5500A

Multi-Product Calibrator

Programmer Reference Guide

PN 105783
December, 1994

FLUKE ®

Table of Contents

WARNING

The 5500A Calibrator can produce voltages up to 1000 V rms and must be programmed with caution to prevent hazardous voltages from being produced without sufficient warning to the operator.

Programs should be written carefully and tested extensively to ensure safe operation of the 5500A Calibrator. Fluke suggests that you include error catching routines in your programs. These error catching routines will assist in detecting programming errors that could result in the instrument behaving differently to your intention. By setting the Service Request Enable (SRQ) register, described in paragraph 5-60, the 5500A Calibrator can be programmed to cause an SRQ when an error is detected. The following program example shows a skeleton program including error catching:

```
10   PRINT @4, “*CLS”   ! Clear status
20   PRINT @4, “*SRE 8” ! Set SRE Error Avail.
30   ON SRQ GOTO 1000   ! Enable SRQ Function

100                     ! Body of program here

900  STOP               ! End of program

1000 REM Start of SRQ Handler     ! Start routine
1010 PRINT @4, “FAULT?” ! Request fault code
1020 INPUT @4, A%       ! Input fault code
1030 PRINT @4, “EXPLAIN? ”;A%! Request fault text
1040 INPUT @4, A$       ! Input fault text
1050 PRINT “Fault ”;A$“ detected” ! Print message
1060 PRINT @4, “STBY”   ! Place 5500A in standby
1070 STOP
```

TYPES OF COMMANDS

Device-Dependent Commands

Commands unique to 5500A.

Common Commands

Commands defined by the IEEE 488.2 standard.

Query Commands

Commands ending with an ?.

Compound Commands

Two or more commands in a single command line.

Coupled Commands

Commands that could interfere with each other.

Overlapped Commands

Commands requiring more time to execute.

Sequential Commands

Commands that execute immediately.

Commands for RS-232 Only

Commands for RS-232 Only

IEEE-488	RS-232 Equivalent
GTL	LOCAL command
GTR	REMOTE command
LLO	LOCKOUT command
SRQ	SRQSTR command
SDC, DCL	^C (<Cntl> C) character [clear the device]
GET	^T (<Cntl> T) character [execute a group trigger]
SPE, SPD	^P (<Cntl> P) character [print the serial poll string]

Also:

```
SP_SET          SPLSTR          SRQSTR
SP_SET?         SPLSTR?         SRQSTR?
```

COMMAND SYNTAX

Parameter Syntax

Units Accepted in Parameters and Responses

Units	Meaning
HZ	Frequency in units of hertz
KHZ	Frequency in units of kilohertz
MHZ	Frequency in units of megahertz
UV	Volts in units of microvolts
MV	Volts in units of millivolts
V	Volts in units of volts
KV	Volts in units of kilovolts
UA	Current in units of microamperes
MA	Current in units of milliamps
A	Current in units of amps
PCT	Percent
PPM	Parts-per-million
DBM	Volts referenced to 1 mW into 600Ω load.
OHM	Resistance in units of ohms
KOHM	Resistance in units of kilohms
MOHM	Resistance in units of megohms
NF	Capacitance in units of nanofarads
PF	Capacitance in units of picofarads
UF	Capacitance in units of microfarads
MF	Capacitance in units of millifarads
F	Capacitance in units of farads
CEL	Temperature in degrees Celsius
FAR	Temperature in degrees Fahrenheit

COMMAND SYNTAX (cont)

General Rules

1. Separate parameters with commas.
2. Numeric parameters up to 15 significant digits and exponents in the range +/-1.0E+/-20.
3. Null parameters cause an error, e.g., the adjacent commas in `OUT 1V, ,2A`.
4. Expressions, for example `4+2*13`, are not allowed as parameters.
5. Binary Block Data can be in one of two IEEE 488.2 formats:

   Indefinite Length Format Accepts data bytes after #0 until the ASCII Line Feed character is received with an EOI signal (for RS-232, a line feed or carriage return will terminate the block).

   Definite Length Format The non-zero digit specifies the number of characters that will follow in the <digits> field.

Extra Space or Tab Characters

One space after a command is required. You can insert extra spaces or tabs as desired.

Terminators

Terminator Characters

Function	ASCII		Control	C Code
	#	Code		
Carriage Return	13	Chr(13)	<Cntl> M	\n
Line Feed	10	Chr(10)	<Cntl> J	\r
Backspace	8	Chr(8)	<Cntl> H	\b
Form Feed	12	Chr(12)	<Cntl> L	\f

COMMAND SYNTAX (cont)

IEEE-488 Interface The 5500A sends the ASCII character Line Feed with the EOI control line held high as the terminator for response messages.

RS-232 Interface The 5500A Calibrator returns an EOL (End of Line) character with each response, selectable as CR, LF or both CRLF.

Incoming Character Processing

1. The most significant data bit (DIO8) is ignored.
2. All data is taken as 7-bit ASCII.
3. Lower-or upper-case characters.
4. ASCII characters less than 32 (Space) are discarded, except for characters 10 (LF) and 13 (CR) and in the `*PUD` command argument.

Response Message Syntax

Response Data Types

DATA TYPE	DESCRIPTION
Integer	Decimal numbers to 32768.
Floating	Numbers plus an exponent.
String	ASCII characters within double quotes (“string”).
Binary Block Data	Defined by the IEEE-488.2.

Status Register Summary

Status Register	Read	Write
Serial Poll Status Byte (STB)	*STB?	—
Service Request Enable Register (SRE)	*SRE?	*SRE
Event Status Register (ESR)	*ESR?	—
Event Status Enable Register (ESE)	*ESE?	*ESE
Instrument Status Register (ISR)	ISR?	—
Instrument Status Change Register (ISCR)	ISCR?	—
ISCR 1 to 0 transition	ISCR0?	—
ISCR 0 to 1 transition	ISCR1?	—
Instrument Status Change Enable Register (ISCE)	ISCE?	ISCE
ISCE 1 to 0 transition	ISCE0?	ISCE0
ISCE 0 to 1 transition	ISCE1?	ISCE1

CHECKING 5500A STATUS (cont)

STB and SRE

7	6	5	4	3	2	1	0
0	**RQS** **MSS**	**ESB**	**MAV**	**EAV**	**ISCB**	**0**	**0**

RQS Requesting Service. Set to 1 whenever bits ESB, MAV, EAV, or ISCB change from 0 to 1 and are enabled (1) in the SRE. When RQS is 1, asserts the SRQ control line.

MSS Master Summary Status. Set to 1 whenever bits ESB, MAV, EAV, or ISCB are 1 and enabled (1) in the SRE. This bit can be read using the *STB? command in serial remote.

ESB Event Status. Set to 1 when one or more enabled ESR bits are 1.

MAV Message Available. The MAV bit is set to 1 whenever data is available in the 5500A's IEEE-488 interface output buffer.

EAV Error Available. An error has occurred and an error is available to be read from the error queue by using the ERR? query.

ISCB One or more enabled ISCR bits are 1.

For RS-232, transmitting the ^P character (hold down the <Cntl> key and press P) returns the SPLSTR (Serial Poll String) and the status byte.

Service Request (SRQ) Line

IEEE-488 Bus control line that asserts to notify the controller that it requires some type of service.

RS-232 Sends the SRQSTR string over the serial interface when the SRQ line is set.

Service Request Enable Register (SRE)

The SRE enables or masks the bits of the Serial Poll Status Byte. The SRE is cleared at power up.

ESR and ESE

15	14	13	12	11	10	9	8
0	0	0	0	0	0	0	0

7	6	5	4	3	2	1	0
PON	**0**	**CME**	**EXE**	**DDE**	**QYE**	**0**	**OPC**

PON Power on. Line power has been turned off and on.

CME Command error. An incorrectly formed command has occurred.

EXE Execution error. An error occurred while the 5500A tried to execute the last command.

DDE Device-dependent error. An error related to a device-dependent command has occurred.

QYE Query error. No response data was available or appropriate.

OPC Operation complete. All commands previous to *OPC command have been executed.

CHECKING 5500A STATUS (cont)

ISR, ISCE, and ISCR

15	14	13	12	11	10	9	8
0	**0**	**RPTBUSY**	**SETTLED**	**REMOTE**	**0**	**UUTBFUL**	**UUTDATA**

7	6	5	4	3	2	1	0
HIVOLT	**MAGCHG**	**TMPCAL**	**0**	**IBOOST**	**VBOOST**	**0**	**OPER**

RPTBUSY	Set to 1 when a calibration report is being printed to the serial port.
SETTLED	Set to 1 when the output has settled or the TC measurement has settled.
REMOTE	Set to 1 when the 5500A is under remote control.
UUTBFUL	Set to 1 when data from the UUT port has filled up the UUT buffer.
UUTDATA	Set to 1 when there is data available from the UUT port.
HIVOLT	Set to 1 when the 5500A is programmed to voltage above 33 V.
MAGCHG	Set to 1 when the output magnitude has changed. Always 0 in the ISR.
TMPCAL	Set to 1 when the 5500A is using temporary calibration data.
IBOOST	Set to 1 when a 5725A Amplifier is sourcing a current.
VBOOST	Set to 1 when a 5725A Amplifier is sourcing a voltage.
OPER	Set to 1 when the 5500A is in operate; 0 to when it is in standby.

Output Queue

The output queue is loaded whenever a query is processed, and holds up to 800 characters. If the queue is empty, the 5500A Calibrator does not respond to the INPUT statement. The Message Available (MAV) bit in the Serial Poll Status Byte is 1 if there is something in the output queue and 0 if the output queue is empty.

Error Queue

When a command error, execution error, or device-dependent error occurs, its error code is placed in the error queue where it can be read by the `ERR?` command. The error queue contains up to 16 entries.

COMMAND SUMMARY

Error Mode Commands	
EDIT	Sets edit field.
EDIT?	Returns edit field setting.
INCR	Increments or decrements output.
MULT	Multiplies reference magnitude.
NEWREF	Sets reference to output value.
OLDREF	Sets output to previous reference.
OUT_ERR?	Returns UUT computed error.
REFOUT?	Returns reference value.
External Connection Commands	
CUR_POST	Selects terminals for current output.
CUR_POST?	Returns terminals for current output.
EARTH	Selects earth ground is open or tied.
EARTH?	Returns earth ground open or tied.
LOWS	Selects low terminals open or tied.
LOWS?	Returns low terminals open or tied.
RTD_TYPE	Sets RTD sensor type.
RTD_TYPE?	Returns RTD sensor type.
TC_REF	Sets internal/external reference value.
TC_REF?	Returns TC reference value.
TC_TYPE	Sets TC sensor type.
TC_TYPE?	Returns TC sensor type.
TSENS_TYPE	Sets temperature sensor type.
TSENS_TYPE?	Returns temperature sensor type.

COMMAND SUMMARY (cont)

Common Commands	
*CLS	Clears ESR, ISCR0, ISCR1, error queue, RQS, and terminates pending *OPC or *OPC?
*ESE	Loads ESE register.
*ESE?	Returns ESE contents.
*ESR?	Returns ESR contents.
*IDN?	Returns instrument identification.
*OPC	Sets OPC bit in ESR to 1 when device operations are complete.
*OPC?	Returns 1 after operations are done.
*OPT?	Returns hardware/software options.
*PUD	Stores a string in nonvolatile memory.
*PUD?	Returns contents of *PUD memory.
*RST	Resets to power-up state.
*SRE	Loads SRE register.
*SRE?	Returns SRE contents.
*STB?	Returns the status byte.
*TRG	Triggers a TC measurement return value.
*TST?	Initiates self test;.return 0 for pass.
*WAI	Waits until commands are executed.
Output Commands	
BOOST	Activates/deactivates 5725A.
BOOST?	Returns 5725A use and output.
CFREQ?	Frequency for capacitance modes.
DC_OFFSET	Applies DC offset to AC output.
DC_OFFSET?	Returns the DC offset voltage.

COMMAND SUMMARY (cont)

Output Commands (cont)	
DPF	Sets displacement power factor.
DPF?	Returns displacement power factor.
DUTY	Sets squarewave duty cycle.
DUTY?	Returns duty cycle.
FUNC?	Returns output function.
HARMONIC	Sets harmonic output.
HARMONIC?	Returns harmonic location.
OPER	Activates 5500A output.
OPER?	Returns operate/standby setting.
OUT	Sets output and reference point.
OUT?	Returns output.
PHASE	Sets phase for dual outputs.
PHASE?	Returns phase output.
POWER?	Returns power for power outputs.
RANGE?	Returns output ranges.
RANGELCK	Locks range or set autorange.
RANGELCK?	Returns locked or autorange.
STBY	Puts 5500A in standby.
WAVE	Sets waveforms for AC outputs.
WAVE?	Returns output waveform.
ZCOMP	Activate/deactivate impedance compensation.
ZCOMP?	Returns status of impedance compensation.

COMMAND SUMMARY (cont)

RS-232 Host Port Commands	
LOCAL	Puts 5500A into local.
LOCKOUT	Puts 5500A into lockout state
REMOTE	Puts 5500A into remote.
SPLSTR	Sets Serial Poll response string.
SPLSTR?	Returns Serial Poll response.
SRQSTR	Sets serial mode SRQ response.
SRQSTR?	Returns serial mode SRQ response.
^P (<cntl>p)	Prints serial poll string.
^C (<cntl>c)	Clears device.
^T (<cntl>t)	Executes group trigger.
Setup and Utility Commands	
FORMAT	Restores default nonvolatile memory.
LIMIT	Sets maximum output magnitudes.
LIMIT?	Returns maximum output magnitudes.
ONTIME?	Returns time since last powered up.
RTD_TYPE_D	Set the default RTD sensor.
RTD_TYPE_D?	Returns default RTD sensor.
SP_SET	Sets serial HOST port settings.
SP_SET?	Returns serial HOST port settings.
SRC_PREF	Sets source preference.
SRC_PREF?	Returns source preference.
TC_TYPE_D	Sets default TC sensor.
TC_TYPE_D?	Returns default TC sensor.
TEMP_STD	Sets temperature standard.
TEMP_STD?	Returns temperature standard.

COMMAND SUMMARY (cont)

Status Commands	
ERR?	Returns first error code in queue and removes it from the queue.
EXPLAIN?	Explains an error code.
FAULT?	Returns first error code in queue and removes it from the queue.
ISCE	Loads bytes into ISCE0 and ISCE1.
ISCE?	Returns ISCE0 and ISCE1 contents.
ISCE0	Loads two bytes into ISCE0.
ISCE0?	Returns contents of ISCE0.
ISCE1	Loads two bytes into ISCE1.
ISCE1?	Returns contents of ISCE1.
ISCR?	Returns contents of ISCR0/ISCR1.
ISCR0?	Returns and clears ISCR0.
ISCR1?	Returns and clears ISCR1.
ISR?	Returns contents of ISR register.
Thermocouple (TC) Measurement Commands	
TC_MEAS	Changes mode to TC measurement.
TC_OFFSET	Sets a TC temperature offset.
TC_OFFSET?	Returns TC temperature offset.
TC_OTCD	Activates/deactivates otc circuit.
TC_OTCD?	Returns status of otc circuit.
VAL?	Returns last TC measurement.
RS-232 UUT Port Commands	
UUT_FLUSH	Flush UUT receive buffer.
UUT_RECV?	Return data from UUT serial port.
UUT_SEND	Sends string to UUT serial port.
UUT_SET	Sets the UUT serial port settings.
UUT_SET?	Returns the UUT serial port settings.

BOOST

Parameters: `ON`
`OFF`

BOOST?

Responses: `VOLTAGE`
`CURRENT`
`OFF`

CFREQ?

Response: <value>

*CLS

Parameter: (None)

CUR_POST

Parameters: `AUX`
`BOOST`

CUR_POST?

Responses: `AUX`
`BOOST`

DC_OFFSET

Parameter: <value

DC_OFFSET?

Response: <value>

DPF

Parameters: <value>`,LEAD`
<value>`,LAG`

DPF?

Responses: `<value>, LEAD`
`<value>, LAG`

DUTY

Parameter: `<value>` with optional `PCT`

DUTY?

Response: `<value>`

EARTH

Parameters: `OPEN`
`TIED`

EARTH?

Responses: `OPEN`
`TIED`

EDIT

Parameters: `PRI`
`SEC`
`FREQ`
`OFF`

EDIT?

Responses: `PRI`
`SEC`
`FREQ`
`OFF`

ERR?

Response: `<value>, <string>`

COMMAND LIST (cont)

*ESE

Parameter:	<value>

*ESE?

Response:	<value>

*ESR?

Response:	<value>

EXPLAIN?

Parameter:	<value>
Response:	<string>

FAULT?

Response:	<value>

FORMAT

Parameter:	ALL CAL SETUP

FUNC?

Responses:	DCV ACV DCI ACI RES CAP RTD TC_OUT DC_POWER AC_POWER DCV_DCV ACV_ACV TC_MEAS

HARMONIC

Parameters: <value>, PRI
<value>, SEC

HARMONIC?

Response: <value>, PRI
<value>, SEC

*IDN?

Response: <manufacturer>,
<model>,
<serial number>,
<main firmware>+
<encoder firmware>+
<inguard firmware>+
<5725A CPU> (or *)

INCR

Parameters: <+ value>
<- value>

ISCE

Parameter: <value>

ISCE?

Response: <value>

ISCE0

Parameter: <value>

ISCE0?

Response: <value>

ISCE1

Parameter: <value>

COMMAND LIST (cont)

ISCE1?

Response: <value>

ISCR?

Response: <value>

ISCR0?

Response: <value>

ISCR1?

Response: <value>

ISR?

Response: <value>

LIMIT

Parameters: <positive value>,<negative value>

LIMIT?

Response: <positive value voltage>,
<negative value voltage>,
<positive value current>,
<negative value current>

LOCAL

Parameter: (None)

LOCKOUT

Parameter: (None)

LOWS

Parameter: `OPEN`
`TIED`

COMMAND LIST (cont)

LOWS?

Response: OPEN
TIED

MULT

Parameter: <value>

NEWREF

Parameter: (None)

OLDREF

Parameter: (None)

ONTIME?

Response: <days>, <hours>

*OPC

Parameter: (None)

*OPC?

Response: 1

OPER

Parameter: (None)

OPER?

Response: 1 (Operate)
0 (Standby)

*OPT?

Responses: <option string>, <option string>, ...
0 (no options)

OUT

Parameters: <value> V
<value> DBM
<value> V, <value> Hz
<value> DBM, <value> Hz
<value> A
<value> A, <value> Hz
<value> OHM
<value> F
<value> CEL
<value> FAR
<value> HZ
<value> V, <value> A
<value> DBM, <value> A
<value> V, <value> A, <value> HZ
<value> DBM, <value> A, <value> HZ
<value> V, <value> V
<value> DBM, <value> DBM
<value> V, <value> V, <value> HZ
<value> DBM, <value> DBM, <value> HZ

OUT?

Parameters: V
A
DBM
CEL
FAR
OHM

Response: <primary amplitude value>,
<primary units>,
<secondary amplitude value>,
<secondary units>,
<fundamental frequency value>

OUT_ERR?

Response: <value of error>, <units>

PHASE	
Parameter:	<phase value> optional DEG
PHASE?	
Response:	<phase value>
POWER?	
Response:	<value>
***PUD**	
Parameter:	#2<nn><nn characters string> #0<character string> “<character string>“
***PUD?**	
Response:	#2nn<nn characters>
RANGE?	
Response:	<primary output>,<secondary output>
RANGELCK	
Parameter:	ON OFF
RANGELCK?	
Response:	ON OFF
REFOUT?	
Response:	<reference value>
REMOTE	
Parameter:	(None)

*RST

Response: (None)

RTD_TYPE

Parameters:
PT385
PT3926
NI120

RTD_TYPE?

Responses:
PT385
PT3926
NI120

RTD_TYPE_D

Parameters:
PT385
PT3926
NI120

RTD_TYPE_D?

Responses:
PT385
PT3926
NI120

SP_SET

Parameters: <300, 600, 1200, 2400, 4800, 9600>,
<TERM, COMP>,
<XON, NOSTALL, RTS>,
<DBIT7, DBIT8>,
<SBIT1, SBIT2>,
<PNONE, PODD, PEVEN>,
<CR, LF, CRLF>

SP_SET?

Responses: <300, 600, 1200, 2400, 4800, 9600>,
<TERM, COMP>,
<XON, NOSTALL, RTS>,
<DBIT7, DBIT8>,
<SBIT1, SBIT2>,
<PNONE, PODD, PEVEN>,
<CR, LF, CRLF>

SPLSTR

Parameter: "<string>\n"

SPLSTR?

Response: <string>

SRC_PREF

Parameters: P5500
P5725

SRC_PREF?

Responses: P5500
P5725

*SRE

Parameter: <value>

*SRE?

Response: <value>

SRQSTR

Parameter: "<string>\n"

SRQSTR?

Response: <string>

*STB?

Response: <value>

STBY

Parameter: (None)

TC_MEAS

Parameters: CEL
FAR

TC_OFFSET

Parameters: <value> CEL
<value> FAR

TC_OFFSET?

Responses: <value> CEL
<value> FAR

TC_OTCD

Parameters: ON
OFF

TC_OTCD?

Responses: ON
OFF

TC_REF

Parameters: INT
EXT, CEL (or FAR)

TC_REF?

Responses: INT, <value>, CEL (or FAR)
EXT, <value>, CEL (or FAR)

TC_TYPE	
Parameters:	B C E J K N R S T X (10 µV/°C)

TC_TYPE?	
Responses:	B C E J K N R S T X (10 µV/°C)

TC_TYPE_D	
Parameters:	B C E J K N R S T X (10 µV/°C)

TC_TYPE_D?

Responses:
B
C
E
J
K
N
R
S
T
X (10 μV/°C)

TEMP_STD

Parameters:
IPTS_68
ITS_90

TEMP_STD?

Responses:
IPTS_68
ITS_90

*TRG

Responses:
<measurement value>, CEL
<measurement value>, FAR
0.00E+00,OVER
0.00E+00,OPENTC
0.00E+00,NONE

TSENS_TYPE

Parameters:
TC
RTD

TSENS_TYPE?

Responses:
TC
RTD

*TST?

Response:
0 (pass)
1 (fail)

UUT_FLUSH

Parameter: (None)

UUT_RECV?

Response: <data>

UUT_SEND

Parameter: #2<nn><nn characters string>
#0<character string>
“<character string>“

Special Case The character string sent to a UUT must end in a carriage return (CR) or line feed (LF) command or both.

Carriage Return	^J	\n
Line Feed	^M	\r
Tab	Tab	\t
Backspace	^H	\b
Form Feed	^L	\f

UUT_SET

Parameters: <300, 600, 1200, 2400, 4800, 9600>,
<XON, NOSTALL, RTS>,
<DBIT7, DBIT8>,
<SBIT1, SBIT2>,
<PNONE, PODD, PEVEN>

UUT_SET?

Responses: <300, 600, 1200, 2400, 4800, 9600>,
<XON, NOSTALL, RTS>,
<DBIT7, DBIT8>,
<SBIT1, SBIT2>,
<PNONE, PODD, PEVEN>

VAL?

Responses: <measurement value>, CEL
<measurement value>, FAR
0.00E+00,OVER
0.00E+00,OPENTC
0.00E+00,NONE

*WAI

Parameters: (none)

WAVE

Parameter: <1st waveform> , (SINE, TRI, SQUARE, TRUNCS, NONE)
<2nd waveform> (SINE, TRI, SQUARE, TRUNCS, NONE)

WAVE?

Responses: <1st waveform> , (SINE, TRI, SQUARE, TRUNCS, NONE)
<2nd waveform> (SINE, TRI, SQUARE, TRUNCS, NONE)

ZCOMP

Parameter: NONE
WIRE2
WIRE4

ZCOMP?

Responses: NONE
WIRE2
WIRE4