Programmer's Guide

HP 8719D/20D/22D Network Analyzer

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How to Use This Guide

The Example Programs Disks

The example programs shipped with this instrument were originally written for the HP 8753D Network Analyzer, but are compatible with the HP 8719D/20D/22D Network Analyzer. In order to maintain compatibility with the HP 8719D/20D/22D, it will be necessary to modify certain example programs . The example programs that need modification are clearly identified in Chapter 2, "HP BASIC Programming Examples."

The following is included with the "Programming Examples HP BASIC" disk:

- HP BASIC example programs (compatible with Rocky Mountain Basic)
- LIF to DOS file-transformation utility, "LIF2DOS.EXE"

The following is included with the "Programming Examples QuickC and QuickBASIC" disk:

- QuickC example programs
- QuickBASIC example programs

Programming Documentation

This Programmer's Guide consists of the following two chapters:

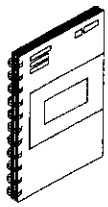
- **HP-IB Programming and Command Reference** provides a reference for operation of the network analyzer under HP-IB control and provides a description of all HP-IB mnemonics.
- **HP BASIC Programming Examples** provides documentation for the factory-tested HP BASIC example programs (which offer solutions for several remotely-controlled analyzer processes).

The programming examples have only been documented for HP BASIC in Chapter 2. However, if the programming language QuickC or QuickBASIC is preferred, these versions of the programming examples can be used or modified while referring to Chapter 2, "HP BASIC Programming Examples" as an overall guide in determining the organization and logic of the programs.

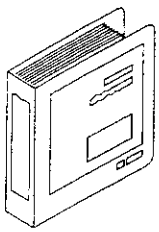
Conventions

(Front-Panel Key)	This represents a key physically located on the instrument.
`Softkey`	This represents a "softkey," a key whose label is determined by the instrument's firmware.
`Screen Text`	This represents text displayed on the instrument's screen.

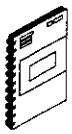
Network Analyzer Documentation Set



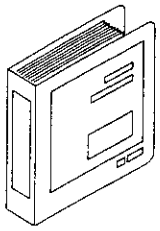
The **Installation and Quick Start Guide** familiarizes you with the network analyzer's front and rear panels, electrical and environmental operating requirements, as well as procedures for installing, configuring, and verifying the operation of the analyzer.



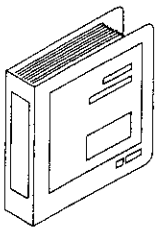
The **User's Guide** shows how to make measurements, explains commonly-used features, and tells you how to get the most performance from your analyzer.



The **Quick Reference Guide** provides a summary of selected user features.



The **Programmer's Guide** provides programming information including an HP-IB programming and command reference as well as programming examples.



The **Service Guide** provides the information needed to adjust, troubleshoot, repair, and verify conformance to published specifications.

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HP-IB Programming and Command Reference

This chapter is a reference for operation of the network analyzer under HP-IB control. You should already be familiar with making measurements with the analyzer. Information about the HP-IB commands is organized as follows:

- Analyzer Command Syntax
  - Code Naming Convention
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- Alphabetical Mnemonic Listing

For information about manual operation of the analyzer, refer to the *HP 8719D/20D/22D Network Analyzer User's Guide.*

Where to Look for More Information

Additional information covering many of the topics discussed in this chapter is located in the following:

- *Tutorial Description of the Hewlett-Packard Interface Bus*, presents a description and discussion of all aspects of the HP-IB. A thorough overview of all technical details as a broad tutorial. HP publication, HP part number 5021-1927.
- *IEEE Standard Digital Interface for Programmable Instrumentation ANSI/IEEE std 488.1-1987* contains detailed information on IEEE-488 operation. Published by the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, New York 10017.
- Chapter 2, "HP BASIC programming examples," includes programming examples in HP BASIC.

Analyzer Command Syntax

Code Naming Convention

The analyzer HP-IB commands are derived from their front-panel key titles (where possible), according to this naming convention:

Simple commands are the first four letters of the function they control, as in POWE, the command name for power. If the function label contains two words, the first three mnemonic letters are the first three letters of the first word, and the fourth mnemonic letter is the first letter of the second word. For example, ELED is derived from electrical delay.

If there are many commands grouped together in a category, as in markers or plotting pen numbers, the command is increased to 8 letters. The first 4 letters are the category label and the last 4 letters are the function specifier. As an example, category pen numbers are represented by the command PENN, which is used in combination with several functions such as PENNDATA, PENNMEMO.

The code naming guidelines, listed in Table 1-1, are used in order to:

- make commands more meaningful and easier to remember
- maintain compatibility with other products (including the HP 8510)

Note There are times when these guidelines are not followed due to technical considerations.

Table 1-1. Code Naming Convention

Convention	Key Title	For HP-IB Code Use	Example
One Word	Power	First Four Letters	POWE
	Start		STAR
Two Words	Electrical Delay	First Three Letters of First Word, First Letter of Second Word	ELED
	Search Right		SEAR
Two Words in a Group	Marker →Center	Four Letters of Both	MARKCENT
	Gate →Span		GATESPAN
Three Words	Cal Kit N 50 Ω	First Three Letters of First Word, First Letter of Second Word, First Four Letters of Third Word	CALKN50
	Pen Num Data		PENNDATA

Some codes require appendages (ON, OFF, 1, 2, etc.). Codes that do not have a front-panel equivalent are HP-IB only commands. They use a similar convention based on the common name of the function.

Valid Characters

The analyzer accepts the following ASCII characters:

- letters
- numbers
- decimal points
- +/–
- semicolons (;)
- quotation marks (")
- carriage returns (CR)
- linefeeds (LF)

Both upper- and lower-case letters are acceptable. Carriage returns, leading zeros, spaces, and unnecessary terminators are ignored, except for those within a command or appendage. If the analyzer does not recognize a character as appropriate, it generates a syntax error message and recovers at the next terminator.

Units

The analyzer can input and output data in basic units such as Hz, dB, seconds, etc.

S	Seconds	HZ	Hertz
V	Volts	DB	dB or dBm

Input data is assumed to be in basic units (see above) unless one of the following units is used (upper and lower case are equivalent):

MS	Milliseconds	KHZ	Kilohertz
US	Microseconds	MHZ	Megahertz
NS	Nanoseconds	GHZ	Gigahertz
PS	Picoseconds	FS	Femtoseconds

Command Formats

The HP-IB commands accepted by the analyzer can be grouped into five input-syntax types. The analyzer does not distinguish between upper- and lower-case letters.

General Structure:

The general syntax structure is: [code][appendage][data][unit][terminator]

The individual sections of the syntax code are explained below.

[code] The root mnemonic (these codes are described in the "Alphabetical Mnemonic Listing" later in this chapter.)

[appendage] A qualifier attached to the root mnemonic. Possible appendages are ON or OFF (toggle a function ON or OFF), or integers, which specify one capability out of several. There can be no spaces or symbols between the code and the appendage.

[data] A single operand used by the root mnemonic, usually to set the value of a function. The data can be a number or a character string. Numbers are accepted as integers or decimals, with power of ten specified by E (for example, `STAR 0.2E+10;` sets the start frequency to 2 GHz). Character strings must be enclosed by double quotation marks.

For example:

A title string using RMB BASIC would look like:

```
OUTPUT 716;"TITL""Unit1""";"
```

where the first two "" are an escape so that RMB BASIC will interpret the third " properly.

[unit] The units of the operand, if applicable. If no units are specified, the analyzer assumes the basic units as described above. The data is entered into the function when either units or a terminator are received.

[terminator] Indicates the end of the command, enters the data, and switches the active-entry area OFF. A semicolon (;) is the recommended terminator.

Terminators are not necessary for the analyzer to interpret commands correctly, but in the case of a syntax error, the analyzer will attempt to recover at the next terminator. The analyzer also interprets line feeds and HP-IB END OR IDENTIFY (EOI) messages as terminators.

Syntax Types

The specific syntax types are:

SYNTAX TYPE 1: [code] [terminator]

These are simple action commands that require no complementary information, such as `AUTO;` (autoscales the active channel).

SYNTAX TYPE 2: [code][appendage][terminator]

These are simple action commands requiring limited customization, such as `CORRON;` and `CORROFF;` (error correction ON or OFF) or `RECA1;`, `RECA2;`, `RECA3;` (recall register 1, 2, 3). There can be no characters or symbols between the code and the appendage.

Note In the following cases: CLEAREG[D], RECAREG[D], SAVEREG[D], and EG[D], [D] must be 2 characters. For example, `CLEAREG01;` will execute, while `CLEAREG1;` will generate a syntax error.

SYNTAX TYPE 3: [code] [data] [unit][terminator]

These are data-input commands such as `STAR 1.0 GHZ;` (set the start frequency to 1 GHz).

SYNTAX TYPE 4: [code] [appendage] [data] [terminator]

These are titling and marker commands that have an appendage, such as `TITR1 "STATE1"` (title register 1 STATE1), `TITR2 "TEST2"` (title register 2 TEST2).

QUERY SYNTAX: [code][?]

To query a front-panel-equivalent function, append a question mark (?) to the root mnemonic. (For example, `POWE?`, `AVERO?`, or `REAL?`.) To query commands with integer appendages, place the question mark after the appendage.

HP-IB Operation

The Hewlett-Packard Interface Bus (HP-IB) is Hewlett-Packard's hardware, software, documentation, and support for IEEE 488.2 and IEC-625 worldwide standards for interfacing instruments. This interface allows you to operate the analyzer and peripherals in two methods:

- by an external system controller
- by the network analyzer in system-controller mode

Device Types

The HP-IB employs a party-line bus structure in which up to 15 devices can be connected on one contiguous bus. The interface consists of 16 signal lines and 8 ground lines within a shielded cable. With this cabling system, many different types of devices including instruments, computers, power meters, plotters, printers, and disk drives can be connected in parallel.

Every HP-IB device must be capable of performing one or more of the following interface functions:

Talker

A talker is a device capable of transmitting device-dependent data when addressed to talk. There can be only one active talker at any given time. Examples of this type of device include:

- power meters
- disk drives
- voltmeters
- counters
- tape readers

The network analyzer is a talker when it sends trace data or marker information over the bus.

Listener

A listener is a device capable of receiving device-dependent data over the interface when addressed to listen. There can be as many as 14 listeners connected to the interface at any given time. Examples of this type of device include:

- printers
- power supplies
- signal generators

The network analyzer is a listener when it is controlled over the bus by a system controller.

Controller

A controller is defined as a device capable of:

1. managing the operation of the bus
2. addressing talkers and listeners

There can be only one active controller on the interface at any time. Examples of controllers include desktop computers, minicomputers, workstations, and the network analyzer. In a multiple-controller system, active control can be passed between controllers, but there can only be one *system* controller connected to the interface. The system controller acts as the master and can regain active control at any time. The analyzer is an active controller when it plots, prints, or stores to an external disk drive in the pass-control mode. The analyzer is also a system controller when it is operating in the system-controller mode.

HP-IB Bus Structure

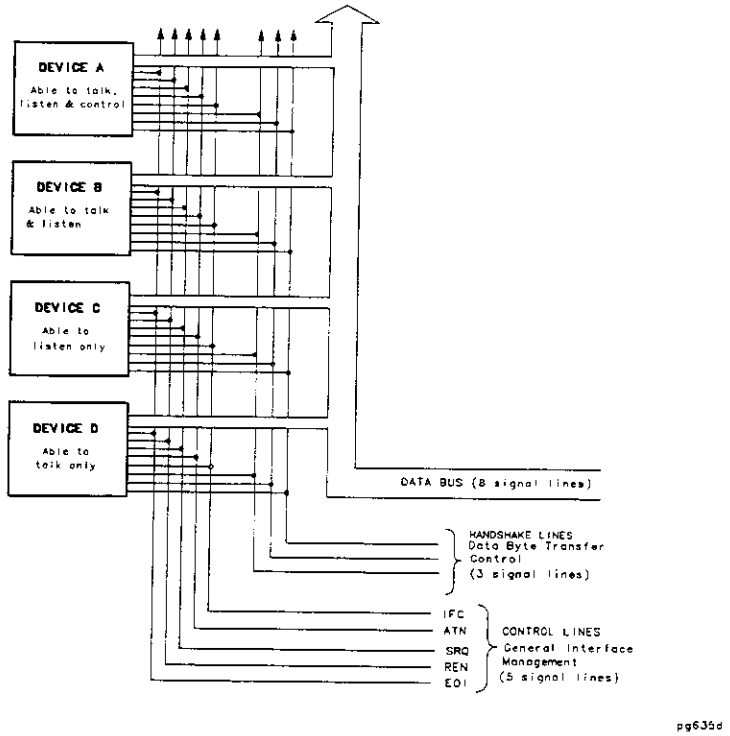


Figure 1-1. HP-IB Bus Structure

Data Bus

The data bus consists of 8 bi-directional lines that are used to transfer data from one device to another. Programming commands and data transmitted on these lines are typically encoded in ASCII, although binary encoding is often used to speed up the transfer of large arrays. Both ASCII- and binary-data formats are available to the analyzer. In addition, every byte transferred over HP-IB undergoes a handshake to insure valid data.

Handshake Lines

A three-line handshake scheme coordinates the transfer of data between talkers and listeners. To insure data integrity in multiple-listener transfers, this technique forces data transfers to occur at the transfer rate of the slowest device connected to the interface. With most computing controllers and instruments, the handshake is performed automatically, making it transparent to the programmer.

Control Lines

The data bus also has five control lines. The controller uses these lines to address devices and to send bus commands.

IFC (Interface Clear) — This line is used exclusively by the system controller. When this line is true (low), all devices (whether addressed or not) unaddress and revert to an idle state.

ATN (Attention)	The active controller uses this line to define whether the information on the data bus is command-oriented or data-oriented. When this line is true (low), the bus is in the command mode, and the data lines carry bus commands. When this line is false (high), the bus is in the data mode, and the data lines carry device-dependent instructions or data.
SRQ (Service Request)	This line is set true (low) when a device requests service and the active controller services the requesting device. The network analyzer can be enabled to pull the SRQ line for a variety of reasons such as requesting control of the interface, for the purposes of printing, plotting, or accessing a disk.
REN (Remote Enable)	This line is used exclusively by the system controller. When this line is set true (low), the bus is in the remote mode, and devices are addressed by the controller to either listen or talk. When the bus is in remote mode and a device is addressed, it receives instructions from the system controller via HP-IB rather than from its front panel (pressing Local returns the device to front-panel operation). When this line is set false (high), the bus and all of the connected devices return to local operation.
EOI (End or Identify)	This line is used by a talker to indicate the last data byte in a multiple-byte transmission, or by an active controller to initiate a parallel-poll sequence. The analyzer recognizes the EOI line as a terminator, and it pulls the EOI line with the last byte of a message output (data, markers, plots, prints, error messages). The analyzer does not respond to parallel poll.

HP-IB Requirements

Number of Interconnected Devices:	15 maximum.
Interconnection Path Maximum Cable Length:	20 meters maximum or 2 meters per device (whichever is less).
Message Transfer Scheme:	Byte serial, bit parallel asynchronous data transfer using a 3-line handshake system.
Data Rate:	Maximum of 1 megabyte-per-second over the specified distances with tri-state drivers. Actual data rate depends on the transfer rate of the slowest device connected to the bus.
Address Capability:	Primary addresses: 31 talk, 31 listen. A maximum of 1 talker and 14 listeners can be connected to the interface at given time.
Multiple-Controller Capability:	In systems with more than one controller (such as this instrument), only one controller can be active at any given time. The active controller can pass control to another controller, but only the system controller can assume unconditional control. Only one *system* controller is allowed.

HP-IB Operational Capabilities

On the network analyzer's rear panel, next to the HP-IB connector, there is a list of HP-IB device subsets as defined by the IEEE 488.2 standard. The analyzer has the following capabilities:

SH1	Full-source handshake.
AH1	Full-acceptor handshake.
T6	Basic talker, answers serial poll, unaddresses if MLA is issued. No talk-only mode.
L4	Basic listener, unaddresses if MTA is issued. No listen-only mode.
SR1	Complete service request (SRQ) capabilities.
RL1	Complete remote/local capability including local lockout.
PP0	Does not respond to parallel poll.
DC1	Complete device clear.
DT1	Responds to a Group Execute Trigger (GET) in the hold-trigger mode.
C1,C2,C3	System controller capabilities in system-controller mode.
C10	Pass control capabilities in pass-control mode.
E2	Tri-state drivers.
LE0	No extended listener capabilities.
TE0	No extended talker capabilities.

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

HP-IB Status Indicators

When the analyzer is connected to other instruments over the HP-IB, the HP-IB status indicators illuminate to display the current status of the analyzer. The HP-IB status indicators are located in the instrument-state function block on the front panel of the network analyzer.

R = Remote Operation

L = Listen mode

T = Talk mode

S = Service request (SRQ) asserted by the analyzer

Bus Device Modes

The analyzer uses a single-bus architecture. The single bus allows both the analyzer and the host controller to have complete access to the peripherals in the system.

Three different controller modes are possible in and HP-IB system:

- system-controller mode
- talker/listener mode
- pass-control mode

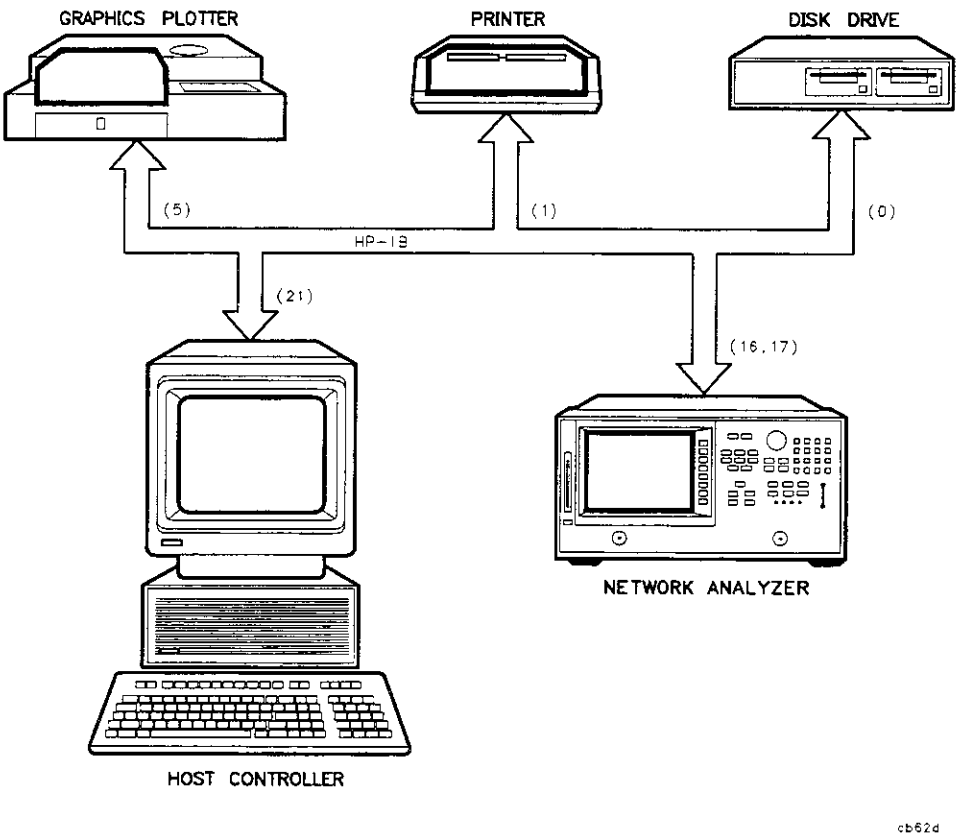


Figure 1-2. Analyzer Single Bus Concept

System-Controller Mode

This mode allows the analyzer to control peripherals directly in a stand-alone environment (without an external controller). This mode can only be selected manually from the analyzer's front panel. It can only be used if no active computer or instrument controller is connected to the system via HP-IB. If an attempt is made to set the network analyzer to the system-controller mode when another controller is connected to the interface, the following message is displayed on the analyzer's display screen:

"ANOTHER SYSTEM CONTROLLER ON HP-IB BUS"

The analyzer must be set to the system-controller mode in order to access peripherals from the front panel. In this mode, the analyzer can directly control peripherals (plotters, printers, disk drives, power meters, etc.) and the analyzer may plot, print, store on disk or perform power meter functions.

Note Do not attempt to use this mode for programming. HP recommends using an external instrument controller when programming. See the following section, "Talker/Listener Mode."

Talker/Listener Mode

This is the mode that is normally used for remote programming of the analyzer. In talker/listener mode, the analyzer and all peripheral devices are controlled from an external instrument controller. The controller can command the analyzer to talk and other devices to listen. The analyzer and peripheral devices cannot talk directly to each other unless the computer sets up a data path between them. This mode allows the analyzer to act as either a talker or a listener, as required by the controlling computer for the particular operation in progress.

Pass-Control Mode

This mode allows the computer to control the analyzer via HP-IB (as with the talker/listener mode), but also allows the analyzer to take control of the interface in order to plot, print, or access a disk. During an analyzer controlled peripheral operation, the host computer is free to perform other internal tasks (i.e. data or display manipulation) while the analyzer is controlling the bus. After the analyzer-controlled task is completed, the analyzer returns control to the system controller.

Note Performing an instrument preset does not affect the selected bus mode, although the bus mode will return to talker/listener mode if the line power is cycled.

Note "Specifications and Measurement Uncertainties" in the *HP 8719D/20D/22D Network Analyzer User's Guide* provides information on setting the correct bus mode from the front-panel menu.

Analyzer Bus Modes

As discussed earlier, under HP-IB control, the analyzer can operate in one of three modes: talker/listener, pass-control, or system-controller mode.

In talker/listener mode, the analyzer behaves as a simple device on the bus. While in this mode, the analyzer can make a plot or print using the `OUTPPLOT;` or `OUTPPRIN;` commands. The analyzer will wait until it is addresses to talk by the system controller and then dump the display to a plotter/printer that the system controller has addressed to listen. Use of the commands `PLOT;` and `PRINALL;` require control to be passed to another controller.

In pass-control mode, the analyzer can request control from the system controller and take control of the bus if the controller addresses it to take control. This allows the analyzer to take control of printers, plotters, and disk drives on an as-needed basis. The analyzer sets event-status register bit 1 when it needs control of the interface, and the analyzer will transfer control back to the system controller at the completion of the operation. It will pass control back to its controller address, specified by ADDRCONT.

The analyzer can also operate in the system-controller mode. This mode is only used when there is no remote controller on the bus. In this mode, the analyzer takes control of the bus, and uses it whenever it needs to access a peripheral. While the analyzer is in this mode, no other devices on the bus can attempt to take control. Specifically, the REN, ATN, and IFC lines must remain unasserted, and the data lines must be freed by all but the addressed talker.

Setting HP-IB Addresses

In systems interfaced using HP-IB, each instrument on the bus is identified by an HP-IB address. This address code must be different for each instrument on the bus. These addresses are stored in short-term, non-volatile memory and are not affected when you press (Preset) or cycle the power. The analyzer occupies two HP-IB addresses: the instrument itself and the display. The display address is derived from the instrument address by complementing the instrument's least-significant bit. Hence, if the instrument is at an even address, the display occupies the next higher address. If the instrument is at an odd address, the display occupies the next lower address.

The analyzer addresses are set by pressing (Local) SET ADDRESSES. In system-controller mode, the addresses must be set for the plotter, printer, disk drive, and power meter.

The default address for the analyzer is device 16, and the display address is device 17.

Note There is also an address for the system controller. This address refers to the controller when the network analyzer is being used in pass-control mode. This is the address that control is passed back to when the analyzer-controlled operation is complete.

Response to HP-IB Meta-Messages (IEEE-488 Universal Commands)

Abort

The analyzer responds to the abort message (IFC) by halting all listener, talker, and controller functions.

Device Clear

The analyzer responds to the device clear commands (DCL, SDC) by clearing the input and output queues, and clearing any HP-IB errors. The status registers and the error queue are unaffected.

Local

The analyzer will go into local mode if the local command (GTL) is received, the remote line is unasserted, or the front-panel local key is pressed. Changing the analyzer's HP-IB status from remote to local does not affect any of the front-panel functions or values.

Local Lockout

If the analyzer receives the local-lockout command (LLO) while it is in remote mode, it will disable the entire front panel except for the line power switch. A local-lockout condition can only be cleared by releasing the remote line, although the local command (GTL) will place the instrument temporarily in local mode.

Parallel Poll

The analyzer does not respond to parallel-poll configure (PPC) or parallel-poll unconfigure (PPU) messages.

Pass Control

If the analyzer is in pass-control mode, is addressed to talk, and receives the take-control command (TCT), from the system control it will take active control of the bus. If the analyzer is not requesting control, it will immediately pass control to the system controller's address. Otherwise, the analyzer will execute the function for which it sought control of the bus and then pass control back to the system controller.

Remote

The analyzer will go into remote mode when the remote line is asserted and the analyzer is addressed to listen. While the analyzer is held in remote mode, all front-panel keys (with the exception of (Local)) are disabled. Changing the analyzer's HP-IB status from remote to local does not affect any front-panel settings or values.

Serial Poll

The analyzer will respond to a serial poll with its status byte, as defined in the "Status Reporting" section of this chapter. To initiate the serial-poll sequence, address the analyzer to talk and issue a serial-poll enable command (SPE). Upon receiving this command, the analyzer will return its status byte. End the sequence by issuing a serial-poll disable command (SPD). A serial poll does not affect the value of the status byte, and it does not set the instrument to remote mode.

Trigger

In hold mode, the analyzer responds to device trigger by taking a single sweep. The analyzer responds only to selected-device trigger (SDT). This means that it will not respond to group execute-trigger (GET) unless it is addressed to listen. The analyzer will not respond to GET if it is not in hold mode.

Analyzer Operation

Operation Complete

Occasionally, there is a need to know when certain analyzer operations have been completed. There is an operation-complete function (OPC) that allows a synchronization of programs with the execution of certain key commands. This mechanism is activated by issuing `OPC;` or `OPC?;` prior to an OPC-compatible command. The status byte or ESR operation-complete bit will then be set after the execution of the OPC-compatible command. For example, issuing `OPC;SING;` causes the OPC bit to be set when the single sweep is finished. Issuing `OPC?;` in place of the `OPC;` causes the analyzer to output a one (1) when the command execution is complete. The analyzer will halt the computer by not transmitting the one (1) until the command has completed. For example, executing `OPC?;PRES;`, and then immediately querying the analyzer causes the bus to halt until the instrument preset is complete and the analyzer outputs a one (1).

As another example, consider the timing of sweep completion. Send the command string `SWET 3 S;OPC?;SING;` to the analyzer. This string sets the analyzer sweep time to 3 seconds, and then waits for completion of a single sweep to respond with a one (1). The computer should be programmed to read the number one (1) response from the analyzer indicating completion of the single sweep. At this point a valid trace exists and the trace data could be read into the computer.

Table 1-2. OPC-compatible Commands

CHAN1	FWDM[1]	REVT[1]
CHAN2	FWDT[1]	RST
CLASS11A[1]	GATEO<ON|OFF>	SAV1
CLASS11B[1]	INSMNETA	SAV2
CLASS11C[1]	INSMTUNR	SAVC
CLASS22A[1]	ISOD	SAVE<1 to 5>
CLASS22B[1]	MANTRIG	SAVEREG<01 to 31>
CLASS22C[1]	NOOP	SAVT
CLEA<1 to 5>	NUMG	SING
CLEARALL	PRES	SLIS
CLEAREG<01 to 31)	RAID	STAN<A to G>
DATI	RECA<1 to 5>	SWPSTART
EXTTOFF	RECAREG<01 to 31>	TIMDTRAN<ON|OFF>
EXTTON	REFD	TRAD
EXTTPOIN	RESPDONE	WAIT
FREQOFFS<ON|OFF>	REVI[1]	
FWDI[1]	REVM[1]	

1 The class commands are OPC-compatible if there is only one standard in the class.

Reading Analyzer Data

Output Queue

Whenever an output-data command is received, the analyzer puts the data into the output queue (or buffer) where it is held until the system controller outputs the next read command. The queue, however, is only one event long: the next output-data command will overwrite the data already in the queue. Therefore, it is important to read the output queue immediately after every query or data request from the analyzer.

Command Query

All instrument functions can be queried to find the current ON/OFF state or value. For instrument state commands, append the question mark character (?) to the command to query the state of the functions. Suppose the operator has changed the power level from the analyzer's front panel. The computer can ascertain the new power level using the analyzer's command-query function. If a question mark is appended to the root of a command, the analyzer will output the value of that function. For instance, `POWE 7 DB;` sets the source power to 7 dB, and `POWE?;` outputs the current RF source power at the test port. When the analyzer receives `POWE?;`, it prepares to transmit the current RF source power level. This condition illuminates the analyzer front-panel talk light (T). In this case, the analyzer transmits the output power to the controller.

ON/OFF commands can be also be queried. The reply is a one (1) if the function is ON or a zero (0) if it is OFF. For example, if a command controls an active function that is underlined on the analyzer display, querying that command yields a one (1) if the command is underlined or a zero (0) if it is not. As another example, there are nine options on the format menu and only one option is underlined at a time. Only the underlined option will return a one when queried.

For instance, send the command string `DUAC?;` to the analyzer. If dual-channel display is switched ON, the analyzer will return a one (1) to the instrument controller.

Similarly, to determine if phase is being measured and displayed, send the command string `PHAS?;` to the analyzer. In this case, the analyzer will return a one (1) if phase is currently being displayed. Since the command only applies to the active channel, the response to the `PHAS?;` query depends on which channel is active.

Identification

The analyzer's response to `IDN?;` is `HEWLETT PACKARD,87NND,0,X.XX` where 87NND is the model number of the instrument and X.XX is the firmware revision of the instrument.

The analyzer also has the capability to output its serial number with the command `OUTPSERN;`, and to output its installed options with the command `OUTPOPTS;`.

Output Syntax

The following three types of data are transmitted by the analyzer in ASCII format:

- response to query
- certain output commands
- ASCII floating-point (FORM 4) array transfers

Marker-output commands and queried commands are output in ASCII format only, meaning that each character and each digit is transmitted as a separate byte, leaving the receiving computer to reconstruct the numbers and strings. Numbers are transmitted as 24-character strings, consisting of:

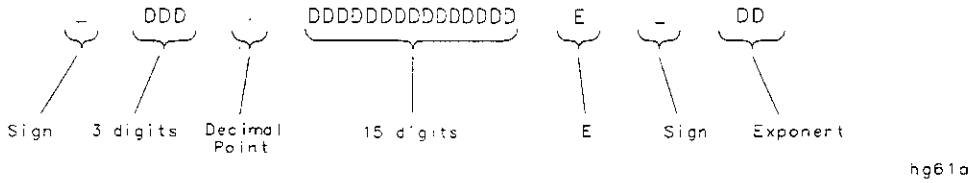


Figure 1-3. FORM 4 (ASCII) Data-Transfer Character String

Sign	'-' for negative, blank for positive.
3 digits	Digits to the left of the decimal point.
Decimal point	Standard decimal point.
15 digits	Digits to the right of the decimal point.
E	Exponent notation.
Sign	'-' for negative, '+' for positive.
Exponent	Two digits for the exponent.

When multiple numbers are sent, the numbers are separated by commas. When number pairs are sent, the numbers are separated by a comma and terminated with a line feed (LF).

Marker data

The network analyzer offers several options for outputting trace-related data. Trace information can be read out of the analyzer in several methods. Data can be selectively read from the trace using the markers, or the entire trace can be read by the controller. If only specific information is required (such as a single point on the trace or the result of a marker search), the marker output command can be used to read the information. Specific data points can be read using the OUTPDATP or OUTPDATR commands. These commands allow a much faster data transfer than when using markers to output specific data points. For more information on these commands, see "Limit Line and Data Point Special Functions," located in Chapter 2.

To read the trace data using the marker, the marker must first be assigned to the desired frequency. This is accomplished using the marker commands. The controller sends a marker command followed by a frequency within the trace-data range. If the actual desired frequency was not sampled, the markers can be set to continuous mode and the desired marker value will be linearly interpolated from the two nearest points. This interpolation can be prevented by putting the markers into discrete mode. Discrete mode allows the marker to only be positioned on a measured trace-data point.

As an alternative, the analyzer can be programmed to choose the stimulus value by using the MARKER SEARCH function. Maximum, minimum, target value, or bandwidths search can be automatically determined with MARKER SEARCH. To continually update the search, switch the marker tracking ON. The trace-maximum search will remain activated until:

- The search is switched OFF.
- The tracking is switched OFF.

- All markers are switched OFF.

Marker data can be output to a controller with a command to the analyzer. This set of commands causes the analyzer to transmit three numbers: marker value 1, marker value 2, and marker stimulus value. For example, in log-magnitude display mode we get the log magnitude at the marker (value 1), zero (for value 2), and the marker frequency. See Table 1-3 for a complete listing of all the possibilities for values 1 and 2. The three possibilities for the marker stimulus value are:

- frequency
- time (as in time domain, Option 010 Only)
- CW time
- power (in power sweep mode)

Table 1-3. Units as a Function of Display Format

Display Format	Marker Mode	OUTPMARK		OUTPFORM		MARKER READOUT*	
		value 1	value 2	value 1	value 2	value	aux value
LOG MAG		dB	†	dB	†	dB	†
PHASE		degrees	†	degrees	†	degrees	†
DELAY		seconds	†	seconds	†	seconds	†
SMITH CHART	LIN MKR	lin mag	degrees	real	imag	lin mag	degrees
	LOG MKR	dB	degrees	real	imag	dB	degrees
	Re/Im	real	imag	real	imag	real	imag
	R + jX	real ohms	imag ohms	real	imag	real ohms	imag ohms
	G + jB	real Siemens	imag Siemens	real	imag	real Siemens	imag Siemens
POLAR	LIN MKR	lin mag	degrees	real	imag	lin mag	degrees
	LOG MKR	dB	degrees	real	imag	dB	degrees
	Re/Im	real	imag	real	imag	real	imag
LIN MAG§		lin mag	†	lin mag	†	lin mag	†
SWR		SWR	†	SWR	†	SWR	†
REAL		real	†	real	†	real	†
IMAGINARY		imag	†	imag	†	imag	†

*The marker readout values are the marker values displayed in the upper right-hand corner of the display. They also correspond to the value and auxiliary value associated with the fixed marker.

† Value 2 is not significant in this format, though it is included in data transfers. See also OUTPFORF.

§ LIN MAG data expressed as: "Watts," for single input measurements (A,B,R), and "Units," for ratioed measurements (A/R, B/R).

Array-Data Formats

The analyzer can transmit and receive arrays in the analyzer's internal binary format as well as four different numeric formats. The current format is set with the FORM1, FORM2, FORM3, FORM4, and FORM5 commands. These commands do not affect learn-string transfers, calibration-kit string transfers, or non-array transfers, such as command query, or output marker values.

A transmitted array will be output in the current format, and the analyzer will attempt to read incoming arrays according to the current format. Each data point in an array is a pair of numbers, usually a real/imaginary pair. The number of data points in each array is the same as the number of points in the current sweep.

The five formats are described below:

FORM1 — The analyzer's internal binary format, 6 bytes-per-data point. The array is preceded by a four-byte header. The first two bytes represent the string "#A", the standard block header. The second two bytes are an integer representing the number of bytes in the block to follow. FORM 1 is best applied when rapid data transfers, not to be modified by the computer nor interpreted by the user, are required.

FORM2 — IEEE 32-bit floating-point format, 8 bytes-per-data point. The data is preceded by the same header as in FORM1. Each number consists of a 1-bit sign, an 8-bit biased exponent, and a 23-bit mantissa. FORM 2 is the format of choice if your computer supports single-precision floating-point numbers.

FORM3 — IEEE 64-bit floating-point format, 16 bytes-per-data point. The data is preceded by the same header as in FORM 1. Each number consists of a 1-bit sign, an 11-bit biased exponent, and a 52-bit mantissa. This format may be used with double-precision floating-point numbers. No additional precision is available in the analyzer data, but FORM 3 may be a convenient form for transferring data to your computer.

FORM4 — ASCII floating-point format. The data is transmitted as ASCII numbers, as described in "Output Syntax".

There is no header. The analyzer always uses FORM 4 to transfer data that is not related to array transfers (i.e. marker responses and instrument settings).

FORM5 — PC-DOS 32-bit floating-point format with 4 bytes-per-number, 8 bytes-per-data point. The data is preceded by the same header as in FORM 1. The byte order is reversed to comply with PC-DOS formats. If you are using a PC-based controller, FORM 5 is the most effective format to use.

The analyzer terminates each transmission by asserting the EOI interface line with the last byte transmitted. Table 1-4 offers a comparative overview of the five array-data formats.

Table 1-4. HP 8719D/20D/22D Network Analyzer Array-Data Formats

Format type	Type of Data	Bytes per Data Value	Bytes per point 2 data values	(201 pts) Bytes per trace	Total Bytes with header
FORM 1	Internal Binary	3	6	1206	1210
FORM 2	IEEE 32-bit Floating-Point	4	8	1608	1612
FORM 3	IEEE 64-bit Floating-Point	8	16	3216	3220
FORM 4	ASCII Numbers	24 (Typical)	50 (Typical)	10,050 (Typical)	10,050* (Typical)
FORM 5	PC-DOS 32-bit Floating-Point	4	8	1608	1612

*No header is used in FORM 4.

Trace-Data Transfers

Transferring trace-data from the analyzer using an instrument controller can be divided into three steps:

1. allocating an array to receive and store the data
2. commanding the analyzer to transmit the data
3. accepting the transferred data

Data residing in the analyzer is always stored in pairs for each data point (to accommodate real/imaginary pairs). Hence, the receiving array has to be two elements wide, and as deep as the number of points in the array being transferred. Memory space for the array must be declared before any data can be transferred from the analyzer to the computer.

As mentioned earlier, the analyzer can transmit data over HP-IB in five different formats. The type of format affects what kind of data array is declared (real or integer), because the format determines what type of data is transferred. Examples of data transfers using different formats are discussed "Example 3: Measurement Data Transfer." For information on the various types of data that can be obtained (raw data, error-corrected data, etc.), see "Data Levels," located later in this chapter.

For information on transferring trace-data by selected points, see "Limit Line and Data Point Special Functions," located in Chapter 2.

Note "Example 7C: Reading ASCII Disk Files to the Instrument Controller's Disk File," located in Chapter 2, explains how to access disk files from a computer.

Stimulus-Related Values

Frequency-related values are calculated for the analyzer display. The start and stop frequencies or center and span frequencies of the selected frequency range are available to the programmer.

In a linear frequency range, the frequency values can be easily calculated because the trace data points are equally spaced across the trace. Relating the data from a linear frequency sweep to frequency can be done by querying the start frequency, the frequency span, and the number of points in the trace.

Given that information, the frequency of point n in a linear-frequency sweep is represented by the equation:

$$F = \text{Start frequency} + (n-1) \times \text{Span}/(\text{Points}-1)$$

In most cases, this is an easy solution for determining the related frequency value that corresponds with a data point. This technique is illustrated in "Example 3B: Data Transfer Using FORM 4 (ASCII Format)."

When using log sweep or a list-frequency sweep, the points are not evenly spaced over the frequency range of the sweep. In these cases, an effective way of determining the frequencies of the current sweep is to use the OUTPLIML command. Although this command is normally used for limit lines, it can also be used to identify all of the frequency points in a sweep. Limit lines do not need to be on in order to read the frequencies directly out of the instrument with the OUTPLIML command. Refer to example 3D, "Data Transfer Using Frequency Array Information."

Note Another method of identifying all of the frequency points in a sweep is to use the marker commands MARKBUCKx and OUTPMARK in a FOR NEXT programming loop that corresponds to the number of points in the sweep. MARKBUCKx places a marker at a point in the sweep, where x is the number of the point in a sweep, and OUTPMARK outputs the stimulus value as part of the marker data.

Data-Processing Chain

This section describes the manner in which the analyzer processes measurement data. It includes information on data arrays, common output commands, data levels, the learn string, and the calibration kit string.

Data Arrays

Figure 1-4 shows the different kinds of data available within the instrument:

- pre-raw measured data
- raw measured data
- error-corrected data
- formatted data
- trace memory
- calibration coefficients

Trace memory can be directly output to a controller with `OUTPMEMO;`, but it cannot be directly transmitted back.

One channel shown.

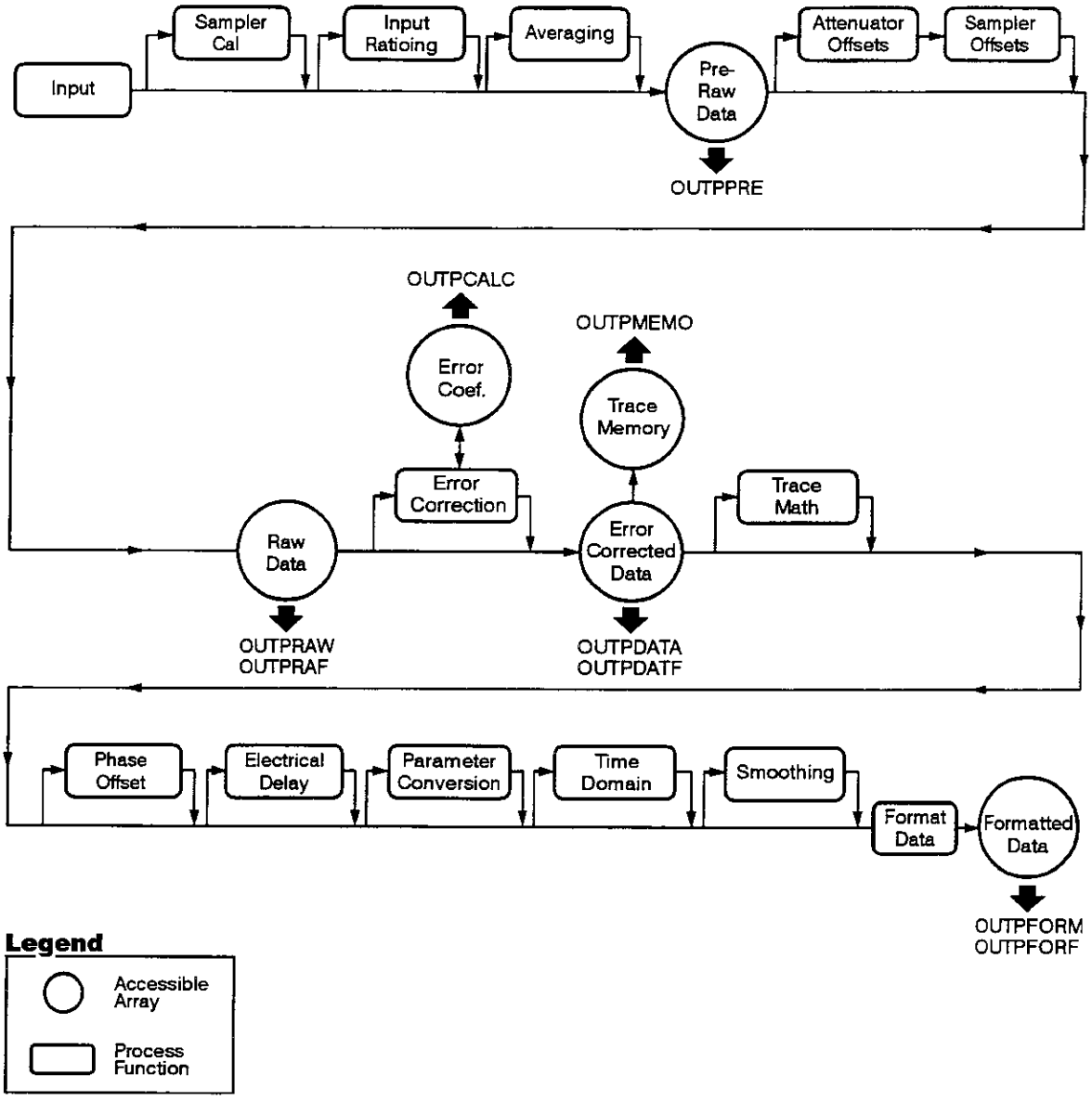


Figure 1-4. The Data-Processing Chain

All the data-output commands are designed to insure that the data transmitted reflects the current state of the instrument:

- OUTPDATA, OUTPRAW<I>, OUTPFORM, OUTPDATF, OUTPRAF<I> and OUTPFORF will not transmit data until all formatting functions have completed.
- OUTPPRE transmits data in conjunction with Take4 mode and the SWPSTART command. See Programming Example 2E: Take4 — Error Correction Processed on an External PC.
- OUTPLIML, OUTPLIMM, and OUTPLIMF will not transmit data until the limit test has occurred (if activated).

- OUTPMARK will activate a marker if a marker is not already selected. It will also insure that any current marker searches have been completed before transmitting data.
- OUTPMSTA insures that the statistics have been calculated for the current trace before transmitting data. If the statistics are not activated, it will activate the statistics long enough to update the current values before deactivating the statistics.
- OUTPMWID insures that a bandwidth search has been executed for the current trace before transmitting data. If the bandwidth-search function is not activated, it will activate the bandwidth-search function long enough to update the current values before switching OFF the bandwidth-search functions.

Fast Data Transfer Commands

The HP 8753D has four distinct fast data transfer commands. These commands circumvent the internal "byte handler" routine and output trace dumps as block data. In other words, the analyzer outputs the entire array without allowing any process swapping to occur. FORM4, ASCII data transfer times are not affected by these routines. However, there are speed improvements with binary data formats. The following is a description of the four fast data transfer commands:

- OUTPDATF outputs the error corrected data from the active channel in the current output format. This data may be input to the analyzer using the INPUDATA command.
- OUTPFORF outputs the formatted display trace array from the active channel in the current output format, but only the first number in each of the OUTPFORM data pairs is actually transferred for the display formats `LOG MAG`, `PHASE`, group `DELAY`, `LIN MAG`, `SWR`, `REAL` and `IMAG`inary. Because the data array does not contain the second value for these display formats, the INPUFORM command may not be used to re-input the data back into the analyzer. The second value may not be significant in some display formats (see Table 1-4), thus eliminating it reduces the number of bytes transferred.
- OUTPMEMF outputs the memory trace from the active channel. The data is in real/imaginary pairs, and, as such, may be input back into the memory trace using INPUDATA or INPUFORM followed by the DATI command.
- OUTPRAF<I> outputs the raw measurement data trace. The data may be input back into the memory trace using the INPURAW<I> command.

Data Levels

Different levels of data can be read out of the instrument. Refer to the data-processing chain in Figure 1-4. The following list describes the different types of data that are available from the network analyzer.

Pre-raw data	This is the raw data without attenuator offsets applied. With raw offsets turned off, the calibration coefficients generated can be transferred to an external controller and used with the data gathered using the OUTPPRE[1-4] commands. See Programming Example 2E: Take4 — Error Correction Processed on an External Computer. The four arrays refer to S11, S21, S12 and S22 respectively. These four arrays are available only if 2-port correction or Take4 mode is on. This data is represented in real/imaginary pairs.
Raw data	The basic measurement data, reflecting the stimulus parameters, IF averaging, and IF bandwidth. If a full 2-port measurement calibration is activated, there are actually four

	raw arrays kept: one for each raw S-parameter. The data can be output to a controller with the commands OUTPRAW1, OUTPRAW2, OUTPRAW3, OUTPRAW4. Normally, only raw 1 is available, and it holds the current parameter. If a 2-port measurement calibration is active, the four arrays refer to S_{11}, S_{21}, S_{12}, and S_{22} respectively. This data is represented in real/imaginary pairs.
Error-corrected data	This is the raw data with error-correction applied. The array represents the currently measured parameter, and is stored in real/imaginary pairs. The error-corrected data can be output to a controller with the `OUTPDATA;` command. The `OUTPMEMO;` command reads the trace memory, if available. The trace memory also contains error-corrected data. Note that neither raw nor error-corrected data reflect such post-processing functions as electrical-delay offset, trace math, or time-domain gating.
Formatted data	This is the array of data actually being displayed. It reflects all post-processing functions such as electrical delay and time domain. The units of the array output depend on the current display format. See Table 1-3 for the various units defined as a function of display format.
Calibration coefficients	The results of a measurement calibration are arrays containing calibration coefficients. These calibration coefficients are then used in the error-correction routines. Each array corresponds to a specific error term in the error model. The *HP 8753D Network Analyzer User's* details which error coefficients are used for specific calibration types, as well as the arrays those coefficients can be found in. Not all calibration types use all 12 arrays. The data is stored as real/imaginary pairs.

Generally, formatted data is the most useful of the five data levels, because it is the same information the operator sees on the display. However if post-processing is unnecessary (e.g. possibly in cases involving smoothing), error-corrected data may be more desirable. Error-corrected data also affords the user the opportunity to input the data to the network analyzer and apply post-processing at another time.

Learn String and Calibration-Kit String

The learn string is a summary of the instrument state. It includes all the front-panel settings, the limit-test tables, and the list-frequency table for the current instrument state. It does not include calibration data or the information stored in the save/recall registers.

The learn string can be output to a controller with the `OUTPLEAS;` command, which commands the analyzer to start transmitting the binary string. The string has a fixed length for a given firmware revision. The array has the same header as in FORM 1. See Example 5, "Using the Learn String."

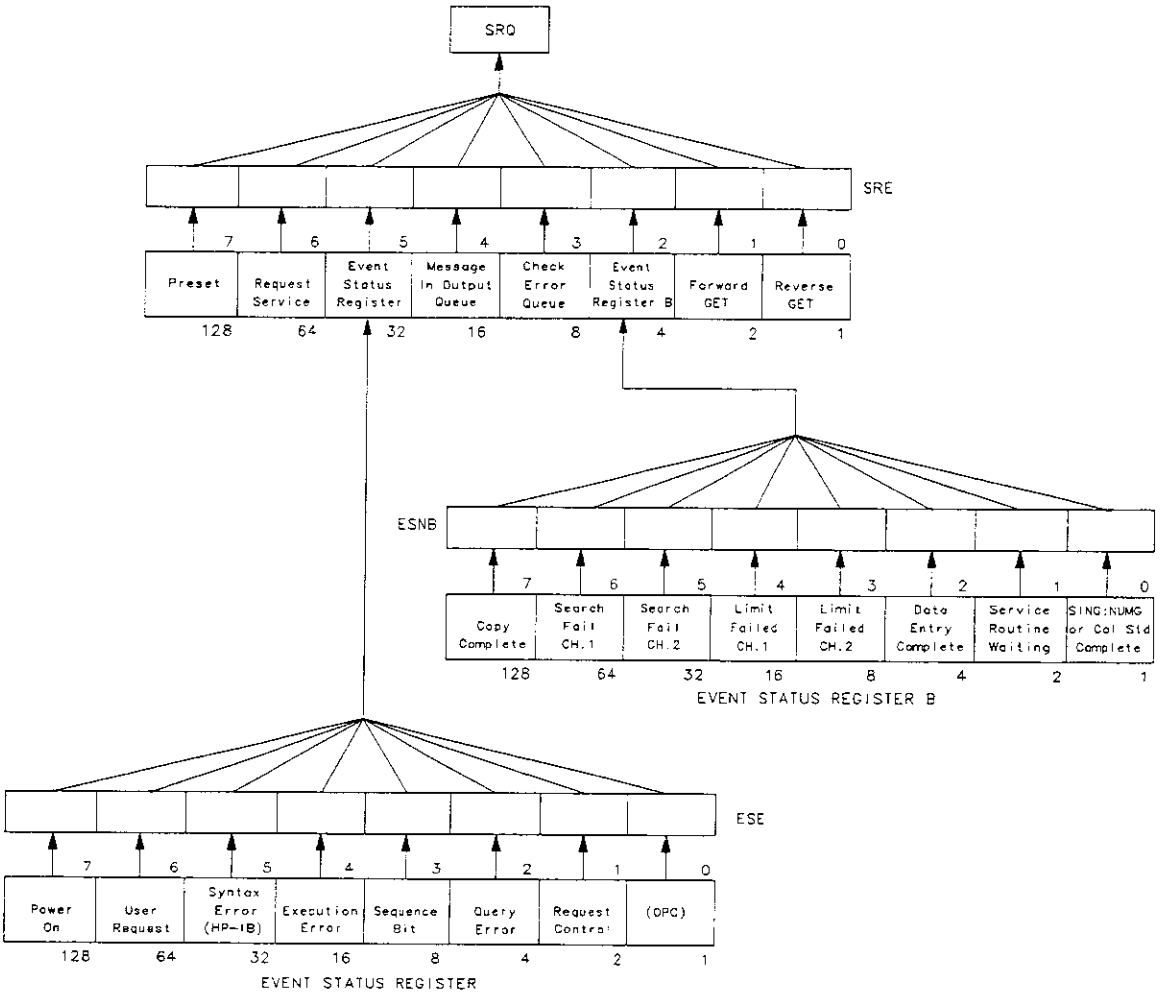
The calibration kit includes a set of key characteristics of the calibration standards used to determine the calibration accuracy. There are default kits for several different connector types. There is also space for a user-defined calibration kit. The command OUTPCALK outputs the currently active calibration kit as a binary string in FORM 1. As with the learn string, the calibration-kit string has a fixed length for a given firmware revision.

Error Reporting

This section describes the analyzer's error-reporting process. It includes information on status reporting, the status byte, the event-status registers, and the error output.

Status Reporting

The analyzer status reporting structure is depicted in Figure 1-5. Refer to Table 1-5 for a description of each bit within the status reporting structure.



pg6151d

Figure 1-5. Status Reporting Structure

Table 1-5. Status Bit Definitions

Status Byte		
Bit	**Name**	**Definition**
0	Waiting for reverse GET	Not applicable for the HP 8719D/20D/22D.
1	Waiting for forward GET	Not applicable for the HP 8719D/20D/22D.
2	Check event-status register B	One of the enabled bits in event status register B has been set.
3	Check error queue	An error has occurred and the message has been placed in the error queue, but has not been read yet.
4	Message in output queue	A command has prepared information to be output, but it has not been read yet.
5	Check event-status register	One of the enabled bits in the event-status register has been set.
6	Request service	One of the enabled status-byte bits is causing an SRQ.
7	Preset	An instrument preset has been executed.
Event-Status Register		
Bit	**Name**	**Definition**
0	Operation complete	A command for which OPC has been enabled has completed operation.
1	Request control	The analyzer has been commanded to perform an operation that requires control of a peripheral, and needs control of HP-IB. Requires pass-control mode.
2	Query error	The analyzer has been addressed to talk but there is nothing in the output queue to transmit.
3	Sequence Bit	A sequence has executed the assert SRQ command.
4	Execution error	A command was received that could not be executed.
5	Syntax error	The incoming HP-IB commands contained a syntax error. The syntax error is can only be cleared by a device clear or an instrument preset.
6	User request	The operator has pressed a front-panel key or turned the RPG.
7	Power on	A power-on sequence has occurred since the last read of the register.
Event-Status Register B		
Bit	**Name**	**Definition**
0	Single sweep, number of groups, or calibration step complete	A single sweep, group, or calibration step has been completed since the last read of the register.
1	Service routine waiting or done	An internal service routine has completed operation, or is waiting for an operator response.
2	Data entry complete	A terminator key has been pressed or a value entered over HP-IB since the last read of the register.
3	Limit failed, Channel 2	Limit test failed on Channel 2.
4	Limit failed, Channel 1	Limit test failed on Channel 1.
5	Search failed, Channel 2	A marker search was executed on Channel 2, but the target value was not found.
6	Search failed, Channel 1	A marker search was executed on Channel 1, but the target value was not found.
7	Copy Complete	A copy has been completed since the last read of the register.

The Status Byte

The analyzer has a status-reporting mechanism that reports information about specific analyzer functions and events. The status byte (consisting of summary bits) is the top-level register. Each bit reflects the condition of another register or queue. If a summary bit is set (equals 1), the corresponding register or queue should be read to obtain the status information and clear the condition. Reading the status byte does not affect the state of the summary bits. The summary bits always reflect the condition of the summarized queue or register. The status byte can be read by a serial poll or by using the command OUTPSTAT. When using this command, the sequencing bit can be set by the operator during the execution of a test sequence. OUTPSTAT does not automatically put the instrument in remote mode, thus giving the operator access to the analyzer front-panel functions.

The status byte:

- summarizes the error queue
- summarizes two event-status registers that monitor specific conditions inside the instrument
- contains a bit that is set when the instrument is issuing a service request (SRQ) over HP-IB
- contains a bit that is set when the analyzer has data to transmit over HP-IB

Any bit in the status byte can be selectively enabled to generate a service request (SRQ) when set. Setting a bit in the service-request-enable register with the `SREnn;` command enables the corresponding bit in the status byte. The units variable *nn* represents the binary equivalent of the bit in the status byte. For example, `SRE24;` enables status-byte bits 3 and 4 (since $2^3 + 2^4 = 24$) and disables all the other bits. SRE will not affect the state of the status-register bits.

The status byte also summarizes two queues: the output queue and the error queue. (The error queue is described in the next section.) When the analyzer outputs information, it puts the information in the output queue where it resides until the controller reads it. The output queue is only one event long. Therefore, the next output request will clear the current data. The summary bit is set whenever there is data in the output queue.

The Event-Status Register and Event-Status Register B

The event-status register and event-status register B are the other two registers in the status-reporting structure. They are selectively summarized by bits in the status byte via enable registers. The event-status registers consist of latched bits. A latched bit is set at the beginning of a specific trigger condition in the instrument. It can only be cleared by reading the register. The bit will not be reactivated until the condition occurs again. If a bit in one of these two registers is enabled, it is summarized by the summary bit in the status byte. The registers are enabled using the commands `ESEnn;` and `ESNBnn;`, both of which work in the same manner as `SREnn`. The units variable *nn* represents the binary equivalent of the bit in the status byte.

If a bit in one of the event-status registers is enabled, and therefore, the summary bit in the status byte is enabled, an SRQ will be generated. The SRQ will not be cleared until one of the five following conditions transpire:

1. The event-status register is read, clearing the latched bit.
2. The summary bit in the status byte is disabled.
3. The event-status register bit is disabled.
4. The status registers are cleared with the `CLES;` command.
5. An instrument preset is performed.

Service requests generated when there are error messages or when the instrument is waiting for the Group Execute Trigger (GET) command are cleared by:

- reading the errors
- issuing GET (disabling the bits)
- clearing the status registers

Error Output

When an error condition is detected in the analyzer, a message is generated, displayed on the analyzer's display screen, and placed in the error queue. Error messages consist of an error number followed by an ASCII string no more than 50-characters long. The string contains the same message that appears on the analyzer's display. The error queue holds up to 20 error messages in the order in which they occur. The error messages remain in the error queue until the errors are read by the system controller using the command OUTPERRO. The OUTPERRO command outputs one error message.

Note The error queue can only be cleared by performing an instrument preset or by cycling the line power. In order to keep the queue up-to-date, it is important to read all of the messages out of the queue each time errors are detected.

Calibration

Measurement calibration over HP-IB follows the same command sequence as a calibration from the front-panel. For detailed information, refer to "Optimizing Measurement Results" in the *HP 8719D/20D/22D Network Analyzer User's Guide.*

1. Start by selecting a calibration kit, such as 50 ohm type N. (`CALKN50;`)
2. Select a calibration type, such as S11 1-port (`CALIS111;`).
3. Call each class used by the calibration type, such as `FORWARD: OPEN` (`CLASS11A;`) During a 2-port calibration, the reflection, transmission, and isolation subsequences must be opened before the classes in the subsequence are called, and then closed at the end of each subsequence.
4. If a class has more than one standard in it, select a standard from the menu presented (`STANA` to `STANG`).
5. If, during a calibration, two standards are measured to satisfy one class, the class must be closed with `DONE;`.
6. Declare the calibration done, such as with `DONE 1-PORT CAL` (`SAV1;` over HP-IB).

The STANA to STANG commands will hold off the HP-IB until completion because they trigger a sweep. If a class has only one standard in it, which means that it will trigger a sweep when called, the class command will also hold off the HP-IB.

Note Since different cal kits can have a different number of standards in a given class, any automated calibration sequence is valid only for a specific cal kit.

Table 1-6. Relationship between Calibrations and Classes

Class	Response	Response and Isolation	S11 1-port	S22 1-port	One path 2-port	Full 2-port	TRL/LRM
Reflection:[1]					•	•	•
S11A, RE FW MTCH			•		•	•	•
S11B, LN FW MTCH			•		•	•	•
S11C, LN FW TRAN			•		•	•	•
S22A, LN RV MTCH				•		•	•
S22B, LN RV TRAN				•		•	•
S22C, LN RV TRAN				•		•	•
Transmission:[1]					•	•	•
Forward match					•	•	•
Forward trans					•	•	•
Reverse match						•	•
Reverse trans						•	•
Isolation:[1]					•	•	•
Forward					•	•	•
Reverse						•	•
Response	•						
Response and isolation:							
Response		•					
Isolation		•					
TRL thru:[2]							•
TRL reflect:[2]							•
TRL line or match:[2]							•

1 These subheadings must be called when doing full 2-port calibrations.

2 These subheadings must be called when doing TRL 2-port calibrations.

Table 1-7. Error Coefficient Arrays

Array	Response	Response and Isolation	1-port	2-port[1]	TRL/LRM
1	E_R or E_T	E_X (E_D)[2]	E_D	E_{DF}	E_{DF}
2		E_T (E_R)	E_S	E_{SF}	E_{SF}
3			E_R	E_{RF}	E_{RF}
4				E_{XF}	E_{XF}
5				E_{LF}	E_{LF}
6				E_{TF}	E_{TF}
7				E_{DR}	E_{DR}
8				E_{SR}	E_{SR}
9				E_{RR}	E_{RR}
10				E_{XR}	E_{XR}
11				E_{LR}	E_{LR}
12				E_{TR}	E_{TR}

1 One path, 2-port cal duplicates arrays 1 to 6 in arrays 7 to 12.

2 Response and isolation corrects for crosstalk and transmission tracking in transmission measurements, and for directivity and reflection tracking in reflection measurements.

Meaning of first subscript:

D=directivity
S=source match
R=reflection tracking
X=crosstalk or isolation
L=load match
T=transmission tracking

Meaning of second subscript:

F=forward
R=reverse

Disk File Names

Disk files created by the analyzer consist of a state name of up to eight characters, such as FILTER, appended with up to two characters. In LIF format, the file name is FILTERXX. In DOS format, the filename is FILTER.XX. The first appended character is the file type, telling the kind of information in the file. The second appended character is a data index, used to distinguish files of the same type.

Error corrected data, raw data, formatted data, memory traces, and calibration files are FORM 3 data files (IEEE 64-bit floating point format). The other files are not meant to be decoded. Table 1-8 lists the appended characters and their meanings.

Table 1-8. Disk File Names

Char 1	Meaning	Char 2	Meaning
I	Instrument state		
G	Graphics	1	Display graphics
D	Error corrected data	1	Channel 1
		2	Channel 2
R	Raw data	1 to 4	Channel 1, raw arrays 1 to 4
		5 to 8	Channel 2, raw arrays 1 to 4
F	Formatted data	1	Channel 1
		2	Channel 2
M	Memory trace	1	Channel 1
		2	Channel 2
P	Instrument state appendix		
C	Cal kit	K	
1	Cal data, channel 1		
		0	Stimulus state
		1 to 9	Coefficients 1 to 9
		A	Coefficient 10
		B	Coefficient 11
		C	Coefficient 12
2	Cal data, channel 2	0 to C	Same as channel 1
F	Full page (HP-GL plot)	P	
L	Left (HP-GL plot)	L	Lower
		U	Upper
R	Right (HP-GL plot)	L	Lower
		U	Upper

Using Key Codes

Using key codes allows remote control of the analyzer keys and can be used as an alternative to using other HP-IB commands. This may be useful, but it is a highly recommended programming practice to use the HP-IB command mnemonic appropriate for the function desired.

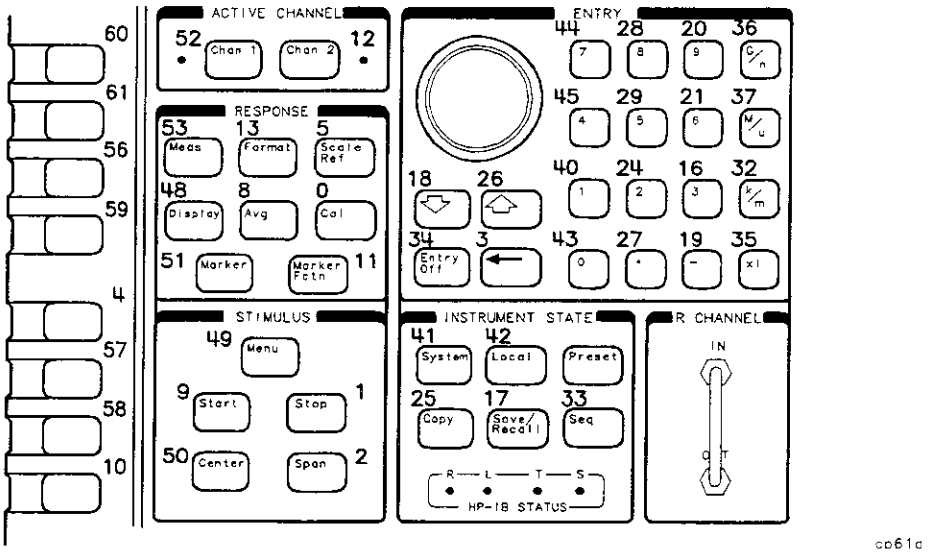


Figure 1-6. Key Codes

When using key codes, the following notes must be taken into consideration:

Note 1: An "invalid key" is reported with a 63.

Note 2: `OUTPKEY`; outputs the key code of the last key pressed. This command reports a knob turn as a −1.

Note 3: `KOR?`; outputs the last key code or knob count. If the reply is positive, it is a key code. If it is negative, then set bit 15 equal to bit 14, and the resulting two byte integer is the RPG knob count. It can be either positive or negative. There are about 120 counts per turn.

Key Select Codes for the Network Analyzer

The HP-IB mnemonics in the following table are functionally arranged by their front-panel key equivalent. For example, all of the mnemonics that correspond to softkeys accessed by means of the [Cal] key, will be listed under the [Cal] key in the following table.

Keys
AVG
CAL-Error correction, calibration
CAL-Calibration kits
CAL-Power Meter Calibration
CHANNEL
COPY
DISPLAY
ENTRY
FORMAT
LOCAL
MEAS
MENU (stimulus)
MARKER
MARKER FCTN
SAVE/RECALL-Internal registers
SAVE/RECALL-Disk files
SCALE REF
SEQ-Sequencing
STIMULUS
SYSTEM
SYSTEM-Limit testing
SYSTEM-Transform

Column headings:

Function	The front-panel function affected by the mnemonic.
Action	The effects of the mnemonic on that function.
Mnemonic	The HP-IB mnemonic.
S	Syntax type. See "Syntax Types", earlier in this chapter.
?	Interrogate response. If a response is defined, it is listed.
O	OPC-compatible command.
Range	The range of acceptable inputs and corresponding units.

Symbol conventions:

[ ]	Optional data.
D	Numerical data.
I	An integer appendage that is part of the command. For example, CLEA<I>, where I = 1 to 5, indicates that the actual commands are CLEA1, CLEA2, CLEA3, CLEA4, and CLEA5.
$	A character string operand which must be enclosed by double quotes.
< >	A necessary appendage.
|	An either/or choice in appendages.

Table 1-9. Key Select Codes

Function	Action	Mnemonic	S	?	O	Range
AVG						
Averaging	Restart	AVERREST	1			
	Factor	AVERFACT[D]	3	D		0 to 999
	On/off	AVERO<ON|OFF>	2	1,0		
Smoothing	Set aperture	SMOOAPER[D]	3	D		0.05 to 20%
	On/off	SMOOO<ON|OFF>	2	1,0		
IF bandwidth	Set bandwidth	IFBW[D]	3	D		10, 30, 100, 300, 1000, 3000, 3700 Hz
CAL-error correction, calibration						
Correction	On/off	CORR<ON|OFF>	2	1,0		
Interpolative correction	On/off	CORI<ON|OFF>	2	1,0		
Resume Cal sequence	Resume a previously started calibration	RESC	1			
Receiver calibration	Take receiver calibration sweep	REIC[D]	3			stimulus power range
Port extensions	Port 1	PORT1[D]	3	D		±10 s
	Port 2	PORT2[D]	3	D		±10 s
	Input A	PORTA[D]	3	D		±10 s
	Input B	PORTB[D]	3	D		±10 s
	Off	PORE<ON|OFF>	2	1,0		
Velocity factor	Set value	VELOFACT[D]	3	D		0 to 10
Z_0	Set Value	SETZ[D]	3	D		0.1 to 500Ω
Adapter removal	Recall Cal Port1	CALSPORT1	1			
	Recall Cal Port2	CALSPORT2	1			
	Adapter delay	ADAP1[D]	3	D		±10 s
	Adapter: coax	ADPTCOAX	1			
	Adapter: waveguide	ADPTWAVE	1			
	Remove adapter	MODS	1			
Test set switching	Continuous/full 2-port cal (continuously measures all 4 S-parameters)	CSWION	2	1,0		
		TSSWION				
	Hold 2-port cal (initially measures all 4 S-parameters, then only 2 parameters)	CSWIOFF	2	1,0		
		TSSWIOFF				
	Number of sweeps 2-port cal	TSSWI[D]	3	D		
Sweep modes	Alternate A and B	ALTAB	1			
	Chop A and B	CHOPAB	1			

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
CAL-error correction, calibration (continued)						
Calibrate menu	None	CALN	1	0,1		
	Response	CALIRESP	1	0,1		
	Response and Isol	CALIRAI	1	0,1		
	S11 1-port	CALIS111	1	0,1		
	S22 1-port	CALIS221	1	0,1		
	Full 2-port	CALIFUL2	1	0,1		
	One path 2-port	CALIONE2	1	0,1		
	TRL/LRM 2-port	CALITRL2	1	0,1		
Intermediate cal steps, 1 path/2-port	Isolation	ISOOP	1			
	Reflection	REFOP	1			
	Transmission	TRAOP	1			
Intermediate cal steps, full 2-port cal	Transmission	TRAN	1			
	Reflection	REFL	1			
	Isolation	ISOL	1			
Intermediate cal steps, TRL/LRM	Transmission	TRLT	1			
	S_{11} Reflection	TRLR1	1			
	S_{22} Reflection	TRLR2	1			
	Line/match 1	TRLL1	1			
	Line/match 2	TRLL2	1			
Select response & isol. class	Response	RAIRESP	1			
	Isolation	RAIISOL	1			
Select reflection class	S11A (forward open)	CLASS11A	1		OPC††	
	S11B (forward short)	CLASS11B	1		OPC††	
	S11C (forward load)	CLASS11C	1		OPC††	
	S22A (reverse open)	CLASS22A	1		OPC††	
	S22B (reverse short)	CLASS22B	1		OPC††	
	S22C (reverse load)	CLASS22C	1		OPC††	
Select transmission class	Fwd transmission	FWDT	1		OPC††	
	Rev transmission	REVT	1		OPC††	
	Fwd match	FWDM	1		OPC††	
	Rev match	REVM	1		OPC††	
Select isolation class	Forward isolation	FWDI	1		OPC††	
	Reverse isolation	REVI	1		OPC††	
	Omit isolation	OMII	1			

†† The class commands are OPC-compatible if there is only one standard in the class. If there is just one standard, that standard is measured automatically. If there is more than one standard in the class, the class command only calls another menu.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
CAL-error correction, calibration (continued)						
Select standard in class	Standard A	STANA	1		OPC	
	Standard B	STANB	1		OPC	
	Standard C	STANC	1		OPC	
	Standard D	STAND	1		OPC	
	Standard E	STANE	1		OPC	
	Standard F	STANF	1		OPC	
	Standard G	STANG	1		OPC	
Sliding load	Set	SLIS	1		OPC	
	Done	SLID	1			
Offset load	Load no offset	LOAN	1			
	Load offset	LOAO	1			
Done with:	Class	DONE	1			
	Isolation	ISOD	1		OPC	
	Reflection	REFD	1		OPC	
	Transmission	TRAD	1		OPC	
	Offset load	OFLD	1			
Save cal	Response	RESPDONE	1		OPC	
	Resp and isol	RAID	1		OPC	
	1-port cal	SAV1	1		OPC	
	2-port cal	SAV2	1		OPC	
	TRL/LRM	SAVT	1		OPC	
CAL-calibration kits						
Select default kits	7-mm	CALK7MM	1	1,0		
	3.5-mmC	CALK35MC*	1	1,0		
	3.5-mmD	CALK35MD	1	1,0		
	Type N, 50 ohm	CALKN50	1	1,0		
	Type N, 75 ohm	CALKN75	1	1,0		
	2.4-mm	CALK24MM	1	1,0		
	2.92-mm	CALK292MM	1	1,0		
	2.92*	CALK292S	1	1,0		
	User-defined	CALKUSED	1	1,0		
	TRL 3.5-mm	CALKTRLK	1	1,0		
Modify kit	Modify current	MODI1	1			
Define std. number (begin std. definition)		DEFS[D]	3			1 to 8

*__CALK35MM__ selects the HP 85033C cal kit for the HP 8752C/53D, and selects the HP 85052 series cal kits for the HP 8719D/20D/22D.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
CAL-calibration kits (continued)						
Define std. type	Open	STDTOPEN	1	1,0		
	Short	STDTSHOR	1	1,0		
	Load	STDTLOAD	1	1,0		
	Delay/thru	STDTDELA	1	1,0		
	Arbitrary imped.	STDTARBI	1	1,0		
Define std. parameters	Open cap. C0	C0[D]	3			±10k (10^{-15} F)
	Open cap. C1	C1[D]	3			±10k (10^{-27} F/Hz)
	Open cap. C2	C2[D]	3			±10k (10^{-36} F/Hz^2)
	Open cap. C3	C3[D]	3			±10k (10^{-45} F/Hz^3)
	Fixed load	FIXE	1			
	Sliding load	SLIL	1			
	Offset load	OFLS	1			
	Terminal imped.	TERI[D]	3			0 to 1 kΩ
Define std. offsets	Delay	OFSD[D]	3			±1 s
	Loss	OFSL[D]	3			0 to 1000 TΩ/s
	Z0	OFSZ[D]	3			0.1 to 500Ω
	Min. frequency	MINF[D]	3			0 to 1000 GHz
	Max. frequency	MAXF[D]	3			0 to 1000 GHz
	Coaxial	COAX	1	0,1		
	Waveguide	WAVE	1	0,1		
Std. done	Standard defined	STDD	1			
Label std		LABS[$]	3			10 char.
Specify class	Response	SPECRESP[I,I..]	3			Std numbers
	Resp & Isol	SPECRESI[I,I..]	3			Std numbers
	S11A (forward open)	SPECS11A[I,I..]	3			Std numbers
	S11B (forward short)	SPECS11B[I,I..]	3			Std numbers
	S11C (forward load)	SPECS11C[I,I..]	3			Std numbers
	S22A (reverse open)	SPECS22A[I,I..]	3			Std numbers
	S22B (reverse short)	SPECS22B[I,I..]	3			Std numbers
	S22C (reverse load)	SPECS22C[I,I..]	3			Std numbers
	Forward Trans	SPECFWDT[I,I..]	3			Std numbers
	Forward Match	SPECFWDM[I,I..]	3			Std numbers
	Reverse Trans	SPECREVT[I,I..]	3			Std numbers
	Reverse Match	SPECREVM[I,I..]	3			Std numbers
	TRL Thru	SPECTRLT[I,I..]	3			Std numbers
	TRL Reflect	SPECTRLR[I,I..]	3			Std numbers
	TRL Line or Match	SPECTRLL[I,I..]	3			Std numbers

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
CAL-calibration kits (continued)						
Class done		CLAD	1			
Label class	Response	LABERESP[$]	3			10 char.
	Resp. & isolation	LABERESI[$]	3			10 char.
	S11A	LABES11A[$]	3			10 char.
	S11B	LABES11B[$]	3			10 char.
	S11C	LABES11C[$]	3			10 char.
	S22A	LABES22A[$]	3			10 char.
	S22B	LABES22B[$]	3			10 char.
	S22C	LABES22C[$]	3			10 char.
	Forward Trans	LABEFWDT[$]	3			10 char.
	Forward Match	LABEFWDM[$]	3			10 char.
	Reverse Trans	LABEREVT[$]	3			10 char.
	Reverse Match	LABEREVM[$]	3			10 char.
	TRL Thru	LABETRLT[$]	3			10 char.
	TRL Reflect	LABETRLR[$]	3			10 char.
	TRL Line or Match	LABETRLL[$]	3			10 char.
Label kit		LABK[$]	3			10 char.
Kit done		KITD	1			
Save kit	Into user kit	SAVEUSEK	1			
TRL/LRM Option	Cal ZO: Line ZO	CALZLINE	1	0,1		
	Cal ZO: System ZO	CALZSYST[D]	1	0,1		
	SET REF: Thru	SETRTHRU	1	0,1		
	SET REF: Reflect	SETRREFL	1	0,1		

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
CAL-power meter calibration						
Power meter cal	Off	PWMCOFF[D]	3	D		Cal power: −100 to 100 dB
	Each sweep	PWMCEACS[D]	3	D		Cal power: −100 to 100 dB
	One sweep	PWMCONES[D]	3	D		Cal power: −100 to 100 dB
	Take cal sweep§	TAKCS	1			
	Number of readings	NUMR[D]	3	D		1 to 100
	Set port cal pwr	PWRMCAL	1	D		−100 to 100 dB
Edit power loss table	On/off	PWRLOSS<ON|OFF>	2	1,0		
	Edit list	POWLLIST	1			
	Use sensor A or B	USES<ENSA|ENSB>	2			Sensor B available with HP 438A only
	Add segment	SADD	1			
	Edit segment N	SEDI[D]	3	D		1 to 12
	Done with segment	SDON	1			
	Delete segment	SDEL	1			
	Done	EDITDONE	1			
	Clear list	CLEL	1			
Edit power loss segment	Frequency	POWLFREQ[D]	3	D		Stimulus range†
	Value	POWLLOSS[D]	3	D		−9900 to 9900 dB
Edit cal sensor table	Edit sensor menu A	CALFSENA	1			
	Edit sensor menu B	CALFSENB	1			HP 438A only
	Add segment	SADD	1			
	Edit segment N	SEDI[D]	3	D		1 to 12
	Done with segment	SDON	1			
	Delete segment	SDEL	1			
	Done	EDITDONE	1			
	Clear list	CLEL	1			
Edit cal sensor segment	Frequency	CALFFREQ[D]	3	D		Stimulus range†
	Cal factor	CALFCALF[D]	3	D		0 to 200%

† For frequency or power sweeps, refer to Chapter 12, "Preset State and Memory Allocation," in the *HP 8719D/20D/22D User's Guide.*

§ Requires pass control mode when using the HP-IB port.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
CHANNEL						
Channel	CH 1 active	CHAN1	1		OPC	
	CH 2 active	CHAN2	1		OPC	
COPY						
Copy display	To printer§	PRINALL	1			
	To plotter§	PLOT	1			
Title plot	To disk	TITP[$]	4			10 char.
Printer	Auto feed	PRNTRAUTF<ON|OFF>	2	1,0		
Printer	Form feed	PRNTRFORF	1			
Printer setup	Default	DEFLPRINT	1			
Plotter	Auto feed	PLTTRAUTF<ON|OFF>	2	1,0		
Plotter	Form feed	PLTTRFORF	1			
Plotter setup	Default	DFLT	1			
List values		LISV	1			
Operating parameters		OPEP	1			
Next page		NEXP	1			
Previous page		PREP	1			
Print List Values or Operating parameters	Raster display dump to HP-IB§	PRINTALL	1			
Restore display		RESD	1			
Select print color	Monochrome	PRIS	1			
	Color	PRIC	1			

§ Requires pass control mode when using the HP-IB port.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
COPY (continued)						
Print feature color	Data channel 1	PCOLDATA1<color>	2			Colors‡
	Data channel 2	PCOLDATA2<color>	2			Colors‡
	Memory channel 1	PCOLMEMO1<color>	2			Colors‡
	Memory channel 2	PCOLMEMO2<color>	2			Colors‡
	Graticule	PCOLGRAT<color>	2			Colors‡
	Text	PCOLTEXT<color>	2			Colors‡
	Warning	PCOLWARN<color>	2			Colors‡
Features to be plotted	Data	PDATA<ON|OFF>	2	1,0		
	Memory	PMEM<ON|OFF>	2	1,0		
	Graticule	PGRAT<ON|OFF>	2	1,0		
	Text	PTEXT<ON|OFF>	2	1,0		
	Marker	PMKR<ON|OFF>	2	1,0		
Quadrant	Left lower	LEFL	1	0,1		
	Left upper	LEFU	1	0,1		
	Right lower	RIGL	1	0,1		
	Right upper	RIGU	1	0,1		
	Full page	FULP	1	0,1		
Pen number	Data	PENNDATA[D]	3			0,1,2 . . . 10
	Memory	PENNMEMO[D]	3			0,1,2 . . . 10
	Graticule	PENNGRAT[D]	3			0,1,2 . . . 10
	Text	PENNTEXT[D]	3			0,1,2 . . . 10
	Marker	PENNMARK[D]	3			0,1,2 . . . 10
Line type	Data	LINTDATA[D]	3			0,1,2 . . . 10
	Memory	LINTMEMO[D]	3			0,1,2 . . . 10
Plot scale	Full page	SCAPFULL	1			
	Graticule to p1,p2	SCAPGRAT	1			
Plot speed	Slow	PLOSSLOW	1			
	Fast	PLOSFAST	1			

‡ Colors = white|cyan|magenta|blue|yellow|green|red|black

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
DISPLAY						
Channels	Dual on/off	DUAC<ON|OFF>	2	1,0		
	Split on/off	SPLD<ON|OFF>	2	1,0		
	D2/D1 to D2 (Channel 2 data divided by channel 1 data, and displayed on channel 2)	D1DIVD2<ON|OFF>	2	1,0		
Display	Data	DISPDATA	1	0,1		
	Memory only	DISPMEMO	1	0,1		
	Data and mem	DISPDATM	1	0,1		
	Data/mem	DISPDDM	1	0,1		
		DIVI				
	Data – mem	DISPDMM	1	0,1		
		MINU				
	Data to mem	DATI	1	0,1	OPC	
	Intensity	INTE[D]	3	D		50 to 100
	Blank Display	BLAD<ON|OFF>	2	1,0		
	Title	TITL[$]	4	$		48 char.
Beeper	On done	BEEPDONE<ON|OFF>	2	1,0		
	On warning message	BEEPWARN<ON|OFF>	2	1,0		
Frequency notation	Blank	FREO	1			
Adjust display	Background intensity	BACI[D]	3	D		0 to 100
	Save colors	SVCO	1			
	Recall colors	RECO	1			
	Default colors	DEFC	1			
Modify specific display feature colors	Ch 1 data/lim ln	COLOCH1D	1			
	Ch 1 memory	COLOCH1M	1			
	Ch 2 data/lim ln	COLOCH2D	1			
	Ch 2 memory	COLOCH2M	1			
	Graticule	COLOGRAT	1			
	Text	COLOTEXT	1			
	Warning	COLOWARN	1			
Adjust specific display feature color	Brightness	CBRI[D]	3	D		0 to 100
	Color	COLOR[D]	3	D		0 to 100
	Tint	TINT[D]	3	D		0 to 100
	Reset color to default	RSCO	1			

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
		ENTRY				
Step keys	Up	UP	1			
	Down	DOWN	1			
Entry off		ENTO	1			
		FORMAT				
Format	Log mag	LOGM	1	0,1		
	Phase	PHAS	1	0,1		
	Delay	DELA	1	0,1		
	Smith chart	SMIC	1	0,1		
	Polar	POLA	1	0,1		
	Lin mag	LINM	1	0,1		
	Real	REAL	1	0,1		
	Imaginary	IMAG	1	0,1		
	SWR	SWR	1	0,1		
		LOCAL				
HP-IB modes	Talker/listener	TALKLIST	1	0,1		
	Use pass control	USEPASC	1	0,1		
Debug	Display commands	DEBU<ON|OFF>	2	1,0		
Disk drive	Unit	DISCUNIT[D]	3	D		0 to 30
	Volume	DISCVOLU[D]	3	D		0 to 30
HP-IB addresses	Plotter	ADDRPLOT[D]	3	D		0 to 30
	Printer	ADDRPRIN[D]	3	D		0 to 30
	Disk drive	ADDRDISC[D]	3	D		0 to 30
	Controller	ADDRCONT[D]	3	D		0 to 30
		PCB[D]				
Power meter	Address	ADDRPOWM[D]	3			0 to 30
	Type	POWM<ON|OFF>	2	0,1		On=436A, Off=438A/437B
Select plotter type	Plotter	PLTTYPPLTR	1			
	HPGL printer	PLTTYPHPGL	1			
Select printer type	ThinkJet	PRNTYPTJ	1			
	DeskJet	PRNTYPDJ	1			
	LaserJet	PRNTYPLJ	1			
	PaintJet	PRNTYPPJ	1			
	Epson-P2	PRNTYPEP	1			
	DJ 540	PRNTYP540	1			

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
LOCAL (continued)						
Select printer port	HP-IB	PRNPRTHPIB	1			
	Parallel	PRNPRTPARA	1			
	Serial	PRNPRTSERI	1			
Select plotter port	HP-IB	PLTPRTHPIB	1			
	Parallel	PLTPRTPARA	1			
	Serial	PLTPRTSERI	1			
	Disk	PLTPRTDISK	1			
Printer serial port	Baud rate	PRNTRBAUD[D]	3	D		1200, 2400, 4800, 9600, 19200
Printer serial port	Handshake	PRNHNDSHK<XON|DTR>	2	1,0		
Plotter serial port	Baud rate	PLTTRBAUD[D]	3	D		1200, 2400, 4800, 9600, 19200
Plotter serial port	Handshake	PLTHNDSHK<XON|DTR>	2	1,0		
Parallel port	Configure	PARAL<GPIO|CPY>	2	0,1		GPIO=Gen.Purpose I/O, CPY=COPY use
MEAS						
Input ports	A/R	AR	1	0,1		
	B/R	BR	1	0,1		
	A/B	AB	1	0,1		
	A	MEASA	1	0,1		
	B	MEASB	1	0,1		
	R	MEASR	1	0,1		
	Selects testport 1 or 2	TSTP<P1|P2>	2			
	Analog input	ANAI[D]	1*	0,1		
S-parameters	S11	S11	1	0,1		
		RFLP				
	S12	S12	1	0,1		
	S21	S21	1	0,1		
		TRAP				
	S22	S22	1	0,1		
Conversion to alternate parameters	Off	CONVOFF	1	0,1		
	Z:reflection	CONVZREF	1	0,1		
	Z:transmission	CONVZTRA	1	0,1		
	Y:reflection	CONVYREF	1	0,1		
	Y:transmission	CONVYTRA	1	0,1		
	1/S	CONV1DS	1	0,1		

* Syntax type 1 when ANABOFF. Syntax type 3, and range = 1 to 31, when ANABON. Refer to the *HP 8719D/20D/22D Network Analyzer Service Guide* for information on the analog bus.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
MENU (stimulus)						
Power	Level	POWE[D]	3	D		−85 to +20 dBm
	Trip	POWT<ON|OFF>	2	1,0		
	Always couple power	COUP<ON|OFF>	2	1,0		
	Port power coupling	PORTP<CPLD|UNCPLD>	2			
	Range 0	POWR00	2			
		PRAN01	2			
	Range 1	POWR01	2			
		PRAN02	2			
	Range 2	POWR02	2			
		PRAN03	2			
	Range 3	POWR03	2			
		PRAN04	2			
	Range 4	POWR04	2			
		PRAN05	2			
	Range 5	POWR05	2			
		PRAN06	2			
	Range 6	POWR06	2			
		PRAN07	2			
	Range 7	POWR07	2			
		PRAN08	2			
	Range 8	POWR08	2			
		PRAN09	2			
	Range 9	POWR09	2			
		PRAN10	2			
	Range 10	POWR10	2			
		PRAN011	2			
	Range 11	POWR11	2			
		PRAN12	2			
	Power range auto/manual	PWRR<PAUTO|PMAN>	2			
	Source power on/off	SOUP<ON|OFF>	2			
	Attenuator A (Option 085)	ATTA[D]	3			0 to 55 dB
	Attenuator B (Option 085)	ATTB[D]	3			0 to 55 dB
Time	Specify	SWET[D]	3	D		0.01 to 86,400 s
	Selects fastest sweep time	SWEA	1			
Measurement	Restart	REST	1			

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
MENU (stimulus) (continued)						
Trigger	Hold	HOLD	1	0,1		
		TRIG				
	Single	SING	1		OPC	
	Number of groups	NUMG[D]	3		OPC	1 to 999
	Continuous	CONT	1	0,1		
		FRER				
	External trigger off	EXTTOFF	2	0,1	OPC	
	External trigger on sweep	EXTTON	2	0,1	OPC	
	External trigger on point	EXTTPOIN	1	0,1	OPC	
	Manual trigger on point	MANTRIG	1	0,1	OPC	
Points	Specify	POIN[D]	3	D		3, 11, 26, 51, 101 201, 401, 801, 1601
Coupled channels	On/off	COUC<ON|OFF>	2	1,0		
CW freq	Set value	CWFREQ[D]	3	D		Stimulus range†
Sweep type	Linear	LINFREQ	1	0,1		
	Log	LOGFREQ	1	0,1		
	List	LISFREQ	1	0,1		
	Select a segment	SSEG[D]	3	0,1		1 to 30
	Select all segments	ASEG	1	0,1		
	Power	POWS	1	0,1		
	CW time	CWTIME	1	0,1		
	Step	STEPSWP<ON|OFF>	2	0,1		
Edit list	Begin	EDITLIST	1			
	Add segment	SADD	1			
	Edit segment N	SEDI[D]	3	D		1 to 30
	Delete segment	SDEL	1			
	Done	EDITDONE	1			
	Clear list	CLEL	1			

† For frequency or power sweeps, refer to Chapter 12, "Preset State and Memory Allocation," in the *HP 8719D/20D/22D User's Guide.* For CW time: 0 to 24 hours. For frequency sweep, transform on: ± 1/frequency step. For CW time sweep, transform on: ±1/time step.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
MENU (stimulus) (continued)						
Edit segment	Start	STAR[D]	3	D		Stimulus range†
	Stop	STOP[D]	3	D		Stimulus range†
	Center	CENT[D]	3	D		Stimulus range†
	Span	SPAN[D]	3	D		Stimulus range†
	Points	POIN[D]	3	D		1 to 1632
	Stepsize	STPSIZE[D]	3	D		Stimulus range†
	CW	CWFREQ[D]	3	D		Stimulus range†
	Done with segment	SDON	1			
Single/All segment	Single segment sweep	SSEG[D]	1			
	All segment sweep	ASEG	1			
MARKER						
Select active	1 to 5	MARK<I>[D]	3	D		Stimulus range†
	All off	MARKOFF	1	0,1		
Marker zero	Zero offsets	MARKZERO	1			
Delta reference	1 to 5	DELR<I>	2	0,1		1 to 5
	Fixed marker	DELRFIXM	1	0,1		
	Mode off	DELO	1	0,1		
Fixed mkr position	Stimulus	MARKFSTI[D]	3	D		Stimulus range†
	Value	MARKFVAL[D]	3	D		Amplitude range#
	Aux value	MARKFAUV[D]	3	D		Amplitude range#
MARKER FCTN						
Marker placement	Discrete	MARKDISC	1	0,1		
	Continuous	MARKCONT	1	0,1		
Coupled	Couple channels	MARKCOUP	1	0,1		
	Uncouple	MARKUNCO	1	0,1		
Displayed	On/off	DISM<ON|OFF>	2	1,0		
Polar markers	Log	POLMLOG	1	0,1		
	Linear	POLMLIN	1	0,1		
	Re/Im	POLMRI	1	0,1		

† For frequency or power sweeps, refer to Chapter 12, "Preset State and Memory Allocation," in the *HP 8719D/20D/22D User's Guide.* For CW time: 0 to 24 hours. For frequency sweep, transform on: ± 1/frequency step. For CW time sweep, transform on: ±1/time step.

For log mag: ± 500 dB. For phase: ± 500 degrees. For Smith chart and Polar: ± 500 units. For linear magnitude: ± 500 units. For SWR: ± 500 units. The scale is always positive, and has minimum values of .001 dB, 10e-12 degrees, 10e-15 seconds, and 10 picounits.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
MARKER FCTN (continued)						
Smith markers	Linear	SMIMLIN	1	0,1		
	Log	SMIMLOG	1	0,1		
	Re/Im	SMIMRI	1	0,1		
	R+jX	SMIMRX	1	0,1		
	G+jB	SMIMGB	1	0,1		
Statistics	On/off	MEASTAT<ON|OFF>	2	1,0		
Set function to marker value	Start	MARKSTAR	1			
	Stop	MARKSTOP	1			
	Center	MARKCENT	1			
	Span	MARKSPAN	1			
	Reference	MARKREF	1			
	Delay	MARKDELA	1			
Search	Off	SEAOFF	1	0,1		
	Maximum	SEAMAX MARKMAXI	1	0,1		
	Minimum	SEAMIN MARKMINI	1	0,1		
	Target	SEATARG[D]	3	D		Amplitude range#
	Search left	SEAL	1			
	Search right	SEAR	1			
Width	Value	WIDV[D]	3	D		Amplitude range#
	Width on/off	WIDT<ON|OFF>	2	1,0		
Tracking search	On/off	TRACK<ON|OFF>	2	1,0		

For log mag: ± 500 dB. For phase: ± 500 degrees. For Smith chart and Polar: ± 500 units. For linear magnitude: ± 500 units. For SWR: ± 500 units.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
SAVE/RECALL-internal registers						
Save	Selected reg	SAVE<I>	2		OPC	1 to 5
	Selected reg	SAVEREG<I>	2		OPC	01 to 31
Clear	Selected reg	CLEA<I>	2		OPC	1 to 5
	Selected reg	CLEAREG<I>	2		OPC	01 to 31
	All regs	CLEARALL	1		OPC	
Recall	Selected reg	RECA<I>	2		OPC	1 to 5
	Selected reg	RECAREG<I>	2		OPC	01 to 31
Title	Internal reg	TITR<I>[$]	4			1 to 5, 10 char.
	Internal reg	TITREG<I>[$]	4			01 to 31, 10 char.
	Save state file	TITF0<I>[$]	4			01 to 31, 10 char.
	Plot	TITP[$]	4			01 to 31, 10 char.
SAVE/RECALL-disk files						
Purge	Selected file§	PURG<I>	2			1 to 5
Store	To disk§	STOR<I>	2			1 to 5
Title	Disk file	TITF<I>[$]	4			1 to 5, 10 char.
	Copy labels from file titles	COPYFRFT	1			
	Copy labels from register titles	COPYFRRT	1			
Include with disk	Data (error corrected, real and imaginary pairs)*	EXTMDATA<ON|OFF>	2	1,0		
files	Raw data	EXTMRAW<ON|OFF>	2	1,0		
	Formatted data	EXTMFORM<ON|OFF>	2	1,0		
	User graphics	EXTMGRAP<ON|OFF>	2	1,0		
	Data only (error corrected, real and imaginary pairs)*	EXTMDATO<ON|OFF>	2	1,0		
Save format	Binary	SAVUBINA	1			
	ASCII/CITIFile	SAVUASCI	1			
Load	From disk§	LOAD<I>	2			1 to 5
	Recall file titles§	REFT	1			

§ Requires pass control mode when using the HP-IB port.
*See Figure 1-1. This error corrected data is the same as that output by the command OUTPDATA.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
SAVE/RECALL-disk files (continued)						
Initialize	Internal disk	INID	1			
	External disk	INIE	1			
	LIF Directory size	DIRS[D]	3	D		256 to 8192
Select storage	Internal memory	INTM	1			
	Internal disk	INTD	1			
	External disk	EXTD	1			
	Internal disk	INTD	1			
Disk format	DOS	FORMATDOS	1			
	LIF	FORMATLIF	1			
SCALE REF						
Scale	Auto	AUTO	1			
	Value	SCAL[D]	3	D		Amplitude range#
Reference	Position	REFP[D]	3	D		0 to 10
	Value	REFV[D]	3	D		Amplitude range#
	Set to mkr	MARKREF	1			
Delay	Set delay	ELED[D]	3	D		± 10.0 s
	Coaxial delay	COAD	1			
	Waveguide delay	WAVD	1			
Phase	Offset	PHAO[D]	3	D		360 deg
SEQ-sequencing						
Sequencing menu	Continue sequence	CONS	1			
	Do sequence	DOSEQ<I>	2			1 to 6
	Gosub sequence	GOSUB<I>	2			1 to 6
	New/modify sequence	NEWSE<I>	2			1 to 6
	Pause to select seq.	PTOS	1			
	Done modify	DONM	1			
	Select sequence	SEQ<I>	2	I		1 to 6
		Q<I>				
	Duplicate seq. X	DUPLSEQ<X>SEQ<Y>	2			X, Y = 1 to 6
	to seq. Y					
	Print sequence I	PRINSEQ<I>	2			1 to 6
	Begin title sequence	TITSQ	1			
	Title sequence I	TITSEQ<I>[$]	2			1 to 6, 10 char.
	Clear sequence I	CLEASEQ<I>	2			1 to 6

For log mag: ± 500 dB. For phase: ± 500 degrees. For Smith chart and Polar: ± 500 units. For linear magnitude: ± 500 units. For SWR: ± 500 units. The scale is always positive, and has minimum values of .001 dB, 10e-12 degrees, 10e-15 seconds, and 10 picounits.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
SEQ-sequencing (continued)						
TTL I/O	TTL out high continuously	TTLOH	1			
	TTL out low continuously	TTLOL	1			
	TTL low - end sweep high	TTLHPULS	1			
	TTL high - end sweep low	TTLLPULS	1			
	Testset I/O forward	TSTIOFWD	1			
	Testset I/O reverse	TSTIOREV	1			
	Programs all GPIO output bits	PARAOUT[D]	3			0 to 255
	Set specified bit on GPIO	SETBIT[D]	2			0 to 7
	Clear specified bit on GPIO	CLEABIT[D]	2			0 to 7
	Specify input GPIO bit for IFBI	PARAIN[D]	2			0 to 4
	Input GPIO bit high - do SEQ<I>	IFBIHIGH	1			
	Input GPIO bit low - do SEQ<I>	IFBILOW	1			
Save/recall sequences	Store sequence I to disk§	STORSEQ<I>	2			1 to 6
	Recall sequence I from disk§	LOADSEQ<I>	2			1 to 6
Special functions	Peripheral address	ADDRPERI[D]	3	D		
	Title to peripheral	TITTPERI	1			
	Wait D seconds	SEQWAIT[D]	3	D		0.1 to 3000 s
	Pause	PAUS	1			
	Marker to CW freq.	MARKCW	1			
	Emit beep	EMIB	1			
	Title to HP-IB printer	TITTPRIN	1			
	Title to pwr mtr/HPIB	TITTPMTR	1			
	Show menus	SHOM	1			
	Assert seq. status bit	ASSS	1			
	Read pwr mtr/HP-IB into title string	PMTRTTIT	1			
	Send number into trace memory	TITTMEM	1			
Decision making	If limit test pass then do sequence I	IFLTPASSSEQ<I>	2			1 to 6
	If limit test fail then do sequence I	IFLTFAILSEQ<I>	2			1 to 6
Loop counter	Set value	LOOC[D]	3			0 to 32,760
	Increment by 1	INCRLOOC				
	Decrement by 1	DECRLOOC				
	If counter equals 0 then do sequence	IFLCEQZESEQ<I>	2			1 to 6
	If counter not equal to 0 then do sequence	IFLCNEZESEQ<I>	2			1 to 6

§ Requires pass control when using the HP-IB port.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
STIMULUS						
Stimulus	Center	CENT[D]	3	D		Stimulus range†
	Span	SPAN[D]	3	D		Stimulus range†
	Start	STAR[D]	3	D		Stimulus range†
	Stop	STOP[D]	3	D		Stimulus range†
SYSTEM						
Set clock	Time stamp	TIMESTAM<ON|OFF>	2	1,0		
	Set date	SETDATE[$]	3			DD MMM YYY
	Set time	SETTIME[$]	3			HH:MM:SS
Configure	Sampler, attenuator offsets	RAWOFFS<ON|OFF>	2	1,0		
	Retrace power	RETP<ON|OFF>	2			
	Step sweep	STEPSWP<ON|OFF>	2			
Instrument mode	Network analyzer	INSMNETA	1	0,1	OPC	
	Tuned receiver	INSMTUNR	1	0,1	OPC	
	External R channel	EXTRCHAN	1			
Service	Analog bus	ANAB<ON|OFF>	2	1,0		
Frequency offset	On/off	FREQOFFS<ON|OFF>	2	1,0	OPC	
	Value	VOFF[D]	3			frequency range of instrument
		LOFREQ[D]	3			
	Set RF > LO	RFGTLO	1			
	Set RF < LO	RFLTLO	1			
	Select up converter	UCONV	1			
	Select down converter	DCONV	1			
	View measurement/mixer setup	VIEM<ON|OFF>	2	1,0		

† For frequency or power sweeps, refer to Chapter 12, "Preset State and Memory Allocation," in the *HP 8719D/20D/22D User's Guide*. For CW time: 0 to 24 hours. For frequency sweep, transform on: ± 1/frequency step. For CW time sweep, transform on: ±1/time step.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
SYSTEM-limit testing						
Limit line	On/off	LIMILINE<ON|OFF>	2	1,0		
Limit test	On/off	LIMITEST<ON|OFF>	2	1,0		
	Beeper	BEEPFAIL<ON|OFF>	2	1,0		
Limit offset	Stimulus	LIMISTIO[D]	3	D		Stimulus range†
	Amplitude	LIMIAMPO[D]	3	D		Amplitude range#
	Marker to offset	LIMIMAOF	1			
Edit table	Begin edit	EDITLIML	1			
	Add segment	SADD	1			
	Edit segment D	SEDI[D]	3	D		1 to 18
	Delete segment	SDEL	1			
	Done with edit	EDITDONE	1			
	Clear list	CLEAL	1			
Edit segment	Stimulus value	LIMS[D]	3	D		Stimulus range†
	Marker to stimulus	MARKSTIM	1			
	Upper limit	LIMU[D]	3	D		Amplitude range#
	Lower limit	LIML[D]	3	D		Amplitude range#
	Delta limits	LIMD[D]	3	D		Amplitude range#
	Middle value	LIMM[D]	3	D		Amplitude range#
	Marker to middle	MARKMIDD	1			
	Segment done	SDON	1			
Limit type	Flat line type	LIMTFL	1	0,1		
	Sloping line type	LIMTSL	1	0,1		
	Single point type	LIMTSP	1	0,1		

† For frequency or power sweeps, refer to Chapter 12, "Preset State and Memory Allocation," in the *HP 8719D/20D/22D User's Guide*. For CW time: 0 to 24 hours. For frequency sweep, transform on: ± 1/frequency step. For CW time sweep, transform on: ±1/time step.

For log mag: ± 500 dB. For phase: ± 500 degrees. For Smith chart and Polar: ± 500 units. For linear magnitude: ± 500 units. For SWR: ± 500 units. The scale is always positive, and has minimum values of .001 dB, 10e-12 degrees, 10e-15 seconds, and 10 picounits.

Table 1-10. Key Select Codes (continued)

Function	Action	Mnemonic	S	?	O	Range
SYSTEM-transform						
Transform	Time Domain Transform On/off	TIMDTRAN<ON|OFF>	2	0,1	OPC	
Set freq	Low pass	SETF	1			
Mode	Low pass impulse	LOWPIMPU	1	0,1		
	Low pass step	LOWPSTEP	1	0,1		
	Bandpass	BANDPASS	1	0,1		
	Specify gate menu	SPEG	1			
Window	Maximum	WINDMAXI	1			
	Normal	WINDNORM	1			
	Minimum	WINDMINI	1			
	Any value	WINDOW[D]	3	D		State dependent
Window shape	Use trace memory	WINDUSEM<ON|OFF>	2	1,0		
Demodulation	Off	DEMOOFF	1	0,1		
	Amplitude	DEMOAMPL	1	0,1		
	Phase	DEMOPHAS	1	0,1		
Gate	On/off	GATEO<ON|OFF>	2	1,0	OPC	
	Start	GATESTAR[D]	3	D		Stimulus range†
	Stop	GATESTOP[D]	3	D		Stimulus range†
	Center	GATECENT[D]	3	D		Stimulus range†
	Span	GATESPAN[D]	3	D		Stimulus range†
Gate shape	Maximum	GATSMAXI	1	0,1		
	Wide	GATSWIDE	1	0,1		
	Normal	GATSNORM	1	0,1		
	Minimum	GATSMINI	1	0,1		

† For frequency or power sweeps, refer to Chapter 12, "Preset State and Memory Allocation," in the *HP 8719D/20D/22D User's Guide*. For CW time: 0 to 24 hours. For frequency sweep, transform on: ± 1/frequency step. For CW time sweep, transform on: ±1/time step.

HP-IB Only Commands

Table 1-10. HP-IB Only Commands

Action	Mnemonic	Syntax	?	Description
MISCELLANEOUS				
Identify instrument	IDN?	1		Outputs the identification string: "HEWLETT PACKARD, 87NND,0,X.XX", where 87NND is the model number of the instrument and X.XX is the firmware revision of the instrument.
Key	KEY[D]	1	D	Imitates pressing a key. The data transmitted is the key code, as defined in Figure 1-6. Range for D = 1 to 61.
Key code	KOR?	1		Outputs last key code or knob count. If the reply is positive, it is a key code. If it is negative, then set bit 15 equal to bit 14, and the resulting two byte integer is the RPG knob count. It can be either positive or negative. There are about 120 counts per turn.
Move marker	MARKBUCK[D]	2	D	Moves the marker to the selected point on the trace. On a 201 point sweep, D can range from 0 to 200.
On completion	OPC	1		Causes reporting of the last OPC-compatible command completion.
Plot/print softkeys	PSOFT<ON|OFF>	2		Includes the softkey menu keys when printing or plotting the screen.
Copy default	DEFLTCPIO	1		Sets up a default state for copy.
Revision	SOFR	1		Displays the software revision on the analyzer.
Learn string	SELL[D]	2	D	Selects the learn string revision to input to and output from the analyzer. The valid parameters are: 0: Defaults to current revision. 201: Revision 8720A 2.01 612: Revision 8720A 6.12

Table 1-11. HP-IB Only Commands (continued)

Action	Mnemonic	Syntax	?	Description
MISCELLANEOUS (continued)				
Sweep start	SWPSTART	1		Initiates a sweep and immediately releases the HP-IB bus, allowing the analyzer to initiate data output as soon as the appropriate data is ready. Use in conjunction with Take4 mode only. OPC-compatible.
Collect raw data	TAKE4<ON|OFF>	2	1,0	Initiates a mode in which every measurement cycle is characterized by sweeping in both the forward and reverse directions and collecting raw data for all four S-parameters. The sweeping can occur when a SWPSTART or SING command is received or when the analyzer is in continuous, number of groups, or external trigger mode.
Self test	TST?	1		Causes a self test. Returns a zero if the test passes.
No operation	NOOP	1		Creates a cycle that has no operation. OPC compatible.
Select 1-port cal	CAL1	1		Provides access to functions within the 1-port cal menu. (HP 8510 compatibility.)
External trigger	EXTTHIGH	1		Sets the trigger polarity high.
	EXTTLOW	1		Sets the trigger polarity low.
Wait	WAIT	1		Makes the analyzer wait for a clean sweep when used with the OPC command.
INPUT				
Error-corrected Data	INPUDATA[D]	3	D	Inputs error-corrected data.
Formatted Data	INPUFORM[D]	3	D	Inputs formatted data.
Raw Data	INPURAW1[D]	3	D	Inputs raw data.
	INPURAW2[D]	3	D	
	INPURAW3[D]	3	D	
	INPURAW4[D]	3	D	
Error coefficient	INPUCALC<01, 02, ... 12>	2		Inputs an individual error coefficient array. Issue the command "CALIXXXX; "(XXXX specifies the data calibration type), then input each of the appropriate individual error coefficients using "INPUCALC". Finally, issue "SAVC; " and trigger a sweep.
	SAVC	1		This OPC compatible command denotes completion of the error coefficients transfer to the instrument.
Power meter cal.	INPUPMCAL<I>	3		Inputs power meter cal array. Values should be entered as 100 times the power meter reading in dB.
Cal kit	INPUCALK[D]	3	D	Inputs a cal kit.
Learn string	INPULEAS[D]	3	D	Inputs the learn string. Preceded by SELL if learn string is not current revision.

Table 1-11. HP-IB Only Commands (continued)

Action	Mnemonic	Syntax	?	Description
OUTPUT				
Active function	OUTPACTI	1		Outputs value of function in active entry area in ASCII format.
Active channel	OUTPCHAN	1		Outputs the active channel number.
Options	OUTPOPTS	1		Outputs an ASCII string of the options installed.
Serial number	OUTPSERN	1		Outputs the serial number of the analyzer.
Identify instrument	OUTPIDEN	1		See IDN?
Error coefficient	OUTPCALC<01,02 ... 12>	2		Outputs the selected error coefficient array from the active channel. Each array is the same as a data array. See Table 1-7, for the contents of the arrays.
Interp. cal.	OUTPICAL<I>	2		Outputs the selected interpolated cal coefficient array.
Cal kit	OUTPCALK	1		Outputs the active cal kit, a less than 1000 byte string in FORM 1.
Data	OUTPDATA	1		Outputs the error corrected data from the active channel in real/imaginary pairs. See Figure 1-4.
	OUTPDATF	1		Fast data transfer command for OUTPDATA.
Error	OUTPERRO	1		Outputs the oldest error in the error queue. The error number is followed by the error message in ASCII format (FORM 4).
Formatted	OUTPFORM	1		Outputs the formatted trace data from the active channel in current display units. See Table 1-3 for data transferred.
	OUTPFORF	1		Fast data transfer command for OUTPFORM. Only the first number of the OUTPFORM data pairs is transferred. See Table 1-4.
Power meter cal.	OUTPIPMCAL<I>	2		Outputs the interpolated power meter cal array for channel 1 or channel 2.
Power meter cal.	OUTPPMCAL<I>	2		Outputs power meter cal array for channel 1 or channel 2. Values are sent as 100 times the power meter reading in dB.
Key code	OUTPKEY	1		Outputs the code of the last key pressed, in ASCII format. See Figure 1-6 for key codes. −1 is transmitted for a knob turn.

Table 1-11. HP-IB Only Commands (continued)

Action	Mnemonic	Syntax	?	Description
OUTPUT (continued)				
Learn string	OUTPLEAS	1		Outputs the learn string in binary, not intended for decoding.
External source	OUTPRFFR	1		Outputs external source RF frequency when in external source instrument mode.
Smoothing	OUTPAPER	1		Outputs the smoothing aperture.
Sequencing	OUTPSEQ<I>	2		Outputs sequence I (I = 1 to 6) listing over HP-IB.
Limit failures	OUTPLIMF	1		Outputs the limit results as described under OUTPLIML for only those stimulus points that failed.
Limit list	OUTPLIML	1		Outputs the limit test results for each stimulus point. The results consist of four numbers. The first is the stimulus value tested, the second is the test result:—1 for no test, 0 for fail, 1 for pass. The third number is the upper limit value, and the fourth is the lower limit value. This is an ASCII transfer (FORM 4).
Limit marker	OUTPLIMM	1		Outputs the limit test results as described for OUTPLIML for the active marker.
Marker	OUTPMARK	1		Outputs the active marker values in 3 numbers. The first two numbers are the marker values, and the last is the stimulus value. See Table 1-3 for the marker values.
Memory	OUTPMEMO	1		Outputs the memory trace from the active channel. It is error corrected data in real/imaginary pairs, and can be treated the same as data from OUTPDATA.
	OUTPMEMF	1		Fast data transfer command for OUTPMEMO.
Marker statistics	OUTPMSTA	1		Outputs marker statistics: mean, standard deviation, and peak to peak deviation. ASCII format (FORM 4).
Bandwidth	OUTPMWID	1		Outputs results of bandwidth search:bandwidth, center, and Q. ASCII format (FORM 4).
Bandwidth + loss	OUTPMWIL	1		Same operation as OUTPMWID plus the loss value.
Plot	OUTPPLOT	1		Outputs the HP-GL plot string in ASCII format to the HP-IB port. Can be directed to an HP-GL plotter or printer.

Table 1-11. HP-IB Only Commands (continued)

Action	Mnemonic	Syntax	?	Description
OUTPUT (continued)				
Print	OUTPPRIN	1		Outputs the print string of the display graphics.
	OUTPPRNALL	1		Outputs all pages List Values or current page of Operating and marker parameters in ASCII. Activate the desired function with LISV to print values or OPEP to print operating parameters prior to this command.
Pre-raw data	OUTPPRE1	1		Array 1 (S11 data). Analogous to OUTPRAW except that pre-raw data has not had sampler correction nor attenuator offsets applied. Use in conjunction with Take4 mode only.
	OUTPPRE2	1		Array 2 (S21 data).
	OUTPPRE3	1		Array 3 (S12 data).
	OUTPPRE4	1		Array 4 (S22 data).
Raw data	OUTPRAW1	1		Array 1 (S11 data).Outputs uncorrected data arrays for the active channel. Raw 1 holds the single parameter data unless a 2-port calibration is on, in which case raw 1 holds S11 and the following arrays hold S21, S12, and S22, respectively. The data is in real/imaginary pairs.
	OUTPRAW2	1		Array 2 (S21 data).
	OUTPRAW3	1		Array 3 (S12 data).
	OUTPRAW4	1		Array 4 (S22 data).
	OUTPRAF<I>	1		Fast data transfer command for OUTPRAW<I>.
Status byte	OUTPSTAT STB?	1		Outputs the status byte. ASCII format (FORM 4).
Display title	OUTPTITL	1		Outputs the display title. ASCII format (FORM 4).
Max values	OUTPAMAX*	1		Outputs max values for all limit line segments.
Min values	OUTPAMIN*	1		Outputs min values for all limit line segments.
Min/max values	OUTPSEGAM*	1		Outputs limit test min/max all segs. Outputs the segment number, max stimulus, max value, min stimulus, min value for all active segments.†
Min/max value	OUTPSEGM*	1		Outputs limit test min/max for a specified segment. See SELSEG[D].†

† For the definition of a limit segment, see "Example Display of Limit Lines" in the Chapter 2 section titled "Limit Line and Data Point Special Functions."

* Refer to the "Limit Line and Data Point Special Functions" section in Chapter 2.

Table 1-11. HP-IB Only Commands (continued)

Action	Mnemonic	Syntax	?	Description
OUTPUT (continued)				
Data: point	OUTPDATP	1		Outputs trace data indexed by point. (see SELPT[D])
Data: range	OUTPDATR	1		Outputs trace data for range of points. (see SELMINPT[D], SELMAXPT[D])
Limit test: ch1	OUTPLIM1*	1		Outputs status§ of limit test for channel 1.
Limit test: ch2	OUTPLIM2*	1		Outputs status§ of limit test for channel 2.
Limit test status	OUTPSEGAF*	1		Outputs the segment number and its limit test status§ for all active segments.†
Limit test status	OUTPSEGF*	1		Outputs the limit test status§ for a specified segment. See SELSEG[D].†
Fail report	OUTPFAIP*	1		This command is similar to OUTPLIMF except that it reports the number of failures first, followed by the stimulus and trace values for each failed point in the test.
Clock	READDATE	1		Outputs the date of the clock in the following format: DD MMM YYYY
Clock	READTIME	1		Outputs the time of the clock in the following format: HH:MM:SS
LIMIT LINE AND DATA POINT TEST				
Min/max recording	MINMAX<ON|OFF>*	2	1,0	Enables/disables min/max recording per segment. Min and max values are recorded per limit segment.
Segment	SELSEG[D]*	3	D	Selects segment number for the OUTPSEGF and OUTPSEGM commands to report on. D can range from 1 to 18.†
Last point	SELMAXPT[D]	3	D	Selects the last point number in the range of points that the OUTPDATR command will report. D can range from 0 to the number of points minus 1.
First point	SELMINPT[D]	3	D	Selects the first point number in the range of points that the OUTPDATR command will report. D can range from 0 to the number of points minus 1.
Specify point	SELPT[D]	3	D	Selects point number that the OUTPDATR command will report. D can range from 0 to the number of points minus 1.

* Refer to the "Limit Line and Data Point Special Functions" section in Chapter 2.

§ Values returned for limit test status are: 1 (PASS), 0 (FAIL), -1 (NO_LIMIT)

† For the definition of a limit segment, see "Example Display of Limit Lines" in the Chapter 2 section titled "Limit Line and Data Point Special Functions."

Table 1-11. HP-IB Only Commands (continued)

Action	Mnemonic	Syntax	?	Description
OUTPUT FORMATS				
	FORM1	1		HP 8719/20/22 internal format, with header.
	FORM2	1		32 bit floating point, with header (IEEE).
	FORM3	1		64 bit floating point, with header (IEEE).
	FORM4	1		ASCII format. No header.
	FORM5	1		32 bit PC format (bytes reversed).
SOFTKEYS				
Press	SOFT[I]	2		Activates softkey I, I = 1 to 8.
Label	WRSK<I>[$]	4		Writes label (10 char) to indicated softkey I, where I = 1 to 8. Initial use of this command requires previous commands MENUFORM; and MENUOFF;.
STATUS REPORTING				
Clear	CLES	1		Clears the status byte.
	CLS			
Interrogate	ESB?	1		Returns event-status register B.
	ESR?	1		Returns the event-status register.
	OUTPSTAT	1		Returns the status byte.
Enable	ESE[D]	1	D	Enables event-status register. (0<D<255)
	ESNB[D]	1	D	Enables event-status register B. (0<D<255)
	SRE[D]	1	D	Enables SRQ. (0<D<255)
MENUS				
Averaging	MENUAVG	1		
Calibration	MENUCAL	1		
Copy	MENUCOPY	1		
Display	MENUDISP	1		
Format	MENUFORM	1		
Marker	MENUMARK	1		
Meas	MENUMEAS	1		
Marker function	MENUMRKF	1		
Off	MENU<ON|OFF>	2		
Save Recall	MENURECA	1		
Save Recall	MENUSAVE	1		
Scale	MENUSCAL	1		
Stimulus	MENUSTIM	1		
System	MENUSYST	1		
Sequencing	MENUSEQU	1		

Alphabetical Mnemonic Listing

Mnemonic	Description
AB	Measures and displays A/B on the active channel.
ADAP1[D]	Sets adapter electrical delay.
ADDRCONT[D]	Controller HP-IB address: the address where control is returned after a pass control.
ADDRDISC[D]	Disk HP-IB address.
ADDRPERI[D]	Peripheral HP-IB address (for sequencing). See also TITTPERI.
ADDRPLOT[D]	Plotter HP-IB address.
ADDRPOWM[D]	Power meter HP-IB address.
ADDRPRIN[D]	Printer HP-IB address.
ADPTCOAX	Sets adapter to COAXial.
ADPTWAVE	Sets adapter to WAVEguide.
ALC	ALC control.
ALTAB	Places the analyzer in the alternate inputs measurement mode, where measurements are made on alternate sweeps. See also `CHOPAB;`.
ANAB<ON|OFF>	Enables the analog bus for service use.
ANAI[D]	Measures and displays the data at the auxiliary input (ANALOG IN).
AR	Measures and displays A/R on the active channel.
ASEG	Uses all segments for list frequency sweep. See also SSEG[D].
ASSS	Asserts the sequence status bit.
ATTA[D]	Attenuator A (Option 085 Only).
ATTB[D]	Attenuator B (Option 085 Only).
AUTO	Auto scale the active channel.
AVERFACT[D]	Sets the averaging factor on the active channel.
AVERO<ON|OFF>	Turns averaging ON and off on the active channel.
AVERREST	Restart the averaging on the active channel.
BACI[D]	Sets the background intensity of the display.
BANDPASS	Selects the time domain bandpass mode.

These 3 commands control the warning beeper, causing it to sound if the indicated condition occurs:

BEEPDONE<ON|OFF>	The completion of functions such as save, done with calibration standard, and data trace saved.
BEEPFAIL<ON|OFF>	A limit test failure.
BEEPWARN<ON|OFF>	The generation of a warning message.
BLAD<ON|OFF>	Blanks the display.

BR Measures and displays B/R on the active channel.

These commands set the open capacitance values of an open circuit while it is being defined as a calibration standard.

C0[D]

C1[D]

C2[D]

C3[D]

CAL1 Accepted for compatibility with the HP 8510, where its function is to begin a calibration sequence.

These commands set the power meter calibration factor corrections for the particular sensor used. Sensor B is only valid for the HP 438A which has two input channels:

CALFCALF[D] Sets the calibration factor.

CALFFREQ[D] Selects the frequency for the calibration factor correction.

CALFSENA Edits the sensor A calibration factor table.

CALFSENB Edits the sensor B calibration factor table.

These commands begin a calibration sequence:

CALIFUL2 Short, load, open, thru (SLOT) 2-port.

CALIONE2 One-path 2-port.

CALIRAI Response and isolation.

CALIRESP Response.

CALIS111 S11 1-port.

CALIS221 S22 1-port.

CALITRL2 Thru, reflect, line or Line, reflect, match (TRL*/LRM*) 2-port.

These commands select a default calibration kit:

CALK24MM 2.4-mm (HP 85056A/D cal kit).

CALK292MM 2.92-mm.

CALK292S 2.92* (HP 85056K cal kit).

CALK35MD 3.5-mm (HP 85052B/D, HP 85033D cal kit).

CALK35MC 3.5-mm (HP 85033C cal kit).

Note **CALK35MM** selects the HP 85033C cal kit for the HP 8752C/53D, and selects the HP 85052 series cal kits for the HP 8719D/20D/22D.

CALK7MM 7-mm (HP 85031B cal kit and HP 85050 series).

CALKN50 Type-N 50 ohm (HP 85032B/E cal kit).

CALKN75 Type-N 75 ohm (HP 85036B/E cal kit).

CALKTRLK TRL 3.5-mm (HP 85052C cal kit).

CALKUSED User-defined calibration kit.

CALN	Calibration: none. Turns calibration type to off.
CALPOW	Provides access to the power meter calibration functions.
CALSPORT1	Recalls cal set associated with Port 1 for adapter removal.
CALSPORT2	Recalls cal set associated with Port 2 for adapter removal.
CALZLINE	Establishes the line or match standard(s) as the characteristic impedance for a TRL/LRM calibration.
CALZSYST[D]	Establishes the system Z_0 (see SETZ) as the characteristic impedance for a TRL/LRM calibration.
CBRI[D]	Adjusts the color brightness of the selected display feature. (See COLOXXXX commands.)
CENT[D]	Sets the center stimulus value. If a list frequency segment is being edited, sets the center of the list segment.
CHAN1	Makes channel 1 the active channel. OPC-compatible.
CHAN2	Makes channel 2 the active channel. OPC-compatible.
CHOPAB	Places the analyzer in the chop measurement mode. See also ALTAB.
CLAD	Class done, modify cal kit, specify class.

These commands call reflection standard classes during a calibration sequence. If only one standard is in the class, it is measured. If there is more than one, the standard being used must be selected with STAN<A|B|C|D|E|F|G>. If there is only one standard in the class, these commands are OPC-compatible.

CLASS11A	S11A: S11 1-port, opens.
CLASS11B	S11B: S11 1-port, shorts.
CLASS11C	S11C: S11 1-port, loads.
CLASS22A	S22A: S22 1-port, opens.
CLASS22B	S22B: S22 1-port, shorts.
CLASS22C	S22C: S22 1-port, loads.

These commands (all OPC- compatible) clear the indicated save/recall registers:

CLEA1	Clears save/recall register 1.
CLEA2	Clears save/recall register 2.
CLEA3	Clears save/recall register 3.
CLEA4	Clears save/recall register 4.
CLEA5	Clears save/recall register 5.
CLEAL	Clears the limit line list. Should be preceded by EDITLIML.
CLEARALL	Clears all the save/recall registers. OPC-compatible.
CLEABIT[D]	Clears the specified bit on the GPIO.

CLEAREG<I>	Clears save/recall registers 01 through 31. CLEAREG01 through CLEAREG05 are the same as CLEA1 through CLEA5. OPC-compatible.

These commands clear the sequence from the internal registers:

CLEASEQ1	Sequence 1.
CLEASEQ2	Sequence 2.
CLEASEQ3	Sequence 3.
CLEASEQ4	Sequence 4.
CLEASEQ5	Sequence 5.
CLEASEQ6	Sequence 6.

CLEL	Clear the currently selected list. This could be a frequency list, power loss list, or limit test list.
CLES	Clears the status register, the event-status registers, and the enable registers.
CLS	Same as CLES.
COAD	Selects coaxial electrical delay. See also WAVD.
COAX	Selects coaxial offsets instead of waveguide while defining a standard during a cal kit modification.

These commands select the indicated display feature for color modification:

COLOCH1D	Channel 1 data and limit lines.
COLOCH1M	Channel 1 memory.
COLOCH2D	Channel 2 data and limit lines.
COLOCH2M	Channel 2 memory.
COLOGRAT	Graticule.
COLOTEXT	Text.
COLOWARN	Warning.

COLOR[D]	Adjusts the color saturation for the selected display feature.
CONS	Continues the paused sequence.
CONT	Continuous sweep trigger mode.

These 6 commands convert the S-parameter data to:

CONV1DS	Inverted S-parameters.
CONVOFF	Conversion OFF.
CONVYREF	Y:reflection.
CONVYTRA	Y:transmission.
CONVZREF	Z:reflection.
CONVZTRA	Z:transmission.

COPYFRFT	Copies labels from file titles.
COPYFRRT	Copies labels from register titles.
CORI<ON|OFF>	Turns interpolative error correction ON and OFF.
CORR<ON|OFF>	Turns error correction ON and OFF.
COUC<ON|OFF>	Couples and uncouples the stimulus between the channels.
COUP<ON|OFF>	Couple the power when coupled channels is turned OFF, COUCOFF.
CSWI<ON|OFF>	Selects test set continuous switching (ON) or test set hold (OFF) when there is a 2-port calibration active. Continuous switching is allowed only when the power ranges on both attenuator ports are set the same. When continuous switching is ON, the analyzer measures all four S-parameters each time before displaying the data for a full 2-port cal measurement. In test set hold mode, the analyzer measures all four S-parameters once and then measures the desired parameter continuously. This is known as a fast 2-port cal measurement and it is less accurate than a full 2-port calibrated measurement.
CWFREQ[D]	Sets the CW frequency for power sweep and CW frequency modes. While the list frequency table segment is being edited, it sets the center frequency of the current segment.
CWTIME	Selects the CW time sweep type.
D1DIVD2<ON|OFF>	This command divides the data in channel 2 by the data in channel 1 and displays the result on channel 2. Dual display must be on (`DUACON;`).
DATI	Stores trace in channel memory. OPC- compatible.
DCONV	Selects down converter for mixer measurements.
DEBU<ON|OFF>	Turns the HP-IB debug mode ON and OFF. When ON, the analyzer scrolls incoming HP-IB commands across the display.
DECRLOOC	Decrements the sequencing loop counter by 1.
DEFC	Sets the default colors for all display features.

DEFLPRINT Sets the printer to the following default setup conditions:

Print	Monochrome
Auto-feed	On
Print Colors:	
Ch 1 Data	Magenta
Ch 1 Memory	Green
Ch 2 Data	Blue
Ch 2 Memory	Red
Graticule	Cyan
Warning	Black
Text	Black

DEFLTCPIO Sets up the following default state for copy. There is no equivalent front-panel key.

Plotter Type:	PLOTTER	Printer Type:	DESKJET
Plotter Port:	SERIAL	Printer Port:	PARALLEL
Baud Rate:	9600	Baud Rate:	19200
Handshake:	Xon-Xoff	Handshake:	Xon-Xoff
HP-IB Address:	5	HP-IB Address:	1
Parallel Port:	COPY		

DEFS[D] Begins standard definition during cal kit modification. D is the standard number.

DELA Displays the data formatted as group delay.

DELO Turns the delta marker mode OFF.

These 6 commands make the indicated marker the delta reference:

DELR1 Marker 1.

DELR2 Marker 2.

DELR3 Marker 3.

DELR4 Marker 4.

DELR5 Marker 5.

DELRFIXM Fixed marker.

DEMOAMPL Turns on transform demodulation and sets the transform demodulation to amplitude demodulation. Only has a meaningful effect with a CW time transform.

DEMOOFF Turns the transform demodulation function OFF.

DEMOPHAS Sets the transform demodulation to phase demodulation. Only has a meaningful effect with a CW time transform.

DFLT Sets the plotter to the following default setup conditions.

Plot Data	On	Pen Number:	
Plot Mem	On	Data	2
Plot Grat	On	Memory	5
Plot Text	On	Graticule	1
Plot Mkr	On	Text	7
Auto-feed	On	Marker	7
Scale Plot	Full	Line Type:	
Plot Speed	Fast	Data	7
		Memory	7

DIRS[D] Sets the number of files in the directory at disk initialization. LIF only.

DISCUNIT[D] Specifies which disk in an external multiple-disk drive to be used for save/recall.

DISCVOLU[D] Specifies which volume of an external multiple-volume disk drive to be used for save/recall.

DISM<ON|OFF> When on, displays the response and stimulus values for all markers that are turned on; when off, only the active marker's value is displayed.

These 6 commands display the indicated combinations of data and trace memory on the active channel:

DISPDATA Data only.

DISPDATM Data and memory.

DISPDDM Data divided by memory (linear division, log subtraction).

DISPDMM Data minus memory (linear subtraction).

DISPMEMO Memory only.

DIVI Same as DISPDDM.

DONE Done with a class of standards, during a calibration. Only needed when multiple standards are measured to complete the class.

DONM Done modifying a test sequence.

DOSEQ<I> Begins execution of the selected sequence. I = 1 to 6.

DOWN Decrements the value in the active entry area (down key).

DUAC<ON|OFF> Dual channel display ON or OFF.

DUPLSEQ[X]SEQ[Y] Duplicates sequence X to sequence Y. X,Y = 1 to 6.

EDITDONE Done editing list frequency or limit table.

EDITLIML	Begins editing limit table.
EDITLIST	Begins editing list frequency table.
ELED[D]	Sets the electrical delay offset.
EMIB	Send out a beep during a sequence.
ENTO	Turns the active entry area OFF.
ESB?	Outputs event-status register B.
ESE[D]	Enables the selected event-status register bits to be summarized by bit 5 in the status byte. An event-status register bit is enabled when the corresponding bit in the operand D is set.
ESNB[D]	Enables the selected event-status register B bits to be summarized by bit 2 of the status byte. A bit is enabled in the register when the corresponding bit in the operand D is set.
ESR?	Outputs the value of the event-status register.
EXTD	Selects the external disk as the active storage device.

These commands include the indicated information when a register is stored on disk. See Figure 1-4 for data types:

EXTMDATA<ON|OFF>	Adds error corrected data (real and imaginary pairs) along with the other files.
EXTMDATO<ON|OFF>	Error corrected data array only (real and imaginary pairs).
EXTMFORM<ON|OFF>	Formatted trace data. Uses currently selected format for data.
EXTMGRAP<ON|OFF>	User graphics.
EXTMRAW<ON|OFF>	Raw data arrays (real and imaginary pairs).
EXTTHIGH	Sets the external trigger line high.
EXTTLOW	Sets the external trigger line low.
EXTTOFF	Deactivates the external trigger mode. OPC- compatible.
EXTTON	Activates the external trigger mode. OPC- compatible.
EXTTPOIN	Sets the external trigger to auto trigger on point. OPC- compatible.
EXTRCHAN<ON|OFF>	Sets the internal phase lock reference selection switch on or off. This allows the analyzer to receive its R channel input through the R CHANNEL IN port or from its own internal source.
FIXE	Specifies a fixed load, as opposed to a sliding load or offset load, when defining a standard during a cal kit modification.

These 5 commands set the data format for array transfers in and out of the instrument:

FORM1	HP 8719D/20D/22D internal format. Preceded by 4 byte header.
FORM2	32 bit floating point format. Preceded by 4 byte header.
FORM3	64 bit floating point format. Preceded by 4 byte header.
FORM4	ASCII format. No header.

FORM5 32 bit floating point PC format. Bytes reversed. Preceded by 4 byte header.

These commands define the format to use on disk initializations:

FORMATDOS Selects DOS as the disk format.

FORMATLIF Selects LIF as the disk format.

FREQOFFS<ON|OFF> Activates the frequency offset instrument mode. OPC- compatible.

FREO Frequency blank. Turns OFF frequency notation.

FRER HP-IB free run. Acts the same as `CONT;` .

FULP Selects full page plotting, as opposed to plotting in one of the four quadrants.

These 3 commands select a forward calibration class, during a 2-port calibration sequence. They are OPC-compatible if there is only one standard in the class:

FWDI Isolation.

FWDM Match.

FWDT Transmission.

These 5 commands control the time domain gate:

GATECENT[D] Center time.

GATEO<ON|OFF> Gate ON/OFF. OPC-compatible.

GATESPAN[D] Span time.

GATESTAR[D] Start time.

GATESTOP[D] Stop time.

These 4 commands set the gate shape:

GATSMAXI Maximum.

GATSMINI Minimum.

GATSNORM Normal.

GATSWIDE Wide.

GOSUB<I> Invokes a sequence as a subroutine. I = 1 to 6.

HOLD Puts the sweep trigger into hold.

IDN? Outputs the identification string: `HEWLETT PACKARD,87NND,0,X.XX`, where 87NND is the model number of the instrument and X.XX is the firmware revision of the instrument.

These 7 commands branch an executing sequence to a new sequence if the following condition is satisfied.

IFBIHIGH Tests the specified input GPIO bit (see `PARAIN[D]`). If high, invokes the sequence which follows.

IFBILOW Tests the specified input GPIO bit (see PARAIN[D]). If low, invokes the sequence which follows.

IFBW[D] Sets the IF bandwidth.

IFLCEQZESEQ<I> If loop counter equals zero, then do the sequence that follows.

IFLCNEZESEQ<I> If loop counter does not equal zero, then do the sequence that follows.

IFLTFAILSEQ<I> If limit test fails, then do sequence that follows.

IFLTPASSSEQ<I> If limit test passes, then do sequence that follows.

IMAG Selects the imaginary display format.

INCRLOOC Increments the sequencing loop counter by 1.

INID Initializes the internal disk. All previous information on the disk will be destroyed.

INIE Initializes the external disk. All previous information on the disk will be destroyed. Requires pass control when using the HP-IB port.

These commands input an individual error coefficient array. Before sending an array, issue a CALIXXXX; command, where XXXX specifies the calibration type of the data. Then input the array or arrays. Lastly store the data with SAVC;. The instrument goes into hold, displaying uncorrected data. Complete the process by triggering a sweep. See Table 1-7, for the contents of the different arrays.

INPUCALC01[D] Array 1.

INPUCALC02[D] Array 2.

INPUCALC03[D] Array 3.

INPUCALC04[D] Array 4.

INPUCALC05[D] Array 5.

INPUCALC06[D] Array 6.

INPUCALC07[D] Array 7.

INPUCALC08[D] Array 8.

INPUCALC09[D] Array 9.

INPUCALC10[D] Array 10.

INPUCALC11[D] Array 11.

INPUCALC12[D] Array 12.

INPUCALK[D] Inputs a cal kit read out with OUTCALK; . After the transfer, the data should be saved into the user cal kit area with SAVEUSEK;.

INPUDATA[D] Inputs an error corrected data array, using the current setting of the FORM command.

INPUFORM[D] Inputs a formatted data array, using current the current setting of the FORM command.

INPULEAS[D] Inputs a learn string read out by OUTPLEAS;.

These commands input power meter calibration arrays into the instrument. Values should be entered as 100 × power meter reading in dB.

INPUPMCAL1 Channel 1.

INPUPMCAL2 Channel 2.

These commands input a raw data array using the current format. See OUTPRAW<I> for the meaning of the arrays. The instrument stops sweeping, error corrects the data, then formats and displays the data.

INPURAW1[D] Array 1.

INPURAW2[D] Array 2.

INPURAW3[D] Array 3.

INPURAW4[D] Array 4.

These commands select the instrument mode. They are all OPC-compatible.:

INSMNETA Standard network analyzer. OPC-compatible.

INSMTUNR Tuned receiver. OPC-compatible.

INTD Selects the internal disk as the active storage device.

INTE[D] Sets the display intensity, 50 to 100 percent.

INTM Selects the internal memory for save/recall.

ISOD Done with isolation subsequence in a 2-port calibration. OPC-compatible.

ISOL Begins the isolation subsequence step in a 2-port calibration.

ISOOP Selects isolation for one path, two port calibration.

KEY[D] Sends a keycode, equivalent to actually pressing the key. It does not matter if the front-panel is in remote mode. See Figure 1-6 for the key codes.

KITD Calibration kit done This is the last step in modifying a cal kit.

KOR? Outputs last key code or knob count. If the reply is positive, it is a key code. If it is negative, then set bit 15 equal to bit 14, and the resulting two byte integer is the RPG knob count. It can be either positive or negative. There are about 120 counts per turn.

These commands enter labels for the standard classes during a cal kit modification:

LABEFWDM[$] Forward match.

LABEFWDT[$] Forward transmission.

LABERESI[$] Response, response and isolation.

LABERESP[$] Response.

LABEREVM[$] Reverse match.

LABEREVT[$] Reverse transmission.

LABES11A[$] S11A (opens).

LABES11B[$] S11B (shorts).

LABES11C[$] S11C (loads).

LABES22A[$] S22A (opens).

LABES22B[$] S22B (shorts).

LABES22C[$] S22C (loads).

LABETRLL[$] TRL line or match.

LABETRLT[$] TRL thru.

LABETRLR[$] TRL reflect.

LABK[$] Enters a cal kit label during a cal kit modification.

LABS[$] Enters a standard's label during standard definition.

LEFL Selects a plot in the left lower quadrant.

LEFU Selects a plot in the left upper quadrant.

LIMIAMPO[D] Enters the limit line amplitude offset.

LIMILINE<ON|OFF> Turns the display of the limit lines ON and OFF.

LIMIMAOF Marker to limit offset. Centers the limit lines about the current marker position using the limit amplitude offset function.

LIMISTIO[D] Enters the stimulus offset of the limit lines.

LIMITEST<ON|OFF> Turns limit testing ON and OFF.

These 8 commands edit a limit test segment. The limit table editing is begun with `EDITLIML;`, and a segment is brought up for editing with `SEDI N;` or added using `SADD;`. The segment is closed with `SDON;`, the table is closed with `EDITDONE;`

LIMD[D] Sets the limit delta value while editing a limit line segment.

LIML[D] Sets the lower limit value.

LIMM[D] Sets the middle limit value.

LIMS[D] Sets the limit stimulus break point.

LIMTFL Makes the segment a flat line.

LIMTSL Makes the segment a sloping line.

LIMTSP Makes the segment a single point.

LIMU[D] Set the upper limit value.

LINFREQ Selects a linear frequency sweep.

LINM Selects the linear magnitude display format.

LINTDATA[D] Enters the line type for plotting data.

LINTMEMO[D] Enters the line type for plotting memory.

LISFREQ Selects the list frequency sweep mode.

LISV Activates the list values function. The next page of values can be called with NEXP; and the previous page can be called with PREP;. The current page can be plotted or printed, in raster graphics mode, with PLOT;, or PRINALL; respectively. The entire L;''. (Since these commands may need to take control of an HP-IB peripheral, the system controller must have pass control capability.)

These 5 commands load the file from disk with the name indicated by the previous TITFn command. The actual file loaded depends on the file title in the file position specified by the TITFn command. Requires pass control mode.

LOAD1 Loads the file from disk using the file name provided by the preceding TITF1; command.

LOAD2 Loads the file from disk using the file name provided by the preceding TITF2; command.

LOAD3 Loads the file from disk using the file name provided by the preceding TITF3; command.

LOAD4 Loads the file from disk using the file name provided by the preceding TITF4; command.

LOAD5 Loads the file from disk using the file name provided by the preceding TITF5; command.

These 6 commands load the file from disk with the name indicated by the previous TITSEQn command. The actual file loaded depends on the file title in the file position specified in the TITSEQn command. Requires pass control mode.

LOADSEQ1 Loads sequence 1 from disk.

LOADSEQ2 Loads sequence 2 from disk.

LOADSEQ3 Loads sequence 3 from disk.

LOADSEQ4 Loads sequence 4 from disk.

LOADSEQ5 Loads sequence 5 from disk.

LOADSEQ6 Loads sequence 6 from disk.

LOAN Measures the load as not being offset when a standard has been defined as an offset load (see OFLS).

LOAO Measures the load as being offset when a standard has been defined as an offset load (see OFLS).

LOFREQ[D] Sets the local oscillator frequency for use in frequency offset mode.

LOGFREQ Selects a log frequency sweep.

LOGM Selects the log magnitude display format.

LOOC[D] Sets the value of the sequencing loop counter.

LOWPIMPU Turns ON the low pass impulse transform.

LOWPSTEP Turns ON the low pass step transform.

LRN? Same as OUTPLEAS (output learn string).

LRN[D] Same as INPULEAS (input learn string).

MANTRIG	Sets the external trigger to manual trigger on point. OPC-compatible.

These commands make the indicated marker active and set its stimulus value:

MARK1[D]	Marker 1.
MARK2[D]	Marker 2.
MARK3[D]	Marker 3.
MARK4[D]	Marker 4.
MARK5[D]	Marker 5.

MARKBUCK[D]	Places the active marker on a specific sweep point (bucket). D is the bucket number, ranging from 0 to number of points less 1.
MARKCENT	Sets the center stimulus value to that of the active marker's stimulus value.
MARKCONT	Places the markers continuously on the trace, not on discrete points (interpolates the marker values between discrete points).
MARKCOUP	Couples the markers between the channels, as opposed to MARKUNCO.
MARKCW	Sets the CW frequency to the active marker's frequency.
MARKDELA	Sets electrical length so group delay is zero at the active marker's stimulus.
MARKDISC	Places the markers on the discrete measurement points.
MARKFAUV[D]	Sets the auxiliary value of the fixed marker position. Works in coordination with MARKFVAL and MARKFSTI.
MARKFSTI[D]	Sets the stimulus position of the fixed marker.
MARKFVAL[D]	Sets the value of the fixed marker position.
MARKMAXI	Same as SEAMAX (search for maximum on current channel's trace).
MARKMIDD	During a limit segment edit, makes the marker amplitude the limit segment middle value.
MARKMINI	Same as SEAMIN (search for minimum on current channel's trace).
MARKOFF	Turns all markers and marker functions OFF.
MARKREF	Sets the reference value to that of the active marker's amplitude.
MARKSPAN	Sets the span for the entire trace to that of the span between the active marker and the delta reference marker.
MARKSTAR	Sets the start stimulus to that of the active marker's.
MARKSTIM	During a limit segment edit, sets the limit stimulus break point to that of the active marker's.
MARKSTOP	Sets the stop stimulus to that of the active marker's.
MARKUNCO	Uncouples the markers between channels, as opposed to MARKCOUP.
MARKZERO	Places the fixed marker at the active marker position and makes it the delta reference.

MAXF[D]	Sets the maximum valid frequency of a standard being defined during a cal kit modification.
MEASA	Measures and displays input A on the active channel.
MEASB	Measures and displays input B on the active channel.
MEASR	Measures and displays input R on the active channel.
MEASTAT<ON|OFF>	Turns trace statistics ON and OFF.
MENU<ON|OFF>	Blanks the softkey menu. Use with caution, as this may give unusual results when setting up an instrument state. Recommend setting up states using MENU<ON> (default) and, when setup is complete, using MENU<OFF>.

These commands bring up the menu associated with the indicated front-panel key:

MENUAVG	AVG
MENUCAL	CAL
MENUCOPY	COPY
MENUDISP	DISPLAY
MENUFORM	FORMAT
MENUMARK	MARKER
MENUMEAS	MEAS
MENUMRKF	MARKER FCTN
MENURECA	RECALL
MENUSAVE	SAVE
MENUSCAL	SCALE
MENUSEQU	SEQUENCE
MENUSTIM	STIMULUS MENU
MENUSYST	SYSTEM
MINF[D]	Sets the minimum valid frequency of a standard being defined during a cal kit modification.
MINU	Displays data minus memory, the same as DISPDMM.
MINMAX<ON|OFF>	Enables/disables min/max recording per segment. Min and max values are recorded per limit segment. Limit testing need not be active.
MODI1	Begins the modify cal kit sequence.
MODS	Computes new cal set using adapter removal.
NEWSEQ<I>	Begins modifying a sequence.
NEXP	Displays the next page of the operating parameters list.
NOOP	No operation. OPC-compatible.
NUMG[D]	Activates D number of groups of sweeps. A group is whatever is needed to update the current parameter once. This function restarts averaging if ON. OPC-compatible.

NUMR[D] Sets the number of power meter readings per point used during a power meter calibration.

OFLD Offset loads done.

OFLS Selects the calibration standard load as being an offset load, as opposed to a sliding or fixed load, during a cal kit modification.

These 3 commands specify the offset value for the indicated parameter for a standard being defined during a cal kit modification:

OFSD[D] Delay offset.

OFSL[D] Loss offset.

OFSZ[D] Impedance offset.

OMII Omits the isolation step of a calibration sequence.

OPC Operation complete. Reports the completion of the next command received by setting bit 0 in the event-status register, or by replying to an interrogation if `OPC?;` is issued.

OPEP Presents a list of key operating parameters. `NEXP;` calls the next page of parameters and the previous page can be called with `PREP;`. Requesting a plot or print copies the current page. The current page can be plotted or printed, in raster graphics mode, with `PLOT;`, or `PRINALL;` respectively. The entire list can be printed, in ASCII text mode, with `PRINTALL;`. Since these commands need to take control of an HP-IB peripheral, the system controller must have pass control capability.

OUTPACTI Outputs the value of the active function, or the last active function if the active entry area is OFF.

OUTPAMAX Outputs the max values for all limit line segments.

OUTPAMIN Outputs the min values for all limit line segments.

OUTPAPER Outputs the smoothing aperture in stimulus units, rather than as a percentage.

These 12 commands output an error correction array for the active calibration on the active channel. See Table 1-7, for the contents of each array. Each array is output in the currently set form determined by the FORMn command. The data is in real/imaginary pairs, the same number of pairs as points in the sweep.

OUTPCALC01 Array 1.

OUTPCALC02 Array 2.

OUTPCALC03 Array 3.

OUTPCALC04 Array 4.

OUTPCALC05 Array 5.

OUTPCALC06 Array 6.

OUTPCALC07 Array 7.

OUTPCALC08 Array 8.

OUTPCALC09 Array 9.

OUTPCALC10 Array 10.

OUTPCALC11 Array 11.

OUTPCALC12 Array 12.

OUTPCALK Outputs the currently active calibration kit, as a less than 1000 byte string. The data is in FORM 1.

OUTPCHAN Outputs the active channel number.

OUTPDATA Outputs the error corrected data from the active channel. See Figure 1-4 and FORMn command.

OUTPDATF Fast data transfer command for OUTPDATA. =

OUTPDATP Outputs the trace data indexed by point (see SELPT[D]).

OUTPDATR Outputs the trace data for range of points (see SELMINPT[D], SELMAXPT[D]).

OUTPERRO Outputs the oldest error message in the error queue. Sends first the error number, and then the error message itself as a string no longer than 50 characters.

OUTPFAIP This command is similar to OUTPLIMF except that it reports the number of failures first, followed by the stimulus and trace values for each failed point in the test.

OUTPFORM Outputs the formatted display data array from the active channel. See Table 1-3 for the contents of the array as a function of display format. See also FORMn command.

OUTPFORF Fast data transfer command for OUTPFORM.

These 12 commands output an interpolated error coefficient array for the active calibration on the active channel. See Table 1-8 for the contents of each array.

OUTPICAL01 Array 1.

OUTPICAL02 Array 2.

OUTPICAL03 Array 3.

OUTPICAL04 Array 4.

OUTPICAL05 Array 5.

OUTPICAL06 Array 6.

OUTPICAL07 Array 7.

OUTPICAL08 Array 8.

OUTPICAL09 Array 9.

OUTPICAL10 Array 10.

OUTPICAL11 Array 11.

OUTPICAL12 Array 12.

OUTPIDEN Outputs the identification string for the analyzer: `HEWLETT PACKARD,87NND,0,X.XX` where 87NND is the model number of the instrument and X.XX is the firmware revision of the instrument.

These 2 commands output the interpolated power meter calibration arrays for channels 1 and 2.

OUTPIPMCL1 Channel 1.

OUTPIPMCL2 Channel 2.

OUTPKEY Outputs the key code of the last key pressed. An invalid key is reported with a 63, a knob turn with a −1. See Figure 1-6 for the front-panel key codes.

OUTPLEAS Outputs the learn string, which contains the entire front panel state, the limit table, and the list frequency table. It is always in binary format not intended for decoding.

OUTPLIM1 Outputs the status of the limit test for channel 1.

OUTPLIM2 Outputs the status of the limit test for channel 2.

These 3 commands output the limit test results. The results consist of four fields. First is the stimulus value for the point. Second is an integer indicating test status. Third is the upper limit at that point. Fourth is the lower limit at that point. If there are no limits at that point, the third and fourth fields are zero. The test status is—1 for no test, 0 for fail, and 1 for pass.

OUTPLIMF Outputs the limit test results for each failed point.

OUTPLIML Outputs the limit test results for each point in the sweep. This is an ASCII transfer.

OUTPLIMM Outputs the limit test results at the marker.

OUTPMARK Outputs the marker values. The first two numbers are the marker response values, and the last is the stimulus value. See Table 1-3 for the meaning of the response values as a function of display format.

OUTPMEMO Outputs the memory trace from the active channel. The data is in real/imaginary pairs, and can be treated the same as data read with the OUTPDATA command.

OUTPMEMF Fast data transfer command for OUTPMEMO.

OUTPMSTA Outputs the marker statistics: mean, standard deviation, and peak-to-peak variation in that order. If statistics is not ON, it is turned ON to generate current values and turned OFF again. See also MEASTAT<ON|OFF>.

OUTPMWID Outputs the marker bandwidths search results: bandwidth, center, and Q in that order. If widths is not ON, it is turned ON to generate current values and turned OFF again.

OUTPMWIL Performs the same operation as OUTPMWID plus appends the loss value as well.

OUTPOPTS Outputs an ASCII string of the options installed.

OUTPPLOT Outputs the plot string. Can be directed to a plotter, or read into the computer.

These commands output the power meter calibration array. Values should be entered as 100 times the power meter reading in dB. A default array is used if a power meter calibration sweep, TAKCS, has not been taken:

OUTPPMCAL1 Channel 1.

OUTPPMCAL2 Channel 2.

These 4 commands output the pre-raw measurement data. See Figure 1-4 for the meaning of the data. Analogous to OUTPRAW except that pre-raw data has not had sampler correction nor attenuator offsets applied. These offsets are not necessary for data that will be fully error corrected. See BASIC programming Example 2E: Take4 — Error Correction Processed on an External Computer. The arrays hold S11, S21, S12, and S22, respectively:

OUTPPRE1 Array 1 (S11 data).

OUTPPRE2 Array 2 (S21 data).

OUTPPRE3 Array 3 (S12 data).

OUTPPRE4 Array 4 (S22 data).

OUTPPRIN Outputs a raster dump of the display, intended for a graphics printer.

OUTPPRNALL Outputs all of the List Values or Operating Parameters in text mode. Activate the desired function by preceding with LISV or OPEP, respectively.

These 5 commands output the raw measurement data. See Figure 1-4 for the meaning of the data. Normally, array 1 holds the current parameter. If a 2-port calibration is active, the arrays hold S11, S21, S12, and S22, respectively:

OUTPRAF<I> Fast data transfer command for OUTPRAW<I>.

OUTPRAW1 Array 1.

OUTPRAW2 Array 2.

OUTPRAW3 Array 3.

OUTPRAW4 Array 4.

OUTPSEGAF Outputs the segment number and it's limit test status for all active segments.

OUTPSEGAM Outputs the limit test min/max for all segments. Outputs the segment number, max stimulus, max value, min stimulus, min value for all active segments.

OUTPSEGF Outputs the limit test status for a specified segment. See SELSEG[D].

OUTPSEGM Outputs limit test min/max for a specified segment. See SELSEG[D].

OUTPSEQ<I> Outputs I's sequence listing. I = 1 to 6.

OUTPSERN Outputs the serial number of the analyzer.

OUTPSTAT Outputs the status byte.

OUTPTITL Outputs the display title.

PARAIN[D]	Specify the input GPIO bit to be used by IFBIHIGH and IFBILOW tests.
PARAL<GPIO|CPY>	Selects use of the parallel port: for general purpose I/O or for the copy function.
PARAOUT[D]	Programs all GPIO output bits (0 to 255) at once.
PAUS	Inserts a pause into a sequence.
PCB[D]	Same as ADDRCONT. Indicates where control will be returned after a pass control.

These 7 commands select the color for printing the indicated display feature where <COLOR> is one of the following colors: white, cyan, magenta, blue, yellow, green, red, or black.

PCOLDATA1<COLOR>	Channel 1 data.
PCOLDATA2<COLOR>	Channel 2 data.
PCOLMEMO1<COLOR>	Channel 1 memory.
PCOLMEMO2<COLOR>	Channel 2 memory.
PCOLGRAT<COLOR>	Graticule.
PCOLTEXT<COLOR>	Displays text.
PCOLWARN<COLOR>	Warning text.
PDATA<ON|OFF>	Selects whether trace data is plotted.

These 5 commands select the pen (value for D) for plotting the indicated display feature for the active channel:

PENNDATA[D]	Data trace.
PENNGRAT[D]	Graticule.
PENNMARK[D]	Markers and marker text.
PENNMEMO[D]	Memory trace.
PENNTEXT[D]	Text and user graphics.
PGRAT<ON|OFF>	Selects whether the graticule is plotted.
PHAO[D]	Sets the phase offset.
PHAS	Selects the phase display format.
PLOS<SLOW|FAST>	Selects the pen speed for plotting. (Slow is useful for transparency plotting.)
PLOT	Initiates a plot.
PLTHNDSHK<XON|DTR>	Selects the plotter handshake mode as either Xon-Xoff or DTR-DSR.
PLTPRTDISK	Sets the plotter port to disk (either internal disk or external disk).
PLTPRTHPIB	Sets the plotter port to HP-IB.
PLTPRTPARA	Sets the plotter port to parallel.
PLTPRTSERI	Sets the plotter port to serial.
PLTTRAUTF<ON|OFF>	Turns ON and OFF the plotter auto feed.
PLTTRBAUD[D]	Sets the plotter baud rate.
PLTTRFORF	Sends a form feed to the plotter.

PLTTYPHPGL	Selects HP-GL compatible *printer* as the plotter type.
PLTTYPPLTR	Selects *plotter* as the plotter type.
PMEM<ON|OFF>	Selects whether memory is plotted.
PMKR<ON|OFF>	Selects whether markers are plotted.
PMTRTTIT	Reads value from power meter or peripheral at the power meter's HP-IB address into title string.
POIN[D]	Sets the number of points in the sweep.
POLA	Selects the polar display format.

These 3 commands select the marker readout format for polar display:

POLMLIN	Linear markers.
POLMLOG	Log markers.
POLMRI	Real/imaginary markers.

PORE<ON|OFF>	Turn port extensions ON and OFF.

These 4 commands set the port extension length for the indicated port or input. Ports 1 and 2 refer to the test set ports:

PORT1[D]	Port 1.
PORT2[D]	Port 2.
PORTA[D]	Input A.
PORTB[D]	Input B.

PORTP<CPLD|UNCPLD>	Selects either coupled or uncoupled for the port powers for a given channel.
PORTR[D]	Same as PORT1.
PORTT[D]	Same as PORT2.
POWE[D]	Sets the output power level. See also PWRR<PAUTO/PMAN>.
POWLFREQ[D]	Selects the frequency for which a power loss correction is entered. This must be followed by a POWLLOSS[D], which sets the value.
POWLLIST	Begins editing a power loss list for a power meter calibration.
POWLLOSS[D]	Sets the loss value for a particular frequency, set by POWLFREQ[D], in the power loss list.
POWM<ON|OFF>	Designates whether the HP 436A (ON) or the HP 437B/438A (OFF) is to be used as the power meter.
POWR<I>	Selects power ranges 00 to 11 when in manual power range.
POWS	Selects power sweep, from the sweep type menu.
POWT<ON|OFF>	Trip power (set maximum attenuation) ON or OFF.
PRAN<I>	Selects power ranges 01 to 12 when in manual power range.
PREP	Displays the previous page of the operating parameters list.
PRES	Presets the analyzer to the factory preset state. OPC-compatible.

PRIC	Selects color print (as opposed to monochrome; see also PRIS).
PRINALL	Copies the display, in raster graphics mode, to a printer.
PRINSEQ<I>	Begins printing the sequence selected.
PRINTALL	Prints all list values or operating and marker parameters in ASCII text mode.
PRIS	Selects standard (monochrome) print.
PRNHNDSHK<XON|DTR>	Selects the printer handshake mode as either Xon-Xoff or DTR-DSR.
PRNPRTHPIB	Sets the printer port to HP-IB.
PRNPRTPARA	Sets the printer port to parallel.
PRNPRTSERI	Sets the printer port to serial.
PRNTRAUTF<ON|OFF>	Turns ON and OFF the printer auto feed.
PRNTRBAUD[D]	Sets the printer baud rate.
PRNTRFORF	Sends a form feed to the printer.
PRNTYP540	Selects the DeskJet 540 or 850C printer as the printer type.
PRNTYPDJ	Selects the DeskJet printer as the printer type.
PRNTYPEP	Selects the Epson ESC/P2 printer control language-compatible printer as the printer type.
PRNTYPLJ	Selects the LaserJet printer as the printer type.
PRNTYPPJ	Selects the PaintJet printer as the printer type.
PRNTYPTJ	Selects the ThinkJet printer as the printer type.
PSOFT<ON|OFF>	Controls whether softkeys are included in the hardcopy print or plot.
PTEXT<ON|OFF>	Selects whether text is plotted.
PTOS	Pauses the sequence to be followed by selection one of the 6 sequences (SEQ<I>).

These 5 commands purge the indicated file from disk. Requires pass control mode when using an external disk drive.

PURG1	File 1.
PURG2	File 2.
PURG3	File 3.
PURG4	File 4.
PURG5	File 5.

These 3 commands select the type of power meter calibration desired. A calibration sweep should be taken (TAKCS) after selecting a "one sweep" Power meter calibration, to ensure a valid calibration. No calibration sweep is needed for "each sweep" power meter calibrations.

PWMCEACS[D]	Each sweep.
PWMCOFF[D]	Off.
PWMCONES[D]	One sweep.

PWRLOSS<ON|OFF>	Selects whether or not to use the power loss table for a power meter calibration.
PWRMCAL	Displays the power meter cal menu and sets the drive port cal power.
PWRR<PAUTO|PMAN>	Select the power range auto or manual mode.
Q<I>	Same as SEQ<I>.
RAID	Completes the response and isolation cal sequence. OPC-compatible.
RAIISOL	Calls the isolation class for the response and isolation calibration.
RAIRESP	Calls the response class for the response and isolation calibration.
RAWOFFS<ON|OFF>	Selects whether sampler and attenuator offsets are ON or OFF. By selecting raw offsets OFF, a full two port error correction can be performed without including the effects of the offsets. It also saves substantial time at recalls and during frequency changes. Raw offsets follow the channel coupling. See BASIC programming Example 2E: Take4 — Error Correction Processed on an External Computer.
READDATE	Outputs the date in the following string format: DD MMM YYYY. HP-IB only command.
READTIME	Outputs the time in the following string format: HH:MM:SS. HP-IB only command.
REAL	Selects the real display format.
RECO	Recalls previously saved display colors.

These 6 commands (OPC-compatible) recall the indicated internal register.

RECA1	Register 1.
RECA2	Register 2.
RECA3	Register 3.
RECA4	Register 4.
RECA5	Register 5.
RECAREG<I>	Recalls save/recall registers 01 through 31. RECAREG01 through RECAREG05 are the same as RECA1 through RECA5. OPC-compatible.
REFD	Completes the reflection calibration subsequence of a 2-port calibration. OPC-compatible.
REFL	Begins the reflection calibration subsequence of a 2-port calibration.
REFOP	Begins the reflection calibration subsequence for one path, two port calibration.
REFP[D]	Enters the reference position. 0 is the bottom, 10 is the top of the graticule.
REFT	Recalls file titles from disk.

REFV[D]	Enters the reference line value.
REIC[D]	Sets the power level reference value for a receiver calibration.
RESC	Resume cal sequence.
RESD	Restores the measurement display after viewing the operating parameters or list values.
RESPDONE	Completes the response calibration sequence. OPC-compatible.
REST	Measurement restart.
RETP<ON|OFF>	Switches retrace power on or off.

These commands (OPC-compatible) call the reverse calibration classes, during a full 2-port calibration.

REVI	Isolation.
REVM	Match.
REVT	Transmission.

These 2 commands are used in frequency offset mode (Option 089) measurements.

RFGTLO	Sets RF greater than LO.
RFLTLO	Sets RF less than LO.
RFLP	Same as S11;
RIGL	Selects a plot in the lower right quadrant.
RIGU	Selects a plot in the upper right quadrant.
RSCO	Resets display colors to the factory default.
RST	Presets the instrument. OPC-compatible.

These 4 commands select the S-parameter for the active channel:

S11

S12

S21

S22

SADD	During either a list frequency or limit table edit, adds a new segment to the table.
SAV1	Completes the 1-port calibration sequence. OPC-compatible.
SAV2	Completes the 2-port calibration sequence. OPC-compatible.
SAVC	Completes the transfer of error correction coefficients back into the instrument. OPC-compatible.

These 6 commands (OPC-compatible) store the current instrument state in the indicated internal register.

SAVE1	Register 1.
SAVE2	Register 2.

SAVE3 Register 3.

SAVE4 Register 4.

SAVE5 Register 5.

SAVEREG<I> Saves to save/recall registers 01 through 31. SAVEREG01 through SAVEREG05 are the same as SAVE1 through SAVE5. OPC-compatible.

SAVT Completes the TRL/LRM calibration sequence. OPC-compatible.

The 2 following commands define the format for saving files to disk.

SAVUASCI Selects ASCII format for saving to disk. Conforms to CITIFile specifications.

SAVUBINA Selects binary format for saving to disk.

SAVEUSEK Stores the active calibration kit as the user kit.

SCAL[D] Sets the trace scale factor.

SCAP<FULL|GRAT> Selects a full plot, or a plot where the graticule is expanded to the plotter's P1 and P2.

SDEL During either a list frequency, a limit table edit, or power loss list, deletes the current segment.

SDON During either a list frequency, a limit table edit, or power loss list, closes a segment after editing.

These 6 commands control the marker searches. The marker searches place the active marker according to the indicated search criteria. The search is continuously updated if tracking is ON (see TRACK):

SEAL Search left for next occurrence of the target value.

SEAMAX Search for trace maximum on the current channel.

SEAMIN Search for trace minimum on the current channel.

SEAOFF Turns the marker search OFF.

SEAR Search right for next occurrence of the target value.

SEATARG[D] Set the search target amplitude.

SEDI[D] During either a frequency, limit, or power loss table edit, selects segment D for editing.

SELL[D] Selects the learn string revision (LRN) or OUTPLEAS, INPULEAS to be used by the analyzer. The valid parameters are:

0: Defaults to current revision.

201: Revision 8720A 2.01

612: Revision 8720A 6.12

SELMAXPT[D] Selects the last point number in the range of points that the OUTPDATR command will report. D can range from 0 to the number of points minus 1.

SELMINPT[D]	Selects the first point number in the range of points that the OUTPDATR command will report. D can range from 0 to the number of points minus 1.
SELPT[D]	Selects the point number that the OUTPDATR command will report. D can range from 0 to the number of points minus 1.
SELSEG[D]	Selects the segment number to report on for the OUTPSEGF and OUTPSEGM commands. D can range from 1 to 18.
SEQ<I>	Selects sequence 1 through 6.
SEQWAIT[D]	Tells the instrument to wait D seconds during a sequence.
SETBIT[D]	Sets the specified bit (0 to 7) on the GPIO.
SETDATE[$]	Sets the date in the following format: DD MMM YYYY, where DD is the day and must be 2 digits, MMM is the month and must be three alpha characters (JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC), and YYYY is the year and must be 4 digits.
SETF	Set frequency for low pass transform, Option 010.
SETRTHRU	Set reference thru.
SETRREFL	Set reference reflect.
SETTIME[$]	Sets the time in the following format: HH:MM:SS, where HH is the hour, MM is minutes, SS is seconds, and each must be 2 digits.
SETZ[D]	Set the characteristic impedance of the measurement system.
SHOM	Displays the desired softkey menu during a sequence.
SING	Single sweep. OPC-compatible.
SLID	Sliding load done.
SLIL	Specifies the standard as a sliding load during a standard definition as part of a cal kit modification, as opposed to a fixed or offset load.
SLIS	Sliding load set. OPC-compatible.
SMIC	Select Smith chart display format.

The following commands select the marker readout format on a Smith chart:

SMIMGB	G+jB (conductance and susceptance).
SMIMLIN	Linear magnitude.
SMIMLOG	Log magnitude.
SMIMRI	Real/imaginary pairs (resistance and reactance).
SMIMRX	R+jX.
SMOOAPER[D]	Sets the smoothing aperture as a percent of the trace.
SMOOO<ON|OFF>	Turns smoothing ON and OFF.
SOFR	Displays the firmware revision on the screen.

The following 8 commands act as though the indicated soft key was pressed:

SOFT1	Softkey 1.
SOFT2	Softkey 2.

SOFT3 Softkey 3.

SOFT4 Softkey 4.

SOFT5 Softkey 5.

SOFT6 Softkey 6.

SOFT7 Softkey 7.

SOFT8 Softkey 8.

SOUP<ON|OFF> Turns the source power ON and OFF.

SPAN[D] Sets the stimulus span. If a list frequency segment is being edited, sets the span of the segment.

The following commands initiate the `SPECIFY CLASS` part of modifying a cal kit. After issuing each command, send the analyzer a series of standard numbers to be included in the class. When the class is full, send `CLAD;` to terminate the specification.

SPECFWDM[I] Forward match.

SPECFWDT[I] Forward transmission.

SPECRESP[I] Response.

SPECRESI[I] For Resp & Isol, specifies the response standards.

SPECREVM[I] Reverse match.

SPECREVT[I] Reverse transmission.

SPECS11A[I] S11A.

SPECS11B[I] S11B.

SPECS11C[I] S11C.

SPECS22A[I] S22A.

SPECS22B[I] S22B.

SPECS22C[I] S22C.

SPECTRLL[I] TRL Line or Match.

SPECTRLT[I] TRL Thru.

SPECTRLR[I] TRL Reflect.

SPEG Displays the specify gate menu. See also DUAC.

SPLD<ON|OFF> Turns the split display mode ON and OFF.

SRE[D] Service request enable. A bit set in D enables the corresponding bit in the status byte to generate an SRQ.

SSEG[D] Selects the desired segment of the frequency list for a list frequency sweep. See also ASEG.

STB? Outputs the status byte. Same as OUTPSTAT.

The following 7 commands (OPC compatible) select a standard from a class during a calibration sequence. If a class is requested, as in CLASS11A (S11 1-port cal) the analyzer will do one of two things. If there is only one standard in the class, it will measure that standard

automatically. If there are several standards in the class, then one of the following commands must be used to select one of these standards, causing it to be measured.

STANA Standard listed under softkey 1.

STANB Standard listed under softkey 2.

STANC Standard listed under softkey 3.

STAND Standard listed under softkey 4.

STANE Standard listed under softkey 5.

STANF Standard listed under softkey 6.

STANG Standard listed under softkey 7.

STAR[D] Enters the start stimulus value. If a list frequency segment is being edited, sets the start of the segment.

STDD Standard done, terminating a define standard sequence, while modifying a cal kit.

The following 5 commands select the standard "type" after the standard number has been entered during a modify cal kit sequence:

STDTARBI Arbitrary impedance.

STDTDELA Delay/thru.

STDTLOAD Load.

STDTOPEN Open.

STDTSHOR Short.

STEPSWP<ON|OFF> Step sweep on or off.

STOP[D] Sets the stimulus stop value. If a list frequency segment is being edited, sets the stop of the segment.

These 5 commands store the indicated file on disk. Used with the INTD and EXTD commands to designate the internal or external disk.

STOR1 Stores the current instrument state to disk using the file name provided by the preceding `TITF1;` command.

STOR2 Stores the current instrument state to disk using the file name provided by the preceding `TITF2;` command.

STOR3 Stores the current instrument state to disk using the file name provided by the preceding `TITF3;` command.

STOR4 Stores the current instrument state to disk using the file name provided by the preceding `TITF4;` command.

STOR5 Stores the current instrument state to disk using the file name provided by the preceding `TITF5;` command.

These commands store the instrument state to the indicated sequence to disk. Used with the INTD and EXTD commands to designate the internal or external disk. Requires pass control mode when using the HP-IB port.

STORSEQ1 Sequence 1.

STORSEQ2	Sequence 2.
STORSEQ3	Sequence 3.
STORSEQ4	Sequence 4.
STORSEQ5	Sequence 5.
STORSEQ6	Sequence 6.
STPSIZE[D]	While editing a list frequency segment, sets step size.
SVCO	Saves display colors.
SWEA	Automatically selects the fastest sweep time based on the current analyzer settings for number of points, IF bandwidth, sweep mode, averaging condition and frequency span.
SWET[D]	Sets the sweep time.
SWPSTART	This OPC-compatible command initiates a sweep and immediately releases the HP-IB bus, allowing the analyzer to initiate data output as soon as the appropriate data is ready. See BASIC programming Example 2E: Take4 — Error Correction Processed on an External Computer.
SWR	Selects the SWR display format.
TAKCS	Begins a power meter calibration sweep.
TAKE4<ON|OFF>	This command initiates a mode in which every measurement cycle is characterized by sweeping in both the forward and reverse directions and collecting raw data for all four S-parameters. The sweeping can occur when a SWPSTART or SING command is received or when the analyzer is in continuous, number of groups, or external trigger mode. See BASIC programming Example 2E: Take4 — Error Correction Processed on an External Computer.
TAKRS	Take receiver calibration sweep.
TALKLIST	Puts the analyzer in talker listener mode.
TERI[D]	Specifies the terminal impedance of an arbitrary impedance standard during a cal kit modification.
TESS?	Query testset. Returns a one on the standard analyzer. This command is compatible with the HP 8753D.
TIMDTRAN<ON|OFF>	Turns the time domain transform ON and OFF. (Option 010). OPC-compatible.
TIMESTAM<ON|OFF>	Turns on the clock time for prints and plots.
TITF0<I>[$]	Titles the SAVE STATE filename, only in sequence mode.
TINT[D]	Adjusts the tint for the selected display feature.

These commands title the indicated file numbers:

TITF1[$]	File 1.
TITF2[$]	File 2.
TITF3[$]	File 3.

TITF4[$]	File 4.
TITF5[$1	File 5.
TITL[$]	Enters a new display title. A maximum of 50 characters are allowed.
TITP[$]	Titles the plot to disk file.

These commands title the indicated internal register:

TITR1[$]	Register 1.
TITR2[$]	Register 2.
TITR3[$]	Register 3.
TITR4[$]	Register 4.
TITR5[$]	Register 5.
TITREG<I>[$]	Titles save/recall registers 01 through 31. TITREG01 through TITREG05 are the same as TITR1 through TITR5.
TITSEQ<I>[$]	Selects the sequence to be titled. I = 1 to 6.
TITSQ	Provides access to the sequence title functions.
TITTMEM	Sends the title string to trace memory.
TITTPMTR	Sends the title string to the power meter's HP-IB address.
TITTPERI	Sends the title string to the peripheral address.
TITTPRIN	Sends the title string to the printer's HP-IB address.
TRACK<ON|OFF>	Turns marker search tracking ON and OFF.
TRAD	Completes the transmission calibration subsequence of a 2-port calibration. OPC-compatible.
TRAN	Begins the transmission calibration subsequence of a 2-port calibration.
TRAOP	Begins the transmission calibration subsequence for one path, two port calibration.
TRAP	Same as S21.
TRIG	HP-IB trigger.
TRLL1	Measures TRL Line/match for Port 1 during a TRL/LRM 2-port calibration.
TRLL2	Measures TRL Line/match for Port 2 during a TRL/LRM 2-port calibration.
TRLR1	Measures TRL S11 reflect during a TRL/LRM 2-port calibration.
TRLR2	Measures TRL S22 reflect during a TRL/LRM 2-port calibration.
TRLT	Measures TRL thru during a TRL/LRM 2-port calibration.
TSSWI<ON/OFF>	Same as CSWI.
TST?	Causes a self test and returns a zero if the test is passed.

TSTIOFWD[D] Defines 3 bits, D0 through D2, on the test set connector I/O for the channel 1 and channel 2 forward settings. These bits can be set to values of 0 through 7.

TSTIOREV[D] Defines 3 bits, D0 through D2, on the test set connector I/O for the channel 1 and channel 2 reverse settings. These bits can be set to values of 0 through 7.

TSTP<P1|P2> Selects test port 1 or 2 for non-S-parameter measurements.

These commands set the TTL output and end of sweep pulse:

TTLHPULS TTL normally low, high pulse at end of sweep.

TTLLPULS TTL normally high, low pulse at end of sweep.

TTLOH Sets TTL continuously high.

TTLOL Sets TTL continuously low.

UCONV Selects up converter for mixer measurements.

UP Increments the value in the active entry area (up key).

USEPASC Puts the analyzer in pass control mode.

These commands select the sensor input being used with the HP 438A power meter. For the HP 436A or 437B, the A sensor is always used:

USESENSA Sensor A.

USESENSB Sensor B.

VELOFACT[D] Enters the velocity factor of the transmission medium.

VIEM<ON|OFF> Displays the measurement trace (ON) or the mixer setup (OFF).

VOFF[D] Sets the local oscillator frequency for use in frequency offset mode. See also LOFREQ[D].

WAIT Waits for a clean sweep when used with the OPC command.

WAVD Selects waveguide electrical delay. (See also COAD.)

WAVE Specifies a waveguide standard while defining a standard as part of a cal kit modification, as opposed to coaxial.

WIDT<ON|OFF> Turns the bandwidth search ON and OFF.

WIDV[D] Enters the widths search parameter.

These 5 commands set the window for the transform (Option 010, time domain):

WINDMAXI Maximum.

WINDMINI Minimum.

WINDNORM Normal.

WINDOW[D] Enters arbitrary window.

WINDUSEM<ON|OFF> Turns the trace memory ON as the window shape.

These 8 commands enter new softkey labels into the indicated softkey positions. Initial use of these commands requires previous commands `MENUFORM;` and `MENUOFF;`.

WRSK1[$] Softkey 1.

WRSK2[$] Softkey 2.

WRSK3[$] Softkey 3.

WRSK4[$] Softkey 4.

WRSK5[$] Softkey 5.

WRSK6[$] Softkey 6.

WRSK7[$] Softkey 7.

WRSK8[$] Softkey 8.

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