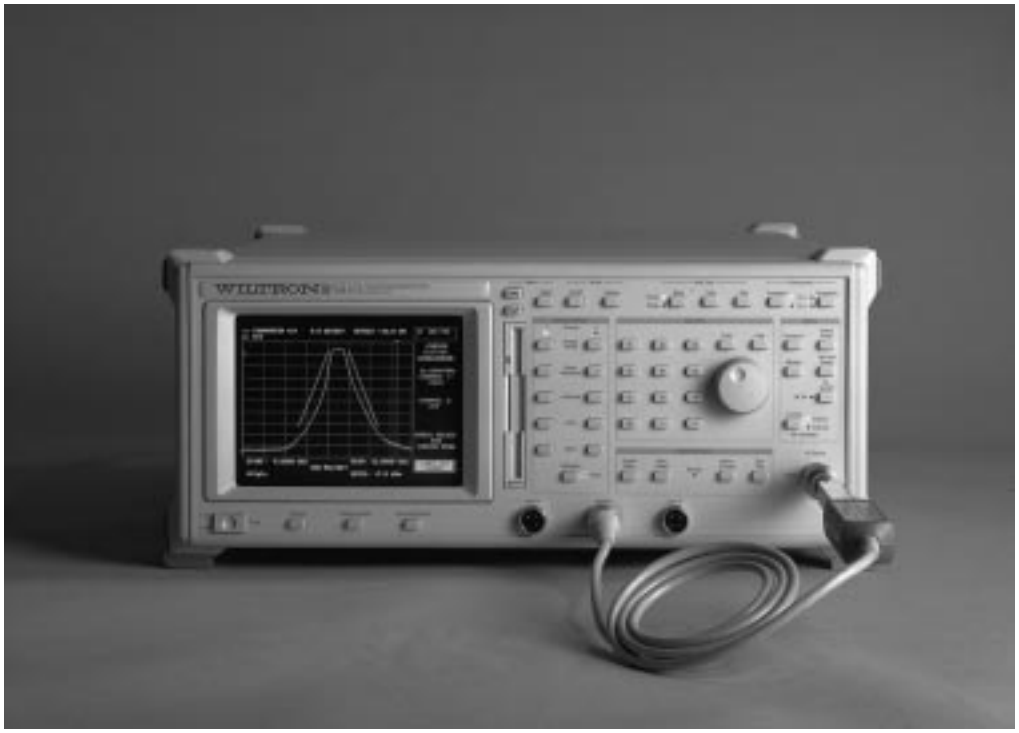
541XXA Series
Network Analyzer

GPIB USER'S GUIDE



This manual supplements the 541XXA Series Network Analyzer Operation Manual. Insert it behind the tab marked "GPIB User's Guide" in that manual.

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1. INTRODUCTION

This User's Guide provides descriptions and listings of the command mnemonics used to control the 541XXA over the IEEE 488 Bus. It also contains general descriptions of the IEEE 488 Bus, generally known as the General Purpose Interface Bus (GPIB), in its two implementations: IEEE 488.1 and IEEE 488.2.

2. ORGANIZATION

The User's Guide is organized by topics. The first eleven paragraphs provide generalized discussions on the IEEE 488 Bus. Paragraphs 12 and 13 describe 541XXA implementations of the IEEE 488 standards.

3. IEEE 488.1 BUS OVERVIEW

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

The following requirements and restrictions apply to the GPIB.

- No more than 15 devices can be interconnected by one contiguous bus; however, an instrumentation system may contain more than one interface bus.
- The maximum total cumulative cable length for one interface bus may not exceed twice the number of devices connected (in meters) , or 20 meters whichever is less.
- A maximum data rate of 1 Mb/s across the interface on any signal line.
- Each device on the interface bus must have a unique address, ranging from 00 to 30.

The devices on the GPIB are connected in parallel, as shown in Figure 1, page 6. The interface consists of 16 signal lines and 8 ground lines in a shielded cable. Eight of the signal lines are the data lines, DIO 1 through DIO 8. These data lines carry messages (data and commands), one byte at a time, among the GPIB devices. Three of the remaining lines are the handshake lines that control the transfer of message bytes between devices. The five remaining signal lines are referred to as interface management lines.

The following paragraphs provide an overview of the GPIB including a description of the functional elements, bus structure, bus data trans-

fer process, interface management bus, device interface function requirements, and message types.

4. IEEE 488 BUS FUNCTIONAL ELEMENTS

Effective communications between devices on the GPIB requires three functional elements; a talker, a listener, and a controller. Each device on the GPIB is categorized as one of these elements depending on its current interface function and capabilities.

Talker A talker is a device capable of sending device-dependent data to another device on the bus when addressed to talk. Only one GPIB device at a time can be an active talker.

Listener A listener is a device capable of receiving device-dependent data from another device on the bus when addressed to listen. Any number of GPIB devices can be listeners simultaneously.

Controller A controller is a device, usually a computer, capable of managing the operation of the GPIB. Only one GPIB device at a time can be an active controller. The active controller manages the transfer of device-dependent data between GPIB devices by designating who will talk and who will listen.

System Controller The system controller is the device that always retains ultimate control of the GPIB. When the system is first powered-up, the system controller is the active controller and manages the GPIB. The system controller can pass control to a device, making it the new active controller. The new active controller, in turn, may pass control on to yet another device. Even if it is not the active controller, the system controller maintains control of the Interface Clear (IFC) and Remote Enable (REN) interface management lines and can thus take control of the GPIB at anytime.

5. IEEE 488 BUS STRUCTURE

The GPIB uses 16 signal lines to carry data and commands between the devices connected to the bus. The interface signal lines are organized into three functional groups.

- 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	Data Available
	NRFD	Not Ready For Data
	NDAC	Not Data Accepted
General Interface Control	ATN	Attention
	IFC	Interface Clear
	SRQ	Service Request
	REN	Remote Enable
	EOI	End Or Identify

6. IEEE 488 DATA BUS DESCRIPTION

The data bus is the conduit for the transfer of data and commands between the devices on the GPIB. It contains eight bi-directional, active-low signal lines—DIO 1 through DIO 8. Data and commands are transferred over the data bus in byte-serial, bit-parallel form. This means that one byte of data (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). Bytes of data are normally formatted in seven-bit ASCII (American Standard Code for Information Interchange) code. The eighth (parity) bit is not used.

Each byte placed on the data bus represents either a command or a data byte. If the Attention (ATN) interface management line is TRUE while the data is transferred, then the data bus is carrying a bus command which is to be received by every GPIB device. If ATN is FALSE, then a data byte is being transferred and only the active listeners will receive that byte.

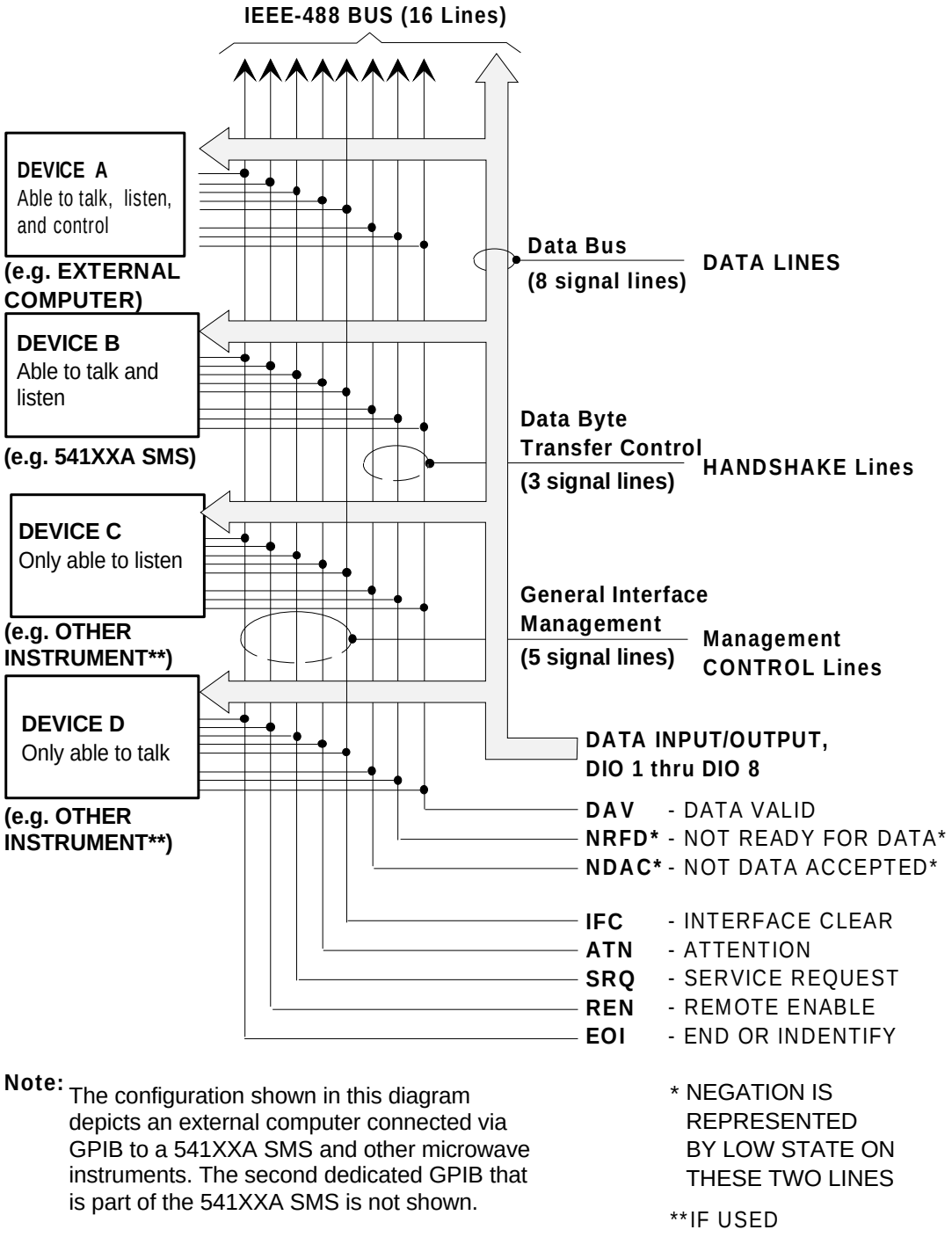


Figure 1. *Interface Connections and Bus Structure*

7. DATA BYTE TRANSFER CONTROL BUS DESCRIPTION

Control of the transfer of each byte of data on the 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 forces data transfers at the speed of the slowest listener, which ensures data integrity in multiple listener transfers. One line (DAV) is controlled by the talker, while the other two (NRFD and NDAC) are wired-OR lines shared by all active listeners. The handshake lines, like the other GPIB lines, are active low. The technique is described briefly in the following paragraphs and is depicted in Figure 2, page 10. For further information, refer to ANSI/IEEE Std 488.1.

DAV *Data Valid*

This line is controlled by the active talker. Before sending any data, the talker verifies that NDAC is TRUE (active low) which indicates that all listeners have accepted the previous data byte. The talker then places a byte on the data lines and waits until NRFD is FALSE (high), which indicates that all addressed listeners are ready to accept the information. When both NRFD and NDAC are in the proper state, the talker sets the DAV line TRUE (active low) to indicate that the data on the bus is valid (stable).

NRFD *Not Ready For Data*

This line is used by the listeners to inform the talker when they are ready to accept new data. The talker must wait for each listener to set the NRFD line FALSE (high), which they will do at their own rate. This assures that all devices that are to accept the data are ready to receive it.

NDAC *Not Data Accepted*

This line is also controlled by the listeners and is used to inform the talker that each device addressed to listen has accepted the data. Each device releases NDAC at its own rate, but NDAC will not go FALSE (high) until the slowest listener has accepted the data byte.

8. GENERAL INTERFACE MANAGEMENT BUS DESCRIPTION

The general interface management bus is a group of five signal lines used to manage the flow of information across the GPIB. A description of the function of each of the individual control lines is provided below.

ATN *Attention*
The active controller uses the ATN line to define whether the information on the data bus is a command or is data. When ATN is TRUE (low), the bus is in the command mode and the data lines carry bus commands. When ATN is FALSE (high), the bus is in the data mode and the data lines carry device-dependent instructions or data.

EOI *End or Identify*
The EOI line is used to indicate the last byte of a multibyte data transfer. The talker sets the EOI line TRUE during the last data byte.

The active controller also uses the EOI line in conjunction with the ATN line to initiate a parallel poll sequence.

IFC *Interface Clear*
Only the system controller uses this line. When IFC is TRUE (low), all devices on the bus are placed in a known, quiescent state (unaddressed to talk, unaddressed to listen, and service request idle).

REN *Remote Enable*
Only the system controller uses this line. When REN is set TRUE (low), the bus is in the remote mode and devices are addressed either to listen or to talk. When the bus is in remote and a device is addressed, it receives instructions from the GPIB rather than from its front panel. When REN is set FALSE (high), the bus and all devices return to local operation.

SRQ *Service Request*
The SRQ line is set TRUE (low) by any device requesting service by the active controller.

9. 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 541XXA, 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 541XXA.

Table 2. *541XXA GPIB Interface Function Subset Capability*

Function Identifier	Function	541XXA Capability
AH1	Acceptor Handshake	Complete Capability
SH1	Source Handshake	Complete Capability
TE0	Talker With Address Only	No Capability
T6	Talker	Complete Capability
L4	Listener	Complete Capability
LE0	Listener With Address Only	No Capability
C0	Controller	No Capability
SR1	Service Request	Complete Capability
RL1	Remote/Local	Complete Capability
PP1	Parallel Poll	Complete Capability
DC1	Device Clear	Complete Capability
DT0	Device Trigger	No Capability

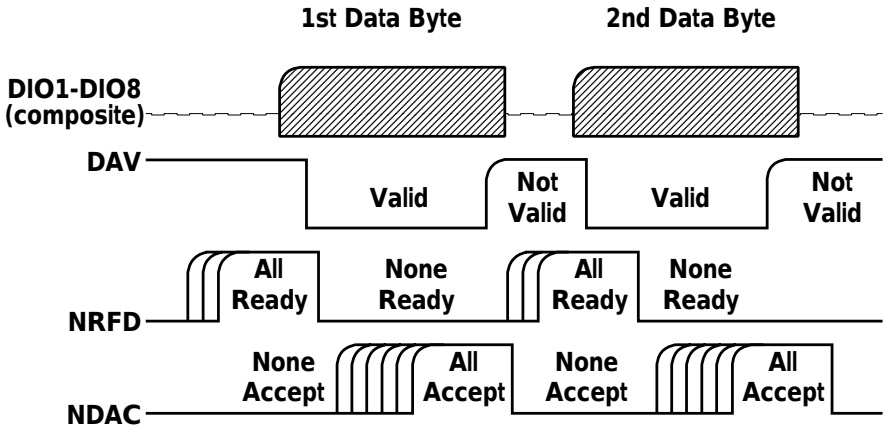


Figure 2. *Typical GPIB Handshake Operation*

10. IEEE-488-1 MESSAGE TYPES

There are three types of information transmitted over the GPIB:

IEEE 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 541XXA to control the setup and measurement operations of the 541XXA. The function and contents of these commands are not specified by the IEEE-488 standard. They are unique and specific to the ANRITSU 541XXA and are described in Table 4–19 of this manual. These commands (also referred to as "541XXA GPIB commands") are transmitted over the data bus of the GPIB interface to the 541XXA in the form of ASCII strings containing one or more codes. They are decoded by the *internal 541XXA controller* and cause the various measurement functions of the system to be performed. (The 541XXA GPIB interface does not decode these commands; it only acts as the transmission channel to the internal controller.)

Data and Instrument Status Messages

These messages are sent by the 541XXA to the external computer via the GPIB. They contain measurement data, setup information, or system status information that the 541XXA 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 541XXA. 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 541XXA. For example, messages to load calibration data.

An SRQ (service request) is an interface function message sent *from the 541XXA* to the external computer to request service from the computer, usually due to some predetermined system condition or error. To send this message, the 541XXA 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 541XXA in response to a serial poll message from the computer, or upon receiving either an OEB or OPB command from the computer. The protocols associated with the SRQ functions are defined in the ANSI/IEEE Std 488-1978 document.

The 541XXA GPIB commands for these functions along with the SRQ status byte format information is contained in Table of this user's guide.

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 Interface Function Messages normally are sent automatically by the GPIB driver software in response to invocation of a software function. For example, to send the SDC interface function message, one would call the ibclr function of the National Instruments software driver. On the other hand, the 541XXA GPIB command RST is sent in a string message to the addressed device (e.g. 541XXA). In the case of the National Instruments example, this would be done by using the ibwrt function call.

11. IEEE 488.2 MANDATED COMMANDS

The following is a listing and description of IEEE 488.2 mandated commands implemented within the 541XXA. (Command/queries not shown are not implemented, e.g., *CAL?, *DDT?, *DMC, *LRN?, *PUD, *PUD?, *RCL, *RDT, *RDT?, and *SAV.) Table 3 describes the 541XXA response to certain queries. The data input and output formats and templates, referred to throughout this User's Guide, are delimited with the less than and greater characters (< >). They are described in Table 3.

***CLS** — *Clear Status Command*

Clear the Status Byte, the Data Questionable Event Register, the Standard Event Status Register, the Standard Operation Status Register, the error queue, the OPC pending flag, and any other registers that are summarized in the Status Byte.

***ESE** *(Standard Event Status Enable Command)*
Sets the Standard Event Status Enable Register bits.

***ESE?** *(Standard Event Status Enable Query)*
Queries the value of the Standard Event Status Enable Register.

***ESR?** *Standard Event Status Register Query*
Queries the value of the Standard Event Status Register. This is a destructive read.

***IDN?** *Identification Query*
This query returns an identifying string to the GPIB. The response will be in the following format: ANRITSU, model, serial number, firmware level; where the actual model number, serial number, and firmware version of the 541XXA queried will be passed.

***IST?** *Individual Status Query*
This query command is sent by the 541XXA in response to a parallel poll. It outputs the value of the IST without having to perform a parallel poll. This output value is 1 if IST is TRUE and 0 it it is FALSE.

***OPC** *Operation Complete Command*
The 541XXA will generate the OPC message in the Standard Event Status Register when all pending operations have finished (such as frequency sweep or power sweep).

***OPC?** *Operation Complete Query*
The 541XXA returns an ASCII 1 when all pending operations have finished.

***PRE?** *Set Parallel Poll Enable Register*
Sets the bits of the Parallel Poll Enable Register to the binary weighted bit pattern of the decimal value entered. The register is cleared by sending a value of 0.

***RST** *Reset Command*
The 541XXA sweep generator is set to a predefined condition. 541XXA is compliant with mandated power-on reset conditions.

***SRE** *Service Request Enable Command*
Sets the Service Request Enable Resister bits.

***SRE?** — *Service Request Enable Query*
Queries the value of the Service Request Enable Register.

***STB?** — *Read Status Byte Query*
Queries the Status Byte. This is a non-destructive read.

***TST?** — *Self-Test Query*
A full internal self-test of the 541XXA instrument is performed and returns one of the following error codes:

0 = Self Test Passed, No Errors
1 = Program RAM (volatile) Failure
2 = Graphics Processor Failure
4 = CPU/GSP Communications Failure
8 = Non-Volatile RAM Failure
16 = Interrupt Controller Failure
32 = Time Slice Failure
64 = Keyboard Interface Failure
128 - Signal Channel PCB Not Fitted
256 = Signal Channel ADC Failure
512 = Frequency Calibration Failure

***WAI** — *Wait-to-Continue Command*
This command prevents the 541XXA from executing any further commands or queries until the pending commands are completed. For example, command shown below permits synchronous sweep operation. It causes the SMS to start a sweep and wait until the sweep is complete before executing the next command.

```
<ST 1.36GHZ; SP 8.00GHZ; SQS 1; *WAI >
```

Table 3. *IEEE 488.2 Common Command Response Syntax*

MNEMONIC CODE	FUNCTION	NUMERIC RESPONSE	DESCRIPTION
*ESE?	Standard Event Status Enable Query	<NR1>	Response data will be in range 0 through 255
*ESR?	Standard Event Status Register Query	<NR1>	Response data will be in range 0 through 255
*IDN?	Identification Query	<Arbitrary ASCII >	Response data <ANRITSU,541xxA,Serial Number,Software Revision> Response string length = 36 characters Serial No. string length = 12 characters Software Rev. string length = 8 characters
*IST?	Individual Status Query	<NR1>	Response data shall be a single ASCII encoded byte as '0' or '1' (30 or 31 Hex)
*OPC?	Operation Complete Query	<NR1>	Response data will be in range 0 through 65535
*RST	Reset to default set		Causes the instrument to perform a reset to default, with the exception of the following data which can be configured to remain unchanged Calibration Data Ch1 and Ch2 Frequency Marker information Limit Line information
*SRE?	Service Request Enable Query	<NR1>	Response data will be in range 0 through 63 or 128 through 191
*STB?	Read Status Byte Query	<NR1>	Response data will be in range 0 through 255
*TST?	Self-Test Query	<NR1>	Response data will be in range -32767 through +32767

Table 4. *Data I/O Formats and Templates*

I/O CODE	DESCRIPTION	EXAMPLE
The data input and output formats and templates, referred to throughout this User's Guide, are delimited with the less-than and greater-than characters (< >).		
<NR1>	ASCII represented integer value. Multiple values can be sent by separating them with commas (,).	1, 0, -29
<NR2>	ASCII reperesented floating point value in decimal point format. Multiple values can be sent by separating them with commas (,).	1.0, -0.00015, 180.02
<NR3>	ASCII represented floating point value in exponential format (scientific notation). Multiple values can be sent by separating them with commas (,).	1.0E9, -7.056E-3, 9.0E2
<NRf>	A flexible decimal numerical data type that allows <NR1>, <NR2>, or <NR3> formatted data to be sent to the 541XXA. Multiple values can be sent by separating them with commas (,).	1.0E9, -10.005, 83
<ASCII String>	This is a string of 7 bit ASCII text characters (decimal 0-127) that is delimited (surrounded) with either single or double quotes (' or "). This allows for transmitting directly displayable or printable text including formatting characters.	"Hello", 'cal_file', "DUT's data is valid."
<Arbitrary ASCII Block>	Allows undelimited, 7 bit ASCII text characters (decimal 0-127) to be sent over the GPIB. The data is sent without quotes delimiting it but must be terminated with the LF character and concurrent setting of the GPIB End of Transmission state signified with <LF^END>. This requirement makes it necessary for <Arbitrary ASCII Block> data to be transmitted at the end of a program or response message, i.e. at the end of a multiple input or output statement.	ANRITSU,54100A,123456 , 1.0<<LF^END>>
<Arbitrary Block>	Allows any 8 bit data byte(s) in the range 00–FF hex (0–255 decimal) to be sent over the GPIB. The data is immediately preceded by a variable length ASCII header that is encoded with the number of data bytes to be sent	#3204<<DAB>><M>1..<<DAB>><M>204 or #512808<<DAB>><M>1..<<DAB>><M>12808

12. IEEE 488.2 DEVICE DOCUMENTATION REQUIREMENTS

Table 5 provides answers to the "Device Documentation Requirements" listing in IEEE Standard 488.2-1992.

Table 5. *Device Documentation Requirements Mandated by IEEE Standard 488.2-1992 (1 of 3)*

Number	Requirement Item	Implementation in SMS
1	Interface Function Subsets Implemented	SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT0. See Table 2.
2	Device behavior when the address is set outside of the 0–30 range.	The 541XXA Device will not allow its GPIB address to be set outside the range 0-30. If an attempt is made to set an invalid address then a data entry error will be reported and the parameter value not accepted.
3	When is a user address change recognized?	The User can only initiate a GPIB address change from the front panel local controls, the new address will be indicated as data entry and 'highlighted'. When the new parameter has been accepted the data entry indication will be replaced with the 'highlighted parameter'.
4	Description of SMS settings at power-on.	The 541XXA settings will be restored to the values when the 541XXA was last powered Off. After loading new software into the instrument and then powering on, the instrument will reset to the default operating conditions.
5	Message exchange options. a. Size and behavior of input buffer b. Queries that return more than one <RESPONSE MESSAGE UNIT> c. Queries that generate a response when parsed. d. Queries that generate a response when read. e. Commands that are coupled.	a. The GPIB Input Buffer is 8192 Bytes in length, when the Input Buffer becomes full it processes the messages currently received before accepting additional messages. All data bytes received will be stored in the Input Buffer until 'end of message' is detected, the message(s) received are then processed in the order received. b. 541XXA contains no Mnemonic Query Commands that return more than One <RESPONSE MESSAGE UNIT> c. All valid queries generate a response when parsed, the reply is generated at the time the Query message is received. d. None e. None

Table 5. *Device Documentation Requirements Mandated by IEEE Standard 488.2-1992 (2 of 3)*

6	Functional elements used in construction of device-specific commands.	< PROGRAM MESSAGE> < PROGRAM MESSAGE UNIT> < COMMAND MESSAGE UNIT> < QUERY MESSAGE UNIT> < PROGRAM DATA> < PROGRAM DATA SEPARATOR> < PROGRAM HEADER SEPARATOR> < PROGRAM MESSAGE TERMINATOR > < COMMAND PROGRAM HEADER > < QUERY PROGRAM HEADER > < CHARACTER PROGRAM DATA> < DECIMAL NUMERIC PROGRAM DATA> < SUFFIX PROGRAM DATA>
7	Buffer size limitations.	8192 Bytes, this is the size of the Input Buffer.
8	<PROGRAM DATA> elements that may appear within an <expression>.	None
9	Response syntax for queries.	INP
10	Description of device-to-device message transfer traffic that does not follow the rules for <RESPONSE MESSAGES>.	A description of the response syntax for every query is given in the table that describes the query command.
11	Size of block data responses.	None
12	Common commands and queries that are implemented.	*IDN?, *RST, *TST, *OPC, *OPC?, *WAI, *IST?, *PRE, *PRE?, *CLS, *ESE, *ESR?, *SRE, *SRE?, *STB?
13	State of SMS following the successful completion of the Calibration query.	Not implemented
14	Maximum length of the block used to define the trigger macro and the method of interpreting *TRG within a *DDT command sequence.	Not implemented
. 15	Maximum length and complexity of macro labels; maximum length of block used to define a macro; and how recursion is handled during macro expansion, if macro commands are implemented.	Not implemented

Table 5.

16	Response to common query *IDN?	< ANRITSU,541XXA,Serial Number,Software Revision > Response string length = 36 characters Serial No. string length = 12 characters Software Rev. string length = 8 characters
17	If *DDT command is implemented: a. Maximum length of block used to define the trigger macro. b. Command sequence sent with the *DDT command.	Common Commands " *PUD, *PUD? " are not supported.
18	Size of resource description, if the *RST command or *RDT query is implemented.	Common Commands " *RDT, *RDT? " are not supported
19	States affected by *RST, *LRN, *RCL, and *SAV.	The Common Command "*RST" will cause the instrument to perform a reset to default, with the exception of the following data which can be configured to remain unchanged: Calibration Data Ch1 and Ch2 Frequency Marker information Limit Line information Common Commands "*LRN?" , "*RCL" and "*SAV" are not supported.
20	Scope of the self test performed by *TST command.	a) Checks Non-Volatile RAM, ensures Checksums are correct. b) Checks instrument Personality and model number for validity c) Checks for data corruption and applies default reset to recover (corruption may be due to power-down when Recalling Setup) d) Checks Keyboard Hardware Interface e) Checks Signal Channel and ADC Interface f) Checks for GPIB Hardware fitted
21	Additional status data structures used in status reporting.	See Table 14.
22	Statement describing whether each command is overlapped or sequential.	All Mnemonic Commands for 541XXA are Sequential, except for the following which are overlapped: TST SelfTest CAL Start Calibration Sequence CTN Continue to next step SQS Program Number of Sweeps SUS Suspend Sweep
23	Functional criteria that is met with an operation complete message is generated in response to that command.	
24	Descriptions used for infinity and not-a-number.	N/A

13. 541XXA GPIB OPERATION, FUNCTIONAL GROUPS

The various GPIB commands used to control the 541XXA are organized in functional groups and described in Tables 6 through 21, which start on the next page. All GPIB commands are listed alphabetically in Table 22, on page 89.

Table 6. 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 54107/109/111; 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 99, 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.
<Response Data> is described in Table 4 (page 16)

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 541XXA is not equipped with an R input.
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), E (Precision Return Loss) C (Calibration data), M (trace Memory) or D (Distance-To-Fault), W (DTF/SWR), G (Relative Group Delay). 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).

Table 6. Network Analyzer Display and Trace Memory Commands (2 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
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 541XXA commands have been provided for some functions of the GPIB in order to provide compatibility with GPIB Controller programs written for earlier ANRITSU instruments. These alternative commands do not generally take advantage of the full capabilities of the 54100A. (For example 'AP' sets channel 1 to measure power from input A only—from input B not possible with this command.)
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

Table 6. Network Analyzer Display and Trace Memory Commands (3 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
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
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 display 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 541XXA 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.

Table 6. Network Analyzer Display and Trace Memory Commands (4 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
	LIMITS SETUP COMMANDS	
	Output Limits Functions Data Commands (OLT, OCH, and OCL) located in Table 17 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).
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

Table 6. Network Analyzer Display and Trace Memory Commands (5 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
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 (M_{1-99})	Save Trace Memories	Argument (M) is a number from 1 to 99 that specifies the trace memory location to which data is to be saved. Memory locations 1 to 19 are internal RAM; locations 20 to 99 are floppy disk. Saves Trace Memories for both channels. See also setup and calibration save/ recall commands in Table 10.
RCT (M_{1-99})	Recall Trace Memories	Argument (M) is a number from 1 to 99 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 (see command TM). See other save/recall commands in Table 10.
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 subtraction is indicated on the top two lines of the screen by the message '(–MEM)'.

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.

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 54128A). 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 54107, 54109, and 54111 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).

For further information, refer to Table 6 (CLH,CLL) and Table 17 (OCH,OCL)

Figure 3. Programming Example: Complex Limits

Table 7. Calibration Sequence Commands

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 54107/109/111; 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 99, 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.
<Response Data> is described in Table 4 (page 16)

MNEMONIC CODE	FUNCTION	DESCRIPTION
CAL	Perform 541XXA Calibration	Initiates the prompted calibration sequence for the 541XXA. 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 8. Cursor Control, Search, and Trace Value Hold 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 54107/109/111; 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 indicateexactly equivalent commands.

MNEMONIC CODE	FUNCTION	DESCRIPTION
	CURSOR CONTROL COMMANDS	
Output Cursor Readout Data Commands (OCF, OCR, etc.) located in Table 17 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.
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 chann
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")

Table 8. Cursor Control, Search, and Trace Value Hold Commands (2 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
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.
	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 Marke	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 16.)

Table 8. Cursor Control, Search, and Trace Value Hold Commands (3 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		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 17).
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.
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.
		NOTES • 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. • Output Cursor Search Data Commands (OBH, OBL, and OBW) located in Table 17 can be used with the bandwidth search commands above to output cursor search data to the external computer.

Table 8. Cursor Control, Search, and Trace Value Hold Commands (4 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
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 Readou	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.
	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 9. 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 54107/109/111; 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 99, 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.
<Response Data> is described in Table 4 (page 16)

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
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).

Table 9. Data Smoothing and Frequency Resolution Control Commands (2 of 2)

MNEMONIC CODE	FUNCTION	DESCRIPTION
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 10. System Functions Control 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 54107/109/111; 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 99, Marker numbers, used for SAVE, RECALL, STORE Marker#, etc. (MEMORY Read/ Write extends to 1 - 19 only, store locations 20 - 99 are on Floppy Disk.
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.
<Response Data> is described in Table 4 (page 16)

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 Chapter 5). 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_{1-99})	Save Setup with Calibration Data	Saves the current control panel setup together with all relevant calibration data to memory (M), where: M = 1 to 99. Saves a Store Title if one has been previosly sent with TSS (Table 13)
SVD(M_{1-99})	Save Displayed Trace	Saves the displayed trace to memory (M), where: M = 1 to 99. Saves a Store Title if one has been previosly sent with TSS (Table 13)
SVS(M_{1-99})	Save Front Panel Setup	Saves the current control panel setup to setup memory location (M), where M = 1 to 99. Saves a Store Title if one has been previously sent with TSS (Table 13)
PSS(M_{1-99})	Alternative Mnemonic	PSS M == SVS M

Table 10. System Functions Control Commands (2 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
RCC(M_{1-99})	Recall with Calibration Data	Recalls the control panel setup from memory location (M), together with calibration data (M = 1 to 99).
RCS(M_{1-99})	Recall Setup	Recalls the control panel setup from setup memory location (M).
PSR(M)	Alternative Mnemonic	RCS M == RCS M
PRV(M_{1-99})	Preview	If M is in the range 1-99, the 541XXA 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.. 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 11.
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 "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,
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

Table 10. System Functions Control Commands (3 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
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.
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 541XXA GPIB Address	Sets the GPIB address of the 541XXA. 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.
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	Query Self-test Errors <Arbitrary ASCII Response Data>	After completion of the 541XXA automatic power-up self-test, the OSE command will return a string of 39 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:

Table 10. System Functions Control Commands (4 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		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: <RAM,GSP,PIP,NVR,INT,TIM,KBD,SIG,ADC,FRQ> OSE Command Reporting Character Codes: 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 "FRQ". 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	Runs the instrument self test routine. The result of the test is available in the extended status byte. If test fails, it is possible to send the CTN or CON mnemonic to attempt to continue (limited) operation of the instrument.
DAT day, month year DAT?	Set Date, UK Format Query date Format for UK <Arbitary ASCII Response Data>	The commands in this group provide the date and time functions. Time information is entered in the 24-hour format, that is: 15:34 is 3:34 pm.
DAU month, day, year DAU?	Set Date, USA Format Query date Format for USA <Arbitary ASCII Response Data>	Examples: DAT 06, 11, 1994 Sets date to 6 November 1994 (UK) DAU 11, 06, 1994 Sets date to November 6, 1994 (USA) TIM 15,34 Sets time to 3:34 pm
TIM hours, minutes TIM?	Query time settings <Arbitary ASCII Response Data>	Time Query (TIM?) response: "hours, minutes" ("15,34) Date Query (DAT?) response: "day, month, year" ("06,11,94")
HDA(S)	Show Date and Time on hard copy printouts	Prints and date and time on hard copy printouts.

Table 10. System Functions Control Commands (5 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
KCL x	Set Keyclick Level	The keyclick provides an audible sound every time a front panel key is pressed. Where x = 0, Keyclick Off x = 1, Keyclick On x = 2, Keyclick On High
CNM	Clear Non-Volatile Memory	Clear saved setups 1 to 19 stored in internal RAM.
RTD	Reset to Factory Defaults	Reset 541XXA to the factory default settings.

Table 11. 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 1-99	Setup + Cal data + trace memories (both channels)	10
SVD	Save	Current	Stores 1-99	Displayed trace	10
SVS	Save	Current	Stores 1-99	Setup	10
PSS	Save	Current	Stores 1-99	Setup (Alt. mnemonic for SVS)	10
SVT	Save	Current	Stores 1-99	Trace memories (both channels)	6
RCC	Recall	Stores 1-99	Current	Setup + Cal data + trace memories (both channels)	10
RCS	Recall	Stores 1-99	Current	Setup	10
PSR	Recall	Stores 1-99	Current	Setup (Alt. mnemonic for RCS)	10
RCT	Recall	Stores 1-99	Current	Trace memories (both channels)	6
PRV	Preview	Stores 1-99	Screen	Summary/titles	10
OSS	Output	Stores 1-99	Controller	Setup	9
OCD	Output	Current	Controller	Cal data (one channel)	9
OTM	Output	Current	Controller	Trace memory (one channel)	9
OIC	Output	Current	Controller	Interpolated Calibration Data	9
LSS	Input	Controller	Stores 1-9P	Setup	9
LCD	Input	Controller	Current	Cal data (one channel)	9
LTM	Input	Controller	Current	Trace memory (one channel)	9

NOTE: Calibration Data and Trace Memories held in store locations 1-99 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 12. Frequency Source Control and Frequency Marker 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 54107/109/111; 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 99, 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.
<Response Data> is described in Table 4 (page 16)

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.

Table 12. Frequency Source Control and Frequency Marker Commands (2 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
	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 54107A, 54109A, and 54111A; 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.
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 54107A, 54109A, and 54111A; 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 541XXA model (refer to Chapter 1, Table 1-1 of the 541XXA Operation Manual). Use this command with unit in Normal (not Alternate) Sweep mode only.

Table 12. Frequency Source Control and Frequency Marker Commands (3 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
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 54107A/54109A/54111A; GHz is assumed for all others. A DMR 1 or DMR 2 command must precede the MK command (page 45). The last marker set is the active marker that is uniquely identified on display (refer to 541XXA Operation Manual, Chapter 3).
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. "**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.

Table 12. Frequency Source Control and Frequency Marker Commands (4 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
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 541XXA. ***NOTE*** The RS command can be used to check if the output is unleveled; see Table 16.
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 Leveling 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 16) to check if an "EXT ALC UNCAL" error exists. Possible causes for this error condition are: 1. The RF output was switched off. 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.

Table 12. Frequency Source Control and Frequency Marker Commands (5 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
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 541XXA 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 541XXA 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. 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:

Table 13. Hard Copy Output Commands (1 of 3)

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 54107/109/111; 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 99, 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.
<Response Data> is described in Table 4 (page 16)

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 541XXA indicates an error by setting bit 7 of primary status byte and sending a SRQ (if enabled). 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.

Table 13. Hard Copy Output Commands (2 of 3)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		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.
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 6.	
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.
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. Title can be up to 8 characters; if more than 8, title will be truncated. For this to be used, it must be sent to the instrument before a setup is saved. EXAMPLE: **TSS 'Atten'** Assign title to current setup **SVS 5** Save current front panel setup in store 5

Table 13. Hard Copy Output Commands (3 of 3)

MNEMONIC CODE	FUNCTION	DESCRIPTION
PLT(X_1)(X_2)	Hardcopy Plot	This command is used to produce a plot of the 541XXA measurement screen on an external GPIB controlled plotter. To use the PLT command, control of the GPIB must be passed to the 541XXA so that it may control the plotter. Refer to the programming examples shown in Figure 4. The 541XXA will respond to a PLT command as follows: 1. After control has been passed to the 541XXA, the 541XXA will send measurement screen data to the plotter via the GPIB. The plot will be formatted as described below. 2. The 541XXA 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 541XXA
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
```

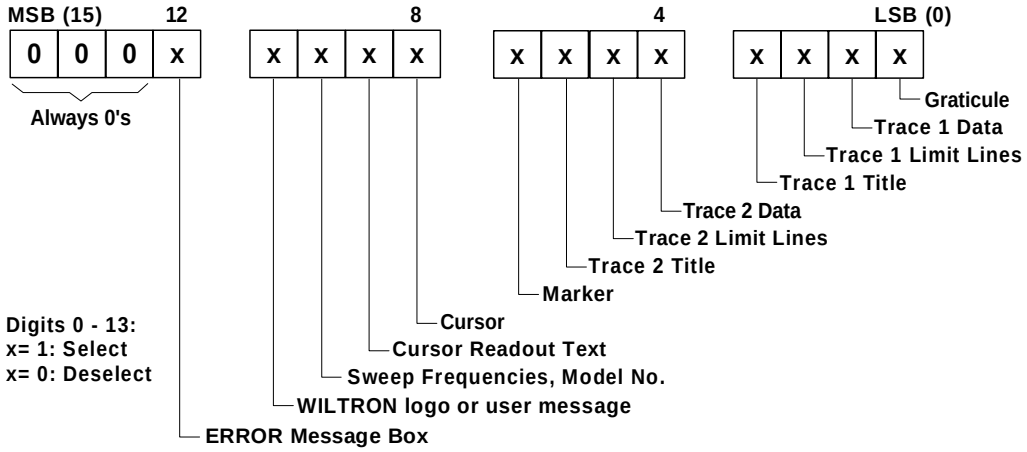
EXAMPLE FOR GPIB-PC 'C' LANGUAGE

```
ibwrt(,,"PLT 0,0");  /* request PLOT, return control to controller at address 0 */
ibpc(analyzer);      /* pass control to 541XXA */
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 541XXA 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 13.



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 14. SRQ Generation and Status Commands (1of 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 54107/109/111; 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 99, 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.
<Response Data> is described in Table 4 (page 16)

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 15 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.

Table 14. SRQ Generation and Status Commands (2 of 2)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		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.	

NOTE

To provide backward compatibility with the 5400A SMS, the 541XXA supports a "Native" mode of operation wherein only IEEE 488.1 operation is available. For that reason, the two versions of SRQ Status Byte reporting are provided. Figure 6 (pages 53 through 55) show the SRQ bytes for the IEEE 488.2 operations. Figure 6A (pages 53A through 55A) show the SRQ bytes for Native mode operation (488.1).

Service Request (SRQ) Generation Function (IEEE488.2)

The 541XXA 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 541XXA 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* (IEEE488.2)**

Bit Assignment:	7	6	5	4	3	2	1	0

Status Reporting Function	Status Byte Bit
Programmed number of sweeps have been completed	0
Hardcopy error encountered	1
Calibration completed	2
End of calibration step	3
MAV, message available for GPIB output*	4
ESR, Event Status Register requesting service	5
Service request bit (this bit is unmaskable*)	6
ESB, Extended Status Byte requesting service	7

* Refer to IEEE-488.2 Standard Document.

Figure a (IEEE488.2).

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.

Figure 6. SRQ Generation, Primary & Extended Status Byte Structures, and Masking (1 of 3)

Primary Status Mask Function (IEEE488.2)

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

The Primary Status Mask byte assumes a default value of binary 0 when the 54XXA is turned on.

Primary Status Mask Byte (IEEE488.2)

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

Figure b.

Figure 6. SRQ Generation, Primary & Extended Status Byte Structures, and Masking (2 of 3)

Extended Status Byte Structure (IEEE488.2)

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 (IEEE488.2)

Bit Assignment:	7	6	5	4	3	2	1	0

Status Reporting Function	Ext'd Status Byte Bit
Print in Progress	0**
Plot in Progress	1
Source Unleveled	2†
Instrument Warning Condition Occurred	3
Calibration Sequence Aborted	4
Not Used	5
Not Used	6
Not Used	7

** This bit will generate SRQ (if enabled and unmasked) at completion of print.
† This bit will generate SRQ when RF output unlevelled condition exists.

Figure d

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).

The Extended Status Byte Mask byte assumes a default value of binary 0 when the 54XXA is turned on.

Figure 6. SRQ Generation, Primary & Extended Status Byte Structures, and Masking (3 of 3)

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Service Request (SRQ) Generation Function (IEEE488.1, "Native")

The 541XXA 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 541XXA 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

Figure a (IEEE488.2).

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.

Figure 6A. SRQ Generation, Primary & Extended Status Byte Structures, and Masking (1 of 3)

Primary Status Mask Function (IEEE488.1, "Native")

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 **(IEEE488.1, "Native")**

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

Figure b.

The Primary Status Mask byte assumes a default value of binary 142 when the 541XXA 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 **(IEEE488.1, "Native")**

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

Figure c

Figure 6A. SRQ Generation, Primary & Extended Status Byte Structures, and Masking (2 of 3)

Extended Status Byte Structure (IEEE488.1, "Native")

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* (IEEE488.1, "Native")**

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†

** This bit will generate SRQ (if enabled and unmasked) at completion of print.
† This bit will generate SRQ when RF output unlevelled condition exists.

Figure d

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 541XXA 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* (IEEE488.1, "Native")**

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

Figure e

Figure 6A. SRQ Generation, Primary & Extended Status Byte Structures, and Masking (3 of 3)

Table 15. SQS Sweep Counter Reset Conditions

Condition for SQS Sweep Counter Reset	Associated GPIB Commands	Table
Receipt of SQS Command	SQS	14
Switching Channel On or Off.	CH, AS, BS	6
Change Number of Data Points	DP, FDP	9
Change Start, Stop, Centre, Width frequency	ST,SP,SC,SW,SFB	12
Change Alternate Sweep Frequency	SAT,SAP,SAC,SAW	12
Change Alternate/Standard Sweep	ALT, SSM, SAA, SAB	12
Change Averaging Conditions	AVC, AVE, AVF, AVG	9
Change Smoothing Conditions	SAX, SIN, SMC, SMO, SOF, SON	9
Change Detector Offset	DOA, DOB, DOR, DO1	7
Calibration	CAL, CON, CTN	7
Change Measurement Mode	SM, ACL, AP, AR, AT, BCL, BP, BR, BT	6
Change Input Selection	SI	6
Change Output Power Level	PWR, RF	12
Change Internal/External Levelling	ELV, ILV, CLV	12
Apply Trace Memory On/Of	TM	6
Recall stored Setup, Calibration, Trace memory	RCS, RCC, RCT	6, 10
Reset	RST, RES	10
Change Scaling	SCL, AA, BA, ADD ,BDD, ASC	6
Change Offset	OFF, AOF ,BOF	6
Application Commands, Hold Trace	HMN, HMX, HMM	6

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 541XXA 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 16. SRQ Generation and Status Commands

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 54107/109/111; 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	Query Extended Status Byte <NR1 Numeric Response Data>	Returns the extended status byte to the controller. The returned data will be a numeric string 0 – 255. See Figure 6 (page 55) for an explanation of bit assignments.
OPB	Query Primary Status Byte <NR1 Numeric Response Data>	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 <Arbitrary ASCII Response Data>	Returns instrument status in a nine field ASCII data string, as shown in Figure 8.
OID	Query Instrument Identity <Arbitrary ASCII Response Data>	Returns identity string to controller, which includes model number and software version number. Output format is: "541XXA, Software Revision". Response string length is 14 characters; Software revision string length is 8 characters.

Data Format for RS Command Data String:

The RS (Return Status) command causes the current status of the 541XXA 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 Appendix B, Table B-3 of the 541XXA Operation Manual.) The error/warning codes are cleared when the 541XXA 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 541XXA 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 2 of the Primary 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 541XXA is ready for a CTN command, or that the calibration sequence is complete.
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,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 17. 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 54107/109/111; 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 99, 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.
<Response Data> is described in Table 4 (page 16)

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 66). 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 11.	
OAT (N)	Output ASCII Trace Data <Arbitrary ASCII Response Data>	Returns 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. EXCEPTION: Returns the ASCII string "error" if N is invalid or missing or channel N is off.
RAT (X)	Output ASCII Trace Data-Alternative Mnemonic for OAT 1 <Arbitrary ASCII Response Data>	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;

Table 17. ASCII Trace Data Save, Recall, and Learn Commands (2 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		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.
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. 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})	Query Marker Reading <NR2 Numeric Response Data>	Returns the scalar value of Channel N at the current position of the specified marker M. Response data range ±99.99 dB. 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})	Query marker reading on Channel 1 (alternative Mnemonic for RTM) <NR2 Numeric Response Data>	Returns the scalar value of channel 1 at the current position of the specified marker. Response data range ±99.99 dB. Data format as OCR. RAM 4 == RTM 1 4
RBM (M_{1-8})	Query marker reading on Channel 2 <NR2 Numeric Response Data>	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 541XXA to the external computer/controller. (Refer to the Cursor Control Commands in Table 8.)	
OCF (N)	Query Cursor Frequency <NR2 Numeric Response Data>	Returns the frequency at the current cursor position for display channel (N). The output format is "12.3456 GHz" Leading zeroes are replaced with spaces, example: " 0.1234 GHz". Models 54107, 54109, and 54111 return all frequency information in MHz; all others return all frequency information in GHz. Response data ranges between 0 and 99.9999 GHz. EXCEPTION: Returns "error" if N is invalid or missing or channel N is off, or if the cursor is off.

Table 17. ASCII Trace Data Save, Recall, and Learn Commands (3 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		When the 541XXA is operated in the Secure Mode, the string containing frequency information that is returned by command OCF is replaced by the string " – – – – – – – ".
OCR (N)	Query Cursor Readout <NR1 Numeric Response Data>	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. Response data range ±99.99 dB. EXCEPTION: Returns "error" if N is invalid or missing or channel N is off, or if the cursor is off.
OCP	Query Cursor Position <NR1 Numeric Response Data>	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)	Query Relative Cursor Frequency <NR2 Numeric Response Data>	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 541XXA is operated in the Secure Mode, the string containing frequency information that is returned by command ODF is replaced by the string " – – – – – – – ".
ODR (N)	Query Relative Cursor Readout <NR2 Numeric Response Data>	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 8, page 30). 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)	Query Reference Cursor Frequency <NR2 Numeric Response Data>	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.

Table 17. ASCII Trace Data Save, Recall, and Learn Commands (4 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		When the 541XXA is operated in the Secure Mode, the string containing frequency information that is returned by command ORF is replaced by the string " – – – – – – – ".
ORP	Query Reference Cursor Position <NR1 Numeric Response Data>	Same as OCP but for the reference cursor.
ORR (N)	Query Reference Cursor Readout <NR2 Numeric Response Data>	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.
	OUTPUT CURSOR SEARCH DATA COMMANDS	
	The following commands are used to return cursor search data from the 541XXA to the external computer/controller. (Refer to the Cursor Search Commands in Table 8.)	
OBH	Query Bandwidth High <NR2 Numeric Response Data>	Returns the high frequency value (GHz) from a previous bandwidth search (CBW).
OBL	Query Bandwidth Low <NR2 Numeric Response Data>	Same as for OBH but returns low frequency value.
OBW	Query Bandwidth <NR2 Numeric Response Data>	Returns the frequency bandwidth from a previous bandwidth search (CBW). Models 54107A, 54109A, and 54111A return bandwidth information in MHz; all others return information in GHz. **BW = (High Frequency – Low Frequency)** ***NOTES*** + • When the 541XXA 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 " – – – – – – – ". • 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).

Table 17. ASCII Trace Data Save, Recall, and Learn Commands (5 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
	OUTPUT LIMITS FUNCTIONS DATA COMMANDS	
	The following commands are used to return limits setup data from the 541XXA to the external computer/controller. (Refer to the Limits Setup Commands in Table 6, page 25.)	
OLT (N)	Query Limits Test Result <Arbitrary ASCII Response Data>	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 <Arbitrary ASCII Response Data>	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 6, page 22, and Figure 3, page 27). EXCEPTION: Returns "error" if N is invalid or missing.
OCL (N)	Output Complex Limits Low <Arbitrary ASCII Response Data>	Same as OCH, but for complex low limit for channel (N). ***NOTE*** When the 541XXA 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 6 and to Figure 3).
RP (X)	Read Parameter <NR2 Numeric Response Data>	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 16). 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.

Table 18. Read Command Parameters

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	
17*	Marker 4 Frequency	GHz	34	– Not Used	

∗In Secure Mode, these strings are returned as " ——- " (Two spaces, five hyphens, and a space).

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
D = DTF DB
G = Relative Group Delay
W = DTF SWR
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

Table 19. Binary Trace Data Save, Recall, Output, 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 54107/109/111; 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 99, 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.
<Response Data> is described in Table 4 (page 16)

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 541XXA, 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 11 (page 40).	
OBT (N)	Output Binary Trace Data <Definite Length Arbitrary Block Response Data>	The 541XXA 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 541XXA measurement setting. The data format for this command is shown in Figure 10 (page 72). 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 541XXA 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 541XXA settings.

NOTE

Table 19. Binary Trace Data Save, Recall, Output, and Learn Commands (2 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
	The 541XXA 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 541XXA is therefore unable to check it for errors or inconsistencies.	
OTM (N)	Output Trace Memory <Definite Length Arbitrary Block Response Data>	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 541XXA 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 72) for descriptions of the data formats used with the commands described above.	
	BINARY CALIBRATION DATA COMMANDS	
OCC (N)	Output Calibration Setup Conditions <Definite Length Arbitrary Block Response Data>	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 541XXA 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.

Table 19. Binary Trace Data Save, Recall, Output, and Learn Commands (3 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		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 541XXA reverts to the normal data termination algorithm.
		NOTE
	Refer to Figure 10 (page 72) for descriptions of the data formats used with the commands described above.	
OCD (N)	Output Calibration Data <Definite Length Arbitrary Block Response 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 541XXA 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 541XXA 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.

Table 19. Binary Trace Data Save, Recall, Output, and Learn Commands (4 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
OIC (N)	Output Interpolated Cal Data <Definite Length Arbitrary Block Response 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 541XXA 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 62). 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 72) for descriptions of the data formats used with the commands described above.
	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 <Definite Length Arbitrary Block Response Data>	Returns stored front panel setup (M) to the controller. The binary data format used with this command is shown in Figure 10 (page 62). 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 ANRITSU. The value of any element of this data may be established through the use of other commands.
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.

Table 19. Binary Trace Data Save, Recall, Output, and Learn Commands (5 of 5)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		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 541XXA 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.

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.

Response Syntax: <DEFINITE LENGTH ARBITRARY BLOCK RESPONSE DATA>
Response data format: <#Nxxxx n m BW1 BW2 BW3 ..... BWp> EOI
Where #Nxxxx = response data preamble (Refer to 488.2 Specification, Section 8.7.9)

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.

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

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

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.

541XXA Native Mode, response format: <X iv pts start stop power offset> [EOI]
541XXA IEEE 488.2, response format: <#Nxxxx X iv pts start stop power offset> [EOI]
Where #Nxxxx = response data preamble (Refer to 488.2 Specification, Section 8.7.9)

Figure 10. Data Formats for Binary Output Data and Learn Commands (2 of 4)

Parameter X is currently described as ASCII character "T" or "S" has been extended to include the following:

X = T, Transmission Calibration data
X = S, SWR Calibration data
X = R, Return Loss Calibration data
X = D, Distance to Fault (DTF) Calibration data
X = E, Precision Return Loss Calibration data

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.

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 541XXA operation; see Table 19.

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

541XXA Native Mode, response format: <"O" B1 B2 B3 B4 .....Bp> [EOI]
541XXA IEEE 488.2, response format: <#Nxxxx "O" B1 B2 B3 B4 .....Bp> [EOI]
Where #Nxxxx = response data preamble (Refer to 488.2 Specification, Section 8.7.9)

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 indi-

Figure 10. Data Formats for Binary Output Data and Learn Commands (3 of 4)

cator). 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).

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. However, when configured for IEEE 488.2 operation, the default Byte Ordering is: High Byte first.
   To select IEEE 488.2 mode, use Mnemonic Command IEE1
   To select the Native (IEEE 488.1) mode, use Mnemonic Command IEE0

   Commands HBF1 and HBF0 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 20. Measurement Applications and Miscellaneous Commands (1 of 3)

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 54107/109/111; 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 99, 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.
<Response Data> is described in Table 4 (page 16)

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

Table 20. Measurement Applications and Miscellaneous Commands (2 of 3)

MNEMONIC CODE	FUNCTION	DESCRIPTION
		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
		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	Query Frequency Scaling Parameters <Arbitrary ASCII Response Data>	Returns frequency scaling parameters to the external computer/controller (see LUS command below). The Frequency Scaling function is described in Section III. When the 541XXA 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
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 541XXA output freq (per Table 1.1) User Freq = Frequency entered *and* displayed Where: *Examples:* **LUS 10 2 40 1** Causes model 54128A to display 80 – 102 GHz with a true output of 8 – 12.4 GHz.

Table 20. Measurement Applications and Miscellaneous Commands (3 of 3)

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.
IEE (S)	Set 541XXA GPIB Emulation Mode	Provides backward compatibility with 5400A, by allowing 541XXA to function in IEEE488.1 (Native) mode. S = 1, selects IEEE 488.2 mode S = 0, selects 541XXA Native mode

54XXA GPIB SETUP/UTILITY SUBROUTINE

The programming example shown below is a subroutine written in QuickBASIC that sets up and initializes the 541XXA 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 541XXA
    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

```
DECLARE SUB noise ()
DECLARE SUB delays (Secs!)
DECLARE SUB GPIBsetup ()
DECLARE SUB read54100 (cursor)

COMMON SHARED sms%

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

DIM cursor(180)          'Measurement array

CONST false = 0, true = NOT false
ProgName$ = "54100TIME"

CLS
' ============================
' HARDWARE SETUP INFORMATION
' ============================
LOCATE 7, 1
PRINT "          54100 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 "54100A instrument with option 5 signal channel R."
PRINT "PC with National Instrument GPIB card installed."
PRINT "Two ANRITSU 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 54100A signal channel inputs A and R.
PRINT
PRINT "      Press any key to continue"
```

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

```
PRINT
CALL uolse JUNK$ = INPUT$(1)
CLS
LOCATE 12, 20
PRINT "PLEASE WAIT PROGRAMME RUNNING ....."
CALL GPIBsetup  ''' Call National instrument GPIB PCB set procedure
CALL delays(2)
' ======
' SET 54100A UP
' ======
CALL ibwrt(sms%, "RST")
CALL delays(4)          ''' wait for 54100A reset.
CALL ibwrt(sms%, "CH20,SMIT") ''' Channel 2 off. Set channel 1 power
CALL delays(2)
CALL ibwrt(sms%, "SII A/R") ''' set ratio mode A/R.
CALL ibwrt(sms%, "DPI")     ''' Set 101 data points.

'================
' A/R CALIBRATION
'================
CALL ibwrt(sms%, "CAL") ''' Calibrate 54100A.
CALL delays(2)
CALL ibwrt(sms%, "CTN") ''' Continue Calibration
CALL delays(4)          ''' wait for cal to finish.

'==================
' 54100A SOURCE SET UP
'==================
CALL ibwrt(sms%, "SW 0")    ''' Set to width zero.

'====================================
' SET 54100A TO FAST CW MEASUREMENT MODE
'====================================
CALL ibwrt(sms%, "RF0") ''' turn the source RF off. This shows the 54100A
                            ''' 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%, "FCWl") ''' Set CW measurement mode ON
CALL delays(l) ''' allow CW mode to settle
PRINT "PLEASE WAIT MEASUREMENT DATA BEING TAKEN ....."

'============================
' EXAMPLE OF A MEASUREMENT LOOP
```

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

```
'============================
FOR x = 1 TO 180
CALL ibwrt(sms%, "OCRl") '"' Ask 54100A for cursor reading
CALL read54100(cursor)      '"' Get 54100A cursor reading
cursor(x) = cursor       '"' Store measurement data for latter use
' Move antena 1 degree for next measurement.
CALL delays(.025)        '"' Wait 25mS for 54100A 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 yl = 7 TO 61 STEP 6
LOCATE x1, yl
PRINT cursor(count)      '"' Display reading on the screen
count = count + 1
NEXT yl
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!
```

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

```
        IF TIMER  Tstart! THEN Tend! = Tend! - 86400: Tstart! = TIMER
    WEND
END SUB

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

SUB noise
    SOUND 1000, 1
END SUB

SUB read54100 (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 21. Distance-To-Fault 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 54107/109/111; 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 99, 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.
<Response Data> is described in Table 4 (page 16)

MNEMONIC CODE	FUNCTION	DESCRIPTION
DCL?	Query Coax Type <NR2 Numeric Response Data>	Response data ranges between 0 and 9999.99 m/ft
DCT 'name' (X1) (X2)	Define New Coax Type <Arbitrary ASCII Response Data>	Defines a new type of coax Where 'name' can be up-to 6 characters X1 is Dielectric Constant (0.00 to 1) X2 is Coax Loss (±99.99 dB)
DCT? 'name'	Query Coax Definition <Arbitrary ASCII Response Data>	Response = X1 X2 Where X1 is Dielectric Constant (0.00 to 1) X2 is Coax Loss (±99.99 dB)
DCT?	Query Current Coax Definition	Response = 'name' X1 X2 Where X1 is Dielectric Constant (0.00 to 1) X2 is Coax Loss (±99.99 dB)
DDT (X)	Show defined DTF Coax/Waveguide Types	Shows the coaxial or waveguide types that have been defined Where X = 1, Show DTF Listing 0, Exit Display Listing and Return to DTF Measurement
DFL (n)	Set DTF Return Loss Offset	Sets the offset value for return loss in the DTF mode. Where n = ±99.99 dB 1, units feet
DFL?	Query DTF Return Loss Offset <NR2 Numeric Response Data>	Response data range ±99.99 dB

Table 21. Distance-To-Fault Commands (2 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
DFM (X)	Set DTF Mode	Selects the coaxial or waveguide DTF mode. Where X = 0, Coax 1, Waveguide
DFR (X)	Set DTF Measurement Resolution	Selects the resolution value for the DTF measurement. Where X = 256, 512, 1024
DFS (X)	Set DTF Sidelobes	Sets the DTF sidelobes Where X = 0, Low Sidelobes 1, Normal Sidelobes
DFU (X)	Set DTF Measurement Units	All DTF distance readout will be converted to the selected m/ft units: Where X = 0, units meters 1, units feet
DFU?	Query DTF Measurement Unitrs <NR1 Numeric Response Data>	Response data 0 = DTF Units is Meters 1 = DTF Units is Feet
DSP (X)	Set DTF Stop Frequency Limit	Select a stop frequency for the DTF measurement. Where X = Frequency (0 to 99.9999 GHz)
DSP?	Query DTF Stop Frequency Limit <NR2 Numeric Response Data>	Select a stop frequency for the DTF measurement. Where X = Frequency (0 to 99.9999 GHz)
DST (X)	Set DTF Start Frequency Limit	Select a start frequency for the DTF measurement. Where X = Frequency (0 to 99.9999 GHz)
DST?	Query DTF Frequency Limit <NR2 Numeric Response Data>	Select a start frequency for the DTF measurement. Where X = Frequency (0 to 99.9999 GHz)
DTR (X)	Set DTF Range	Sets the DTF range Where X = 0 to 9999.99 m/ft (Unit identifier "m" (meters) or "ft" (feet) may be sent with the data for clarity.
DTR?	Query DTF Range <NR2 Numeric Response Data>	Response data ranges between 0 and 9999.99 m/ft
DWT name f1 f2 fc X2	Define New Waveguide Type	Defines a new waveguide line type to be added to the list of waveguide types stored in the program. Where name = up to 6 characters f1 = fu Frequency (0 to 99.999 GHz) f2 = fo Frequency (0 to 99.999 GHz) fc = Cutoff Frequency (0 to 99.999 GHz) X2 = Waveguide Loss (±99.99 dB)
DWT? 'name'	Query Waveguide Definition <Arbitrary ASCII Response Data>	Response = f1, f2, fc, X2

Table 21. Distance-To-Fault Commands (3 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
DWT?	Query Current Waveguide Definition <Arbitrary ASCII Response Data>	Entered parameters should follow rules Where f1 and f2 are greater than fc, and f2 is greater than f1
DZP (X)	Set DTF Zoom Stop Distance	Sets the DTF zoom stop distance Where X = 0 to 9999.99 m/ft
DZP?	Query DTF Zoom Stop Distance <NR1 Numeric Response Data>	
DZT (X)	Set DTF Zoom Start Distance	Sets the DTF zoom start distance Where X = 0 to 9999.99 m/ft
DZT?	Query DTF Zoom Distance <NR1 Numeric Response Data>	Response data ranges between 0 and 9999.99 m/ft
ODA	Output DTF Measurement Data, ASCII Format <Arbitrary ASCII Response Data>	The raw DTF measurement data string returned in ASCII format will be n m val1 val2 val3 . . . . valp <CR> <LF> [EOI] Where n = Start Character 2, DTF Resolution 256 Points 5, DTF Resolution 512 Points 1, DTF Resolution 1024 Points m = Data Identifier 'D' val1 to valp = ASCII Measurement Values
ODB	Output DTF Measurement Data, Binary Format <Definite Length Arbitrary Block Response Data>	The raw DTF measurement data string returned in Binary format will be n m val1 val2 val3 . . . . valp (EOI) Where n = Start Character 2, DTF Resolution 256 Points 5, DTF Resolution 512 Points 1, DTF Resolution 1024 Points m = Data Identifier 'D' val1 to valp = Binary Measurement Values
SCT 'name'	Select Coax from Defined List	Selects the name of a predefined coax from a listing Where 'name' can be up-to 6 characters
SM N (X)	Set Distance to Fault Measurement Mode	Places the 541XXA in the DTF measurement mode. Where N = 1 or 2 (channel selection) X = D (DTF mode) X = W for DTF/SWR mode. X = G for Relative Group Delay
SWT 'name'	Select Waveguide from Defined List	Selects the name of a predefined waveguide from a listing Where 'name' can be up-to 6 characters

Table 21. Distance-To-Fault Commands (4 of 4)

MNEMONIC CODE	FUNCTION	DESCRIPTION
SWT name	Select Waveguide Type	Selects the type of waveguide line. Where name = up to 6 characters
TM (N) (S)	Display DTF Minus Trace Memory on Channel 2	Displayed the DTF measurement subtracted by trace memory. Applies only to Channel 2.. Where N = 2 (channel selection, only allowed on channel 2) S = 1 (Subtract trace memory)
TMD (N)	Copy DTF Channel 1 to Trace Memory on Channel 2	Places the 541XXA in the DTF measurement mode. Where N = 2 (channel selection, only allowed on channel 2) S = 1 (Subtract trace memory)

Table 22. Alphabetical Index to 541XXA GPIB 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 54107/109/111; 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: 183.4E-3 = 0.183; 6.2e1 = 62.00

Table 22. Alphabetical Index to 541XXA GPIB Commands (2 of 5)

MNEMONIC CODE	FUNCTION	PAGE NUMBER
CBM(N)(n)	Cursor Bandwidth Search from Maximum Point	31
CBW(N)(n)	Cursor Bandwidth Search Using (n) dB Reference (chan N)	31
CF	Cursor Off	29
CH(N)(S)	Set Channel N On/Off	23
CHI(N)(S)	Complex High Limit, channel N On/Off	25
CLH(N)(L)	Enter High Complex Limits, channel N	25
CLL(N)(L)	Enter Low Complex Limits, channel N	25
CLM(N)(n)	Cursor Search, Left of Maximum Point	31
CLO(N)(S)	Complex Low Limit, channel N On/Off	25
CLT(N)(n)	Move Cursor Left to n dB, channel N	30
CLV	Rescale External Leveling	44
CMK(M_{1-8})	Move Cursor To Marker M	30
CMM(N)	Cursor Search, Min/Max	31
CMN(N)	Move Cursor To Min, channel N	30
CMX(N)	Move Cursor To Max, channel N	30
CN	Cursor On	29
CNM	Clear Non-Voilatile Memory	39
CON	Continue to next Calibration/test step	28
CRF(N)(F)	Move Cursor To Frequency F on Channel N	29
CRM(N)(n)	Cursor Search, Right of Maximum Point	31
CRP(P)	Move Cursor To Position P	29
CRT(N)(n)	Move Cursor Right To n dB, channel N	31
CSB	Clear Primary Status Byte	51
CSR(S)	Cursor Search Repeat	32
CTN	Continue to Next Calibration Step (or after Self Test Failed)	28
DAT day, month, year	Set Date, UK Format	38
DAT ?	Query date format, UK	38
DAU day, month, year	Set Date, USA Format	38
DAU ?	Query date format, USA	38
DB (dB)	Reserved Mnemonic	—
DBM (dBm)	Reserved Mnemonic	—
DCC(S)	DC Calibration Mode Enable/ Disable	35
DCL?	Query Coax Length	84
DCT 'name' X1 X2	Define New Coax Type	84
DCT? 'name'	Query New Coax Type	84
DCT?	Query New Coax Type	84
DDT(X)	Show Defined Waveguide/Coax Types	84
DFL(n)	Set DTF Measurement Return Loss Offsets	84
DFL?	Query DTF Measurement Return Loss Offsets	84
DFM(X)	Set DTF Mode	85
DFR(X)	Set DTF Measurement Resolution	85
DFS(X)	Set DTF Sidelobes	85
DFU(X)	Set DTF Measurement Units	85
DFU?	Query DTF Measurement Units	85
DLT	Display Limits Test	26
DMR (o), or DMR (X)	Displays marker readout information in screen display menu area	45
DO1 (n)	Alt. for DOR (Det Offset R)	28
DOA (n)	Detector Offset, input A	28
DOB (n)	Detector Offset, input B	28
DOF	Relative (delta) Mode Off	30
DON	Relative (delta) Mode On	30
DOR (n)	Detector Offset, input R	28
DP(X)	Set Resolution To 221/201/401/51 Data Points	34
DS(o)	Blank/Unblank CRT	37
DSI(S)	Display Segment Identifiers	26
DSP X	Set Stop Frequency Limit for DTF	85
DSP?	Query DTF Stop Frequency Limit	85
DST X	Set Start Frequency Limit for DTF	85
DST?	Query DTF Start Frequency Limit	85
DTR(X)	Set DTF Range	85
DTR?	Query DTF Range	85
DWT 'name' fu fo fc X2	Define New Waveguide Type	85
DWT? 'name'	Query New Waveguide Type	85

Table 22. Alphabetical Index to 541XXA GPIB Commands (3 of 5)

MNEMONIC CODE	FUNCTION	PAGE NUMBER
DWT?	Query New Waveguide Type	86
DZP(X)	Set DTF Zoom Stop Distance	86
DZP?	Query DTF Zoom Stop Distance	86
DZT(X)	Set DTF Zoom Start Distance	86
DZT?	Query DTF Zoom Start Distance	86
ELV	Select External levelling	44
FCW(S)	Fast CW Measurement Mode	78
FDP (X)	Alternative for DP	34
FLO (S)	Frequency Locking on/off	44
FM (o)	Frequency Markers On/Off	45
GCG	Start gain compression testing	76
GCM(n)	Set Amplifier Gain Compression Test Maximum Power (n)	76
GCS(n)	Set Amplifier Gain Compression Test Start Power (n)	76
GIN(X)	Set Graticule Intensity	37
GHZ (GHz)	Reserved Mnemonic	—
GOF	Turn Off Graticule Display	35
GON	Turn On Graticule Display	35
GR(o)	Turn Graticule Display On/Off	35
GSF	GPIB Status Indication Off	36
GSN	GPIB Status Indication On	36
HBF(S)	High Byte First/Last	70
HCH (X)	Hold Channel Enable	37
HDA (S)	Show Date and Time on Hardcopy Printouts	38
HLD(o)	Hold On/Off	37
HMF	Hold Trace Values Off	32
HMM(N)	Hold Min/Max Trace Values	32
HMN(N)	Hold Minumum Trace Values	32
HMX(N)	Hold Maximum Trace Values	32
HOF	Hold Off	37
HON	Hold On	37
HP	Halt Print or Plot	47
HWM(o)	Select Visible Hardware Markers	45
IEE(S)	Set 541XXA GPIB Emulation Mode	78
IEM($X_{0\text{-}255}$)	Input Extended Mask	51
ILV	Select Internal Levelling	44
INT(X)	Set Display Intensity	37
IPM($X_{0\text{-}255}$)	Input Primary Mask	51
KCLx	Set Keyclick Level	39
LAT(N)(data stream)	Learn ASCII Trace	61
LBT(N)(bin. data)	Learn Binary Trace	67
LCC(N)	Learn Calibration Setup Conditions	68
LCD(N)(X)	Learn Calibration Data	69
LDE "device"	Label for Test Device	47
LHF(N)	High Limit Off, channel N	25
LHI(N)(n)	High Limit On, channel N	25
LID "ident"	Label for User Identification	47
LLF(N)	Low Limit Off, channel N	25
LLO(N)(n)	Low Limit On, channel N	25
LSS (M)(bin. data)	Learn Stored Setup	70
LTM (N)(X)	Learn Trace Memory	68
LUS(m)(d), (f)(S)	Learn Frequency Scaling Parameters	77
M ($M_{1\text{-}8}$)(o), or M ($M_{1\text{-}8}$)(F)	Identical to command MK (m)(o/F)	43
MHZ (MHz)	Reserved Mnemonic	—
MK($M_{1\text{-}8}$)(F)	Select / Set Frequency Marker	43
nS	Reserved Mnemonic (nanosecond)	—
NUL	Nul Command (see Para 3.6 also)	51
OAT(N)	Output ASCII Trace Data, channel N	60
OBH	Output Bandwidth High Frequency	63
OBL	Output Bandwidth Low Frequency	63
OBT	Output Binary Trace Data, channel N	67
OBW	Output Bandwidth Frequency	63
OCC(N)	Output Calibration Setup Condition Data	68
OCD(N)	Output Calibration Data, channel N	69
OCF(N)	Output Cursor Frequency	61
OCH (N)	Output Complex Limits High	64
OCL (N)	Output Complex Limits Low	64
OCP	Output Cursor Position	62
OCR(N)	Output Cursor Readout, channel N	62
ODA	Output DTF Measurement Data, ASCII Format	86
ODB	Output DTF Measurement Data, Binary Format	86

Table 22. Alphabetical Index to 541XXA GPIB Commands (4 of 5)

MNEMONIC CODE	FUNCTION	PAGE NUMBER
ODF(N)	Output Relative (delta) Cursor Frequency, channel N	62
ODR(N)	Output Relative (delta) Cursor Readout, channel N	62
OEB	Output Extended Status Byte	58
OFF(N)(n)	Set Channel N Offset (dB)	23
OIC(N)	Output Interpolated Cal. Data.	70
OID	Output Instrument Identity	58
OLT(N)	Output Limits Test Result, channel N	64
OPB	Output Primary Status Byte	58
ORF(N)	Output Ref. Cursor Frequency, channel N	62
ORP	Output Ref. Cursor Position	63
ORR(N)	Output Ref. Cursor Readout, channel N	63
OSB	Output (Primary) Status Byte	58
OSE	Output Self-Test Errors	37
OSS (M_{1-9})	Output Stored Setup M	70
OTM (N)	Output Trace Memory, channel N	68
OUS	Return Frequency Scaling Parameters	77
PG	Print Graph	46
PGR	Print Graph	46
PLT(X_1)(X_2)	Hardcopy Plot	48
PRV(M_{1-99})	Display Preview screen from setup M	36
PSR(M)	Recall Front Panel Setup from store M	36
PSS(M_{1-99})	Save Front Panel Setup in store M	35
PST	Stop Print	47
PT(X_{0-5})	Print Tabular Data	46
PTL	Print Complex Limits	47
PWR(n|o)	Set Output Power Level/ Turn On/Off	43
Q(M_{0-7})(o)	Set Primary Status Byte Mask Bit	51
RAM (M_{1-8})	Reading at Marker, channel 1	61
RAT	Output (read) ASCII Trace Data, channel N	60
RBM (M_{1-8})	Reading at Marker, channel 2	61
RBT	Output (read) ASCII Trace Data, channel 2	61
RCC(M_{1-99})	Recall With Calibration Data from store M	36
RCF(N)(F)	Move Reference Cursor To Frequency F, channel N	29
RCP(P)	Move Reference Cursor To Position P	29
RCS(M_{1-9})	Recall Front Panel Setup from store M	36
RCT(X_{1-99})	Recall trace memory from store X	26
RCW	Re-lock frequency in CW mode	44
REF(N)(X)	Set Reference Line Position, channel N	23
RES	Reset Instrument	36
RF(S)	RF Power On/Off	43
RGB(p)(r), (g)(b)	Set VGA monitor pixel plane	76
ROF(N)	Reference Line Display Off, channel N	23
RON(N)	Reference Line Display On, channel N	23
RP (X)	Read Parameter (X)	64
RS	Output Status String	58
RSC(X)	Reset Configure	36
RST	Reset Instrument	36
RTD	Reset to Factory Defaults	39
RTL	Return To Local	37
RTM(N)(M_{1-8})	Read Trace at Marker	61
SAA	Set Sweep to Alternate A/A Mode	41
SAB	Set Sweep to Alternate A/B Mode	41
SAC(F)	Set Alternate Sweep Center Frequency	42
SAP(F)	Set Alternate Sweep Stop Frequency	42
SAT(F)	Set Alternate Sweep Start Frequency	42
SAW(F)	Set Alternate Sweep Width Frequency	42
SAX	Set Smoothing to Maximum, both channels	33
SC(F)	Set Sweep Center Frequency	42
SCL(N)(X)	Set (Scale) Resolution (dB/Div.), channel N	24
SCP(Mask)	Specify Custom Plot	48
SCT name	Select Coax Type	86

Table 22. Alphabetical Index to 541XXA GPIB Commands (5 of 5)

MNEMONIC CODE	FUNCTION	PAGE NUMBER
SDX(X)	Set 54XXA GPIB Address	37
SFB	Sweep Full Band	42
SI(N)(X)	Set Input for channel N	22
SIN	Set Smoothing to Minimum, both channels	33
SM (N)(X)	Set Channel N Measurement Display	22
SM N(X)	Set Distance-To-Fault Measurement Mode	86
SMC(N)(X_{0-5})	Set channel N smoothing to level X	33
SMO(MX_{0-2})	Set Smoothing (Alternative for SMC)	33
SOF	Smoothing Off	33
SON(X_{0-2})	Set Smoothing Off/Min/Max	33
SP(F)	Set Sweep Stop Frequency	42
SQ(S)	Enable/Disable SRQs	51
SQS(X)	Program Number of Sweeps to SRQ	51
SSM	Set Standard (Normal) Sweep Mode	41
SSS	Select Secret Mode	37
SST	Set Standard Titles	24
ST(F)	Set Sweep Start Frequency	42
SUS(K)	Suspend Sweeping	42
SUT(N)	Set User Title	24
SVC(M_{1-99})	Save Setup With Calibration to store x	35
SVD(M_{1-99})	Save Displayed Trace	35
SVS(M_{1-99})	Save Front Panel Setup to store M	35
SVT(X_{1-99})	Save Trace Memory to store M	26
SW(F)	Set Sweep Width Frequency	42
SWT name	Select Waveguide Type	86
T(X)	Print Tabular Data	47
TCR(N)	Move Trace at Cursor to Ref. Line	24
TIM hours, minutes	Set Time Format	38
TIM?	Query time format	38
TM(N)(S)	Apply/Remove Trace Memory to Channel N	26
TM(N)(S)	Display DTF Minus Trace Memory Ch2	87
TMD(N)	Load Trace Memory With Signal Trace Data	26
TMD(N)	Copy DTF Ch1 to Trace Memory Ch 2	87
TMH(N)	Load Trace Memory With Complex High Limits	26
TML(N)	Load Trace Memory With Complex Low Limits	26
TMO	Table Print, Markers only	47
TSS "title"	Load Setup Title for Stored Setups	47
TST	Run Instrument Self-Test Routine	38
XCG	Exchange Cursor and Ref Cursor	30