and no error will be noted: IM (Input SRQ Mask), IP (Input P1 and P2), IW (Input Window), OC (Output Current Position), OE (Output Error), PG (Output Page), SL (Character Slant), and SR (Size Relative for characters).

	HP-IB Command	Command Description
Erase Page	EPn	Erase Page n, where n = 1 to 8; if no n value is given, all pages are erased.
Select Graphics Page On/Off	GPn,m	Turn graphics page n (1 to 8) on/off (m = 1 or 0). Pages 1 through 7 may use up to 500 16 bit words. Page 8 may contain up to 4000 words. GP without parameters selects and turns on page 1. Also resets point to start of page.
Default Colors HP 8757C	DEC	**Pen Number** **Color** 0 Black 1 Bright White 2 Half-bright White 3 Dim White 4 Red 5 Half-bright White 6 Dim White 7 Bright White 8 Gold 9 Gold 10 Blue 11 Blue 12 Salmon 13 Salmon 14 Green 15 Green
Select HP BASIC Default Colors	BC	0 Black 1 White 2 Red 3 Yellow 4 Green 5 Cyan 6 Blue 7 Magenta 8 Black 9 Olive Green 10 Aqua 11 Royal Blue 12 Maroon 13 Brick Red 14 Orange 15 Brown
Default Monochrome	DF	0 Black 1 Bright Green 2 Half-bright Green 3 Dim Green

Table 5.   HP 8757C/E Modified ASCII Character Set

HP 8757C/E MODIFIED ASCII CODE CONVERSION TABLE

Note: These characters are output only when the LB command is used directly.

		0	1	2	3	4	5	6	7
	0	null	centered*	space	0	@	P	`	p
	1	HP logo	centered o	!	1	A	Q	a	q
	2	β	↑	"	2	B	R	b	r
	3	ETX	←	#	3	C	S	c	s
	4	upper-half tic	↓	$	4	D	T	d	t
	5	lower-half tic	→	%	5	E	U	e	u
LEAST	6	left-half tic	√	&	6	F	V	f	v
SIGNIFICANT	7	right-half tic	π	'	7	G	W	g	w
CHARACTER	8	back space	Δ	(	8	H	X	h	x
	9	½ shift down	μ	)	9	I	Y	i	y
	A	line feed	°(degree)	*	:	J	Z	j	z
	B	inv. line feed	Ω	+	;	K	[	k	{
	C	½ shift up	ρ	'	<	L	\	l	|
	D	carriage return	Γ	-	=	M	]	m	}
	E	horizontal tic	θ	.	>	N	^	n	□
	F	vertical tic	λ	/	?	O	—	o	▶

MOST SIGNIFICANT CHARACTER (column header above 0–7)

EXAMPLES:

HP logo	= 01
A	= 41
i	= 69
√	= 16
▶	= 7F
line feed	= 0A
ETX	= End of text; use to end labelling

Table 6.   HP 8757C File Extensions

Disk files created by the HP 8757C can be read on any HP 9000 Series 200/300 computer. Each file has an extension appended which serves to identify the file type.

File Type	Extension
Instrument State	IS
Measurement Data Channel q	Dq
Memory Data Channel q	Mq
CRT Graphics	CG
Normalized Data Channel q	Nq

File identities are determined by their extensions. For example, a normalized data file for channel 2 named "FILE1" would have "N2" appended resulting in "FILE1N2".

Where q represents a channel number 1 to 4.

Table 7. HP 8757C/E Status Byte Descriptions

STATUS BYTE (#1)								
BIT #	7	6	5	4	3	2	1	0
Decimal Value	128	64	32	16	8	4	2	1
Function	N/A	Request Service (SRQ)	SRQ on HP-IB Syntax Error	SRQ on Operation Complete (Sweep, Plot or Print)	SRQ on Softkey Only Pressed	SRQ on Change in Extended Status Byte	SRQ on Numeric Entry Completed (HP-IB or Front Panel)	SRQ on Any Front Panel Key Pressed
EXTENDED STATUS BYTE (#2)								
BIT #	7	6	5	4	3	2	1	0
Decimal Value	128	64	32	16	8	4	2	1
Function	N/A	SRQ on Detector Uncal	SRQ on Front Panel Preset or Power-on	SRQ on Limit Test Failed	SRQ on Action Requested not possible	SRQ on Knob Activity	N/A	SRQ on Self Test Failure

Table 8. Front Panel Keycodes (values are in decimal)

SOFTKEYS
Softkey 1 (top) = 32
Softkey 2 = 8
Softkey 3 = 0
Softkey 4 = 16
Softkey 5 = 14
Softkey 6 = 38
Softkey 7 = 40
Softkey 8 (bottom) = 41

CHANNEL
Channel 1 = 42
Channel 2 = 43

FUNCTION
Measurement = 44
Display = 45
Scale = 52
Reference = 46
Cursor = 47
Averaging = 48
Calibration = 49
Special = 50

ENTRY
Step down = 22
Step up = 6
0 Key = 20
1 Key = 4
2 Key = 3
3 Key = 7
4 Key = 12
5 Key = 11
6 Key = 15
7 Key = 36
8 Key = 35
9 Key = 39
. Key = 19
- Key = 23
Entry off = 9
Enter = 1
dBm/dB = 33
Backspace = 17

INSTRUMENT STATE
System = 51
Save = 28
Recall = 26
Local = 29

Table 9. Alphabetical Listing of HP 8757C/E Programming Codes (1 of 2)

Code	Action	Code	Action
A0	Averaging off	COTd	Tint adjust, one color[1]
AB	A/B ratio measurement	CR	C/R ratio measurement[2]
AC	A/C ratio measurement[2]	CS	Clear status bytes
AFd	Averaging on and factor d	CTm	Auto system calibration on/off
ANm	Adaptive Normalization on/off	CUm	Cursor on/off
AR	A/R ratio measurement	CWm	CW mode on/off
AS	Autoscale	CX	Cursor to maximum
AZm	Autozero repeat on/off of the DC detectors	DAd	Detector A offset set to d
AZ2	Autozero the DC detectors once	DBd	Detector B offset set to d
BA	B/A ratio measurement	DCd	Detector C offset set to d[2]
BC	B/C ratio measurement[2]	DEC	Set default colors[1]
BFm	Plotter buffer on/off[4]	DFA	Set disk format to ASCII[1]
BL0	Restore CRT to normal mode	DFB	Set disk format to binary[1]
BL1	Blank frequency labels (secure frequency mode, frequency labels cannot be restored)	DHm	Display Hold on/off of the active channel trace
BL2	Blank all labels	DIAd	Set disk HP-IB address[1]
BL3	Blank active channel trace	DIUd	Set disk unit number[1]
BL4	Blank softkey labels	DIVd	Set disk volume number[1]
BL5	Blank all (except user CRT graphics)	DLF	Delete file from disk[1]
BL6	Blank title	DM0	All inputs set to DC detection
BL7	Blank mode labels	DM1	All inputs set to AC detection
BL8	Blank the active entry area	DN	Step down (decrement)
BL9	Blank the limit lines	DRd	Detector R offset set to d
BLA	Blank all (except user CRT graphics and softkeys)	DS0	Display trace data in log magnitude
BR	B/R ratio measurement	DS1	Display trace data in standing wave ratio (SWR) format
BTNd	Overall display brightness	ER0	Erase all save/recall registers
BW	Display the search bandwidth on the CRT[1]	FAs	Start frequency label
C0	Channel off	FBs	Stop frequency label
C1	Channel 1 on/active	FD0	Format data ASCII
C2	Channel 2 on/active	FD1	Format data binary (HP BASIC compatible)
C3	Channel 3 on/active[1]	FD2	Format data extended ASCII
C4	Channel 4 on/active[1]	FD3	Format data binary (PC compatible)
CA	C/A ratio measurement[2]	FR0	Logarithmic (dB) cursor format[4]
CB	C/B ratio measurement[2]	FR1	SWR cursor format[4]
CC1	Set channel 1 color[1]	FSm	Step sweep on/off[4,5]
CC2	Set channel 2 color[1]	IA	Input A absolute power measurement
CC3	Set channel 3 color[1]	IB	Input B absolute power measurement
CC4	Set channel 4 color[1]	IC	Input C absolute power measurement[2]
CDm	Cursor delta on/off	ILs	Input Learn string
CGL	Set labels color[1]	IND	Initialize disk format[1]
CGN	Set background color[1]	IP	Instrument preset
CGR	Set grid color[1]	IR	Input R absolute power measurement
CGW	Set warning label color[1]	IX	External ADC input (AUX) voltage measurement[1]
CL	Perform system configuration of detectors and channels	LE	Erase limit lines for active channel[3]
CLB	Color list, black[1]	LFA	Load instrument information file from disk[1]
CLG	Color list, green[1]	LFC	Load CRT graphics file from disk[1]
CLL	Color list, blue[1]	LFD	Load data trace file from disk[1]
CLR	Color list, red[1]	LFH	Load instrument information file from disk and place instrument in hold mode.[1,6]
CLS	Color list, salmon[1]	LFI	Load instrument state file from disk[1]
CLW	Color list, white[1]	LFM	Load memory trace file from disk[1]
CLY	Color list, yellow[1]	LFs	Enter limit test flat line data[3]
CN	Cursor to minimum	LL	Store lower limit line into memory[3]
COBd	Brightness adjust, one color[1]		
COCd	Color adjust, one color[1]		

1. HP 8757C only.
2. HP 8757C Option 001 only (detector C).
3. Limit line functions valid only for channels 1 or 2, HP 8757C only.

4. Revision 3.1 or above for an HP 8757C; revision 4.1 or above for an HP 8757E.
5. HP 8340, HP 8341, HP 8360 only with 8757 SYSTEM INTERFACE connected and active.
6. Revision 3.1 or above for an HP 8757C.

Table 9. Alphabetical Listing of HP 8757C/E Programming Codes (2 of 2)

Code	Action	Code	Action
LPs	Enter limit test point data[3]	PR1	Print all to monochrome printer, except softkeys and CRT graphics
LSs	Enter limit test sloped line data[3]	PR2	Print tabular display data in monochrome
LTm	Limit line test on/off[3]	PR3	Print tabular marker/cursor data to external printer
LU	Store upper limit line into memory[3]		
M-	Display normalized data (measurement −memory)	PR4	Print all to color printer, except softkeys and CRT graphics[1]
MDm	Modulation on/off	PTd	Passthrough address set to d
ME	Display measurement data	R1	R/A ratio measurement
MM	Display the channel menu (main menu)	R2	R/B ratio measurement
MN	Display normalized data (same as M-)	R3	R/C ratio measurement[2]
MOC	Monochrome display[1]	RCn	Recall register n
MR	Marker (or cursor) to reference line	RLd	Reference level set to d
MSm	Manual sweep mode on/off	RMd	Service request mask set to d
MU0	Display the measurement menu	RPq	Reference position set to vertical division q
MU1	Display the display menu	RS	Restart averaging
MU2	Display the scale menu	SCd	Set cursor to horizontal position d
MU3	Display the reference menu	SDd	Scale per division set to d
MU4	Display the cursor menu	SFA	Store all instrument information to disk in file[1]
MU5	Display the average menu	SFC	Store CRT graphics to disk in file[1]
MU6	Display the calibration menu	SFD	Store data trace to disk in file[1]
MU7	Display the special menu	SFI	Store instrument state to disk in file[1]
MU8	Display the system menu	SFM	Store memory trace to disk in file[1]
MY	Display memory data	SFN	Store normalized trace to disk in file[1,4]
MZ	Manual calibration of DC detectors	SKq	Select softkey q: q = 1 to 8
NSm	Non-standard sweep mode on/off	SL	Cursor search left[1]
OC	Output cursor value	SM	Store measurement into memory
OD	Output trace data	SN	Store normalized data (measurement −memory) into memory
OE1	Output error status of display channel 1		
OE2	Output error status of display channel 2	SOd	Smoothing set to d % of frequency span
OI	Output identity	SPd	Number of points set to d: d = 101, 201, 401, 801, 1601
OK	Output keycode of last key pressed		
OL	Output learn string	SR	Cursor search right[1]
OM	Output memory data	SSd	Cursor search value set to d[1]
ON	Output normalized (measurement −memory) data	STd	Reference level step size set to d
		SUd	Specify custom plot according to d
OPxx	Output interrogated parameter value xx = AF, BW, DA, DB, DC, DR, RL, RP, SD, SL, SO, SP, SR, SS, ST	SVn	Save register n
		SW0	Non-swept mode; non-swept operation
OR	Output rotary knob value (−32768 ≤ value ≤ +32767)	SW1	Swept mode; normal swept operation
		SW2	Sweep hold mode; non-swept mode with HP-IB bus hold off until completion of TSd
OS	Output status bytes		
OT1m	Control output #1 on/off	TCm	Continuous Temperature Compensation on/off
OT2m	Control output #2 on/off	TIFs	Title for file[1]
OV	Output CW value	TSd	Take d sweeps, then hold display
P1	Plot channel 1 trace on external plotter	UP	Step up (increment)
P2	Plot channel 2 trace on external plotter	WKs	Write softkey label
P3	Plot channel 3 trace on external plotter[1]	WMs	Write to channel memory.
P4	Plot channel 4 trace on external plotter[1]	WTs	Write title, s is an ASCII string of up to 50 characters
PA	Plot all on external plotter		
PBm	System interface control on/off	XAs	External detector cal vlaue for detector A
PC	Plot labels on external plotter	XBs	External detector cal value for detector B
PD	Plot custom plot	XCs	External detector cal value for detector C[2]
PG	Plot grid on external plotter	XRs	External detector cal value for detector R

1. HP 8757C only.
2. HP 8757C Option 001 only (detector C).
3. Limit line functions valid only for channels 1 or 2, HP 8757C only.
4. Revision 3.1 or above for an HP 8757C.

NOTES:
n = decimal integer 1 to 9
d = variable length numeric
m = 0 for off / 1 for on
q = unique value
s = ASCII or binary string

For more information, call your local HP sales office listed in your telephone directory or an HP regional office listed below for the location of your nearest sales office.

United States:
Hewlett-Packard Company
4 Choke Cherry Road
Rockville, MD 20850
(301) 670-4300

Hewlett-Packard Company
5201 Tollview Drive
Rolling Meadows, IL 60008
(312) 255-9800

Hewlett-Packard Company
5161 Lankershim Blvd.
No. Hollywood, CA 91601
(818) 505-5600

Hewlett-Packard Company
2015 South Park Place
Atlanta, GA 30339
(404) 955-1500

Canada:
Hewlett-Packard Ltd.
6877 Goreway Drive
Mississauga, Ontario L4V1M8
(416) 678-9430

Japan:
Yokogawa-Hewlett-Packard Ltd.
29-21, Takaido-Higashi 3-chome
Suginami-ku, Tokyo 168
(03) 331-6111

Latin America:
Latin American Region Headquarters
Monte Pelvoux Nbr. 111
Lomas de Chapultepec
11000 Mexico, D.F. Mexico
(905) 596-79-33

Australia/New Zealand:
Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, Victoria 3130
Melbourne, Australia
(03) 895-2895

Far East:
Hewlett-Packard Asia Ltd.
22/F Bond Centre
West Tower
89 Queensway
Central, Hong Kong
(5) 8487777

Germany:
Hewlett-Packard GmbH
Vertriebzentrale Deutschland
Hewlett-Packard-Strasse
Postfach 1641
6380 Bad Homburg v.d.H.
Federal Republic of Germany
06172/400-0

France:
Hewlett-Packard France
Parc d'activité du Bois Briard
2, avenue du Lac
91040 Evry Cedex
01/60 77 83 83

United Kingdom:
Hewlett-Packard Ltd.
Customer Information Centre
King Street Lane
Winnersh
Wokingham
Berkshire RG11 5AR
0734 777828

Italy:
Hewlett-Packard Italiana S.p.A.
Via G. di Vittorio, 9
20063 Cernusco Sul Naviglio (MI)
Milano
02/923691

European Multi Country Region:
Hewlett-Packard S.A.
Route du Nant d'Avril 150
1217 Meyrin 2 - Geneva
Switzerland
(41) 22/83 81 11

Or write to:

United States:
Hewlett-Packard Company
P.O. Box 10301
Palo Alto, CA 94303-0890

Europe/Middle East/Africa:
Hewlett-Packard S.A.
Central Mailing Department
P.O. Box 529
1180 AM Amstelveen
The Netherlands

For all other areas:
Hewlett-Packard Company
Intercontinental Headquarters
3495 Deer Creek Road
Palo Alto, CA 94304
U.S.A.

HEWLETT PACKARD

Introductory Programming Guide
For the HP 8757C/E scalar network analyzer with
the HP 9000 series 200/300 desktop computer (BASIC)
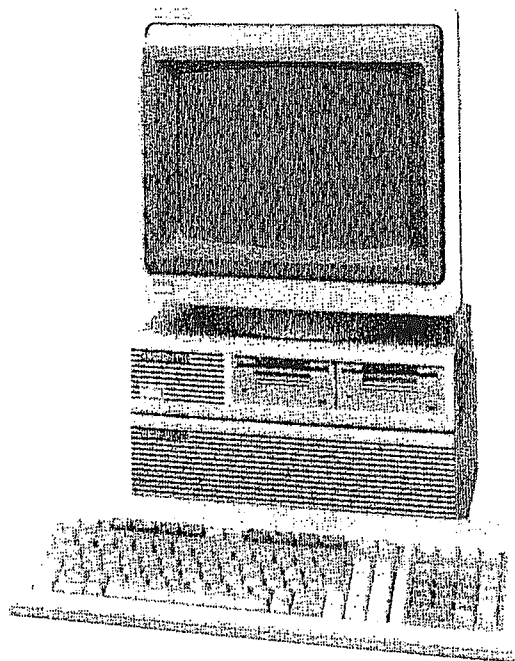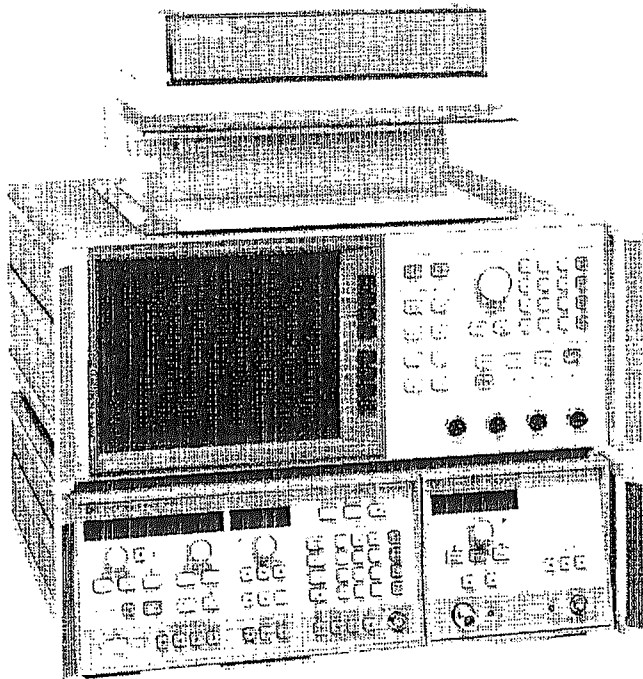
Introduction

This programming note describes the remote operation
of the HP 8757C/E Scalar Network Analyzer with the
HP 9000 Series 200/300 desktop computer used as a
controller. This includes the PC-308, which features an
HP Vectra PC and the HP 82300B HP BASIC Language
Processor Card. Included in this guide are several short
programs that demonstrate the use of the analyzer with
HP-IB commands, and a diagram of system connections
for remote control.

The HP 8757C/E is a fully programmable analyzer capable
of making magnitude-only transmission and reflection
measurements over an RF and microwave frequency range
of 10 MHz to 100 GHz. When used with an HP-IB
computer, the analyzer's front panel may be remotely
controlled, along with most softkey functions and some
functions accessible only via HP-IB. The analyzer exerts
control over a source (HP 8350B or HP 8340B/41B), digital
plotter (HP 7440A or HP 7550A), and printer (HP 2225A
ThinkJet, HP 3630A PaintJet, or HP 2227B QuietJet Plus)
connected to the 8757 SYSTEM INTERFACE.

This note assumes you are familiar with local (non-remote)
operation of the HP 8757C/E. If not, refer to the operating
manual. You should also be familiar with the HP 9000
Series 200/300 computer, particularly HP-IB operation.
Throughout the rest of this document, the term *computer*
refers to any of these computers.

Reference information

The following texts provide additional information on the
HP Interface Bus, the analyzer, the source, or the computer.
See "Replaceable Parts" for ordering information.

HP 8757C/E literature

- *HP 8757C/E Operating Manual.*
- Programming Note: *Quick Reference Guide for the
  HP 8757C/E Scalar Network Analyzer.*

Source literature

- Programming Note: *Introductory Operating Guide for the
  HP 8350B Sweep Oscillator with the HP 9000 Series 200
  Computers (BASIC).*
- Programming Note: *Quick Reference Guide for the HP 8350B
  Sweep Oscillator.*
- Programming Note: *Introductory Operating Guide for the
  HP 8340A Synthesized Sweeper with the HP 9000 Series 200
  Computers (BASIC).*
- Programming Note: *Quick Reference Guide for the HP 8340B
  Synthesized Sweeper.*

HP 9000 series 200/300 computer literature

- BASIC Operating Manual.
- BASIC Programming Techniques.
- BASIC Language Reference.
- BASIC Interfacing Techniques.
- BASIC Graphics Techniques.

General HP-IB literature

- *Condensed Description of the Hewlett-Packard Interface Bus.*
- *Tutorial Description of the Hewlett-Packard Interface Bus.*

Equipment required

1   HP 8757C/E Scalar Network Analyzer.

1   HP 8350B Sweep Oscillator with plug-in or HP 8340B/41B Synthesized Sweeper.

1   HP 9000 Series 200/300 Computer with BASIC extensions 2.0, 2.1, 3.0, 4.0, 5.0, or 5.1 and at least 64K bytes of free user memory.

1   HP 85027A/B/C/D/E Directional Bridge.

1   HP 11664A/E Detector or HP 85025A/B/D/E Detector with connector type to match bridge and test device.

1   Shielded open circuit with connector to mate with bridge.

1   Short circuit with connector to mate with bridge.

3   HP 11170C BNC cables, 122 cm (48 in.). (4 are needed with HP 8340B/41B).
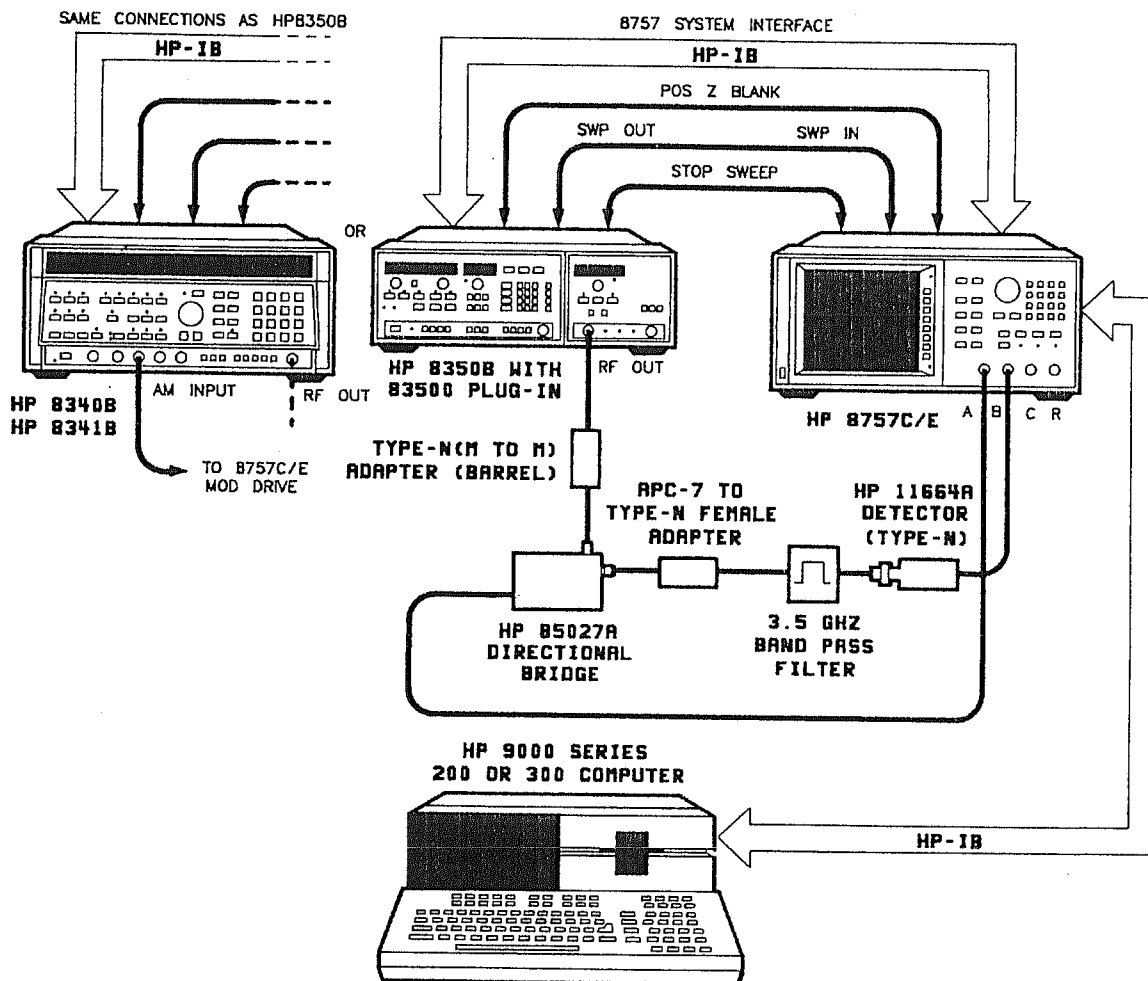
2   HP 10833A/B/C/D HP-IB cables.

1   Test device.

Figure 1. System Connections

2

Set-up

Connect the instruments as shown in figure 1. The following procedure sets the HP-IB addresses of the instruments to operate properly with the programs contained in this guide.

1. Turn on the HP 8350B Sweep Oscillator. Press **[SHIFT] [LCL]**. The FREQUENCY/TIME display shows the current HP-IB address of the source. If it is not 19, press **[1] [9]** to set the address to 19. The HP 8340B or 8341B Synthesized Sweeper operates the same, although the address is displayed in the right-hand display area.

2. Power on the HP 8757C/E Scalar Network Analyzer. The current HP-IB address is shown in the active entry area of the CRT. If it is not 16, press **[LOCAL]** *[8757]* **[1] [6] [ENT]** to set the address to 16.

3. Insert the BASIC system disk into the disk drive of the computer and turn it on. After a few seconds, the computer displays: BASIC Ready x.x, where "x.x" is the BASIC version number (2.0, 3.0, etc.). If you are using BASIC 3.0, 4.0, or 5.0, you must also load the following binary (BIN) programs: DISC, CS80, HPIB, GRAPH, ERR, and IO, using the LOAD BIN command.

Check out procedure

1. Press **[PRESET]** on the analyzer. If the 8757 SYSTEM INTERFACE is properly connected, and the address of the source correctly set, both the analyzer and the source will perform an instrument preset. If either instrument detects a failure during instrument preset, that instrument displays the error encountered. The operating manual of the source gives instructions to help you interpret the error message. If the analyzer displays an error message, see "In Case of Difficulty."

2. To verify the HP-IB connections made between the analyzer and the computer, perform these steps:

   a. Press **[SHIFT] [PAUSE]** to reset the computer.

   b. Type "REMOTE 716" and press **[EXECUTE]**.

   The R (remote) and L (listen) lights in the analyzer INSTRUMENT STATE area will light. The analyzer has received its HP-IB listen address.

Programming examples

In the following sections, example programs introduce the HP-IB capabilities of the analyzer. Each example program consists of these sections:

1. A description of the functions exercised.

2. The program listing.

3. An explanation of each program line.

4. Detailed instructions for operating the program.

When you finish all of the example programs, you will have a good idea of the power of the HP 8757C/E when used in an automatic system.

1. HP 8757C only.
2. HP 8757C Option 001 only.

Program 1: remote, local, and local lockout

The analyzer may be used with the front panel (local operation) or programmed via HP-IB (remote operation). The programmer of the instrument system has control over the operation of all instruments in the system.

When the computer first addresses an instrument, the instrument is placed in a special remote operating mode, called remote mode. When in remote, the instrument does not respond to its front panel, except for the [LOCAL] key. [LOCAL], when pressed, cancels the remote mode and allows the instrument to be used with its front panel.

The computer can also return the instrument to local operation. To do so, the computer sends a special command that forces the instrument to go to local mode.

Occasionally, the programmer of an automatic system needs to prevent the instrument operator from returning the instrument to local operation (via [LOCAL]). When the local lockout function of the computer is used, the instruments are prevented from exiting remote mode, even when [LOCAL] is pressed.

Frequently, the programmer needs to place the instruments connected to the computer into a known state. When preset, the analyzer defaults to the conditions shown below. The instrument preset function operates the same as the front panel [PRESET] key on the analyzer and the source. When presetting the analyzer and source, send the PRESET command only to the analyzer. The analyzer will preset the source attached to the 8757 SYSTEM INTERFACE.

HP 8757C/E instrument preset conditions

Channels 1 and 2 on. The channel menu appears in the softkey label area of the CRT.

- Measure power A on channel 1.
- Measure power B on channel 2.
- Measure power C[1] (or B[2]) on channel 3.
- Measure power R on channel 4[1].
- Display measurement data in log magnitude format.
- Scale = 20 dB/div.
- Reference level 0 dB for all channels.
- Reference level step size = 20 dB.
- Averaging off.
- Averaging factor = 8.
- Cursor off.
- All labels on.
- Channel 1 as the active channel.
- Modulation drive on.
- Number of points = 401.
- Detector mode set for AC detection.
- Smoothing set for 5.0% of span (off).
- Cursor format = log magnitude.
- Search value = −3 dB[1].
- Adaptive normalization off[1].
- Temperature compensation on.
- Repeat autozero off.

Source

- Instrument preset.
- Sweep time set to 200 ms.
- HP 8350B square wave modulation on.
- HP 8340/41 SHIFT PULSE on; RF Output on.

Plotter

- Abort plot if in progress.
- P1 and P2 scaling points unchanged.
- Selection of plotter pens unchanged.

Printer

- Abort plot if in progress.

Disk drive[1]

- Aborts any data transfers in progess.
- Unit number unchanged.
- Volume number unchanged.
- ASCII or binary mode unchanged.

The following analyzer conditions are not changed during a PRESET (IP) command execution:

- Reference position.
- Trace memory.
- Save/Recall registers.
- HP-IB addresses.
- Request mask.
- Limit lines[1].
- Title.
- Detector offset.
- User-defined plot.
- 8757 System Interface control on/off.
- Repeat autozero timer.
- Display intensity.
- Display colors[1].

Program 1 listing

```
10    ASSIGN @Sna TO 716
20    ABORT 7
30    CLEAR @Sna
40    REMOTE @Sna
50    PAUSE
60    REMOTE @Sna
70    LOCAL LOCKOUT 7
80    PAUSE
90    LOCAL 7
100   PAUSE
110   OUTPUT @Sna;"IP"
120   END
```

Program 1 explanation

Line 10   Assign the address of the HP 8757C/E to an I/O path. This is not required, but it is good programming practice. If you change the address of the instrument later, you only change the address in one place in your program.

Line 20   Abort any HP-IB transfers and reset the computer's HP-IB interface.

Line 30   Clear the analyzer's HP-IB interface.

Line 40   Set the analyzer and source to remote mode.

Line 50   Temporarily stop execution.

Line 60   Set the analyzer and source to remote mode.

Line 70   Lock out the [LOCAL] key of the analyzer and source.

Line 80   Temporarily stop execution.

Line 90   Set the analyzer and source to local mode.

Line 100   Temporarily stop execution.

Line 110   Preset the analyzer and source.

Line 120   End program execution.

Running program 1

1. Press **[SHIFT] [RESET]** on the computer. Type "SCRATCH" and press **[EXECUTE]**. This clears the program memory of the computer.

2. Type in the program.

3. Press **[RUN]** on the computer.

4. When the program stops, the analyzer is in remote mode. You can verify this by observing the lights in the INSTRUMENT STATE area of the analyzer. The R (remote) and L (listen) lights should be on. Try pressing any key on the analyzer (except [LOCAL]). Nothing happens. The source is also in remote mode. Now press **[LOCAL]** and verify that the keys on the analyzer are active. Also, notice the R light went out when you pressed [LOCAL]. The source went into local mode along with the analyzer.

5. Press **[Continue]** on the computer. The analyzer is again in remote mode. This time, however, the [LOCAL] key is locked out. Try pressing **[LOCAL]** and the other keys. None of the keys on the analyzer or the source cause any action.

6. Press **[Continue]** on the computer. All instruments on the HP-IB interface are returned to local mode, including the analyzer and source. To set only the analyzer into local mode, the LOCAL 716 command can be given from the computer. Verify that the R light on the analyzer is off and the REM light on the source is off.

7. Press **[Continue]** on the computer. The analyzer and source are both preset. Note that the computer sent the instrument PRESET command only to the analyzer. The analyzer, in turn, preset the source.

Remember, to preset both the analyzer and the source, you only need to send the instrument PRESET command to the analyzer. Do not send instrument PRESET to the source by way of passthru mode (discussed in program 3).

1. HP 8757C only.
2. HP 8757C Option 001 only.

4

Program 2: controlling the front panel

All front panel keys and most of the softkeys of the analyzer may be programmed remotely via HP-IB. For example, you can program the scale per division, reference level, and reference position for each channel.

Program 2 listing

```
10    ASSIGN @Sna TO 716
20    ABORT 7
30    CLEAR @Sna
40    OUTPUT @Sna;"IP"
50    PAUSE
60    OUTPUT @Sna;"C1C0C2"
70    PAUSE
80    OUTPUT @Sna;"SD10"
90    PAUSE
100   OUTPUT @Sna;"RL-10"
110   PAUSE
120   OUTPUT @Sna;"RP4"
130   PAUSE
140   OUTPUT @Sna;"IA"
150   PAUSE
160   OUTPUT @Sna;"C0C1 SD5; RP4; RL-5"
170   END
```

Program 2 explanation

Line 10   Assign an I/O path to the HP-IB address of the HP 8757C/E.

Line 20   Abort any transfers and clear the HP-IB interface of the computer.

Line 30   Clear the HP-IB interface of the analyzer.

Line 40   Preset the analyzer and the source.

Line 50   Temporarily stop execution.

Line 60   Select channel 1 and turn it off. Turn channel 2 on.

Line 70   Temporarily stop execution.

Line 80   Set the scale per division to 10 dB. No terminator (;) is needed because this is the last command in the statement.

Line 90   Temporarily stop execution.

Line 100   Set the reference level to −10 dBm. Again, note the absence of a terminator (;).

Line 110   Temporarily stop execution.

Line 120   Set the reference position line to the center of the CRT (4th graticule). No terminator is needed because this is the last command on the line.

Line 130   Temporarily stop execution.

Line 140   Program channel 2 to measure reflection (input A) instead of transmission (input B).

Line 150   Temporarily stop execution.

Line 160   Many commands on one line, with terminators. Turn channel 2 off (C2C0) and channel 1 on (C1). Set the scale per division (SD) to 5 dB, the reference position line (RP) to the center of the CRT, and the reference level (RL) to −5 dBm.

Line 170   End execution.

Running program 2

1. Type "SCRATCH" and press [EXECUTE] on the computer. This erases the previous program.

2. Type in this program and press [RUN] on the computer.

3. The computer presets the analyzer and source and pauses. Note the settings of channel 1 and 2, then press [Continue].

4. Channel 1 is turned off. Channel 2 is now the active channel, as you can see from the highlighted box around the channel 2 mode labels on the analyzer CRT. Press [Continue].

5. Channel 2 scale per division is now set to 10 dB. It defaulted to 20 dB/div at preset. Press [Continue].

6. The reference level is set to −10 dBm (it was 0.0 dBm). Press [Continue].

7. The reference position line is set to the center of the CRT (graticule 4). The top of the CRT is graticule 8 and the bottom is graticule 0. Press [Continue].

8. Change the measurement to reflection (input A), instead of transmission (input B). At preset, channel 2 defaults to input B. Press [Continue].

9. In one statement: turn off channel 2, turn on channel 1, set the scale per division to 5 dB, set the reference position line to the center of the CRT, and set the reference level to −5 dBm.

    NOTE: The semicolon (;) terminators are needed after any analyzer command that can have a variable length. Extra terminators never hurt, so use them liberally.

Program 3:   passthru mode

In normal operation, the system source, digital plotter, printer, and disk drive (HP 8757C only) are connected to the 8757 SYSTEM INTERFACE. This connection allows the analyzer to control and extract information from the other parts of the measurement system. To allow you to control the source and plotter with the computer, the analyzer has a built-in PASSTHRU command that takes a command from the computer and passes it on to one of the instruments connected to the 8757 SYSTEM INTERFACE.

To initiate passthru mode, first tell the analyzer which instrument you wish to command by setting the passthru address. Then, to talk (or listen) to that device, address the analyzer's special passthru HP-IB address (which is different from the analyzer's HP-IB address). While in the passthru mode, the analyzer stops updating its CRT and does not respond to its front panel (because it's in remote mode). To remove the analyzer from passthru mode, simply address it via HP-IB. While in passthru mode, do not press [LOCAL] on the analyzer.

The analyzer's passthru address is calculated from its HP-IB address. If the address of the analyzer is even (such as 16 decimal) then the passthru address is the next larger number (17 decimal). If the address of the analyzer is odd (such as 15 decimal), then the passthru address is the next smaller number (14 decimal). Never set the address of the analyzer such that its address conflicts with one of the instruments connected to the 8757 SYSTEM INTERFACE. For instance, if the source is set to 19 decimal, do not set the address of the analyzer to 19.

Data can be sent to or received from any instrument on the 8757 SYSTEM INTERFACE via passthru mode. LOCAL, REMOTE, and TRIGGER HP-IB messages do not pass through the analyzer.

Program 3 listing

```
10    PRINTER IS 1
20    ASSIGN @Sna TO 716
30    ASSIGN @Passthru TO 717
40    ABORT 7
50    CLEAR @Sna
60    OUTPUT @Sna;"IP"
70    OUTPUT @Sna;"PT19"
80    OUTPUT @Passthru;"OPFA"
90    ENTER @Passthru;Min_freq
100   Min_freq=Min_freq/1.E+9
110   OUTPUT @Passthru;"OPFB"
120   ENTER @Passthru;Max_freq
130   Max_freq=Max_freq/1.E+9
140   OUTPUT @Sna
150   PRINT "Frequency limits:";
      Min_freq;"to";Max_freq;"GHz"
160   INPUT "Start frequency (GHz)?",Start_freq
170   INPUT "Stop frequency (GHz)?",Stop_freq
180   OUTPUT @Passthru;"FA";Start_freq;"GZ
      FB";Stop_freq;"GZ"
190   OUTPUT @Sna
200   END
```

Program 3 explanation

Line 10	Direct the printed output to the computer CRT.
Line 20	Assign an I/O path to the address of the analyzer. (This is the analyzer's control address).
Line 30	Assign an I/O path to the analyzer's passthru address. By communicating to this HP-IB address, the computer will control a device connected to the 8757 SYSTEM INTERFACE.
Line 40	Abort any transfers and clear the HP-IB interface of the computer.
Line 50	Clear the HP-IB interface of the analyzer.
Line 60	Preset the analyzer and source.
Line 70	Tell the analyzer which device is controlled through the analyzer's passthru address. In this case, the source (device 19).
Line 80	Send a command to the source. Command it to output its current start frequency.
Line 90	Read the start frequency from the source.
Line 100	Scale the start frequency to display it in GHz.
Line 110	Command the source to output its current stop frequency.
Line 120	Read the stop frequency from the source.
Line 130	Scale the stop frequency to display it in GHz.
Line 140	Exit passthru mode by addressing the analyzer.
Line 150	Print the start and stop frequency.
Line 160	Get the start frequency from the user.
Line 170	Get the stop frequency from the user.
Line 180	Set the start and stop frequency of the source to those given by the user.
Line 190	Exit passthru mode by addressing the analyzer.
Line 200	End program execution.

Running program 3

1. Clear the program memory of the computer and type in the program.

2. Press **[RUN]** on the computer.

3. The computer presets the analyzer and the source, reads the start and stop frequency of the source, and displays it on the CRT of the computer. At preset, the source defaults to the full frequency range of the plug-in. The values read, then, represent the frequency limits of this plug-in. When the computer stops, it displays the prompt:

    `Start frequency (GHz)?`

    Enter a start frequency in the frequency range of the plug-in and press **[Continue]**.

4. The computer displays the prompt:

`Stop frequency (GHz)?`

Enter a stop frequency in the frequency range of the plug-in (but higher than the start frequency) and press **[Continue]**.

5. The computer sets the start and stop frequency of the source to those you entered. The analyzer immediately begins sweeping the frequency range you defined.

6. Try deleting or "commenting out" line 190 in the program. Now, when the program ends, the analyzer shows the message DATA PASSTHROUGH EXECUTING and the display is frozen (not sweeping). To exit passthru mode, type "OUTPUT 716" and press **[EXECUTE]** on the computer. The analyzer displays DATA PASSTHROUGH COMPLETE and begins sweeping.

Points to remember: You must address the analyzer after using passthru mode to return it to normal swept operation. Any command can be sent via passthru mode to any instrument on the 8757 SYSTEM INTERFACE, and any data can be read. Service requests and parallel polls do not pass through the analyzer.

Program 4: cursor operations

To enhance the speed and accuracy of measurements, the analyzer contains a built-in cursor that displays the frequency and magnitude of a trace at any given point. To make measurements even more efficient, the cursor may be set to the maximum or minimum point on the trace simply by pressing a softkey. These cursor functions are available via HP-IB commands.

With a computer, the cursor may be turned on and off, its position (0 to n-1, where n is the number of points per trace) set, its value and position read, and set to the maximum or minimum point on the trace. The cursor functions all apply to the active channel. You have complete control over cursor operations via HP-IB.

Cursor programming is especially useful for measuring parameters like flatness and maximum power, where you are interested in the highest and lowest point on the trace. For measuring parameters such as 3 dB points and other specific points (not a maximum or minimum), it is more efficient to use either the cursor search functions (available on the HP 8757C only) or to read the entire trace and search for the points you need.

Program 4 listing

```
10    PRINTER IS 1
20    Start_freq=.01
30    Stop_freq=20
40    ASSIGN @Sna TO 716
50    ASSIGN @Passthru TO 717
60    ABORT 7
70    CLEAR @Sna
80    OUTPUT @Sna;"IP"
90    OUTPUT @Sna;"PT19"
100   OUTPUT @Passthru;"FA";Start_freq;"GZ
      FB";Stop_freq;"GZ"
110   OUTPUT @Sna;"C2 CXOC"
120   ENTER @Sna;Value,Posn
130   PRINT "Cursor reads ";Value;"dB at position";Posn
140   INPUT "Desired cursor position
      (0..400)?",New_posn
150   OUTPUT @Sna;"SC";INT(New_posn+.5)
160   OUTPUT @Sna;"OC"
170   ENTER @Sna;Value,Posn
180   PRINT "Value at position";Posn;"is ";Value;"dB."
190   INPUT "Cursor frequency (GHz)?",Cur_freq
200   New_posn=400*((Cur_freq-
      Start_freq)/(Stop_freq-Start_freq))
210   OUTPUT @Sna;"SC";INT(New_posn+.5)
220   OUTPUT @Sna;"OC"
230   ENTER @Sna;Value,Posn
240   Cur_freq=Start_freq+(Stop_freq-
      Start_freq)*(Posn/400)
250   PRINT "Cursor reads ";Value;"dB
      at";Cur_freq;"GHz."
260   END
```

Program 4 explanation

Line 10   Direct the printed output to the computer CRT.

Line 20   Define the start frequency of the desired sweep in GHz.

Line 30   Define the stop frequency of the desired sweep in GHz.

Line 40   Assign an I/O path to the address of the analyzer.

Line 50   Assign an I/O path to the passthru address of the analyzer.

Line 60   Abort any transfers and clear the HP-IB interface of the computer.

Line 70   Clear the HP-IB interface of the analyzer.

Line 80   Preset the analyzer and source. This sets the number of points per trace to 401.

Line 90   Tell the analyzer which instrument is controlled through the passthru address (19 is the source).

Line 100 Command the source to set a start frequency of .0 GHz and a stop frequency of 20 GHz.

Line 110 Set the cursor to the maximum point on channel 2 and command the analyzer to output the cursor's value and position.

Line 120   Read the value and position of the cursor.

Line 130   On the computer CRT, print the value and position of the cursor.

Line 140   Get the new cursor position from the user. Input should be between 0 and 400.

Line 150   Set the cursor to the new cursor position chosen by the user. The INT function truncates instead of rounding, so add 0.5 to the cursor position before making it an integer.

Line 160   Command the analyzer to output the cursor's value and position.

Line 170   Read the value and position of the cursor at its new position.

Line 180   Print the cursor's value and position on the computer CRT.

Line 190   Get the new cursor frequency from the user. It must be within the frequency range of the sweep selected.

Line 200   Calculate the position of the cursor from its frequency and the start and stop frequencies of the current measurement.

Line 210   Set the cursor to the desired position.

Line 220   Command the analyzer to output the cursor's value and position.

Line 230   Read the cursor's value and position.

Line 240   Calculate the cursor's actual frequency from its position and the start and stop frequencies of the current measurement. You can easily program other start and stop frequencies by following the example in program 3.

Line 250   On the computer CRT, print the value and actual frequency of the cursor.

Line 260   End program execution.

Running program 4

1. Clear the program memory of the computer and type in the program.

2. Press [RUN] on the computer.

3. The computer turns on both channels and sets channel 1 to reflection (input A) and channel 2 to transmission (input B). The cursor is positioned to the maximum point on the channel 2 trace, and its value and position are read and displayed. At preset, the number of points per trace is 401.

4. The computer displays the prompt:

   Desired cursor position(0..400)?

Type in a number between 0 and 400 and press [Continue]. A position of 0 represents the left side of the analyzer's CRT (lowest frequency) and 400 represents the right side of the CRT (highest frequency). The position is set, and the cursor's value and position are read and printed on the CRT of the computer.

5. The computer stops and displays the prompt:

   Cursor frequency (GHz)?

Enter a frequency within the current start and stop frequencies of the measurement (0.01 to 20 GHz). The nearest cursor position is calculated and set. The cursor's value and position are read, and the actual cursor frequency is calculated from the cursor's position.

Note: The original desired frequency and the actual cursor frequency are usually different. Because there are only 401 possible cursor positions, some frequencies cannot be set exactly.

To use more points per trace when using the HP 8757C, modify line 80 to be "IP SP801" for 801 points. Then modify "400" in lines 140, 200, and 240, to "800".

Program 5:   read a single value

Measurements often require that a single value be read at a CW frequency, particularly when extremely good frequency accuracy and resolution are required.

The analyzer is able to read and send a single reading of any measurement channel, via HP-IB, to the computer. The OUTPUT VALUE (OV) command operates on the active channel and causes the analyzer to send one reading of measurement data. Even when the analyzer is in normalized mode (MEAS-MEM), the OV command sends the measured, not the normalized, data. This command, like the OUTPUT DATA command in program 6, can operate with either ASCII or fast binary formats.

Program 5 listing

```
10    PRINTER IS 1
20    ASSIGN @Sna TO 716
30    ASSIGN @Passthru TO 717
40    ABORT 7
50    CLEAR @Sna
60    OUTPUT @Sna;"IP"
70    OUTPUT @Sna;"PT19"
80    OUTPUT @Sna;"SW0"
90    Freq=2
100   Freq_step=.1
110   OUTPUT @Passthru;"CW";Freq;"GZ
      SF";Freq_step;"GZ"
120   OUTPUT @Sna;"C1IA"
130   FOR I=1 TO 21
140      OUTPUT @Sna;"OV"
150      ENTER @Sna;Value
160      PRINT I;": ",Value;"dB at";Freq;"GHz"
170      OUTPUT @Passthru;"CW; UP"
180      Freq=Freq+Freq_step
190   NEXT I
200   OUTPUT @Passthru;"FA2GZ FB4GZ"
210   OUTPUT @Sna;"SW1"
220   END
```

Program 5 explanation

Line 10   Direct the printed output to the computer CRT.

Line 20   Assign an I/O path to the address of the analyzer.

Line 30   Assign an I/O path to the passthru address of the analyzer.

Line 40   Abort any transfers and clear the HP-IB interface of the computer.

Line 50   Clear the HP-IB interface of the analyzer.

Line 60   Preset the analyzer and source.

Line 70   Tell the analyzer which instrument is controlled through the passthru address (19 is the source).

Line 80   Put the analyzer in non-swept mode. This step is necessary when you read single values. After receiving this command, the analyzer stops updating its display.

Line 90   Define a start frequency for further measurements (in GHz).

Line 100   Define a frequency increment (in GHz).

Line 110   Put the source into CW mode at the start frequency, and set its frequency step size to that of the frequency increment.

Line 120   Command the analyzer to measure reflection (input A) on channel 1. This statement also causes the analyzer to exit passthru mode.

Line 130   Make 21 measurements, at equally spaced CW frequencies.

Line 140   Command the analyzer to send the current reading of channel 1 (the active channel) to the computer. The reading is taken immediately.

Line 150   Read the value. In this instance, no format has been defined so the default format of ASCII is in effect.

Line 160   Print the measurement number, the reading, and the frequency on the computer CRT.

Line 170   Command the source to increment the CW frequency by the step size set earlier (line 90). This is a very fast way of setting a series of equally spaced frequencies.

Line 180   Increment the variable that contains the current frequency. This variable is only used for printing the current frequency at each repetition of the loop.

Line 190   End of the loop.

Line 200   Command the source to sweep from 2 to 4 GHz. The source exits CW mode and returns to start/stop mode.

Line 210   Command the analyzer to return to swept mode. The analyzer again updates the trace information on the CRT. This command also exits passthru mode.

Line 220   End program execution.

Running program 5

1. Clear the program memory of the computer and type in the program.

2. Press [RUN] on the computer.

3. The source frequency is set immediately to 2 GHz and the computer begins reading reflection (input A) on the analyzer and printing the measurements. After 21 readings, the program ends.

Program 6:   trace transfer

One feature that sets the HP 8757C/E apart is its ability to transfer an entire measurement trace to a computer at very high speed. A complete, high-resolution (0.01 dB), 401-point measurement can be sent to the computer in 35 milliseconds (binary format) or 800 milliseconds (ASCII format). Transfer time will be less for fewer points per trace, and greater for more points per trace.

The analyzer gives you complete flexibility when reading measurement traces via HP-IB. You can read from the active channel and you can read the stored memory trace, the current measurement trace, or the normalized trace (measurement-minus-memory). In addition, the memory trace can be written back to the analyzer, allowing you to save and restore calibration traces via HP-IB.

With trace transfer measurements, some frequency resolution is sacrificed for measurement speed. The number of points per trace can be programmed to control the resolution across the frequency range being swept. If you are measuring a device that changes very rapidly with frequency, it is possible to miss very narrowband responses that occur between measurement points if the resolution is low. For these cases, the measurement should be made at a higher resolution. The trace transfer method of measurement is much faster than CW point-by-point measurements.

Program 6 listing

```
10   ASSIGN @Sna TO 716
20   ASSIGN @Fast_sna TO 716;FORMAT OFF
30   ABORT 7
40   CLEAR @Sna
50   OUTPUT @Sna;"IP"
60   DIM Ascii_dat(0:400)
70   INTEGER Bin_dat(0:400)
80   OUTPUT @Sna;"C1IA C2IB"
90   WAIT 1
100  OUTPUT @Sna;"FD0 C1OD"
110  ENTER @Sna;Ascii_dat(*)
120  OUTPUT @Sna;"C1WM";Ascii_dat(*)
130  PAUSE
140  OUTPUT @Sna;"FD1 C2OD"
```

```
150  ENTER @Fast_sna;Bin_dat(*)
160  OUTPUT @Sna USING "#,K";"C2WM"
170  OUTPUT @Fast_sna;Bin_dat(*)
180  PAUSE
190  FOR I=0 TO 400
200     Bin_dat(I)=(I MOD 100)
210  NEXT I
220  OUTPUT @Sna;"C2C0 C1MY"
230  OUTPUT @Sna USING "#,K";"FD1 WM"
240  OUTPUT @Fast_sna;Bin_dat(*)
250  OUTPUT @Sna;"AS"
260  END
```

Program 6 explanation

Line 10 Assign an I/O path to the address of the analyzer.

Line 20 Assign another I/O path to the address of the analyzer, to be used for fast binary transfers.

Line 30 Abort any transfers and clear the HP-IB interface of the computer.

Line 40 Clear the HP-IB interface of the analyzer.

Line 50 Preset the analyzer and the source. This sets the number of points per trace to 401.

Line 60 Dimension an array to hold a trace in ASCII format. An array is 401 elements (0 to 400, inclusive).

Line 70 Dimension an array to hold a trace in binary format. It is also 401 elements.

Line 80 Set channel 1 to reflecion (input A) and channel 2 to transmission (input B).

Line 90 Wait for the source to sweep a few times, to insure the traces contain valid data. When you command the analyzer to output a trace, it responds immediately.

Line 100 Set the format to ASCII and command the analyzer to output the channel 1 measurement trace data.

Line 110 Read the measurement trace. Note the use of an asterisk (*) to designate the entire array.

Line 120 Write the measured trace back to the trace memory of channel 1. Reading the measurement trace and storing it into the memory trace is equivalent to executing the MEAS →MEM function (SM).

Line 130 Temporarily stop program execution.

Line 140 Set the format to binary and command the analyzer to output its channel 2 measurement trace.

Line 150 Enter the measurement trace through the I/O path that suspends formatting. This technique is useful for reading data from the analyzer at the highest possible speed.

Line 160 Command the analyzer to accept the trace into its channel 2 memory. Note the suppression of the normal carriage return/line feed sequence by the "#,K" format. If the cr/lf isn't suppressed, the analyzer assumes the first data point is null.

Line 170 Send the trace to the analyzer, again through the I/O path that suspends formatting.

Line 180 Temporarily stop program execution.

Line 190 Set up a loop for all 401 measurement points read from the analyzer.

Line 200 Calculate an arbitrary function and fill the binary data array. This function has no particular meaning, but represents some special calibration data (such as a short/open average).

Line 210 End of the loop.

Line 220 Turn off channel 2 and command channel 1 to display the trace memory data.

Line 230 Set the format to binary (redundant, but good practice) and command the analyzer to accept the following trace to channel 1 memory. Again, suppress the cr/lf sequence at the end of the line.

Line 240 Write the trace to the memory through the I/O path that suspends formatting.

Line 250 Command the analyzer to autoscale the current display, which is the memory trace just written.

Line 260 End program execution.

Running program 6

1. Clear the program memory of the computer and type in the program.

2. Press [RUN] on the computer.

3. Watching the analyzer CRT, you will see DATA DUMP TO HP-IB when it begins sending trace data to the computer, and DATA DUMP TO TRACE MEMORY when the computer sends the data back. The transfer takes about 800 milliseconds each way (ASCII transfer).

4. Watching the analyzer CRT, press [Continue] on the computer. The computer again reads and writes a trace of data, and the analyzer displays the same messages. The transfer is very fast, about 35 milliseconds each way (binary format).

5. Press [Continue] on the computer. The computer calculates an arbitrary function and sends it to a trace memory of the analyzer, where it is autoscaled and displayed. This function (a sawtooth pattern) has no significance. It represents a special calibration trace, such as a short/open average. With a computer, the analyzer measurement system may be calibrated over several different frequency ranges and changed from one to another very quickly, without re-calibration.

When writing memory traces in ASCII format, be sure to set the analyzer to ratio or single-input measurements before sending the trace. If you wish to transfer a higher resolution trace, modify line 50 to be "IP SP801" for 801 points. Then modify the "400" in lines 60, 70, and 190, to "800".

Program 7:
using the TAKE SWEEP command

To make measurements as quickly and efficiently as possible, it is often necessary to synchronize the source with the analyzer. The TAKE SWEEP command gives the analyzer the ability to command the source to make a specified number of complete sweeps (1 to 255). This command is especially useful when using the trace transfer method of reading data from the analyzer.

To use the TAKE SWEEP command, place the analyzer in non-swept mode (SW0). Then give the TAKE SWEEP command with the number of sweeps desired (TSd). At the end of the specified number of sweeps, the analyzer informs the computer of the completion of this operation by setting a bit in its status byte.

The computer can detect this event in two ways:

- Monitor the status byte continuously until the bit is set (polling).

- Let the analyzer generate a service request (SRQ) and interrupt the computer.

Table 1 is a diagram of the status bytes of the analyzer. It shows all of the bits that can be used to either monitor or interrupt the computer. In this program, bit 4 (decimal value 16) is used to signal operation complete (all of the sweeps specified by the TAKE SWEEP command have been completed.)

When you follow the take sweep command with an output statement, such as OUTPUT DATA (OD), the data is sent immediately, not after the instructed number of sweeps. The two approaches mentioned overcome this by letting us send the data at the end of the specified number of sweeps, not

immediately. A third approach is to use the sweep hold mode (SW2) instead of the non-swept mode (SW0). In this mode the analyzer will prevent any HP-IB operations until the completion of the TAKE SWEEP command.

Program 7 listing

```
10      DIM Ascii_dat(0:400)
20      ASSIGN @Sna TO 716
30      ASSIGN @Passthru TO 717
40      ABORT 7
50      CLEAR @Sna
60      OUTPUT @Sna;"IP"
70      OUTPUT @Sna;"PT19"
80      OUTPUT @Passthru;"ST250MS"
90      OUTPUT @Sna;"C2C0 IB"
100     OUTPUT @Sna;"SW0 CS RM16"
110     OUTPUT @Sna;"TS10"
120     Stat=SPOLL(@Sna)
130     IF BIT(Stat,4)=0 THEN 120
140     OUTPUT @Sna;"C1OD"
150     ENTER @Sna;Ascii_dat(*)
160     OUTPUT @Sna;"SW1"
170     PAUSE
180     OUTPUT @Sna;"SW0 CS RM16"
190     ON INTR 7 GOTO Srq_recv
200     ENABLE INTR 7;2
210     OUTPUT @Sna;"TS10"
220     GOTO 220
230     Srq_recv: !
240     Stat=SPOLL(@Sna)
250     OUTPUT @Sna;"RM0"
260     OUTPUT @Sna;"C1OD"
270     ENTER @Sna;Ascii_dat(*)
280     OUTPUT @Sna;"SW1"
290     END
```

Table 1.   HP 8757C/E Status Byte Descriptions

STATUS BYTE (#1)							
BIT #	7	6	5	4	3	2	1	0
Decimal Value	128	64	32	16	8	4	2	1
Function	N/A	Request Service (SRQ)	SRQ on HP-IB Syntax Error	SRQ on Operation Complete (Sweep, Plot or Print)	SRQ on Softkey Only Pressed	SRQ on Change in Extended Status Byte	SRQ on Numeric Entry Completed (HP-IB or Front Panel)	SRQ on Any Front Panel Key Pressed

EXTENDED STATUS BYTE (#2)							
BIT #	7	6	5	4	3	2	1	0
Decimal Value	128	64	32	16	8	4	2	1
Function	N/A	SRQ on Detector Uncal	SRQ on Front Panel Preset or Power-on	SRQ on Limit Test Failed	SRQ on Action Requested not possible	SRQ on Knob Activity	N/A	SRQ on Self Test Failure

Program 7 explanation

Line 10   Dimension an array large enough to hold a trace of data (401 points).

Line 20   Assign an I/O path to the address of the analyzer.

Line 30   Assign an I/O path to the passthru address of the analyzer.

Line 40   Abort any transfers and clear the HP-IB interface of the computer.

Line 50   Clear the HP-IB interface of the analyzer.

Line 60   Preset the analyzer and source.

Line 70   Tell the analyzer which device is controlled through the passthru address. Address 19 belongs to the sweeper.

Line 80   Set the source to 250 milliseconds per sweep.

Line 90   Turn off channel 2 of the analyzer and select transmission (input B) for display on channel 1.

Line 100   Put the analyzer into non-swept mode. Clear the status register of the analyzer. Set the request mask to 16 (bit 4) so that the analyzer will set bit 4 ("operation complete") at the completion of the TAKE SWEEP command. Table 2 has a description of all bits in the status bytes.

Line 110   Command the analyzer to take 10 sweeps.

Line 120   Wait for the 10 sweeps to completed by reading the analyzer status byte.

Line 130   Test the status byte to see if bit 4 is set. If it is, then 10 sweeps have been completed. If bit 4 is not set, then continue to read and test the status byte until it is set.

Line 140   Command the analyzer to output the channel 1 trace data.

Line 150   Read the trace data.

Line 160   Return the analyzer to swept mode. The display now updates continuously.

Line 170   Temporarily stop program execution.

Line 180   Put the analyzer into non-swept mode. Clear the status register of the analyzer. Set the request mask to 16 (bit 4, OPERATION COMPLETE) so that the analyzer will send the computer a service request (SRQ) at the completion of the TAKE SWEEP command. This is the same as in line 100 except we will look for interrupts this time.

Line 190   Define the routine to be executed when the SRQ is received from the analyzer. The label "Srq_recv" is equivalent to line 230.

Line 200   Turn on interrupts in the computer. Specifically, allow an HP-IB service request to interrupt the computer. See the BASIC Language Reference of the computer for more detail about HP-IB programming.

Line 210   Command the analyzer to take 10 sweeps.

Line 220   Wait for the SRQ from the analyzer by putting the computer into a tight loop. If a PAUSE statement were used, the computer would not respond to interrupts.

Line 230   The computer begins execution here after receiving the SRQ from the analyzer.

Line 240   Read the status byte of the analyzer. This action clears the SRQ flag of the analyzer.

Line 250   Disable interrupt generation from the analyzer.

Line 260   Command the analyzer to output the channel 1 data trace.

Line 270   Read the channel 1 trace.

Line 280   Return the analyzer to swept mode. The analyzer display begins updating continuously.

Line 290   End of execution.

Running program 7

1. Clear the program memory of the computer and type in the program.

2. Press [RUN] on the computer.

3. The computer first presets the analyzer and source. It then sets the source to 250 milliseconds per sweep, and sets the analyzer to display transmission on channel 1.

4. The computer commands the analyzer to take 10 sweeps and polls the analyzer status byte to determine when they were completed. The computer reads a trace from the analyzer. Just before the trace is sent, you should see the display "freeze" as the TAKE SWEEP command is completed.

5. Press [Continue], and the computer again tells the analyzer to take 10 sweeps. This time the computer receives an interrupt after the last sweep. The computer sits in a loop (line 220) and waits until the analyzer signals completion of the TAKE SWEEP command. In this segment of the program, you should not see the display "freeze" at all. Immediately after it receives the interrupt, the computer puts the analyzer back into swept mode. This method of sensing the end of a TAKE SWEEP command via an interrupt is more time-efficient than the polling method previously used because the computer can be doing something else during the 10 sweeps.

To use the sweep hold mode, modify line 100 to "SW2" and delete lines 120 and 130. The program will wait at line 140 until the 10 sweeps are completed. Whenever practical, use the service request interrupt to sense the end of a TAKE SWEEP command. In fact, you can use the time to do plotting or printing of data, instead of sitting in a loop. Service requests are also useful for other events, as demonstrated by the next program.

12

Program 8:
programming the softkeys

The analyzer has eight screen-labeled softkeys that make your measurements faster and easier. Under HP-IB control, you can re-label the softkeys with any annotation and sense when they are pressed.

Use the softkeys to branch to special measurement programs. By making full use of the softkeys, your automatic system may not need a normal computer keyboard at all, making it as easy to use as a manual instrument.

Program 8 listing

```
10      PRINTER IS 1
20      ASSIGN @Sna TO 716
30      ABORT 7
40      CLEAR @Sna
50      OUTPUT @Sna;"IP"
60      OUTPUT @Sna;"CS RM8"
70      ON INTR 7 GOTO Srq_recv
80      OUTPUT @Sna;"WK1 CAL 1"
90      OUTPUT @Sna;"WK2 TEST 1"
100     OUTPUT @Sna;"WK3 CAL 2"
110     OUTPUT @Sna;"WK4 TEST 2"
120     OUTPUT @Sna;"WK8 ABORT"
130 Wait_srq: !
140     ENABLE INTR 7;2
150     GOTO 150
160 Srq_recv: !
170     Stat = SPOLL(@Sna)
180     OUTPUT @Sna;"OK"
190     ENTER @Sna;Key_code
200     SELECT Key_code
210         CASE = 32
220             PRINT "Calibration #1"
230         CASE = 8
240             PRINT "Test #1"
250         CASE = 0
260             PRINT "Calibration #2"
270         CASE = 16
280             PRINT "Test #2"
290         CASE = 41
300             PRINT "Abort measurement"
310             GOTO 360
320         CASE ELSE
330             PRINT "* * * undefined * * *"
340     END SELECT
350     GOTO Wait_srq
360     END
```

Program 8 explanation

Line 10   Direct output to the CRT of the computer.

Line 20   Assign an I/O channel to the address of the analyzer.

Line 30   Abort any transfers and clear the HP-IB interface of the computer.

Line 40   Clear the HP-IB interface of the analyzer.

Line 50   Preset the analyzer and source.

Line 60   Set the request mask to interrupt the computer whenever a softkey is pressed (bit 3). See table 2 for the description of the status bytes.

Line 70   Define the line that the computer will go to whenever it receives an interrupt.

Line 80   Label softkey 1 with "CAL 1". Softkey 1 is the softkey at the top of the CRT.

Line 90   Label softkey 2 with "TEST 1".

Line 100   Label softkey 3 with "CAL 2".

Line 110   Label softkey 4 with "TEST 2".

Line 120   Label softkey 8 with "ABORT".

Line 130   Line label for routine that waits for an interrupt.

Line 140   Turn on the SRQ interrupts in the computer.

Line 150   Wait for the interrupt in a tight loop. If PAUSE were used, the interrupts would not be active.

Line 160   Line label for the routine that services the interrupts.

Line 170   Serial poll the analyzer. Reading the status byte of the analyzer clears the SRQ. The CLEAR STATUS (CS) command could also be used.

Line 180   Command the analyzer to output the key code of the last key pressed.

Line 190   Read the key code.

Line 200   Multi-way branch on key code value.

Line 210   If the key code is 32, then softkey 1 was pressed.

Line 220   Print an appropriate message.

Line 230   If the key code is 8, then softkey 2 was pressed.

Line 240   Print an appropriate message.

Line 250   If the key code is 0, then softkey 3 was pressed.

Line 260   Print an appropriate message.

Line 270   If the key code is 16, then softkey 4 was pressed.

Line 280   Print an appropriate message.

Line 290   If the key code is 41, then softkey 8 was pressed.

Line 300   Print an appropriate message.

Line 310   Exit the program by jumping to the end.

Line 320   If the key code doesn't match any of the preceding codes, another key was pressed. In this case, the key code has to be for softkey 5, 6, or 7 (key codes 14, 38, or 40) since these are the only other keys that can interrupt the computer.

Line 330   Print an appropriate message.

Line 340   End of multi-way branch.

Line 350 Re-enter the program at the "Wait_srq" label. At that point, the interrupts are re-enabled and the computer waits for another SRQ.

Line 360 End program execution.

Running program 8

1. Clear the program memory of the computer and type in the program.

2. Press **[RUN]** on the computer.

3. After the computer presets the analyzer and source, it writes the softkey labels on the analyzer CRT. When the first key label is written, the analyzer labels it and blanks the other softkey labels. Since all labels except softkeys 5, 6, and 7 are given new labels, softkeys 5, 6, and 7 remain blank.

4. Press any key on the analyzer except the *[ABORT]* softkey. Pressing a softkey causes a message to be printed on the CRT of the computer. Note that softkeys 5, 6, and 7 generate an interrupt, even though they weren't labeled. No other keys of the analyzer generate an interrupt, because of the SRQ mask specified. Because the analyzer is in remote mode, nothing is changed by pressing its keys.

5. Press the *[ABORT]* softkey to end program execution.

In this example, the service request mask was set to interrupt the computer whenever a softkey was pressed. Another bit in the mask causes an interrupt to be generated when any key is pressed.

Because the analyzer was left in remote mode, it didn't respond to any keys pressed on its front panel. In some applications it is useful to put the analyzer into local operation, so that it can be controlled from the front panel and still generate interrupts whenever a key is pressed.

Program 9: CRT graphics

For applications requiring diagrams, drawings, or limit lines, the CRT of the analyzer may be written to as if it were a Hewlett-Packard plotter. By defining the analyzer as the plot device used by the computer, you can even use the special plotting statements built into the computer, such as MOVE, DRAW, PEN, AXES, VIEWPORT, etc.

This program draws a connections diagram for a hypothetical test system measuring an amplifier. It will blank the analyzer's standard display containing the graticule, annotation, and softkeys so that we have a blank CRT. Figure 2 shows what the CRT should look like when the program is done. Since the program involves drawing many lines, it will use the BASIC data statement to more efficiently store where to draw lines.

For fast, easy-to-use graphics, the graphics memory of the HP 8757C/E is divided into seven "pages" of 500 words and an eighth page of 4000 words. One vector requires two words. Each of the pages may be selected to receive data, and be turned on and off independently. You can keep different drawings in each of the graphics memory pages and simply turn on the drawing you need by turning on the appropriate page. Each page may also be erased independently.

To use the graphics capability of the HP 8757C/E, first define the passthru address to be one digit less than the analyzer's control address. If the analyzer's address is 16, its graphics address is 15. To the computer, the CRT of the analyzer looks like a plotter connected to the 8757 SYSTEM INTERFACE.

CONNECTION DIAGRAM

Figure 2.   The CRT Graphics Display

14
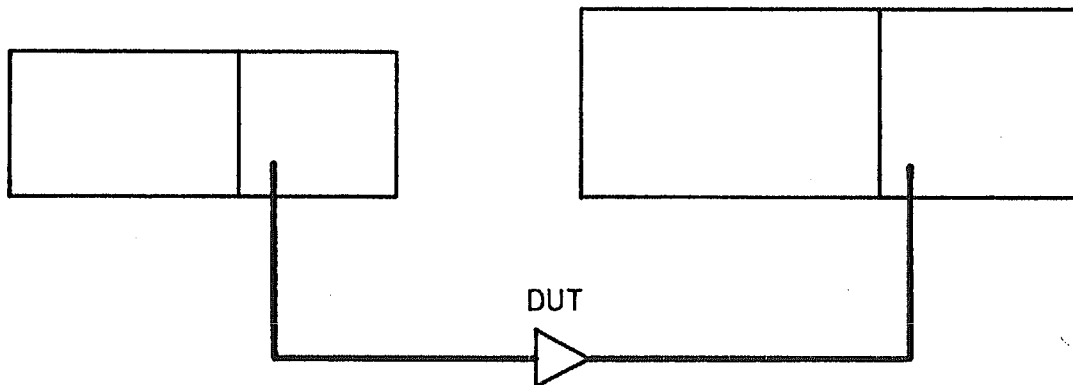
Program 9 listing

```
10        ASSIGN @Sna TO 716
20        ASSIGN @Passthru TO 717
30        ABORT 7
40        CLEAR @Sna
50        OUTPUT @Sna;"IP BL5 PT15"
60        GINIT
70        PLOTTER IS 717,"HPGL"
80        WINDOW 0,2924,0,2047
90        CLIP 0,2900,0,2000
100       OUTPUT @Passthru;"EP; GP1,1; DF"
110       PEN 9
120       GRID 100,100
130       PEN 10
140       RESTORE Graphix
150       REPEAT
160          READ Pen_mode$,X,Y
170          SELECT Pen_mode$
180             CASE "D"
190                DRAW X,Y
200             CASE "M"
210                MOVE X,Y
220             END SELECT
230          UNTIL Pen_mode$ = "E"
240       MOVE 600,1600
250       OUTPUT @Passthru USING "K";"SI0.28,0.34;
          LBCONNECTION DIAGRAM";CHR$(3)
260       MOVE 1200,250
270       LABEL "DUT"
280    Graphix: !
290       DATA "M",300,800,"D",1100,800,"D",1100,1100,
          "D",300,1100
300       DATA "D",300,800,"M",800,800,"D",800,1100
310       DATA
          "M",1500,800,"D",2300,800,"D",2300,1200,
          "D",1500,1200
320       DATA "D",1500,800,"M",1950,800,
          "D",1950,1200
330       DATA "M",875,850,"D",875,500,"D",1200,500
340       DATA "M",1400,500,"D",2050,500,"D",2050,850
350       DATA "M",1200,400,"D",1400,500,"D",1200,
          600,"D",1200,400
360       DATA "E",0,0
370       END
```

Program 9 explanation

Line 10   Assign an I/O path to the address of the analyzer.

Line 20   Assign an I/O path to the passthru address of the analyzer.

Line 30   Abort any transfers and clear the HP-IB interface of the computer.

Line 40   Clear the HP-IB interface of the analyzer.

Line 50   Preset the analyzer and blank the CRT display. Define the CRT graphics as the target of passthru commands. The graphics address is always one less than the analyzer's HP-IB address.

Line 60   Initialize the graphics. This sets a default line type, scale, and clipping limits in the computer.

Line 70   Define the analyzer CRT as the plot device and tell the computer that it is an HP-GL (Hewlett-Packard Graphics Language) device.

Line 80   Scale the plotting area to the entire CRT. The numbers are the corners of the CRT (the CRT is described in the *Operating Reference*.)

Line 90   Define the soft clip area to maintain a clean display.

Line 100   Erase all graphics pages. Turn on graphics page 1 to ensure that the graphics start in it. Set the display to monochrome default colors.

Line 110   Select to plot with pen 9, the lowest intensity for the analyzer CRT.

Line 120   Plot a grid on the CRT. These are 100 by 100 graphic units per square, giving you an indication of where the X and Y coordinates are on the CRT.

Line 130   Select to plot with pen 10, the brightest intensity for the analyzer CRT.

Line 140   Define where to start looking for data. Here we've indicated that the data starts at the line label "Graphix", which is line 280. This ensures that we always start at the right data statement.

Line 150   Define the beginning of a loop.

Line 160   Read three items from the data statement. "Pen_mode$" is a one character string indicating whether we should move (M), draw (D), or end (E) the plotting. X and Y are the plotting coordinates.

Line 170   Multi-way branch on the "Pen_mode$" value.

Line 180   If "Pen_mode$" is "D", then we want to draw.

Line 190   Draw to coordinates X,Y.

Line 200   If "Pen_mode$" is "M", then we want to move.

Line 210   Move to coordinates X,Y.

Line 220   End of multi-way branch.

Line 230   End of the repeat loop. Repeat lines 160 through 220 again if "Pen_mode$" isn't "E". If it was, then we are done plotting the data in the data statements.

Line 240   Move the pen to title our display.

Line 250   Title the display with the label "CONNECTION DIAGRAM". This shows one way to label the analyzer display by using its internal character set. To do this, we must first specify which set to use via the SI command. This specifies the width and height respectively of each character and is similar to the computer's CSIZE instruction. We indicate what the label is with the LB command and follow it with the label. We must terminate the label with an "end-of-text" (ETX) character (a byte equal to a binary 3.)

Line 260   Move the pen to label our device under test (DUT).

Line 270   Label the DUT using the computer's LABEL statement. Notice the difference between this label and the one generated in line 250. First, the intensity is less. Second, the characters look more round and smooth. This is because the computer generates each character by plotting several small strokes (more than the HP 8757C/E's internal CRT does for its characters.) This means that you will also use much more graphics memory than with the internal character set.

Line 280   Define the start of the data statements containing our plotting information for all of the lines on the CRT. While these may be less legible than lots of MOVEs and DRAWs, it is more efficient programming.

Line 290   This data statement draws the outline of the source.

Line 300   This data statement draws the RF plug-in.

Line 310   This data statement draws the outline of the analyzer.

Line 320   This data statement draws the CRT of the analyzer.

Line 330   This data statement draws the connections from the source to the DUT.

Line 340   This data statement draws the connections from the DUT to the analyzer.

Line 350   This data statement draws the DUT (an amplifier.)

Line 360   This data statement indicates the end of our plotting. The X and Y values are needed here only for the read statement in line 160.

Line 370   End program execution.

Running program 9

1. Clear the program memory of the computer and type in the program.

2. Press [RUN] on the computer.

3. After the analyzer and source are preset, the CRT will be blanked. First a grid is plotted on the CRT. While this isn't necessary for our connection diagram, it does give you a good indication of where the X and Y coordinates are on the analyzer's CRT.

4. All of the lines are plotted on the analyzer's CRT. These are just a sequence of MOVEs and DRAWs as specified by the data statements. If brighter lines are desired, draw each line twice.

5. Finally the labeling is added. The label "CONNECTION DIAGRAM" is done using the analyzer CRT's internal character set. The "DUT" label uses the computer's character set. The significant differences are that while using the computer's LABEL statement is easier, it also takes a lot more graphics memory than the internal character set. This can become very important is you have several labels or want to have several hookup diagrams.

In this example, only graphics page 1 is used. You can independently control up to 7 separate pages of graphics information. If you write too much information into one page, it overflows into the next page.

When a graphics page is selected, the the first location of memory that receives information (identified by the "pointer") is reset to the beginning of the page. Thus, as information is written into the page, the old information is destroyed. If we were plotting a line, this would appear as a new trace overwriting an old one.

Program 10:
learning the instrument state

Being able to save a specific instrument state is helpful when it is needed several times in a test or measurement procedure. You can save the instrument state by manually logging the important analyzer and sweeper parameters, such as start/stop frequency, sweep time, number of trace points, scale per division, and display format, then re-input them at the appropriate time. A simpler approach is to save the instrument state in one of the nine internal save/recall registers of the analyzer/source combination, then recall it when needed.

You have two additional options with HP-IB: the interrogate function and the learn string. With the output interrogated parameter function (OP), you can selectively interrogate the values of all functions that have numeric values (such as frequency and number of trace points.) This function operates the same in both the analyzer and the source. It is illustrated in program 3 where the source start and stop frequencies are interrogated in lines 80 through 130.

For a more thorough approach, use the learn string functions of the analyzer and source. Learn string describes the present instrument state and is similar to one of the internal save/recall registers. For the analyzer, the learn string also includes all of the global parameters, but does not include limit line information. Once an instrument state is learned, the analyzer and source states can be restored at any later time. The following program demonstrates how to both learn and restore the instrument states of the HP 8757C/E and the HP 8350B Sweep Oscillator by using their learn string functions. If you use the HP 8340B or 8341B Synthesized Sweepers, perform the modification described at the end of "Program 10 Explanation".

Program 10 listing

```
10      OPTION BASE 1
20      DIM Lswpr$[90],Lsna$[150]
30      ASSIGN @Sna TO 716
40      ASSIGN @Passthru TO 717
50      ABORT 7
60      CLEAR @Sna
70      OUTPUT @Sna;"PT19;"
80      LOCAL @Sna
90      INPUT "SET UP SYSTEM, PRESS
        CONTINUE",A$
100     OUTPUT @Sna;"OL"
110     ENTER @Sna USING "#,150A";Lsna$
120     OUTPUT @Passthru;"OL"
130     ENTER @Passthru USING "#,90A";Lswpr$
140     OUTPUT @Sna;"IP"
150     INPUT "TO RESTORE SETUP, PRESS
        CONTINUE",A$
160     OUTPUT @Sna USING "2A,150A";"IL",Lsna$
170     OUTPUT @Passthru USING
        "2A,90A";"IL",Lswpr$
180     OUTPUT @Sna
190     LOCAL @Sna
200     END
```

Program 10 explanation

Line 10   Define the first element of any array to be at index number 1.

Line 20   Dimension two strings large enough to hold the learn strings of the source (90 bytes) and the analyzer (150 bytes).

Line 30   Assign an I/O path to the address of the analyzer.

Line 40   Assign an I/O path to the passthru address of the analyzer.

Line 50   Abort any transfers and clear the HP-IB interface of the computer.

Line 60   Clear the HP-IB interface of the analyzer.

Line 70   Tell the analyzer which device is controlled through the passthru address. Address 19 belongs to the source.

Line 80   Set the analyzer and source to local mode.

Line 90   Prompt the user to set up the system and wait for the Continue key press.

Line 100   Program the analyzer to output its learn string.

Line 110   Read the analyzer learn string into the string "Lsna$". Notice the "#,150A" format. The analyzer learn string is 150 contiguous binary bytes that does not end with a cr/lf (since these could actually be part of the learn string information). The computer must read all 150 bytes and this format ensures that it will.

Line 120   Program the source to output its learn string.

Line 130   Read the source learn string into the string "Lswpr$". Notice the "#,90A" format. As on line 110, the computer must read the entire source learn string. For the HP 8350B Sweep Oscillator, it is 90 bytes long.

Line 140   Preset the analyzer and source to clear the instrument states.

Line 150   Prompt the user and wait for the [Continue] key press.

Line 160   Program the analyzer to accept its learn string, then send the learn string. Notice the "2A,150A" format ensures that the IL command and the 150 bytes of the learn string are sent continuously. The HP 8757C/E expects the learn string to start immediately after the IL command.

Line 170   Program the source to accept its learn string, then send the learn string. Notice the "2A,90A" format. As on line 160, this ensures that the source learn string is sent properly.

Line 180   Re-address the analyzer to exit passthru mode and continue sweeping.

Line 190   Set the analyzer and source to local mode.

Line 200   End of execution.

Running program 10

1. Clear the program memory of the computer and type in the program.

2. Press [RUN] on the computer.

3. The computer stops and displays:

    SET UP SYSTEM, PRESS CONTINUE.

    Adjust the analyzer and source to a preferred instrument state, then press [Continue] on the computer.

4. The computer will save the learn strings of both the analyzer and the source. After completing this, the analyzer and source will be preset to destroy your original instrument state.

5. The computer stops and displays:

    TO RESTORE SETUP, PRESS CONTINUE.

    Press [Continue] on the computer. The computer will restore your original instrument state via the two learn strings. Verify on the displays of the analyzer and the source that your instrument state has been restored.

This example is designed to work with the HP 8350B Sweep Oscillator, which has a learn string of 90 bytes. The program can be easily modified to work with the HP 8340B and 8341B Synthesized Sweepers which have learn strings 123 bytes in length. To do this, change the "90" in lines 20, 130, and 170 to "123".

Program 11: CRT graphics on the HP 8757C

As was illustrated by program 9, it is possible to utilize the CRT of the HP 8757C/E as a plotter. This program goes one step further by utilizing the CRT to create a simple connection diagram which can be recalled by the user, at any time, from the front panel of the analyzer.

This program draws the same hypothetical connection diagram as was drawn by program 9. It blanks most of the analyzer's standard display including the graticle and all annotation except the softkeys. In addition it adds one softkey under both the save and the recall hardkey menus. This softkey will allow the user to toggle the state of the CRT graphics off and on.

To use the graphics off/on capability of the analyzer, simply change "BL5" in line 50 of program 9 to "BLA" and make the necessary changes in the size of the background grid. These changes are illustrated in the following listing.

The same principle may be used to save to disk anything stored in the first seven pages of user graphics on the analyzer. By having the softkeys available, the user can store CRT graphics onto a disk for later recall.

Program 11 listing

```
10      ASSIGN @SNA TO 716
20      ASSIGN @PASSTHRU to 717
30      ABORT 7
40      CLEAR @Sna
50      OUTPUT @Sna;"IP BLA PT15"
60      GINIT
70      PLOTTER IS 717,"HPGL"
80      WINDOW 0,2924,0,2047
90      CLIP 0,2700,0,2000
100     OUTPUT @Passthru;"EP; GP1,1;DF"
110     PEN 9
120     GRID 100,100
130     PEN 10
140     RESTORE Graphix
150     REPEAT
160         READ Pen_mode$,X,Y
170         SELECT Pen_mode$
180             CASE "D"
190                 DRAW X,Y
200             CASE "M"
210                 MOVE X,Y
220         END SELECT
230     UNTIL Pen_mode$="E"
240     MOVE 600,1600
250     OUTPUT @Passthru USING
        "K";"SI0.28,0.34;LBCONNECTION
        DIAGRAM";CHR$(3)
260     MOVE 1200,250
270     LABEL "DUT"
280     LOCAL 7
290  Graphix: !
300     DATA "M",300,800,"D",1100,800,
        "D",1100,1100,"D",300,1100
310     DATA "D",300,800,"M",800,800,"D",800,1100
320     DATA "M",1500,800,"D",2300,800,
        "D",2300,1200,"D",1500,1200
330     DATA "D",1500,800,"M",1950,800,
        "D",1950,1200
340     DATA "M",875,850,"D",875,500,"D",1200,500
350     DATA "M",1400,500,"D",2050,500,"D",2050,850
360     DATA "M",1200,400,"D",1400,500,
        "D",1200,600,"D",1200,400
370     DATA "E",0,0
380     END
```

Program 11 explanation

Line 10   Assign an I/O path to the address of the analyzer.

Line 20   Assign an I/O path to the passthru address of the analyzer.

Line 30   Abort any transfers and clear the HP-IB interface of the computer.

Line 40   Clear the HP-IB interface of the analyzer.

Line 50   Preset the analyzer and blank all the CRT display except the softkeys. Define the CRT graphics as the target of passthru commands. The graphics address is always one less than the analyzer's HP-IB address.

Line 60   Initialize the graphics. This sets a default line type, scale, and clipping limits in the computer.

Line 70   Define the analyzer CRT screen as the plot device and tell the computer that it is an HP-GL (Hewlett-Packard Graphics Language) device.

Line 80   Scale the plotting area to the CRT screen, allowing space for the softkeys. The numbers are the corners of the CRT, as described in the *HP 8757C/E Operating Manual*.

Line 90   Define the soft clip area to maintain a clean display.

Line 100   Erase all graphics pages. Turn on graphics page 1 on to ensure that the graphics start there.

Line 110   Select to plot with pen 3, the lowest intensity for the analyzer CRT.

Line 120   Plot a grid on the CRT. These are 100 by 100 squares, giving you an indication of where the X and Y coordinates are on the CRT.

Line 130   Select to plot with pen 1, the brightest intensity for the analyzer CRT.

Line 140   Define where to start looking for data. Here we've indicated that the data starts at the line label "Graphix", which is line 280. This ensures that we always start at the right data statement.

Line 150   Define the beginning of a loop.

Line 160   Read three items from the data statement. Pen_mode$ is a one character string indicating whether we should move "M", draw "D", or end "E" the plotting. X and Y are the plot coordinates.

Line 170	Multi-way branch on the Pen_mode$ value.
Line 180	If Pen_mode$ is "D", then we want to draw.
Line 190	Draw to coordinates X,Y.
Line 200	If Pen_mode$ is "M", then we want to move.
Line 210	Move to coordinates X,Y.
Line 220	End of multi-way branch.
Line 230	End of the repeat loop. Repeat lines 160 through 220 again if Pen_mode$ isn't "E". If it was, then we are finished plotting the data in the data statements.
Line 240	Move the pen to title our display.
Line 250	Title the display with the label "CONNECTION DIAGRAM". This shows one way to label the analyzer display by using its internal character set. To do this, we must first specify which set to use via the "SI" command. This specifies the width and height respectively of each character and is similar to the computer's CSIZE instruction. We indicate what the label is with the "LB" command and follow it with the label. We must terminate the label with an "end-of-text" (ETX) character — a byte equal to a binary 3.
Line 260	Move the pen to label our device under test (DUT).
Line 270	Label the DUT using the computer's LABEL statement. Notice the difference between this label and the one generated in line 250. First, the intensity is less. Second, the characters look more round and smooth. This is because the computer generates each character by plotting several small strokes (more than the HP 8757C/E's internal CRT does for its characters). This means that you will also use much more graphics memory than with the internal character set.
Line 280	Set the analyzer and the source to local mode.
Line 290	Define the start of the data statements containing our plotting information for all of the lines on the CRT. While these may be less legible than lots of MOVEs and DRAWs, it is more efficient programming.
Line 300	This data statement draws the outline of the sweeper.
Line 310	This data statement draws the plug-in in the sweeper.
Line 320	This data statement draws the outline of the analyzer.
Line 330	This data statement draws the CRT of the analyzer.
Line 340	This data statement draws the connections from the sweeper to the DUT.
Line 350	This data statement draws the connections from the DUT to the analyzer.
Line 360	This data statement draws the DUT (an amplifier.)
Line 370	This data statement indicates the end of our plotting. The X and Y values are needed here only to keep the read statement in line 160 happy.
Line 380	End program execution.

Running program 11

1. Clear the program memory of the computer and type in the program.

2. Press [RUN] on the computer.

3. After the analyzer and source are preset, the CRT will be blanked except the softkeys. First a grid is plotted on the CRT. While this isn't neccessary for our connection diagram, it does give you a good indication of where the X and Y coordinates are on the analyzer's CRT.

4. All of the lines are plotted on the analyzer's CRT. These are just a sequence of MOVEs and DRAWs as specified by the data statements. If brighter lines are desired, draw each line twice, or select different pen numbers.

5. Finally the labeling is added. The label "CONNECTION DIAGRAM" is done using the analyzer CRT's internal character set. The "DUT" label was done using the computer's character set. The key differences are that while using the computer's LABEL statement is easier, it also takes a lot more graphics memory than the internal character set. This can become very important if you have several labels or want to have several hookup diagrams.

Program 12: reading disks from the HP 8757C

In many cases it may be necessary to manipulate data that was saved onto disk with the HP 8757C. This program can be used to read the data files and display the contents of those files on the computer's CRT display. No frequency information is read or displayed.

The CITIFile (Common Instrumentation Transfer and Interchange File) disk format is used on the data disks for the HP 8757C. This program reads in a single array of data from a CITIFile data disk. It then outputs the point number and the magnitude associated with that point.

In order to use this program you must have saved either memory or measurement data in files onto a disk with the HP 8757C. In addition this data needs to be stored in ASCII format in order for it to be read by the CITIFile routine.

Program 12 listing

```
10        INTEGER Intvar(1:30),Counter
20        REAL Data_pt(1:1601,1:2,1:1)
30        DIM Filename$[30]
40        LINPUT "Name of file to read? ",Filename$
50        Read_citifile(Filename$,Data_pt(*),Intvar(*))
60        PRINT "POINT #REAL IMAG "
70        FOR Counter=1 TO Intvar(1)
80           PRINT Counter;TAB(10);Data_pt(Counter,1,1);
             TAB(24);Data_pt(Counter,2,1)
90        NEXT Counter
100       PRINT "Printed the data array from file
          ";Filename$;"."
110       PRINT "The file contained an array with
          ";Intvar(1);" data points."
120       END
130       SUB Read_citifile(Filename$,Data_pt(*),INTEGER
          Intvar(*))
140       INTEGER Done,Count1
150       ALLOCATE
          Current_line$[256],Token_found$[32]
160       ASSIGN @Disk TO Filename$
170       Done=0
180       REPEAT
190          ENTER @Disk;Current_line$
200          Current_line$=TRIM$(Current_line$)
210          GOSUB Get_next_token
220          IF (Token_found$<>"") THEN
230             SELECT Token_found$
240             CASE "VAR"
250                FOR Count1=1 TO 2
260                   GOSUB Remove_one_word
270                NEXT Count1
280                Intvar(1)=VAL(Current_line$)
290             CASE "BEGIN"
300                ALLOCATE Dstring$(1:Intvar(1))[30]
310                ENTER @Disk;Dstring$(*)
320                FOR Count1=1 TO Intvar(1)
330                   Data_pt(Count1,1,1)=VAL
                      (Dstring$(Count1))
340                   Data_pt(Count1,2,1)=VAL
                      (Dstring$(Count1)
                      [POS(Dstring$(Count1),",")+1])
350                NEXT Count1
360                Done=1
370             END SELECT
380          END IF
390       UNTIL Done
400       SUBEXIT
410   Get_next_token: !
420       Space_pos=POS(Current_line$," ")
430       IF Space_pos=0 THEN
440          Token_found$=Current_line$
450          Current_line$=""
460       ELSE
470          Token_found$=Current_line$[1,Space_pos-1]
480          GOSUB Remove_one_word
490       END IF
500       RETURN
510   Remove_one_word:Current_line$=TRIM$
          (Current_line$[POS(Current_line$," ")+1])
520       RETURN
530       SUBEND
```

Program 12 Explanation

Line 10	Declare an integer variable and dimension an integer array for use within the program.
Line 20	Dimension a real array for data storage.
Line 30	Dimension and reserve memory for the filename string.
Line 40	Prompt for and, accept alphanumeric input from the keyboard and place it in the "Filename$" string.
Line 50	Call the subprogram that reads the file named via line 40.
Line 60	Setup a header for the printout of data from the array read in by the "Read_citifile" subprogram.
Line 70	Set up a counter to determine the number of points to be printed from the data array. Note that the length of the array is kept in "Intvar(1)". This value is returned from the "Read_citifile" subprogram call.
Line 80	Print the data point, the REAL component, and the IMAGINARY component. For a scalar analyzer the imaginary components are always presumed to be zero. It is illustrative here to point out that the most general means of storing data in all analyzers requires the inclusion of phase as well as magnitude data. This is accomplished by storing the linear REAL and IMAGINARY components of the measurements.
Line 90	Continue printing until the entire data array is completed.
Line 100	Print the name of the file just listed at the end of the listing.
Line 110	Finish the printout by printing the number of data points in the data array.
Line 120	End of the main program.
Line 130	Define a subprogram that can be used to input the data array for the file named by the user. This routine is written to be modular so that it can be easily adapted for use in other programs.
Line 140	Declare the INTEGER variables to be used in the subprogram.
Line 150	Dynamically allocate memory for string variables used in the subprogram.
Line 160	Assign an I/O path name to the mass storage file of interest. In this case it is the filename input by the user.
Line 170	Set the expression "Done" to zero. This will be used to determine if all data has been read into the data array.
Line 180	Define a loop which is repeated until the value for "Done" is greater than zero.

Line 190 Statement used to input data from the file of interest and assign the values entered to a string variable.

Line 200 This function is used to return the string stripped of all leading and trailing ASCII spaces.

Line 210 Call a subprogram used to locate the first word on the line.

Line 220 If the boolean expression within the parenthesis is evaluated as true then the following conditions are tested. In this case the expression can be set true by the "Get_next_token" subprogram.

Line 230 Provide for conditional execution of one of two program statements using the string expression.

Line 240 If the string expression is "VAR", then remove two words from the data array. This is done to locate a piece of data that specifies the length of the array to follow.

Line 250 Begin loop to remove two words.

Line 260 Call to subprogram which removes a word.

Line 270 Continue the loop until two words have been removed.

Line 280 Convert the string expression for the length of the data array into a numeric value that can be used in the program as a counter.

Line 290 If the string expression is "BEGIN" this signifies the beginning of the data array to be input.

Line 300 Dynamically allocate space for the data array to be input.

Line 310 Input the data from the file specified.

Line 320 Begin a loop which converts the data string to numeric data pairs.

Line 330 Convert a REAL data point from the string into a numeric value and store the numeric value in an array.

Line 340 Convert an IMAGINARY data point from the string into a numeric value. The data is listed in pairs, separated by a comma, with the REAL component preceeding the IMAGINARY component.

Line 350 Proceed to the next data pair.

Line 360 After completing input of the data array, set "Done" greater than 0.

Line 370 Finish of the construct which allowed for the conditional execution of one of two cases.

Line 380 Complete IF .... THEN sequence.

Line 390 Check to see that "Done" is greater than 0.

Line 400 This statement is used to return from the subprogram at some point other than the SUBEND statement. It allows for more than one exit from a subprogram.

Line 410 Define a subprogram called by "Read_citifile" to locate the next "token". The tokens of interest to this program are "VAR" and "BEGIN".

Line 420 Locate the position of the next ASCII space within the data string.

Line 430 If the value returned for the position of the next ASCII space is 0, then the ASCII space character doesn't exist in the string being searched.

Line 440 Set the token to whatever is currently in the data string.

Line 450 Set the string to a null character.

Line 460 If the value returned is greater than zero, then perform the following operations.

Line 470 Remove keyword from the string and make it the current token.

Line 480 Increment the pointer along the data string.

Line 490 Complete IF ... THEN sequence.

Line 500 Return from the "Get_next_token" subprogram.

Line 510 Define a subprogram called by "Get_next_token" subprogram. Used to increment the pointer along the data string to the next word.

Line 520 Return from the "Get_next_token" subprogram.

Line 530 End of the "Read_citifile" subprogram.

Running Program 12

1. Clear the program memory of the computer and type in the program.

2. Press [RUN] on the computer.

3. The computer displays the prompt:

   `Name of file to read?`

   At the prompt enter the name of the ASCII data file to be read by the program then press [Continue]. The program will begin reading the file specified and display the data from the disk onto the CRT of the computer in a tabular format.

4. The data will be listed as linear values for both the real and the imaginary components.

Table 2. Alphabetical Listing of HP 8757C/E Programming Codes (1 of 2)

Code	Action	Code	Action
A0	Averaging off	COBd	Brightness adjust, one color[1]
AB	A/B ratio measurement	COCd	Color adjust, one color[1]
AC	A/C ratio measurement[2]	COTd	Tint adjust, one color[1]
AFd	Averaging on and factor d	CR	C/R ratio measurement[2]
ANm	Adaptive Normalization on/off	CS	Clear status bytes
AR	A/R ratio measurement	CTm	Auto system calibration on/off
AS	Autoscale	CUm	Cursor on/off
AZm	Autozero repeat on/off of the DC detectors	CWm	CW mode on/off
AZ2	Autozero the DC detectors once	CX	Cursor to maximum
BA	B/A ratio measurement	DAd	Detector A offset set to d
BC	B/C ratio measurement[2]	DBd	Detector B offset set to d
BL0	Restore CRT to normal mode	DCd	Detector C offset set to d[2]
BL1	Blank frequency labels (secure frequency mode, frequency labels cannot be restored)	DEC	Set default colors[1]
		DFA	Set disk format to ASCII[1]
BL2	Blank all labels	DFB	Set disk format to binary[1]
BL3	Blank active channel trace	DHm	Display Hold on/off of the active channel trace
BL4	Blank softkey labels	DIAd	Set disk HP-IB address[1]
BL5	Blank all (except user CRT graphics)	DIUd	Set disk unit number[1]
BL6	Blank title	DIVd	Set disk volume number[1]
BL7	Blank mode labels	DLF	Delete file from disk[1]
BL8	Blank the active entry area	DM0	All inputs set to DC detection
BL9	Blank the limit lines	DM1	All inputs set to AC detection
BLA	Blank all (except user CRT graphics and softkeys)	DN	Step down (decrement)
		DRd	Detector R offset set to d
BR	B/R ratio measurement	DS0	Display trace data in log magnitude
BTNd	Overall display brightness	DS1	Display trace data in standing wave ratio (SWR) format
BW	Display the search bandwidth on the CRT		
C0	Channel off	ER0	Erase all save/recall registers
C1	Channel 1 on/active	FAs	Start frequency label
C2	Channel 2 on/active	FBs	Stop frequency label
C3	Channel 3 on/active[1]	FD0	Format data ASCII
C4	Channel 4 on/active[1]	FD1	Format data binary (HP BASIC compatible)
CA	C/A ratio measurement[2]	FD2	Format data extended ASCII
CB	C/B ratio measurement[2]	FD3	Format data binary (PC compatible)
CC1	Set channel 1 color[1]	IA	Input A absolute power measurement
CC2	Set channel 2 color[1]	IB	Input B absolute power measurement
CC3	Set channel 3 color[1]	IC	Input C absolute power measurement[2]
CC4	Set channel 4 color[1]	ILs	Input Learn string
CDm	Cursor delta on/off	IND	Initialize disk format[1]
CGL	Set labels color[1]	IP	Instrument preset
CGN	Set background color[1]	IR	Input R absolute power measurement
CGR	Set grid color[1]	IX	External ADC input (AUX) voltage measurement[1]
CGW	Set warning label color[1]		
CL	Perform system configuration of detectors and channels	LE	Erase limit lines for active channel[3]
		LFA	Load instrument information file from disk[1]
CLB	Color list, black[1]	LFC	Load CRT graphics file from disk[1]
CLG	Color list, green[1]	LFD	Load data trace file from disk[1]
CLL	Color list, blue[1]	LFI	Load instrument state file from disk[1]
CLR	Color list, red[1]	LFM	Load memory trace file from disk[1]
CLS	Color list, salmon[1]	LFs	Enter limit test flat line data[3]
CLW	Color list, white[1]	LL	Store lower limit line into memory[3]
CLY	Color list, yellow[1]		
CN	Cursor to minimum		

1. HP 8757C only.
2. HP 8757C Option 001 only (detector C).
3. Limit line functions valid only for channels 1 or 2, HP 8757C only.

Table 2. Alphabetical Listing of HP 8757C/E Programming Codes (2 of 2)

Code	Action	Code	Action
LPs	Enter limit test point data[3]	PR1	Print all to monochrome printer, except softkeys and CRT graphics
LSs	Enter limit test sloped line data[3]		
LTm	Limit line test on/off[3]	PR2	Print tabular display data in monochrome
LU	Store upper limit line into memory[3]	PR3	Print tabular marker/cursor data to external printer
M-	Display normalized data (measurement −memory)		
		PR4	Print all to color printer, except softkeys and CRT graphics[1]
MDm	Modulation on/off		
ME	Display measurement data	PTd	Passthrough address set to d
MM	Display the channel menu(main menu)	R1	R/A ratio measurement
MN	Display normalized data (same as M-)	R2	R/B ratio measurement
MOC	Monochrome display[1]	R3	R/C ratio measurement[2]
MR	Marker (or cursor) to reference line	RCn	Recall register n
MSm	Manual sweep mode on/off	RLd	Reference level set to d
MU0	Display the measurement menu	RMd	Service request mask set to d
MU1	Display the display menu	RPq	Reference position set to vertical division q
MU2	Display the scale menu	RS	Restart averaging
MU3	Display the reference menu	SCd	Set cursor to horizontal position d
MU4	Display the cursor menu	SDd	Scale per division set to d
MU5	Display the average menu	SFA	Store all instrument information to disk in file[1]
MU6	Display the calibration menu	SFC	Store CRT graphics to disk in file[1]
MU7	Display the special menu	SFD	Store data trace to disk in file[1]
MU8	Display the system menu	SFI	Store instrument state to disk in file[1]
MY	Display memory data	SFM	Store memory trace to disk in file[1]
MZ	Manual calibration of DC detectors	SKq	Select softkey q: q = 1 to 8
NSm	Non-standard sweep mode on/off	SL	Cursor search left
OC	Output cursor value	SM	Store measurement into memory
OD	Output trace data	SN	Store normalized data (measurement −memory) into memory
OE1	Output error status of display channel 1		
OE2	Output error status of display channel 2	SOd	Smoothing set to d % of frequency span
OI	Output identity	SPd	Number of points set to d: d = 101, 201, 401, 801, 1601
OK	Output keycode of last key pressed		
OL	Output learn string	SR	Cursor search right
OM	Output memory data	SSd	Cursor search value set to d
ON	Output normalized (measurement −memory) data	STd	Reference level step size set to d
		SUd	Specify custom plot according to d
OPxx	Output interrogated parameter value xx = AF, BW, DA, DB, DC, DR, RL, RP, SD, SL, SO, SP, SR, SS, ST	SVn	Save register n
		SW0	Non-swept mode; non-swept operation
		SW1	Swept mode; normal swept operation
OR	Output rotary knob value (−32768 ≤ value ≤ +32767)	SW2	Sweep hold mode; non-swept mode with HP-IB bus hold off until completion of TSd
OS	Output status bytes	TCm	Continuous Temperature Compensation on/off
OT1m	Control output #1 on/off	TIFs	Title for file[1]
OT2m	Control output #2 on/off	TSd	Take d sweeps, then hold display
OV	Output CW value	UP	Step up (increment)
P1	Plot channel 1 trace on external plotter	WKs	Write softkey label
P2	Plot channel 2 trace on external plotter	WMs	Write to channel memory.
P3	Plot channel 3 trace on external plotter[1]	WTs	Write title, s is an ASCII string of up to 50 characters
P4	Plot channel 4 trace on external plotter[1]		
PA	Plot all on external plotter	XAs	External detector cal vlaue for detector A
PBm	System interface control on/off	XBs	External detector cal value for detector B
PC	Plot labels on external plotter	XCs	External detector cal value for detector C[2]
PD	Plot custom plot	XRs	External detector cal value for detector R
PG	Plot grid on external plotter		

1. HP 8757C only.
2. HP 8757C Option 001 only (detector C).
3. Limit line functions valid only for channels 1 or 2, HP 8757C only.

NOTES: n = decimal integer 1 to 9
  d = variable length numeric
  m = 0 for off/1 for on
  q = unique value
  s = ASCII or binary string

For more information, call
your local HP sales office
listed in your telephone
directory or an HP regional
office listed below for the
location of your nearest sales
office.

United States:
Hewlett-Packard Company
4 Choke Cherry Road
Rockville, MD 20850
(301) 670-4300

Hewlett-Packard Company
5201 Tollview Drive
Rolling Meadows, IL 60008
(312) 255-9800

Hewlett-Packard Company
5161 Lankershim Blvd.
No. Hollywood, CA 91601
(818) 505-5600

Hewlett-Packard Company
2015 South Park Place
Atlanta, GA 30339
(404) 955-1500

Canada:
Hewlett-Packard Ltd.
6877 Goreway Drive
Mississauga, Ontario L4V1M8
(416) 678-9430

Australia/New Zealand:
Hewlett-Packard Australia Ltd.
31-41 Joseph Street,
Blackburn, Victoria 3130
Melbourne, Australia
(03) 895-2895

Europe/Africa/Middle East:
Hewlett-Packard S.A.
Central Mailing Department,
P.O. Box 529
1180 AM Amstelveen,
The Netherlands
(31) 20/547 9999

Far East:
Hewlett-Packard Asia Ltd.
22/F Bond Centre
West Tower
89 Queensway
Central, Hong Kong
(5) 8487777

Japan:
Yokogawa-Hewlett-Packard Ltd.
29-21, Takaido-Higashi 3-chome
Suginami-ku, Tokyo 168
(03) 331-6111

Latin America:
Latin American Region Headquarters
Monte Pelvoux Nbr. 111
Lomas de Chapultepec
11000 Mexico, D.F. Mexico
(905) 596-79-33

**HEWLETT
PACKARD**

HP-IB Programming Note

Introductory Programming Guide
For the HP 8757C/E scalar network analyzer with
the HP Vectra Personal Computer using Microsoft® QuickBASIC 4.0

Introduction

This programming note describes the remote operation of
the HP 8757C/E Scalar Network Analyzer with the
HP Vectra Personal Computer (or IBM compatible using the
HP 82990A HP-IB Command Library and Microsoft
QuickBASIC 4.0. Included in this guide are several short
programs that demonstrate the use of the analyzer with
HP-IB commands, and a diagram of system connections for
remote control.

The HP 8757C/E is a fully programmable analyzer capable
of making magnitude-only transmission and reflection
measurements over an RF and microwave frequency range
of 10 MHz to 100 GHz. When used with an HP-IB
computer, the analyzer's front panel may be remotely
controlled, along with most softkey functions and some
functions accessible only via HP-IB. The analyzer exerts
control over a source (HP 8350B or HP 8340B/41B), digital
plotter (HP 7440A or HP 7550A), and printer (HP 2225A
ThinkJet, HP 3630A PaintJet, or HP 2227B QuietJet Plus)
connected to the 8757 SYSTEM INTERFACE.

This note assumes you are familiar with local (non-remote)
operation of the HP 8757C/E. If not, refer to the operating
manual. You should also be familiar with the HP Vectra
Personal Computer (or compatible), particularly HP-IB
operation using the HP 82990A Command Library.

The following are sample programs included in this guide:

- Program 1: Remote, Local, and Local Lockout.
- Program 2: Controlling the Front Panel.
- Program 3: Passthru Mode.
- Program 4: Cursor Operations.
- Program 5: Read a Single Value.
- Program 6: Trace Transfer.
- Program 7: Using the TAKE SWEEP Command.
- Program 8: Programming the Softkeys.
- Program 9: CRT Graphics.
- Program 10: Learning the Instrument State.
- Program 11: Guided Instrument Setup with CRT
  Graphics.

Reference information

The following texts provide additional information on the
HP Interface Bus, the analyzer, the source, or the
HP Vectra Personal Computer. See "Replaceable Parts" for
ordering information.

HP 8757C/E literature
- *HP 8757C/E Operating Manual*.
- Programming Note: *Quick Reference Guide for the
  HP 8757C/E Scalar Network Analyzer*.

Source literature
- Programming Note: *Quick Reference Guide for the HP 8350B
  Sweep Oscillator*.
- Programming Note: *Quick Reference Guide for the HP 8340B
  Synthesized Sweeper*.

HP Vectra Personal Computer literature
- *HP 82990A HP-IB Command Library Manual*.
- *Microsoft QuickBASIC 4.0: BASIC Language Reference Manual*.
- *Microsoft QuickBASIC 4.0: Learning and Using Microsoft Quick-
  BASIC*.
- *Microsoft QuickBASIC 4.0: Programming in BASIC: Selected
  Topics*.

Equipment required

1	HP 8757C/E Scalar Network Analyzer.
1	HP 8350B Sweep Oscillator with plug-in or HP 8340B/41B Synthesized Sweeper.
1	HP Vectra Personal Computer (or compatible) with Microsoft QuickBASIC 4.0, HP 82990A HP-IB Interface Card, MS-DOS 3.1 or higher, and at least 320K bytes of memory.
1	HP 85027A/B/C/D/E Directional Bridge.
1	HP 11664A/E Detector or HP 85025A/B/D/E Detector with connector type to match bridge and test device.
1	Shielded open circuit with connector to mate with bridge.
1	Short circuit with connector to mate with bridge.
3	HP 11170C BNC cables, 122 cm (48 in.). (4 are needed with HP 8340B/41B).
2	HP 10833A/B/C/D HP-IB cables.
1	Test device.

Figure 1. System Connections

Set-up

Connect the instruments as shown in figure 1. The following procedure sets the HP-IB addresses of the instruments to operate properly with the programs contained in this guide. If the HP 82990A HP-IB interface card is not installed in the HP Vectra PC, follow the instructions in Appendix B of the *HP 82990A HP-IB Command Library Manual* (pages B-6 through B-10) for installation. Before installation, set the interface select code to 3 (see pages B-3 to B-4).

1. Turn on the HP 8350B Sweep Oscillator. Press **[SHIFT] [LCL]**. The FREQUENCY/TIME display shows the current HP-IB address of the source. If it is not 19, press **[1] [9] [GHz]** to set the address to 19. The HP 8340B or 8341B Synthesized Sweeper operates the same, although the address is displayed in the right-hand display area.

2. Power on the HP 8757C/E Scalar Network Analyzer. The current HP-IB address is shown in the active entry area of the CRT. If it is not 16, press **[LOCAL]** *[8757]* **[1] [6] [ENT]** to set the address to 16.

3. Load Microsoft QuickBASIC by typing "QB /L QB4HPIB" at the MS-DOS prompt.

Check out procedure

Press **[PRESET]** on the analyzer. If the 8757 SYSTEM INTERFACE is properly connected, and the address of the source correctly set, both the analyzer and the source will perform an instrument preset. If either instrument detects a failure during instrument preset, that instrument displays the error encountered. The operating manual of the source gives instructions to help you interpret the error message. If the analyzer displays an error message, see "In Case of Difficulty."

This note assumes you are familiar with local (non-remote) operation of the HP 8757C/E. If not, refer to the operating manual. You should also be familiar with the HP Vectra Personal Computer (or compatible), particularly HP-IB operation using the HP 82990A Command Library.

The following are sample programs included in this guide:

- Program 1: Remote, Local, and Local Lockout.
- Program 2: Controlling the Front Panel.
- Program 3: Passthru Mode.
- Program 4: Cursor Operations.
- Program 5: Read a Single Value.
- Program 6: Trace Transfer.
- Program 7: Using the TAKE SWEEP Command.
- Program 8: Programming the Softkeys.
- Program 9: CRT Graphics.
- Program 10: Learning the Instrument State.
- Program 11: Guided Instrument Setup with CRT Graphics.

Reference information

The following texts provide additional information on the HP Interface Bus, the analyzer, the source, or the HP Vectra Personal Computer. See "Replaceable Parts" for ordering information.

Microsoft® is a U.S. registered trademark of Microsoft Corp.

Equipment required

1   HP 8757C/E Scalar Network Analyzer.

1   HP 8350B Sweep Oscillator with plug-in or HP 8340B/41B Synthesized Sweeper.

1   HP Vectra Personal Computer (or compatible) with Microsoft QuickBASIC 4.0, HP 82990A HP-IB Interface Card, MS-DOS 3.1 or higher, and at least 320K bytes of memory.

1   HP 85027A/B/C/D/E Directional Bridge.

1   HP 11664A/E Detector or HP 85025A/B/D/E Detector with connector type to match bridge and test device.

1   Shielded open circuit with connector to mate with bridge.

1   Short circuit with connector to mate with bridge.

3   HP 11170C BNC cables, 122 cm (48 in.). (4 are needed with HP 8340B/41B).

2   HP 10833A/B/C/D HP-IB cables.

1   Test device.

Figure 1. System Connections

Set-up

Connect the instruments as shown in figure 1. The following procedure sets the HP-IB addresses of the instruments to operate properly with the programs contained in this guide. If the HP 82990A HP-IB interface card is not installed in the HP Vectra PC, follow the instructions in Appendix B of the *HP 82990A HP-IB Command Library Manual* (pages B-6 through B-10) for installation. Before installation, set the interface select code to 3 (see pages B-3 to B-4).

1. Turn on the HP 8350B Sweep Oscillator. Press **[SHIFT] [LCL]**. The FREQUENCY/TIME display shows the current HP-IB address of the source. If it is not 19, press **[1] [9] [GHz]** to set the address to 19. The HP 8340B or 8341B Synthesized Sweeper operates the same, although the address is displayed in the right-hand display area.

2. Power on the HP 8757C/E Scalar Network Analyzer. The current HP-IB address is shown in the active entry area of the CRT. If it is not 16, press **[LOCAL]** *[8757]* **[1] [6] [ENT]** to set the address to 16.

3. Load Microsoft QuickBASIC by typing "QB /L QB4HPIB" at the MS-DOS prompt.

Check out procedure

Press **[PRESET]** on the analyzer. If the 8757 SYSTEM INTERFACE is properly connected, and the address of the source correctly set, both the analyzer and the source will perform an instrument preset. If either instrument detects a failure during instrument preset, that instrument displays the error encountered. The operating manual of the source gives instructions to help you interpret the error message. If the analyzer displays an error message, see "In Case of Difficulty."

2

Programming examples

In the following sections, example programs introduce the HP-IB capabilities of the analyzer. Each example program consists of these sections:

1. A description of the functions exercised.

2. The program listing.

3. An explanation of each program line.

4. Detailed instructions for operating the program.

When you finish all of the example programs, you will have a good idea of the power of the HP 8757C/E when used in an automatic system. Note that line numbers aren't required in Microsoft QuickBASIC but are included in the examples for clarity. Each line number represents a complete statement. No hard line returns are used in the statements although they may appear that way (to improve your ability to read the programs).

In normal programs an error checking line should follow every call to a subprogram:

    IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR

This statement may be eliminated if this helps program clarity. During error trapping, if an error occurs, the number corresponding to that error is assigned to the variable PCIB.ERR. PCIB.ERR is compared to NO ERR (=0) and then branches to a HP-IB Command Library subprogram for error handling. A message appears on the computer screen stating the error number and type of error.

Program 1: remote, local, and local lockout

The analyzer may be used with the front panel (local operation) or programmed via HP-IB (remote operation). The programmer of the instrument system has control over the operation of all instruments in the system.

When the computer first addresses an instrument, the instrument is placed in a special remote operating mode, called remote mode. When in remote, the instrument does not respond to its front panel, except for the [LOCAL] key. [LOCAL], when pressed, cancels the remote mode and allows the instrument to be used with its front panel.

The computer can also return the instrument to local operation. To do so, the computer sends a special command that forces the instrument to go to local mode.

Occasionally, the programmer of an automatic system needs to prevent the instrument operator from returning the instrument to local operation (via [LOCAL]). When the local lockout function of the computer is used, the instruments are prevented from exiting remote mode, even when [LOCAL] is pressed.

Frequently, the programmer needs to place the instruments connected to the computer into a known state. When preset, the analyzer defaults to the conditions shown below. The instrument preset function operates the same as the front panel [PRESET] key on the analyzer and the source. When presetting the analyzer and source, send the PRESET command only to the analyzer. The analyzer will preset the source attached to the 8757 SYSTEM INTERFACE.

HP 8757C/E instrument preset conditions

Channels 1 and 2 on. The channel menu appears in the softkey label area of the CRT.

- Measure power A on channel 1.
- Measure power B on channel 2.
- Measure power C[1] (or B[2]) on channel 3.
- Measure power R on channel 4[1].
- Display measurement data in log magnitude format.
- Scale = 20 dB/div.
- Reference level 0 dB for all channels.
- Reference level step size = 20 dB.
- Averaging off.
- Averaging factor = 8.
- Cursor off.
- All labels on.
- Channel 1 as the active channel.
- Modulation drive on.
- Number of points = 401.
- Detector mode set for AC detection.
- Smoothing set for 5.0% of span (off).
- Cursor format = log magnitude.
- Search value = −3 dB[1].
- Adaptive normalization off[1].
- Temperature compensation on.
- Repeat autozero off.

Source

- Instrument preset.
- Sweep time set to 200 ms.
- HP 8350B square wave modulation on.
- HP 8340/41 SHIFT PULSE on; RF Output on.

Plotter

- Abort plot if in progress.
- P1 and P2 scaling points unchanged.
- Selection of plotter pens unchanged.

Printer

- Abort plot if in progress.

---

1. HP 8757C only.
2. HP 8757C Option 001 only.

Disk drive[1]

- Aborts any data transfers in progress.
- Unit number unchanged.
- Volume number unchanged.
- ASCII or binary mode unchanged.

The following analyzer conditions are not changed during a PRESET (IP) command execution:

- Reference position.
- Trace memory.
- Save/Recall registers.
- HP-IB addresses.
- Request mask.
- Limit lines[1].
- Title.
- Detector offset.
- User-defined plot.
- 8757 System Interface control on/off.
- Repeat autozero timer.
- Display intensity.
- Display colors[1].

Program 1 Listing

```
10   REM $INCLUDE: 'QB4SETUP'
20   CLS
30   ISC& = 3
40   Sna& = 316
50   CALL IOTIMEOUT(ISC&, 10!):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
60   CALL IOABORT(ISC&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
70   CALL IOCLEAR(ISC&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
80   CALL IOREMOTE(Sna&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
90   GOSUB PAUSE
100  CALL IOREMOTE(Sna&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
110  CALL IOLLOCKOUT(ISC&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
120  GOSUB PAUSE
130  CALL IOLOCAL(Sna&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
140  GOSUB PAUSE
150  A$ = "IP": CALL IOOUTPUTS(Sna&, A$,
     LEN(A$)):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
160  END
170  PAUSE: DO UNTIL INKEY$ = CHR$(13): LOOP
180  RETURN
```

Program 1 explanation

Line 10 Call the QuickBASIC initialization file "QB4SETUP", which is the setup program for the MS-DOS HP-IB Command Library. This command must appear before the body of the program whenever calls to the HP-IB Command Library are to be made.

Line 20 Clear the computer CRT.

Line 30 Assign the interface select code to a variable. This select code is set on the HP 82990A HP-IB interface card.

Line 40 Assign the address of the HP 8757C/E to a variable.

Line 50 Define a system timeout of 10 seconds. Timeout allows recovery from I/O operations that aren't completed in less than 10 seconds. Perform error trapping.

Line 60 Abort any HP-IB transfers. Perform error trapping.

Line 70 Clear the analyzer's HP-IB interface. Perform error trapping.

Line 80 Set the analyzer and source to remote mode. Perform error trapping.

Line 90 Press [ENTER] to continue.

Line 100 Set the analyzer and source to remote mode. Perform error trapping.

Line 110 Lock out the [LOCAL] key of the analyzer and source. Perform error trapping.

Line 120 Press [ENTER] to continue.

Line 130 Set the analyzer and source to local mode. Perform error trapping.

Line 140 Press [ENTER] to continue. Perform error trapping.

Line 150 Preset the analyzer and source. Perform error trapping.

Line 160 End program execution.

Line 170 Define a subroutine that waits for the [ENTER] key to be pressed.

Line 180 Return from the subroutine.

---

1. HP 8757C only.
2. HP 8757C Option 001 only.

Running program 1

1. Press [ALT] [F] [N] on the computer. This clears the QuickBASIC screen.

2. Type in the program.

3. Press [ALT] [D] [T] to trace the program as it runs. Press [ALT] [R] [S] on the computer to run the program.

4. When the program pauses, the analyzer is in remote mode. You can verify this by observing the lights in the INSTRUMENT STATE area of the analyzer. The R (remote) and L (listen) lights should be on. Try pressing any key on the analyzer (except [LOCAL]). Nothing happens. The source is also in remote mode. Now press [LOCAL] and verify that the keys on the analyzer are active. Also, notice the R light went out when you pressed [LOCAL]. The source went into local mode along with the analyzer.

5. Press [ENTER] on the computer. The analyzer is again in remote mode. This time, however, the [LOCAL] key is locked out. Try pressing [LOCAL] and the other keys. None of the keys on the analyzer or the source cause any action.

6. Press [ENTER] on the computer. All instruments on the HP-IB interface are returned to local mode, including the analyzer and source. Verify that the R light on the analyzer is off and the REM light on the source is off.

7. Press [ENTER] on the computer. The analyzer and source are both preset. Note that the computer sent the instrument PRESET command only to the analyzer. The analyzer, in turn, preset the source.

Remember, to preset both the analyzer and the source, you only need to send the instrument PRESET command to the analyzer. Do not send instrument PRESET to the source by way of passthru mode (discussed in program 3).

Program 2:   controlling the front panel

All front panel keys and most of the softkeys of the analyzer may be programmed remotely via HP-IB. For example, you can program the scale per division, reference level, and reference position for each channel.

Program 2 listing

```
10    REM $INCLUDE: 'QB4SETUP'
20    CLS
30    ISC& = 3
40    Sna& = 316
50    CALL IOTIMEOUT(ISC&, 10!):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
60    CALL IOABORT(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
70    CALL IOCLEAR(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
80    A$ = "IP": GOSUB IOOUTS
90    GOSUB PAUSE
100   A$ = "C1C0C2": GOSUB IOOUTS
110   GOSUB PAUSE
120   A$ = "SD10": GOSUB IOOUTS
130   GOSUB PAUSE
140   A$ = "RL-10": GOSUB IOOUTS
150   GOSUB PAUSE
160   A$ = "RP4": GOSUB IOOUTS
170   GOSUB PAUSE
180   A$ = "IA": GOSUB IOOUTS
190   GOSUB PAUSE
200   A$ = "C0C1 SD5; RP4; RL-5": GOSUB IOOUTS
210   END
220   PAUSE: DO UNTIL INKEY$ = CHR$(13)
230   LOCATE 25, 1: PRINT "Press ENTER to
      continue": LOOP: CLS
240   RETURN
250   IOOUTS: CALL IOOUTPUTS(Sna&, A$, LEN(A$))
260   IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
270   RETURN
```

Program 2 explanation

Line 10   Call the QuickBASIC initialization file "QB4SETUP".

Line 20   Clear the computer CRT.

Line 30   Assign the interface select code to a variable.

Line 40   Assign the HP-IB address of the analyzer to a variable.

Line 50   Define a system timeout of 10 seconds. Perform error trapping.

Line 60   Abort any HP-IB transfers. Perform error trapping.

Line 70   Clear the HP-IB interface of the analyzer. Perform error trapping.

Line 80   Preset the analyzer and source.

Line 90   Press [ENTER] to continue.

Line 100 Select channel 1 and turn it off. Turn on channel 2.

Line 110 Press [ENTER] to continue.

Line 120 Set the scale per division to 10 dB. No terminator (;) is needed because this is the only command in the statement.

Line 130 Press [ENTER] to continue.

Line 140 Set the reference level to −10 dBm. Again, note the absence of a terminator (;).

Line 150 Press [ENTER] to continue.

Line 160 Set the reference position line to the center of the screen (graticule 4). No terminator is needed because this is the only command on the line.

Line 170 Press [ENTER] to continue.

Line 180 Program channel 2 to measure reflection (input A) instead of transmission (input B).

Line 190 Press [ENTER] to continue.

5

Line 200   There are many commands on one line, with terminators. Turn channel 2 off and channel 1 on (C0C1). Set the scale per division (SD) to 5 dB, the reference position line (RP) to the center of the screen, and the reference level (RL) to −5 dBm.

Line 210   End execution.

Line 220   Define a subroutine that waits for the [ENTER] key to be pressed before returning to program execution.

Line 230   Locate and print a prompt on the CRT. Clear the screen if the loop is terminated.

Line 240   Return from the subroutine.

Line 250   Define a subroutine that outputs commands to the analyzer.

Line 260   Perform error trapping.

Line 270   Return from the subroutine.

Running program 2

1. Press [ALT] [R] [N] on the computer. This clears the previous program.

2. Type in this program and press [ALT] [R] [S] on the computer.

3. The computer presets the analyzer and source and pauses. Note the settings of channel 1 and 2, then press [ENTER].

4. Channel 1 is turned off. Channel 2 is now the active channel, as you can see from the highlighted box around the channel 2 mode labels on the analyzer CRT. Press [ENTER].

5. Channel 2 scale per division is now set to 10 dB. It defaulted to 20 dB/div at preset. Press [ENTER].

6. The reference level is set to −10 dBm (it was 0.0 dBm). Press [ENTER].

7. The reference position line is set to the center of the CRT (graticule 4). The top of the CRT is graticule 8 and the bottom is graticule 0. Press [ENTER].

8. Change the measurement to reflection (input A), instead of transmission (input B). At preset, channel 2 defaults to input B. Press [ENTER].

9. In one statement: turn off channel 2, turn on channel 1, set the scale per division to 5 dB, set the reference position line to the center of the CRT, and set the reference level to −5 dBm.

NOTE: The semicolon (;) terminators are needed after any analyzer command that can have a variable length. Extra terminators never hurt, so use them liberally.

Program 3:   passthru mode

In normal operation, the system source, digital plotter, printer, and disk drive (HP 8757C only) are connected to the 8757 SYSTEM INTERFACE. This connection allows the analyzer to control and extract information from the other parts of the measurement system. To allow you to control other instruments with the computer, the analyzer has a built-in PASSTHRU command that takes a command from the computer and passes it on to one of the instruments connected to the 8757 SYSTEM INTERFACE.

To initiate passthru mode, first tell the analyzer which instrument you wish to command by setting the passthru address. Then, to talk (or listen) to that device, address the analyzer's special passthru HP-IB address (which is different from the analyzer's HP-IB address). While in the passthru mode, the analyzer stops updating its CRT and does not respond to its front panel (because it's in remote mode). To remove the analyzer from passthru mode, simply address it via HP-IB. While in passthru mode, do not press [LOCAL] on the analyzer.

The analyzer's passthru address is calculated from its HP-IB address. If the address of the analyzer is even (such as 16 decimal) then the passthru address is the next larger number (17 decimal). If the address of the analyzer is odd (such as 15 decimal), then the passthru address is the next smaller number (14 decimal). Never set the address of the analyzer such that its address conflicts with one of the instruments connected to the 8757 SYSTEM INTERFACE. For instance, if the source is set to 19 decimal, do not set the address of the analyzer to 19.

Data can be sent to or received from any instrument on the 8757 SYSTEM INTERFACE via passthru mode. The IOLOCAL, IOREMOTE, and IOTRIGGER HP-IB messages do not pass through the analyzer.

Program 3 listing

```
10    REM $INCLUDE: 'QB4SETUP'
20    CLS
30    ISC& = 3
40    Sna& = 316
50    Passthru& = 317
60    CALL IOTIMEOUT(ISC&, 10!):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
70    CALL IOABORT(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
80    CALL IOCLEAR(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
90    A$ = "IP": GOSUB IOOUTS
100   A$ = "PT19": GOSUB IOOUTS
110   A$ = "OPFA": GOSUB IOOUTSP
120   CALL IOENTER(Passthru&, Min.freq):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
```

```
130 Min.freq = Min.freq / 1E+09
140 A$ = "OPFB": GOSUB IOOUTSP
150 CALL IOENTER(Passthru&, Max.freq):
    IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
160 Max.freq = Max.freq / 1E+09
170 A$ = "": GOSUB IOOUTS
180 PRINT "Frequency limits:"; Min.freq; "to";
    Max.freq; "GHz"
190 INPUT "Start frequency (GHz)?", Start.freq
200 INPUT "Stop frequency (GHz)?", Stop.freq
210 A$ = "FA" +STR$(Start.freq) +"GZ FB"
    +STR$(Stop.freq) +"GZ": GOSUB IOOUTSP
220 A$ = "": GOSUB IOOUTS
230 END
240 IOOUTS: CALL IOOUTPUTS(Sna&,A$,LEN(A$))
250 IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
260 RETURN
270 IOOUTSP: CALL IOOUTPUTS(Passthru&, A$,
    LEN(A$))
280 IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
290 RETURN
```

Program 3 explanation

Line 10   Call the QuickBASIC initialization file "QB4SETUP".

Line 20   Clear the computer CRT.

Line 30   Assign the interface select code to a variable.

Line 40   Assign the address of the analyzer to a variable. (This is the analyzer's control address).

Line 50   Assign the analyzer's passthru address to a variable. By communicating to this HP-IB address, the computer will control a device connected to the 8757 SYSTEM INTERFACE.

Line 60   Define a system timeout of 10 seconds. Perform error trapping.

Line 70   Abort any HP-IB transfers. Perform error trapping.

Line 80   Clear the HP-IB interface of the analyzer. Perform error trapping.

Line 90   Preset the analyzer and source.

Line 100 Tell the analyzer which device is controlled through the analyzer's passthru address. In this case, the source (device 19).

Line 110 Send a command to the source. Command it to output its current start frequency.

Line 120 Read the start frequency from the source. Perform error trapping.

Line 130 Scale the start frequency to display it in GHz.

Line 140 Command the source to output its current stop frequency.

Line 150 Read the stop frequency from the source. Perform error trapping.

Line 160 Scale the stop frequency to display it in GHz.

Line 170 Exit passthru mode by addressing the analyzer.

Line 180 Print the start and stop frequencies.

Line 190 Get start frequency from user.

Line 200 Get stop frequency from user.

Line 210 Set start and stop frequencies of source to those given by the user.

Line 220 Exit passthru mode by addressing the analyzer.

Line 230 End program execution.

Line 240 Define a subroutine that outputs commands to the analyzer.

Line 250 Perform error trapping.

Line 260 Return from the subroutine.

Line 270 Define a subroutine that outputs commands to the source through the passthru address of the analyzer.

Line 280 Perform error trapping.

Line 290 Return from the subroutine.

Running program 3

1. Clear the computer CRT and type in the program.

2. Press [ALT] [R] [S] on the computer to run the program.

3. The computer presets the analyzer and the source, reads the start and stop frequency of the source, and displays it on the CRT of the computer. At preset, the source defaults to the full frequency range of the plug-in. The values read represent the frequency limits of this plug-in. When the computer stops, it displays the prompt:

   Start frequency (GHz)?

   Enter a start frequency in the frequency range of the plug-in and press [ENTER].

4. The computer displays the prompt:

   Stop frequency (GHz)?

   Enter a stop frequency in the frequency range of the plug-in (but higher than the start frequency) and press [ENTER].

5. The computer sets the start and stop frequency of the source to those you entered. The analyzer immediately begins sweeping the frequency range you defined.

Points to remember: You must address the analyzer after using passthru mode to return it to normal swept operation. Any command can be sent via passthru mode to any instrument on the 8757 SYSTEM INTERFACE, and any data can be read. Service requests and parallel polls do not pass through the analyzer.

Program 4:   cursor operations

To enhance the speed and accuracy of measurements, the analyzer contains a built-in cursor that displays the frequency and magnitude of a trace at any given point. To make measurements even more efficient, the cursor may be set to the maximum or minimum point on the trace simply by pressing a softkey. These cursor functions are available via HP-IB commands.

With a computer, the cursor may be turned on and off, its position (0 to n-1, where n is the number of points per trace) set, its value and position read, and set to the maximum or minimum point on the trace. The cursor functions all apply to the active channel (the channel accessed most recently). You have complete control over cursor operations via HP-IB.

Cursor programming is especially useful for measuring parameters like flatness and maximum power, where you are interested in the highest and lowest point on the trace. For measuring parameters such as 3 dB points and other specific points (not a maximum or minimum), it is more efficient to use either the cursor search functions (available on the HP 8757C only) or to read the entire trace and search for the points you need.

Program 4 listing

```
10    REM $INCLUDE: 'QB4SETUP'
20    CLS
30    Start.freq = 2
40    Stop.freq = 5
50    ISC& = 3
60    Sna& = 316
70    Passthru& = 317
80    CALL IOTIMEOUT(ISC&, 10!):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
90    CALL IOABORT(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
100   CALL IOCLEAR(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
110   A$ = "IP": GOSUB IOOUTS
120   A$ = "PT19": GOSUB IOOUTS
130   A$ = "FA" +STR$(Start.freq) +"GZ FB"
      +STR$(Stop.freq) +"GZ": GOSUB IOOUTSP
140   A$ = "C2 CXOC": GOSUB IOOUTS
150   Max% = 2
160   Actual% = 0
170   DIM Cursor.vals(Max%)
180   CALL IOENTERA(Sna&, SEG Cursor.vals(0),
      Max%, Actual%):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
190   PRINT "Cursor reads "; Cursor.vals(0); "dB
      at position "; Cursor.vals(1)
200   INPUT "Desired cursor position (0..400)?",
      New.posn
210   A$ = "SC" +STR$(INT(New.posn +.5)): GOSUB
      IOOUTS
220   A$ = "OC": GOSUB IOOUTS
230   CALL IOENTERA(Sna&, SEG Cursor.vals(0),
      Max%, Actual%):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
240   PRINT "Value at position"; Cursor.vals(1);
      " is "; Cursor.vals(0); "dB."
250   INPUT "Cursor frequency (GHz)?", Cur.freq
260   New.posn = 400 * ((Cur.freq -Start.freq) /
      (Stop.freq -Start.freq))
270   A$ = "SC" +STR$(INT(New.posn +.5)): GOSUB
      IOOUTS
280   A$ = "OC": GOSUB IOOUTS
290   CALL IOENTERA(Sna&, SEG Cursor.vals(0),
      Max%, Actual%):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
300   Cur.freq = Start.freq +(Stop.freq -
      Start.freq) * (Cursor.vals(1) / 400)
310   PRINT "Cursor reads "; Cursor.vals(0); "dB
      at "; Cur.freq; "GHz."
320   END
330   IOOUTS: CALL IOOUTPUTS(Sna&, A$ LEN(A$))
340   IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
350   RETURN
360   IOOUTSP: CALL IOOUTPUTS(Passthru&, A$,
      LEN(A$))
370   IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
380   RETURN
```

Program 4 explanation

Line 10   Call the QuickBASIC initialization file "QB4SETUP".

Line 20   Clear the computer CRT.

Line 30   Define the start frequency of the desired sweep in GHz.

Line 40   Define the stop frequency of the desired sweep in GHz.

Line 50   Assign the interface select code to a variable.

Line 60   Assign the address of the analyzer to a variable.

Line 70   Assign the passthru address of the analyzer to a variable.

Line 80   Define a timeout of 10 seconds. Perform error trapping.

Line 90   Abort any HP-IB transfers. Perform error trapping.

Line 100   Clear the HP-IB interface of the analyzer. Perform error trapping.

Line 110   Preset the analyzer and source. This sets the number of points per trace to 401.

Line 120   Tell the analyzer which instrument is controlled through the passthru address (19 is the source).

Line 130	Command the source to set a start frequency of 2 GHz and a stop frequency of 5 GHz.
Line 140	Set the cursor to the maximum point on channel 2 and command the analyzer to output the cursor's value and position.
Line 150	Define the maximum number of elements to be read into an array.
Line 160	Define the actual number of elements read.
Line 170	Dimension an array to contain the cursor value and position.
Line 180	Read the value and position of the cursor. Perform error trapping.
Line 190	Print the value and position of the cursor on the computer CRT.
Line 200	Get new cursor position from the user. Input should be between 0 and 400.
Line 210	Set the cursor to the new cursor position chosen by the user.
Line 220	Command the analyzer to output the cursor's value and position.
Line 230	Read the value and position of the cursor at its new position. Perform error trapping.
Line 240	Print the cursor's value and position on the computer CRT.
Line 250	Get new cursor frequency from the user. It must be within the frequency range of the sweep selected.
Line 260	Calculate the position of the cursor from its frequency and the start and stop frequencies of the current measurement.
Line 270	Set the cursor to the desired position.
Line 280	Command the analyzer to output the cursor's value and position.
Line 290	Read the cursor's value and position. Perform error trapping.
Line 300	Calculate the cursor's actual frequency from its position and the start and stop frequencies of the current measurement. You can easily program other start and stop frequencies by following the example in program 3.
Line 310	On the computer CRT, print the value and actual frequency of the cursor.
Line 320	End program execution.
Line 330	Define a subroutine that outputs commands to the analyzer.
Line 340	Perform error trapping.
Line 350	Return from the subroutine.
Line 360	Define a subroutine that outputs commands to the source through the passthru address of the analyzer.
Line 370	Perform error trapping.
Line 380	Return from the subroutine.

Running program 4

1. Clear the computer CRT and type in the program.

2. Press **[ALT] [R] [S]** on the computer.

3. The computer turns on both channels and sets channel 1 to reflection (input A) and channel 2 to transmission (input B). The cursor is positioned to the maximum point on the channel 2 trace and its value and position are read and displayed. At preset, the number of points per trace is 401.

4. The computer displays the prompt:

   `Desired cursor position(0..400)?`

   Type in a number between 0 and 400 and press **[ENTER]**. A position of 0 represents the left side of the analyzer's CRT (lowest frequency) and 400 represents the right side of the CRT (highest frequency). The position is set, and the cursor's value and position is read and printed on the CRT of the computer.

5. The computer stops and displays the prompt:

   `Cursor frequency (GHz)?`

   Enter a frequency within the current start and stop frequencies of the measurement (0.01 to 20 GHz). The nearest cursor position is calculated and set. The value and position of the cursor are read, and the actual cursor frequency is calculated from the cursor's position.

   Note: The original desired frequency and the actual cursor frequency are usually different. Because there are only 401 possible cursor positions, some frequencies cannot be set exactly.

To use more points per trace when using the HP 8757C, modify line 90 to be "IP SP801" for 801 points. Then modify the "400" in lines 180, 240, and 280, to "800".

Program 5: read a single value

Measurements often require that a single value be read at a CW frequency, particularly when extremely good frequency accuracy and resolution are required.

The analyzer is able to read and send a single reading of any measurement channel, via HP-IB, to the computer. The OUTPUT VALUE (OV) command operates on the active channel and causes the analyzer to send one reading of measurement data. Even when the analyzer is in normalized mode (MEAS-MEM), the OV command sends the measured, not the normalized, data.

Program 5 listing

```
10   REM $INCLUDE: 'QB4SETUP'
20   CLS
30   ISC& = 3
40   Sna& = 316
50   Passthru& = 317
60   CALL IOTIMEOUT(ISC&, 10!):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
70   CALL IOABORT(ISC&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
80   CALL IOCLEAR(ISC&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
90   A$ = "IP": GOSUB IOOUTS
100  A$ = "PT19": GOSUB IOOUTS
110  A$ = "SW0": GOSUB IOOUTS
120  Freq = 2
130  Freq.step = .1
140  A$ = "CW" +STR$(Freq) +"GZ SF"
     +STR$(Freq.step) +"GZ": GOSUB IOOUTSP
150  A$ = "C1IA": GOSUB IOOUTS
160  FOR I = 1 TO 21
170    A$ = "OV": GOSUB IOOUTS
180    CALL IOENTER(Sna&, Value):
       IF PCIB.ERR <>NOERR THEN ERROR
       PCIB.BASERR
190    PRINT I; ": ", Value; "dB at"; Freq;
       "GHz"
200    A$ = "CW UP": GOSUB IOOUTSP
210    Freq = Freq +Freq.step
220  NEXT I
230  A$ = "FA2GZ FB4GZ": GOSUB IOOUTSP
240  A$ = "SW1": GOSUB IOOUTS
250  END
260  IOOUTS: CALL IOOUTPUTS(Sna&, A$, LEN(A$))
270  IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
280  RETURN
290  IOOUTSP: CALL IOOUTPUTS(Passthru&, A$,
     LEN(A$))
300  IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
310  RETURN
```

Program 5 explanation

Line 10   Call the QuickBASIC initialization file "QB4SETUP".

Line 20   Clear the computer CRT.

Line 30   Assign the interface select code to a variable.

Line 40   Assign the address of the analyzer to a variable.

Line 50   Assign the passthru address of the analyzer to a variable.

Line 60   Define a system timeout of 10 seconds. Perform error trapping.

Line 70   Abort any HP-IB transfers. Perform error trapping.

Line 80   Clear the HP-IB interface of the analyzer. Perform error trapping.

Line 90   Preset the analyzer and source.

Line 100   Tell the analyzer which instrument is controlled through the passthru address (19 is the source).

Line 110   Put the analyzer in non-swept mode. This step is necessary to read single values. After receiving this command, the analyzer stops updating its display.

Line 120   Define a start frequency for further measurements (in GHz).

Line 130   Define a frequency increment (in GHz).

Line 140   Put the source into CW mode at the start frequency and set its frequency step size to that of the frequency increment.

Line 150   Command the analyzer to measure reflection (input A) on channel 1. This statement also causes the analyzer to exit passthru mode.

Line 160   Make 21 measurements, at equally-spaced CW frequencies.

Line 170   Command the analyzer to send the current reading of channel 1 (the active channel) to the computer. The reading is taken immediately.

Line 180   Read the value. In this instance, no format has been defined so the default format of ASCII is in effect.

Line 190   Print the measurement number, the reading, and the frequency on the computer CRT.

Line 200   Command the source to increment the CW frequency by the step size set earlier (line 110). This is a very fast way of setting a series of equally-spaced frequencies.

Line 210   Increment the variable that contains the current frequency. This variable is only used for printing the current frequency at each iteration of the loop.

Line 220   End of the loop.

Line 230   Command the source to sweep from 2 to 4 GHz. The source exits CW mode and returns to start/stop mode.

Line 240   Command the analyzer to return to swept mode. The analyzer again updates the trace information on the display. This command also exits passthru mode.

Line 250   End program execution.

Line 260   Define a subroutine that outputs commands to the analyzer.

Line 270   Perform error trapping.

Line 280   Return from the subroutine.

Line 290   Define a subroutine that outputs commands to the source through the passthru address of the analyzer.

Line 300   Perform error trapping.

Line 310   Return from the subroutine.

Running program 5

1. Clear the computer CRT and type in the program.

2. Press [ALT] [R] [S] on the computer.

3. The source frequency is set immediately to 2 GHz and the computer begins reading reflection (input A) of the analyzer and printing the measurements. After 21 readings, the program ends.

Program 6:   trace transfer

One feature that sets the HP 8757C/E apart is its ability to transfer an entire measurement trace to a computer at very high speed. A complete, high-resolution (0.01 dB) 401-point measurement can be sent to the computer in 800 milliseconds (ASCII format). Transfer time will be less for fewer points per trace, and greater for more points per trace.

The analyzer gives you complete flexibility when reading measurement traces via HP-IB. You can read from the active channel and you can read the stored memory trace, the current measurement trace, or the normalized trace (measurement-minus-memory). In addition, the memory trace can be written back to the analyzer, allowing you to save and restore calibration traces via HP-IB.

With trace transfer measurements, some frequency resolution is sacrificed for measurement speed. The number of points per trace can be programmed to control the resolution across the frequency range being swept. If you are measuring a device that changes very rapidly with frequency, it is possible to miss very narrowband responses that occur between measurement points if the resolution is low. For these cases, the measurement should be made at a higher resolution. The trace transfer method of measurement is much faster than CW point-by-point measurements.

Program 6 listing

```
10   REM $INCLUDE: 'QB4SETUP'
20   CLS
30   ISC& = 3
40   Sna& = 316
50   CALL IOTIMEOUT(ISC&, 10!):
     IF PCIB.ERR <>NOERR THEN ERROR
     PCIB.BASERR
60   CALL IOABORT(ISC&):
     IF PCIB.ERR <>NOERR THEN ERROR
     PCIB.BASERR
70   CALL IOCLEAR(ISC&):
     IF PCIB.ERR <>NOERR THEN ERROR
     PCIB.BASERR
80   A$ = "IP": CALL IOOUTPUTS(Sna&, A$,
     LEN(A$)):
     IF PCIB.ERR <>NOERR THEN ERROR
     PCIB.BASERR
90   DIM ARRAY1.dat(1 TO 401)
100  DIM ARRAY2.dat(1 TO 401)
110  DAT$ = SPACE$(2 * 401)
120  DAT2$ = SPACE$(8 * 401 +1)
130  TOTAL$ = SPACE$(8 * 401 +1)
140  A$ = "C1IA C2IB": CALL IOOUTPUTS(Sna&,
     A$, LEN(A$)):
     IF PCIB.ERR <>NOERR THEN ERROR
     PCIB.BASERR
150  Start = TIMER
160  Stopped = TIMER
170  DO UNTIL ((Stopped -Start) >5)
180  Stopped = TIMER
190  LOOP
200  A$ = "FDO C2OD": CALL IOOUTPUTS(Sna&,
     A$, LEN(A$)):
     IF PCIB.ERR <>NOERR THEN ERROR
     PCIB.BASERR
210  Max1% = 401
220  Max2% = 2 * Max1%
230  Max8% = 8 * Max1% +1
240  Actual% = 0
250  CALL IOENTERS(Sna&, DAT2$, Max8%,
     Actual%):
     IF PCIB.ERR <>NOERR THEN ERROR
     PCIB.BASERR
260  A$ = "C2WM" +DAT2$: CALL IOOUTPUTS(Sna&,
     A$, LEN(A$)):
     IF PCIB.ERR <>NOERR THEN ERROR
     PCIB.BASERR
270  A$ = "C1CO C2MY": CALL IOOUTPUTS(Sna&,
     A$, LEN(A$)):
     IF PCIB.ERR <>NOERR THEN ERROR
     PCIB.BASERR
280  PARSE0% = 1
290  FOR I% = 1 TO 401
300  PARSE1% = INSTR(PARSE0%, DAT2$, ",")
310  ARRAY1.dat(I%) = VAL(MID$(DAT2$,
     PARSE0%, PARSE1% -PARSE0%))
320  PARSE0% = PARSE1% +1
330  NEXT I%
```

```
340 DO UNTIL INKEY$ = CHR$(13): LOCATE 25, 1
350 PRINT "Press ENTER to continue": LOOP: CLS
360 A$ = "C2C0 C1MY": CALL IOOUTPUTS(Sna&, A$,
    LEN(A$)):
    IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
370 CALL IOMATCH(ISC&, CHR$(10), 0):
    IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
380 Actual% = 0
390 A$ = "FD3 C10D": CALL IOOUTPUTS(Sna&, A$,
    LEN(A$)):
    IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
400 CALL IOENTERS(Sna&, DAT$, Max2%, Actual%):
    IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
410 A$ = "C1WM" +DAT$: CALL IOOUTPUTS(Sna&,
    A$, LEN(A$)):
    IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
420 CALL IOMATCH(ISC&, CHR$(10), 1):
    IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
430 DO UNTIL INKEY$ = CHR$(13): LOCATE 25, 1
440 PRINT "Press ENTER to continue": LOOP: CLS
450 FOR I% = 1 TO Max1%
460 ARRAY2.dat(I%) = (I% MOD 90) -70
470 NEXT I%
480 A$ = "FD0 C2C0 C1MY": CALL IOOUTPUTS(Sna&,
    A$, LEN(A$)):
    IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
490 TOTAL$ = ""
500 FOR I% = 1 TO Max1%
510 TEMP$ = STR$(ARRAY2.dat(I%))
520 TOTAL$ = TOTAL$ +TEMP$ +","
530 NEXT I%
540 A$ = "C1WM" +TOTAL$: CALL IOOUTPUTS(Sna&,
    A$, LEN(A$)):
    IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
550 A$ = "AS": CALL IOOUTPUTS(Sna&, A$,
    LEN(A$)):
    IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
560 END
```

Program 6 explanation

Line 10   Call the QuickBASIC initialization file
           "QB4SETUP".

Line 20   Clear the computer CRT.

Line 30   Assign the interface select code to a variable.

Line 40   Assign the address of the analyzer to a variable.

Line 50   Define a system timeout of 10 seconds. Perform
           error trapping.

Line 60   Abort any HP-IB transfers. Perform error
           trapping.

Line 70   Clear the HP-IB interface of the analyzer.
           Perform error trapping.

Line 80   Preset the analyzer and the source. This sets the
           number of points per trace to 401. Perform error
           trapping.

Line 90   Dimension an array to hold a trace of 401 points.

Line 100   Dimension a second array to hold another 401
           point trace.

Line 110   Set aside a string of 802 spaces. This string will be
           utilized in the binary trace transfer.

Line 120   Set aside a string of 3209 spaces. This string will
           be used when inputing ASCII data from the
           analyzer is performed. For more information
           regarding the number of ASCII digits in each
           trace point refer to the *Quick Reference Guide for the
           HP 8757C/E Scalar Network Analyzer*.

Line 130   Set aside a string of 3209 spaces. This string will
           be used in outputting ASCII data created by this
           program.

Line 140   Set channel 1 to reflection (input A) and channel
           2 to transmission (input B). Perform error
           trapping.

Line 150   Set a start time using the TIMER function in
           QuickBASIC.

Line 160   Set an intial stop time to be compared to the start
           time.

Line 170   Loop until 5 seconds have elapsed from the start
           time.

Line 180   Update the time.

Line 190   End of the 5 second loop

Line 200   Set the format to ASCII and command the
           analyzer to output channel 2 measurement trace
           data. Perform error trapping.

Line 210   Create a variable based on the number of points
           per sweep on the analyzer. By using a variable
           here it helps to make the program easily
           adaptable to different numbers of points per
           trace.

Line 220   Create a variable to be used in the binary trace
           transfer.

Line 230   Create a variable to be used in the string transfer
           of ASCII data.

Line 240   Create a variable to be used in entering strings. It
           is a numeric variable specifying the number of
           elements actually read.

Line 250   Command the computer to input an ASCII string
           from the analyzer. The string is stored in DAT2$.
           Perform error trapping.

Line 260 Write back the data string to the channel 2 memory of the analyzer. Reading the measurement trace and storing it back into trace memory is equivalent to executing the MEAS→MEM function (HP-IB command SM). Perform error trapping.

Line 270 Turn off channel 1 and command channel 2 to display the trace memory data. Perform error trapping.

Line 280 Set up a variable to be used in a parsing the ASCII data string. With the following few statements it is possible to create an ASCII array from the ASCII string DAT2$.

Line 290 Begin parsing the string data into an array of 401 points.

Line 300 Locate and save the position of the first comma within the data string. On each subsequent iteration locate the next comma down the string.

Line 310 Pull the value of the current data within the string and assign it to a unique location within an array.

Line 320 Increment along the array to the next piece of data.

Line 330 Continue until the entire string has been placed in an array.

Line 340 Press [ENTER] to continue.

Line 350 Print a message on the computer's CRT notifying the user that the computer is waiting for a key to be pressed before continuing.

Line 360 Turn channel 2 off and channel 1 on. Command the analyzer to display the trace memory from channel 1. Perform error trapping.

Line 370 Disable character matching for the IOENTERS command. This must be done to be certain that the entire binary string will be read in.

Line 380 Initialize the variable specifying the number of elements actually read into a string.

Line 390 Change the data format to a PC binary format. Command the analyzer to output its data for the channel 1 trace. Perform error trapping.

Line 400 Input the the binary data string for the channel 1 trace. Perform error trapping

Line 410 Write the binary data string back to channel 1 trace memory in the analyzer. Perform error trapping.

Line 420 Enable character matching for the IOENTERS command. Perform error trapping.

Line 430 Press [ENTER] to continue.

Line 440 Print a message on the computer's CRT notifying the user that the computer is waiting for a key to be pressed before continuing.

Line 450 Set up a loop to create 401 measurement points.

Line 460 Calculate some arbitrary function and create an array from the data. This function has no particular meaning, but represents some special calibration data (such as a short/open average).

Line 470 End of the loop.

Line 480 Change the data format to ASCII. Turn channel 2 off. Display channel 1 trace memory. Perform error trapping.

Line 490 Initialize a string to be used in converting the array created above into a data string.

Line 500 Set up a loop to take each value from the array created above and place them into a string.

Line 510 Create a temporary string which contains the immediate value from the array converted into a string.

Line 520 Concentrate the temporary string to the existing string. By using this procedure it is possible to create a string of ASCII data separated by commas.

Line 530 End of the loop.

Line 540 Write to channel 1 memory the string created above. Perform error trapping.

Line 550 Autoscale the display on channel 1. Perform error trapping.

Line 560 End of program execution.

Running program 6

1. Clear the computer CRT and type in the program.

2. Press [ALT] [R] [S] on the computer.

3. Watching the analyzer CRT, you will see DATA DUMP TO HP-IB when it begins sending trace data to the computer, and DATA DUMP TO TRACE MEMORY when the computer sends data back.

4. Watching the analyzer CRT, press [ENTER] on the computer. The computer again reads and writes a trace of data. The analyzer displays the same messages. This time the transfer occurs much more rapidly. A binary transfer takes about 35 milliseconds to be completed while an ASCII trace transfer requires about 800 milliseconds each way.

5. Press [ENTER] on the computer. The computer calculates an arbitrary function and sends it to trace memory of the analyzer, where it is autoscaled and displayed. This function has no significance. It represents a special calibration trace, such as a short/open average. With a computer, the analyzer measurement system can be calibrated over several different frequency ranges and changed from one to another very quickly, with-out recalibration.

If you wish to transfer a higher resolution trace with the HP 8757C, modify line 80 to be "IP SP801" for 801 points. Then modify "401" in lines 90, 100, 110, 120, 130, and 210 to "801".

Program 7:
using the TAKE SWEEP command

To make measurements as quickly and efficiently as possible, it is often necessary to synchronize the source with the analyzer. The TAKE SWEEP command gives the analyzer the ability to command the source to make a specified number of complete sweeps (1 to 255). This command is especially useful when using the trace transfer method of reading data from the analyzer.

To use the TAKE SWEEP command, place the analyzer in non-swept mode (SWO). Then give the TAKE SWEEP command with the number of sweeps desired (TSd). At the end of the specified number of sweeps, the analyzer informs the computer of the completion of this operation by setting a bit in its status byte.

Table 1 is a diagram of the status bytes of the analyzer. It shows all of the bits that can be used to either monitor or interrupt the computer. In this program, bit 4 (decimal value 16) is used to signal "operation complete" (all of the sweeps specified by the TAKE SWEEP command have been completed.) When you follow the TAKE SWEEP command with an output statement, such as OUTPUT DATA (OD), the data is sent immediately, not after the instructed number of sweeps.

Program 7 listing

```
10    REM $INCLUDE: 'QB4SETUP'
20    CLS
30    DIM ASCIIDAT(0 TO 400)
40    ISC& = 3
50    Sna& = 316
60    Passthru& = 317
70    CALL IOTIMEOUT(ISC&, 10!):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
```

```
80    CALL IOABORT(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
90    CALL IOCLEAR(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
100   A$ = "IP": GOSUB IOOUTS
110   A$ = "PT19": GOSUB IOOUTS
120   A$ = "ST250MS": CALL IOOUTPUTS(Passthru&,
      A$, LEN(A$)):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
130   A$ = "C2C0 IB": GOSUB IOOUTS
140   A$ = "SWO CS RM16": GOSUB IOOUTS
150   Stat% = 0
160   A$ = "TS10": GOSUB IOOUTS
170   DO UNTIL ((Stat% MOD 32) >15)
180   CALL IOSPOLL(Sna&, Stat%):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
190   LOOP
200   A$ = "C10D": GOSUB IOOUTS
210   Max% = 401
220   Actual% = 0
230   CALL IOENTERA(Sna&, SEG ASCIIDAT(0), Max%,
      Actual%):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
240   A$ = "SW1": GOSUB IOOUTS
250   END
260   IOOUTS: CALL IOOUTPUTS(Sna&, A$, LEN(A$))
270   IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
280   RETURN
```

Table 1.   HP 8757C/E Status Byte Descriptions

STATUS BYTE (#1)							
BIT #	7	6	5	4	3	2	1	0
Decimal Value	128	64	32	16	8	4	2	1
Function	N/A	Request Service (SRQ)	SRQ on HP-IB Syntax Error	SRQ on Operation Complete (Sweep, Plot or Print)	SRQ on Softkey Only Pressed	SRQ on Change in Extended Status Byte	SRQ on Numeric Entry Completed (HP-IB or Front Panel)	SRQ on Any Front Panel Key Pressed

EXTENDED STATUS BYTE (#2)							
BIT #	7	6	5	4	3	2	1	0
Decimal Value	128	64	32	16	8	4	2	1
Function	N/A	SRQ on Detector Uncal	SRQ on Front Panel Preset or Power-on	SRQ on Limit Test Failed	SRQ on Action Requested not possible	SRQ on Knob Activity	N/A	SRQ on Self Test Failure

Program 7 explanation

Line 10	Call the QuickBASIC initialization file "QB4SETUP".
Line 20	Clear the computer CRT.
Line 30	Dimension an array large enough to hold a trace of data (401 points).
Line 40	Assign the interface select code to a variable.
Line 50	Assign the address of the analyzer to a variable.
Line 60	Assign the passthru address of the analyzer to a variable.
Line 70	Define a system timeout of 10 seconds. Perform error trapping.
Line 80	Abort any HP-IB transfers. Perform error trapping.
Line 90	Clear the HP-IB interface of the analyzer. Perform error trapping.
Line 100	Preset the analyzer and source.
Line 110	Tell the analyzer which device is controlled through the passthru address. Address 19 belongs to the source.
Line 120	Set the source to 250 milliseconds per sweep. Perform error trapping.
Line 130	Turn off channel 2 of the analyzer and select transmission (input B) for display on channel 1.
Line 140	Put the analyzer into non-swept mode. Clear the status register of the analyzer. Set the request mask to 16 (bit 4) so that the analyzer will set bit 4 (operation complete) at the completion of the TAKE SWEEP command. Table 1 has a description of all bits in the status bytes.
Line 150	Assign the status variable initially to zero.
Line 160	Command the analyzer to take 10 sweeps.
Line 170	Wait for the 10 sweeps to completed by testing the status byte to see if bit 4 is set. Remain in the loop until bit 4 is set.
Line 180	Read the analyzer status byte. Perform error trapping.
Line 190	End of the loop.
Line 200	Command the analyzer to output the channel 1 trace data.
Line 210	Define the maximum number of elements to be read into an array.
Line 220	Define the actual number of elements read.
Line 230	Read the trace data. Perform error trapping.
Line 240	Return the analyzer to swept mode. The display now updates continuously.
Line 250	End program execution.
Line 260	Define a subroutine that outputs commands to the analyzer.
Line 270	Perform error trapping.
Line 280	Return from the subroutine.

Running program 7

1. Clear the computer CRT and type in the program.

2. Press [ALT] [R] [S] on the computer.

3. The computer first presets the analyzer and source. It then sets the source to 250 milliseconds per sweep, and sets the analyzer to display transmission on channel 1.

4. The computer commands the analyzer to take 10 sweeps and polls the analyzer status byte to determine when they were completed. The computer reads a trace from the analyzer. Just before the trace is sent, you should see the display "freeze" as the TAKE SWEEP command is completed.

To use the sweep hold mode, modify line 140 to "SW2" and delete lines 130, 150, 170, 180, and 190. The program will wait at line 200 until the 10 sweeps are completed.

Program 8: programming the softkeys

The HP 8757C/E has eight screen-labeled softkeys that make your measurements faster and easier. Under HP-IB control, you can re-label the softkeys with any annotation and sense when they are pressed.

Use the softkeys to branch to special measurement programs. By making full use of the softkeys, your automatic system may not need a normal computer keyboard at all, making it as easy to use as a manual instrument.

Program 8 listing

```
10    REM $INCLUDE: 'QB4SETUP'
20    CLS
30    ISC& = 3
40    Sna& = 316
50    CALL IOTIMEOUT(ISC&, 10!):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
60    CALL IOABORT(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
70    CALL IOCLEAR(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
80    A$ = "IP": GOSUB IOOUTS
90    A$ = "CS RM8": GOSUB IOOUTS
100   A$ = "WK1 CAL1": GOSUB IOOUTS
110   A$ = "WK2 TEST1": GOSUB IOOUTS
120   A$ = "WK3 CAL2": GOSUB IOOUTS
130   A$ = "WK4 TEST2": GOSUB IOOUTS
140   A$ = "WK8 ABORT": GOSUB IOOUTS
150   PRINT "SOFT KEYS LOADED"
160   Wait.srq:
```

```
170     Intr.bit% = 0
180     DO UNTIL ((Intr.bit% MOD 16) >7)
190         CALL IOSPOLL(Sna&, Intr.bit%)
            IF PCIB.ERR <>NOERR THEN ERRR
            PCIB.BASERR
200     LOOP
210 A$ = "OK": GOSUB IOOUTS
220 CALL IOENTER(Sna&, Keycode)
230 SELECT CASE Keycode: CASE 32
240     CLS : LOCATE 12, 29: PRINT
        "Calibration #1"
250     CASE 8
260         CLS : LOCATE 12, 29: PRINT "Test #1"
270     CASE 0
280         CLS : LOCATE 12, 29: PRINT
            "Calibration #2"
290     CASE 16
300         CLS : LOCATE 12, 29: PRINT "Test #2"
310     CASE 41
320         CLS : LOCATE 12, 29: PRINT "Abort":
            GOTO 380
330     CASE ELSE
340         CLS : LOCATE 12, 29: PRINT
            "***Undefined***"
350 END SELECT
360 A$ = "CS": GOSUB IOOUTS
370 GOTO Wait.srq
380 END
390 IOOUTS: CALL IOOUTPUTS(Sna&, A$, LEN(A$))
400 IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
410 RETURN
```

Program 8 explanation

Line 10   Call the QuickBASIC initialization file "QB4SETUP".

Line 20   Clear the computer CRT.

Line 30   Assign the interface select code to a variable.

Line 40   Assign the address of the analyzer to a variable.

Line 50   Define a system timeout of 10 seconds. Perform error trapping.

Line 60   Abort any HP-IB transfers. Perform error trapping.

Line 70   Clear the HP-IB interface of the analyzer. Perform error trapping.

Line 80   Preset the analyzer and source.

Line 90   Set the request mask to 8 (bit 3). See table 1 for the description of the status bytes.

Line 100   Label softkey 1 with "CAL 1". Softkey 1 is the softkey at the top of the CRT.

Line 110   Label softkey 2 with "TEST 1".

Line 120   Label softkey 3 with "CAL 2".

Line 130   Label softkey 4 with "TEST 2".

Line 140   Label softkey 8 with "ABORT".

Line 150   Print a message to the user.

Line 160   Line label for routine that waits for an interrupt.

Line 170   Assign the status variable initially to zero.

Line 180   Wait for a softkey to be pressed by testing the status byte to see if bit 3 is set. Remain in the loop until bit 3 is set.

Line 190   Read the analyzer status byte.

Line 200   End of the loop.

Line 210   Command the analyzer to output the key code of the last key pressed.

Line 220   Read the key code.

Line 230   Multi-way branch on key code value. When lines are labeled with numbers in QuickBASIC, "SELECT CASE ... CASE" for the first case must occur on the same line and be separated by a statement separator. If the key code is 32, then softkey 1 was pressed.

Line 240   Move to row 12, column 29, on the computer CRT and print an appropriate message.

Line 250   If the key code is 8, then softkey 2 was pressed.

Line 260   Move to row 12, column 29, and print an appropriate message.

Line 270   If the key code is 0, then softkey 3 was pressed.

Line 280   Move to row 12, column 29, and print an appropriate message.

Line 290   If the key code is 16, then softkey 4 was pressed.

Line 300   Move to row 12, column 29, and print an appropriate message.

Line 310   If the key code is 41, then softkey 8 was pressed.

Line 320   Move to row 12, column 29, print an appropriate message, and go to the end of the program.

Line 330   If the key code doesn't match any of the preceding codes, another key was pressed. In this case, the key code has to be for softkey 5, 6, or 7 (key codes 14, 38, or 40) since these are the only other keys that can interrupt the computer.

Line 340   Move to row 12, column 29, and print an appropriate message.

Line 350   End of multi-way branch.

Line 360   Command the analyzer to clear the status byte.

Line 370   Re-enter the program at the "Wait.srq" label.

Line 380   End program execution.

Line 390   Define a subroutine that outputs commands to the analyzer.

Line 400   Perform error trapping.

Line 410   Return from the subroutine.

16

Running program 8

1. Clear the computer CRT and type in the program.

2. Press **[ALT] [R] [S]** on the computer.

3. After the computer presets the analyzer and source, it writes the softkey labels on the analyzer CRT. When the first key label is written, the analyzer labels it and blanks the other softkey labels. Since all labels except softkeys 5, 6, and 7 are given new labels, softkeys 5, 6, and 7 remain blank.

4. Press any key on the analyzer. Pressing a softkey causes a message to be printed on the CRT of the computer. Note that soft keys 5, 6, and 7 generate an interrupt, even though they weren't labeled. No other keys of the analyzer generate an interrupt, because of the SRQ mask specified.

Because the analyzer was left in remote mode, it didn't respond to any keys pressed on its front panel. In some applications it is useful to put the analyzer into local operation, so that it can be controlled from the front panel and still generate interrupts whenever a key is pressed.

Program 9: CRT graphics

For applications requiring diagrams, drawings, or special limit lines, the CRT of the analyzer may be used as a plotter.

This program draws a connection diagram for a hypothetical test system measuring an amplifier. It will blank the analyzer's standard display containing the graticule, annotation, and softkeys so that we have a blank CRT. Figure 2 shows what the CRT should look like when the program is done.

For fast, easy-to-use graphics, the graphics memory of the HP 8757C/E is divided into seven "pages" of 500 words. One vector requires two words. Each of the pages may be selected to receive data, and turned on and off independently. You can keep different drawings in each of the graphics memory pages and simply turn on the drawing you need by turning on the appropriate page. Each page may also be erased independently.

To use the graphics capability of the HP 8757C/E, first define the passthru address to be one less than the analyzer's control address. If the analyzer's address is 16, its graphics address is 15. To the computer, the CRT of the analyzer looks like a plotter connected to the 8757 SYSTEM INTERFACE.

CONNECTION DIAGRAM

Figure 2.   The CRT Graphics Display

17
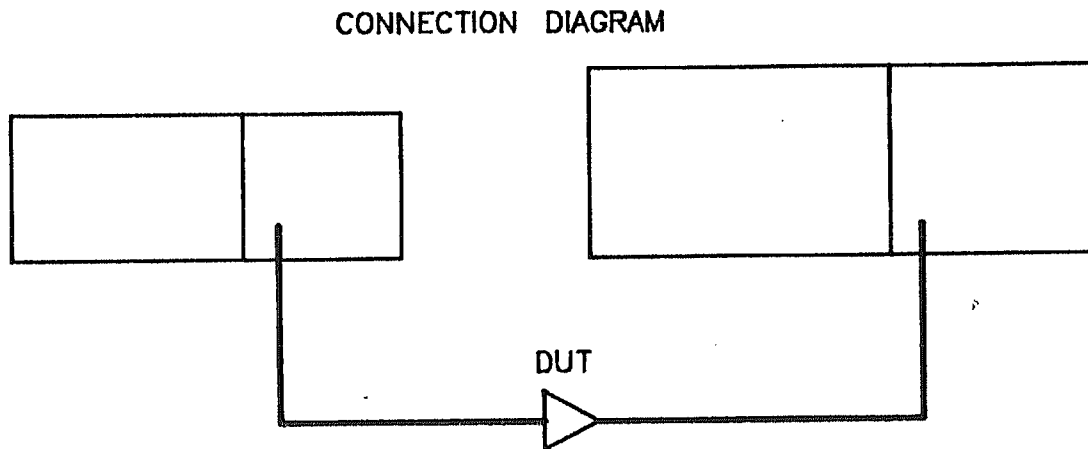
Running program 9

```
10   REM $INCLUDE: 'QB4SETUP'
20   CLS
30   ISC& = 3
40   Sna& = 316
50   Passthru& = 317
60   CALL IOTIMEOUT(ISC&, 10!):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
70   CALL IOABORT(ISC&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
80   CALL IOCLEAR(ISC&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
90   A$ = "IP BL5 PT15": GOSUB IOOUTS
100  A$ = "EP; GP1; DF": GOSUB IOOUTSP
110  A$ = "SP 9": GOSUB IOOUTSP
120  FOR Col = 0 TO 29
130    A$ = "PU;PA " +STR$(Col * 100)
       +",0;PD;PA " +STR$(Col * 100) +",2000;":
       GOSUB IOOUTSP
140  NEXT Col
150  FOR Row = 0 TO 20
160    A$ = "PU;PA 0," +STR$(Row * 100) +";PD;PA
       2900," +STR$(Row * 100) +";": GOSUB
       IOOUTSP
170  NEXT Row
180  A$ = "SP 1": GOSUB IOOUTSP
190  A$ = "PU; PA 600,1600; PD": GOSUB IOOUTSP
200  A$ = "SI0.28,0.34; LBCONNECTION DIAGRAM"
     +CHR$(3): GOSUB IOOUTSP
210  A$ = "PU; PA 1200,250; PD": GOSUB IOOUTSP
220  A$ = "SI0.28,0.34; LBDUT" +CHR$(3): GOSUB
     IOOUTSP
230  A$ = "PU; PA 300,800; PD; PA
     1100,800,1100,1100,300,1100,300,800":
     GOSUB IOOUTSP
240  A$ = "PU; PA 800,800; PD; PA 800,1100":
     GOSUB IOOUTSP
250  A$ = "PU; PA 1500,800; PD; PA
     2300,800,2300,1200,1500,1200,1500,800":
     GOSUB IOOUTSP
260  A$ = "PU; PA 1950,800; PD; PA 1950,1200":
     GOSUB IOOUTSP
270  A$ = "PU; PA 875,850; PD; PA
     875,500,1200,500": GOSUB IOOUTSP
280  A$ = "PU; PA 1400,500; PD; PA
     2050,500,2050,850": GOSUB IOOUTSP
290  A$ = "PU; PA 1200,400; PD; PA
     1400,500,1200,600,1200,400": GOSUB IOOUTSP
300  A$ = "PU; PA 0,0": GOSUB IOOUTSP
310  END
320  IOOUTS: CALL IOOUTPUTS(Sna&, A$, LEN(A$))
330  IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
340  RETURN
350  IOOUTSP: CALL IOOUTPUTS(Passthru&, A$,
     LEN(A$))
360  IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
370  RETURN
```

Program 9 explanation

Line 10	Call the QuickBASIC initialization file "QB4SETUP".
Line 20	Clear the computer CRT.
Line 30	Assign the interface select code to a variable.
Line 40	Assign the address of the analyzer to a variable.
Line 50	Assign the passthru address of the analyzer to a variable.
Line 60	Define a system timeout of 10 seconds. Perform error trapping.
Line 70	Abort any HP-IB transfers. Perform error trapping.
Line 80	Clear the HP-IB interface of the analyzer. Perform error trapping.
Line 90	Preset the analyzer and blank the CRT display. Define the CRT graphics as the target of passthru commands. The graphics address is always one less than the analyzer's HP-IB address.
Line 100	Erase all graphics pages. Turn on graphics page 1 to ensure that the graphics start in it. Set the color selection to default (monochrome) colors.
Line 110	Select to plot with pen 9, the lowest intensity for the analyzer CRT.
Line 120	Repeat a loop 29 times to draw part of the grid.
Line 130	Draw a vertical line down the CRT.
Line 140	End of the loop.
Line 150	Repeat loop 20 times to draw the horizontal part of the grid.
Line 160	Draw a horizontal line across the CRT.
Line 170	End of the loop.
Line 180	Select to plot with pen 1, the brightest intensity for the analyzer CRT.
Line 190	Move the pen to title the display.
Line 200	Specify the width and height of each character, indicate what the title is, terminate the title with an end of text character.
Line 210	Move the pen to label the DUT.
Line 220	Specify the width and height of each character, indicate what the title is, terminate the title with an end of text character.
Line 230	Move the pen and draw the outline of the source.
Line 240	Draw the plug-in of the source.
Line 250	Move the pen and draw the outline of the analyzer.
Line 260	Draw the CRT of the analyzer.

Line 270	Draw the connections from the source to the DUT.
Line 280	Draw the connections from the DUT to the analyzer.
Line 290	Draw the DUT (an amplifier.)
Line 300	Move to the bottom left corner of the CRT.
Line 310	End program execution.
Line 320	Define a subroutine that outputs commands to the analyzer.
Line 330	Perform error trapping.
Line 340	Return from the subroutine.
Line 350	Define a subroutine that addresses the analyzer as a plotter.
Line 360	Perform error trapping.
Line 370	Return from the subroutine.

Running program 9

1. Clear the computer CRT and type in the program.

2. Press [ALT] [R] [S] on the computer.

3. After the analyzer and source are preset, the CRT will be blanked. First a grid is plotted on the CRT. While this isn't necessary for our connection diagram, it does give you a good indication of where the X and Y coordinates are on the analyzer's CRT.

4. The labeling is added. The labels "CONNECTION DIAGRAM" and "DUT" are done using the analyzer CRT's internal character set.

5. All of the lines are plotted on the analyzer's CRT. If brighter lines are desired, draw each line twice or select a different pen number.

In this example, only graphics page 1 is used. You can independently control up to 7 separate pages of graphics information. If you write too much information onto one page, it overflows onto the next page.

When a graphics page is selected, the first location of memory that receives information (identified by the "pointer") is reset to the beginning of the page. Thus, as information is written onto the page, the old information is destroyed. If we were plotting a line, this would appear as a new trace overwriting an old one.

Program 10:
learning the instrument state

Being able to save a specific instrument state is helpful when it is needed several times in a test or measurement procedure. You can save the instrument state by manually logging the important analyzer and source parameters, such as start/stop frequency, sweep time, number of trace points, scale per division, and display format, then replace them at the appropriate time. A simpler approach is to save the instrument state in one of the nine internal save/recall registers of the analyzer/source combination, then recall it when needed.

You have two additional options with HP-IB: the interrogate function and the learn string. With the output interrogated parameter function (OP), you can selectively interrogate the values of all functions that have numeric values (such as frequency and number of trace points). This function operates the same way in both the analyzer and the source. It is illustrated in program 3 where the source start and stop frequencies are interrogated in lines 110 through 140.

For a more thorough approach, use the learn string functions of the analyzer and source. The learn string describes the present instrument state and is similar to one of the internal save/recall registers. For the analyzer, the learn string also includes all of the global parameters, but does not include limit line information. Once an instrument state is learned, the analyzer and source states can be restored at any later time. The following program demonstrates how to both learn and restore the instrument states of the HP 8757C/E and the HP 8350B Sweep Oscillator by using their learn string functions. If you use the HP 8340B or 8341B Synthesized Sweepers, perform the modification described at the end of "Program 10 Explanation".

Program 10 listing

```
20    REM $INCLUDE: 'QB4SETUP'
20    CLS
30    OPTION BASE 1
40    Maxsna% = 150
50    Maxswpr% = 90
60    Lsna$ = SPACE$(Maxsna%)
70    Lswpr$ = SPACE$(Maxswpr%)
80    Actual% = 0
90    ISC& = 3
100   Sna& = 316
110   Passthru& = 317
120   CALL IOTIMEOUT(ISC&, 10!):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
130   CALL IOABORT(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
```

```
140  CALL IOCLEAR(ISC&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
150  A$ = "IP": GOSUB IOOUTS
160  A$ = "PT19;": GOSUB IOOUTS
170  CALL IOLOCAL(Sna&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
180  INPUT "SET UP SYSTEM,PRESS ENTER", B$
190  Enable%= 1
200  Disable%= 0
210  MATCH$ = CHR$(10): CALL IOMATCH(ISC&,
     MATCH$, Actual%):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
220  A$ = "OL": GOSUB IOOUTS
230  CALL IOENTERS(Sna&, Lsna$, Maxsna%,
     Actual%):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
240  CALL IOOUTPUTS(Passthru&, A$, LEN(A$)):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
250  CALL IOENTERS(Passthru&, Lswpr$,
     Maxswpr%, Actual%):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
260  CALL IOMATCH(ISC&, MATCH$, Maxswpr%):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
270  A$ = "IP": GOSUB IOOUTS
280  INPUT "TO RESTORE SETUP,PRESS ENTER", B$
290  A$ = "IL" +Lsna$: GOSUB IOOUTS
300  A$ = "IL" +Lswpr$: CALL
     IOOUTPUTS(Passthru&, A$, LEN(A$))
310  A$ = "": GOSUB IOOUTS
320  CALL IOLOCAL(Sna&):
     IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
330  END
340  IOOUTS: CALL IOOUTPUTS(Sna&, A$, LEN(A$))
350  IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
360  RETURN
```

Program 10 explanation

Line 10   Call the QuickBASIC initialization file "QB4SETUP".

Line 20   Clear the computer CRT.

Line 30   Define the first element of any array to be at index number 1.

Line 40   Define the maximum number of characters for the analyzer learn string.

Line 50   Define the maximum number of characters for the learn string of the source.

Line 60   Dimension a string large enough to hold the learn string of the analyzer (150 bytes).

Line 70   Dimension a string large enough to hold the learn string of the source.

Line 80   Define the actual number of elements read.

Line 90   Assign the interface select code to a variable.

Line 100 Assign the address of the analyzer to a variable.

Line 110 Assign the passthru address of the analyzer to a variable.

Line 120 Define a system timeout of 10 seconds. Perform error trapping.

Line 130 Abort any HP-IB transfers. Perform error trapping.

Line 140 Clear the HP-IB interface of the analyzer. Perform error trapping.

Line 150 Preset the analyzer and the source.

Line 160 Tell the analyzer which device is controlled through the passthru address. Address 19 belongs to the source.

Line 170 Set the analyzer and source to local mode. Perform error trapping.

Line 180 Prompt the user to set up the system. Then wait for the [ENTER] key to be pressed.

Line 190 Define a flag to enable character matching.

Line 200 Define a flag to disable character matching.

Line 210 Disable character matching for the linefeed. The analyzer learn string is 150 contiguous binary bytes that does not end with a cr/lf (since this could actually be part of the learn string information).

Line 220 Program the analyzer to output its learn string.

Line 230 Read the analyzer learn string into the string "Lsna$".

Line 240 Program the source to output its learn string.

Line 250 Read the source learn string into the string "Lswpr$". The computer must read the entire source learn string which, for the HP 8350B Sweep Oscillator, is 90 bytes long.

Line 260 Enable character matching; this results in termination on a linefeed when a string is read.

Line 270 Preset the analyzer and source to clear the instrument states.

Line 280 Prompt the user, then wait for the [ENTER] key to be pressed.

Line 290 Program the analyzer to accept its learn string, then send it.

Line 300	Program the source to accept its learn string, then send it.
Line 310	Re-address the analyzer to exit passthru mode and continue sweeping.
Line 320	Set the analyzer and source to local mode.
Line 330	End program execution.
Line 340	Define a subroutne that outputs commands to the analyzer.
Line 350	Perform error trapping.
Line 360	Return from the subroutine.

Running program 10

1. Clear the computer CRT and type in the program.

2. Press [ALT] [R] [S] on the computer.

3. When the computer stops and displays:

   SET UP SYSTEM, PRESS CONTINUE.

   Adjust the analyzer and source to a preferred instrument state, then press the [ENTER] key on the computer.

4. The computer will save the learn strings of both the analyzer and the source. After completing this, the analyzer and source will be preset to destroy your original instrument state.

5. The computer stops and displays:

   TO RESTORE SETUP, PRESS CONTINUE.

   Press the [ENTER] key. The computer will restore your original instrument state via the two learn strings. Verify on the displays of the analyzer and the source that your state has been restored.

This example is designed to work with the HP 8350B Sweep Oscillator, which has a learn string of 90 bytes. The program can be easily modified to work with the HP 8340B and 8341B Synthesized Sweepers which have learn strings 123 bytes in length. To do this, change the "90" in line 50 to "123".

Program 11: guided instrument setup with CRT graphics

As was illustrated by program 9, it is possible to utilize the CRT of the HP 8757C/E as a plotter. This program goes one step further by utilizing the CRT to create a simple connection diagram which may be recalled by the user, at any time, from the front panel of the analyzer.

This program draws the same hypothetical connection diagram that was drawn by program 9. It blanks most of the analyzer's standard display, including the graticle and all annotation except the soft keys. In addition, it adds one softkey under both the save and the recall hardkey menus. This softkey will allow the user to toggle the state of the CRT graphics off and on.

To use the graphics off/on capability of the HP 8757C/E, change "BL5" in line 90 of program 9 to "BLA", and make the necessary changes in the size of the background grid. These, and other changes are illustrated in the following listing.

The same principle can be used to save anything stored to disk on the HP 8757C in the first seven pages of user graphics. By having the softkeys available, the user can store CRT graphics onto a disk for later recall.

Program 11 listing

```
10    REM $INCLUDE: 'QB4SETUP'
20    CLS
30    ISC& = 3
40    Sna& = 316
50    Passthru& = 317
60    CALL IOTIMEOUT(ISC&, 10!):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
70    CALL IOABORT(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
80    CALL IOCLEAR(ISC&):
      IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
90    A$ = "IP BLA PT15": GOSUB IOOUTS
100   A$ = "EP; GP1; DEF": GOSUB IOOUTSP
110   A$ = "SP 6": GOSUB IOOUTSP
120   FOR Col = 0 TO 25
130     A$ = "PU;PA" +STR$(Col * 100)
        +",0;PD;PA" +STR$(Col * 100) +",2000;":
        GOSUB IOOUTSP
140   NEXT Col
150   FOR Row = 0 TO 20
160     A$ = "PU;PA 0," +STR$(Row * 100) +";PD;PA
        2500," +STR$(Row * 100) +";": GOSUB
        IOOUTSP
170   NEXT Row
180   A$ = "SP 8": GOSUB IOOUTSP
190   A$ = "PU; PA 600,1600; PD": GOSUB IOOUTSP
200   A$ = "SIO.28,0.34; LBCONNECTION DIAGRAM"
      +CHR$(3): GOSUB IOOUTSP
210   A$ = "PU; PA 1200,250; PD": GOSUB IOOUTSP
220   A$ = "SIO.28,0.34; LBDUT" +CHR$(3): GOSUB
      IOOUTSP
230   A$ = "PU; PA 300,800; PD; PA
      1100,800,1100,1100,300,1100,300,800":
      GOSUB IOOUTSP
240   A$ = "PU; PA 800,800; PD; PA 800,1100":
      GOSUB IOOUTSP
250   A$ = "PU; PA 1500,800; PD; PA 2300,
      800,2300,1200,1500,1200,1500,800": GOSUB
      IOOUTSP
260   A$ = "PU; PA 1950,800; PD; PA 1950,1200":
      GOSUB IOOUTSP
270   A$ = "PU; PA 875,850; PD; PA
      875,500,1200,500": GOSUB IOOUTSP
```

```
280 A$ = "PU; PA 1400,500; PD; PA
    2050,500,2050,850": GOSUB IOOUTSP
290 A$ = "PU; PA 1200,400; PD; PA
    1400,500,1200,600,1200,400": GOSUB IOOUTSP
300 A$ = "PU; PA 0,0": GOSUB IOOUTSP: A$ = "":
    GOSUB IOOUTS
310 CALL IOLOCAL(ISC&):
    IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
320 END
330 IOOUTS: CALL IOOUTPUTS(Sna&, A$, LEN(A$))
340 IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
350 RETURN
360 IOOUTSP: CALL IOOUTPUTS(Passthru&, A$,
    LEN(A$))
370 IF PCIB.ERR <>NOERR THEN ERROR PCIB.BASERR
380 RETURN
```

Program 11 explanation

Line 10   Call the QuickBASIC initialization file "QB4SETUP".

Line 20   Clear the computer screen.

Line 30   Assign the interface select code to a variable.

Line 40   Assign the address of the HP 8757C/E to a variable.

Line 50   Assign the passthru address of the HP 8757C/E to a variable.

Line 60   Define a system timeout of 10 seconds. Perform error trapping.

Line 70   Abort any HP-IB transfers. Perform error trapping.

Line 80   Clear the HP-IB interface of the HP 8757C/E. Perform error trapping.

Line 90   Preset the analyzer and blank all the CRT display except the softkeys. Define the CRT graphics as the target of passthru commands. The graphics address is always one less than the analyzer's HP-IB address.

Line 100   Erase all graphics pages. Turn graphics page 1 on to ensure that the graphics start in it.

Line 110   Select to plot with pen 6, the lowest intensity for the analyzer CRT.

Line 120   Repeat a loop 25 times to draw vertical part of the grid.

Line 130   Draw a vertical line down the CRT screen.

Line 140   End of the loop.

Line 150   Repeat loop 20 times to draw horizontal part of the grid.

Line 160   Draw a horizontal line across the CRT.

Line 170   End of the loop.

Line 180   Select to plot with pen 8, the brightest intensity for the analyzer CRT.

Line 190   Move the pen to title the display.

Line 200   Specify the width and height of each character, indicate what the title is, terminate the title with an end of text character.

Line 210   Move the pen to label the device under test.

Line 220   Specify the width and height of each character, indicate what the title is, terminate the title with an end of text character.

Line 230   Move the pen and draw the outline of the source.

Line 240   Draw the plug-in of the source.

Line 250   Move the pen and draw the outline of the analyzer.

Line 260   Draw the CRT of the analyzer.

Line 270   Draw the connections from the source to the DUT.

Line 280   Draw the connections from the DUT to the analyzer.

Line 290   Draw the DUT (an amplifier.)

Line 300   Move to the bottom left corner of the CRT.

Line 310   Place the analyzer and the source in local mode. Perform error trapping.

Line 320   End program execution.

Line 330   Define a subroutine that outputs commands to the analyzer.

Line 340   Perform error trapping.

Line 350   Return from the subroutine.

Line 360   Define a subroutine that addresses the analyzer as a plotter.

Line 370   Perform error trapping.

Line 380   Return from the subroutine.

Running program 11

1. Clear the screen of the computer and type in the program.

2. Press **[ALT] [R] [S]** on the computer.

3. After the analyzer and source are preset, the CRT is blanked, except for softkeys. First a grid is plotted on the CRT. While this isn't neccessary for our connection diagram, it does give you a good indication of where the X and Y coordinates are on the analyzers' CRT.

4. The labelling is added. The labels "CONNECTION DIAGRAM" and "DUT" are written using the analyzer CRT's internal character set.

5. All of the lines are plotted on the analyzer's CRT. If brighter lines are desired, draw each line twice or, select different pen numbers.

6. The analyzer is placed in local mode with the front panel and the softkeys active. Press the softkey labeled *[GRAPHICS ON/OFF]*. Note that the diagram will now disappear from the CRT display. Press the *[GRAPHICS ON/OFF]* softkey again and the diagram will reappear.

Table 2. Alphabetical Listing of HP 8757C/E Programming Codes (1 of 2)

Code	Action	Code	Action
A0	Averaging off	COBd	Brightness adjust, one color[1]
AB	A/B ratio measurement	COCd	Color adjust, one color[1]
AC	A/C ratio measurement[2]	COTd	Tint adjust, one color[1]
AFd	Averaging on and factor d	CR	C/R ratio measurement[2]
ANm	Adaptive Normalization on/off	CS	Clear status bytes
AR	A/R ratio measurement	CTm	Auto system calibration on/off
AS	Autoscale	CUm	Cursor on/off
AZm	Autozero repeat on/off of the DC detectors	CWm	CW mode on/off
AZ2	Autozero the DC detectors once	CX	Cursor to maximum
BA	B/A ratio measurement	DAd	Detector A offset set to d
BC	B/C ratio measurement[2]	DBd	Detector B offset set to d
BL0	Restore CRT to normal mode	DCd	Detector C offset set to d[2]
BL1	Blank frequency labels (secure frequency mode, frequency labels cannot be restored)	DEC	Set default colors[1]
		DFA	Set disk format to ASCII[1]
BL2	Blank all labels	DFB	Set disk format to binary[1]
BL3	Blank active channel trace	DHm	Display Hold on/off of the active channel trace
BL4	Blank softkey labels	DIAd	Set disk HP-IB address[1]
BL5	Blank all (except user CRT graphics)	DIUd	Set disk unit number[1]
BL6	Blank title	DIVd	Set disk volume number[1]
BL7	Blank mode labels	DLF	Delete file from disk[1]
BL8	Blank the active entry area	DM0	All inputs set to DC detection
BL9	Blank the limit lines	DM1	All inputs set to AC detection
BLA	Blank all (except user CRT graphics and softkeys)	DN	Step down (decrement)
		DRd	Detector R offset set to d
BR	B/R ratio measurement	DS0	Display trace data in log magnitude
BTNd	Overall display brightness	DS1	Display trace data in standing wave ratio (SWR) format
BW	Display the search bandwidth on the CRT		
C0	Channel off	ER0	Erase all save/recall registers
C1	Channel 1 on/active	FAs	Start frequency label
C2	Channel 2 on/active	FBs	Stop frequency label
C3	Channel 3 on/active[1]	FD0	Format data ASCII
C4	Channel 4 on/active[1]	FD1	Format data binary (HP BASIC compatible)
CA	C/A ratio measurement[2]	FD2	Format data extended ASCII
CB	C/B ratio measurement[2]	FD3	Format data binary (PC compatible)
CC1	Set channel 1 color[1]	IA	Input A absolute power measurement
CC2	Set channel 2 color[1]	IB	Input B absolute power measurement
CC3	Set channel 3 color[1]	IC	Input C absolute power measurement[2]
CC4	Set channel 4 color[1]	ILs	Input Learn string
CDm	Cursor delta on/off	IND	Initialize disk format[1]
CGL	Set labels color[1]	IP	Instrument preset
CGN	Set background color[1]	IR	Input R absolute power measurement
CGR	Set grid color[1]	IX	External ADC input (AUX) voltage measurement[1]
CGW	Set warning label color[1]		
CL	Perform system configuration of detectors and channels	LE	Erase limit lines for active channel[3]
		LFA	Load instrument information file from disk[1]
CLB	Color list, black[1]	LFC	Load CRT graphics file from disk[1]
CLG	Color list, green[1]	LFD	Load data trace file from disk[1]
CLL	Color list, blue[1]	LFI	Load instrument state file from disk[1]
CLR	Color list, red[1]	LFM	Load memory trace file from disk[1]
CLS	Color list, salmon[1]	LFs	Enter limit test flat line data[3]
CLW	Color list, white[1]	LL	Store lower limit line into memory[3]
CLY	Color list, yellow[1]		
CN	Cursor to minimum		

1. HP 8757C only.
2. HP 8757C Option 001 only (detector C).
3. Limit line functions valid only for channels 1 or 2, HP 8757C only.

Table 2.   Alphabetical Listing of HP 8757C/E Programming Codes (2 of 2)

Code	Action	Code	Action
LPs	Enter limit test point data[3]	PR1	Print all to monochrome printer, except softkeys and CRT graphics
LSs	Enter limit test sloped line data[3]	PR2	Print tabular display data in monochrome
LTm	Limit line test on/off[3]	PR3	Print tabular marker/cursor data to external printer
LU	Store upper limit line into memory[3]	PR4	Print all to color printer, except softkeys and CRT graphics[1]
M-	Display normalized data (measurement −memory)	PTd	Passthrough address set to d
MDm	Modulation on/off	R1	R/A ratio measurement
ME	Display measurement data	R2	R/B ratio measurement
MM	Display the channel menu(main menu)	R3	R/C ratio measurement[2]
MN	Display normalized data (same as M-)	RCn	Recall register n
MOC	Monochrome display[1]	RLd	Reference level set to d
MR	Marker (or cursor) to reference line	RMd	Service request mask set to d
MSm	Manual sweep mode on/off	RPq	Reference position set to vertical division q
MU0	Display the measurement menu	RS	Restart averaging
MU1	Display the display menu	SCd	Set cursor to horizontal position d
MU2	Display the scale menu	SDd	Scale per division set to d
MU3	Display the reference menu	SFA	Store all instrument information to disk in file[1]
MU4	Display the cursor menu	SFC	Store CRT graphics to disk in file[1]
MU5	Display the average menu	SFD	Store data trace to disk in file[1]
MU6	Display the calibration menu	SFI	Store instrument state to disk in file[1]
MU7	Display the special menu	SFM	Store memory trace to disk in file[1]
MU8	Display the system menu	SKq	Select softkey q: q = 1 to 8
MY	Display memory data	SL	Cursor search left
MZ	Manual calibration of DC detectors	SM	Store measurement into memory
NSm	Non-standard sweep mode on/off	SN	Store normalized data (measurement −memory) into memory
OC	Output cursor value	SOd	Smoothing set to d % of frequency span
OD	Output trace data	SPd	Number of points set to d; d = 101, 201, 401, 801, 1601
OE1	Output error status of display channel 1		
OE2	Output error status of display channel 2	SR	Cursor search right
OI	Output identity	SSd	Cursor search value set to d
OK	Output keycode of last key pressed	STd	Reference level step size set to d
OL	Output learn string	SUd	Specify custom plot according to d
OM	Output memory data	SVn	Save register n
ON	Output normalized (measurement −memory) data	SW0	Non-swept mode; non-swept operation
		SW1	Swept mode; normal swept operation
OPxx	Output interrogated parameter value xx = AF, BW, DA, DB, DC, DR, RL, RP, SD, SL, SO, SP, SR, SS, ST	SW2	Sweep hold mode; non-swept mode with HP-IB bus hold off until completion of TSd
OR	Output rotary knob value (−32768 ≤ value ≤ +32767)	TCm	Continuous Temperature Compensation on/off
		TIFs	Title for file[1]
OS	Output status bytes	TSd	Take d sweeps, then hold display
OT1m	Control output #1 on/off	UP	Step up (increment)
OT2m	Control output #2 on/off	WKs	Write softkey label
OV	Output CW value	WMs	Write to channel memory.
P1	Plot channel 1 trace on external plotter	WTs	Write title, s is an ASCII string of up to 50 characters
P2	Plot channel 2 trace on external plotter		
P3	Plot channel 3 trace on external plotter[1]	XAs	External detector cal vlaue for detector A
P4	Plot channel 4 trace on external plotter[1]	XBs	External detector cal value for detector B
PA	Plot all on external plotter	XCs	External detector cal value for detector C[2]
PBm	System interface control on/off	XRs	External detector cal value for detector R
PC	Plot labels on external plotter		
PD	Plot custom plot		
PG	Plot grid on external plotter		

1. HP 8757C only.
2. HP 8757C Option 001 only (detector C).
3. Limit line functions valid only for channels 1 or 2, HP 8757C only.

NOTES: n = decimal integer 1 to 9
        d = variable length numeric
        m = 0 for off/1 for on
        q = unique value
        s = ASCII or binary string

For more information, call your local HP sales office listed in your telephone directory or an HP regional office listed below for the location of your nearest sales office.

United States:
Hewlett-Packard Company
4 Choke Cherry Road
Rockville, MD 20850
(301) 670-4300

Hewlett-Packard Company
5201 Tollview Drive
Rolling Meadows, IL 60008
(312) 255-9800

Hewlett-Packard Company
5161 Lankershim Blvd.
No. Hollywood, CA 91601
(818) 505-5600

Hewlett-Packard Company
2015 South Park Place
Atlanta, GA 30339
(404) 955-1500

Canada:
Hewlett-Packard Ltd.
6877 Goreway Drive
Mississauga, Ontario L4V1M8
(416) 678-9430

Australia/New Zealand:
Hewlett-Packard Australia Ltd.
31-41 Joseph Street,
Blackburn, Victoria 3130
Melbourne, Australia
(03) 895-2895

Europe/Africa/Middle East:
Hewlett-Packard S.A.
Central Mailing Department,
P.O. Box 529
1180 AM Amstelveen,
The Netherlands
(31) 20/547 9999

Far East:
Hewlett-Packard Asia Ltd.
22/F Bond Centre
West Tower
89 Queensway
Central, Hong Kong
(5) 8487777

Japan:
Yokogawa-Hewlett-Packard Ltd.
29-21, Takaido-Higashi 3-chome
Suginami-ku, Tokyo 168
(03) 331-6111

Latin America:
Latin American Region Headquarters
Monte Pelvoux Nbr. 111
Lomas de Chapultepec
11000 Mexico, D.F. Mexico
(905) 596-79-33

HEWLETT PACKARD

CONTENTS

INTRODUCTION

Use these suggestions when minor problems arise with the analyzer that do not involve defects in the analyzer's internal circuitry. This includes manual, system, and remote operation problems, cable connections, and other miscellaneous problems. If help for your problem cannot be found here, see section 8 in the service manual.

(HP 8757C ONLY)

Text that applies *only* to the HP 8757C is enclosed with these symbols. In a table, text that is HP 8757C-only is referenced to a footnote.

MANUAL OPERATION

Line Power Problems

If the power switch is turned on, but all front panel LEDs remain off and the fan is not operating, suspect a power problem.

● Make sure the power line cable is properly connected.

● Check that the correct line voltage is selected at the rear panel power line module. The voltage-selector PC board must be correctly installed. Refer to section 2 for installation instructions.

● Make sure the correct fuse is installed in the fuse holder of the power line module. The required fuse rating for each line voltage is listed in table 2-1, and also below the power line module on the rear panel of the analyzer.

Error Codes

When the front panel [PRESET] key is pressed, the analyzer performs a series of self-tests before establishing the preset conditions. If any of these tests fail, an error code from 1 through 15 is displayed in binary form with lighted LEDs. This error code appears in two places: on the front panel in the INSTRUMENT STATE HP-IB STATUS area, using the LEDs labeled R, L, T, and S; and on the A3 CPU assembly, using four of the eight LEDs near the top left corner of the board. These are arranged in an 8-4-2-1 sequence with the most significant bit (8) being on the left. In many cases, an error message is also shown on the CRT. The best failure indicators are the LEDs on the CPU assembly, since the front panel LEDs will *not* light in the event of a front panel failure. Table 1 is the list of error codes and most probable cause of failure. If you encounter an error message, refer to the service manual for troubleshooting.

Table 1. Summary of Error Codes

LED Reading 8-4-2-1	Error Code	Test Description/Explanation	Probable Cause of Failure
1-1-1-1	15	Microprocessor kernel	A3
1-1-1-0	14	ROM checksum	A3
1-1-0-1	13	RAM checksum	A3
1-1-0-0	12	Power supply	A12
1-0-1-1	11	Instrument bus	A3, A6
1-0-1-0	10	Display Interface —GSP	A14, A3
1-0-0-1	9	Display interface —DRAM bus	A14
1-0-0-0	8	Display interface —DRAM download	A14
0-1-1-1	7	Display interface —DRAM cell	A14
0-1-1-0	6	Display interface —VRAM bus	A14
0-1-0-1	5	Display interface —VRAM cell	A14
0-1-0-0	4	Display interface —Video control	A14
0-0-1-1	3	Display interface —RGB	A14
0-0-1-0	2	Interrupt test	A3, A14, A2, A4, A6
0-0-0-1	1	Other self-test failure includes: EEROM Write Enable Battery failure Unexpected Keypress Configuration Error	As indicated on CRT
0-0-0-0	0	Pretest pass	—

SYSTEM OPERATION

If the analyzer is configured as the system controller with other instruments connected to the 8757 system interface bus, problems may occur in the configuration itself, rather than in a specific instrument.

General

- Press **[PRESET]** on each instrument (or cycle the power). In normal operation avoid pressing [PRESET] on the source; this may cause a system lock-up.

- Isolate each instrument by disconnecting and reconnecting them one at a time from the analyzer system interface. This helps locate a problem in an instrument or its connections.

- Clean the filter on the AC fan on the rear panel. All instrument filters should be cleaned regularly, at least monthly. A clogged filter will cause overheating and consequent degradation of performance.

- If the system cannot be controlled from the analyzer front panel, cycle the power with the LINE switch on the analyzer.

- Be sure that the source is compatible with the analyzer. The HP 8350B Sweep Oscillator can be used with an HP 83500-series RF Plug-in, or with an HP 86200-series RF Plug-in with an HP 11869A Adapter. Some of these plug-ins require an external modulator for AC compatibility with the analyzer. The HP 8340-and 8341-series Synthesized Sweepers are also compatible with the analyzer. Refer to "Equipment Required But Not Supplied" in Chapter 1 for a complete list of source firmware versions that are compatible with the scalar analyzer.

HP-IB Connections and Addresses

If the instrument addresses are not set correctly, or if the HP-IB cables are not connected properly, a system malfunction may occur.

- Verify that the HP-IB cables are functional. Check for shorts and opens. Make certain that the connectors are not damaged.

- Make sure that the cables for the source and other peripherals are connected to the 8757 SYSTEM INTERFACE connector, not the HP INTERFACE BUS connector. Only a system controller should be connected to the HP INTERFACE BUS connector.

- Make sure that the system interface is on. When it is *off*, SYS INTF OFF is shown in the status line on the CRT.

- Check that the HP-IB address of each instrument is set correctly and that no two instruments are set to the same address. To check the expected address for each instrument in the system, press **[LOCAL]**. Then press the softkey for each instrument and the HP-IB addresses will be shown on the CRT. Check the address for each instrument and verify that they correspond to the expected addresses.

  If the addresses do not agree, change them using the local menu, or reset the HP-IB address on the instrument itself.

Other Cable Connections

For most uses, the STOP SWEEP, POS Z BLANK, and SWEEP IN 0-10V analyzer outputs must be connected to the source. Section 2 "Installation" describes how to make these connections with the HP 8350B Sweep Oscillator and the HP 8340- and 8341-series Synthesized Sweepers. Other connections may be necessary for different applications.

Remote Operation

Most remote operation problems occur due to improper programming.

● Check all program code for proper syntax. Ensure that the proper number of bytes are transferred when sending or requesting data to and from the analyzer.

● When transferring binary data, ensure that an HP 9876A Printer is *not* connected to the bus. This may prevent proper transfer.

● If a printer is connected to the 8757 system interface, do not set it to send out an SRQ if the paper runs out. If this happens, it will significantly slow system performance.

● Do not set the HP-IB address of any instrument on the 8757 system interface to a value one digit greater or smaller than the analyzer's HP-IB address. (To do so will cause conflict with the analyzer's passthrough address. See "Remote Operation" for more information on passthrough addresses.)

INACCURATE OPERATION

If the analyzer is functional but you doubt the accuracy of the measurements, the problem may be with calibration or with the modulation frequency of the input signals.

Calibration

● Make sure the system is correctly configured for the detectors connected. The system automatically reconfigures whenever a detector is replaced or exchanged. Press [CAL] *[CONFIG SYSTEM]*. The analyzer will determine the types of detectors connected and calibrate each input.

● If you are using DC detection, make sure the detectors are zeroed to compensate for the effects of DC drift. Press [CAL] *[DC DET ZERO]* and choose manual or automatic zeroing.

● Make sure the correct value of detector offset is entered. The status line shows which detectors have an offset entered. Press [CAL] *[DET OFFSET]*, and verify or change the offset values for each detector input. Remember that instrument preset does *not* reset the offset values to zero.

● For further information on calibration procedures, see "[CAL] Calibration Menus" in the *Operating Reference*.

Modulation Characteristics

- If you are using AC detection, verify that the modulation frequency of the input signals to the detectors is 27.778 kHz ±20 Hz. The ON/OFF ratio must be at least 30 dB, with an ON/OFF symmetry of 50/50 ±5%.

Sweep Speed

- If the 8757 system interface is used, the analyzer will automatically limit the sweep speed. Without the system interface, it is the responsibility of the user to ensure proper sweep speed.

If a problem occurs that is not solved with these suggestions, see section 8 of the service manual.

MISCELLANEOUS PROBLEMS

The following paragraphs provide additional information that may clarify some analyzer features.

Alternate Sweep

The alternate sweep feature allows a device to be simultaneously tested over two distinct frequency ranges or power levels. In this mode, the analyzer displays the alternating sweep conditions at the same time. One use for this feature is testing a filter's broadband and passband characteristics simultaneously. This is accomplished by alternating the source state between a broadband and narrowband frequency range. Another use is simultaneously testing an amplifier in its linear and compressed operating regions. This is accomplished by alternating the source state between two different power levels.

NOTE: For the alternate sweep function to operate, the analyzer's System Interface must be connected to the source's HP-IB interface. Also, ensure that the System Interface is turned on.

NOTE: Alternate state information cannot be saved on disk. If an attempt is made to save alternate state, the analyzer disables the alternate sweep mode.

The following procedure demonstrates how to implement the alternate sweep feature.

1. Set up the analyzer for the desired measurement on channels 1 and 2 (A, B, R, A/R, B/R, and so on). Turn channels 3 and 4 off.

2. Define one of your source states as the primary configuration and the other as the secondary (alternate) configuration. For the above filter measurement, the broadband sweep could be defined as the primary configuration (this will be measured and displayed on analyzer channel 1) and the narrowband sweep as the secondary (this will be measured and displayed on analyzer channel 2).

3. Select channel 2 and set up the source for the secondary configuration.

4. For a normalized measurement, calibrate the system and set the analyzer to display MEAS-MEM on channel 2.

5. Store this state in analyzer register 2.

6. Select channel 1 and set up the source for the primary configuration.

7. For a normalized measurement, calibrate the system and set the analyzer to display MEAS-MEM.

8. Store this state in analyzer register 1.

9. Activate the alternate sweep function on the source and enter register 2 as the alternating register.

If implemented as described above, the source will alternate between the sweep conditions stored in registers 1 and 2 and the analyzer will display the measurement results for both conditions.

NOTE: For more information on the alternate sweep function, refer to the HP 8757 User's Guide.

(HP 8757C ONLY)

Number of Trace Points and Trace Memory

The number of channels that can be shown on the CRT is limited by the number of trace points selected. All four channels can be shown when 101, 201, or 401 points are selected. With 801 trace points, only channels 1 and 2 are available. With 1601 trace points, only channel 1 is available.

The channel trace memory for channels that are turned off will be destroyed when you choose 801 or 1601 points.

Autozero of DC Detectors

When the analyzer is in DC detection mode, it must periodically zero its AC/DC detectors to maintain accurate low-level measurements. When using a source connected to the 8757 system interface, you can engage the autozero function and let the analyzer control the source power off/on sequence. In order to preserve the front panel settings of the source, the analyzer must use save/recall register 9 on both the source and the analyzer. Register 9 is accessed each time an autozero is performed, whether it is forced by the operator or the autozero repeat function is engaged. Do not use register 9 for storing other information. The information will be lost when the analyzer writes over it.

Save/Recall Registers

The save/recall registers store most of the front panel settings, with a few exceptions. Some of the system menu functions are not stored because they apply to every instrument state, rather than to a specific channel. The following information is stored in the save/recall registers:

- The channel status (which channel is active, and which channels are on.)
- For all channels:
  - Measurement selected (A, A/R, etc.).
  - Display mode (MEAS, MEM, etc.).
  - Averaging on/off status.
  - Averaging factor.
  - Reference level.
  - Reference position.
  - Scale per division.
  - Smoothing on/off status.
  - Smoothing factor.
- Detection mode (AC or DC).
- Number of trace points.
- Internal modulation on/off status.
- Cursor on/off status.
- Cursor position.
- Cursor delta on/off status.
- Cursor delta position.
- Cursor search value.

- Adaptive normalization on/off status.[1]
- Non-standard sweep on/off status.
- Limit line on/off status (channels 1 and 2).[1]

Registers 1 through 4 also save the following:

- Trace memory at 401 points for channels 1 and 2.
- Limit line entries for channels 1 and 2.[1]
- Title.

The following information applies to the entire instrument rather than the individual channels, and is not saved:

- System Interface on/off status.
- Labels on/off status.
- Title on/off status.
- Frequency labels on/off status.
- Repeat autozero on/off status.
- Color selection.[1]
- CRT intensity.
- HP-IB addresses.
- Disk unit number.[1]
- Disk volume number.[1]

NOTE: Instrument-state information of an HP 8360 Series Synthesized Sweeper can only be saved or recalled on disk with firmware Revision 3.1.

System Interface On/Off

The analyzer uses the 8757 system interface bus to control the other instruments connected to the system interface. The 8757 system interface should be on in most applications. To verify that it is on, check the CRT status line. SYS INTF OFF appears when the system interface is off. When the system interface is off, the analyzer has no control or knowledge of the existence of any HP-IB instrument connected to this interface. To turn the system interface on, press **[SYSTEM]** *[MORE]* *[SWEEP MODE]* *[SYSINTF ON]*.

It is important that no two instruments connected to the system interface have the same HP-IB address. If this occurs, the analyzer may freeze operation until the situation is corrected. "HP-IB Address Selection" in "Installation" explains how to verify or change the addresses the analyzer is expecting.

When the system interface is off, the following analyzer system functions are not possible:

- Autozero of DC detectors.
- Alternate sweep.
- Start/stop/cursor frequency annotation.
- System save/recall and preset.
- System CW and manual sweep modes.
- Adaptive normalization.[1]
- Hard copy plot and print.
- Disk access.[1]

If you try to plot or print with the system interface turned off, the analyzer will perform an instrument preset after a few seconds.

---

1. HP 8757C only.

Measurement-Memory→Memory

This function can only be used with ratio measurements.

(HP 8757C ONLY)

Cursor Search

Search functions differ from normal cursor operation. The cursor is updated with every sweep to reflect the present amplitude response at the cursor frequency. In search left, search right, and bandwidth modes, the trace is put into hold after the first search, and the trace freezes on the CRT. This makes it possible to inspect the trace without it changing.

There are two ways to exit search mode and return to the normal cursor mode. Press *[PRIOR MENU] [CURSOR OFF]*. Or press [CURSOR].

ON-SITE SERVICE — REPAIRS

On-site analyzer repair includes assembly level troubleshooting, replacement of the defective assembly, and possible re-calibration. The equipment required to re-calibrate varies with the failure. The service manual gives complete troubleshooting instructions. This guide will quickly resolve 90% of the failures where error messages are displayed and other obvious failures (such as a dead A, B, or R input). The motherboard must be functional, with no opens or shorts. This guide is organized by error code or error message. Error code interpretation is described in "Error Codes."

Notes on Equipment Required:

Where the HP 11613A/B Calibrator is listed as required equipment, a computer with disk drive is also required. Only an HP 9000 series 200/300 Computer with a compatible disk drive can be used. The software provided with the HP 11613 includes both 3.5 inch and 5.25 inch formats. Follow the instructions provided with the calibrator.

Where a DVM is listed, use a digital voltmeter with at least 4.5 digits of resolution, except during adjustment of the A4 board, where 5.5 digits are required.

Notes on Re-calibration:

● If the A1, A2, A5, A6, A11, A13, or A14 assemblies are replaced, perform no adjustments.

● If the A3, A4, A7, A8, A9, or A10 assemblies are replaced, regenerate the cal constants with the HP 11613A/B.

● If the A12 power supply is replaced, adjust all supply voltages. Adjust all power supplies within 0.05 volts of their nominal voltages. Adjust the 5 volt supplies to 5.1 volts.

● Replacing the A15 display requires no adjustments although the intensity levels may vary slightly from the previous display.

● If the A4 ADC board is replaced, check the DAC gain adjustment with a DVM. Use this following procedure after the analyzer has warmed up:

1. Connect DVM LO to A4TP4 (AGND) and DVM HI to A4TP2 (DAC). Both test points and A4R6 are accessible without removing the A4 assembly cover.

2. Preset the analyzer.

3. Note the maximum SWEEP DAC VOLTAGE (approximately 0.0 V) indicated on the DVM by pressing **[SYSTEM]** *[MORE] [SERVICE] [A4 ADC] [MORE] [CHANNEL VOLTS] [CHANV OTHER] [SWP DAC MAX]*.

4. Note the minimum SWEEP DAC VOLTAGE on the DVM by pressing *[SWP DAC MIN]*. The *difference* between this value and the value noted in step 3 should be −10.2375 ±0.0005 VDC. If not, adjust A4R6 (DAC ADJ) to bring the difference within specification.

5. Repeat steps 3 and 4 until this difference is attained.

MAIN ERROR CODES

Error Codes 15 through 13:

Failure: All of these codes are associated with the A3 CPU board. Replacement of the A3 board will restore operation.

Equipment Required: HP 11613A/B.

Error Code 12:

Failure: One or more of the power supplies have failed. First check all fuses. Remove boards one at a time (except the A3 CPU board), and cycle the power each time to check for board shorts. If none of these solve the problem, replace the A12 power supply board.

Equipment required: DVM (if the A12 is replaced.)

Error Code 11:

Failure: The A3 CPU cannot communicate with the A6 board via the instrument bus. Either the A3, the A6, or the motherboard could be bad. Since the bus also goes to other boards, remove the A2, A4, and A14 boards to eliminate the possibility of shorts on these boards. Verify that the same failure occurs. If it does, replace all the boards that were removed, remove the A6 board, and close switch A3S1-D. This will bypass all self tests. If the instrument then seems to perform normally (locally), the problem is with the A6 board; if it does not perform normally, the problem is with the A3 board.

Equipment required: HP 11613A/B (if the A3 is replaced.)

Error Code 10:

Failure: The A3 CPU cannot communicate with the A14 display interface board. Either board could be bad, or the ribbon cable, W8, could be bad. Since the A3 has been well tested already, there is a 90% chance that the A14 board caused the failure. No test equipment or re-calibration is required.

Error Codes 9 through 3:

Failure: All these error codes relate to the A14 display interface board. Replacement of this board should cure the problem. No test equipment or re-calibration is required.

Error Code 2:

Failure: The A3 CPU has encountered an interrupt it was not expecting, or did not receive one it did expect. Interrupts come from the A2, A3, A4, A6, or A14 boards. The problem could also be on the motherboard. Extensive troubleshooting is required to isolate this problem. Either substitute known working boards for those listed, or refer to the service manual for further information.

Error code 1:

Failure: A failure has occured with either the instrument verify routine or with the other tests listed.

Equipment required: Varies with the failure.

INSTRUMENT VERIFY

- RAM: Replace the A3 CPU board.

- Instrument Bus: See error code 11.

- Display Bus: See error code 10.

- Timer: Replace the A3 CPU board.

- ADC Measurement: Check the +/-15V power supplies for accuracy. If OK, replace the A4 board.

- ADC Bit Check: Same as ADC Measurement.

- DAC Bit Check: Same as ADC Measurement.

- Sweep Compare: Same as ADC Measurement.

- Detector Control: Same as ADC Measurement.

OTHER TESTS

EEROM Write Enabled: Close switch A3S1-E. This is a warning; not a failure.

Battery Failure: Replace the battery on the A3 board, then cycle the power *twice*. The error message should disappear; if not, replace the A3 CPU board.

Note: The battery life should be about 10 years.

Unexpected Key Press: Either a front panel key is stuck (as indicated on the display) or the A2 board is defective. Check the indicated key or replace the A1 or the A2 board.

Configuration Error: This generally does not indicate a failure. Contact your local HP sales or service office for more information.

Other Problems

- Default calibration table used on A, B, C, or R: This indicates a need to recalibrate using the HP 11613A/B. If the problem persists, it indicates a problem with the A3 CPU board.

- If one input always seems bad and there is no detector offset active for that input, suspect the logger board for that input (A7, A8, A9, A10 for inputs A, B, C, R, respectively). Verify this by interchanging the logger board to see if the problem follows the board. *Be sure to replace the boards in their original position*. If the problem does not follow the board, it indicates a problem with the A4 ADC board.

- Failure to sweep properly or "Sweep Sync Errors" indicate a problem on the A4 ADC board (asssuming the source used is functioning properly).

- Lack of any signal displayed when using the modulator drive output from the analyzer could indicate a failed A5 modulator drive board. Measure the open circuit output voltage at the MODULATOR DRIVE BNC on the rear panel. When the modulator drive is turned off, the output should be about +6.4 volts *DC*. When the modulator drive is on, the output voltage should be about 6 volts *AC*. Failure to turn on is probably caused by the A5 board, but could also be caused by the A3 CPU board.

- Any of the following error messages indicate either a problem on the A3 CPU board or a problem in the firmware. If the problem occurs continuously, suspect the A3 board. If the problem only occurs during a specific keystroke sequence, it may be caused by a problem in the firmware. These messages may be accompanied with a numeric error code and flashing LEDs on the front panel and on the A3DS2 LEDs. Please note these messages and error codes when returning the instrument or board assembly to HP.

  The messages are: BUS ERROR
  Adr Error
  Code Err
  Zero Div
  Chk Instr
  Trap Instr
  Priv violation
  Trace
  −1010 emulator
  −1111 emulator
  Processing Error

ON-SITE SERVICE — CALIBRATION

Calibration can be quickly and easily performed with the HP 11613A or 11613B calibrator. An HP 9000 series 200 or 300 computer with a compatible disk drive is also required. The software provided with the HP 11613 includes both 3.5 inch and 5.25 inch formats. Follow instructions provided with the HP 11613. Only software revision 3.0 should be used with the HP 8757C/E. No other calibration is required. The entire process (except for the analyzer warm-up) takes less than 15 minutes.

MICROWAVE
CONNECTOR CARE

ILLUSTRATIONS

TABLES

Recent advances in measurement capabilities have made connectors and connection techniques more important than ever before. Damage to the connectors on calibration and verification devices, and on test ports, cables, and other devices also represents an increasing burden in downtime and expense.

This publication, the Hewlett-Packard **Microwave Connector Care Manual**, is an inclusive general reference. Its purpose is to help you get the best performance from all coaxial microwave connectors regardless of type or application: to know what to look for when cleaning and inspecting them, in order to preserve their precision and extend their life; and to make the best possible microwave connections, improving both the accuracy and repeatability of all of your measurements, saving both time and money.

Part One provides general information that applies to all connector types and gives Hewlett-Packard's recommendations on:

- handling and storing microwave connectors
- preventing electrostatic discharge
- inspecting microwave connectors visually for damage, dirt, and contamination
- cleaning microwave connectors using compressed air and, if required, a cleaning solvent
- inspecting microwave connectors mechanically, using precision connector gages, and
- making connections with microwave connectors.

These general recommendations are summarized in Hewlett-Packard Application Note 326, **Principles of Microwave Connector Care**. One copy of this summary is also included with each copy of this **Microwave Connector Care Manual**, bound separately for easy removal. Besides the text, it includes a quick-reference card suitable for bench use. Additional copies are available by contacting your local Hewlett-Packard representative.

Part Two of the present manual provides detailed information on each main connector type. It reviews the information in Part One that applies to each connector type, and it explains special points about cleaning, mechanical inspection, connection, and disconnection that apply to individual connector types. It also gives the critical mechanical dimensions of each connector interface.

Your comments on all Hewlett-Packard publications are welcome. For your convenience, a Reader Comment Sheet is included, postage paid in the United States.

PART ONE – PRINCIPLES OF CONNECTOR CARE

Part One – Principles of Connector Care

INTRODUCTION

Dimensions of microwave connectors are small and some of the mechanical tolerances are very precise, on the order of a few ten-thousandths of an inch. Seemingly minor defects, damage, and dirt can significantly degrade repeatability and accuracy. In addition, the mating surfaces of most precision connectors are gold, plated over a beryllium-copper alloy. This makes them very susceptible to mechanical damage, due to the comparative softness of the metals.

Part One of this Hewlett-Packard **Microwave Connector Care Manual** provides general information that applies to all connector types. It gives Hewlett-Packard's recommendations on handling and storage of all microwave connectors, on visual and mechanical inspection of connectors using a connector gage, and on making connections.

Among the most important general recommendations made in Part One of this manual are these:

- microwave connectors must be kept clean and the mating plane surfaces protected from harm during storage; never store connectors loose in a box or a drawer

- connectors should be inspected visually before every connection and damaged connectors discarded immediately

- connectors should be cleaned first with compressed air; if a solvent must be used, pure liquid Freon is the best

- solvent should never be sprayed into a connector; use a cotton swab or lint-free cloth and the least amount of solvent possible; avoid wetting plastic support beads with solvent

- connectors should be inspected mechanically, using a connector gage, before being used for the first time and periodically after that

- in making a connection, the connectors should be aligned carefully, a preliminary connection made lightly by turning the connector nut (only) to pull the connectors together, and the final connection made using a torque wrench

- connections and disconnections should never be made by screwing one connector into the other; this is extremely harmful and can occur whenever the device body rather than the connector nut alone is turned.

Part Two of this manual provides detailed information on each main connector type, repeating and expanding upon key points presented in Part One.

HANDLING AND STORAGE

- **Keep connectors clean.**
- **Do not touch the mating plane surfaces.**
- **Do not set connectors contact-end down.**
- **Before storing, extend the sleeve or connector nut.**
- **Use plastic end caps over the mating plane surfaces.**
- **Never store connectors loose in a box or a drawer.**

Microwave connectors must be handled carefully, inspected before use, and when not in use stored in a way that gives them maximum protection.

Avoid touching the connector mating plane surfaces and avoid setting the connectors contact-end down on any hard surface. Natural skin oils and microscopic particles of dirt are easily transferred to the connector interface and are very difficult to remove. Damage to the plating and to the mating plane surfaces occurs readily when the interface comes in contact with any hard surface.

Never store connectors with the contact end exposed. Plastic end caps are provided with all Hewlett-Packard connectors, and these should be retained after unpacking and placed over the ends of the connectors whenever they are not in use. Extend the threads of connectors that have a retractable sleeve or sliding connector nut. Then put the plastic end cap over the end of the connector.

Above all, never store any devices loose in a box or in a desk or a bench drawer. Careless handling of this kind is the most common cause of connector damage during storage.

Calibration and verification devices and test fixtures should be stored in a foam-lined storage case, and protective plastic end caps should always be placed over the ends of all connectors.

Cables should be stored in the same shape as they have when they are used – **they should not be straightened** – and plastic end caps should be placed over both connectors.

Figure 1 summarizes these Hewlett-Packard recommendations on handling and storing devices that have microwave connectors.

HANDLE AND STORE CONNECTORS CAREFULLY

NEVER PLACE CONNECTORS
CONTACT-END DOWN

EXTEND THREADS FULLY,
USE PLASTIC END CAPS

- Use foam-lined storage cases if available
- Never store devices loose in a box or in a desk or bench drawer
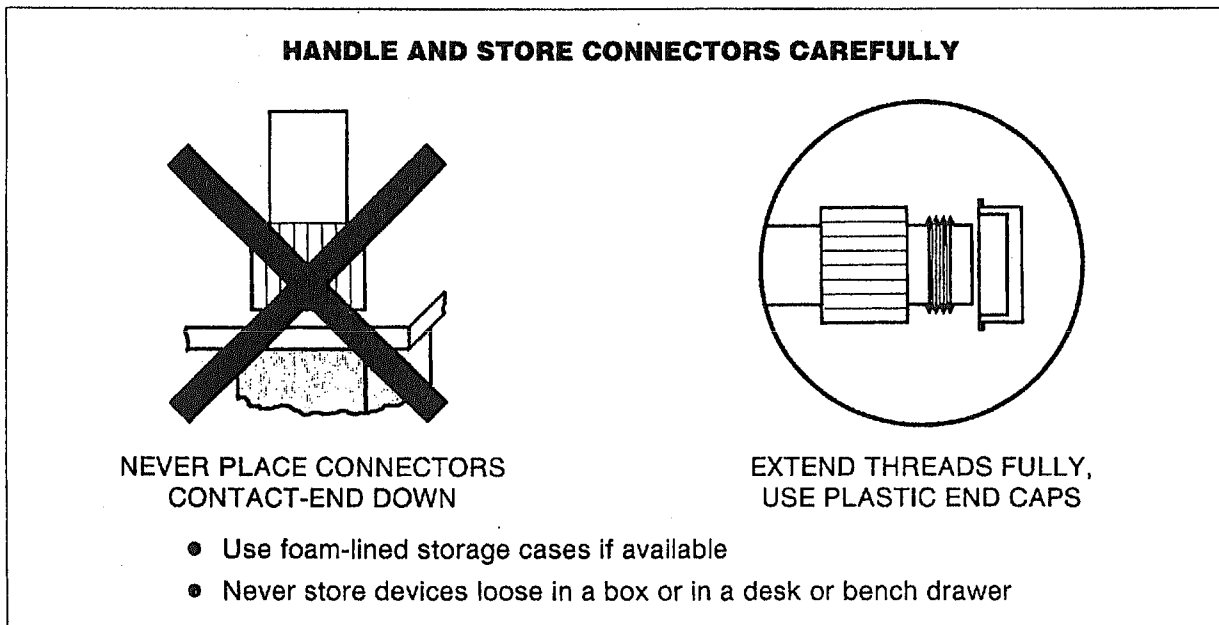
Figure 1. Handling and Storage

ELECTROSTATIC DISCHARGE

- **Wear a grounded wrist strap.**
- **Use an anti-static mat.**
- **Discharge static electricity from your body and from all devices before making connections or cleaning connectors.**

Protection against electrostatic discharge is essential before cleaning or inspecting connectors attached to any static-sensitive circuits (such as those found in bridges and detectors) or to test ports which may be connected to similar circuits.

Static electricity builds up on the body and can easily damage sensitive internal circuit elements when discharged by contact with the center conductor. Static discharges too small to be felt can nevertheless cause permanent damage. Devices such as calibration components and devices under test can also carry an electrostatic charge.

Always install a grounded anti-static mat in front of the test equipment and wear the grounded wrist strap attached to it. Such a mat, including installation hardware and a grounded wrist strap, is available as HP Part Number 85043-80013.

In addition, before cleaning, inspecting, or making any connection to a static-sensitive device or test port, ground yourself – for example by grasping the grounded, outer shell of the test port briefly, as shown in Figure 2.

Also discharge static electricity from all devices before connecting them by touching the device briefly to the outer shell of the test port or to another exposed ground. This will discharge any static electricity on your body or the device and protect the circuitry of the test equipment.

AVOID ELECTROSTATIC DISCHARGE

- Wear a grounded wrist strap.
- Use an anti-static mat.
- Ground yourself to discharge static electricity.
  Also discharge all devices before connecting them.
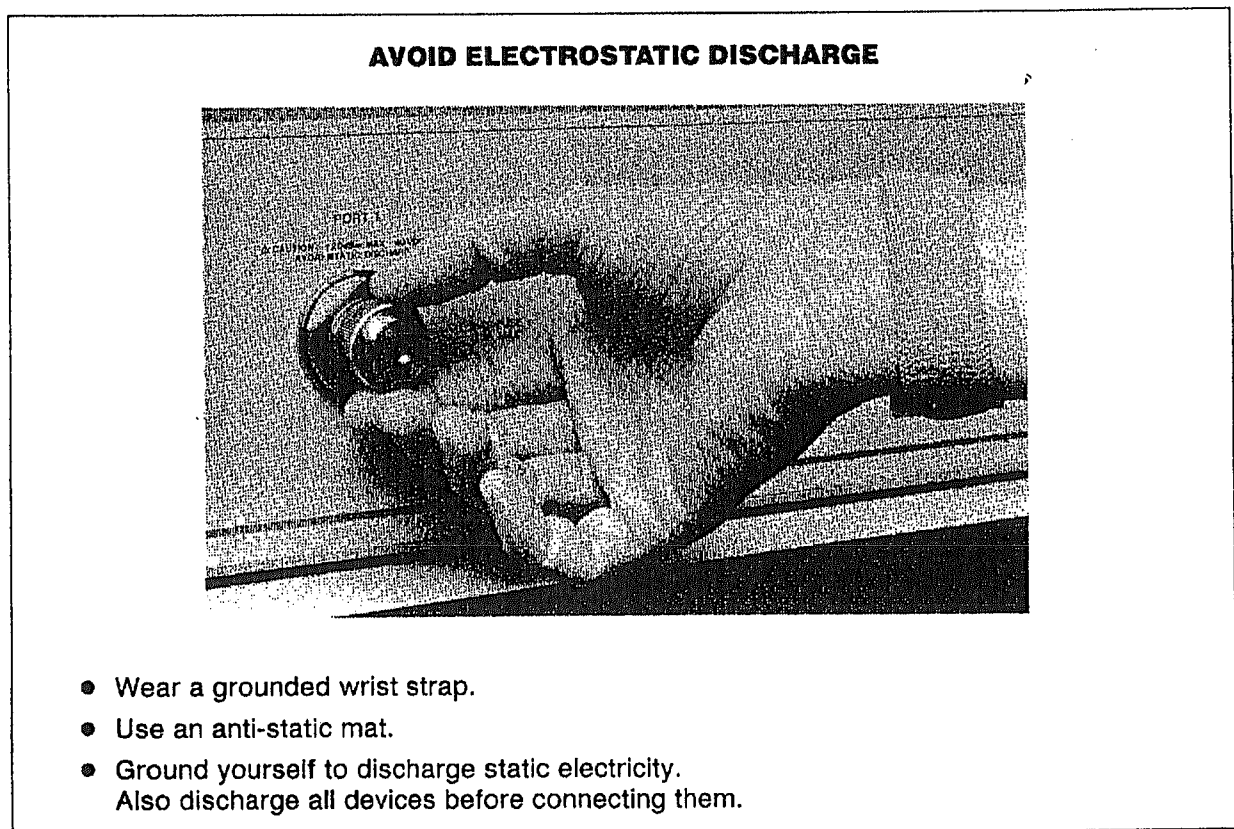
Figure 2. Electrostatic Discharge

VISUAL INSPECTION

- **Inspect all connectors carefully before every connection.**
- **Look for metal particles, scratches, dents.**
- **Never use a damaged connector.**

Visual inspection and, if necessary, cleaning should be done every time a connection is made. Metal and metal by-product particles from the connector threads often find their way onto the mating plane surfaces when a connection is disconnected, and even one connection made with a dirty or damaged connector can damage both connectors beyond repair.

Magnification is helpful when inspecting connectors, but it is not required and may actually be misleading. Defects and damage that cannot be seen without magnification generally have no effect on electrical or mechanical performance. Magnification is of great use in analyzing the nature and cause of damage, and in cleaning connectors, but it is not required for inspection.

Obvious Defects or Damage. Examine the connectors first for obvious defects or damage: badly worn plating, deformed threads or bent, broken, or misaligned center conductors. Connector nuts should move smoothly and be free of burrs, loose metal particles, and rough spots. Immediately discard, or mark and send away for repair, any connector that has obvious defects like these.

Mating Plane Surfaces. Next concentrate on the mating plane surfaces. Flat contact between the connectors at all points on their mating plane surfaces is required for a good connection. Therefore, particular attention should be paid to deep scratches or dents, and to dirt and metal or metal by-product particles on the connector mating plane surfaces.

Also look for bent or rounded edges on the mating plane surfaces of the center and outer conductors and for any signs of damage due to excessive or uneven wear or misalignment.

Light burnishing of the mating plane surfaces is normal, and is evident as light scratches or shallow circular marks distributed more or less uniformly over the mating plane surface. Other small defects and cosmetic imperfections are also normal. None of these affect electrical or mechanical performance.

If a connector shows deep scratches or dents, particles clinging to the mating plane surfaces, or uneven wear, clean it and inspect it again. Damage or defects of these kinds – dents or scratches deep enough to displace metal on the mating plane surface of the connector – may indicate that the connector itself is damaged and should not be used. Try to determine the cause of the damage before making further connections.

Precision 7mm Connectors. Precision 7mm connectors, among them APC-7® connectors, should be inspected visually with the center conductor collets in place, and whenever the collet has been removed. (APC-7 is a U.S.-registered trademark of the Bunker Ramo Corporation.)

The collet itself should be inspected for edge or surface damage and for any signs that the spring contacts are bent or twisted. If they are, replace the collet. When the collet has been re-inserted, verify that it springs back immediately when pressed with a blunt plastic rod or with the rounded plastic handle of the collet removing tool. Never use a pencil or your finger for this purpose.

Sexed Connectors. On sexed connectors, especially precision 3.5mm (APC-3.5) and SMA connectors, pay special attention to the female center conductor contact fingers. These are very easily bent or broken, and damage to them is not always easy to see. Any connector with damaged contact fingers will not make good electrical contact and must be replaced.

Scratches

Light burnishing of the mating plane surfaces is normal, and it consists of uniform, shallow, concentric scratches distributed more or less uniformly over the plated surface. These are caused by the normal slight rotation of the mating planes against one another as the connection is made and generally do not affect performance.

Deep scratches are caused by individual hard particles, generally metal or metal by-product particles, or burrs left from machining, sliding across the mating plane surface and displacing metal in the same way as a plow moves dirt.

Deep scratches *running concentrically* (as do the grooves in a phonograph record) generally indicate that one or both of the connector mating plane surfaces was not perfectly clean when the connection was made, or that the one of the connectors has a burr or high spot somewhere on its surface. Deep scratches running *across* the mating plane surface are generally the result of rough handling during connection, disconnection, or storage.

On gold plated connectors, any scratch that goes through the gold plating to the beryllium copper underneath is a possible source of trouble. Inspect the scratch carefully under magnification to see whether the scratch has left a high spot of pushed-up metal on the mating plane surface. If it has, do not use the connector. It will only damage other connectors it is mated to, by cutting into the plating.

If all of the metal displaced in the scratch has been removed or has worn away, and no high spots remain, the connector may still be usable. Full, flat circular contact between the mating plane surfaces will not occur, but the connection may still be satisfactory for most purposes.

Dents

Dents occur most often on the outside edges of mating plane surfaces, and under magnification they look like small craters or valleys. Metal is pushed outward and upward from the point of impact.

Sometimes dents are caused by careless handling or assembly of connectors during manufacture. Much more often, however, they are caused by dirt or metallic particles being pressèd into the mating plane surface, either during connection or while the connector is not in use. Even an apparently clean work surface may have particles on it large and hard enough to dent or scratch a connector if any pressure is applied. Dents are also caused by sudden, sharp, metal-to-metal impact, as occurs most often when a connector is dropped or another metal part is bumped against it.

Connectors that have dents anywhere on the mating plane surfaces will not make perfect contact, and the raised edges will dent any connectors they are mated to. Unless the damage is very slight, all such connectors should be replaced.

Metal and Metal By-Product Particles

Metal and metal by-product particles such as metallic salts on the connector mating plane surfaces are the most common kinds of dirt found on connectors, and these particles can be extremely damaging. They are very hard and can quickly scratch or dent the gold plating on connectors they are mated to.

Metal and metal by-product particles originate most often on the connector nut threads, and if such particles are found, the connector should be cleaned completely. First clean and re-inspect the connector nut threads, then clean the mating plane surfaces and blow the entire connector dry with compressed air. Details on cleaning appear in the next section of this **Microwave Connector Care Manual.**

Particle contamination can also result from setting the connectors contact-end down on a work surface, even on one that appears to be clean, and from touching the mating plane surfaces, even with clean hands. Particles left behind after cleaning, for example fibers from cleaning swabs, can generally be removed by blowing the connector dry with clean compressed air.

CLEANING

- **Try compressed air first.**

- **If a solvent is necessary, use pure liquid Freon.
  Clean very dirty connectors with pure isopropanol.
  Other solvents should not be used.**

- **Use the least amount of solvent possible, and avoid wetting any plastic parts in the connectors with the solvent.**

- **Never spray solvent directly into a connector.**

- **Check solvents periodically for contamination.**

Careful cleaning of all connectors is essential to assure long, reliable connector life, to prevent accidental damage to connectors, and to obtain maximum measurement accuracy and repeatability. Yet it is the one step most often neglected or done improperly.

Supplies recommended for cleaning microwave connectors are shown in Figure 3. Cotton swabs are the most useful generally, for cleaning connector threads and mating plane surfaces. A lint-free cleaning cloth is useful for cleaning precision 7mm connectors and the interior surfaces of all connectors.

Compressed Air

Always use protective eyewear when using compressed air, even if the source is a small pressurized can.

Loose particles on the connector mating plane surfaces can usually be removed with a quick blast of compressed air. This is very easy to do and should always be tried first. Clean air cannot damage the connectors or leave particles or residues behind.

Any source of clean, dry, low-pressure compressed air can be used if it has an effective oil-vapor filter and liquid condensation trap placed just before the outlet hose. The hose nozzle should be grounded to prevent electrostatic discharge, and the air pressure set for a very low velocity (< 60 psi). High-velocity air can cause undesirable electrostatic effects when directed into a connector.

But the easiest method is to use compressed air (actually compressed Freon) from a small pressurized can. This is available as HP Part Number 8500-2503, and the stream of air can be directed exactly where it is wanted through a plastic (not metal) nozzle. No hoses or other connections are needed.

Hold the can upright, to avoid spraying liquid along with the vapor. The liquid (propellant) will not damage the connectors. But rapid vaporization and expansion of the liquid as it escapes from the end of the plastic tube can cool the connector very rapidly. The undesirable result is that water vapor from the atmosphere condenses on and inside the the connector, and sometimes the interior support bead may be cracked or shift position.

If liquid is accidentally sprayed onto a connector, immediately move the air source away from the connector and purge the liquid from the plastic tube with more vapor. When the tube is empty, spray the connector with vapor from a distance of about 6 inches (15 cm) to evaporate any condensation. Then allow the connector to return to normal room temperature before using it. If the bead has cracked or shifted position, the connector will have to be repaired or replaced.

Cleaning Solvents

Use solvents only in well ventilated areas. Avoid prolonged breathing of solvent vapors and contact of solvents with the skin.

Dirt and stubborn contaminants that cannot be removed with compressed air can often be removed with a cotton swab (HP Part Number 8520-0023) or lint-free cleaning cloth (HP Part Number 9310-4242) moistened with a solvent.

Use the least amount of solvent possible, and avoid wetting any plastic parts in the connectors with the solvent.

Recommended Solvents. Generally, pure liquid Freon (trichlorotrifluoroethane), available as HP Part Number 8500-1251, is the best solvent for cleaning microwave connectors. It is chemically inert and evaporates cleanly, without leaving a residue or film.

Very dirty connectors can be cleaned with isopropanol. Be aware that isopropanol quickly absorbs water from the atmosphere, however. Water applied to connectors even in this way takes a long time to evaporate and until it evaporates may result in a loss of measurement repeatability. Use at least 92 per cent isopropanol and a very small container, and replace the supply often.

Other solvents, including types of liquid Freon and isopropanol that contain additives, should not be used.

Acetone, methanol, denatured alcohol, and chlorinated hydrocarbons such as trichloroethylene (TCE), are all harmful to the plastic dielectric support beads in microwave connectors. Alcohols such as ethanol or isopropanol are less harmful than methanol but are not always easy to obtain in sufficiently pure form. Ethanol is often denatured with methanol; isopropanol, especially in the common form of rubbing alcohol, often contains large amounts of water and additives such as glycerine, oils, and perfume. Pure liquid Freon is inexpensive, it is easy to obtain and use, and with very few exceptions is not harmful to plastic parts.

COMPRESSED "AIR"
HP Part Number 8500-2503

LIQUID FREON
HP Part Number 8500-1251

COTTON SWABS
HP Part Number 8520-0023

LINT-FREE CLEANING CLOTH
HP Part Number 9310-4242
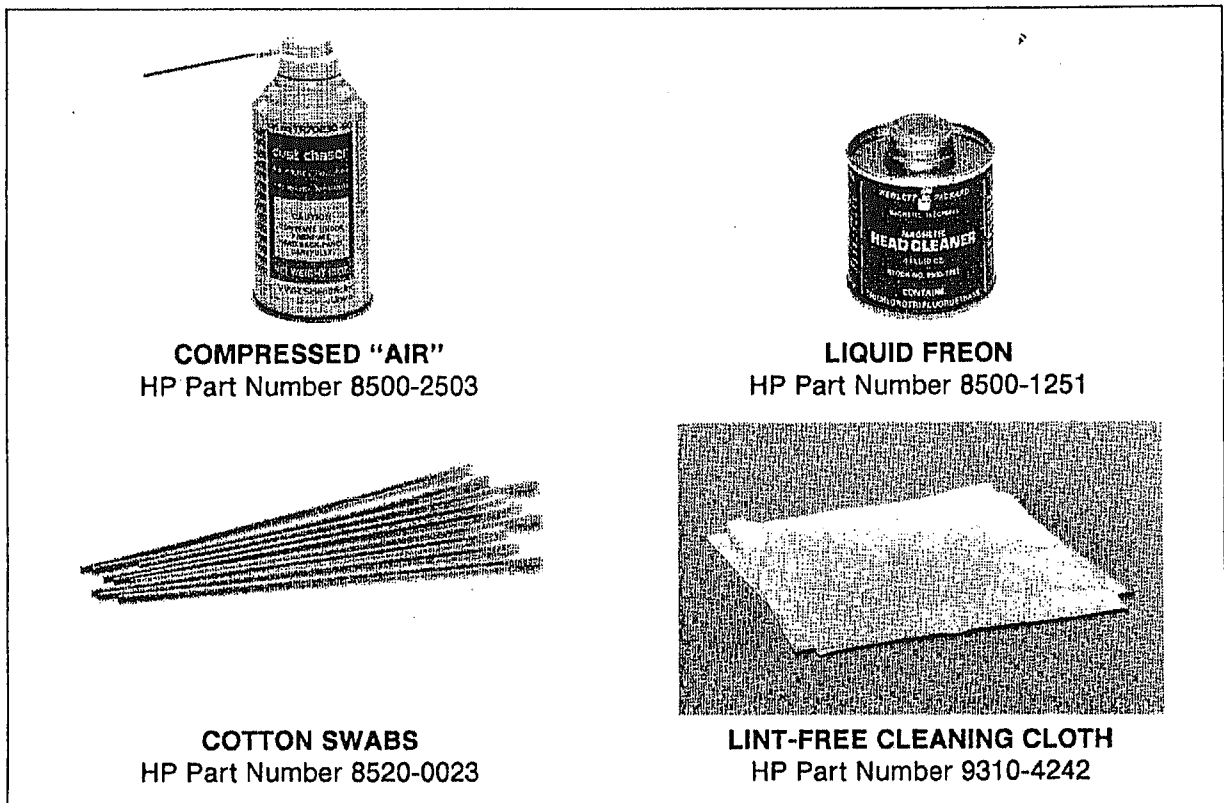
Figure 3. Recommended Cleaning Supplies

Using Solvents. Whichever solvent is used, always use the least amount of solvent possible, and carefully avoid wetting the plastic support bead inside the connector and blow the connector dry immediately with a gentle stream of compressed air. Support beads are easily damaged by solvents.

Use solvents in liquid rather than spray form. If a spray must be used, always spray the solvent onto a cloth or swab, never directly into a connector.

Check the solvent periodically for contamination by pouring a few drops of the solvent onto a clean glass plate or microscope slide and letting it evaporate. Then examine the glass in reflected light. It should be perfectly clean and free of residue. If it is not, do not use solvent from that container.

Cleaning Technique

In cleaning connectors, apply a very small amount of solvent to a cotton swab or a lint-free cleaning cloth. Then clean the connector as gently as you can. Do not apply solvent directly to the connector, for example from a spray can, because this can lead to excessive cooling of the connector as the excess solvent evaporates.

Cleaning Connector Threads. Clean the threads of the connectors first. Every time a connection or a disconnection is made, a small amount of metal wears off of the threads, and this metal often finds its way onto the mating plane surfaces of the connectors.

Use a cotton swab and pure liquid Freon to scrub all connector threads. Allow the solvent to evaporate and then blow the threads dry with a gentle stream of clean, low-pressure compressed air.

Cleaning the Connector Mating Plane Surfaces. When the connector threads have been cleaned, apply a small amount of solvent to a new swab and clean the mating plane surfaces. If the connector is a precision 7mm connector, this should be done first with the center conductor collet removed.

Use very short horizontal or vertical strokes (across the connector), and the least pressure possible, to avoid damaging the center conductor. This is especially necessary when when female connectors are being cleaned, to avoid snagging the cleaning swab on the center conductor contact fingers. An illuminated magnifying glass is very helpful in making these small areas easy to see.

Cleaning Connectors on Static-Sensitive Devices. Cleaning connectors attached to static-sensitive circuits, test set connectors for example, requires special care to avoid static discharge. When cleaning such connectors (Figure 4), always wear a grounded wrist strap and before touching the connector itself (even with a plastic swab) discharge static electricity to ground. This is easily done by grasping the outer shell of the test port briefly. These precautions will prevent electrostatic discharge (ESD) and possible circuit damage.

CLEAN CONNECTORS CAREFULLY

- Try clean compressed "air" (Freon) first.
- If solvent is necessary, use pure liquid Freon.
- Use as little solvent as possible, and avoid wetting plastic connector parts.
- Clean connector threads first.
- Clean hard-to-reach areas by wrapping lint-free cloth around a thin wooden or plastic rod.
- After cleaning them, blow connectors dry with clean compressed "air" (Freon).

CLEANING CONNECTORS ON STATIC-SENSITIVE DEVICES

COMPRESSED   LIQUID   COTTON   GROUNDED
AIR   FREON   SWAB   WRIST STRAP
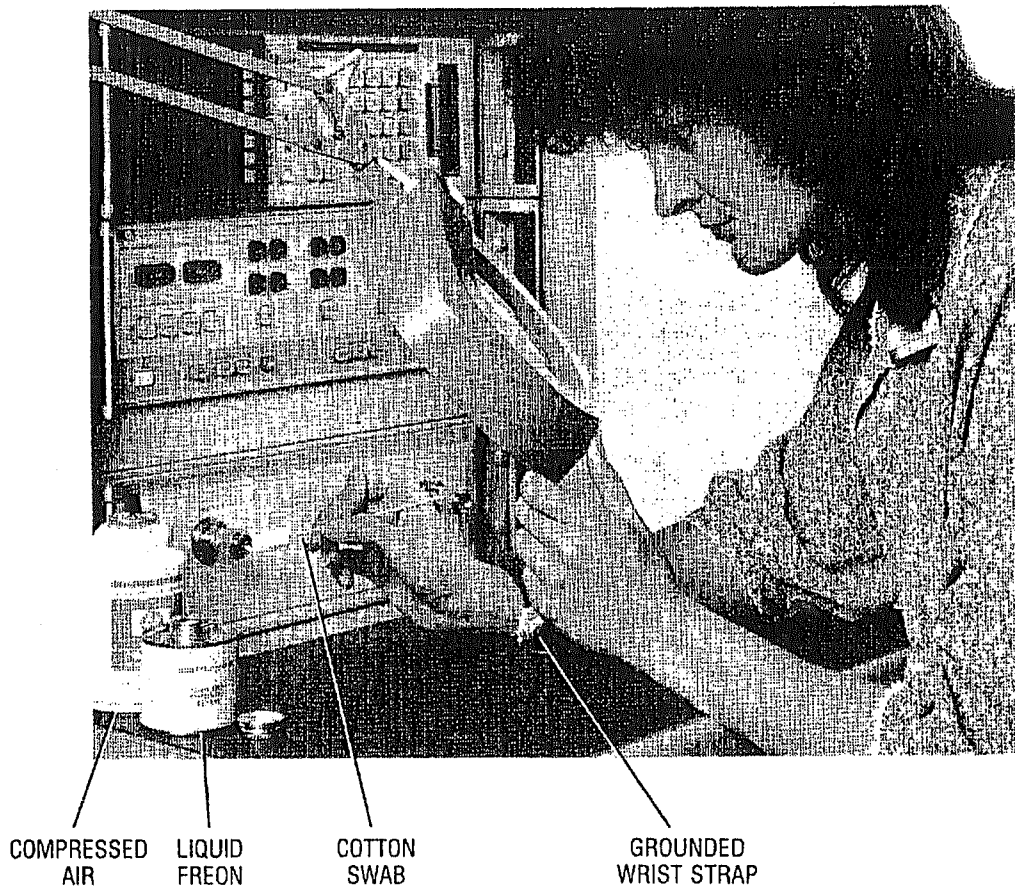
Figure 4.   Cleaning Microwave Connectors

Cleaning Interior Surfaces.   Interior surfaces, especially on 3.5mm connectors, are very difficult to reach, and it is easy to damage connectors in trying to clean them. The openings are very small, and generally the center conductor is supported only at the inner end, by a plastic dielectric support bead. This makes it very easy to bend or break the center conductor.

One suitable method (Figure 5) is to cut off the sharp tip of a round wooden toothpick and then to wrap it with a single layer of lint-free cleaning cloth.

A round wooden toothpick or a very small diameter wooden rod is required: metal must never be used (it will scratch the plated surfaces), and in cleaning precision 3.5mm connectors the diameter must not exceed 0.070 in. (1.7 mm). The wooden handle of a cotton swab, for example, is too large for this purpose. Even though the handle can sometimes be inserted into the connector, even when wrapped in lint-free cloth, movement of the handle against the center conductor can exert enough force on the center conductor to damage it severely.

Moisten the cloth with a small amount of cleaning solvent and carefully insert it into the connector to clean the interior surfaces.   Use an illuminated magnifying glass or microscope to see clearly the areas you wish to clean.

Precision 7mm Connectors.   When precision 7mm connectors have been cleaned with the center conductor collet removed, insert the collet and clean the mating plane surfaces again.

When the connector is attached to a small component, or to a cable or calibration of verification standard, the easiest way to do this is to put a lint-free cleaning cloth flat on a table and to put a drop or two of cleaning solvent in the center of the cloth (Figure 5). Note that it is not necessary to remove the collet in order to use this cleaning method. Retract the connector sleeve threads so that the connector interface is exposed. Then gently press the contact end of the connector into the cloth moistened with solvent and turn it.

Dirt on the connector interface will be scrubbed away by the cloth without damaging the connector. Blow the connector dry with a gentle stream of compressed air. Keep the cloth in a plastic bag or box so that it does not collect dust or get dirty when not in use.

This cleaning method can be adapted even for fixed connectors such as those attached to test ports. Simply fold the cloth into several layers of thickness, moisten it, press it against the connector interface, and turn it to clean the connector. Blow the connector dry with a gentle stream of compressed air.

Drying Connectors.   When you have cleaned a connector, always be sure that it is completely dry before reassembling or using it. Blow the connector dry with a gentle stream of clean compressed air and inspect it again under a magnifying glass to be sure that no particles or solvent residues remain.

CLEANING INTERIOR SURFACES
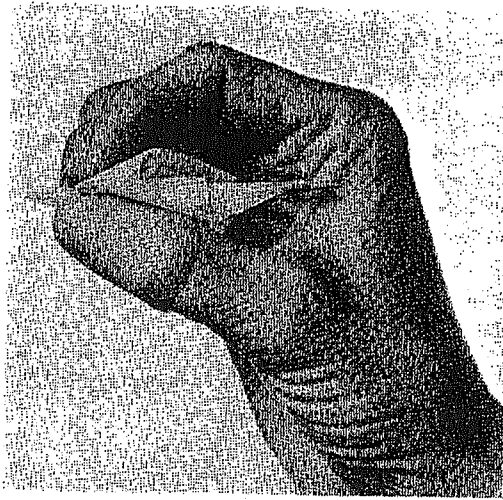
CLEANING PRECISION 7mm CONNECTORS

- Put a drop or two of cleaning solvent in the center of a lint-free cleaning cloth.
- Retract the connector sleeve threads. Press the contact end of the connector into the cloth and turn it.
- Removing the collet is not necessary.
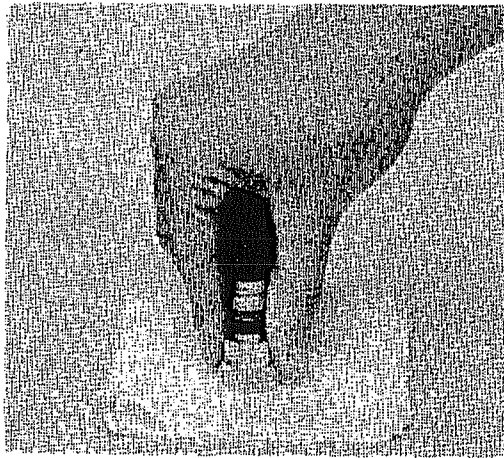
- Blow the connector dry with a gentle stream of compressed air.
- Keep the cloth clean in a plastic bag or box when it is not in use.

Figure 5. Cleaning Interior Surfaces and Precision 7mm Connectors

MECHANICAL INSPECTION: CONNECTOR GAGES

- **Inspect connectors mechanically, using a connector gage, before they are used for the first time and periodically after that.**

- **Use the correct gage type and gage calibration block for the connector being gaged.**

- **Inspect, clean, and zero the gage before using it. Check the zero setting again before each measurement.**

- **Connector specifications depend on the device. Consult the mechanical specifications provided with the connector or the device itself to determine whether it is within specification.**

Even a perfectly clean, unused connector can cause trouble if it is mechanically out of specification. Since the critical tolerances in microwave connectors are on the order of a few ten-thousandths of an inch, using a connector gage is essential.

Before using any connector for the first time, inspect it mechanically using a connector gage. How often connectors should be gaged after that depends upon usage.

In general, connectors should be gaged whenever visual inspection or electrical performance suggests that the connector interface may be out of specification, for example due to wear or damage. Connectors on calibration and verification devices should also be gaged whenever they have been used by someone else or on another system or piece of equipment.

Precision 3.5mm and SMA connectors should be gaged relatively more often than other connectors, owing to the ease with which the center pins can be pulled out of specification during disconnection.

Connectors should also be gaged as a matter of routine – after every 100 connections and disconnections initially, more or less often after that as experience suggests.

Mechanical Specifications

The critical dimension to be measured, regardless of connector type, is the position (generally, the recession or setback) of the center conductor relative to the outer conductor mating plane. See Figures 6 through 9.

Mechanical specifications for connectors specify a maximum distance and a minimum distance that the center conductor can be positioned behind (or, in female Type-N connectors, in front of) the outer conductor mating plane.

Nominal specifications for each connector type exist. But the allowable tolerances (and sometimes the dimensions themselves) differ from manufacturer to manufacturer and from device to device.

Therefore, before gaging any connector, consult the mechanical specifications provided with the connector or the device itself.

Precision 7mm Connectors.   In precision 7mm connectors (Figure 6), contact between the center conductors is made by spring-loaded contacts called collets. These protrude slightly in front of the outer conductor mating plane when the connectors are apart. When the connection is tightened, the collets are compressed into the same plane as the outer conductors.

For this reason, two mechanical specifications are generally given for precision 7mm connectors: the maximum *recession of the center conductor* behind the outer conductor mating plane with the center conductor collet removed; and a minimum and maximum allowable *protrusion of the center conductor collet* in front of the outer conductor mating plane with the collet in place.

The center conductor collet should also spring back immediately when pressed with a blunt plastic rod or with the rounded plastic handle of the collet removing tool.

With the center conductor collet removed, no protrusion of the center conductor in front of the outer conductor mating plane is ever allowable, and sometimes a minimum recession is required. Consult the mechanical specifications provided with the connector or the device itself.

**PRECISION 7mm CONNECTOR
CENTER CONDUCTOR COLLET IN PLACE**

OUTER
CONDUCTOR
MATING
PLANE →

COLLET
PROTRUSION
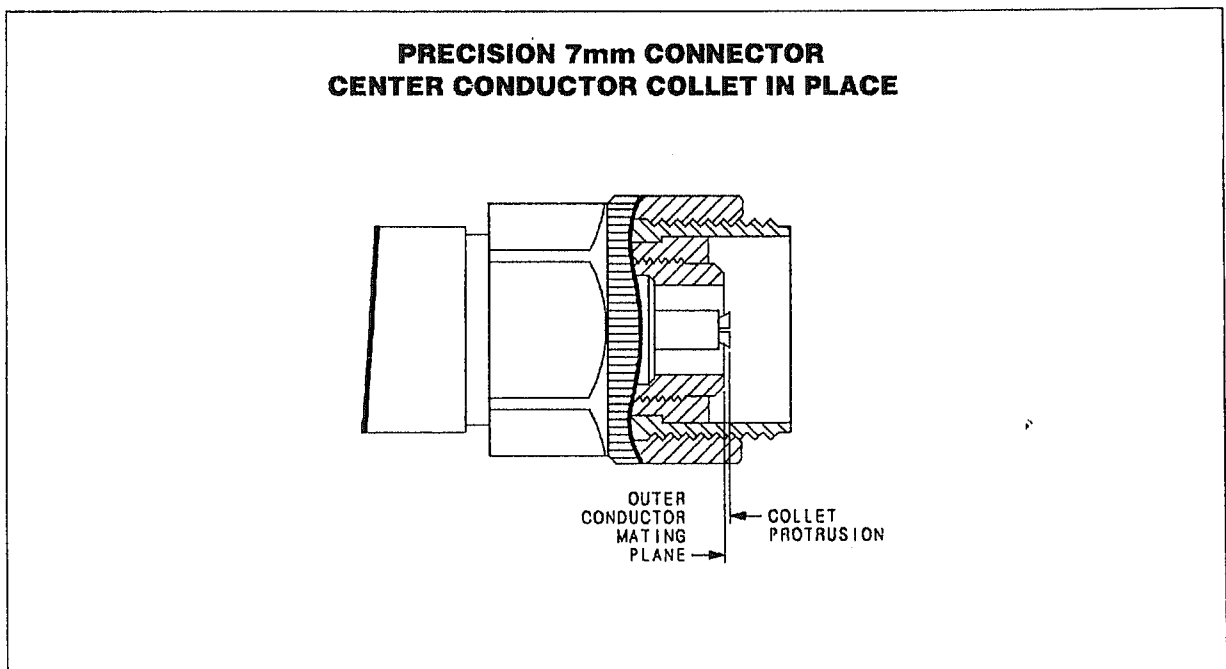
Figure 6.   Precision 7mm Connector

Type-N Connectors. Type-N connectors differ from other connector types in that the outer conductor mating plane is offset from the mating plane of the center conductors (Figure 7). The outer conductor sleeve in the male connector extends in front of the shoulder of the male contact pin. When the connection is made, this outer conductor sleeve fits into a recess in the female outer conductor behind the plane defined by the tip of the female contact fingers.

In Type-N connectors, the position of the center conductor in the male connector is defined as the position of the shoulder of the male contact pin – not the position of the tip. The male contact pin slides into the female contact fingers and electrical contact is made by the inside surfaces of the tip of the female contact fingers on the sides of the male contact pin.

Hence the critical mechanical specifications of Type-N connectors are a *maximum protrusion of the female contact fingers* in front of the outer conductor mating plane and a *minimum recession of the shoulder of the male contact pin* behind the outer conductor mating plane.

As Type-N connectors wear, the protrusion of the female contact fingers generally increases, due to wear of the outer conductor mating plane inside the female connector. This decreases the total center conductor contact separation and should be monitored carefully.

No Type-N connector should ever be used when there is any possibility of interference between the shoulder of the male contact pin and the tip of the female contact fingers when the connectors are mated. In practice this means that no Type-N connector pair should be mated when the separation between the tip of the female contact fingers and the shoulder of the male contact pin could be less than zero when the connectors are mated. Gage Type-N connectors carefully to avoid damage.

75Ω Type-N Connectors. 75Ω Type-N connectors differ from 50Ω Type-N connectors most significantly in that the center conductor, male contact pin, and female contact hole are all smaller. Therefore, mating any male 50Ω Type-N connector with a female 75Ω Type-N connector will destroy the female 75Ω connector by spreading the female contact fingers apart permanently or even breaking them.

If both 75Ω and 50Ω Type-N connectors are among those on the devices you are using, mark the 75Ω Type-N connectors to be sure that they are never mated with any 50Ω Type-N connectors.
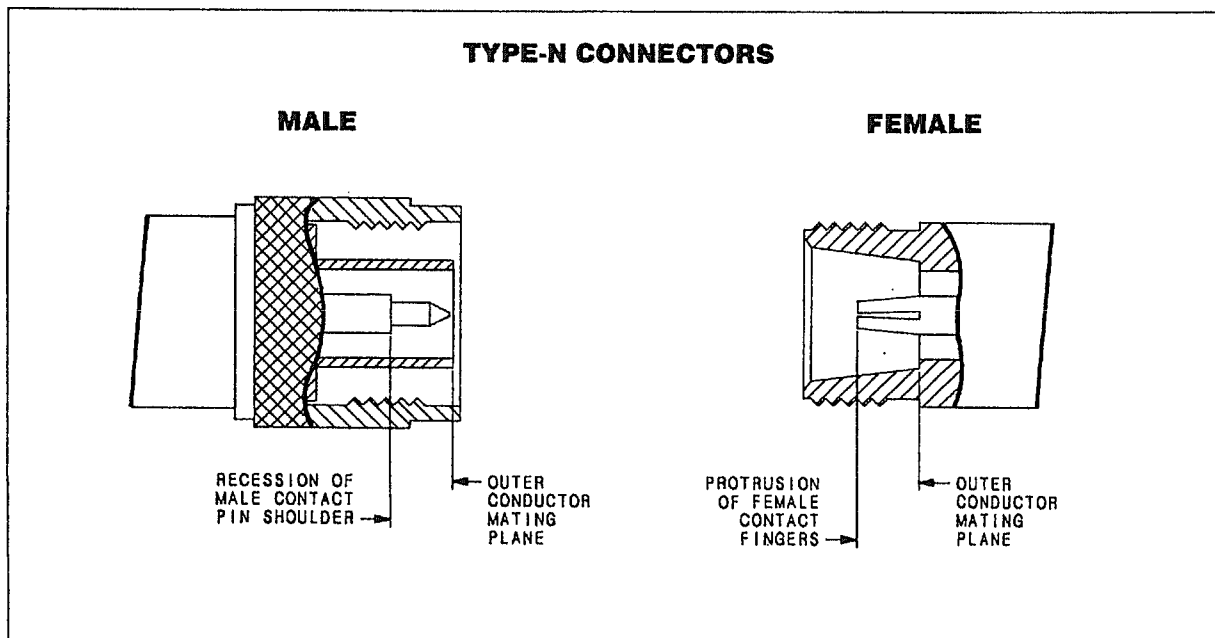
Figure 7.   *Type-N Connectors*

SMA and Precision 3.5mm Connectors. Because of their smaller size, SMA and precision 3.5mm connectors can be used at higher frequencies than 7mm and Type-N connectors can. Both types are in common use today.

SMA connectors (Figure 8) are low-cost connectors generally used up to about 23 GHz. A solid plastic dielectric separates the center and outer conductors. Precision 3.5mm connectors, also known as APC-3.5 connectors, are precision air-dielectric connectors that will mate with SMA connectors. They offer much greater repeatability of connection than SMA connectors do, and for this reason they are widely used on electronic test equipment. Precision 3.5mm connectors can be used up to about 34 GHz.

Both SMA and precision 3.5mm connectors are sexed connectors. The male contact pin slides into the female contact fingers and electrical contact is made by the inside surfaces of the tip of the female contact fingers on the sides of the male contact pin. The mechanical specifications for both SMA and precision 3.5mm connectors give a maximum and a minimum *recession of the shoulder of the male contact pin* and a maximum and a minimum *recession of the tip of the female contact fingers* behind the outer conductor mating plane.

No protrusion of the shoulder of the male contact pin or of the tip of the female contact fingers in front of the outer conductor mating plane is ever allowable, and sometimes a minimum recession (other than zero) is also required. Consult the mechanical specifications provided with the connector or the device itself.

SMA CONNECTORS

MALE   **FEMALE**

OUTER CONDUCTOR
MATING PLANE

Figure 8.   SMA Connectors

PRECISION 3.5mm CONNECTORS

MALE   **FEMALE**

OUTER CONDUCTOR
MATING PLANE
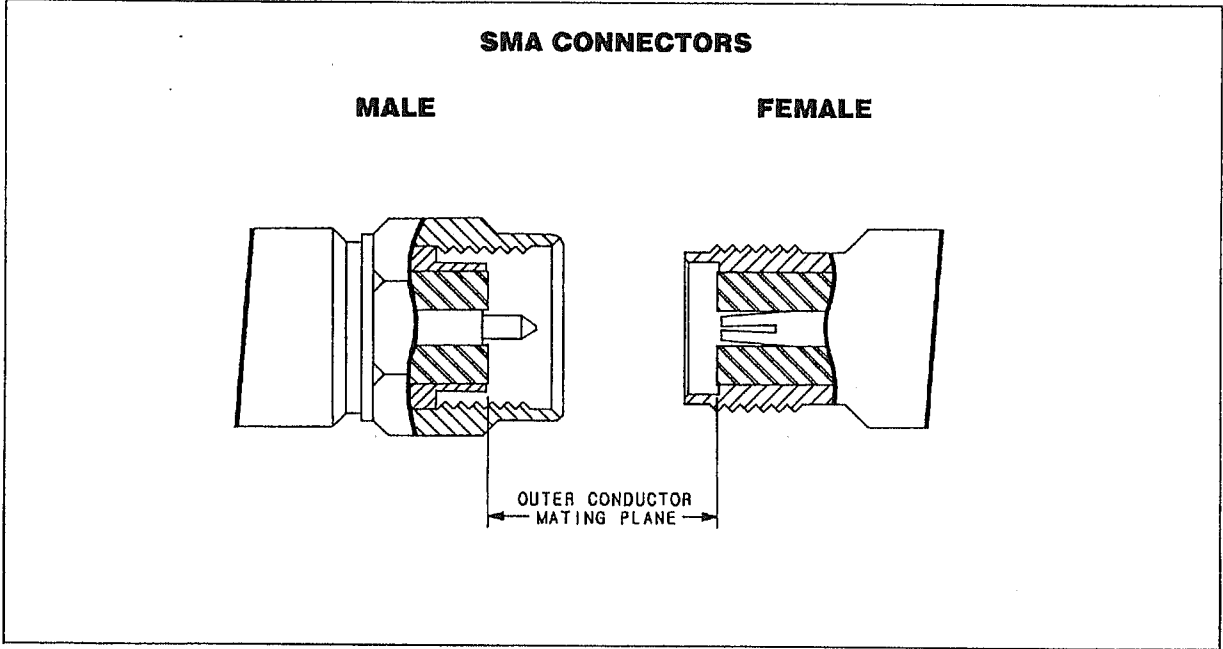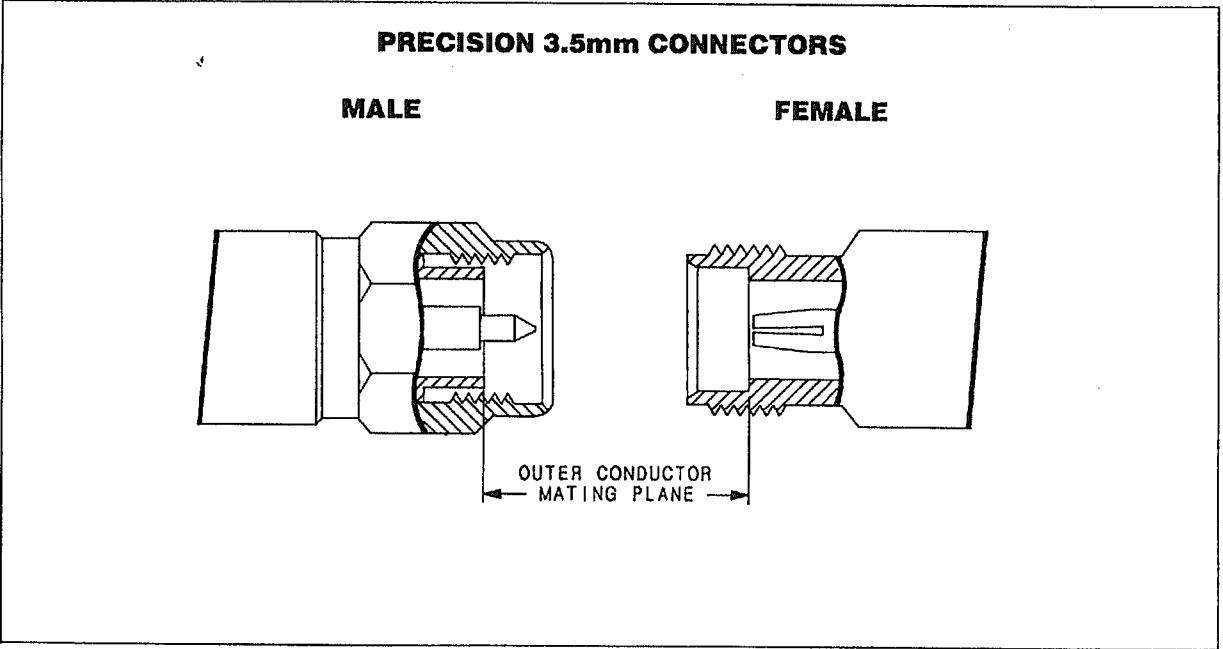
Figure 9.   Precision 3.5mm Connectors

Types of Gages

A different connector gage is required for each type of connector. Sexed connectors require two gages, male and female, or (in the case of Type-N connectors) a single gage and male and female adapter bushings, and every connector gage requires a gage calibration block for zeroing the gage. Connector gages for precision 7mm connectors also require an aligning pin and pin wrench in order to measure the center conductor depth of beadless airlines with the centering pin removed.

Care is necessary in selecting a connector gage to measure microwave connectors. Some gages have a very strong gage plunger spring – strong enough, in some cases, to push the center conductor back through the connector, damaging the device itself. Other gages may compress the center conductor collet in precision 7mm connectors during the measurement, giving an inaccurate reading when the collet protrusion is measured.

Connector gage kits containing gages recommended for microwave connectors and all of the other items required are included in many Hewlett-Packard calibration kits, and they are also available separately. Part numbers are given in Table 1.

Table 1. Recommended Connector Gages

Connector Type	Manufacturer's Part Number	HP Part Number
Precision 7mm		
Gage Kit	—	1250-1875
Gage	MMC 299-D-009 *or*	
	Starrett 81-11-624	
Calibration Block	MMC 028-2	
Aligning Pin	MMC 024-4	
Pin Wrench	MMC 024-5	
Precision 3.5mm		
Gage Kit	—	1250-1862
Male Gage	MMC A034B-M	
Female Gage	MMC A034B-F	
Calibration Block	MMC 027-3	
Type-N		
Gage Kit		85054-60024
SMA		
Gage Kit	MMC A-027A	

MMC   = Maury Microwave Corporation,   8610 Helms Avenue, Cucamonga, California   91730
             Telephone: 714-987-4715   TWX: 910-581-3408

Starrett   = L. S. Starrett Company,   Athol, Massachusetts   01331
             Telephone: 617-249-3551   TWX: 710-390-0271

Using Connector Gages

Before a connector gage is used, it must be inspected, cleaned, and zeroed.

Inspecting and Cleaning the Gage.   Inspect the connector gage and the gage calibration block carefully, exactly as you have inspected the connector itself, and clean or replace them if necessary. Dirt on the gage or the gage calibration block will make the gage measurements of the connectors inaccurate and can transfer dirt to the connectors themselves, damaging them during gaging or when the connection is made.

Zeroing the Gage.   Zero the gage by following the steps described below and shown in Figure 10. Be sure that you are using the correct connector gage and correct end of the gage calibration block for the connector being measured.

Hold the gage by the plunger barrel (not the dial housing or cap) and, for male connectors, slip the protruding end of the calibration block into the circular bushing on the connector gage. For precision 7mm connectors and female precision 3.5mm connectors, use the flat end of the gage calibration block. For female Type-N connectors, use the recessed end of the gage calibration block.

Hold the gage by the plunger barrel *only* (Figure 10). Doing so will prevent errors in gage readings due to the application of stresses to the gage plunger mechanism through the dial indicator housing.

Carefully bring the gage and gage block together, applying only enough pressure to the gage and gage block to result in the dial indicator pointer settling at a reading.

Gently rock the two surfaces together, to make sure that they have come together flatly. The gage pointer should now line up exactly with the zero mark on the gage. If it does not, inspect and clean the gage and gage calibration block again and repeat this process. If the gage pointer still does not line up with the zero mark on the gage, loosen the dial lock screw and turn the graduated dial until the gage pointer exactly lines up with zero. Then re-tighten the lock screw.

Gages should be checked often to make sure that the zero setting has not changed. Generally, when the gage pointer on a gage that has been zeroed recently does not line up exactly with the zero mark, the gage or calibration block needs cleaning. Clean both of these carefully and check the zero setting again.

Measuring Connectors.   Measuring the recession of the center conductor behind the outer conductor mating plane in a connector is done in exactly the same way as zeroing the gage, except of course that the graduated dial is not re-set when the measurement is made.

If the connector has a retractable sleeve or sliding connector nut – precision 7mm connectors, for example – extend the sleeve or nut fully. This makes it easier to keep the gage centered in the connector.

Hold the gage by the plunger barrel and slip the gage into the connector so that the gage plunger rests against the center conductor. Carefully bring the gage into firm contact with the outer conductor mating plane. Apply only enough pressure to the gage as results in the gage pointer settling at a reading.

Gently rock the connector gage within the connector, to make sure that the gage and the outer conductor have come together flatly. Then read the recession (or protrusion) from the gage dial.

For maximum accuracy, measure the connector several times and take an average of the readings. Rotate the gage relative to the connector between each measurement. To monitor connector wear, record the readings for each connector over time.

ZEROING THE CONNECTOR GAGE

GAGE CALIBRATION
BLOCK

HOLD GAGE
BY PLUNGER BARREL
ONLY

DIAL LOCK
SCREW

HOLD GAGE FIRMLY AGAINST
GAGE CALIBRATION BLOCK

GAGE POINTER
SHOULD LINE UP
EXACTLY WITH ZERO

IF NOT, LOOSEN DIAL LOCK
SCREW AND TURN GRADUATED
DIAL UNTIL POINTER LINES
UP EXACTLY WITH ZERO MARK

TIGHTEN DIAL
LOCK SCREW
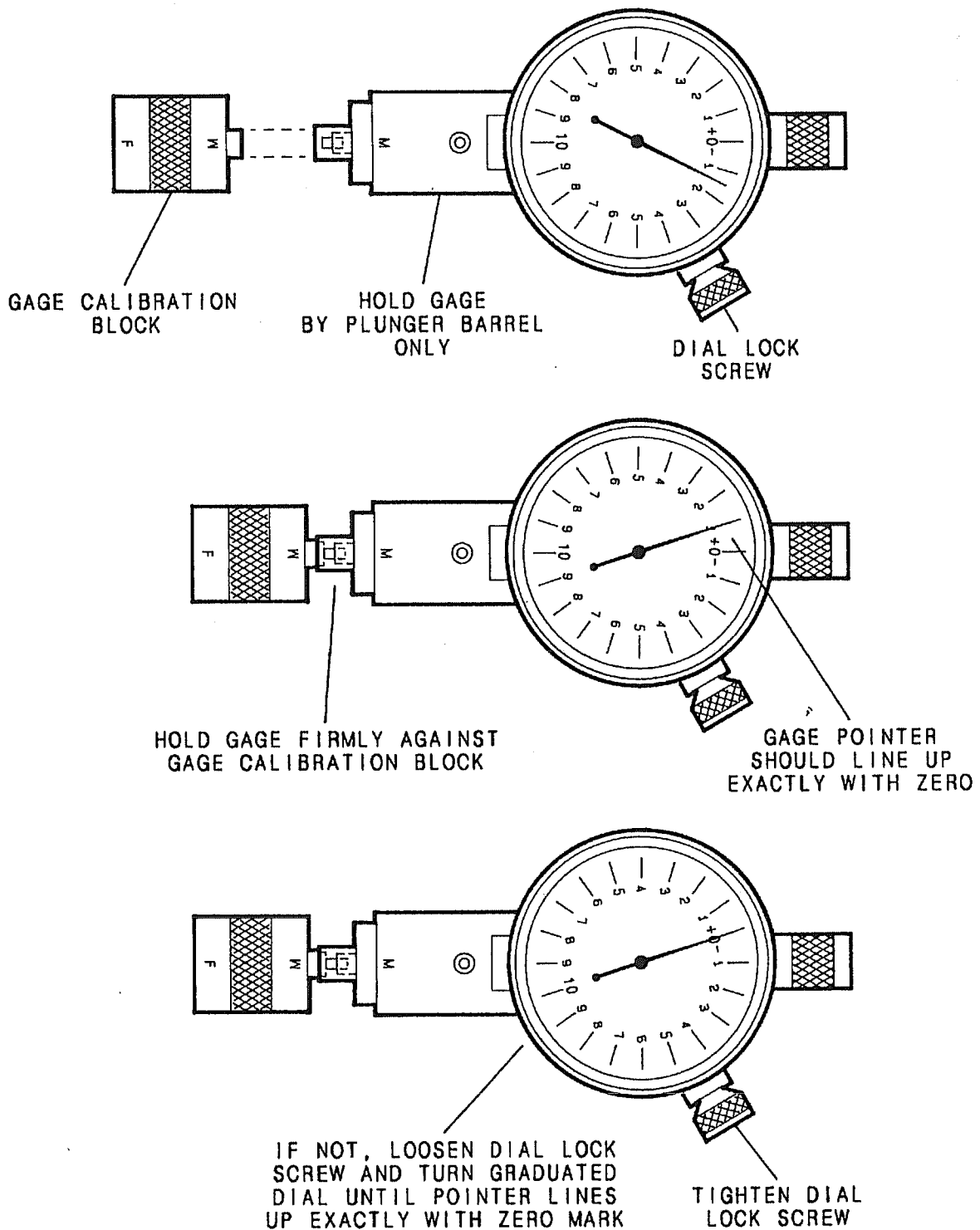
Figure 10.   Zeroing the Connector Gage

Gage Accuracy

An important general point about measuring connectors is that setback dimensions are difficult to measure, owing to measurement uncertainties of the connector gages (typically one small division on the dial) and to variations in technique from user to user.

For example, using a gage with 0.0001-inch small divisions on the dial to measure a connector that has an actual setback of 0.0005 inches may result in gage readings from 0.0004 to 0.0006 inches, depending on the gage. Note that this range of readings is possible due strictly to the measurement uncertainty of the gage. Other variables such as cleaning and gage technique can cause still further variations to appear between measurements of exactly the same connector.

For these reasons, Hewlett-Packard recommends that before deciding that a connector is out of specification, at least four things be done:

- Clean the connector, the connector gage, and the gage block again, following carefully the suggestions on cleaning made earlier in this **Microwave Connector Care Manual**. Zero the gage again and repeat the measurement. Measurements in which differences of 0.0001 inch are significant can be affected greatly by dirt and contamination.

- Measure the connector several times yourself, and also have another person make some measurements, in order to determine an average reading. This technique will help reduce uncertainties due to differences of technique and random variations in gage accuracy.

- Measure the connector using several different orientations of the gage within the connector. Averaging several readings, each taken after a quarter-turn rotation of the gage, will reduce measurement variations that result from the gage or the connector face not being exactly perpendicular to the center axis.

- Avoid holding the connector gage any other way than by the gage barrel, below the dial indicator. Holding the gage by the barrel offers maximum stability. It also improves measurement accuracy by preventing stresses from being applied to the gage plunger mechanism through the dial indicator housing – as occurs when the gage is cradled in the hand or held by the dial indicator.

In addition, keep records of the setback measurements made for each device over time. Noticeable differences from one set of measurements to the next may indicate errors in measurement technique or that the connector is damaged and needs to be replaced.

MAKING CONNECTIONS

- **Align connectors carefully.**
- **Make a preliminary connection lightly.**
- **Turn the connector nut ONLY in making connections.**
- **Do not rotate devices in making connections.**
- **Use a torque wrench for the final connection.**

Operator skill is essential in making good connections. The sensitivity of modern test instruments and the mechanical tolerances of the precision microwave connectors that are used today are such that slight errors in operator technique that once went unnoticed now have a significant effect on measurements and measurement uncertainties.

Making good connections is easy if a few simple principles are kept in mind:

- all connectors must be undamaged, clean, and within mechanical specification
- the connectors must be precisely aligned with one another and in flat physical contact at all points on the mating plane surfaces
- the connection must not be too tight or too loose
- lateral or horizontal (bending) force must not be applied to the connection, nor should any connection ever be twisted.

General Connection Technique

The steps to follow generally in making microwave connections are shown in Figures 11 and 12. For illustration, a fixed load that has a precision 7mm connector is shown being connected to a 7mm test port connector. But the steps and principles are the same regardless of connector type.

Before making any connections, inspect all connectors visually, clean them if necessary, and use a connector gage to verify that all center conductors are within specification.

If connections are made to any static-sensitive device, avoid electrostatic discharge by wearing a grounded wrist strap and grounding yourself and all devices before making any connections.

● Align connectors carefully

Careful alignment of the connectors is critical in making a good connection, both to avoid damaging connectors and devices and to assure accurate measurements.

As you bring one connector up to the other and as you make the actual connection, be alert for any sign that the two connectors are not aligned perfectly. If you suspect that misalignment has occurred, stop and begin again.

Alignment is especially important in the case of sexed connectors such as precision 3.5mm and SMA connectors, to avoid bending or breaking the contact pins. The center pin on the male connector must slip concentrically into the contact fingers of the female connector, and this requires great care in aligning the two connectors before and as they are mated.

When they have been aligned, the center conductors must be pushed straight together, not twisted or screwed together, and only the connector nut (not the device itself) should then be rotated to make the connection. Slight resistance is generally felt as the center conductors mate.

Alignment of precision 7mm connectors is made easier by the fact that the connector sleeve on one of the connectors must be extended fully (and the sleeve on the other connector retracted fully) in order to make the connection). Extending the sleeve creates a cylinder into which the other connector fits.

If one of the connectors is fixed, as on a test port, extend that connector sleeve and spin its knurled connector nut to make sure that the threads are fully extended. Fully retract the connector sleeve on the other connector.

● Make a preliminary connection lightly

Align the two connectors carefully and engage the connector nut over the exposed connector sleeve threads on the other connector. Then **turn the connector nut only** to make the preliminary connection.

Let the connector nut pull the two connectors straight together.

Do NOT twist one connector into the other as one might drive a screw or insert a light bulb. This is extremely harmful and can occur whenever the device body rather than the connector nut alone is turned.

When the mating plane surfaces make uniform, light contact, the preliminary connection is tight enough. **Do not overtighten this connection.**

At this point all you want is a connection in which the outer conductors make gentle contact at all points on both mating surfaces. Very light finger pressure (no more than 2 inch-ounces of torque) is enough.

GENERAL CONNECTION TECHNIQUE

● **Align connectors carefully**
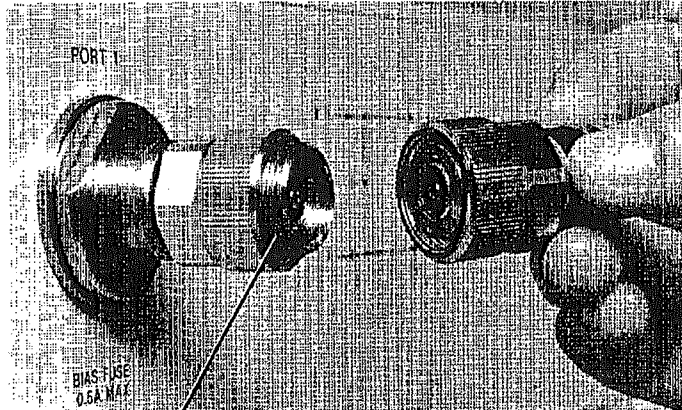
PRECISION 7mm CONNECTORS:
EXTEND CONNECTOR SLEEVE

● **Make preliminary connection lightly**
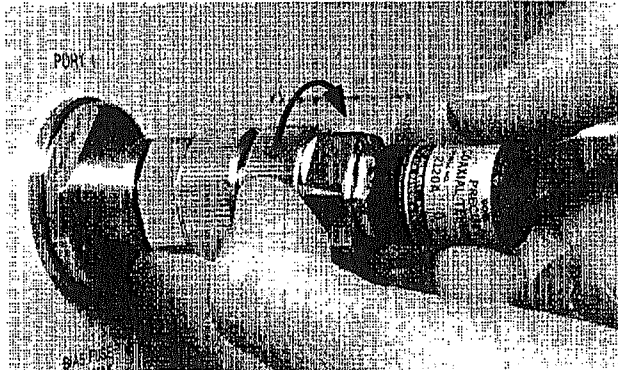
Engage connector nut over
exposed threads. Turn *connector
nut only* to tighten connection.

Light finger pressure (< 2 in-ounces) is enough. Connectors only need to make
uniform, light contact. Do not overtighten.

Figure 11.   General Connection Technique

● Use a torque wrench to make the final connection

When the preliminary connection has been made, use a torque wrench to make the final connection (Figure 12). Tighten the connection only until the "break" point of the wrench is reached, when the wrench handle gives way at its internal pivot point. **Do not tighten the connection further.**

Also make sure that torque actually is being applied to the connection through the torque wrench, not only to the wrench handle or in any way that prevents the "break" point of the wrench from controlling the torque applied to the connection. Suggestions are given below.

Using a torque wrench guarantees that the connection will not be too tight, thus preventing possible damage to the connectors and impaired electrical performance. It also guarantees that all connections will be made with the same degree of tightness every time they are made.

Torque wrenches pre-set to the correct value for each connector type are included in many Hewlett-Packard calibration kits, and they are also available separately. Torque settings and part numbers appear in Table 2.

In using a torque wrench, prevent rotation of anything other than the connector nut that is being tightened with the torque wrench. Generally this is easy to do by hand, all the more so if one of the connectors is fixed, as on a test port. In other situations, an open-end wrench can be used to keep the bodies of the connectors from turning.

Hold the torque wrench lightly by the knurled end of the handle only, in the manner shown in Figure 12. Apply force at the end of the torque wrench only, perpendicular to the wrench and always in a plane parallel to the outer conductor mating planes. This will result in torque being applied to the connection through the wrench until the "break" point of the wrench is reached.

Avoid pivoting the wrench handle on the thumb or other fingers. This results in an unknown amount of torque being applied to the connection when the "break" point of the wrench is reached. Avoid twisting the head of the wrench relative to the outer conductor mating plane. This results in applying more than the recommended torque.

Above all, avoid holding the wrench tightly, in such a way that the handle is not pivoted but simply pushed downward the same amount throughout its length. If this is done, an unlimited amount of torque can be applied.

Hold the wrench at the same point near the end of the handle every time, and always in the same orientation. When possible, begin tightening the connection with the wrench held nearly horizontal.

● Use a torque wrench to make the final connection
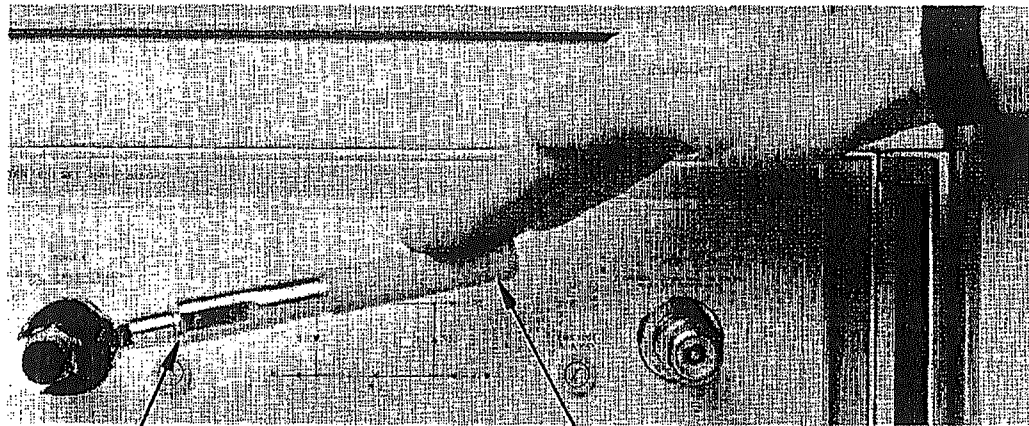
INTERNAL PIVOT
POINT OF WRENCH

KNURLED END
OF HANDLE

Hold the wrench lightly by the knurled end of the handle only.

Apply force on one side of the wrench only, perpendicular to the wrench and parallel to the plane of the outer conductors.

Allow the wrench to transmit force to the connection, through its internal pivot point. Do not twist the wrench.
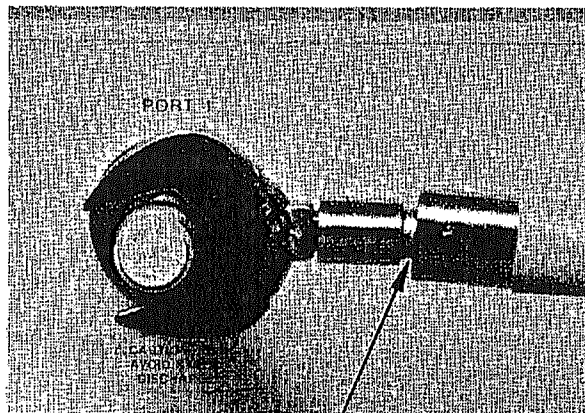
Proper torque has been achieved when the "break" point of the wrench is reached. Do not overtighten.

Figure 12.   Using the Torque Wrench   (1 of 2)

- ● **Avoid holding the torque wrench incorrectly**

  NOT RECOMMENDED - Wrench gripped tightly
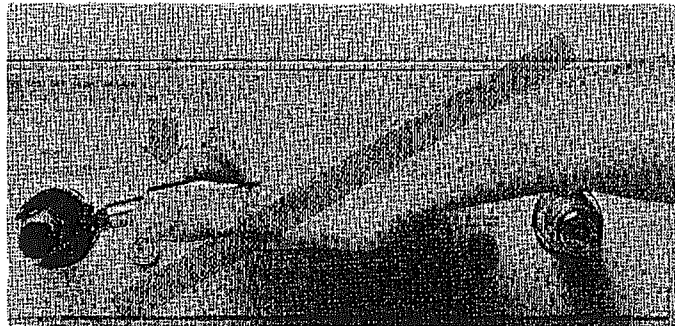
  NOT RECOMMENDED - Wrench pivoted on thumb
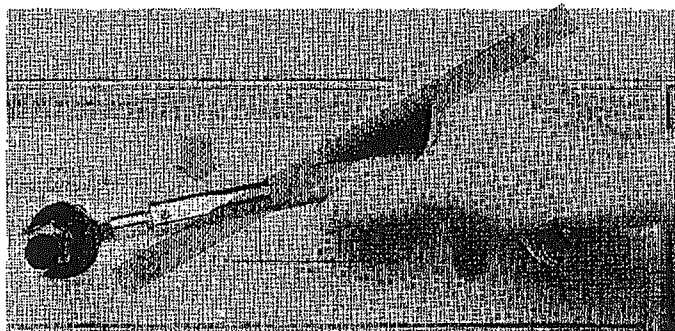
- ● **Always use the wrench in the correct orientation**

  RECOMMENDED
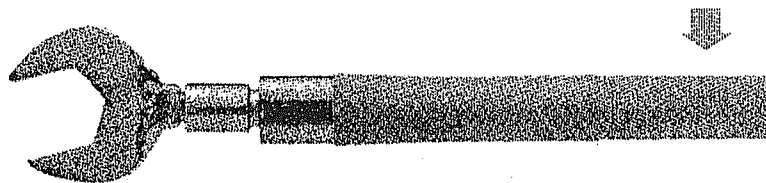
  NOT RECOMMENDED
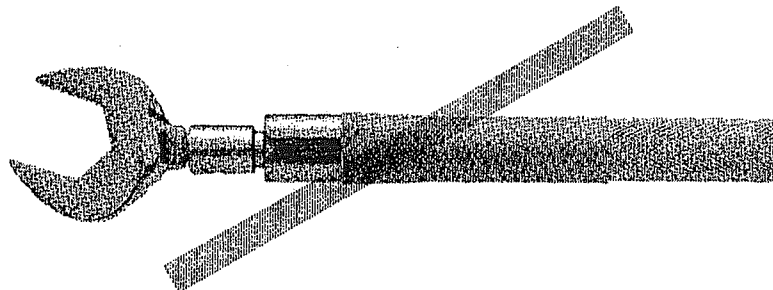
Figure 12.   Using the Torque Wrench   (2 of 2)

Table 2. Torque Wrenches

Connector Type	Torque Setting	HP Part Number
Precision 7mm	12lb-in 136 N-cm	1250-1874
Precision 3.5mm	8 lb-in 90 N-cm	1250-1863
Type-N	NOT REQUIRED Type-N connectors may be connected finger tight. If a torque wrench is used, 12 lb-in (136 N-cm) is recommended.	
SMA	5 lb-in 56 N-cm Use this wrench also when connecting male SMA connectors to female precision 3.5mm connectors. Connections of male precision 3.5mm connectors to female SMA connectors can be made with the precision 3.5mm torque wrench (8 lb-in).	8710-1582

Type-N and "NMD-3.5" Connectors. Note that Type-N connectors, unlike other connectors, do not have wrench flats and thus can only be connected by hand. Connect Type-N connectors finger tight. The same is true of the "NMD-3.5" precision 3.5mm connectors used (for example) on the HP 8513A and HP 8515A test sets and on the HP 85131A/B 3.5mm test port return cables. These connectors are also designed to give the correct torque when the connector nut is connected finger tight.

Excessive Connector Nut Tightness, Precision 7mm Connectors. Sometimes it is almost impossible to apply torque to a precision 7mm connector without causing the device itself to turn. If this occurs, clean the connector nut threads carefully and make the connection again. If great resistance is still encountered, probably the outer nut and the inner sleeve are locking together at the back plane of the connector where the force of the torque is transferred to the inner sleeve.

Disassemble the connector nut assembly and inspect the interior bearing surfaces for galling of the stainless steel on these surfaces. If galling is evident, replace the connector nut assembly. This can generally be done without any degradation of connection repeatability or measured data because the connector interface is not disturbed.

If the interior bearing surfaces are undamaged, a small amount of molybdenum disulfide lubricant can be applied, **provided that great care is taken to avoid getting any lubricant on the mating plane surfaces or the connector threads.** Lubricant on the connector nut threads tends to collect dirt and thus counteract the benefits of the lubricant.

● Disconnection

Disconnect connectors by grasping the device body firmly to prevent it from turning. Then loosen the connector nut that was tightened in order to make the connection. If necessary, use the torque wrench or an open-end wrench to start the process, but leave the connection finger tight. At all times support the devices and the connection to avoid putting lateral (bending) force on the connector mating plane surfaces.

Complete the disconnection by disconnecting the connector nut completely. As in making connections, turn only the connector nut.

Never disconnect connectors by twisting one connector or device out of the other as one might remove a screw or a light bulb. This is extremely harmful and can occur whenever the device body rather than the connector nut alone is turned.

If the connection is between sexed connectors, pull the connectors straight apart, and be especially careful not to twist the body of any device as you do so.

Twisting the connection can damage the connector by damaging the center conductors or the interior component parts to which the connectors themselves are attached. It can also scrape the plating off of the male contact pin or even (in rare instances) unscrew the male or female contact pin slightly from its interior mounting, bringing it out of specification. This can also occur if the female contact fingers are unusually tight.

If such a male pin is then inserted into a female connector it will damage the female connector by pushing its center conductor back too far. Be aware of this possibility and measure the center conductor recession of all such connectors before mating them again.

PART TWO – CONNECTOR TYPES

Precision 7mm connectors, among them APC-7® connectors, are used in the dc to 18 GHz range and offer the lowest SWR and the most repeatable connections of any 7mm connector type. Development of these connectors was begun by Hewlett-Packard in the mid-1960's and improved upon by Amphenol Corporation, now one of the principal manufacturers of the connector. APC-7 is a U.S.-registered trademark of the Bunker Ramo Corporation.

Precision 7mm connectors (Figure 13) are air dielectric devices. The center conductor is supported only by a plastic support bead inside the connector body.

Precision 7mm connectors are durable, making them suitable for many connections and disconnections. For this reason, they are widely used in test and measurement applications requiring a high degree of accuracy and repeatability. They are generally made of beryllium copper alloy plated with gold.

Precision 7mm connectors are generally designed for use as sexless connectors, able to mate with all other precision 7mm connectors. There is no male or female, and contact between the center conductors is made by replaceable inserts called collets designed to make spring-loaded butt contact when the connection is tightened.

Small mechanical differences do sometimes exist between precision 7mm connectors made by different manufacturers, and occasionally these differences can cause difficulty in making connections. Always inspect all connectors mechanically, using a precision connector gage, to make sure that they meet their critical specifications.

MECHANICAL SPECIFICATIONS OF PRECISION 7mm CONNECTORS

- **With the center conductor collet removed, no protrusion of the center conductor in front of the outer conductor mating plane is ever allowable, and sometimes a minimum recession is required. Consult the mechanical specifications provided with the connector or the device itself.**

- **The center conductor collet should spring back immediately when pressed with a blunt plastic rod or with the rounded plastic handle of the collet removing tool.**

In precision 7mm connectors, contact between the center conductors is made by spring-loaded contacts called collets. These protrude slightly in front of the outer conductor mating plane when the connectors are apart. When the connection is tightened, the collets are compressed into the same plane as the outer conductors.

For this reason, two mechanical specifications are generally given for precision 7mm connectors:

- the maximum and minimum *recession of the center conductor* behind the outer conductor mating plane with the center conductor collet removed

- a minimum and maximum allowable *protrusion of the center conductor collet* in front of the outer conductor mating plane with the collet in place.

The critical mechanical specification is the recession (setback) of the center conductor relative to the outer conductor mating plane with the center conductor collet removed. No protrusion of the center conductor in front of the outer conductor mating plane is ever allowable, and sometimes a minimum recession is required. Consult the mechanical specifications provided with the connector or the device itself.

The center conductor collet should also spring back immediately when pressed with a blunt plastic rod or with the rounded plastic handle of the collet removing tool.

Nominal specifications for precision 7mm connectors exist. But the allowable tolerances (and sometimes the dimensions themselves) differ from manufacturer to manufacturer and from device to device.

Before gaging any precision 7mm connector, therefore, consult the mechanical specifications provided with the connector or the device itself.

Cleaning Precision 7mm Connectors

Cleaning is discussed in detail in Part One of this **Microwave Connector Care Manual**, which should be consulted for further information.

Whenever the center conductor collet has been removed from a precision 7mm connector, the interior surfaces should be inspected carefully and (if necessary) cleaned. The most suitable method is to cut off the sharp tip of a round wooden toothpick and to wrap it with a single layer of lint-free cleaning cloth. Moisten the cloth with a small amount of cleaning solvent and carefully insert it into the connector to clean the interior surfaces. Use an illuminated magnifying glass or microscope to see clearly the areas you wish to clean.

With the center conductor collet in place, the easiest and best way to clean precision 7mm connectors on small components, cables, and calibration or verification standards is to put a lint-free cleaning cloth flat on a table and put a drop or two of cleaning solvent in the center of the cloth. Retract the connector sleeve threads so that the connector interface is exposed. Then gently press the contact end of the connector into the cloth moistened with solvent and turn it. Blow the connector dry with a gentle stream of compressed air. This method can be adapted for fixed connectors (such as those attached to test ports) by folding the cloth and pressing it onto the connector.

PRECISION 7mm CONNECTOR

DIELECTRIC SUPPORT BEAD · OUTER CONDUCTOR · CONNECTOR NUT · SLEEVE (FULLY EXTENDED) · CENTER CONDUCTOR · COLLET · OUTER CONDUCTOR MATING PLANE · COLLET PROTRUSION
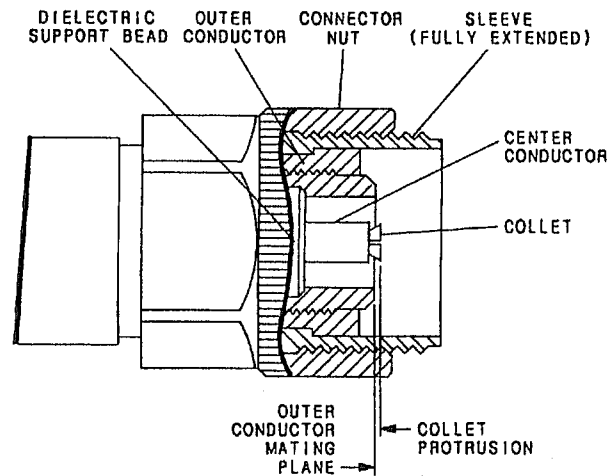
CENTER CONDUCTOR COLLET IN PLACE

Measure collet protrusion.

If attached, remove aligning pin from connector gage.

Use flat end of gage calibration block.

CENTER CONDUCTOR COLLET REMOVED

Measure center conductor recession.

Center conductor must not protrude beyond outer conductor mating plane.

Airlines require attaching the aligning pin to the connector gage: in these cases, use the recessed end of the gage calibration block.

Figure 13. Precision 7mm Connector

Removing Center Conductor Collets

Figure 14 shows how to remove the center conductor collet from a precision 7mm connector. This is required in order to gage the connector with the collet removed, if the collet is damaged, or if the protrusion of the collet is not within specification.

Pull back the handle of the collet removing tool (Figure 14) to open the interior collet removal jaws fully. Keep the handle pulled back and the jaws open and insert the tool carefully but completely into the connector, inside the outer conductor, until it comes to rest lightly on the interior support bead. Release the handle and remove the tool (and collet) from the connector. The collet removing tool required for this purpose is supplied in many Hewlett-Packard calibration kits and is also available separately, as HP Part Number 5060-0236.

Two types of center conductor collets exist: 4-slot collets (HP Part Number 1250-0907) and 6-slot precision collets (HP Part Number 85050-20001). The two types are interchangeable, and the 6-slot type is recommended for maximum durability and repeatability of connections.

Both types of collets can be re-used after they are removed, but before doing so the collet should be inspected carefully.

Look especially for edge or surface damage and for any signs that the spring contacts are bent or twisted. If they are, replace the collet and the collet removing tool. No damage to the collet should occur due to the removing tool.

To insert a collet, pick up the collet by the slotted end, using tweezers, and insert it carefully (flat end first) into the center conductor of the connector. Press the collet gently until it snaps into place, using a blunt plastic rod or the rounded plastic handle of the collet removing tool. Do not use a pencil or your finger for this purpose.

When the collet has been re-inserted, verify that it springs back immediately when pressed with a blunt plastic rod or the rounded plastic handle of the collet removing tool.

When removing or replacing collets in test port connectors, take care to avoid electrostatic discharge. Wear a grounded wrist strap and grasp the outer, grounded shell of the test port briefly before removing or inserting the collet. Ground all tools in the same way.

COLLET REMOVAL
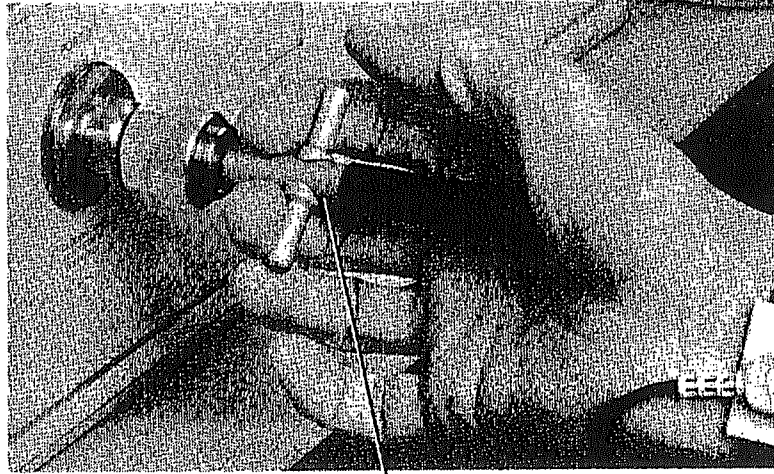
COLLET REMOVING TOOL
HP Part Number 5060-0236

Pull back the handle of the collet removing tool. Keep the handle pulled back and insert the tool into the connector until it comes to rest lightly on the interior support bead. Release the handle and remove the old collet and the tool.

COLLET INSERTION

COLLET   TWEEZERS

PUSH LIGHTLY TO
SNAP INTO PLACE
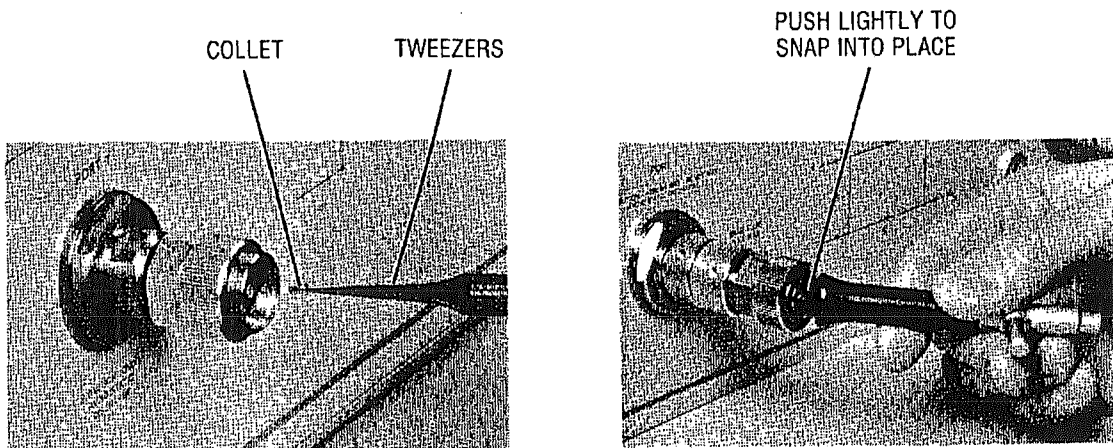
4-SLOT COLLET
HP Part Number 1250-0907

6-SLOT PRECISION COLLET
HP Part Number 85050-20001

Figure 14. Center Conductor Collet Removal and Insertion

Selecting a Connector Gage

Care is necessary in selecting a connector gage to measure precision 7mm connectors. Some gages have a very strong gage plunger spring – strong enough, in some cases, to push the center conductor back through the connector, damaging the device itself. Other gages may compress the center conductor collet during the measurement, giving an inaccurately low reading of the actual collet protrusion.

Connector gage kits containing a gage recommended for precision 7mm connectors and all of the other items required are included in many Hewlett-Packard calibration kits, and they are also available separately. Part numbers are given in Part One of this **Microwave Connector Care Manual.**

Gaging Precision 7mm Connectors

Gaging is discussed in detail in Part One of this **Microwave Connector Care Manual**, which should be consulted for further information.

The critical mechanical specification in precision 7mm connectors is the recession (setback) of the center conductor relative to the outer conductor mating plane with the center conductor collet removed. No protrusion of the center conductor in front of the outer conductor mating plane is ever allowable, and sometimes a minimum recession is required.

Gaging precision 7mm connectors (Figure 15) is done with the aligning pin removed from the gage plunger and using the flat end of the gage calibration block – except when the connectors have no support beads, as in the case of beadless airlines. In these cases, the (removable) aligning pin is installed into the gage plunger and is used to center the gage and center conductor within the connector. When the aligning pin is used, the recessed end of the gage calibration block is used.

Before gaging the connector, always extend the sleeve of the connector fully. This creates a cylinder into which the gage can fit and greatly reduces the danger of damage to the connector due to the gage slipping sideways during gaging.

If the connector is within specification, re-insert the collet or insert a new one, and gage the connector again with the center conductor collet in place. This is necessary to verify that the connector is still within specification after assembly. Also verify that the new collet recesses completely and springs back immediately by pressing on it gently with a blunt plastic rod or with the rounded plastic handle of the collet removing tool. If it does, the connector is ready to use.

GAGING PRECISION 7mm CONNECTORS

● Extend connector sleeve fully.
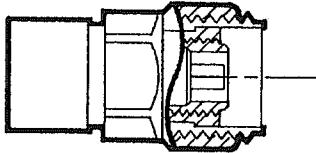
● Zero gage using flat end of gage calibration block.

● Insert gage into connector.

0.0005 in

0
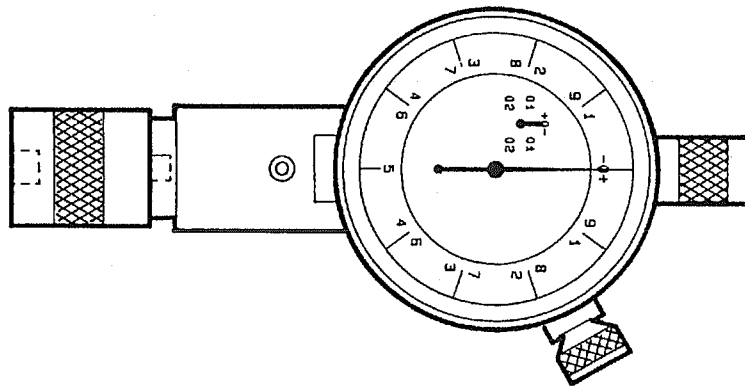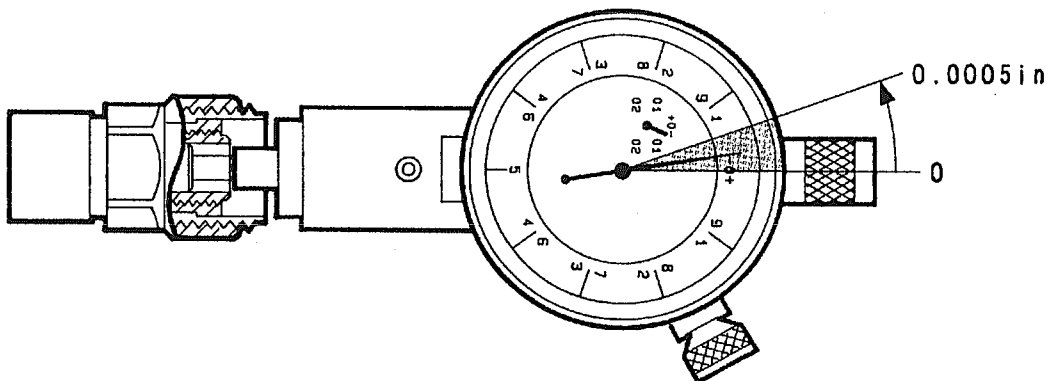
Figure 15. Gaging Precision 7mm Connectors   (1 of 2)

GAGING PRECISION 7mm CONNECTORS
USING GAGE ALIGNING PIN

● Use pin wrench to attach aligning pin to gage plunger.
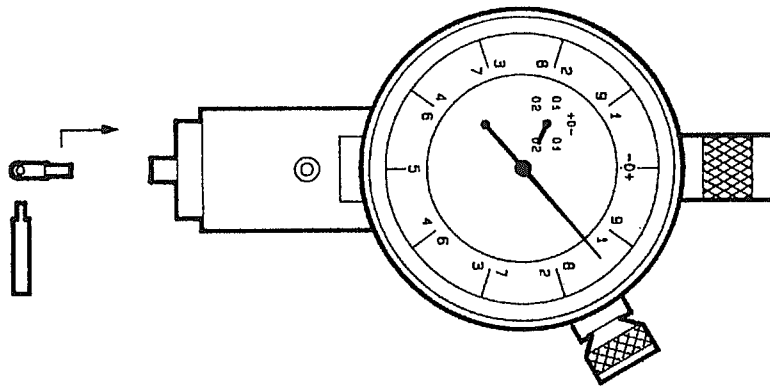
● Zero gage using recessed end of gage calibration block.
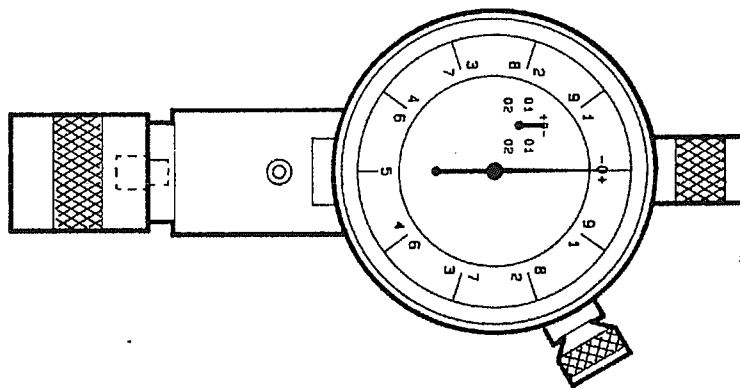
● Insert aligning pin into center conductor and gage into connector.

0.0005in

0
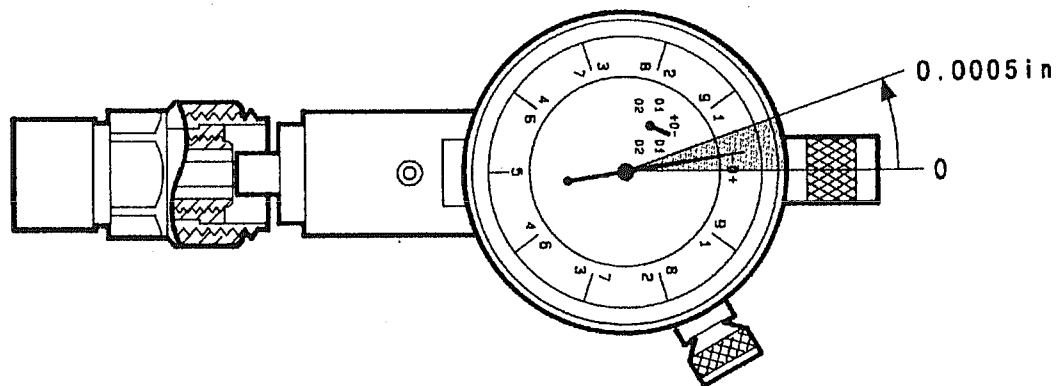
Figure 15. Gaging Precision 7mm Connectors   (2 of 2)

Making Connections

Before making connections between precision 7mm connectors, review the general principles outlined in Part One of this manual. Connectors must be undamaged, clean, and within mechanical specification. They must be aligned carefully, connected by turning the connector nut only, and final connections should always be made with a torque wrench.

Alignment of precision 7mm connectors is made easier by the fact that the connector sleeve on one of the connectors must be extended fully (and the sleeve of the other connector retracted fully) in order to make the connection. Extending the sleeve creates a cylinder into which the other connector fits. Spin the knurled connector nut to make sure that the threads are fully extended.

Seating Precision 7mm Connectors. In applications requiring the utmost in repeatability and accuracy, one additional step has been found to be helpful in making connections between precision 7mm connectors. It is called seating and is recommended only for the most demanding measurement applications and only for gold-plated precision 7mm connectors.

After the preliminary connection has been made using very light finger pressure (2 inch-ounces of torque), hold the connector nut stationary with one hand and with the other hand gently turn *the body of the device being connected* 5 to 15 degrees in a direction opposite to the direction of tightening. A few degrees is enough: on a clock face, one hourly division is 30 degrees, twice the maximum amount of rotation recommended for seating. Smooth, uniform movement without resistance should occur almost immediately.

Often a sudden, slight "breaking loose" of the connection is felt when the device being connected is rotated. This is not abnormal and occurs as the mating plane surfaces or connector nut threads move into correct alignment. It results in a slight loosening of the connector nut, however. Therefore, if it occurs, tighten the connector nut slightly and repeat the rotation. Smooth, uniform motion without resistance should now occur. Make the final connection using the recommended torque wrench.

Some wear of the gold plating on the mating plane surfaces due to abrasion does occur when this technique is used, and for this reason seating is generally omitted except in the most demanding measurement applications, in order to extend the life of the connectors. This latter consideration may be primary in high-volume and production environments, in most lower-frequency applications, and when the utmost in repeatability is not required.

Above all, even when seating is not used it is essential that the connectors be clean and undamaged. Connector wear is greatly accelerated if the connectors have not first been inspected visually, cleaned, and gaged correctly, or if the connection is very tight when the connectors are rotated. The seating technique described here must never be used as a substitute for careful cleaning and complete mechanical inspection of connectors. Inspect and clean connectors carefully. Do not overtighten the preliminary connection.

● Seating Precision 7mm Connectors
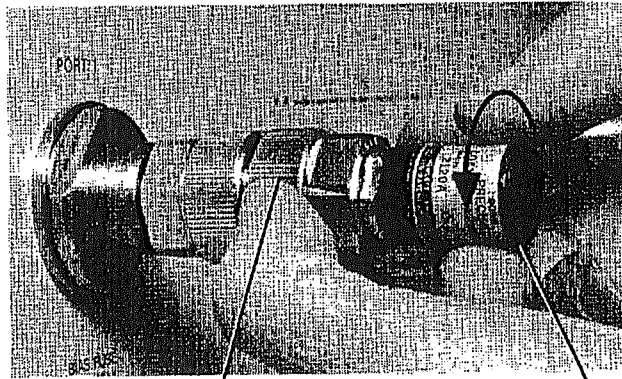
HOLD CONNECTOR NUT STATIONARY   TURN BODY OF THE DEVICE 5 TO 15 DEGREES
                                     OPPOSITE DIRECTION OF TIGHTENING

Make the preliminary connection lightly (2 inch-ounces). Do not turn devices more than 15 degrees. Use a torque wrench to make the final connection.

Figure 16.   Seating Precision 7mm Connectors

ADAPTERS FOR PRECISION 7mm CONNECTORS

- **Use adapters to reduce wear on connectors that may be difficult or expensive to replace.**
- **Use adapters to change the connector interface.**
- **Use adapters whenever devices that have SMA connectors must be measured.**

Adapters are used to connect devices with one connector interface to a device or to test equipment that has another interface, or to reduce wear on connectors that may be difficult or expensive to replace. Adapters are often used to connect devices that have Type-N, precision 3.5mm, or SMA connectors to test instruments that have precision 7mm connectors. They are also used to minimize connector wear, especially when the devices-under-test have SMA connectors.

Figure 17 shows the adapters that are recommended for converting a precision 7mm interface to various other interfaces. When an SMA interface is desired, use an adapter that has a precision 3.5mm interface. Precision 3.5mm connectors are compatible with SMA connectors. There are no separate 7mm-to-SMA adapters.

Using adapters is strongly recommended whenever devices that have SMA connectors must be measured. SMA connectors are low-cost connectors and are not precision mechanical devices. They are not designed for repeated connections and disconnections, they wear out quickly, and they are very often found, upon assembly, to be out of specification – even before they have been used. This makes them potentially destructive to any precision 3.5mm connectors with which they might be mated. It is much easier (and much cheaper) to replace an adapter than it is to repair or replace test equipment.

In all instances, the new interface will have the connector type listed in Figure 17. For example, using a male precision 3.5mm (SMA-compatible) adapter, HP Part Number 1250-1746, will result in a **male precision 3.5mm interface** to which devices or cables with female 3.5mm or SMA connectors can be connected. In most applications, two adapters will be required, one each at the input and the output of the device. Adapters are included in many HP calibration kits or may be ordered separately using the part numbers given in Figure 17.

SMA-Compatible Adapters for HP 85021/27-series Directional Bridges.   When devices with SMA connectors are to be measured at frequencies from 10 MHz to 18 GHz using an HP 85021/27-series directional bridge, Hewlett-Packard recommends using the HP 85021/27A (7mm) directional bridge and 7mm-to-3.5mm adapters. If a slight loss in directivity can be tolerated, this arrangement is much better than using the HP 85021/27B (3.5mm) directional bridge and connecting the SMA devices directly to it.

It is much easier (and much cheaper) to replace a male or female 3.5mm-to-7mm adapter than it is to repair a bridge.

HP 85130A Special Adapter Kit.   In order to produce a 7mm interface on the 3.5mm test ports of the HP 8513A and HP 8515A test sets, for example to use 7mm calibration or verification devices or the HP 85041A transistor test fixture with these test sets, the adapters in the HP 85130A special 3.5mm (F) to 7mm adapter kit should be used at the test ports instead of any other adapters. This kit has been developed expressly for this single purpose.

The adapters in the HP 85130A special adapter kit have two special features: (1) the 3.5mm side is a special "NMD-3.5" connector designed specifically to mate with HP 3.5mm test ports, and (2) the 7mm side has a center conductor setback that is the same as the setback on HP 7mm test ports. Thus the 7mm interface that results is the same as is found on test sets with 7mm connectors. Other adapters may be used at non-port connections, to connect ordinary 7mm devices to ordinary 3.5mm devices.

7mm-to-3.5mm (SMA-COMPATIBLE) ADAPTERS

male precision 3.5mm –
precision 7mm

female precision 3.5mm –
precision 7mm

HP Part Number 1250-1746   HP Part Number 1250-1747
[4-slot center conductor collets]

HP Part Number 85052-60004   HP Part Number 85052-60003
[6-slot precision center conductor collets]

7mm-to-Type-N ADAPTERS

male Type-N –
precision 7mm
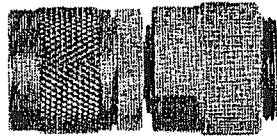
female Type-N –
precision 7mm

HP Part Number 85054-60009   HP Part Number 85054-60001

Figure 17. Precision 7mm Adapters

Type-N connectors are relatively inexpensive, rugged 7mm connectors developed for severe operating environments and for applications in which many connections and disconnections must be made. They are among the most popular general-purpose connectors used in the dc to 18 GHz frequency range. HP Precision Type-N connectors are stainless steel or beryllium copper Type-N connectors developed for measurement applications.

Unlike precision 7mm connectors, Type-N connectors (Figure 18) are sexed connectors. The male contact pin slides into the female contact fingers and electrical contact is made by the inside surfaces of the tip of the female contact fingers on the sides of the male contact pin. The position of the center conductor in the male connector is defined as the position of the shoulder of the male contact pin – not the position of the tip.

Type-N connectors differ from other connectors in that the outer conductor mating plane is offset from the mating plane of the center conductors. The outer conductor sleeve in the male connector extends in front of the shoulder of the male contact pin. When the connection is made, this outer conductor sleeve fits into a recess in the female outer conductor behind the tip of the female contact fingers.

No Type-N connector should ever be used when there is any possibility of interference between the shoulder of the male contact pin and the tip of the female contact fingers when the connectors are mated. In practice this means that no Type-N connector pair should be mated when the separation between the tip of the female contact fingers and the shoulder of the male contact pin could be less than zero when the connectors are mated. Gage Type-N connectors carefully to avoid damage.

As Type-N connectors wear, the protrusion of the female contact fingers generally increases, due to wear of the outer conductor mating plane inside the female connector. This decreases the total center conductor contact separation and should be monitored carefully.

75Ω Type-N Connectors. 75Ω Type-N connectors differ from 50Ω Type-N connectors most significantly in that the center conductor, male contact pin, and female contact hole are smaller. Therefore, mating a male 50Ω Type-N connector with a female 75Ω Type-N connector will destroy the female 75Ω connector by spreading the female contact fingers apart permanently or even breaking them.

If both 75Ω and 50Ω Type-N connectors are among those on the devices you are using, mark the 75Ω Type-N connectors to be sure that they are never mated with any 50Ω Type-N connectors.

MECHANICAL SPECIFICATIONS OF TYPE-N CONNECTORS

- **Type-N connectors require a minimum recession of the shoulder of the male contact pin of 0.207 inches and allow a maximum protrusion of the tip of the female contact fingers in front of the outer conductor mating plane of 0.207 inches.**

- **Pin depth specifications for 75Ω Type-N connectors are the same as for 50Ω Type-N connectors. The connector types differ in the size of the center pin, not in the mating plane offsets.**

Several mechanical specifications for Type-N connectors exist, among them those listed in Table 4. All specify a minimum recession of the shoulder of the male contact pin and a maximum protrusion of the tip of the female contact fingers.

The strictest specification is the HP Precision specification, which differs from MIL-C-39012, Class II, in reducing (by 0.001 in) the minimum allowable recession of the shoulder of the male contact pin. None of the specifications allows the total contact separation to be zero or less, and most require a minimum contact separation of 0.001 in (or more). Only the HP Precision specification allows a separation of zero.

Before gaging any Type-N connector, therefore, consult the mechanical specifications provided with the connector or the device itself.

Table 3.   Mechanical Specifications, Type-N Connectors

Specification	Recession (Male)	Protrusion (Female)
MIL-C-71B	0.214 – 0.232 in	0.187 – 0.207 in
	CONTACT SEPARATION 0.007 – 0.045 in	
MIL-C-39012 Class II	0.208 in, minimum	0.207 in, maximum
	CONTACT SEPARATION 0.001 in, minimum	
MIL-C-39012 Class I	0.208 – 0.211 in	0.204 – 0.207 in
	CONTACT SEPARATION 0.001 – 0.007 in	
HP Precision	0.207 – 0.210 in	0.204 – 0.207 in
	CONTACT SEPARATION 0.000 – 0.006 in	

TYPE-N CONNECTORS

MALE

RECESSION OF
MALE CONTACT
PIN SHOULDER ➞

➞ OUTER
CONDUCTOR
MATING
PLANE

FEMALE

RECESSION
OF FEMALE
CONTACT
FINGERS ➞
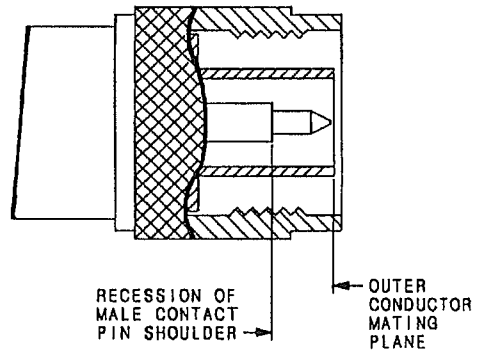
➞ OUTER
CONDUCTOR
MATING
PLANE
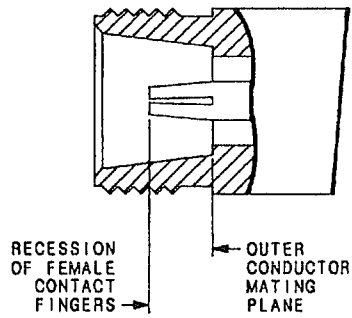
Figure 18. Type-N Connectors

Electrical Effects of Contact Separation

Type-N connectors are often usable in many applications even when the total separation between the shoulder of the male contact pin and the tip of the female contact fingers exceeds the maximum implied by the mechanical specifications. Figure 19 shows the approximate effects of total contact separation on the reflection coefficient of Type-N connections. As can be seen, at lower frequencies the effects even of fairly wide total contact separations are small. Only at higher frequencies does contact separation become important.
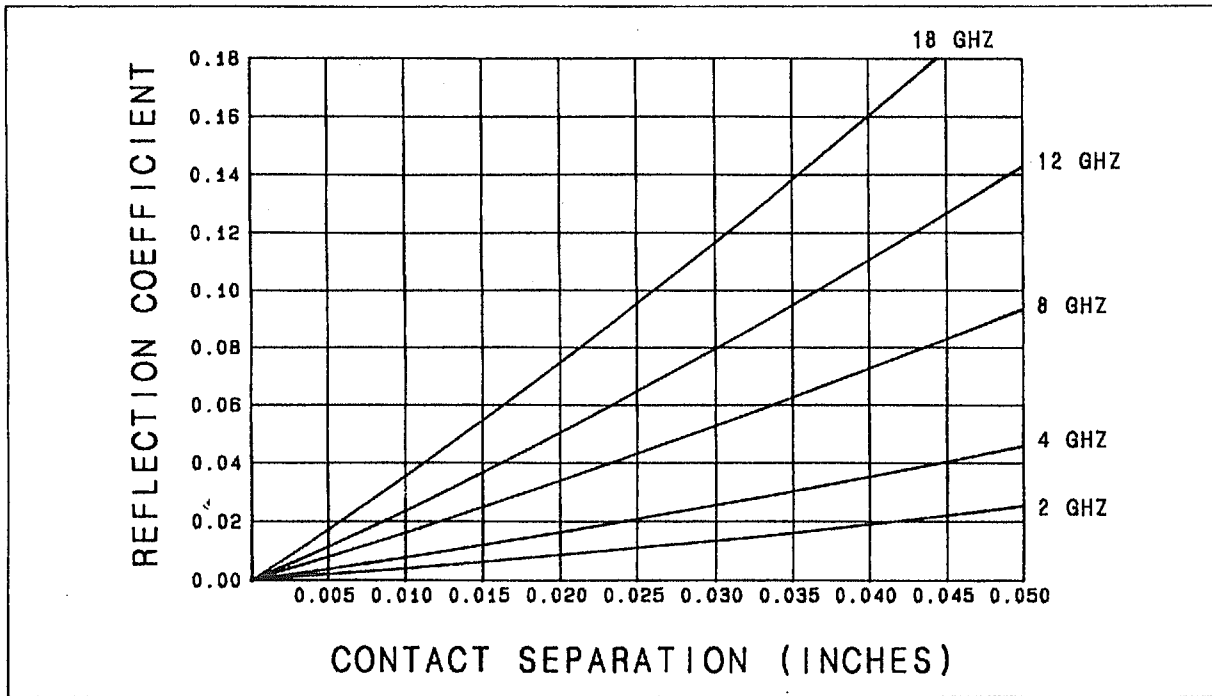
Figure 19.   Approximate Effects of Contact Separation on Reflection Coefficient, Type-N Connectors

Gaging Type-N Connectors

A single gage that has separate bushings for male and female connectors is used to gage Type-N connectors. A connector gage kit containing all of the items required is available as HP Part Number 85054-60024.

Male Type-N Connectors. To gage male Type-N connectors (Figure 20), first attach the bushing for male connectors to the dial indicator assembly. Slip the bushing over the gage plunger assembly on the gage and fasten it there using the two Allen screws in the bushing.

The outer end of the male bushing is flat and has a hole in it, and the gage plunger is inserted through the bushing so that the plunger protrudes from the bushing when the bushing has been attached.

Zero the gage using the recessed end of the gage calibration block. Insert the gage plunger into the hole in the gage calibration block and zero the gage according to the instructions given in Part One of this **Microwave Connector Care Manual**. Then measure the connector.

Insert the gage carefully into the male connector so that it is centered and the flat outer part of the gage bushing rests on the outer conductor. The male contact pin slips into the hole for this purpose in the gage plunger.

Gently rock the connector gage within the connector, to make sure that the gage and the outer conductor have come together flatly. When the gage pointer settles consistently at a reading, read the gage indicator dial.

Counterclockwise deflection of the gage pointer (a "minus" reading on the gage indicator dial) indicates that the shoulder of the male contact pin meets its minimum specification of being recessed at least 0.207 inches. The amount of deflection tells how much more than the minimum the shoulder of the contact pin is recessed. A reading of "minus" 0.003 inches, for example, indicates a recession of 0.210 inches, the maximum recession allowed in HP Precision Type-N connectors.

In the same way, clockwise deflection of the gage pointer (a "plus" reading on the gage indicator dial) indicates that the shoulder of the male contact pin is recessed less than the minimum recession of 0.207 inches behind the outer conductor mating plane. Such a connector is out of specification. It will damage other connectors to which it is mated and should not be used.

MALE TYPE-N CONNECTORS

- Attach male bushing to dial indicator assembly.
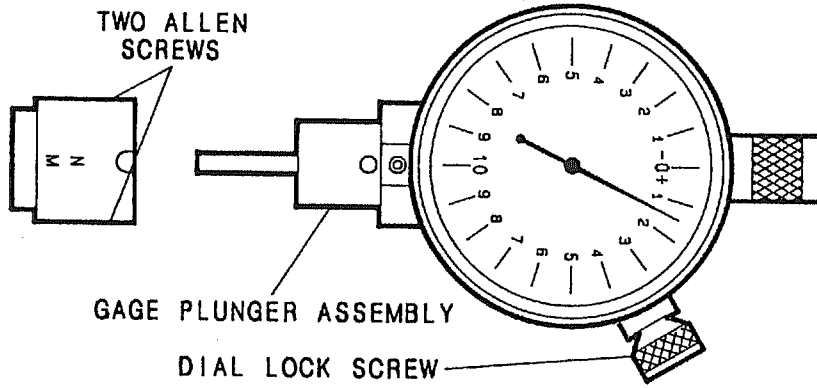
TWO ALLEN
SCREWS

GAGE PLUNGER ASSEMBLY

DIAL LOCK SCREW

- Zero gage using recessed end of gage calibration block.

- Insert gage into connector.

0.210in

COUNTER-
CLOCKWISE
DEFLECTION

0.207in
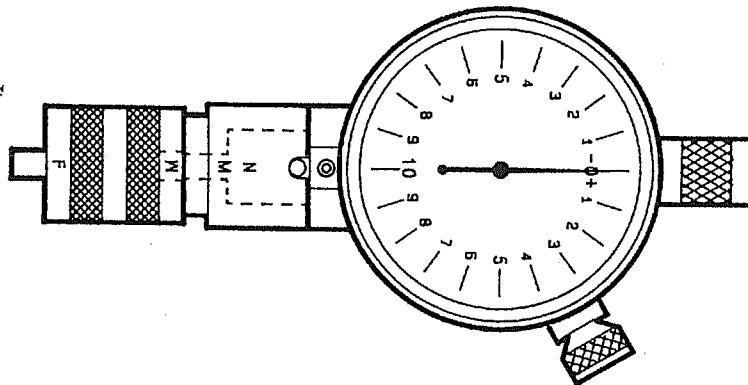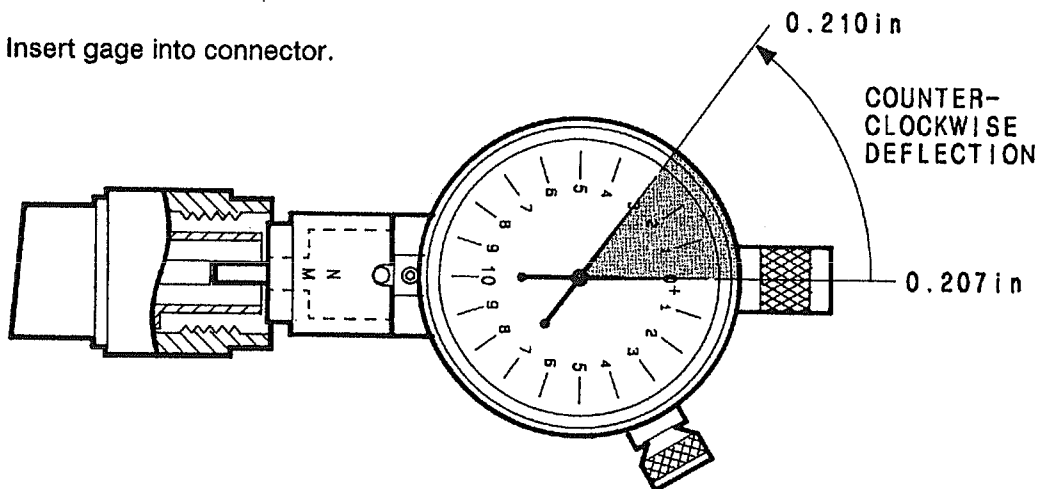
Figure 20.   Gaging Type-N Connectors   (1 of 2)

FEMALE TYPE-N CONNECTORS

- Attach female bushing to dial indicator assembly.
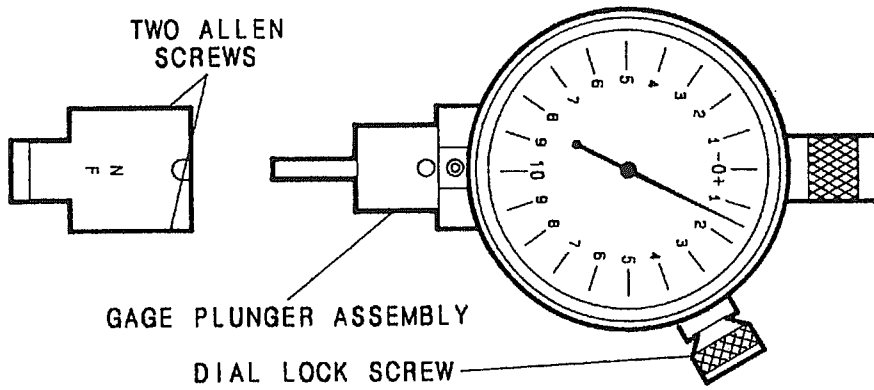
TWO ALLEN SCREWS

GAGE PLUNGER ASSEMBLY

DIAL LOCK SCREW

- Zero gage using protruding end of gage calibration block.

- Insert gage into connector.

0.204 in

COUNTER-CLOCKWISE DEFLECTION

0.207 in
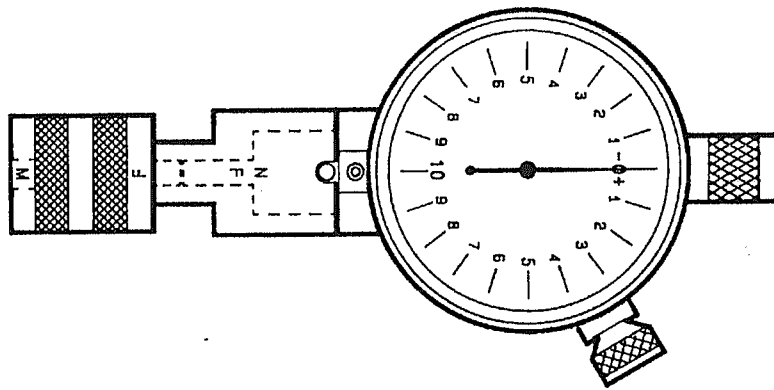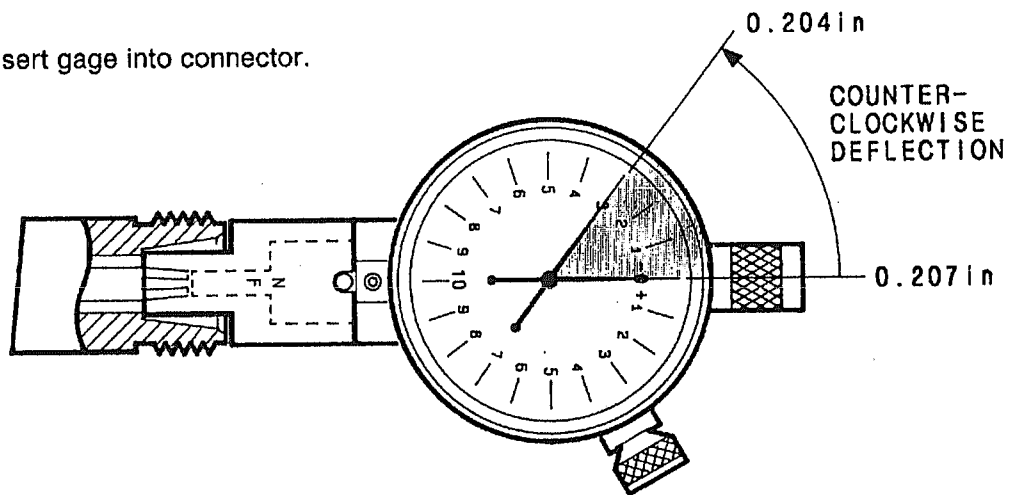
Figure 20.   Gaging Type-N Connectors   (2 of 2)

Female Type-N Connectors. To gage female Type-N connectors (Figure 20), first attach the bushing for female connectors to the dial indicator assembly. This bushing has a protruding circular sleeve, and when the bushing has been attached to the dial indicator assembly the gage plunger will be inside this circular sleeve. The bushing is fastened to the gage plunger assembly using the two Allen screws in the bushing.

Zero the gage using the protruding end of the gage calibration block. Insert the protruding end of the block into the circular sleeve so it comes to rest on the gage plunger inside the female bushing. Zero the gage according to the instructions given in Part One of this manual. Then measure the connector.

Insert the gage carefully into the female connector so that it is centered and the female contact fingers in the connector slip inside the protruding circular sleeve on the gage. The circular sleeve on the bushing should come to rest on the outer conductor mating plane inside the connector, behind the female contact fingers.

Gently rock the connector gage within the connector, to make sure that the gage and the outer conductor have come together flatly. When the gage pointer settles consistently at a reading, read the gage indicator dial.

Counterclockwise deflection of the gage pointer (a "minus" reading on the gage indicator dial) indicates that the tip of the female contact fingers meets the specification of protruding no more than 0.207 inches. The amount of deflection tells how much less than this maximum the tip of the female contact fingers is protruding. A reading of "minus" 0.003 inches, for example, indicates a protrusion of 0.204 inches, the minimum protrusion allowed in HP Precision Type-N connectors.

In the same way, clockwise deflection of the gage pointer (a "plus" reading on the gage indicator dial) indicates that the tip of the female contact fingers is protruding more than the maximum of 0.207 inches in front of the outer conductor mating plane. Such a connector is out of specification. It will damage other connectors to which it is mated and should not be used.

Connection Technique

In two important respects, connections made between Type-N connectors differ from those made between other connectors:

- Type-N connectors are never rotated relative to one another
- Type-N connectors are connected finger tight

Because Type-N connectors are made of brass or (in the case of HP Precision Type-N connectors) stainless steel, special care should be taken to avoid rotating the mating plane surfaces against one another.

In particular, the optional step recommended for seating precision 7mm connectors must never be used when connecting Type-N connectors together.

A torque wrench is not needed (and generally cannot be used) in making the final connection of Type-N connectors because the standard connector nuts on male Type-N connectors do not have wrench flats. Connections will be tight enough when the nuts are connected finger tight. If a torque wrench is used (for example, a wrench equipped with a special non-slip end), the correct torque setting is the same as for precision 7mm connectors: 12 lb-in (136 N-cm). As with other connectors, always turn the connector nut only to tighten the connection.

Careful inspection and cleaning of Type-N connectors is also essential, and the recommendations on these subjects in Part One of this **Microwave Connector Care Manual** should be followed carefully.

Because of their smaller size, SMA and precision 3.5mm connectors can be used at higher frequencies than 7mm connectors can. SMA connectors are low-cost 3.5mm connectors generally used up to about 23 GHz. The name is an abbreviation of the connector type: SubMiniature connector, type **A**. A solid plastic dielectric separates the center and outer conductors.

Precision 3.5mm connectors, also known as APC-3.5 connectors, are precision air-dielectric connectors that will mate with SMA connectors. They offer much greater repeatability of connection than SMA connectors do, and for this reason they are widely used on electronic test equipment. Precision 3.5mm connectors can be used up to about 34 GHz.

Both SMA and precision 3.5mm connectors are sexed connectors. The male contact pin slides into the female contact fingers and electrical contact is made by the inside surfaces of the tip of the female contact fingers on the sides of the male contact pin. The mechanical specifications for both SMA and precision 3.5mm connectors give a maximum and a minimum *recession of the shoulder of the male contact pin* and a maximum and a minimum *recession of the tip of the female contact fingers* behind the outer conductor mating plane.

SMA CONNECTORS

- **SMA connectors are not precision devices. Inspect them and use them carefully, with a knowledge of their limitations.**

- **Inspect all male SMA connectors mechanically, using a precision connector gage, and for misalignment or burrs on the male contact pin. Do not use any connectors that are out-of-specification or damaged.**

SMA connectors (Figure 21) are inexpensive 3.5mm connectors in which a solid plastic dielectric is used between the center and outer conductors. SMA connectors are not precision devices. They are not designed for repeated connections and disconnections, they wear out quickly, and they are very often found, upon initial assembly, to be out of specification – even before they have been used. They are used most often as one-time-only connectors in internal component assemblies and in similar applications in which few connections or disconnections will be made.

Specifications and manufacturing tolerances of SMA connectors are fairly loose. This helps keep their cost low, but it also makes SMA connectors potentially destructive both to one another and – especially – to any precision 3.5mm connectors with which they might be mated. See the discussion later in this section before mating SMA and precision 3.5mm connectors.

SMA Connector Problems

Two types of problems are the most common with SMA connectors:

- problems due to the solid plastic dielectric
- problems due to SMA male pins

Dielectric Protrusion. Some SMA connector specifications allow protrusion of the solid plastic dielectric in front of the outer conductor mating plane, sometimes as much as 0.002 or 0.003 inches. This is not necessarily harmful when SMA connectors are mated to one another because some compression of the dielectric can occur. But it can be extremely harmful if the SMA connector is mated to a precision 3.5mm connector. The protruding dielectric can force the rigid center conductor of the precision 3.5mm connector back through the connector itself, damaging not only the connector but sometimes the device to which it is attached.

For this reason, SMA connectors in which the solid plastic dielectric protrudes in front of the outer conductor mating plane must never be mated to precision 3.5mm connectors. Always inspect SMA connectors for protrusion of the solid plastic dielectric before mating them to precision 3.5mm connectors.

Protrusion of the dielectric can also occur due merely to connection and disconnection. The mechanical force of pulling the connectors apart can result in movement of the dielectric. Aging and temperature cycling can also cause the dielectric to move out of specification.

Out-of-Specification SMA Male Pins. The other main source of problems is the SMA male pin. Partly because low manufacturing costs are desirable in SMA connectors, the male contact pins in some SMA connectors are not held securely in position. These pins are very easily pulled out of specification, especially if the female contact fingers in the other connector are unusually tight. A male SMA connector pin that is bent or is too long may smash or break the delicate fingers on the female connector, especially if it is a precision 3.5mm connector.

Very often, too, SMA male pins are actually not pins at all but the cut-off ends of the center conductor in ordinary semi-rigid coaxial cable. Misalignment and burrs are common in this situation, and burrs on the end of the male pin can ruin any female SMA or precision 3.5mm connector that they are mated to.

Inspect all male SMA connectors for misalignment or burrs on the male contact pin and discard any that are damaged.

SMA CONNECTORS

MALE

OUTER
CONDUCTOR

PLASTIC
DIELECTRIC

CENTER
CONDUCTOR

OUTER CONDUCTOR
MATING PLANE

FEMALE

OUTER
CONDUCTOR

PLASTIC
DIELECTRIC

CENTER
CONDUCTOR
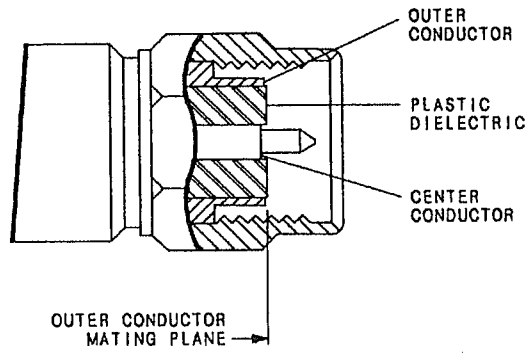
OUTER CONDUCTOR
MATING PLANE
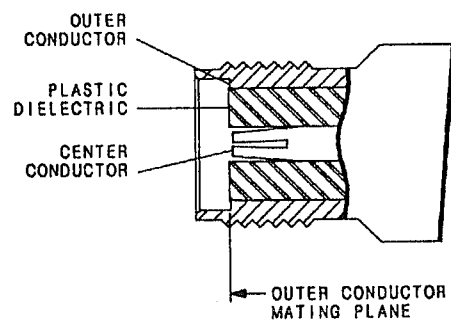
Figure 21. SMA Connectors

Precision 3.5mm Connectors

Precision 3.5mm connectors, also known as APC-3.5 connectors, were developed during the early 1970's jointly by Hewlett-Packard and Amphenol Corporation. The design objective was to produce a durable high-frequency microwave connector that would mate with SMA connectors, exhibit low SWR and insertion loss, and be mode free up to about 34 GHz.

Unlike SMA connectors, precision 3.5mm connectors are air dielectric devices (Figure 22). Air is the insulating dielectric between the center and outer conductors, and the center conductor is supported by a plastic support bead inside the connector body. Precision 3.5mm connectors are precision devices. They are more expensive than SMA connectors and they are durable enough to permit repeated connections and disconnections.

NMD-3.5 connectors are precision 3.5mm connectors recently developed by Hewlett-Packard and used on cables, test port connectors, and in the HP 85130A special 3.5mm-to-7mm adapter set. These connectors are especially rugged and are designed to provide an exceptionally strong coupling mechanism for measurement applications.

PRECISION 3.5mm CONNECTORS

MALE

OUTER
CONDUCTOR

CENTER
CONDUCTOR

OUTER CONDUCTOR
MATING PLANE

FEMALE

OUTER
CONDUCTOR

CENTER
CONDUCTOR
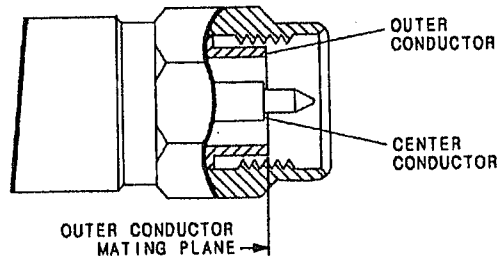
OUTER CONDUCTOR
MATING PLANE
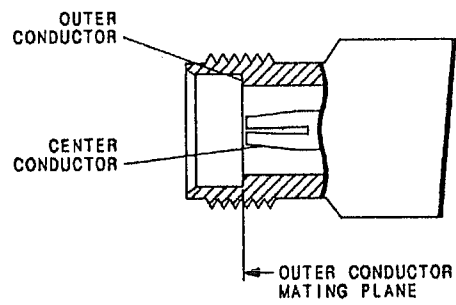
Figure 22. Precision 3.5mm Connectors

MATING SMA AND PRECISION 3.5mm CONNECTORS

- **All SMA connectors should be inspected mechanically, using a precision connector gage, before use and before being mated to any precision 3.5mm connector. Out-of-specification SMA connectors can damage other connectors permanently even on the very first connection.**

- **If an SMA connector is to be mated to a precision 3.5mm connector, the SMA connector must meet the setback specifications of precision 3.5mm connectors. In particular, there must be no protrusion of the plastic dielectric, or of the shoulder of the male contact pin or the tip of the female contact fingers, in front of the outer conductor mating plane.**

- **Take great care with alignment. Dimensions of SMA and precision 3.5mm connectors differ enough that the male SMA pin can slip to the side of the female contact fingers in the precision connector. Align the connectors carefully and avoid twisting the connectors or devices as the connection is made.**

- **Whenever possible, use 3.5mm-to-3.5mm adapters as "connector-savers" between the SMA connector and the precision 3.5mm connector. Using an adapter has only a small effect on electrical performance, and wear or damage occurs only on the adapter — not on expensive components or devices.**

One key feature of precision 3.5mm connectors is that they can be mated with SMA connectors (Figure 23). This was among the original design objectives for the connector. But great care is necessary when making such connections, to avoid damaging the connectors owing to their slightly different dimensions and mechanical characteristics.

The recommendations above will help prevent damage when SMA connectors are mated to precision 3.5mm connectors. Gage both connectors carefully; be sure that the setback specifications for precision 3.5mm connectors are also met by the SMA connector; and take great care with alignment.

Push the two connectors straight together, with the male contact pin precisely concentric with the female. Do not rotate either connector or overtighten the connection. Turn only the outer nut of the male connector and use a torque wrench (5 lb-in, 56 N-cm) for the final connection.

Note that this torque is less than is used when mating precision 3.5mm connectors with each other. A torque wrench suitable for SMA connectors, preset to 5 lb-in (56 N-cm), is available as HP Part Number 8710-1582.

These precautions are all necessary because of the nature of SMA connectors. SMA connectors are designed to be inexpensive, one-time-only connectors. They are not precision mechanical devices, and they should be used carefully, with a full knowledge of their limitations.

Worn, damaged, or out-of-specification SMA connectors can destroy a precision 3.5mm connector even on the very first connection.

When more than a few connections of SMA connectors to a precision 3.5mm interface will be made, a 3.5mm-to-3.5mm adapter (sometimes called a "connector saver") is generally installed on the 3.5mm connector. In this way, the original connector is protected from damage and only the adapter needs to be replaced when it is worn. Adapters are discussed later in this section.

PRECISION 3.5mm INTERFACE

APC-3.5   APC-3.5

0.0208
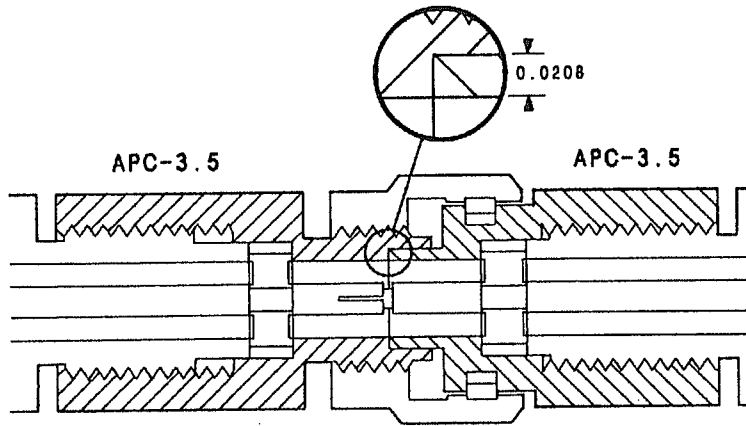
PRECISION 3.5mm – SMA INTERFACE

.0208 ±.0012

+.002
+.000
-.003

+.000
-.004

THIS WALL DIMENSION IS
A FUNCTION OF DIELECTRIC
CONSTANT. WITH A BORE
OF .161/162 THE WALL
IS 0.009 ±.0015.

APC-3.5   SMA
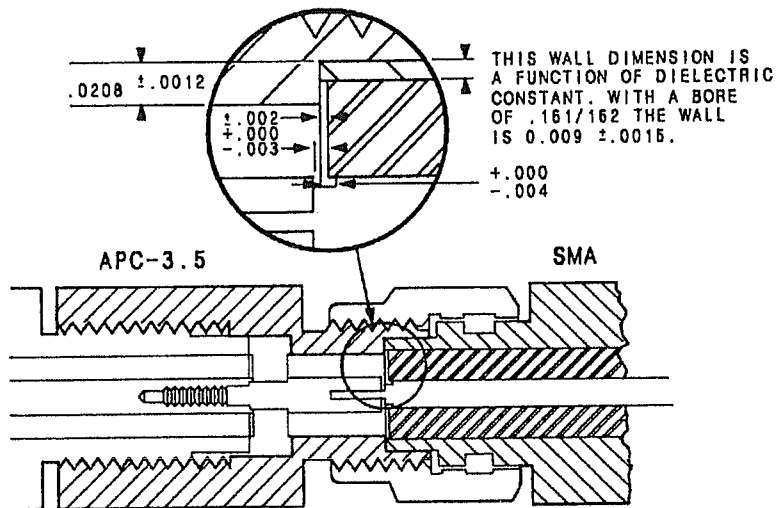
Figure 23.   Precision 3.5mm Connector and Precision 3.5mm-SMA Connector Interfaces

Electrical Performance

Electrically, junctions coupled with precision 3.5mm connectors (only) exhibit greatly superior electrical performance compared to junctions coupled with SMA connectors or with an SMA connector connected to a precision 3.5mm connector. Typical values are shown in Figure 24.

As will be seen, when an SMA connector is mated with a precision 3.5mm connector the connection itself exhibits a mismatch (SWR), typically about 1.10 at 20 GHz. This mismatch is less than is obtained when two SMA connectors are mated. But it is still much higher than occurs when precision 3.5mm connectors alone are used. Keep this fact in mind when making measurements on SMA and precision 3.5mm coupled junctions.
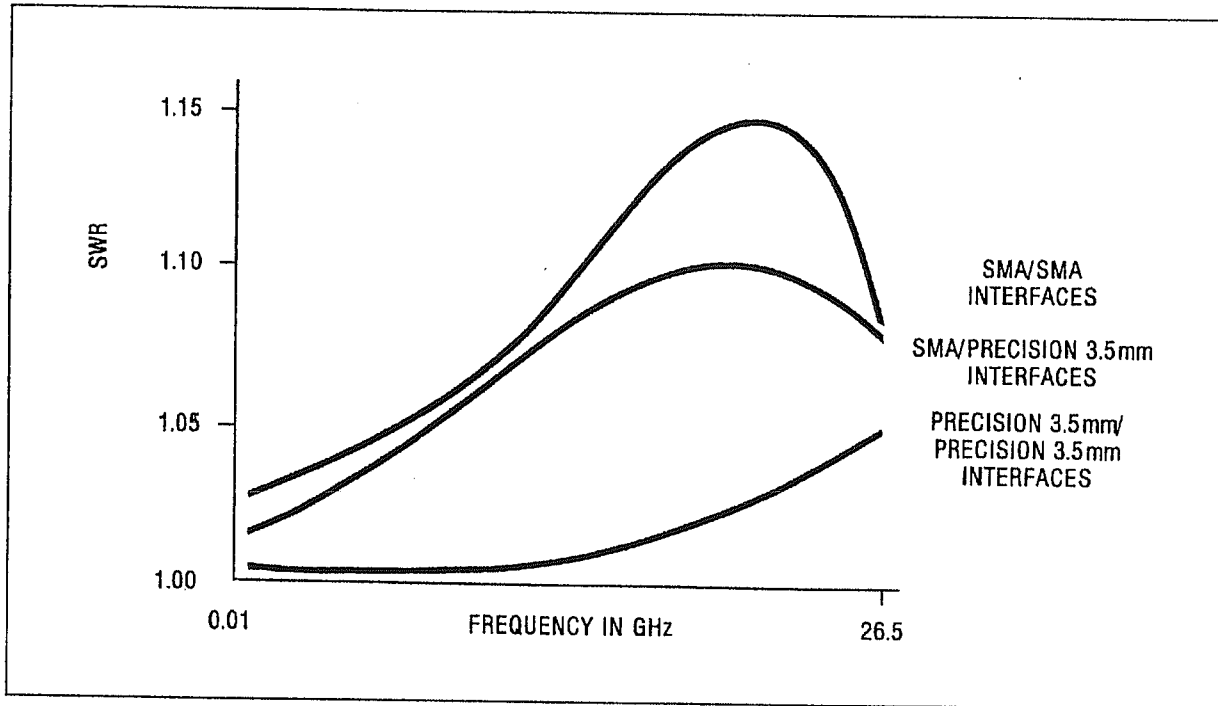
Figure 24. Typical SWR of Precision 3.5mm and SMA Coupled Junctions

Adapters

Adapters are used for two main purposes with SMA and precision 3.5mm connectors: to connect a device with one connector interface to a device or to test equipment that has another interface, or to reduce wear on connectors that may be difficult or expensive to replace. Reducing wear is possibly the most important use of adapters, especially when devices that have SMA connectors are being used.

In most applications, two adapters will be required, one each at the input and the output of the device. Male-female adapters cause no change in the sex of the interface. The same interface is presented when the adapter is in place as is presented in the original setup.

Same-sex adapters (male-male, female-female) change the sex of the interface. For example, if the original interface presents a male connector, attaching a female-female adapter will result in a female interface to which devices or cables that have male SMA (or male precision 3.5mm) connectors can be connected.

3.5mm-to-3.5mm (or SMA) Adapters. High-quality precision adapters, sometimes called "connector savers," are recommended whenever more than a few connections will be made between SMA and precision 3.5mm connectors. In this way, only the adapter needs to be replaced when it is worn and the precision connector is at all times protected from accidental damage due to the SMA connector.

Figure 25 shows the 3.5mm-to-3.5mm adapters that are available for making through or "connector-saver" connections between SMA and precision 3.5mm connectors or for changing the sex of a connector interface. The HP 85052-series adapters, available in all three types, are high-performance adapters that can be used in any application. The HP 85027-series adapters, available in male-female and male-male form only, are designed to be used only with HP 85021/27-series directional bridges.

7mm-to-3.5mm (or SMA) Adapters. Devices or cables that have SMA or precision 3.5mm connectors can be connected to devices or cables that have a precision 7mm interface using the 7mm-to-3.5mm (or SMA) adapters shown in Figure 25. This use of adapters is especially recommended to reduce wear on connectors that may be difficult or expensive to replace. Adapters with precision 6-slot collets are recommended for the utmost in repeatability and performance. Adapters with 4-slot collets are good general purpose adapters.

HP 85021/27-series Directional Bridges. Reducing wear due to SMA connectors may also influence the choice of equipment. For example, when devices with SMA connectors are to be measured at frequencies from 10 MHz to 18 GHz using an HP 85027-series directional bridge, Hewlett-Packard recommends using the HP 85027A (7mm) directional bridge and 7mm-to-3.5mm adapters.

If a slight loss in directivity can be tolerated, this arrangement is much better than using the HP 85027B (3.5mm) directional bridge and connecting the SMA devices directly to it – in part because the 7mm interface, because it is larger, is more rigid and durable. The 7mm-to-3.5mm adapter serves as a "connector saver" in this application. It is much easier (and much cheaper) to replace an adapter than it is to repair the bridge.

Some idea of the effects on electrical performance when "connector-saver" adapters are used may be seen in Figure 26. Typical directivity of the HP 85021/27 directional bridges with "connector-saver" adapters in place is compared to the 40-dB directivity (up to 18GHz) specification of the bridges alone. As will be seen, the minimum directivity is typically 34 dB when 7mm-to-3.5mm adapters are used with an HP 85021/27A directional bridge. The minimum directivity is also 34 dB when 3.5mm-to-3.5mm adapters are used with an HP 85021/27B bridge, but these bridges are usable up to 26.5 GHz.
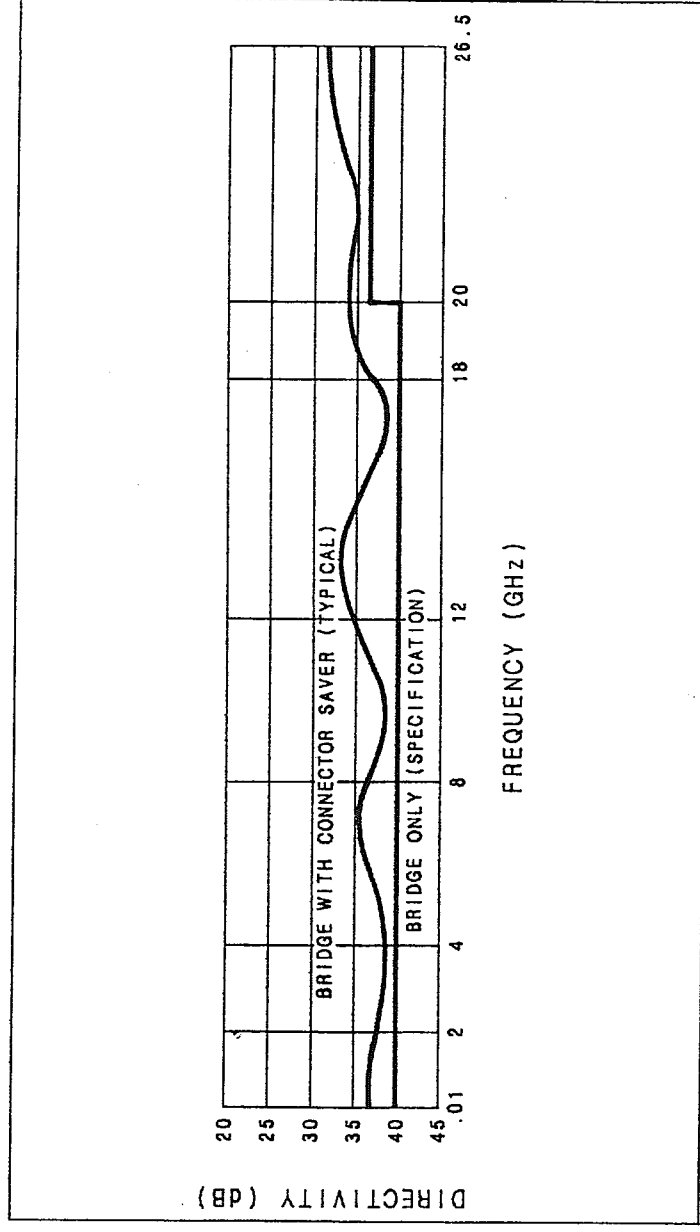
Figure 26. Typical Directivity Using "Connector-Saver" Adapters

Special 3.5mm (F)-to-Precision 7mm Adapters. One special use of adapters should be noted. In order to produce a 7mm interface on the 3.5mm test ports of the HP 8513A and HP 8515A test sets, for example to use 7mm calibration or verification devices or the HP 85041A transistor test fixture with these test sets, the adapters in the HP 85130A special 3.5mm (F) to 7mm adapter kit should be used at the test ports instead of any other adapters.

The adapters in the HP 85130A special adapter kit have two special features: (1) the 3.5mm side is a special "NMD-3.5" connector designed specifically to mate with HP 3.5mm test ports, and (2) the 7mm side has a center conductor setback that is the same as the setback on HP 7mm test ports. Thus the 7mm interface that results is the same as is found on test sets with 7mm connectors. Other adapters may be used at non-port connections, to connect ordinary 7mm devices to ordinary 3.5mm devices.
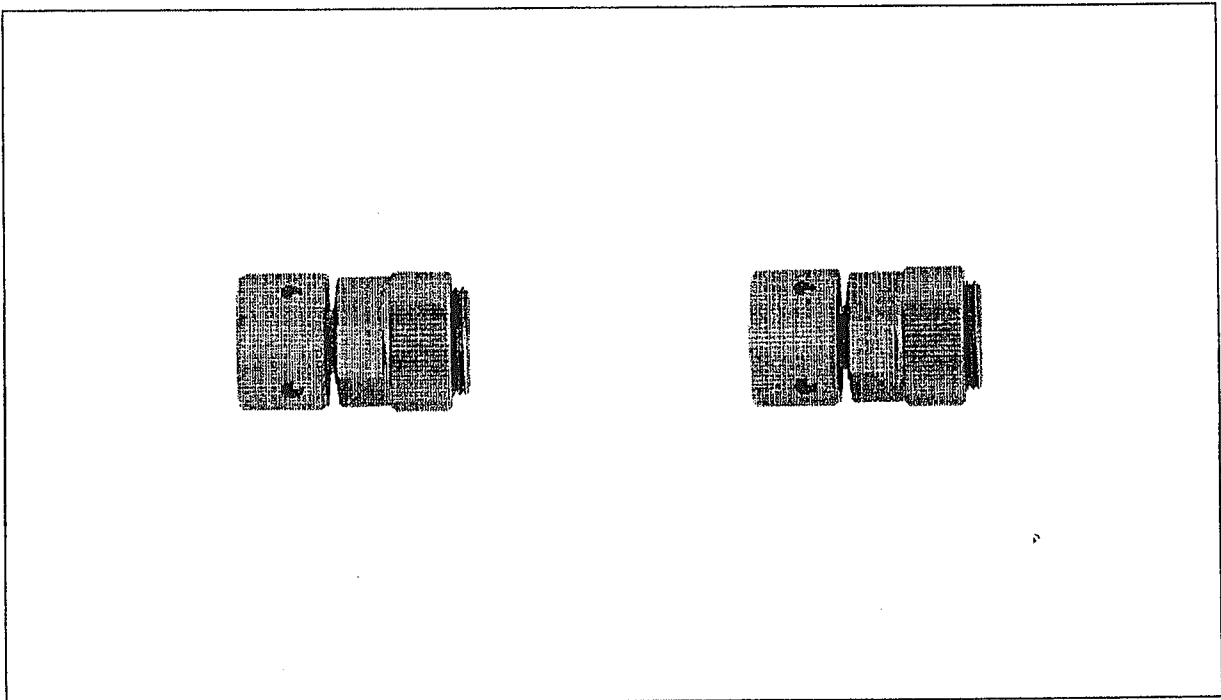
Figure 27. HP 85130A Special 3.5mm (F)-to-Precision 7mm Adapters

CLEANING SMA AND PRECISION 3.5mm CONNECTORS

- **Use great care to avoid bending or breaking the center conductor pins. Female contact fingers in precision 3.5mm connectors are especially easy to damage.**

- **Avoid wetting plastic support parts. Use the least amount of solvent possible and blow connectors dry with a gentle stream of compressed air.**

SMA and precision 3.5mm connectors require special care in cleaning, because of their delicacy, small size, and intricate geometry. Center conductor contact pins (especially the contact fingers on female connectors) are very easily bent or broken. In precision 3.5mm connectors, moreover, the center conductor is supported only at the inner end, by a plastic dielectric support bead. This makes it very easy to bend or break the center conductor.

Magnification and good lighting are helpful, and especially for cleaning the interior surfaces of these connectors the method given in Part One of this **Microwave Connector Care Manual** is recommended: cutting off the sharp tip of a round wooden toothpick, wrapping it with a single layer of lint-free cleaning cloth, and moistening the cloth with liquid Freon. Insert the cloth carefully into the connector to clean the interior surfaces. When it has been cleaned, blow the connector dry with a gentle stream of compressed air.

Cleaning Solvents. Contact with solvents can affect the plastic dielectric that surrounds the center conductor in SMA connectors and the plastic interior support beads in precision 3.5mm connectors. Generally, this is not a problem if the solvent is applied with a cloth or swab and if the least possible solvent is used. It can be a problem if the connector is sprayed directly with solvent or if the connector is immersed in solvent. Both of these practices should be avoided.

If a connector does become wet with solvent during cleaning, immediately invert the connector to allow the liquid to flow out, then purge the remaining solvent using a gentle stream of compressed air. This should be done slowly, to prevent damage to the connector due to excessive cooling due to rapid evaporation of the solvent. Allow the connector to return to room temperature before use. If contact with the solvent has been prolonged, inspect the plastic dielectric or support bead for signs of swelling or deterioration before using the connector and discard any connectors that are damaged.

GAGING SMA AND PRECISION 3.5mm CONNECTORS

- **No protrusion of the shoulder of the male contact pin or of the female contact fingers in front of the outer conductor mating plane is ever allowable, and sometimes a minimum recession is required. Consult the mechanical specifications provided with the connector or the device itself.**

- **If an SMA connector is to be mated to a precision 3.5mm connector, the SMA connector must meet the setback specifications of precision 3.5mm connectors. In particular, there must be no protrusion of the plastic dielectric, or of the shoulder of the male contact pin or the tip of the female contact fingers, in front of the outer conductor mating plane.**

The same gages can be used to measure SMA and precision 3.5mm connectors. Separate male and female gages are required, and connector gage kits containing all the items required are included in many Hewlett-Packard calibration kits. Gage kits are also available separately. Part numbers are given in Part One of this **Microwave Connector Care Manual.**

Male SMA and Precision 3.5mm Connectors. Gages used to measure male SMA and precision 3.5mm connectors are usually marked M and have a circular metal bushing surrounding the gage plunger (Figure 28). When the connector is gaged, the outer bushing rests on the outer conductor mating plane and the male contact pin slips inside the gage plunger. In this way the recession of the shoulder of the male contact pin is measured relative to the outer conductor mating plane.

Male gages are zeroed using the protruding end of the gage calibration block supplied with the gage. This end of the gage block is usually also marked M. Slip the calibration block into the outer bushing so that this bushing comes to rest on the outer flat area of the calibration block. When the connector is measured, this outer bushing will rest on the outer conductor mating plane inside the connector. Follow the instructions for zeroing the gage given in Part One of this **Microwave Connector Care Manual.**

To gage male SMA and precision 3.5mm connectors, center the gage carefully relative to the connector before inserting it. As you insert the gage, be sure that the male contact pin slips into the hole for this purpose in the gage plunger, as it will if the gage is exactly centered in the connector. This is required to give the correct center conductor measurement for male connectors: the position of the shoulder of the male contact pin (not the tip) relative to the outer conductor mating plane. Gently rock the connector gage within the connector, to make sure that the gage and the outer conductor have come together flatly. Then read the recession (or protrusion) from the gage dial.

Female SMA and Precision 3.5mm Connectors. Gages used to measure female SMA and precision 3.5mm connectors are usually marked F and are zeroed using the flat end of the calibration block supplied with the gage (Figure 28). This end of the gage block is usually marked F. When the connector is measured, the gage plunger comes to rest on the outer end of the female contact fingers.

Gaging female SMA and precision 3.5mm connectors is done in the same way as it is for male connectors.

MALE SMA AND PRECISION 3.5mm CONNECTORS

- Use male connector gage (has circular bushing).
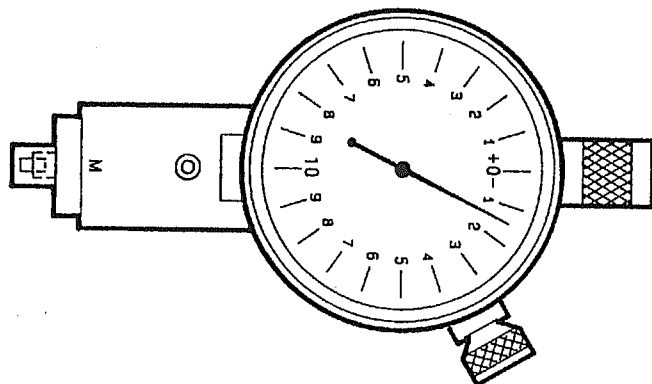
- Zero gage using protruding end of gage calibration block.
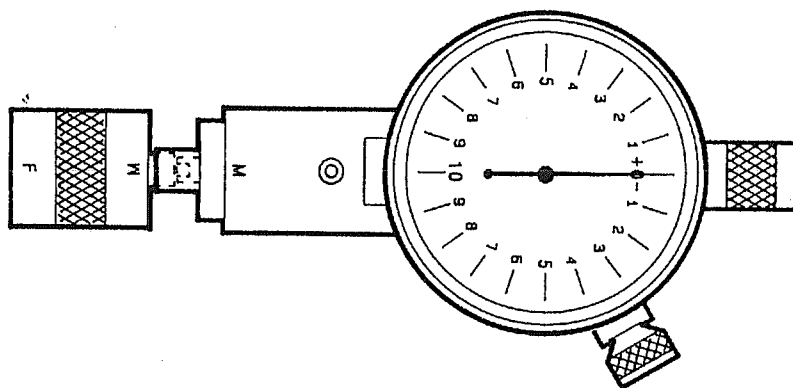
- Insert gage into connector.
  Male pin slips into gage plunger.

0.003 in

0
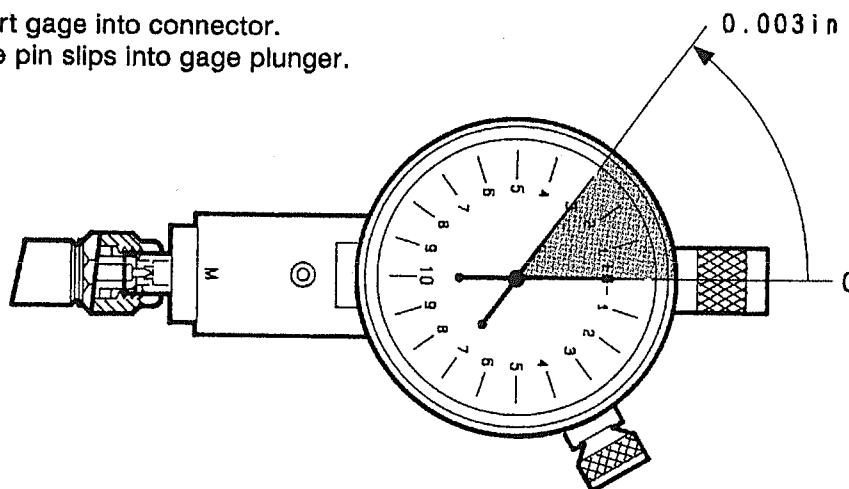
Figure 28.   Gaging SMA and Precision 3.5mm Connectors   (1 of 2)

FEMALE SMA AND PRECISION 3.5mm CONNECTORS

● Use female connector gage (has no circular bushing).
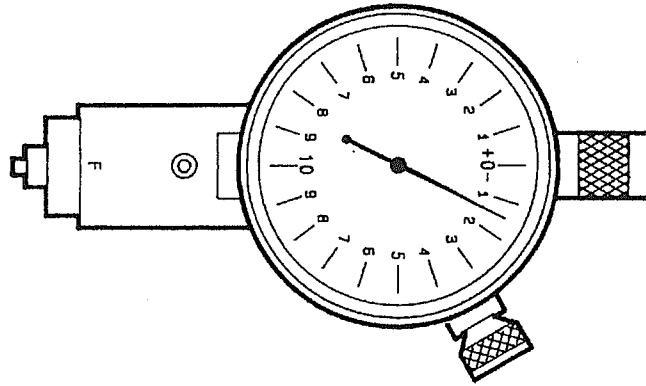
● Zero gage using flat end of gage calibration block
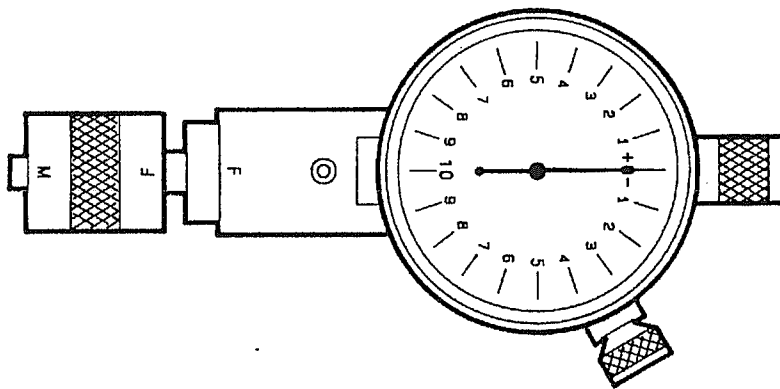
● Insert gage into connector.
Plunger rests on end of female contact fingers.

0.003 in

0
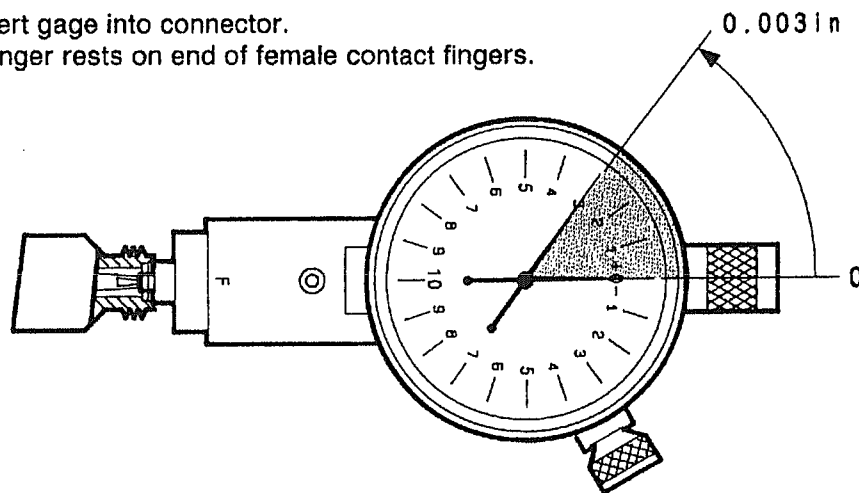
Figure 28. Gaging SMA and Precision 3.5mm Connectors (2 of 2)

Abort. To cut short or break off an action, operation, or procedure.

Active Channel. The highlighted channel that front panel functions will affect.

Address. An identification, as represented by a name, label, or number for a register, location in storage, or any other data source or destination (such as the location of a station in a communications network or a device on the Hewlett-Packard Interface Bus).

ALC. An abbreviation for Automatic Level Control. The process of monitoring and maintaining constant source power output.

Analog. Of or pertaining to the general class of devices or circuits in which the output varies as a continuous function of the input.

Annotation. The labeling of specific information such as frequency or power on the CRT.

Aperture. The amount of a trace (in percent) on either side of a given point that is averaged together to perform the smoothing function.

Array. A set of numbers or characters that represents any given function.

ASCII. An abbreviation for American Standard Code for Information Interchange. A specific format used to transfer information to and from the analyzer or magnetic disk.

AUX. An abbreviation for Auxiliary. Refers to rear panel input.

Binary. 1. A method of representing numbers in a scale of two (on or off, high level or low level, one or zero). 2. A compact, fast format used to transfer information to and from the analyzer or magnetic disk.

Bit. The smallest part of information in a binary notation system.

Buffer. A storage device used to compensate for a difference in the rate of flow of information between two devices when transmitting information.

Bus. One or more conductors used as a path over which information is transmitted from any of several sources to any of several destinations.

Byte. Eight bits of data representing one character processed as a unit.

Calibration. A process or operation which removes or reduces measurement errors.

Checksum. A summation of digits or bits primarily used for checking purposes.

Clamp. To limit a signal at a specified level.

Color brightness. A measure of the brightness or intensity of a color.

Color. 1. That aspect of light sources that is caused by differing qualities of the light emitted by them. Color is described in terms of three parameters: brightness (intensity), color (saturation), and tint (hue). 2. Color is used as a softkey label representing saturation (a color parameter).

Command. A set of bytes that defines a computer or instrument operation.

Controller. 1. A device capable of specifying the talker and listeners for an information transfer. 2. An external computer connected to an instrument to control its operation.

CPU. An abbreviation for Central Processing Unit. Used to refer to the A3 board or 68000 chip on the A3 board.

CRT. An abbreviation for Cathode Ray Tube. Used in this manual to refer to the display screen.

Cursor. An electronically generated pointer which moves across the trace to identify point values.

CW. An abbreviation for Continuous Wave. Refers to a single frequency (versus a swept frequency).

dB. An abbreviation for Decibel. A relative unit of measure.

dBm. Power in decibels expressed in terms of its ratio to 1 mW of power.

Default. A known set of conditions used by the analyzer in the absence of user-defined conditions.

Detector. A device used with the analyzer which converts a microwave signal to a 27.778 kHz signal that the analyzer can interpret.

Digital. Of or pertaining to the class of devices or circuits in which the output varies in discrete steps.

Dimension. 1. To specify the size of an array. 2. The number of array rows or columns.

Disk. A circular, magnetic storage medium.

Display. 1. To show annotation and measurement data on the CRT. 2. The CRT and its associated driver circuits (A15).

Engage. To activate a function.

Enter. The process of inputting information to the analyzer.

Firmware. Programs or instructions that are stored in read-only memory (EPROM).

GSP. An abbreviation for Graphics System Processor (A14U25). The central controller for all display processing.

Graticule. An electronically drawn grid on the CRT.

Hardkey. A front panel key which engages a single analyzer function or presents a single menu of softkeys.

Hex. An abbreviation for hexadecimal number system (base 16).

Horizontal Resolution. How closely spaced the horizontal data points are taken over the full sweep.

HP-IB. An abbreviation for Hewlett-Packard Interface Bus. HP-IB is Hewlett-Packard's hardware, software, documentation, and support for IEEE-488 and IEC-625 worldwide standards for interfacing instruments.

Hue. 1. The dimension of color that is referred to a scale of perceptions ranging from red through yellow, green, and blue, and back to red. 2. A particular gradation of color; tint; shade.

Initialize. The process in which information locations are assigned to a disk to prepare the magnetic media to accept files.

Insertion loss. The difference between the power measured before and after the insertion of a device.

Intensity. Brightness. Emitting or reflecting light. Luminosity.

Interpolate. To determine a value of a signal between two adjacent points by a procedure or algorithm.

I/O path. Input/output path.

Local Lock Out. A condition or command that prevents analyzer front panel entries (and disables the [LOCAL] key.)

Local operation. To operate manually from the front panel.

Log. An abbreviation for logarithm.

Logger. A circuit designed to output a voltage proportional to the log of an input voltage.

Magnitude. The magnitude of variation in a changing signal from its zero value. The length of a vector.

Marker. An indicator at a specified frequency point.

Menu. A selection of softkey choices.

Microprocessor kernel. The devices which are critical to the basic operation of the micro-processor.

Monitor. Any external display.

Monochrome. Having only one chromaticity or color.

Multisync. A type of monitor that can synchronize its horizontal sweep to various frequencies within a specified range.

Nit. The unit of luminance (photometric brightness) equal to one candela per square meter.

Normalize. To subtract one trace from another to eliminate calibration data errors or to obtain relative information.

PAL. An abbreviation for Programmable Array Logic. A programmable multiple input/output device which outputs a specific pattern for a given input.

Passthrough mode. That mode of the analyzer which allows HP-IB commands from a controller to be sent to devices on the analyzer's system interface bus.

Port. An input or output point of a circuit or device.

Preset. 1. A pre-defined instrument state (which also runs a self-test in the analyzer). 2. The action of pushing the [PRESET] key.

Raster. The process of drawing on the CRT by deflecting the electron beam rapidly from left to right and relatively slowly from top to bottom.

Reflection. The phenomenon in which a traveling wave that strikes a discontinuity is returned to the original medium.

Remote. A mode of operation where an instrument is controlled by another device or computer via the HP-IB. In this mode, the instrument front panel keys are disabled.

Return loss. The ratio, expressed in dB, between power incident upon and power reflected from a device. Calculated as $-20\,LOG_{10}\rho$ (where ρ is the reflection coefficient in magnitude).

RPG. 1. An abbreviation for Rotary Pulse Generator. 2. The analyzer front panel knob.

Saturation. The degree of purity of a color. A scale from white to pure color.

Scalar. 1. A quantity that has magnitude but no phase. 2. A network analyzer that is capable of measuring magnitude only.

Self-test. A group of tests performed at power up or preset that verify proper instrument operation.

Softkey. A key whose function is defined by the current instrument state.

Source. A device which supplies signal power. Used in this document to refer to sweep oscillators or synthesized sweepers.

Sweeper. A signal source that outputs a signal which varies in frequency.

SWR. An abbreviation for Standing Wave Ratio, calculated as $(1 + \rho)/(1 - \rho)$.

Sync. An abbreviated term for synchronization.

Termination. A load connected to a transmission line or other device.

Terminator. A keystroke (or code, if programming) that indicates the end of a numeric entry.

Thru. An abbreviation for "through" which is used to refer to a calibration technique.

Tint. A shade of a color; hue.

Toggle. To switch states, usually to change a function from on to off or off to on.

Transmission. The measurement of the insertion loss or gain of a network or device.

Transparent. Something that is not visible to the user. Usually a procedure that occurs without the user's initiation or knowledge.

Variable. A symbol, the numeric value of which changes from one iteration of a program to the next or within each iteration of a program.

Vector. 1. A quantity that has both magnitude and phase. 2. A network analyzer capable of measuring both magnitude and phase.

Vertical Resolution. The degree to which an instrument can differentiate between 2 closely spaced signal amplitudes.

KEY (where X represents the page number): 1-X = General Information; 2-X = Installation; X = Operating Reference; UG X = User's Guide; RO X = Remote Operation (looseleaf page behind tab); QRG X = Quick Reference Guide; IPG X = Introductory Programming Guide for HP 9000 Series 200/300 Computer; IPV X = Introductory Programming Guide for HP Vectra; DIF X = In Case of Difficulty

KEY (where X represents the page number): **1-X** = General Information; **2-X** = Installation; **X** = Operating Reference; **UG X** = User's Guide; **RO X** = Remote Operation (looseleaf page behind tab); **QRG X** = QuickReference Guide; **IPG X** = Introductory Programming Guide for HP9000 Series 200/300 Computer; **IPV X** = Introductory Programming Guide for HP Vectra; **DIF X** = In Case of Difficulty

KEY (where X represents the page number): **1-X** = General Information; **2-X** = Installation; **X** = Operating Reference; **UG X** = User's Guide; **RO X** = Remote Operation (looseleaf page behind tab); **QRG X** = QuickReference Guide; **IPG X** = Introductory Programming Guide for HP9000 Series 200/300 Computer; **IPV X** = Introductory Programming Guide for HP Vectra; **DIF X** = In Case of Difficulty

KEY (where X represents the page number): **1-X** = General Information; **2-X** = Installation; **X** = Operating Reference; **UG X** = User's Guide; **RO X** = Remote Operation (looseleaf page behind tab); **QRG X** = QuickReference Guide; **IPG X** = Introductory Programming Guide for HP9000 Series 200/300 Computer; **IPV X** = Introductory Programming Guide for HP Vectra; **DIF X** = In Case of Difficulty

KEY (where X represents the page number): 1-X = General Information; 2-X = Installation; X = Operating Reference; UG X = User's Guide; RO X = Remote Operation (looseleaf page behind tab); QRG X = QuickReference Guide; IPG X = Introductory Programming Guide for HP9000 Series 200/300 Computer; IPV X = Introductory Programming Guide for HP Vectra; DIF X = In Case of Difficulty