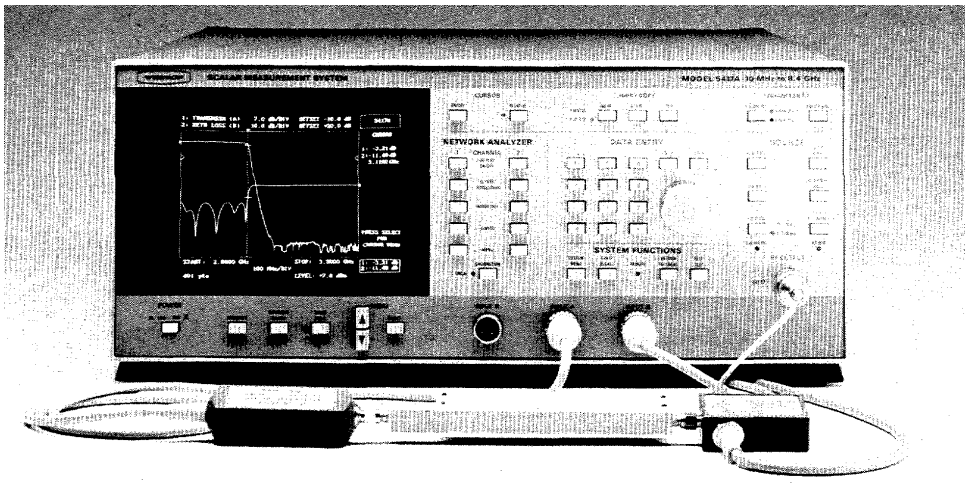
WILTRON

54XXA Series Scalar Measurement Systems

GPIB USER'S GUIDE

Software Version 4.1



This manual supplements the 54XXA Series Scalar Measurement Systems Operation Manual. Insert it behind the tab marked "Options/Supplements" in that manual.

P/N: 10410-00119
REVISION: C
PRINTED: October 1993

WARRANTY

The WILTRON product(s) listed on the title page is (are) warranted against defects in materials and workmanship for one year from the date of shipment, except for YIG-tuned oscillators, which are warranted for two years.

WILTRON's obligation covers repairing or replacing products which prove to be defective during the warranty period. Buyers shall prepay transportation charges for equipment returned to WILTRON for warranty repairs. Obligation is limited to the original purchaser. WILTRON is not liable for consequential damages.

LIMITATION OF WARRANTY

The foregoing warranty does not apply to WILTRON connectors that have failed due to normal wear. Also, the warranty does not apply to defects resulting from improper or inadequate maintenance by the Buyer, unauthorized modification or misuse, or operation outside of the environmental specifications of the product. No other warranty is expressed or implied, and the remedies provided herein are the Buyer's sole and exclusive remedies.

54XXA GPIB USER'S GUIDE

CONTENTS

TABLE INDEX

54XXA GPIB USER'S GUIDE

1 INTRODUCTION

This User's Guide provides information for operating Series 54XXA Scalar Measurement Systems with the IEEE-488 General Purpose Interface Bus (GPIB). All 54XXA GPIB commands (i.e., Product Specific Commands) are listed and described. The set of IEEE-488 Interface Function Messages recognized by the 54XXA are listed and the 54XXA response described.

Included is a brief description of the IEEE-488 General Purpose Interface Bus hardware and the bus data transfer and control functions. The information about the IEEE-488 interface bus presented in this manual is general in nature. For complete and specific information, refer to the ANSI/IEEE Std 488-1978 document entitled "IEEE Standard Digital Interface for Programmable Instrumentation". This document precisely defines the set of dedicated hardware signal lines, interface functions, protocols, and messages for the interface bus.

This manual is intended to be used in conjunction with the Series 54XXA Scalar Measurement System Operation Manual. Refer to that manual for information about equipment set up for GPIB operation and installation of the National Instruments GPIB-PCII/IIA interface card and associated software.

For additional information about use of 54XXA systems with the IEEE-488 GPIB bus, refer to Application Note 5400A-3 (located behind this manual). This application note contains example program routines for automated data save/recall operations that are written in Microsoft QuickBASIC®.

2 DESCRIPTION OF THE IEEE-488 (IEC-625) INTERFACE BUS

The IEEE-488 General Purpose Interface Bus (GPIB) is an instrumentation interface for integrating instruments, computers, and other controllers into systems. The bus uses 16 signal lines to effect transfer of data and commands to all instruments connected on the bus.

No more than 15 instruments may be connected to the interface bus (however, a system may contain more than one interface bus). The maximum total accumulative cable length for one interface bus may not exceed twice the number of instruments connected (in meters) , or 20 meters—whichever is less.

The instruments on the bus are connected in parallel, as shown in Figure 2. The eight data lines (DIO1 through DIO8) are used for the transfer of data and other messages in a byte-serial, bit-parallel form. The remaining eight lines are used for communications timing, control, and status information. Data is transmitted on the eight GPIB data lines as a series of eight-bit characters, referred to as bytes. Normally, seven-bit ASCII (American Standard Code for Information Interchange) code is used.

Data transfer is by means of an interlocked handshake technique (Figure 1). This technique permits asynchronous communications over a wide range of data rates. The following paragraphs provide an overview of the data and handshake buses and describe how these buses interface with the 54XXA.

2.1 IEEE-488 Hardware Interface

The IEEE-488 interface bus hardware implementation is made up of 16 signal lines that comprise three functional groups (Figure 2).

- Data Bus (8 lines)
- Data Byte Transfer Control Bus (3 lines)
- General Interface Management Bus (5 lines)

The signal lines in each of the three groups are designated according to function. Table 1 lists these designations.

Table 1. Interface Bus Signal Line Designations

BUS TYPE	SIGNAL LINE	
	Name	Function
Data Bus	DIO1– DIO8	Data Input/Output, 1 thru 8
Data Byte Transfer and Control	DAV NRFD NDAC	Data Available Not Ready For Data Not Data Accepted
General Interface Control	ATN IFC SRQ REN EOI	Attention Interface Clear Service Request Remote Enable End Or Identify

Microsoft QuickBASIC® is a registered trademark of Microsoft Corporation.

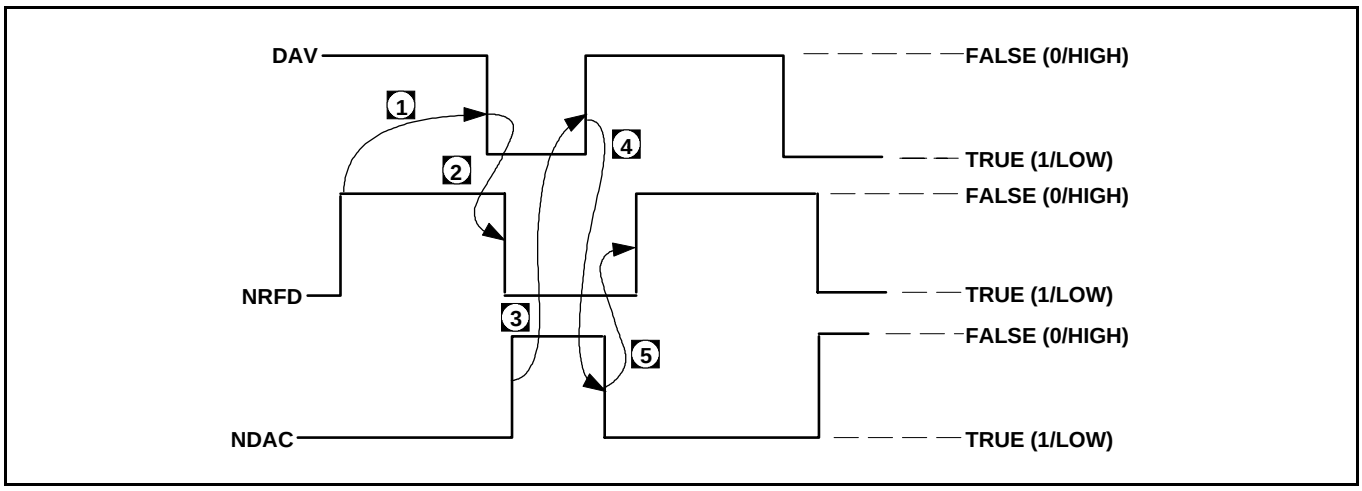


Figure 1. Typical Handshake Operation

2.2 Data Bus Description

The data bus is the conduit for transmitting data and Product Specific Commands between the external computer/controller and the 54XXA. It contains eight bi-directional, active-low signal lines—DIO 1 through DIO 8. One byte of information (eight bits) is transferred over the bus at a time. DIO 1 represents the least-significant bit (LSB) in this byte and DIO 8 represents the most-significant bit (MSB). Each byte represents a peripheral address (either primary or secondary), a control word, or a data byte. Data bytes are usually formatted in ASCII code, without parity.

2.3 Data Byte Transfer Control Bus Description

Control of information transfer on the GPIB data Bus is accomplished by a technique called the "three-wire handshake", which involves the three signal lines of the Data Byte Transfer Control Bus. This technique is described briefly below and is depicted in Figure 1. For further information, refer to the ANSI/IEEE Std 488-1978 document.

a. DAV (Data Valid)

This line goes TRUE (arrow 1) when the talker has (1) sensed that NRFD is FALSE, (2) placed a byte of data on the bus, and (3) waited an appropriate length of time for the data to settle.

b. NRFD (Not Ready For Data)

This line goes TRUE (arrow 2) when a listener indicates that valid data has not yet been accepted. The time between the events shown by arrows 1 and 2 is variable and depends upon the speed with which a listener can accept the information.

c. NDAC (Not Data Accepted)

This line goes FALSE to indicate that a listener has accepted the current data byte for internal processing. When the data byte has been accepted, the listener releases its hold on NDAC and allows the line to go FALSE. However, since the GPIB is constructed in a wired-OR configuration, NDAC will not go FALSE until all listeners participating in the interchange have also released the line. As shown by arrow 3, when NDAC goes FALSE, DAV follows suit a short time later. The FALSE state of DAV indicates that valid data has been removed; consequently, NDAC goes LOW in preparation for the next data interchange (arrow 4).

Arrow 5 shows the next action in time: NRFD going FALSE after NDAC has returned TRUE. The FALSE state of NRFD indicates that all listeners are ready for the next information interchange. The time between these last two events is variable and depends on how long it takes a listener to process the data byte. In summation, the wired-OR construction forces a talker to wait for the slowest instrument to accept the current data byte before placing a new data byte on the bus.

2.4 General Interface Management Bus Description

The General Interface Management Bus is a group of five signal lines used to control the operation of the bus system. Functional information regarding the individual control lines is provided below.

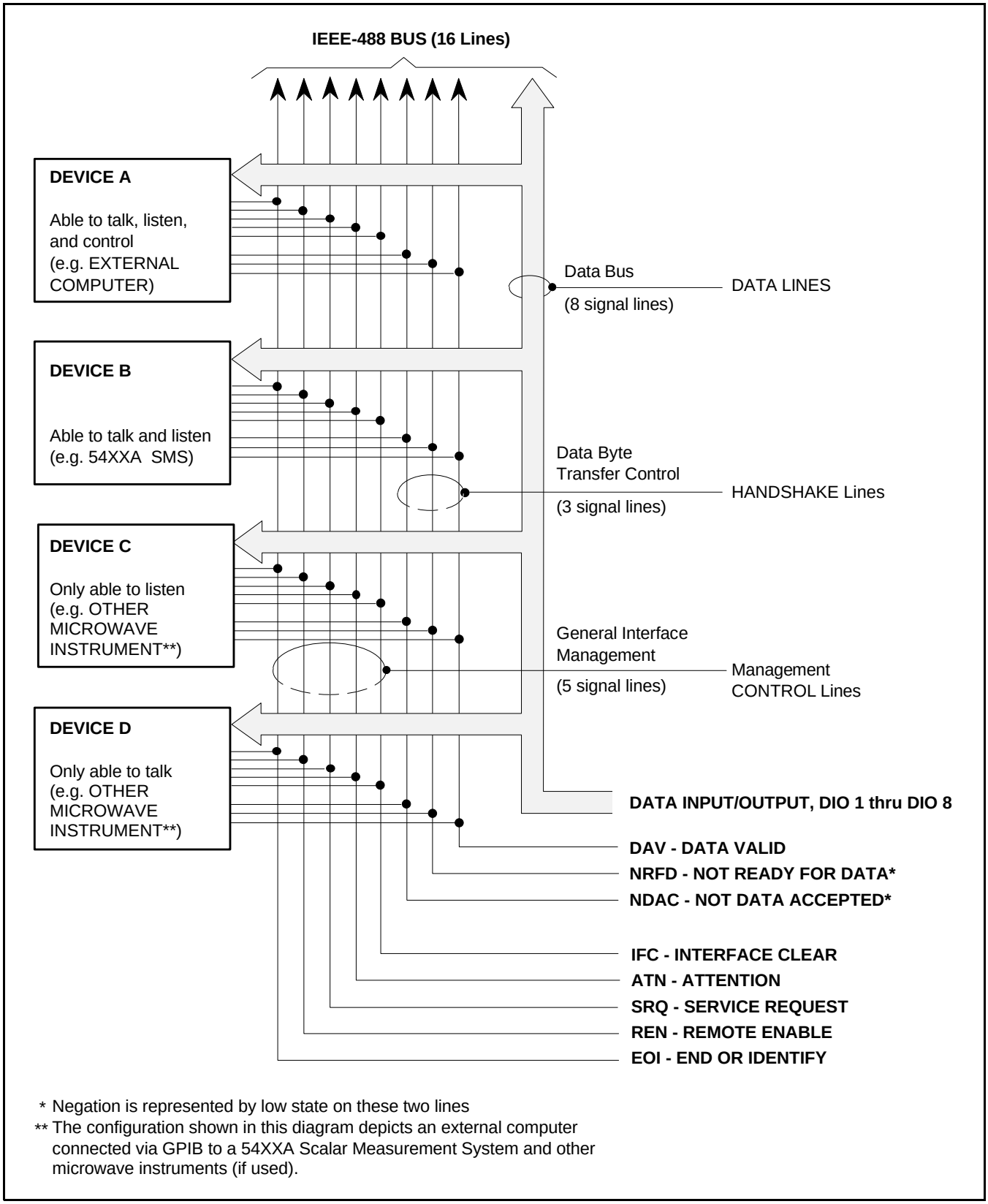


Figure 2. Interface Connections and Bus Structure

a. ATN (Attention)
When TRUE, the 54XXA responds to appropriate interface messages—such as, device clear and serial poll—and to its own listen/talk address.

b. EOI (End Or Identify)
When TRUE, the last byte of a multi-byte message has been placed on the line. Also used in conjunction with ATN to indicate a parallel poll.

c. IFC (Interface Clear)
When TRUE, the 54XXA interface functions are placed in a known state—such as, unaddressed to talk, unaddressed to listen, and service request idle.

d. REN (Remote Enable)
When TRUE, the 54XXA is enabled—upon receipt of its listen address—for entry into the remote state. The mode is exited either when the REN line goes FALSE (high) or when the 54XXA receives a go-to-local (GTL) message.

e. SRQ (Service Request)
This line is pulled LOW (true) by the 54XXA to indicate that certain pre-programmed conditions exist.

2.5 IEEE-488 Interface Functions and Protocols

The IEEE-488 standard document describes a total of 11 different possible interface functions. Each of these interface functions acts in accordance with a specific protocol defined in the standard. This set of functions and protocols define every possible manner that information and control can be passed between devices connected to the GPIB.

Specific instruments, such as the 54XXA, are implemented using only a portion, or subset, of the total set of interface functions defined by the standard. Table 2 lists the functional subset supported by the 54XXA.

2.6 IEEE-488 Message Types

There are three types of information transmitted over the GPIB:

- **IEEE-488 Interface Function Messages —** These messages are sent on the data lines and interface management lines to control the state of the interface and the manner in which it responds to commands. These messages are used to maintain control of the interface. The user generally has control over these signals; however, the extent of user control is implementation-dependent and varies with the specific hardware and software used with the external controller.
- **Product-Specific Commands —** These commands are mnemonic codes sent by the external computer to the 54XXA to control the setup and measurement operations of the 54XXA. The function and contents of these commands are not specified by the IEEE-488 standard. These commands are unique and specific to the WILTRON Model 54XXA. They are referred to as "54XXA GPIB commands" or simply "commands" throughout this manual and are described in Tables 4 through 17.

  The 54XXA GPIB commands are transmitted over the data bus of the GPIB interface to the 54XXA in the form of ASCII strings containing one or more codes. They are decoded by the *internal 54XXA controller* and cause the various measurement functions of the system to be performed. (The 54XXA GPIB interface does not decode these commands; it only acts as the transmission channel to the internal controller.)

Table 2. 54XXA GPIB Interface Function Capability

GPIB SUBSET	FUNCTION	DESCRIPTION
AH1	Acceptor Handshake	Complete Capability
SH1	Source Handshake	Complete Capability
T6	Talker	No Talk Only (TON)
TE0	Talker With Address Extension	No Capability
L4	Listener	No Listen Only (LON)
LE0	Listener With Address Extension	No Capability
SR1	Service Request	Complete Capability
RL1	Remote Local	Complete Capability
PP0	Parallel Poll	No Capability
DC1	Device Clear	Complete Capability
DT0	Device Trigger	No Capability
C0	Controller	No Capability

- Data (Messages) and Instrument Status Messages —These messages are sent by the 54XXA to the external computer via the GPIB. They contain measurement data, setup information, or system status information that the 54XXA transmits over the data bus in response to specific commands from the external computer requesting the data. The contents of these messages are specific to the 54XXA. They may be in the form of ASCII strings or binary data.

  In some cases data messages will be transmitted from the external computer to the 54XXA. For example, messages to load calibration data.

  An SRQ (service request) is an interface function message sent *from the 54XXA* to the external computer to request service from the computer, usually due to some predetermined system condition or error. To send this message, the 54XXA sets the SRQ bit of the General Interface Management Bus true and then sends a status byte on the data bus lines.

  An SRQ interface function message is also sent by the 54XXA in response to a serial poll message from the computer, or upon receiving either an OEB or OPB command. The protocols associated with the SRQ functions are defined in the ANSI/IEEE Std 488-1978 document. The 54XXA GPIB commands for these functions along with the SRQ status byte format information is contained in Tables 12, 13 and Figure 6.

The manner in which Interface Function Messages and Product-Specific Commands are invoked in programs is implementation specific for the GPIB interface used with the external computer. Even though both message types are represented by mnemonics, they are implemented and used in different ways. The GPIB interface assumed for use with the 54XXA is the National Instruments GPIB-PCII/IIA interface card and associated software. (Refer to Section II — Installation — of the Series 54XXA Scalar Measurement System Operation Manual.)

Normally, the Interface Function Messages are sent automatically by the GPIB driver software in response to invocation of a software function. For example, to send the IFC interface function message, one would call the **`ibsic`** function of the National Instruments software driver. On the other hand, the 54XXA GPIB command RST is sent in a string message to the addressed device (e.g. 54XXA). In the case of the National Instruments example, this would be done by using the **`ibwrt`** function call.

3 GPIB OPERATION

All front panel key functions (except POWER on/off) are controllable via GPIB commands. When in the REMOTE (GPIB) mode, the 54XXA functions as both a listener and a talker. The subset of GPIB functions implemented by the 54XXA GPIB interface are listed in Table 2.

3.1 Setting GPIB Interface Operating Mode

The 54XXA GPIB interface may be set to either the SYSTEM GPIB operating mode or PLOTTER ONLY mode by use of the GPIB Mode Change Menu. This menu is accessed from the System Menu and is described in Section III, along with a description of the PLOTTER ONLY mode of operation. (The SYSTEM GPIB operating mode is described in this user's guide.)

3.2 Setting 54XXA GPIB Address

The 54XXA leaves the factory with the address of the GPIB interface preset to a value of 6. A different address can be entered via the front panel RETURN TO LOCAL key. This procedure is explained in Section III.

3.3 GPIB Data Delimiting

Data used for the input and output functions of the 54XXA are terminated as follows:

a. Input Functions of the 54XXA:

- All ASCII data strings received by the 54XXA must be terminated with either LF, EOI, LF and EOI, CR LF, or CR LF and EOI.
- All binary data streams received by the 54XXA must be terminated with EOI true with the last data byte.

b. Output Functions of the 54XXA:

- Ends of all output ASCII data strings are terminated with CR LF and EOI. The EOI provides complete data termination and is sent with the LF character (Figure 9, page 45).
- Ends of all output binary data streams are terminated with EOI (End or Identify) true.
- All frequency information is output in MHz for models 5407, 5409, and 5411; it is output in GHz for all other models.

3.4 Data Input Restrictions and Notes

To initiate a GPIB command mnemonic, enter the command together with any required parameter(s). For multiple parameters, a space must be used to separate the command and each parameter. Although not required for all commands, *this usage is recommended for use with all commands.*

Several commands may be entered on one line; however, each must be separated by a valid delimiter. The recommended delimiters are the comma and the space. Other valid delimiters that may be used are the colon (:), dollar sign ($), and semicolon (;).

The following is an example of a valid command structure:

```
SI 1 A, SM 1 R, OFF 1 20 dB, GON,
CRF 1 20GHz, OCR 1
```

The command string above will cause the 54XXA to perform the following sequence:

1. Set the channel 1 signal trace to be from input A.
2. Set the measurement type to be displayed on display channel 1 to be the return loss of the test device.
3. Set the channel 1 offset to be 20 dB.
4. Turn on the graticule grid display.
5. Move the cursor to 20 GHz on the channel 1 trace.
6. Return the cursor readout for channel 1 to the controller.

3.5 Alternative 54XXA GPIB Commands

Alternative GPIB commands have been provided for some functions of the 54XXA in order to provide compatibility with controller programs written for earlier WILTRON instruments. These commands are labeled as such in the tables that contain the command descriptions. Unless required for compatibility with older programs, use of these commands should be avoided in new program applications. (The alternative commands generally do not take full advantage of the 54XXA capabilities.)

3.6 Unit Designators and Null Mnemonics

Command strings may contain the following unit designators: dB, dBm, MHz and GHz. They may be used for clarity, or may be omitted for brevity. Frequency units MHz or GHz may be specified; if not, MHz is assumed for models 5407, 5409, and 5411; GHz is assumed for all other models. These units may be abbreviated as MH and GH, respectively.

Mnemonics NUL and UUU are recognized by the 54XXA GPIB interface, but have no effect on instrument operation. These codes may be used to exercise the GPIB without disturbing the operation of the 54XXA; they are useful for debugging program problems.

3.7 Response to GPIB Command Syntax Errors

If the 54XXA is unable to execute (or does not recognize) a GPIB command or message sent by the external computer/controller, it will respond as follows:

- Bit 1 of the Primary Status Byte will be set true.
- If the SRQ function has been enabled (i.e., a "SRQ 1" command has been received), an SRQ will be sent to the external computer/controller. When the computer responds to the SRQ, the Primary Status Byte will be cleared.
- If the command is one which normally returns an output to the computer, the string 'error' will be sent instead of the normal output. (This only applies to cases 2 and 3 listed below.)

  Conditions that may cause error responses are:

  1. The command sent was not a valid 54XXA command mnemonic.
  2. The parameter(s) following the command are not within the allowed range. Example: "**CH 4 1**" received (there is no Channel 4).
  3. The parameter(s) following the command conflict with current instrument settings. Example: "**ASC 2**" received when Chan. 2 turned off.
  4. The 54XXA is sending print or plot data to a buffer and a command is received other than the following: PST, HP, RST, TST, OPB, OEB, RS, RTL, NUL.
  5. The 54XXA is in Preview Mode and a command is received other than the following: OEB, PRV, PGR, PST, RTL, or NUL.
  6. The 54XXA is performing a calibration and a command is received other than the following: CTN, CON, OEB, NUL, or RTL.
  7. The 54XXA is performing a Reset operation.

8. The external computer/controller has requested output data from the 54XXA without first sending a command to specify the output data. In this case, the 54XXA returns the string "error" to the controller.

9. Other conditions as described for the individual commands in Tables 4 through 17.

4 RECOGNIZED IEEE-488 INTERFACE FUNCTION MESSAGES

Table 3 lists the IEEE-488 Interface Function messages that are recognized and responded to by the 54XXA. The 54XXA action/response for each message is indicated.

Interface function messages are transmitted on the GPIB data lines and interface management lines as either unaddressed or addressed commands. The manner in which these messages are invoked in programs is implementation dependent. For programming information, refer to the documentation included with the GPIB Interface for the external computer used.

5 DESCRIPTIONS OF 54XXA GPIB COMMANDS

The GPIB Product-Specific commands implemented by the 54XXA are described in Tables 4 through 17. Each table contains descriptions for a specific group of commands. The Table Index on page 1 references these tables by group function and page number.

An alphabetical index of all 54XXA GPIB commands is contained in Table 18 (page 57). The page number of the table containing the command description is referenced for each command.

An example GPIB setup subroutine that is written in QuickBASIC is shown in Figure 11 (page 56). This subroutine initializes the 54XXA GPIB function and displays SRQ information on the external computer/controller display screen.

Table 3. IEEE-488 Interface Function Messages Recognized by the 54XXA

Interface Function Message*	Message Function	Addressed Command	54XXA Response
DCL	Device Clear	No	Resets the 54XXA to its default state. Sending this message is equivalent to sending the RST command.
GTL	Go to Local	Yes	Returns the instrument to local (front panel) control. (See LLO below.)
GET	Group Execute	Yes	No action.
IFC	Interface Clear	No	Stops the 54XXA GPIB interface from listening or talking. (The front panel controls are not cleared.)
LLO	Local Lockout	No	Prevents the front panel RETURN TO LOCAL key (or RTL GPIB command) from returning the instrument to local (front panel) control. Local control may be enabled using GTL message; however, any subsequent GPIB command (except DCL) will return to Local Lockout condition. The Local Lockout condition is cleared by DCL message.
REN**	Remote Enable	No	Places the instrument under remote (GPIB) if the 54XXA has been addressed to listen.
SPE#	Serial-Poll Enable	No	Requests 54XXA to output status byte to external computer.
SPD#	Serial Poll Disable	No	Disables the serial-poll function.

* These are *not* Device Specific Commands. These messages are implementation dependent — refer to the documentation included with the GPIB Interface for the external computer used.

** If the instrument is placed in remote and not supplied with program data, its operation is determined by the positions in which the front panel controls were set immediately prior to going remote.

For information about serial-poll operation, refer to the ANSI/IEEE Std 488-1978 document or to the documentation included with the GPIB Interface for the external computer used.

Table 4. Network Analyzer Display and Trace Memory Commands (1 of 5)

The following is a list of Mnemonic parameters as indicated within parenthesis:

N = 1 or 2 for channel selection
n = a number within range ±99.99
F = a frequency within range 0 to 999.9999 GHz or 0 to 9999.99 MHz. If units are omitted, MHz is assumed for Models 5407/09/11; GHz is assumed for all others.
S = 0 or 1 for ON/OFF indication (1 = ON, 0 = OFF)
o = ∗ or / for ON/OFF indication (∗ = ON, / = OFF)
M = 1 to 9, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc.
P = 0 to 400, to select pixel position
X = a variable that is defined in the descriptive text
L = limit values - see Figure 3

Parameters (n) and (F) may use 'Scientific ('E') Notation,
examples: 123.4E-3 = 0.123; 6.2e1 = 62.00
Where alternative Mnemonics exist for a function, the double equals ('==') is used to indicate exactly equivalent commands.

MNEMONIC CODE	FUNCTION	DESCRIPTION
	COMMANDS FOR DISPLAY FUNCTIONS	
SI (N)(X)	Set Input For Channel N	Selects input to be displayed on selected display channel, where X is the selected input connector (or combination): A, B, R, A/R, or B/R. EXAMPLE: "**SI2 B/R**" sets the signal ratio of (input B/ input R). This input is displayed as the Channel 2 trace.
		NOTE A syntax error will be generated if this command is received with X = R, or X = A/R, or X = B/R, and the 54XXA is not equipped with an R input (i.e, without Option 05 — refer to Section I).
SM (N)(X)	Set Channel N Display	Sets measurement type to be displayed on selected display channel. X is selected measurement type: P (Power), R (Return loss), S (SWR), T (Transmission), C (Calibration data), or M (trace Memory). EXAMPLES: "**SM2R**" sets channel 2 to display the return loss of the device under test from the selected input (see SI(N)(X)); "**SM 1 P**" sets channel 1 to display a measure of absolute power in dBm.
AP, AT, AR, ACL	Alternative Mnemonics for 'SM 1 (X)'	Sets display channel 1 to display Power, Transmission, Return Loss (from A input), or to view Cal Data, respectively. AP == SI 1 A, SM 1 P
BP, BT, BR, BCL	Alternative Mnemonics for 'SM 2 (X)'	Same as AP, AT, AR, ACL, except for display channel 2 (from B input).
CH (N)(S)	Set Channel N On/Off	Turns the selected channel on or off. S=1 for ON, S=0 for OFF. EXAMPLE: "**CH2 1**" turns display channel 2 on.

NOTE

Alternative 54XXA commands have been provided for some functions of the GPIB in order to provide compatibility with GPIB Controller programs written for earlier WILTRON instruments. These alternative commands do not generally take advantage of the full capabilities of the 5400A. (For example 'AP' sets channel 1 to measure power from input A only—from input B not possible with this command.)

Table 4. Network Analyzer Display and Trace Memory Commands (2 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
AS (o)	Alternative Mnemonic for 'CH 1 (S)'	Turn channel 1 on (*) or off(/). EXAMPLE: "**AS/**" turns display channel 1 off.
BS (o)	Alternative Mnemonic for 'CH 2 (S)'	Turn channel 2 on (*) or off(/).
RON (N) ROF (N)	Reference Line On Reference Line Off	Selects the style of the reference line indicator for channel N,(1 or 2). Following RON, the position is displayed by a chevron "<" ">" and a broken line drawn across the screen display. The default display is ROF which displays the reference line position using only the chevron "<" or ">".
REF(N)(X_{0-10})	Reference Line Position	Sets reference line to position "X" on selected channel (N), where X = 0 to 10. The top of screen is 0, bottom of screen is 10, default is 2. EXAMPLE: "**REF 1 9**" places the reference line for trace 1 at the ninth line from the top (i.e. almost at the bottom).
ADR(X_{0-10})	Alternative Mnemonic	Alternative to REF for channel 1. Reference line position is same as for REF: ADR 1 == REF 1 1.
BDR (X_{0-10})	Alternative Mnemonic	Alternative to REF for channel 2. Reference line position is same as for REF: BDR 4 == REF 2 4.
OFF (N)(n)	Offset (dB)	Sets the Offset (n) on the selected channel (N). Valid range for (n) depends on current measurement type: SWR: 1.00 to 60.00 dB or dBm: +/–99.99 EXAMPLE: "**OFF 2 -10.5 dB**" sets the trace offset on channel 2 to –10.5 dB.
AOF (n)	Alternative Mnemonic	Alternative for OFF 1 (n): AOF 1.5 == OFF 1 1.5
BOF (n)	Alternative Mnemonic	Alternative for OFF 2 (n): BOF –1.1E1 == OFF 2 –11.0
SCL (N)(X)	Resolution (scale)	Sets the Resolution Scaling for the selected channel (N), appropriate to the selected measurement type: dB or dBm: XdB / division; X = 0.1 to 10.0 in any 0.1 increment SWR: XSWR / division; X = 0.01 to 10 in 0.01 increments. EXAMPLE: "**SCL 1 .5**" sets channel 1 to 0.5 dB/Div (assuming dB mode) The signal trace is scaled about the Reference line.
ADD (X)	Alternative Mnemonic	Alternative to SCL for channel 1: ADD 3 == SCL 1 3
BDD (X)	Alternative Mnemonic	Alternative to SCL for channel 2: BDD .7 == SCL 2 0.7

Table 4. Network Analyzer Display and Trace Memory Commands (3 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
TCR (N)	Trace At Cursor to Reference Line	Automatically adjusts the offset such that the trace at the cursor is placed on the reference line for channel N. The Resolution (scale) if not changed. Valid for all measurement modes providing the cursor is on.
ASC (N)	Autoscale	Automatically adjusts the resolution and offset for channel (N) to fit the signal trace on the screen. Resolution is set to the most appropriate value on a '1,2,5' sequence. Offset will be a multiple of the selected resolution.
AA	Alternative Mnemonic	Alternative for ASC 1: AA == ASC 1
BA	Alternative Mnemonic	Alternative for ASC 2: BA == ASC 2
	USER TITLE SETUP COMMANDS	
SUT (N)('Title String')	Set User Title	Allows entry of a title string, for either channel (N), that is displayed in place of the measurement type title at the top left of the display screen. The string may be up to 12 characters in length and must be enclosed in single quotes ('). EXAMPLE: If measurement diplay title is currently "1: Transmission (A)", receipt of command **SUT 1 'Amp Output'** will change title to "1: Amp Output".
SST	Set Standard Titles	Cancels SUT command and restores the standard measurement display type titles.
	NOTE	
		User Title setups are retained by the 54XXA processor. Subsequent entry (or re-entry) of a title setup for one channel will cause a previous title setup *for the other channel* to be displayed also.
	LIMITS SETUP COMMANDS	
		Output Limits Functions Data Commands (OLT, OCH, and OCL) located in Table 15 can be used with the commands below to output limits data to the external computer.
LHI (N)(n) or LLO (N)(n)	High Limit On / Low Limit On	Sets straight line limit to (n) dB for the selected channel (N). These limits can be used as a guide to test signal trace response. Setting these limits suspends the application of any complex limits previously sent for that channel. EXAMPLE: "**LHI 2 10 dB**" Will set the high limit for channel 2 to 10 dB. The limits can be used as a guide to test signal trace response. For example, by setting Low and High limits to suitable values on channel 1, it would be easy to see if the signal trace (displayed on channel 1) of a device under test falls outside this defined range. The result (pass/fail) of these limit tests may be shown on screen (DLT), sent to the controller (OLT) or sent to the user I/O outputs (LIO).

Table 4. Network Analyzer Display and Trace Memory Commands (4 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
LHF (N)	High Limit Off	Turns High Limit off for selected channel (N).
LLF (N)	Low Limit Off	Turns Low Limit off for selected channel (N).
AH (n)(o) or AH (o)	Set Channel 1 High Limit Channel 1 High limit on/off Alternative Mnemonic	Alternative to LHI 1. o = "*" turns limit line on; o = "/" turns limit line off. "AH 32 *" == LHI 1 32. "AH /" == LHF 1. "AH 12 /" == LHF 1. The value (12) is ignored. "AH *" Turns on channel 1 high limit, using a previously entered value.
BH (n)(o)	Alternative Mnemonic	Same as AH but for channel 2.
AL (n)(o)	Alternative Mnemonic	Same as AH but for Low limit line.
BL (n)(o)	Alternative Mnemonic	Same as AL but for channel 2.
CLH (N)(L) and CLL (N)(L)	Enter Complex Limits High Enter Complex Limits Low	These commands set the complex limits for channel (N). The format for the limits string (L) is shown in Figure 3. For these commands, a space *must* be used as a delimiter between parameters (N) and (L).
CHI (N)(S)	Complex High Limit ON/OFF	Displays (S = 1) or turns off (S = 0) the High Complex Limits for channel N
CLO (N)(S)	Complex LowLimit ON/OFF	Displays (S = 1) or turns off (S = 0) the Low Complex Limits for channel N
DSI (S)	Display Segment Identifiers	If enabled (S = 1), a numeric identifier is displayed to identify each segment of complex limit lines; Disabling (S = 0) removes the identifiers.
DLT	Display Limits Test	Displays a menu that performs pass/fail testing on every sweep for pre-entered limits.
	TRACE MEMORY COMMANDS	
SVT (X_{1-4})	Save Trace Memories	Argument (X) is a number from 1 to 4 that specifies the trace memory location to which data is to be saved. Saves Trace Memories for both channels. See also setup and calibration save/ recall commands in Table 8.
RCT (X_{1-4})	Recall Trace Memories	Argument (X) is a number from 1 to 4 that specifies the Trace Memory location from which data is to be recalled. Restores both Trace Memories to current memory. This command does not cause them to be applied

NOTE: Descriptions of the general characteristics of the mnemonic parameters used in this table are located at the top of page 10.

Table 4. Network Analyzer Display and Trace Memory Commands (5 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		(see command TM). See other save/recall commands in Table 8.
TMD (N)	Load Trace Memory with signal trace data	Stores current signal trace data for channel (N) to that channel's Trace Memory.
TMH (N)	Load Trace Memory with complex high limits	Stores current Complex High Limits data for channel (N) to that channel's Trace Memory
TML (N)	Load Trace Memory with complex low limits	Stores current Complex Low Limits data for channel (N) to that channel's Trace Memory A zero value will be stored in Trace Memory for any frequency range for which a complex limit has not been defined. Where there is a gap, no change will occur when Trace Memory is subsequently applied.
TM (N)(S)	Apply /Remove Trace Memory	S = 1: Apply Trace Memory subtraction to selected channel (N) trace display. S = 0: Do not apply Trace Memory subtraction for selected channel (N) trace display. Trace memory subtrac-

NOTE: Descriptions of the general characteristics of the mnemonic parameters used in this table are located at the top of page 10.

Commands: CLH, CLL, OCH, OCL.

Bus Command: **`CLH 1 1 900MHz 4GHZ -3DB 7 DB D 2 4GHZ 6.2 7 -20.03dB d`**

The command example above sets the high values of complex limits for channel 1. Two limit segments are shown in this example. The second segment is defined but turned off. The order in which data for each segment is entered is as follows:

- Segment Number {1,10}
- Start Frequency
- Stop Frequency
- Limit Value at Start Frequency
- Limit Value at Stop Frequency
- Segment status, {D|d|S|s} D = dB or dBm, segment on; d = segment off; S = SWR, segment on; s = segment off.

The command example illustrates setting the complex limits for segments 1 and 2. For the frequency parameter, either "GHz" or "MHz" may be used; if neither is specified, MHz is assumed for models 5407, 5409, and 5411; GHz is assumed for all other models.

The "dB" mnemonic as used in the string is optional and may be used to improve readability. The command mnemonics may be in either upper or lower case, or mixed; *however, the segment status character is case-sensitive*.

Up to ten segments (1 – 10) may be specified, a complete set of segment values may be entered using a single command, or each segment may be entered individually.

The segment definitions are checked by the instrument and any overlap, where a single frequency has two different values specified by different segments, is treated as a command syntax error. (refer to paragraph 3.7).

The data is entered in an ASCII format.

Bus Command : **`OCH 1`**

EXAMPLE INSTRUMENT OUTPUT:

1	8.0000	10.0000	0.00	+15.00 D	2	10.0000	12.0000	+15.00	0.00 D
3	8.0000	8.0000	0.00	0.00 d	4	8.0000	8.0000	0.00	0.00 d
5	8.0000	8.0000	0.00	0.00 d	6	8.0000	8.0000	0.00	0.00 d
7	8.0000	8.0000	0.00	0.00 d	8	8.0000	8.0000	0.00	0.00 d
9	8.0000	8.0000	0.00	0.00 d	10	8.0000	8.0000	0.00	0.00 d

In this example, just the first two segments have been defined (for a 5428A). The instrument full band start frequency (8 GHz) appears as the default frequency for undefined segments.

Commands **OCH** and **OCL** return definitions for all 10 possible segments irrespective of how many have been explicitly defined. Undefined segments have default values and lowercase Segment Status character. All frequency information is output from models 5407, 5409, and 5411 in MHz and in GHz for all other models (regardless of input format used).

If a limit is requested with **OCH** or **OCL** when that limit is off or a Single Line Limit is currently used, the last known data or default values will be returned but all segment status characters will be lowercase (d or s).

Figure 3. Programming Example: Complex Limits

Table 5. Calibration Sequence Commands (1 of 1)

The following is a list of Mnemonic parameters as indicated within parenthesis:

N = 1 or 2 for channel selection
n = a number within range ±99.99
F = a frequency within range 0 to 999.9999 GHz or 0 to 9999.99 MHz. If units are omitted, MHz is assumed for Models 5407/09/11; GHz is assumed for all others.
S = 0 or 1 for ON/OFF indication (1 = ON, 0 = OFF)
o = ∗ or / for ON/OFF indication (∗ = ON, / = OFF)
M = 1 to 9, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc.
P = 0 to 400, to select pixel position
X = a variable that is defined in the descriptive text
L = limit values - see Figure 3

Parameters (n) and (F) may use 'Scientific ('E') Notation,
examples: 123.4E-3 = 0.123; 6.2e1 = 62.00
Where alternative Mnemonics exist for a function, the double equals ('==') is used to indicate exactly equivalent commands.

MNEMONIC CODE	FUNCTION	DESCRIPTION
CAL	Perform 54XXA Calibration	Initiates the prompted calibration sequence for the 54XXA. When a step has been completed the instrument will display a message prompting the user to set up the equipment ready for the next calibration step. It will also issue an SRQ (if SRQ is enabled and bit 2 is unmasked, i.e., 'SQ 1, PM 4'). Also, bit 2 in the Primary Status Byte will be set, indicating to the controller that the instrument is ready for a "continue" instruction (CTN or CON).
CTN	Continue Calibration	Performs sweeps as necessary to take the data for the prompted conditions and continues to the next step. Also performs an equivalent function during instrument self test.
CON	Alternative Mnemonic	CON == CTN.
DOA (n)	Detector Offset A	Offsets the measurement data by (n) dB for input A measurements without affecting the calibration data. The allowed offset range is +/– 99.9 dB. This offset is cleared by re-entering a zero value for "n". This applies to the individual input detector so it applies whether db, dBm or SWR is being measured. Note: This offset is not cleared by Reset.
DOB (n)	Detector Offset B	Same as DOA for input B.
DOR (n)	Detector Offset R	Same as DOA for input R.
DO1 (n)	Alternative Mnemonic	DO1 == DOR.

Table 6. Cursor Control, Search, and Trace Value Hold Commands (1 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
	CURSOR CONTROL COMMANDS	
	Output Cursor Readout Data Commands (OCF, OCR, etc.) located in Table 15 can be used with the commands below to output cursor readout data to the external computer.	
CF	Cursor Off	Turn cursor off (see DON and DOF).
CN	Cursor On	Turn cursor on (see DON and DOF).
CRP (P)	Move Cursor to Position P	Move cursor to position (P) on measurement trace. Range of "P" is 0 to 400, where 0 is maximum left screen position and 400 is maximum right, irrespective of number of data points currently in use. CRP 201 will place cursor one pixel (dot) right of middle.
RCP (P)	Move Reference Cursor to Position P.	Same as CRP, but for reference cursor. This is a Relative Cursor operation and requires that Relative Mode has been selected. (see "DON")
CRF (N)(F)	Move Cursor to Frequency F	Move cursor to position corresponding to frequency (F) on measurement trace (N). The cursor data readout is interpolated between actual data points, as necessary. Frequency is assumed to be in GHz, unless otherwise designated. EXAMPLE: "**CRF 1 12000 MHz**" Will move the cursor to Frequency 12.0GHz on the signal trace for channel 1.
RCF(N)(F)	Move Reference Cursor to Frequency F	Same as CRF, but for reference cursor. EXAMPLE: "**RCF 1 10**" Will move the reference cursor to Frequency 10.0 GHz on the signal trace for channel 1. This is a Relative Cursor operation and requires that this mode has been selected. (see command "DON")
XCG	Exchange Cursors	Exchanges positions of Cursor and Reference cursor.
DON	Relative Mode On	Turn relative cursor mode on. This will not override a previous CF command; if CF has been sent, cursors will not be displayed by DON until CN is sent. In Relative Cursor mode, the difference value between the Main and Reference cursors is displayed in addition to the Main cursor value. If the Main cursor is placed at a greater value than the Reference cursor, the difference value will be positive. The pseudo-unit dBr is used to designate "Relative dB". EXAMPLE: if the Reference cursor is at 10 GHz with a value of –3 dB and the Main cursor is at 12 GHz with a value of –5 dB, then the relative readings will be 2 GHz and –2 dB.
DOF	Relative Mode Off	Turn relative cursor mode off.

Table 6. Cursor Control, Search, and Trace Value Hold Commands (2 of

MNEMONIC CODE	FUNCTION	DESCRIPTION
	CURSOR SEARCH COMMANDS	
CMX(N)	Move Cursor to Max	Cursor will move to *maximum* trace value on designated measurement trace (N).
CMN(N)	Move Cursor to Minimum	Cursor will move to *minimum* trace value on designated measurement trace (N).
CMK(M_{1-8})	Move Cursor to Marker M	Move cursor to frequency marker 1 – 8, as specified. EXAMPLE: "**CMK 4**" will move the cursor to the same frequency as marker 4. Markers do not apply to the alternate frequency sweep. If the reference cursor is to be moved to marker 3, use "XCG CMK 3 XCG" to exchange cursors before and after the move.
CAM	Move Cursor to Active Marker	Move cursor to the active (last selected) frequency marker.
CLT(N)(n)	Move Cursor Left to n dB or SWR	Move cursor left of the present position on trace (N) to nearest data point that corresponds to (n) dB (or SWR). If the relative cursor is off, the search will be for an absolute value left of the cursor position. If the relative cursor is on, the search will be for a value relative to the reference cursor value. If the trace does not attain the specified search value, the cursor stays where it is and "NOT FOUND" is displayed in the Error Box (bottom right of screen). (The "NOT FOUND" error condition can be checked using the RS command; see Table 14.) EXAMPLE: "**CLT 1 12.0**" If in SWR mode, this will move the cursor left to the nearest frequency at which channel 1 measures 12 SWR. (or 12.0 dB if in dB mode). If the instrument is in Relative cursor mode and the reference cursor is at a point where the level is 4 SWR (or dB), the cursor will be moved left to a point where the level is 16 SWR (or dB).
CRT(N)(n)	Move Cursor Right to n dB	Same as CLT, but search is to right of cursor position.
CMM (N)	Cursor Search, Min/Max	Positions the reference cursor at the minimum point of trace (N) and the active cursor at the maximum point of the trace. EXAMPLE: **"CMM 2"** marks the minumum and maximum points of trace 2.
CBW(N)(n)	Cursor Bandwidth Search using (n) dB Reference	Displays the bandwidth value using dB reference (n) on trace (N). The reference cursor is positioned at the lower frequency [(n) dB point] and the main cursor at the higher frequency [(n) dB point]. The method of search is as described above (refer also to the manual mode of operation described in Section III). The frequency data can be returned to the external computer using commands ORF, OCF and ODF (Table 15).

Table 6. Cursor Control, Search, and Trace Value Hold Commands (3 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
CBM (N)(n)	Cursor Bandwidth Search From Maximum Point	Positions the reference and active cursors to the (n) dB points to the left and to the right of the maximum point of trace (N). The reference cursor will be positioned at the first occurance of the (n) dB point to the left of the maximum point, and the active cursor will be positioned at the first occurance of the (n) dB point to the right. EXAMPLE: **"CBM 1 –1.5"** marks the –1.5 dB points to the left and to the right of the maximum point of trace 1.
CLM (N)(n)	Cursor Search, Left of Maximum Point	Positions the reference cursor at the maximum point of trace (N), and the active cursor at the first occurance of the (n) dB point to the left of the maximum point. EXAMPLE: **"CLM 2 –3"** places the reference cursor on the maximum point of trace 2 and the active cursor on the first –3 dB point to the left of the maximum point.
CRM (N)(n)	Cursor Search, Right of Maximum Point	Same as command CLM, but searches to the right of the maximum point.
	NOTE 1	
	For commands CBM, CLM and CRM, value "(n)" is specified *in relation to the maximum point of the trace*; it should always be specified as negative.	
	NOTE 2	
	Output Cursor Search Data Commands (OBH, OBL, and OBW) located in Table 15 can be used with the bandwidth search commands above to output cursor search data to the external computer.	
CSR (S)	Cursor Search Repeat	Repeats the last defined cursor search operation *at the end of each sweep.* S = 1 starts cursor search repetition; S = 0 stops it. Repeated search will also be terminated by any subsequent command, *except* a Graticule on/off or Trace Hold command. EXAMPLE: **"CSR 1"** starts repeated cursor search.
CAX(S)	Set Alternate Cursor Readout	Sets the alternate cursor readout on/off, where S = 1 is on and S = 0 is off. CAX 1 will force cursor on, if it is off. CAX 1 causes cursor readout data to be displayed in the Error Box located in the lower right-hand corner of the measurement screen display (refer to Figure 3-1 in the Series 54XXA Scalar Measurement Systems Operation Manual). The readout information will be displayed only if the GPIB status indicators are turned off (command GSF) and no Warning or Error messages are currently displayed.
NOTE: Descriptions of the general characteristics of the mnemonic parameters used in this table are located at the top of page 16.		

Table 6. Cursor Control, Search, and Trace Value Hold Commands (4 of

TRACE VALUE HOLD COMMANDS		
HMX (N)	Hold Maximum Trace Values	For each succeding sweep, each point of trace (N) is updated to the maximum scalar value for that frequency so far.
HMN (N)	Hold Minimum Trace Values	Same as for command HMX, but holds the mimimum scalar values for trace (N).
HMM (N)	Hold Min/Max Trace Values	Alternately holds the maximum and mimimum scalar values for trace (N). The result is a zig-zag trace envelope display showing the minumum and maximum values of each portion of the trace.
HMF	Hold Trace Values Mode Off	This command cancels any previous HMX, HMN, or HMM command.

Table 7. Data Smoothing and Frequency Resolution Control Commands (1 of 2)

The following is a list of Mnemonic parameters as indicated within parenthesis:
N = 1 or 2 for channel selection
n = a number within range ±99.99
F = a frequency within range 0 to 999.9999 GHz or 0 to 9999.99 MHz. If units are omitted, MHz is assumed for Models 5407/09/11; GHz is assumed for all others.
S = 0 or 1 for ON/OFF indication (1 = ON, 0 = OFF)
o = ∗ or / for ON/OFF indication (∗ = ON, / = OFF)
M = 1 to 9, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc.
P = 0 to 400, to select pixel position
X = a variable that is defined in the descriptive text
L = limit values - see Figure 3

Parameters (n) and (F) may use 'Scientific ('E') Notation,
examples: 123.4E-3 = 0.123; 6.2e1 = 62.00
Where alternative Mnemonics exist for a function, the double equals ('==') is used to indicate exactly equivalent commands.

MNEMONIC CODE	FUNCTION	DESCRIPTION
DATA SMOOTHING COMMANDS		
SON (X_{0-2})	Trace Smoothing On	Controls signal trace smoothing function, where X = 0,1, or 2. When X is 0, smoothing is off; X = 1, minimum smoothing (level 1); X= 2, maximum smoothing (level 5). This function controls both measurement traces.
SOF	Trace Smoothing Off	SOF == SON 0 (Trace Smoothing off, both channels).
SMC (N)(X_{0-5})	Smoothing Channel Level	Apply smoothing level X to channel N. Level 0 will turn smoothing off for that channel; Levels 1-5 will turn smoothing on at that level. NOTE: If instrument was previously set, from the front panel controls, to 'coupled channels' at a common smoothing level, this command will set the specified channel as required and the OTHER channel will be set to its previous independent smoothing level. EXAMPLE: "**SMC 1 3 SMC 2 5**" will apply smoothing level 3 to channel 1 and smoothing level 5 to channel 2

Table 7. Data Smoothing and Frequency Resolution Control Commands (2 of 2)

MNEMONIC CODE	FUNCTION	DESCRIPTION
SMO (X_{0-2})	Alternative Mnemonic	SMO X == SON X.
SIN	Alternative Mnemonic	SIN == SON 1 (Minimum Smoothing, both channels).
SAX	Alternative Mnemonic	SAX == SON 2 (Maximum smoothing, both channels).
AVC (N)(X_{1-8})	Averaging Channel	Turns on averaging for channel N only. Averaging function (if used) on the other channel is left as it was. The number of sweeps averaged is equal to 2 raised to the power (X), where X = 1 to 8. If X = 0, averaging is turned off for that channel. EXAMPLE: **AVC 2 3** Channel 2 is averaged over 8 sweeps.
AVG (X_{1-8})	Alternative Mnemonic	Turns measurement averaging function on. The number of sweeps averaged is equal to 2 raised to the power (X), where X = 1 to 8. This command applies to both channels. AVG 4 == AVC 1 4, AVC 2 4
AVE ($X_{2,4,8,16,32,64,128,256}$)	Alternative Mnemonic	Turns measurement averaging function on. Number of averaged sweeps = (X). Valid values for X are 2, 4, 8, 16, 32, 64, 128, and 256; other values will be rounded down. This command applies to both channels. EXAMPLE: "**AVE 16**" (== AVG 4) Each display point will be the average of the last 16 measurement sweeps. This command may be followed with 'SQS 16' which will cause SRQ after 16 sweeps, when averaged data as required will be available.
AVF	Averaging Off	Turns measurement averaging function off for both channels
DATA POINT AND FREQUENCY RESOLUTION COMMANDS		
DP ($X_{1,2,4,5}$)	Set Number of Data Points	Sets the *screen display* resolution in terms of number of data points: X=1, 101 points; X=2, 201 points; X=4, 401 points. X=5, 51 points.
FDP ($X_{1,2,4,5)}$	Alternative Mnemonic	FDP X == DP X.

Table 8. System Functions Control Commands (1 of 3)

MNEMONIC CODE	FUNCTION	DESCRIPTION
DCC(S)	DC Calibration Mode Enable/Disable	Turns the DC Calibration mode on/off: DCC 1 Turns DC Calibration mode on *if in POWER measurement mode*. Auto-zero function will be disabled (see Section III). DCC 0 Re-enables normal Auto-zero operation, etc.
GON	Turn Graticule On	Turns the graticule grid display on. Lines are spaced at intervals in a sequence of 1, 2, 5, or 10 frequency units/division so that there are always between 3 and 10 vertical graticule lines on the screen.
GOF	Turn Graticule Off	Turns the graticule grid display off. Residual tick marks are displayed for reference.
GR(o)	Alternative Mnemonic	Alternative for GON/GOF: o = "∗" turns graticule display on; X = "/" turns graticule off. GR∗ == GON.
SVC(M_{1-4})	Save Setup with Calibration Data	Saves the current control panel setup together with all relevant calibration data to memory (M), where: M = 1 to 4. Saves a Store Title if one has been previosly sent with TSS (Table 11)
SVS(M_{1-9})	Save Front Panel Setup	Saves the current control panel setup to setup memory location (M), where M = 1 to 9.Saves a Store Title if one has been previously sent with TSS (Table 11)
PSS(M_{1-9})	Alternative Mnemonic	PSS M == SVS M
RCC(M_{1-4})	Recall with Calibration Data	Recalls the control panel setup from memory location (M), together with calibration data (M = 1 to 4).
RCS(M_{1-9})	Recall Setup	Recalls the control panel setup from setup memory location (M).
PSR(M)	Alternative Mnemonic	RCS M == RCS M
PRV(M_{1-9})	Preview	If M is in the range 1-9, the 54XXA will display the control panel setup from memory location (M). When Preview mode is selected, only the following functions are allowed: other Preview setups, stop print function, and print graph function (refer to paragraph 3.7, item 5). Command "PRV 0" deselects the Preview mode.
		NOTE A summary of the GPIB commands for setup and trace data save, recall and preview functions is contained in Table 9.
GSN	GPIB Status Indication On	Turns the GPIB Status Indication display on. This is the default while in Remote operation. The Status Indication uses the error/warning box at lower right of screen.
GSF	GPIB Status Indication Off	Turns the GPIB status indication display off. This restores normal display of error/warning messages (or

NOTE: Descriptions of the general characteristics of the mnemonic parameters used in this table are located at the top of page 20.

Table 8. System Functions Control Commands (2 of 3)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		"Continuous Cursor Readout" if selected) in the box at bottom right of screen during remote operation.
RST	Reset Instrument	Resets the instrument to factory default control panel settings. Will normally delete existing Calibration Data, Limits Data, and Markers, but may be configured to save these items using RSC command (below). This command does not clear detector offset values set up with DOA, DOB, or DOR commands.
RES	Alternative Mnemonic	RES == RST.
RSC(X)	Reset Configure	Configures reset function (see RST command) to save or delete Calibration Data, Limits Data, and Markers during the reset operation. The items saved or deleted are determined by the value of (X) as shown below. The X parameter may have a value of 0 to 7, as follows: 0 = Clear Calibration Data, Limits, and Markers 1 = Save Calibration Data 2 = Save Markers 3 = Save Calibration Data and Markers 4 = Save Limits 5 = Save Limits and Calibration Data 6 = Save Limits and Markers 7 = Save Calibration Data, Limits, and Markers
HCH(X_{0-3})	Hold Channel Enable	Determines which channel(s) will be held by subsequent HON or HLD commands: 0 = Neither channel 1 = Channel 1 only 2 = Channel 2 only 3 = Both channels. Default condition is "HCH 3"
HON	Hold Trace.	Holds the current data being displayed on the screen. Displayed traces may be re-scaled but no new data is taken. Applies to channels previously selected by HCH command. If no HCH (or equivalent front panel action) has been given, defaults to both channels.
HOF	Release Hold	Releases hold mode (resume measurements).
HLD(o)	Alternative Mnemonic	Alternative for HON/HOF: X = "∗" puts unit in hold mode; o = "/" returns unit to normal mode. HLD ∗ == HON HLD / == HOF
BC(S)	Blank CRT	Blanks or unblanks display screen: S = 1 blanks CRT; S = 0 restores display.
DS(o)	Alternative Mnemonic	Alternative for BC: X = "∗" blanks CRT; X = "/" restores display. DS ∗ == BC 1
INT(X)	Set Display Intensity	Sets the intensity of the measurement trace portion(s) of the display. X = 0 is minimum intensity; X = 9 is maximum.

Table 8. System Functions Control Commands (3 of 3)

MNEMONIC CODE	FUNCTION	DESCRIPTION
GIN(X)	Set Graticule Intensity	Sets the intensity of the graticule portion of the display. X = 5 sets graticule intensity equal to measurement trace intensity. X = 9 sets maximum intensity, etc.
SDX(X)	Set 54XXA GPIB Address	Sets the GPIB address of the 54XXA. Valid addresses for (X) are 0 to 30. (Use this command with caution: further addressing may fail if the program does not take the address change into account.) Default value is 6.
RTL	Return To Local	Returns the analyzer from the GPIB mode to the local mode. This command does not override the Local Lockout condition set by the LLO IEEE-488 Interface Function Message (Table 3).
SSS	Select SECURE Mode	Select SECURE mode of operation. In this mode, no frequency information is displayed on screen. The RST or RES commands are used to return to normal mode.
OSE	Output Self-test Errors	After completion of the 54XXA automatic power-up self-test, the OSE command will return a string of 47 ASCII characters that indicates the self-test results. The reporting character codes used with this command are listed below. If the self-test passes, the string will be as follows: E30 E31 E32 RAM GSP PIP NVR INT TIM KBD SIG ADC FRQ If the self-test fails, the character code of the failed function will be replaced with "XXX". A Graphics System Processor board failure would be reported as follows: E30 E31 E32 RAM **XXX** PIP NVR INT TIM KBD SIG ADC FRQ OSE Command Reporting Character Codes: E30 Eprom checksum failure, U30 on CPU board E31 Eprom checksum failure, U31 on CPU board E32 Eprom checksum failure, U32 on CPU board RAM Program (volatile) Random Access Memory failed GSP Graphics System Processor board failure PIP CPU/GSP communications pipe failure NVR Non-volatile RAM data inconsistency INT Interrupt Controller failure TIM Time slice failure KBD keyboard interface failure SIG Signal channel board not present ADC Signal channel Analog/Digital Converter failure FRQ Frequency Calibration complete (no problems) A Frequency Calibration error problem will return a number between 201 and 250 in place of "FRS". Numbers 201–222 are generated during Self Test. Numbers 223–250 are generated during normal operation, if error messages are enabled.
TST	Self-Test Instrument	

Table 9. Summary of Commands for Setup and Trace Memory Data Save, Recall and Preview Functions

Command	Function	From	To	Data	Refer to Table
SVC	Save	Current	Stores 1-4	Setup + Cal data + trace memories (both channels)	8
SVS	Save	Current	Stores 1-9	Setup	8
PSS	Save	Current	Stores 1-9	Setup (Alt. mnemonic for SVS)	8
SVT	Save	Current	Stores 1-4	Trace memories (both channels)	4
RCC	Recall	Stores 1-4	Current	Setup + Cal data + trace memories (both channels)	8
RCS	Recall	Stores 1-9	Current	Setup	8
PSR	Recall	Stores 1-9	Current	Setup (Alt. mnemonic for RCS)	8
RCT	Recall	Stores 1-4	Current	Trace memories (both channels)	4
PRV	Preview	Stores 1-9	Screen	Summary/titles	8
OSS	Output	Stores 1-9	Controller	Setup	16
OCD	Output	Current	Controller	Cal data (one channel)	16
OTM	Output	Current	Controller	Trace memory (one channel)	16
OIC	Output	Current	Controller	Interpolated Calibration Data	16
LSS	Input	Controller	Stores 1-9	Setup	16
LCD	Input	Controller	Current	Cal data (one channel)	16
LTM	Input	Controller	Current	Trace memory (one channel)	16

NOTE: Calibration Data and Trace Memories held in store locations 1-4 cannot be transferred directly to the external controller. They must first be moved from the store locations to "current" using the RCC command. Then the data for each required channel must be transferred to the external controller using OCD or OTM commands. To transfer from the external controller to store locations, use the LCD or LTM commands, followed by the SVC command.

Table 10. Frequency Source Control and Frequency Marker Commands (1 of 4)

The following is a list of Mnemonic parameters as indicated within parenthesis:

N = 1 or 2 for channel selection
n = a number within range ±99.99
F = a frequency within range 0 to 999.9999 GHz or 0 to 9999.99 MHz. If units are omitted, MHz is assumed for Models 5407/09/11; GHz is assumed for all others.
S = 0 or 1 for ON/OFF indication (1 = ON, 0 = OFF)
o = ∗ or / for ON/OFF indication (∗ = ON, / = OFF)
M = 1 to 9, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc.
P = 0 to 400, to select pixel position
X = a variable that is defined in the descriptive text
L = limit values - see Figure 3

Parameters (n) and (F) may use 'Scientific ('E') Notation,
examples: 123.4E-3 = 0.123; 6.2e1 = 62.00
Where alternative Mnemonics exist for a function, the double equals ('==') is used to indicate exactly equivalent commands.

MNEMONIC CODE	FUNCTION	DESCRIPTION
	SWEEP MODE COMMANDS	
SSM	Set Normal Sweep Mode	Sets the unit in normal sweep mode; the reverse of ALT command. Both channels sweep over the same range of frequencies.
ALT	Set Alternate Sweep mode	Sets the unit in alternate sweep mode. Channel 2 can be set to sweep over a different (alternate) range of frequencies to that for channel 1. See SAT, SAP, SAC, SAW.
SAA	Set Sweep to Alternate A/A Mode. Alternative mnemonic to ALT.	Alternate sweep mode: displays Input A using main and alternate sweep setups. The frequency limits for both sweeps are shown on the screen display. SAA == SI 1 A, SI 2 A, ALT
SAB	Set Sweep to Alternate A/B Mode. Alternative mnemonic to ALT.	Alternate sweep mode: displays Input A using main sweep setup. Also displays Input B using alternate sweep. SAB == SI 1 A, SI 2 B, ALT
		NOTE An attempt to use one of the commands above while in Trace Hold will be treated as a syntax error.
	FREQUENCY SWEEP RANGE COMMANDS	
ST (F)	Set Sweep Start Frequency	Sets the sweep start frequency to (F) GHz or MHz. If terminator is omitted, MHz is assumed for Models 5407, 5409, and 5411; GHz is assumed for all others. This command is used in conjunction with the SP (stop frequency) command. EXAMPLES: "**ST 8.4**" sets start to 8.4 GHz. "**ST2300MHz**" sets start to 2.3 GHz.
SP (F)	Set Sweep Stop Frequency	Same as ST, but for sweep stop frequency.

Table 10. Frequency Source Control and Frequency Marker Commands (2 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
SC (F)	Set Sweep Center Frequency	Sets the center frequency of sweep to (F) GHz or MHz. If terminator is omitted, MHz is assumed for Models 5407, 5409, and 5411; GHz is assumed for all others. This is the frequency about which the source frequency will be swept. This command is used in conjunction with the SW (sweep width) command.
SW (F)	Set Sweep Width Frequency	Sets the sweep width to (F) GHz or MHz This command is used in conjunction with the SC (center frequency) command.
	NOTE	
	An invalid frequency or an attempt to use one of these commands while in Trace Hold will be treated as a syntax error. CW mode can be entered by turning off both channels using the CH (N)(S) command.	
SAT(F)	Set Alternate Sweep Start Frequency	Same as ST, but for *alternate* sweep.
SAP(F)	Set Alternate Sweep Stop Frequency	Same as SP, but for *alternate* sweep.
SAC(F)	Set Alternate Sweep Center Frequency	Same as SC, but for *alternate* sweep.
SAW(F)	Set Alternate Sweep Width Frequency	Same as SW, but for *alternate* sweep.
SFB	Sweep Full Band	Sets start and stop frequencies to minimum and maximum frequency values available from frequency source for particular 54XXA model (refer to Section I, Table 1-1 of the 54XXA Operation Manual). Use this command with unit in Normal (not Alternate) Sweep mode only.
SUS(K)	Suspend Sweeping	Suspends frequency sweeping operation at end of K th sweeps, where K is ≥0≤255. K = 1 suspends sweeping at end of current sweep. K = 0 resumes sweeping.
	FREQUENCY MARKER COMMANDS	
MK (M_{1-8})(F) or	Set Frequency Marker;	Select frequency marker (M1 – M8) as active marker and set to frequency (F). If F = 0, the marker will be off. F is assumed to be in MHz for Models 5407/5409/5411; GHz is assumed for all others. A DMR 1 or DMR 2 command must precede the MK command (page 29). The last marker set is the active marker that is uniquely identified on display (refer to 54XXA Operation Manual, Section III).
MK (M_{1-8})(O)	Turn Frequency Marker On/Off	Alternate format may be used to turn markers on/off individually: O = "∗" turns marker on; O = "/" turns off. EXAMPLES: "**DMR 1 MK 2 10.2**" turns on marker number 2 and displays it at 10.2 GHz.

Table 10. Frequency Source Control and Frequency Marker Commands (3 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		"**DMR 2 MK 7 0**" (or "**MK 7 /**") turns off marker number 7 and removes it from the display.
M (M_{1-8})(F) or M (M_{1-8})(o)	Alternative Mnemonic for MK Command	Identical to command MK above; this command provides backward compatability with control programs written for Series 6400 RF Analyzers.
		NOTE "M" is not a valid abbreviation for MHZ; use mnemonic MH. Likewise, "G" is not a valid abbreviation for GHZ; use mnemonic GH.
		POWER CONTROL COMMANDS
RF(S)	Turn Output Power On/Off	"RF 0" Turns output power off; "RF 1" Turns output power on at last defined output level.
PWR(n) or PWR(o)	Set Output Power Level; Turn Output Power On/Off (Alternative Mnemonic)	Turn frequency source output power on and set output level to (n) dBm. After output level has been specified, the alternate command format may be used to turn output on/off: X = "∗" turns output power on; X = "/" turns output off. EXAMPLE: "**PWR -1**" sets output power at –1.0 dBm and turns it on if it was off. PWR / == RF 0 (turn off RF output)
ILV	Select Internal Levelling	Causes the frequency source output power to be monitored (and controlled) internally. (default condition).
ELV	Select External Levelling	Causes the frequency source output power to be levelled using the external power monitor signal (see command CLV, below). NOTE: External ALC control is provided as Option 06 to the 54XXA.
		NOTE The RS command can be used to check if the output is unleveled; see Table 14.
CLV	Rescale External Levelling Loop	Adjusts External ALC input sensitivity to suit incoming signal. (See Note with command ELV,above.) This command should be used after External Levelling has been selected and with appropriate external circuitry applying a signal to the rear panel EXTERNAL ALC connector. This command should always be followed by an RS command (Table 14) to check if an "EXT ALC UNCAL" error exists. Possible causes for this error condition are: 1. The RF output was switched off.

NOTE: Descriptions of the general characteristics of the mnemonic parameters used in this table are located at the top of page 26.

Table 10. Frequency Source Control and Frequency Marker Commands (4 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		2. The External ALC input signal amplitude is outside the specified operating range.
		FREQUENCY LOCKING CONTROL COMMANDS
RCW	Re-lock frequency in CW mode.	If both channels are Off, relocks frequency source to Start Frequency. Produces syntax error report if instrument is not in CW mode.
FLO (S)	Turn Frequency Lock Operation On/Off	Turns frequency lock operation on/off: S = 1 turns lock operation on; S = 0 turns lock operation off. Default condition is ON. With lock turned off the instrument will not maintain frequency accuracy.
HWM (o)	Select Visible Display of "Hardware" Frequency Markers	Select visible display of "Hardware" Frequency Markers on measurement display: o = "∗" produces elevated marker display; o = "/" turns marker display off. Default condition is OFF.
		NOTE This marker display is a visual guide only. Under certain conditions, not all markers will be displayed.
		The following commands have been implemented in the 54XXA GPIB command set to provide maximum backward compatibility with control programs written for Series 6400 RF Analyzers. These commands will allow some control programs written for 6400 series units to be used with 54XXA units.
DMR (o), or DMR (X)	Display Marker Readout	Displays marker frequency and readout values in the menu display area of the screen, as shown below. This command is used in conjunction with the MK command that sets up the frequency markers (page 27). DMR 1 Displays markers 1 – 4 DMR 2 Displays markers 5 – 8 DMR ∗ Displays current markers (1 – 4 or 5 – 8, depending on last use). DMR / Clears marker readout from menu area (previous menu display is restored).
FM (o)	Frequency Markers On/Off	Controls the display of frequency markers on the screen, as follows: FM ∗ Displays all defined screen frequency marker lines. FM / Removes all frequency marker lines from display. The markers retain their frequency definitions and may be restored using the "FM ∗" command.

NOTE: Descriptions of the general characteristics of the mnemonic parameters used in this table are located at the top of page 26.

Table 11. Hard Copy Output Commands (1 of

The following is a list of Mnemonic parameters as indicated within parenthesis:

N = 1 or 2 for channel selection
n = a number within range ±99.99
F = a frequency within range 0 to 999.9999 GHz or 0 to 9999.99 MHz. If units are omitted, MHz is assumed for Models 5407/09/11; GHz is assumed for all others.
S = 0 or 1 for ON/OFF indication (1 = ON, 0 = OFF)
o = ∗ or / for ON/OFF indication (∗ = ON, / = OFF)
M = 1 to 9, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc.
P = 0 to 400, to select pixel position
X = a variable that is defined in the descriptive text
L = limit values - see Figure 3

Parameters (n) and (F) may use 'Scientific ('E') Notation,
examples: 123.4E-3 = 0.123; 6.2e1 = 62.00
Where alternative Mnemonics exist for a function, the double equals ('==') is used to indicate exactly equivalent commands.

MNEMONIC CODE	FUNCTION	DESCRIPTION
PRINT COMMANDS, PGR, PG, PT, PTL, T, TMO, PST, HP.		
The data is temporarily stored in an internal buffer, and the unit is ready for a new instruction after approximately 1-12 seconds. If the buffer cannot store the amount of data requested or if the printer is not ready, the 54XXA indicates an error by setting bit 7 of primary status byte and sending a SRQ (if enabled). Refer to paragraph 3.7, item 4, (page 8) for a description of causes of print/plot process errors. Bit 0 of the Extended Status Byte indicates that a print is in progress. The printer is connected to the rear panel PARALLEL PRINTER INTERFACE connector.		
PGR	Print Graph	A pixel (dot-by-dot) plot of the measurement screen display is sent to the external printer.
PG	Alternative Mnemonic	PG == PGR.
PT(X_{0-5})	Print Tabular Data	Sends tabular measurement data to external printer, as follows: X = 0 401 data points are sent; X = 1 201 data points are sent; X = 2 101 data points are sent; X = 3 51 data points are sent; X = 4 26 data points are sent; X = 5 data at current markers only is sent Where there is currently a marker at a data point frequency, it is identified and emphasized in the table. Where a marker currently exists at another frequency, it is printed in its correct order in the table, as an additional entry. EXAMPLE: Command "**PT 4**" This will print a table of 26 equi-spaced frequencies with the corresponding measurement for each channel. If all 8 markers are currently set and they are all within the current frequency range and none of them fall at the exact frequency of any of the 26 points, there will be 8 additional lines to the table, identified as markers.

Table 11. Hard Copy Output Commands (2 of

MNEMONIC CODE	FUNCTION	DESCRIPTION
T(X)	Alternative Mnemonic	Alternative for PT, where (X) is as follows: X = 40 401 data points are sent (PT 0) X = 20 201 data points are sent (PT 1) X = 10 101 datapoints are sent (PT 2) X = 5 51 data points are sent (PT3) X = 2 26 data points are sent.(PT 4) For markers only, use TMO.
TMO	Table of Markers Only	Sends Table of markers to external printer. TMO == PT 5
PTL	Print Complex Limits	Provides a hardcopy printout of Complex Limits data.
PST	Stop Print	Stops any printing of hard copy currently in progress.
HP	Alternative Mnemonic	Halt Print. HP == PST
IDENTIFICATION STRING DEFINITIONS:		These text strings are reproduced verbatim on hardcopy outputs where used. Suggested use is as fixed labels; however, they may be used as text strings for other annotation, as needed. Maximum length of string is 12 characters (including spaces). String must be enclosed by 'single quote marks'. Refer also the SUT and SST commands in Table 4.
LID 'Ident'	Load Identification Label	Sets up an ASCII string that is used as an 'Identify' label for printer or plotter output containing header or title information. Typically it will include the name of the operator or test device serial number. EXAMPLE: **LID 'A. Wilkinson'** causes the operator's name, to be included on external printer or plotter output.
LDE 'Device'	Load Test Device Label	Same as LID, but the string forms the 'Test Device' label.
LDA 'Date'	Load Date Label	Same as LID, but the string forms the 'Date' label.
TSS 'Title'	Set Title String for Stored Setups	Same as LID, but the string is used as a DESCRIPTION in the Preview Index for stored front panel setups. For this to be used, it must be sent to the instrument before a setup is saved. EXAMPLE: **TSS 'Attenuators'** Assign title to current setup **SVS 5** Save current front panel setup in store 5

Table 11. Hard Copy Output Commands (3 of

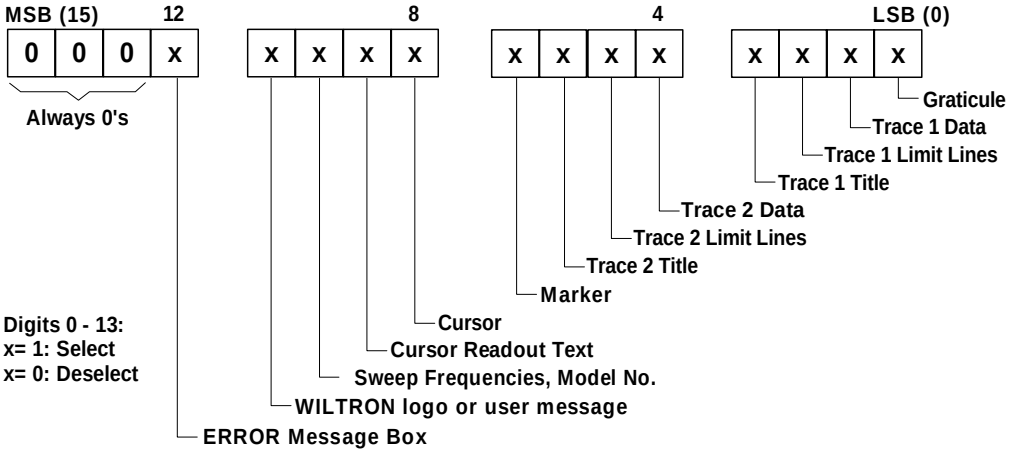
MNEMONIC CODE	FUNCTION	DESCRIPTION
PLT(X_1)(X_2)	Hardcopy Plot	This command is used to produce a plot of the 54XXA measurement screen on an external GPIB controlled plotter. To use the PLT command, control of the GPIB must be passed to the 54XXA so that it may control the plotter. Refer to the programming examples shown in Figure 4. The 54XXA will respond to a PLT command as follows: 1. After control has been passed to the 54XXA, the 54XXA will send measurement screen data to the plotter via the GPIB. The plot will be formatted as described below. 2. The 54XXA will then pass control of the GPIB back to the computer/ controller at the address specified by parameter X_1. The plot produced will be formatted as specified by the value of parameter X_2, or by the SCP command if Custom Plot is selected (X_2=6). If used, the SCP command should be sent prior to sending the PLT command. The X_2 parameter may have a value of 0 to 6, as follows: 0 = Plot All 1 = Plot Graticle and Reference Lines 2 = Plot of signal traces(s) – without color pen rotation 3 = Plot Titles only 4 = Plot Cursor only 5 = Plot of signal traces(s) – with color pen rotation 6 = Custom Plot
SCP (Mask)	Specify Custom Plot	This command configures the hardcopy plot produced using the PLT command (above). When Custom Plot is selected (X_2=6) for the PLT command, the plot setup options sent to the plotter are determined by the SCP mask parameters shown in Figure 5. The SCP command should be sent prior to sending the PLT command.

```
EXAMPLE FOR HP 85:
  10  OUTPUT 706; "PLT 21 0" @ REMARK Request plot, Return Address of contrl'r = 21
  20  PASSCONTROL 706  @ REMARK Pass control to 54XXA
  30  ENABLE INTR 7;32 @ REMARK Enable interrupt on receiving control
  40  ON INTR 7 GOTO 100
  50  GOTO 50

  100 PRINT "RECEIVED CONTROL BACK"
  110 REMARK Continue with remainder of program
  120 RESET
  999 END


EXAMPLE FOR GPIB-PC 'C' LANGUAGE
  ibwrt(,,"PLT 0,0");   /* request PLOT, return control to controller at address 0 */
  ibpc(analyzer);      /* pass control to 54XXA */
  ibwait(board0,0x20;   /* wait for control to be received back */
  */
  ** Have control back, now continue
  */
```

Figure 4. Programming Examples for PLT Command Usage

The mask that follows the SCP command mnemonic is a 16 digit ASCII string that defines which plot elements will be active in the custom plot being setup. The first three digits of this string are always zero. The remaining 13 digits turn various plot characteristics on/off, as shown below. As shown in the example, note that spaces may be inserted at any place in the string to improve program readablility.

The SCP command does not actually produce the defined plot; the next PLT command encountered in the program will produce the defined plot. The plot elements activated by the SCP command will be produced in the subsequent plot only if they are currently displayed on the 54XXA screen. Also, if measurement limits are activated by the SCP command, but have not been specified (or are not active), they will not be plotted. The SCP and PLT command mnemonics are described in Table 11.



EXAMPLE: **SCP (0000 0000 0010 0001)**

This example will setup a custom plot that will contain only a graticule, reference lines and Trace 2 limit lines.

Figure 5. SCP Command Mask Bit Assignments

Table 12. SRQ Generation and Status Commands (1 of

The following is a list of Mnemonic parameters as indicated within parenthesis:
N = 1 or 2 for channel selection
n = a number within range ±99.99
F = a frequency within range 0 to 999.9999 GHz or 0 to 9999.99 MHz. If units are omitted, MHz is assumed for Models 5407/09/11; GHz is assumed for all others.
S = 0 or 1 for ON/OFF indication (1 = ON, 0 = OFF)
o = ∗ or / for ON/OFF indication (∗ = ON, / = OFF)
M = 1 to 9, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc.
P = 0 to 400, to select pixel position
X = a variable that is defined in the descriptive text
L = limit values - see Figure 3

Parameters (n) and (F) may use 'Scientific ('E') Notation,
examples: 123.4E-3 = 0.123; 6.2e1 = 62.00
Where alternative Mnemonics exist for a function, the double equals ('==') is used to indicate exactly equivalent commands.

MNEMONIC CODE	FUNCTION	DESCRIPTION
SQ(S)	Enable/Disable SRQ	Enables or disables the SRQ generation function for the instrument: S = 0 disables SRQ function (default); S = 1 enables function.
SQS(X_{0-255})	Set Number of Sweeps for SRQ	After (X+1) number of frequency sweeps are completed by the instrument, an SRQ will be generated *if* SRQ is enabled (see above) and bit 0 is unmasked (see IPM command). The sweep counter for this function is reset to zero and sweep count recommences whenever the conditions listed in Table 13 are encountered.
NUL	Null command	Exercises GPIB bus and command system without producing any response from the instrument. May be useful with some controllers having a restricted SRQ function.
IPM(X_{0-255})	Input Mask for Primary Status Byte	Specifies an 8-bit data mask that is used to enable specified bits of the primary status byte, which is returned to the controller. The mask argument (X) is a number from 0 to 255. Figure 6 shows the mask argument decoding, the function of each bit of the status byte and the default value.
IEM(X_{0-255})	Input Mask for Extended Status Byte	Same as IPM, but for the extended status byte. See Figure 6.
CSB	Clear Primary Status Byte	Clears the primary status byte.
Q(M_{0-7})(o)	Set Primary Status Byte Mask Bit	This command is similar in function to IPM, but sets each status bit individually. It enables/ disables bits 0 – 7 of the Primary Status Mask as follows: For M = 0 – 7: o = "∗" enable bit; o = "/" sets bit to 0. EXAMPLE: **'Q 2 ∗'** unmasks bit 2 of the primary status byte (enables SQS function), **'Q 2 /'** disables it. Bit definitions associated with these commands are shown in Figure 6. Example usage of SRQ commands is shown in Figure 7.

See related commands **OEB, OPB, OSB, RS, OID**, in Table 14.

Service Request (SRQ) Generation Function

The 54XXA generates GPIB service requests (SRQs) to report instrument status and syntax errors, etc, to the external controller. When a SRQ is generated, the GPIB SRQ control line is set true (low) and the Primary Status Byte is returned to the controller on the GPIB data lines, DIO 1 thru DIO 8.

The 54XXA will generate a SRQ if:

1. The SRQ generation function has been enabled using the SQ 1 command and,
2. One (or more) of the status reporting functions listed below in Figure **a** is true and,
3. The Primary Status Byte bit associated with the true status reporting function has been *enabled* by the Primary Status Mask function (command IPM — see Figure **b**).

Primary Status Byte

Bit Assignment:	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**

Status Reporting Function	Status Byte Bit
Programmed number of sweeps have been completed	0
Syntax error encountered	1
Warning condition encountered	2
Calibration step finished	3
Not used (MAV function*)	4
Extended Status Byte contains valid information (see below)	5
Service request bit (this bit is unmaskable*)	6
Hardcopy error	7

Bit 6 of the Primary Status Byte (SRQ bit) is not maskable. It will be true for the status byte returned to the controller for all internally generated SRQ's and in response to a serial poll request.

When an SRQ is serviced by the controller, the Primary Status Byte bit(s) that caused the SRQ generation will automatically be reset. (The corresponding Primary Status *Mask* bit(s) will not.) The Primary Status Byte may be cleared at any time via the CSB command.

The contents of the Primary Status byte will also be returned to the controller in response to the OPB and OSB commands.

If the SRQ generation function is not used, the instrument status can still be be checked using the IPM, OPB, OSB and CSB commands.

Primary Status Mask Function

The IPM command sets the bits in the Primary Status Mask Byte. A true bit in this byte will enable the corresponding status reporting function in the Primary Status Byte. A false bit will disable the function. The value assigned with the IPM command designates the binary weight of all true bits. EXAMPLE:

IPM 3 enables bits 0 and 1 (binary weight 1+2) in the Primary Status Byte

Primary Status Mask Byte

Bit Assignment:	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Binary Bit Weight:	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**

Figure 6. SRQ Generation, Primary & Extended Status Byte Structures, and Masking (1 of 2)

The Primary Status Mask byte assumes a default value of binary 142 when the 54XXA is turned on. This default mask enables Primary Status Byte bits 1, 2, 3 and 7, as shown in Figure c.

Default Primary Status Mask Byte

Bit Assignment:	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
Binary Bit Weight:	**128**				**8**	**4**	**2**		**Total = 142**

Figure c

Extended Status Byte Structure

The Extended Status Byte bits always reflect the status of the instrument functions listed in Figure **d**. These bits are enabled/disabled in the same manner as the Primary Status Byte bits by the Extended Status Byte Mask command, IEM. When one (or more) of the status conditions listed below are true and the associated status bit is enabled, bit 5 of the Primary Status Byte is set true (if enabled). If SRQ's are enabled, a SRQ will be generated in the normal manner. The Extended Status Byte can then be read by the controller via the OEB command.

Extended Status Byte

Bit Assignment:	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**

Status Reporting Function	Ext'd Status Byte Bit
Print in Progress	0**
Reserved	1
Unlevelled Indicator	2†
Instrument is uncalibrated	3‡
Instrument is in Calibration mode	4‡
Instrument is in Secret mode	5‡
Instrument failed Self Test	6‡
Instrument is in Preview mode	7‡

The OEB command returns the contents of the Extended Status Byte as a binary number with a value of 0 – 255 (the status of bits 0, 1, 3, and 4 can also be obtained using the RS command).

EXAMPLE: a returned value of 34 (32+2) would indicate that the 54XXA in in the Secret mode and a plot is in progress.

The Extended Status Byte Mask byte assumes a default value of binary 251 when the 54XXA is turned on. This default mask enables all Extended Status Byte bits except bit 2 (Figure **e)**.

Default Extended Status Mask Byte

Bit Assignment:	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
Binary Bit Weight:	**128**	**64**	**32**	**16**	**8**		**2**	**1**	**Total = 251**

Figure 6. SRQ Generation, Primary & Extended Status Byte Structures, and Masking (2 of 2)

Table 13. SQS Sweep Counter Reset Conditions (1 of 1)

Condition for SQS Sweep Counter Reset	Associated GPIB Commands	Table
Receipt of SQS Command	SQS	12
Switching Channel On or Off.	CH, AS, BS	4
Change Number of Data Points	DP, FDP	7
Change Start, Stop, Centre, Width frequency	ST,SP,SC,SW,SFB	10
Change Alternate Sweep Frequency	SAT,SAP,SAC,SAW	10
Change Alternate/Standard Sweep	ALT, SSM, SAA, SAB	10
Change Averaging Conditions	AVC, AVE, AVF, AVG	7
Change Smoothing Conditions	SAX, SIN, SMC, SMO, SOF, SON	7
Change Detector Offset	DOA, DOB, DOR, DO1	5
Calibration	CAL, CON, CTN	5
Change Measurement Mode	SM, ACL, AP, AR, AT, BCL, BP, BR, BT	4
Change Input Selection	SI	4
Change Output Power Level	PWR, RF	10
Change Internal/External Levelling	ELV, ILV, CLV	10
Apply Trace Memory On/Of	TM	4
Recall stored Setup, Calibration, Trace memory	RCS, RCC, RCT	4, 8
Reset	RST, RES	8

Example Usage of SRQ Commands

Before enabling the SRQ generation function, it is necessary to set the Primary Status Mask first so that the appropriate status bits will be enabled in the Primary and Extended Status Bytes. A typical sequence of commands to perform these steps is shown in the following example:

IPM 103 103 = 01100111 binary (Enable bits 0,1,2,5 and 6 of the Primary Status Byte)
IEM 255 255 = 11111111 binary (Enabled all bits of the Extended Status Byte)
CSB (Clear all existing status bits)
SQ 1 (Enable SRQ's)

(The power-on default values for the Primary Status Byte Mask and Extended Status Byte Mask are shown in Figures **c** and **e**, respectively).

EXAMPLE USE OF OSB COMMAND: If a syntax error occurs when bit 1 of the Primary Status mask has been set (IPM 2) but before the SRQ function has been enabled ('**SQ 1**'), it is possible to check the status byte with the **OSB** command, which will return the value '2' if a syntax error has ocurred since the last time the Status Byte was cleared (**CSB**).

If the SRQ function has been enabled and the external controller has been set to respond to them, a controller response to a SRQ from the 54XXA will clear the status byte. Therefore, there is no point in using **OSB** (or **CSB)** if SRQ's are enabled.

In the above example, if the **CSB** command is omitted before the **SQ 1** command, the next occurence of an SRQ may deliver the previous status information along with current status that shows the cause of the SRQ.

Figure 7. Example Usage of SRQ Function

Table 14. Status Byte Output Commands (1 of 1)

The following is a list of Mnemonic parameters as indicated within parenthesis:

N = 1 or 2 for channel selection
n = a number within range ±99.99
F = a frequency within range 0 to 999.9999 GHz or 0 to 9999.99 MHz. If units are omitted, MHz is assumed for Models 5407/09/11; GHz is assumed for all others.
S = 0 or 1 for ON/OFF indication (1 = ON, 0 = OFF)
o = ∗ or / for ON/OFF indication (∗ = ON, / = OFF)
M = 1 to 9, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc.
P = 0 to 400, to select pixel position
X = a variable that is defined in the descriptive text
L = limit values - see Figure 3

Parameters (n) and (F) may use 'Scientific ('E') Notation,
examples: 123.4E-3 = 0.123; 6.2e1 = 62.00
Where alternative Mnemonics exist for a function, the double equals ('==') is used to indicate exactly equivalent commands.

MNEMONIC CODE	FUNCTION	DESCRIPTION
	STATUS BYTES	
OEB	Output Extended Status Byte (ASCII)	Returns an ASCII representation of the extended status byte to the controller. The returned data will be a numeric string 0 – 255. see Figure 6 (page 35) for an explanation of bit assignments.
OPB	Output Primary Status Byte	Returns the primary status byte to the controller; see Figure 6 for explanation of bit assignments.
OSB	Alternative Mnemonic	Alternative for command OPB. OSB == OPB
RS	Return Status String	Returns instrument status in a nine field ASCII data string, as shown in Figure 8.
OID	Output Identify	Returns identity string to controller, which includes model number and software version number. Output format is: "54nnA, n.nn". where "n" designates model number or software version number. Total string length is 13 characters. (Version field is padded with spaces.)

Data Format for RS Command Data String:

The RS (Return Status) command causes the current status of the 54XXA to be returned to the controller in a nine-field ASCII string. The codes contained in each of the fields are as follows:

FIELD	NAME	CODE/DESCRIPTION
1	Current Error/ Warning	Three digit error code (000–255) that identifies the current error or warning message (if error/warning condition exists). This code is identical to the error or warning message that would be displayed in the message area of the screen in the local mode of operation. (These warning messages are described in Table A-3 in the Appendix of the 54XXA Operation Manual.) The error/warning codes are cleared when the 54XXA is returned to local mode.
2	Previous Error/ Warning	Same as Field 1, but for the Error/Warning message(s) that were *last* in effect.
3	Calibrated/ Uncalibrated	"C" signifies the measurement is calibrated; "U" signifies that it is uncalibrated. The 54XXA is "uncalibrated" before any calibration sequence has been performed. If a new calibration sequence is started, it is again uncalibrated from the start of the second step to the end of the calibration sequence. This status is also reported as bit 3 of the Extended Status Byte.
4	Calibration Step in Process	"C" signifies that a calibration sequence is progress; "M" signifies that it is not. This code is set to "C" at the beginning of each calibration step. It is reset to "M" at the end of the step, thus indicating that the 54XXA is ready for a CTN command, or that the calibration sequence is complete. This status is also reported as bit 4 of the Extended Status Byte.
5	Reserved	Reserved (Currently, "M" is returned).
6	Printing	"P" signifies that data is being printed; "M" signifies that no print operation is in progress. This status is also reported as bit 0 of the Extended Status Byte.
7	RF Output Unlevelled	"U" signifies that the RF output is unlevelled; "L" signifies that the ALC function is operating normally. (External ALC operation is provided as Option 06, refer to Section I.)
8	Source Frequency Re-Lock Status	"P" signifies that source frequency relock is pending; "L" signifies that relock has been completed.
9	Sweep Counter	Three-digit number valued from 000 to 255 that indicates the number of sweeps that have occurred since the SQS sweep counter was reset. The counter is reset by the SQS command or by any of the other reset conditions listed in Table 13.

An example output string returned by command RS is shown below. Note delimiting commas:

015,015,U,C,M,M,L,123 (Current error code 015, last error code 015, uncalibrated measurement, calibration step in progress, N/A, no print in progress, re-lock completed, 123 sweeps completed since SQS counter set.)

Figure 8. Character String Format For RS Command

Table 15. ASCII Trace Data Save, Recall, and Learn Commands (1 of 5)

The following is a list of Mnemonic parameters as indicated within parenthesis:

N = 1 or 2 for channel selection
n = a number within range ±99.99
F = a frequency within range 0 to 999.9999 GHz or 0 to 9999.99 MHz. If units are omitted, MHz is assumed for Models 5407/09/11; GHz is assumed for all others.
S = 0 or 1 for ON/OFF indication (1 = ON, 0 = OFF)
o = ∗ or / for ON/OFF indication (∗ = ON, / = OFF)
M = 1 to 9, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc.
P = 0 to 400, to select pixel position
X = a variable that is defined in the descriptive text
L = limit values - see Figure 3

Parameters (n) and (F) may use 'Scientific ('E') Notation,
examples: 123.4E-3 = 0.123; 6.2e1 = 62.00
Where alternative Mnemonics exist for a function, the double equals ('==') is used to indicate exactly equivalent commands.

MNEMONIC CODE	FUNCTION	DESCRIPTION
	ASCII TRACE DATA FUNCTIONS	
		Commands requesting ASCII or binary data output from the instrument return the (ASCII) message "error" in addition to the usual SRQ response if a syntax error is detected or if the requested data is not available for some reason. (Example: if the channel for which data is requested is not switched on at the time.) The exact conditions are given with each relevant command in this table. The data formats used with these commands is shown in Figure 9 (page 45). A summary of the GPIB commands for setup and trace data save, recall and output functions (OSS, OCD, OTM, LSS, LCD and LTM) is contained in Table 9 (page 25).
OAT (N)	Output ASCII Trace Data	Returns an ASCII representation of the measurement trace data for display channel (N). Returns 101, 201, or 401 data points, according to current measurement setting. See the data format for this command shown in Figure 9 (page 45). EXCEPTION: Returns the ASCII string "error" if N is invalid or missing or channel N is off.
RAT (X)	Read 'A' Trace - Alternative Mnemonic for OAT 1.	Return Trace 1 data. Parameter (X) designates number of data points returned: X = 40 401 data points; X = 20 201 data points; X = 10 101 data points; X = 5 51 data points; X = 2 26 data points; An error condition is generated if the number of points requested exceeds the number currently used for measurement. If the number of points requested is less than the current setting, the returned points will be equally spaced to cover the whole range of measurement; EXAMPLE: "RAT 2" If instrument is set to measure at 201 points, This will return points 1, 9, 17 ,25, …, 193, and 201 from channel 1. EXCEPTION: Returns "error" if X is any other value or missing.

Table 15. ASCII Trace Data Save, Recall, and Learn Commands (2 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
RBT (X)	Read 'B' Trace - Alternative Mnemonic for OAT 2.	Same as RAT(X) but for trace 2.
LAT (N)(data string)	Learn ASCII Trace Data	The instrument receives ASCII measurement trace data string sent from the controller for channel (N). 'Data String' format is the same as for command OAT; see Figure 9 (page 45). The number of data points sent (101, 201, 401) and measurement type (T, P, R, S) should correspond to the current instrument setting; otherwise, the data will be unusable. The instrument should be placed in HOLD (mnemonic HON) before this command is used, otherwise the restored (learned) data will be immediately overwritten with new data.
RTM (N)(M_{1-8})	Read Trace at Marker	Returns the scalar value of Channel N at the current position of the specified marker M. Data format is as for command OCR. EXCEPTION: Returns "error" if N is invalid or missing, or if marker M is not on screen, or if number specified for M is invalid or is missing.
RAM (M_{1-8})	Return Trace 1 value at marker (alternative Mnemonic for RTM)	Returns the scalar value of channel 1 at the current position of the specified marker. Data format as OCR. RAM 4 == RTM 1 4
RBM (M_{1-8})	Return Trace 2 value at marker (alternative Mnemonic for RTM)	Same as RAM but for channel 2. RBM 8 == RTM 2 8
OUTPUT CURSOR READOUT DATA COMMANDS		
The following commands are used to return cursor readout data from the 54XXA to the external computer/controller. (Refer to the Cursor Control Commands in Table 6.)		
OCF (N)	Output Cursor Frequency	Returns the frequency at the current cursor position for display channel (N). The (ASCII) output format is "12.3456 GHz" Leading zeroes are replaced with spaces, example: " 0.1234 GHz". Models 5407, 5409, and 5411 return all frequency information in MHz; all others return all frequency information in GHz. EXCEPTION: Returns "error" if N is invalid or missing or channel N is off, or if the cursor is off. When the 54XXA is operated in the Secure Mode, the string containing frequency information that is returned by command OCF is replaced by the string " – – – – – – – ".
OCR (N)	Output Cursor Readout	Returns the scalar value at the current cursor position for display channel (N). The returned (ASCII) value format is "+/–12.34" or "+/–1.23" and will be in dB's, or SWR, depending on the measurement mode currently selected. EXCEPTION: Returns "error" if N is invalid or missing or channel N is off, or if the cursor is off.

Table 15. ASCII Trace Data Save, Recall, and Learn Commands (3 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
OCP	Output Cursor Position	Returns the current cursor pixel position (0 – 400). Position is defined as 0 at left edge, 400 at right edge, irrespective of current number of data points. EXCEPTION: Returns "error" if the cursor is off.
ODF (N)	Output Relative Cursor Frequency	Returns the frequency difference between the reference cursor and the main cursor for display channel (N). Data format same as OCF, except that data value will be preceded by "–" if reference cursor is at higher frequency than main cursor. EXCEPTION: Returns "error" if N is invalid or missing or channel N is off, or if the instrument is not in relative cursor mode. When the 54XXA is operated in the Secure Mode, the string containing frequency information that is returned by command ODF is replaced by the string " – – – – – – – ".
ODR (N)	Output Relative Cursor Readout	Returns the difference value between the reference cursor scalar value and the main cursor scalar value for display channel (N). Data format similar to OCR, but in dBr (see description of dBr associated with command DON in Table 6). EXCEPTION: Returns "error" if N is invalid or missing or channel N is off, or if the instrument is not in relative cursor mode.
ORF (N)	Output Reference Cursor Frequency	Returns the frequency at the current reference cursor position for display channel (N). Data format as OCF. EXCEPTION: Returns "error" if N is invalid or missing or channel N is off, or if the instrument is not in relative cursor mode. When the 54XXA is operated in the Secure Mode, the string containing frequency information that is returned by command ORF is replaced by the string " – – – – – – – ".
ORP	Output Reference Cursor Position	Same as OCP but for the reference cursor. EXCEPTION: Returns "error" if the instrument is not in relative cursor mode.
ORR (N)	Output Reference Cursor Readout	Returns the scalar value at the current reference cursor position for display channel (N). Data format as OCR. EXCEPTION: Returns "error" if N is invalid or missing or channel N is off, or if the instrument is not in relative cursor mode.

Table 15. ASCII Trace Data Save, Recall, and Learn Commands (4 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
	OUTPUT CURSOR SEARCH DATA COMMANDS	
	The following commands are used to return cursor search data from the 54XXA to the external computer/controller. (Refer to the Cursor Search Commands in Table 6.)	
OBH (N)	Output Bandwidth High	Returns the high frequency value (GHz) from a previous bandwidth search (CBW).
OBL (N)	Output Bandwidth Low	Same as for OBH but returns low frequency value.
OBW (N)	Output Bandwidth	Returns the frequency bandwidth from a previous bandwidth search (CBW). Models 5407, 5409, and 5411 return bandwidth information in MHz; all others return information in GHz. **BW = (High Frequency – Low Frequency)**
	NOTE 1	
	When the 54XXA is operated in the Secure Mode, the strings containing frequency information that are returned by commands OBH, OBL, and OBW are replaced by the string " – – – – – – – ".	
	NOTE 2	
	If a OBH, OBL, or OBW command is sent when a bandwidth search has not been previously performed, "error" is returned and an SRQ (Syntax Error) is generated (if SRQ's enabled).	
	OUTPUT LIMITS FUNCTIONS DATA COMMANDS	
	The following commands are used to return limits setup data from the 54XXA to the external computer/controller. (Refer to the Limits Setup Commands in Table 4.)	
OLT (N)	Output Limits Test Result	Returns a pass/fail indication to the controller. "PASS" is sent for pass and "FAIL" for fail; "NOT SET" is sent if no limits set. If fail, the first frequency at which failed test occurred is returned immediately following "FAIL" in the format used for OCF. EXCEPTION: Returns "error" if N is invalid or missing or channel N is off.
OCH (N)	Output Complex Limits High	Returns ASCII data string for complete complex high limit for display channel (N) to the controller. The data format used with this command is the same as used with the CLH and CLL commands (refer to Table 4 and Figure 3). EXCEPTION: Returns "error" if N is invalid or missing.
OCL (N)	Output Complex Limits Low	Same as OCH, but for complex low limit for channel (N).
	NOTE	
	When the 54XXA is operated in the Secure Mode, the strings containing frequency information that are returned by commands OCH and OCL are replaced by the string " – – – – – – – ".	
	Example (for a two-segment complex limit): 1 – – – – – – – – – – – – – – – – x.x x.x D 2 – – – – – – – – – – – – – – – – x.x x.x D	
	Where "x.x x.x D" is amplitude limit data (refer to Table 4 and to Figure 3).	

Table 15. ASCII Trace Data Save, Recall, and Learn Commands (5 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
RP (X)	Read Parameter	This command is similar to the series 6400 command, RP (X), and the read parameters (X) are almost identical to those for the series 6400 command (see table). All values are returned to the external controller as eight-character ASCII numeric strings using the digits 0–9, Decimal Point, and Space characters. The output string is terminated with a Carriage-return and Line-feed. Units are not included as part of the output strings. For convenience, the table below lists the applicable unit for each parameter. Parameters 33 and 34 (which which correspond to series 6400 "dB value of Trace A Active Marker" and "…Trace B …") are not implemented for the 54XXA, as there is no "Active Marker" function. Parameters shown as "not used" will return string "0 " (char 0, followed by seven spaces).

Param. No. (x)	Parameter Function	Applicable Units	Param No. (x)	Parameter Function	Applicable Units
1	Trace A Offset	dB	18*	Marker 5 Frequency	GHz
2	Trace B Offset	dB	19*	Marker 6 Frequency	GHz
3	Trace A Resolution	dB/Division	20*	Marker 7 Frequency	GHz
4	Trace B Resolution	dB/Division	21*	Marker 8 Frequency	GHz
5	Trace A High Limit	dB	22	– Not Used	
6	Trace A Low Limit	dB	23	– Not Used	
7	Trace B High Limit	dB	24	Output Power Level	dBm
8	Trace B Low Limit	dB	25*	ALT Sweep Start Freq	GHz
9*	Sweep Start Frequency	GHz	26*	ALT Sweep Stop Freq	GHz
10*	Sweep Stop Frequency	GHz	27*	ALT Sweep Center Freq	GHz
11*	Sweep Center Frequency	GHz	28*	ALT Sweep Width	GHz
12	Sweep Width	GHz	29	– Not Used	
13	– Not Used		30	– Not Used	
14*	Marker 1 Frequency	GHz	31*	Graticule Value	GHz/Division
15*	Marker 2 Frequency	GHz	32	No.-of-Sweeps Counter	Count
16*	Marker 3 Frequency	GHz	33	– Not Used	

Data Formats For:
ASCII Data Streams Output Commands: OAT, RAT, RBT and ASCII Data Learn (Input) Command: LAT

Data Format for OAT(N) - *Output Ascii Trace Command.*

The format for the ASCII data string returned by this command (for channel N) is as follows:

n m VAL1 VAL2 VAL3 VAL4 • • • • • • • • • • • VAL$_P$ <CR> <LF> [EOI]

Where: n = Start Character. This character specifies the number of data points contained in measurement trace as follows:
n = '4'(ASCII) for 401 data points;
n = '2' for 201 data points;
n = '1' for 101 data points.

m = measurement type designator, as listed below. If designator character is capitalized, the data is for current measurement; if lower case, it is Trace Memory data.
P = Power
R = Return loss)
S = SWR
T = Transmission
C = Calibration data
M = Trace Memory

VAL$_P$ = last data value, where P equals maximum number of data points.

The data format (ASCII) of the last value, **VAL$_P$**, is: **S X X . D D**

Where: S = sign (also used as delimiter between values);
XX = integer portion of data;
. = decimal point;
DD = decimal portion of data

The individual values are delimited (separated) by a space character. The end of the ASCII data string is designated by a <CR> <LF> and EOI true sent with LF character (0Ah). An example data string of the type produced by command OAT is shown below.

2T+10.22 +10.12 +10.02 +9.92 +9.82 . . . . . –3.37 –3.33<CR><LF>[EOI]

Data Format for* RAT(X)/RBT(X)*, Read 'A/B' Trace Command:

The format for the ASCII data string returned by this command (for trace X) is as follows:

m VAL1 VAL2 VAL3 VAL4 • • • • • • • • • • • VAL$_P$ <CR> <LF> [EOI]

Where: m = measurement type designator (see command OAT, above).

Data format (ASCII) of **VAL$_P$** (last value) is: **S X X . D D** (same as for command OAT).

The individual values are delimited (separated) by a space character.

The end of the ASCII data string is designated by a <CR> <LF> and EOI true sent with LF character (0Ah).

Data Format for* LAT(N) *, Learn Ascii Trace Command.

The data format of the ASCII string used with this command is identical to that for command OAT.

Figure 9. Data Formats for ASCII Output Data and Learn Commands (1 of 1)

Table 16. Binary Trace Data Save, Recall, Output, and Learn Commands (1 of 4)

The following is a list of Mnemonic parameters as indicated within parenthesis:

N = 1 or 2 for channel selection
n = a number within range ±99.99
F = a frequency within range 0 to 999.9999 GHz or 0 to 9999.99 MHz. If units are omitted, MHz is assumed for Models 5407/09/11; GHz is assumed for all others.
S = 0 or 1 for ON/OFF indication (1 = ON, 0 = OFF)
o = ∗ or / for ON/OFF indication (∗ = ON, / = OFF)
M = 1 to 9, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc.
P = 0 to 400, to select pixel position
X = a variable that is defined in the descriptive text
L = limit values - see Figure 3

Parameters (n) and (F) may use 'Scientific ('E') Notation,
examples: 123.4E-3 = 0.123; 6.2e1 = 62.00
Where alternative Mnemonics exist for a function, the double equals ('==') is used to indicate exactly equivalent commands.

MNEMONIC CODE	FUNCTION	DESCRIPTION

BINARY TRACE DATA COMMANDS

If the controller is expecting Binary data to be returned (OBT, OCD, OIC, OTM, etc), and an error condition is detected and reported by the 54XXA, the controller's received message buffer may be expected to include the (error) ASCII string termination characters (**0Dh,0Ah**).

The binary data "Learn Commands", LBT, LCC, LCD , LTM, and LSS, *must* be terminated using a LF or CR, LF or EOI terminator *before* the transfer of binary data is started. Any occurrence of ASCII data bytes **0Dh,0Ah** within the binary data will be ignored by these commands.

A summary of the GPIB commands for setup and trace data save, recall and output functions (OSS, OCD, OTM, LSS, LCD and LTM) is contained in Table 9 (page 25).

OBT (N)	Output Binary Trace Data	The 54XXA sends a binary representation of the measurement trace data for display channel (N) to the controller. Returns 101, 201 or 401 data points, according to the current 54XXA measurement setting. The data format for this command is shown in Figure 10 (page 50). EXCEPTION: Returns the ASCII string "error" instead of the normal data stream if N is invalid or missing, or if channel N is off.
LBT (N) (bin. data stream)	Learn Binary Trace Data	The 54XXA receives the binary trace data steam sent from the controller. The data stream contains a binary representation of the measurement trace data for display channel (N) previously received by the controller (using command OBT). The Binary Data Stream format is the same as for command OBT (Figure 10). As with command LAT, the number of data points sent and the measurement type should correspond to the current 54XXA settings.

NOTE

The 54XXA must be put in the HOLD mode (using the HON command) before receipt of the LBT command; otherwise, the restored (learned) data will be overwritten with new data. Use care when manipulating this data as it is in minimal binary form; the 54XXA is therefore unable to check it for errors or inconsistencies.

Table 16. Binary Trace Data Save, Recall, Output, and Learn Commands (2 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
OTM (N)	Output Trace Memory	Returns contents of Trace Memory for selected channel (N) to the controller. This data may be a stored measurement trace, or a trace representation of a complex limit line. Returns 101, 201 or 401 data points, according to the current instrument measurement setting. The data format used with this command is the same as that for the OCD and OIC commands. EXCEPTION: Returns the ASCII string "error" if N is invalid or missing or channel N is off.
LTM (N)T(binary data)	Learn Trace Memory	The 54XXA receives Trace Memory data stream sent from the controller for channel (N). Data format is same as for command OTM. As with LAT, the number of data points sent should equal the current instrument setting.
		NOTE Refer to Figure 10 (page 50) for descriptions of the data formats used with the commands described above.
		BINARY CALIBRATION DATA COMMANDS
OCC (N)	Output Calibration Setup Conditions	Returns binary information about the setup conditions at the time of the last calibration of Channel N. Data includes: measurement type, input, validity, number of points, start and stop frequencies, power, and offset settings. The frequencies returned are "Internal Frequencies", i.e., true output frequencies.
LCC (N)	Learn Calibration Setup Conditions	The 54XXA receives binary data stream sent from the controller. The data stream contains information for calibration setup conditions for channel (N) that were previously received by the controller using command OCC (N). This command is normally used in conjunction with command LCD (N). EXCEPTION: A syntax error is generated if Channel (N) is off, or if the number of data points received is less than that currently selected. ADDITIONAL DATA TERMINATION REQUIREMENTS: The three binary data "Learn Commands", LCC, LCD, and LSS, *must* be terminated using a LF or CR, LF or EOI terminator *before* the transfer of binary data is started. Thereafter, any occurrence of data bytes **`0Dh,0Ah`** will be treated as part of the binary data, and the transfer of that data must be terminated with and EOI. When the binary data has been properly terminated, the 54XXA reverts to the normal data termination algorithm; refer to paragraph 3.3.
		NOTE Refer to Figure 10 (page 50) for descriptions of the data formats used with the commands described above.

Table 16. Binary Trace Data Save, Recall, Output, and Learn Commands (3 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
OCD (N)	Output Calibration Data	Returns calibration trace data for the selected channel (N) and data describing calibration conditions to the controller. This is the data taken during the most recent calibration of that channel. The data returned will relate directly to current trace data *ONLY* if instrument settings (Start/Stop Frequencies, Output Power, Data Points, Input(s), etc) have not been changed since calibration. If any such changes have been made, "OIC (N)" may be more appropriate. The command OCC(N) should be used in conjunction with this command to obtain a record of relevant instrument settings at the time of calibration. Data output produced by the OCD and OCC commands may be restored with the LCD and LCC commands, respectively. (LCD should always precede LCC.) EXCEPTION: Returns the ASCII string "error" if N is invalid or missing or channel N is off.
LCD (N)(binary data)	Learn Calibration Data	The 54XXA receives the calibration data stream sent from the controller for channel (N). The Binary Data format used with this command is the same as for command OCD. Care must be exercised when manipulating this data as it is in minimal binary form; the 54XXA is therefore unable to check it for errors or inconsistencies. ADDITIONAL DATA TERMINATION REQUIREMENTS: as with other binary data "Learn Commands", this command *must* be terminated using a LF or CR, LF or EOI terminator *before* the transfer of binary data is started; refer to the LCC command.
OIC (N)	Output Interpolated Cal Data	Returns Calibration data relating to the current data points. These may have been interpolated from the actual calibration data if the frequency sweep has been reduced since the last calibration. There is no equivalent 'learn' command as these are derived data and therefore should not be re-entered. To restore a calibration condition from the controller: use commands OCD with OCC, and LCD with LCC, to cause the 54XXA to repeat the interpolation as required. This output is provided for external manipulation only. The Output (binary) data format produced in response to this command is shown in Figure 10 (page 50). NOTE: Unlike OCD, the response to this command provides only the calibration values. Data about instrument conditions must be obtained separately; e.g. command "RP 9" will return the current start frequency. EXCEPTION: Returns the ASCII string "error" if N is invalid or missing or channel N is off.

NOTE

Refer to Figure 10 (page 50) for descriptions of the data formats used with the commands described above.

Table 16. Binary Trace Data Save, Recall, Output, and Learn Commands (4 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
	BYTE ORDERING COMMANDS	
HBF (S)	High Byte First	Command HBF 1 changes the binary data transfers performed by commands OBT, LBT, OCD, LCD, OIC OTM, LTM, LCC, and OCC to transfer the high (most-significant) byte of 16 bit and 32 bit values first. Command HBF 0 reverts to the default order, which is low-byte first. This command is provided for use with computers/ controllers that expect the high-byte to be sent first. For this application the command HBF 1 should be sent at the start of the program. It will remain in effect for the binary data transfer commands listed above until a HBF 0 command is sent. The HBF command has no effect on the OSS, LSS or other Stored Setup & Limits commands.
	BINARY SETUP & LIMITS DATA FUNCTIONS	
OSS (M_{1-9})	Output Stored Front Panel Setup	Returns stored front panel setup (M) to the controller. The binary data format used with this command is shown in Figure 10 (page 50). This command is suitable ONLY for providing external storage for additional setups. It should NOT be used for amending them as this may result in unpredictable instrument operation and is not supported by WILTRON. The value of any element of this data may be established through the use of other commands. EXCEPTION: Returns "error" if M is invalid or missing.
LSS (M_{1-9})O(binary data)	Learn Stored Front Panel Setup	The instrument receives data stream for stored front panel setup (M) sent from controller. Data format is the same as for command OSS. ADDITIONAL DATA TERMINATION REQUIREMENTS: as with other binary data "Learn Commands", this command *must* be terminated using a LF or CR, LF or EOI terminator *before* the transfer of binary data is started; refer to the LCC command.

NOTE

The OSS and LSS commands are intended as a means of providing external storage of front panel setups. They are not intended for amending setup data strings stored in external memory. Any attempt to do so may result in unpredictable 54XXA operation. It is possible to correctly establish any front panel setup operation by first setting it (using appropriate GPIB commands), then outputting the complete stored setup.

NOTE: Descriptions of the general characteristics of the mnemonic parameters used in this table are located at the top of page 46.

Data Formats For:
Binary Data Streams Output Commands: OBT, OCC, OCD, OIC, OTM OSS and Binary Data Learn (Input) Commands: LBT, LCC, LCD LTM, LSS

Data Format for* OBT(N), *Output Binary Trace Command:

The format for the binary data stream returned by this command for channel (N) is described below. Refer also to Note 1 at the end of this figure for additional information concerning the data streams used with these commands.

n m BW1 BW2 BW3 BW4 • • • • • • • • • • • BW_P **[EOI]**

Where: n = Start Character. This character specifies the number of data points contained in measurement trace as follows:

n = '4'(ASCII) for 401 data points;
n = '2' for 201 data points;
n = '1' for 101 data points. The exact message length can be deduced from the value of n.
m = measurement type designator; (see command OAT in Figure 9 for values).
BW_P = last data value, where P equals maximum number of data points.

BW1 to BW_N are individual binary data signed words with data weighting factor: 1 bit = 0.004 dB (∗250).

If m = 'S' (SWR measurement) the data is expressed as an unsigned word with data weighting factor:
1 = 0.002(SWR) (∗500); allowable range is 1 to +60 (SWR)

Data is transmitted in bytes. Each word is sent as two bytes with the Least Significant Byte first (see Note 2);

EXAMPLE: bytes 77h, 01h = word 0177h = integer +375 = 1.5 dB.
bytes E7h, FFh = word FFE7h (–0019h) = integer –25 = –0.1 dB.

EXAMPLE: (for m = 'S')
bytes 34h, 21h = word 2134h = integer 8500 = 17 (SWR).

The end of the binary data stream used with this command is designated by EOI true.

Data Format for* LBT(N), *Learn Binary Trace Command:

The data format of the binary data stream used with this command is identical to that for command OBT.

Data Format for Data Output Commands:
OCD(N), Output Calibration Data
OIC(N), Output Interpolated Calibration Data Command, and
OTM(N), Output Trace Memory Data

The format for the binary data stream returned by these commands for channel (N) is as follows:

n D BW1 BW2 BW3 BW4 • • • • • • • • • • • BW_P **[EOI]**

Where: n = Start Character :This character specifies the number of data points contained in measurement trace as follows:
n = '4'(ASCII) for 401 data points;
n = '2' for 201 data points;
n = '1' for 101 data points. The exact message length can be deduced from the value of n.

D is Data Type (ASCII) character:
'I' identifies data as Interpolated Calibration Data
'M' identifies data as Trace Memory data; see Figure 9.

Figure 10. Data Formats for Binary Output Data and Learn Commands (1 of 4)

Data Format for OCD, OIC, and OTM Commands (Continued):

BW_1 to BW_N are individual binary data signed words, using the same format and data weighting as for command OBT, above.

The end of the binary data stream used with this command is designated by EOI true.

Data Format for Data Learn Commands:

LCD(N), *Learn Calibration Data, and*
LTM(N), *Learn Trace Memory Data Command*

The data format of the binary data stream used with these commands is identical to that for commands OCD, OIC, etc.

Data Format for OCC(N), Output Calibration Setup Data Command:

The format for the binary data stream returned by this command for channel (N) is as follows:

X i v <pts> <start> <stop> <power> <offset> [EOI] (This is a fixed length message of 24 data bytes.)

Where: X i v <pts> <start> <stop> <power> <offset> are eight parameters describing the conditions at the time of calibration for channel (N):

X = Measurement Type identifier (ASCII character): 'T', or 'S'.

i = Input signal connector identifier (ASCII character): 'A','B',' or R'

v = Data Valid indicator (False/True), binary data:
0 signifies that calibration data is not valid for current frequency range.
FFh (255 decimal) signifies that data is valid.

<pts> = Number of data points, binary data:
Least Significant Byte is sent first, e.g., 91h,01h (0191h) signifies 401 points (see Note 2).

<start>, <stop>, <power>, and <offset> are 32-bit (double word) binary data values each sent as four bytes with least significant byte first and most significant byte last (see Note 2):

<start> = Start Frequency, expressed in kHz.
<stop> = Stop Frequency, expressed in kHz.
EXAMPLE: 80h, 35h, BDh, 00h = 00BD3580h = 12400000 kHz = 12.4 GHz.
<power> = Output Power, expressed in μdBm.
EXAMPLE: FFF0BDC0h = –1000000 = –1 dBm

<offset> = Reserved for offset variable; currently set = 0.

The end of the binary data stream used with this command is designated by EOI true.

Data Format for* LCC(N) *, Learn Calibration Setup Data Data Command:

The data format of the binary data stream used with this command is identical to that for command OCC.

Figure 10. Data Formats for Binary Output Data and Learn Commands (2

Data Format for OSS(M), *Output Stored Front Panel Setup Command:*

The format for the binary data stream returned by this command for stored front panel setup (M) is as follows:

'O' B1 B2 B3 B4 • • • • B_P **[EOI]**

Where: O = Start Character (ASCII); identifies stream as Setup Data stream.
P = maximum number of data bytes.

B1 to B_N are individual data bytes which make up the overall structure of a stored setup. The maximum stream size is 2045 bytes (N = 2045); See Note 3 at the end of this figure. No details of the internal structure of the data bytes is provided (see note below).

NOTE

The OSS and LSS commands are intended as a means of providing external storage of front panel setups. They are not intended for amending setup data streams stored in external memory. Any attempt to do so may result in unpredictable 54XXA operation; see Table 16.

The end of the (binary) stored setup data stream is designated by EOI true.

Data Format for LSS(M), *Learn Stored Front Panel Setup Command:*

The data format of the binary data stream used with this command is identical to that for command OSS.

NOTES:

1. For OBT, OCD and OIC commands, all values are sent across the GPIB as binary integers. If a data type is intrinsically a fractional quantity (e.g., 1.24 dB) it is first multiplied by a stated weighting factor (in this case 250) to convert it to an integer, e.g., 1.24 * 250 = 310.

   The data is transferred across the GPIB interface in Bytes. Each byte consists of eight binary digits (bits) of data. These may be represented using Hexadecimal (Hex) notation (base 16). (The set of Hex digits is: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E and F; e.g., number 13 decimal is represented as '0D h' —where 'h' is the Hex base indicator). Any 8-bit byte can be represented as a 'hex pair': e.g., 3 decimal is 03h; 109 decimal is 6Dh. A single byte transfer can therefore pass any value between 00h and FFh (0 - 255 decimal).

   Most data values to be sent require more than 8 bits (data values greater than 255). For such data, **Words** which are 16 bits or **Dwords** (double words) which are 32 bits are used. These data words are sent over GPIB as a sequence of 2 or 4 bytes respectively. In each case the bytes making up a word or dword value are sent with the Least Significant Byte (LSB) first and the Most Significant Byte (MSB) last. If the data type is **signed** and if the value is negative, the Most Significant Bit (bit 15 or bit 31) is set to a logic 1 (see Note 2).

EXAMPLES: Data Type	Value	Hex Value	Bytes Sent
unsigned byte	+1	01h	01h
signed byte	+123	7Bh	7Bh
signed byte	–1	–01h	FFh
unsigned word	23456	5BA0h	A0h,5Bh
signed word	–8765	–223Dh = DDC3h	C3h,DDh
unsigned dword	100000	186A0h	A0h,86h,01h,00h
signed dword	–62	–3Eh = FFFFFFC2h	C2h,FFh,FFh,FFh

F

NOTES (Continued):

The binary data may include the value '0Ah' (ASCII Linefeed); therefore, it is not possible to use that character as an end-of-message character. The last character of the binary data stream is therefore always marked by signal EOI 'true'. The GPIB controller software must handle this situation. Normally, a convention exists for receiving such binary data transfers.

EXAMPLE:

Using an HP-85 system controller, the program routine to place the binary data in R$ from a GPIB device at address 5 is:

```
DIM R$[1000]                    Set up receive buffer
       (code):
      (code):
ENTER 705 USING "#%,#%K" ; R$   Terminate on EOI only; ignore linefeed char.
```

The program routine to transmit data (from T$) is:

```
DIM T$[1000]                    Set up transmit buffer
 IOBUFFER T$                    Required for TRANSFER
       (code):
      (code):
CONTROL 7,16 ; 128              Terminate  with EOI only
TRANSFER T$ TO 705 FHS          Use 'Fast Hand Shake'
CONTROL 7,16 ; 2,13,10          Restore normal handshake  (CR, LF)
```

2. All data formats in this figure are shown using the conventional (default) mode for byte-order transfer. This byte-order transfer is used for both transmitting data and for receiving data. This order is: Low Byte first, High Byte last.

   Commands HBF 1 and HBF 0 are provided for use with controller GPIB software that uses the reverse byte-order transfer mode. Refer to Table 16.

3. The maximum data stream size for command OSS is currently 2045 bytes. This value may possibly change in the future to reflect technical changes to the software.

Figure 10. Data Formats for Binary Output Data and Learn Commands (4 of 4)

Table 17. Measurement Applications and Miscellaneous Commands (1 of

The following is a list of Mnemonic parameters as indicated within parenthesis:

N = 1 or 2 for channel selection
n = a number within range ±99.99
F = a frequency within range 0 to 999.9999 GHz or 0 to 9999.99 MHz. If units are omitted, MHz is assumed for Models 5407/09/11; GHz is assumed for all others.
S = 0 or 1 for ON/OFF indication (1 = ON, 0 = OFF)
o = ∗ or / for ON/OFF indication (∗ = ON, / = OFF)
M = 1 to 9, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc.
P = 0 to 400, to select pixel position
X = a variable that is defined in the descriptive text
L = limit values - see Figure 3

Parameters (n) and (F) may use 'Scientific ('E') Notation,
examples: 123.4E-3 = 0.123; 6.2e1 = 62.00
Where alternative Mnemonics exist for a function, the double equals ('==') is used to indicate exactly equivalent commands.

MNEMONIC CODE	FUNCTION	DESCRIPTION
	AMPLIFIER GAIN COMPRESSION TEST COMMANDS	
GCG	Start Gain Compression Testing	Start gain compressiong testing.
GCM (n)	Set Amplifier Gain Compression Test Maximum Power	Sets maximum input power (n) for amplifier gain compression application test. Input variable (n) is in dBm. EXAMPLE: **GCM 7** Sets maximum input power for amplifier gain compression application test to +7 dBm.
GCS (n)	Set Amplifier Gain Compression Test Start Power	Sets starting input power (n) for amplifier gain compression application test. Input variable (n) is in dBm. EXAMPLE: **GCS –1.5** Sets starting input power for amplifier gain compression application test to –1.5 dBm.
	EXTERNAL VGA MONITOR SETUP COMMAND	
RGB (p)(r)(g)(b)	Set VGA Monitor Pixel Plane	Sets up the color parameters for the specified pixel plane (p) of the external VGA monitor. Where: p = pixel plane to be set up, 0 = Text; 1 or 2 = Channel; 3 = graticule. r = Red intensity, 0 to 15; 0 = off; 15 = max g = Green intensity, 0 to 15; 0 = off; 15 = max b = Blue intensity, 0 to 15; 0 = off; 15 = max EXAMPLES: RGB 0 11 1 2 Text is brown RGB 1 1 11 2 Chan 1 is bottle green RGB 3 1 1 12 Graticule is deep blue DEFAULT VALUES: RGB 0 0 15 15 Text is cyan RGB 1 15 15 0 Chan 1 is yellow RGB 2 15 0 0 Chan 2 is red RGB 3 0 15 0 Graticule is green

Table 17. Measurement Applications and Miscellaneous Commands (2 of

MNEMONIC CODE	FUNCTION	DESCRIPTION
		NOTE Spaces must be used as delimiters between values for parameters p, r, g, and b. Otherwise, the meaning of the string is ambiguous and the resulting pixel plane setup will be unpredictable.
		FREQUENCY SCALING COMMANDS
OUS	Return Frequency Scaling Parameters	Returns frequency scaling parameters to the external computer/controller (see LUS command below). The Frequency Scaling function is described in Section III. When the 54XXA is operated in the Secure Mode, the parameter containing offset frequency information that is returned by the OUS command is replaced by the string " – – – – – – – ". Example: If the following parameters are returned in the normal operating mode: 10 2 40 1 They will be as follows in the Secure Mode: 10 2 – – – – – – – 1
LUS (m)(d)(f)(S)	Learn Frequency Scaling Parameters	Inputs frequency scaling parameters listed below from the external computer/controller. Spaces *must* be used as delimiters between these parameters. m = Frequency Multiplier, an integer value, range 1 – 10; d = Frequency Divisor, an integer value, range 1 – 10; f = Frequency Offset, range 0 – ±99.9999 GHz. S = Frequency Scaling on/off. S=1 turns on Frequency Scaling using included scaling parameters. S=0 turns off frequency scaling. and: Int Freq = Real 54XXA output freq (per Table 1.1) $$User\ Freq = \frac{Int\ Freq \times m}{d} + f$$ User Freq = Frequency entered *and* displayed Where: EXAMPLES: **LUS 10 2 40 1** Causes model 5428A to display 80 – 102 GHz with a true output of 8 – 12.4 GHz.

Table 17. Measurement Applications and Miscellaneous Commands (3 of

MNEMONIC CODE	FUNCTION	DESCRIPTION
		LUS 0 0 0 0 (or **LUS 1 1 0 1)** returns frequency scaling to normal (Power-on Reset) default setting.
FCW(S)	Turn Fast CW ON/OFF	Allows fast signal channel processing when the analyzer is operating in CW sweep mode. Each measurement cycle is approximately 25 ms, which— when combined with a GPIB transfer time of 25 ms or less—gives a total update time of 50 ms. *Operation:* One measurement channel on only, with width equal to 0 MHz. Connect a detector to the active input before the mode is turned on. The mode will be disabled if, 1. The unit is returned to local, 2. A channel is turned on or off, 3. The GPIB command "FCW0" is sent, 4. Or if the unit is reset. Best results will be obtained if the unit is allowed to warm up before the mode is used. Note zeroing and locking are not active when the mode is operating. "FCW0" — Turn off Fast CW "FCW1" — Turn on Fast CW See Figure 12 for a BASIC language example of FCW programming.

54XXA GPIB SETUP/UTILITY SUBROUTINE

The programming example shown below is a subroutine written in QuickBASIC that sets up and initializes the 54XXA GPIB interface. It also displays the SRQ type for any service requests (SRQ's) on the display screen of the external computer/controller.

```
SUB SetupGPIB0

   board% = ILFIND("GPIB")                                  Find the Controller Board
   IF board% < 0 THEN PRINT "Cannot find."
   ELSE PRINT USING "#####"; board%

   DUT% = ILFIND("DEV6")                                    Find the 54XXA
   IF DUT% < 0 THEN PRINT "Cannot find."
   ELSE PRINT USING "#####"; DUT%

   PRINT "SIC - Set Interface Clear . . . . .  ";           Clear the Controller Board
   IF ILSIC(board%) <0 THEN CALL GPIBError(IBSTA%)

   IF ILCLR(DUT%) <0 THEN CALL GPIBError(IBSTA%)            Clear (Reset) Instrument
   PRINT "ON PEN....";
   ON PEN GOSUB SRQresponse                                 Set up Response Vector
   PEN ON                                                   Enable SRQ's
   PRINT "Set up done."
   PRINT

END SUB


SRQresponse                                                 This routine displays the SRQ type
                                                            on the controller display.
   SPR% = 32
   CALL IBRSP(DUT%, SPR%)
   IF SPR% > 0 THEN
      PRINT ">>> SRQ <<<";
      PRINT "code: ";SPR%
      IF SPR% > 127 THEN PRINT "- Hardcopy Fault. "; : SPR% = SPR% - 128
      IF SPR% > 63 THEN  SPR% = SPR% - 64
      IF SPR% > 31 THEN PRINT "- bit 5 error. "; : SPR% = SPR% - 32
      IF SPR% > 15 THEN PRINT "- bit 4 error. "; : SPR% = SPR% - 16
      IF SPR% > 7 THEN PRINT "- Cal Step Done. "; : SPR% = SPR% - 8
      IF SPR% > 3 THEN PRINT "- Warning Displayed. "; : SPR% = SPR% - 4
      IF SPR% > 1 THEN PRINT "- Syntax Error. "; : SPR% = SPR% - 2
      IF SPR% > 0 THEN PRINT "- Required Sweeps Completed. "; : SPR% = SPR% - 1
      CALL hesitate
      PRINT
   END IF

RETURN
```

Figure 11. Example GPIB Setup and Utility Subroutine

```
LOCATE 12, 20
PRINT "PLEASE WAIT PROGRAMME RUNNING ......"
CALL GPIBsetup  '''' Call National instrument GPIB PCB set procedure
CALL delays(2)
' ======
' SET 5400A UP
' ======
CALL ibwrt(sms%, "RST")
CALL delays(4)     '''' wait for 5400A reset.
CALL ibwrt(sms%, "CH20,SM1T") '''' Channel 2 off. Set channel 1 power
CALL delays(2)
CALL ibwrt(sms%, "SI1 A/R") '''' set ratio mode A/R.
CALL ibwrt(sms%, "DP1")       '''' Set 101 data points.

'================
' A/R CALIBRATION
'================
CALL ibwrt(sms%, "CAL") '''' Calibrate 5400A.
CALL delays(2)
CALL ibwrt(sms%, "CTN") '''' Continue Calibration
CALL delays(4)              '''' wait for cal to finish.

'==================
' 5400A SOURCE SET UP
'==================
CALL ibwrt(sms%, "SW 0")     '''' Set to width zero.

'====================================
' SET 5400A TO FAST CW MEASUREMENT MODE
'====================================
CALL ibwrt(sms%, "RF0") '''' turn the source RF off. This shows the 5400A
                        '''' cursor working very rapidly.
CALL delays(2)            '''' wait for sweep to complete and CW measurement
                        '''' mode to start.

100 ''' Line number pointer for repeating measurements
CLS
LOCATE 12, 5
CALL ibwrt(sms%, "FCW1") '''' Set CW measurement mode ON
CALL delays(1) '''' allow CW mode to settle
PRINT "PLEASE WAIT MEASUREMENT DATA BEING TAKEN ......."

'============================
' EXAMPLE OF A MEASUREMENT LOOP
'============================
FOR x = 1 TO 180
CALL ibwrt(sms%, "OCR1") '''' Ask 5400A for cursor reading
CALL read5400(cursor)       '''' Get 5400A cursor reading
cursor(x) = cursor        '''' Store measurement data for latter use
' Move antena 1 degree for next measurement.
```

Figure 12. BASIC Language Program Using the "FCW(S) Command (2 of 4)

```
DECLARE SUB noise ()
DECLARE SUB delays (Secs!)
DECLARE SUB GPIBsetup ()
DECLARE SUB read5400 (cursor)

COMMON SHARED sms%

'$INCLUDE: 'D:\work\3j\pcit\qbdecl4.bas'

DIM cursor(180)    'Measurement array

CONST false = 0, true = NOT false
ProgName$ = "5400TIME"

CLS
' ==========================
' HARDWARE SETUP INFORMATION
' ==========================
LOCATE 7, 1
PRINT "     5400 FAST CW MEASUREMENT MODE DEMO PROGRAMME"
PRINT
PRINT "                    VERSION 1.00"
PRINT
PRINT "                DATE: 28 AUGUST 1993"
CALL delays(3)
CLS

PRINT "Equipment Required"
PRINT "       "
PRINT "5400A instrument with option 5 signal channel R."
PRINT "PC with National Instrument GPIB card installed."
PRINT "Two Wiltron RF detectors."
PRINT "One power splitter."
PRINT "GPIB cables."
PRINT
PRINT "Hardware Set Up"
PRINT "      "
PRINT "1. Switch on all the test equipment"
PRINT
PRINT "2. Connect GPIB cables from the PC national GPIB card to the 5400A"
PRINT
PRINT "3. Connect a power splitter to the 5400A RF output."
PRINT
PRINT "4. Connect the two RF detectors from the RF outputs of the power splitter to"
PRINT "    the 5400A signal channel inputs A and R.
PRINT
PRINT "       Press any key to continue"
PRINT
CALL uolse JUNK$ = INPUT$(1)
CLS
```

Figure 12. BASIC Language Program Using the "FCW(S) Command (1 of 4)

```
CALL delays(.025) '''' Wait 25mS for 5400A to make a measurement
NEXT x
CALL ibwrt(sms%, "FCW0 R)
CALL delays(2)
CLS
PRINT "                                5400 MEASUREMENT DATA"
PRINT "                                ======================"
count = 1
FOR x1 = 4 TO 21
FOR y1 = 7 TO 61 STEP 6
LOCATE x1, y1
PRINT cursor(count)                    '''' Display reading on the screen
count = count + 1
NEXT y1
NEXT x1
200 ''' Line number pointer for bad input of loop below
LOCATE 23, 1
PRINT
LOCATE 23, 1
INPUT "Press R to repeat measurements or E to end programme"; JUNK$
JUNK$ = UCASE$(JUNK$)
IF JUNK$ = "E" THEN
   END ELSE
IF JUNK$ = "R" THEN
   GOTO 100
ELSE
   GOTO 200
END IF
END
SUB ack
CONST false = 0. true = NOT false
      IF ((Recycle = false) AND (NonStop = false)) THEN
            SOUND 400, 1
           INPUT "            [] to acknowledge", JUNK$
      END IF
END SUB
SUB delays (Secs)
      Seconds! = Secs
      Tstart! = TIMER
      Tend! = Seconds! + Tstart!
      WHILE TIMER  Tend!
           IF TIMER  Tstart! THEN Tend! = Tend! - 86400: Tstart! = TIMER
      WEND
END SUB

SUB GPIBsetup
        CALL IBFIND("gpib0", board%)
        CALL IBFIND("dev6", sms%)
END SUB
```

Figure 12. BASIC Language Program Using the "FCW(S)" Command (3 of 4)

```
SUB noise
        SOUND 1000, 1
END SUB

SUB read5400 (cursor)
RD$ = SPACE$(50)
CALL IBRD(sms%, RD$)
cursor = VAL(RD$)
END SUB
```

Figure 12. BASIC Language Program Using the "FCW(S) Command (4 of 4)

Table 18. Alphabetical Index to 54XXA GPIB Commands (1 of 4)

The following is a list of Mnemonic parameters as indicated within parenthesis:
N = 1 or 2 for channel selection
n = a number within range ±99.99
F = a frequency within range 0 to 999.9999 GHz or 0 to 9999.99 MHz. If units are omitted, MHz is assumed for Models 5407/09/11; GHz is assumed for all others.
S = 0 or 1 for ON/OFF indication (1 = ON, 0 = OFF)
o = ∗ or / for ON/OFF indication (∗ = ON, / = OFF)
M = 1 to 9, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc.
P = 0 to 400, to select pixel position
X = a variable that is defined in the descriptive text
L = limit values - see Figure 3
Parameters (n) and (F) may use 'Scientific ('E') Notation,
examples: 123.4E-3 = 0.123; 6.2e1 = 62.00

Table 18. Alphabetical Index to 54XXA GPIB Commands (2 of 4)

Table 18. Alphabetical Index to 54XXA GPIB Commands (3 of 4)

The following is a list of Mnemonic parameters as indicated within parenthesis:
N = 1 or 2 for channel selection
n = a number within range ±99.99
F = a frequency within range 0 to 999.9999 GHz or 0 to 9999.99 MHz. If units are omitted, MHz is assumed for Models 5407/09/11; GHz is assumed for all others.
S = 0 or 1 for ON/OFF indication (1 = ON, 0 = OFF)
o = ∗ or / for ON/OFF indication (∗ = ON, / = OFF)
M = 1 to 9, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc.
P = 0 to 400, to select pixel position
X = a variable that is defined in the descriptive text
L = limit values - see Figure 3
Parameters (n) and (F) may use 'Scientific ('E') Notation, examples: 123.4E-3 = 0.123; 6.2e1 = 62.00

Table 18. Alphabetical Index to 54XXA GPIB Commands (4 of 4)

MNEMONIC CODE	FUNCTION	PAGE NUMBER
RP (X)	Read Parameter (X)	44
RS	Output Status String	38
RSC(X)	Reset Configure	23
RST	Reset Instrument	23
RTL	Return To Local	24
RTM(N)(M_{1-8})	Read Trace at Marker	41
SAA	Set Sweep to Alternate A/A Mode	26
SAB	Set Sweep to Alternate A/B Mode	26
SAC(F)	Set Alternate Sweep Center Frequency	27
SAP(F)	Set Alternate Sweep Stop Frequency	27
SAT(F)	Set Alternate Sweep Start Frequency	27
SAW(F)	Set Alternate Sweep Width Frequency	27
SAX	Set Smoothing to Maximum, both channels	21
SC(F)	Set Sweep Center Frequency	27
SCL(N)(X)	Set (Scale) Resolution (dB/Div.), channel N	11
SCP(Mask)	Specify Custom Plot	32
SDX(X)	Set 54XXA GPIB Address	24
SFB	Sweep Full Band	27
SI(N)(X)	Set Input for channel N	10
SIN	Set Smoothing to Minimum, both channels	21
SM (N)(X)	Set Channel N Measurement Display	10
SMC(N)(X_{0-5})	Set channel N smoothing to level X	20
SMO(MX_{0-2})	Set Smoothing (Alternative for SMC)	21
SOF	Smoothing Off	20
SON(X_{0-2})	Set Smoothing Off/Min/Max	20
SP(F)	Set Sweep Stop Frequency	26
SQ(S)	Enable/Disable SRQs	34
SQS(X)	Program Number of Sweeps to SRQ	34
SSM	Set Standard (Normal) Sweep Mode	26
SSS	Select Secret Mode	24
SST	Set Standard Titles	12
ST(F)	Set Sweep Start Frequency	26
SUS(K)	Suspend Sweeping	27
SUT(N)	Set User Title	12
SVC(M_{1-4})	Save Setup With Calibration to store x	22
SVS(M_{1-9})	Save Front Panel Setup to store M	22
SVT(X_{1-4})	Save Trace Memory to store M	13
SW(F)	Set Sweep Width Frequency	27
T(X)	Print Tabular Data	31
TCR(N)	Move Trace at Cursor to Ref. Line	12
TM(N)(S)	Apply/Remove Trace Memory to Channel N	14
TMD(N)	Load Trace Memory With Signal Trace Data	14
TMH(N)	Load Trace Memory With Complex High Limits	14
TML(N)	Load Trace Memory With Complex Low Limits	14
TMO	Table Print, Markers only	31
TSS "title"	Load Setup Title for Stored Setups	31
TST	Run Instrument Self-Test Routine	24