

- A PRBS waveform using polynomial PN x is generated by a shift register of x bits, and the output waveform begins with x sample periods of high output. Sample period is the reciprocal of the sample rate (**FUNCTION:PRBS:BRATe**), and the channel's **Sync** pulse indicates the waveform's start. For example, if the PRBS uses PN23 with sample rate 500 Hz, the output begins with 46 ms of high output (23 x 2 ms). The polynomials are shown below.

Sequence Type	Polynomial	Length
PN3	$x^3 + x^2 + 1$	3
PN4	$x^4 + x^3 + 1$	4
PN5	$x^5 + x^3 + 1$	5
PN6	$x^6 + x^5 + 1$	6
PN7	$x^7 + x^6 + 1$	7
PN8	$x^8 + x^6 + x^5 + x^4 + 1$	8
PN9	$x^9 + x^5 + 1$	9
PN10	$x^{10} + x^7 + 1$	10
PN11	$x^{11} + x^9 + 1$	11
PN12	$x^{12} + x^6 + x^4 + x^1 + 1$	12
PN13	$x^{13} + x^4 + x^3 + x^1 + 1$	13
PN14	$x^{14} + x^5 + x^3 + x^1 + 1$	14
PN15	$x^{15} + x^{14} + 1$	15
PN16	$x^{16} + x^{15} + x^{13} + x^4 + 1$	16
PN17	$x^{17} + x^{14} + 1$	17
PN18	$x^{18} + x^{11} + 1$	18
PN19	$x^{19} + x^6 + x^2 + x^1 + 1$	19
PN20	$x^{20} + x^{17} + 1$	20
PN21	$x^{21} + x^{19} + 1$	21
PN22	$x^{22} + x^{21} + 1$	22
PN23	$x^{23} + x^{18} + 1$	23
PN24	$x^{24} + x^{23} + x^{22} + x^{17} + 1$	24
PN25	$x^{25} + x^{22} + 1$	25
PN26	$x^{26} + x^6 + x^2 + x^1 + 1$	26

Sequence Type	Polynomial	Length
PN27	$x^{27} + x^5 + x^2 + x^1 + 1$	27
PN28	$x^{28} + x^{25} + 1$	28
PN29	$x^{29} + x^{27} + 1$	29
PN30	$x^{30} + x^6 + x^4 + x^1 + 1$	30
PN31	$x^{31} + x^{28} + 1$	31
PN32	$x^{32} + x^{22} + x^2 + x^1 + 1$	32

[SOURCE[1|2]:]FUNCTION:PRBS:TRANSITION[:BOTH] {<seconds>|MINimum|MAXimum|DEFAULT}
[SOURCE[1|2]:]FUNCTION:PRBS:TRANSITION[:BOTH]? [{MINimum|MAXimum}]

Sets PRBS transition edge time on both edges of a PRBS transition.

Parameter	Typical Return
33500 Series: 8.4 ns (default) to 1 μ sec, limited as described below 33600 Series: 2.9 ns up to 4 Vpp, and 3.3 ns above 4Vpp to 1 μ sec; limited as described below	+1.0000000000000000E-08
Set edge time to 10 ns for the leading and trailing edges (two methods): FUNC:PRBS:TRAN 10 ns FUNC:PRBS:TRAN .000000010	

- The default "BOTH" keyword is optional and allows simultaneous control of the leading and trailing edges of the PRBS waveform.
- The edge time applies to both the rising and falling edges, and represents the time between the 10% and 90% thresholds of each edge.
- The specified edge time must fit within the specified period. The instrument will limit the edge time as needed to accommodate the specified bit rate. From the remote interface, a "Settings conflict" error will also be generated.

[SOURCE[1|2]:]FUNCTION:PULSe:DCYClE {<percent>|MINimum|MAXimum|DEFAULT}
 [SOURCE[1|2]:]FUNCTION:PULSe:DCYClE? [{MINimum|MAXimum}]

Sets pulse duty cycle.

Parameter	Typical Return
0 to 100, limited as described below; default 10	+5.000000000000000E+01
Set duty cycle to 50%: FUNC:PULS:DCYC 50	

- The **FUNCTION:PULSe:DCYClE** and **FUNCTION:PULSe:WIDTh** commands affect the same parameter. In some applications, it is natural to adjust pulse width directly (in seconds); in others, adjusting duty cycle seems more natural. When frequency is adjusted, if pulse width was most recently adjusted as duty cycle on the front panel, then duty cycle will be kept constant as frequency or period changes. However, if pulse width was the last setting, then pulse width will be kept constant as frequency or period changes. See **FUNCTION:PULSe:HOLD**.
- The pulse duty cycle is defined as:

$$\text{Duty Cycle} = 100 \times \text{Pulse Width} \div \text{Period}$$

Pulse width is the time from the 50% threshold of a pulse's rising edge to the 50% threshold of the next falling edge.

- The pulse duty cycle range is 0 percent to 100 percent. However, the pulse duty cycle is limited by *minimum pulse width* and *edge time* restrictions, which prevent you from setting exactly 0 percent or 100 percent. For example, for a 1 kHz pulse waveform, you are typically restricted to pulse duty cycles in the range 0.002 percent to 99.998 percent. This is limited by the minimum pulse width of 16 ns on the 33500 Series or 5 ns up to 4 Vpp and 8 ns up to 10 Vpp on the 33600 Series.
- Restrictions Based on Pulse Width: The specified pulse duty cycle must conform to the following restrictions determined by the *minimum pulse width*. The instrument will adjust pulse duty cycle as needed to accommodate the specified period. *From the remote interface, a "Settings conflict" error will also be generated.*

$$\text{Duty Cycle} \geq 100(\text{Minimum Pulse Width} / \text{Period})$$

and

$$\text{Duty Cycle} \leq 100 (1 - \text{Minimum Pulse Width} / \text{Period})$$

On the 33500 Series, the minimum pulse width is 16 ns. On the 33600 Series, the minimum pulse width is 5 ns up to 4 Vpp and 8 ns up to 10 Vpp.

- *Restrictions Based On and Affecting Edge Time:* The specified pulse duty cycle may affect the edge time. The edge time is adjusted first, and then the duty cycle is adjusted to accommodate the specified period, conforming to the following restriction. From the remote interface, a "Settings conflict" error will also be generated.

$$\text{Duty Cycle} \geq [(0.8 \times \text{Leading Edge Time}) + (0.8 \times \text{Trailing Edge Time})] / \text{Period} \times 100$$

and

$$\text{Duty Cycle} \leq [1 - [(0.8 \times \text{Leading Edge Time}) + (0.8 \times \text{Trailing Edge Time})] / \text{Period}] \times 100$$

[SOURce[1|2]:]FUNCTION:PULSe:HOLD {WIDTh|DCYClE}

[SOURce[1|2]:]FUNCTION:PULSe:HOLD?

Sets the pulse waveform parameter (either pulse width or duty cycle) to be held constant as other parameters are varied.

Parameter	Typical Return
{WIDTh DCYClE}, default WIDTh	WIDTh or DCYC
Set the instrument to hold duty cycle for pulse waveforms: FUNC:PULS:HOLD DCYC	

- **WIDTh:** the instrument holds the pulse width setting (in seconds) constant as the period is varied. If a command to set a duty cycle value is received, the duty cycle is converted to the equivalent pulse width. If pulse width modulation (PWM) is turned on, the pulse width and width deviation are held as the period is varied. Duty cycle deviation commands are converted to width deviations.

Minimum width and edge time restrictions apply. May cause a change in the selected edge times, pulse width, or both.

- **DCYClE:** the instrument holds the pulse duty cycle setting (in percent) constant as the period is varied. If a command to set a pulse width value is received, the width is converted to the equivalent duty cycle. If pulse width modulation (PWM) is turned on, the pulse duty cycle and the duty cycle deviation are held as the period is varied. Width deviation commands are converted to duty cycle deviation values.

Minimum width and edge time restrictions apply. May cause a change in the selected edge times, duty cycle, or both.

NOTE

The FUNCtion:PULSe:HOLD command does not limit period settings. The pulse width or duty cycle may be adjusted if necessary to accommodate a new period setting.

[SOURce[1|2]:]FUNCTION:PULSe:PERiod {<seconds>|MINimum|MAXimum|DEFAULT}

[SOURce[1|2]:]FUNCTION:PULSe:PERiod? [{MINimum|MAXimum}]

Sets the period for pulse waveforms. This command is paired with the **FREQuency** command; the one executed last overrides the other, as frequency and period specify the same parameter.

Parameter	Typical Return
From reciprocal of instrument's maximum frequency up to 1,000,000 s. Default 1 ms	+2.0000000000000000E-07
Set the period to 500 ms: FUNC:PULS:PER .5 or FUNC:PULS:PER 500 ms	

- The specified period must be greater than the sum of the pulse width and the edge time. The instrument will adjust edge time and pulse width as needed to accommodate the specified period. From the remote interface, a "Settings conflict" error will also be generated. The edge time is minimized first, and then the width (or duty cycle) is adjusted as shown below.

$$\text{Period} \geq [\text{Pulse Width} + ((\text{Lead Edge Time} + \text{Trail Edge Time}) * 0.625)]$$

- This command affects the period (and frequency) for all waveform functions (not just pulse). For example, if you select a period using FUNCTION:PULSe:PERiod and then change the output function to sine wave, the specified period will be used for the new function.
- Function Limitations: If you change to a function whose minimum period exceeds the value set by this command, the period is adjusted to the new function's minimum pulse. For example, if you set a period of 2 μ s and then change to the ramp function, the instrument adjusts the period to 5 μ s (the minimum for ramps). From the remote interface, a "Settings conflict" error will also be generated.

[SOURce[1|2]:]FUNCTION:PULSe:TRANsition[:BOTH] {<seconds>|MINimum|MAXimum|DEFAULT}

[SOURce[1|2]:]FUNCTION:PULSe:TRANsition:LEADing {<seconds>|MINimum|MAXimum|DEFAULT}

[SOURce[1|2]:]FUNCTION:PULSe:TRANsition:LEADing? [{MINimum|MAXimum}]

[SOURce[1|2]:]FUNCTION:PULSe:TRANsition:TRAILing {<seconds>|MINimum|MAXimum|DEFAULT}

[SOURce[1|2]:]FUNCTION:PULSe:TRANsition:TRAILing? [{MINimum|MAXimum}]

Sets the pulse edge time on the leading, trailing, or both edges of a pulse.

Parameter	Typical Return
33500 Series: 8.4 ns (default) to 1 μ sec, limited as described below 33600 Series: 2.9 ns up to 4 Vpp, and 3.3 ns above 4 Vpp, to 1 μ sec; limited as described below	+1.0000000000000000E-08
Set leading edge time to 10 ns (two methods): FUNC:PULS:TRAN:LEADing 10 ns FUNC:PULS:TRAN:LEADing .000000010	

- The leading edge time applies to rising edge, and represents the time from the 10% threshold to the 90% threshold of the edge; the trailing edge represents the time from the 90% threshold to the 10% threshold.
- The specified edge time must fit within the specified pulse width and period. The instrument will limit the edge time to accommodate the specified pulse width or duty cycle. From the remote interface, a "Settings conflict" error will also be generated.

[SOURCE[1|2]:]FUNCTION:PULSE:WIDTH {<seconds>|MINimum|MAXimum|DEFAULT}

[SOURCE[1|2]:]FUNCTION:PULSE:WIDTH? [{MINimum|MAXimum}]

Sets pulse width.

Parameter	Typical Return
16 ns (33500 Series), 5 ns (33600 Series up to 4 Vpp), or 8 ns (33600 Series up to 10 Vpp) up to approximately 1,000,000 s, limited as described below; default 100 μ s	+5.000000000000000E-03
Set pulse width to 5 ms (two methods): FUNC:PULS:WIDT 5 ms FUNC:PULS:WIDT .005	

- The **FUNCTION:PULSE:DCYCLE** and **FUNCTION:PULSE:WIDTH** commands affect the same parameter. In some applications, it is natural to adjust pulse width directly (in seconds); in others, adjusting duty cycle seems more natural. When frequency is adjusted, if pulse width was most recently adjusted as duty cycle on the front panel, then duty cycle will be kept constant as frequency or period changes. However, if pulse width was the last setting, then pulse width will be kept constant as frequency or period changes. See **FUNCTION:PULSE:HOLD**.
- Pulse width is the time from the 50% threshold of a pulse's rising edge to the 50% threshold of the next falling edge.
- The specified pulse width must be less than the difference between the *period* and the *minimum pulse width* as shown below. The instrument will adjust pulse edge time first and then limit pulse width as needed to accommodate the period. From the remote interface, a "Settings conflict" error will also be generated.

$$\text{Pulse Width} \leq \text{Period} - W_{\text{min}}$$

- The specified pulse width must also be less than the difference between the *period* and the *edge time* as shown below. The instrument will adjust pulse edge time first and then limit pulse width as needed to accommodate the period. From the remote interface, a "Settings conflict" error will also be generated.

$$\text{Pulse Width} \leq [\text{Period} - ((\text{Leading Edge Time} + \text{Trailing Edge Time}) * 0.625)]$$

- The pulse width must also be greater than the total time of one edge as shown below.

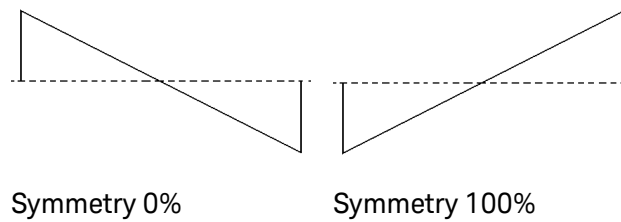
$$\text{Pulse Width} \geq [(\text{Leading Edge Time} + \text{Trailing Edge Time}) * 0.625]$$

[SOURCE[1|2]:]FUNCTION:RAMP:SYMMetry {<percent>|MINimum|MAXimum|DEFAULT}
 [SOURCE[1|2]:]FUNCTION:RAMP:SYMMetry? [{MINimum|MAXimum}]

Sets the symmetry percentage for ramp waves.

Parameter	Typical Return
0 to 100, default 100	+5.000000000000000E+01
Set symmetry to 50%: FUNC:RAMP:SYMM 50	

- Symmetry represents the amount of time per cycle that the ramp wave is rising (assuming that the waveform polarity is not inverted).



- For ramp waveforms, the **APPLY:RAMP** command overrides the current symmetry setting and selects 100%. To set a symmetry other than 100%, select the ramp waveform output with the **FUNCTION RAMP** command, then use **FUNCTION:RAMP:SYMMetry** to set the symmetry.
- The symmetry setting is remembered when you change from ramp wave to another function. When you return to the ramp wave function, the previous symmetry is used.
- When ramp is the modulating waveform for AM, FM, PM, or PWM, the symmetry setting does not apply. The instrument always uses a ramp waveform with 100% symmetry.

[SOURce[1|2]:]FUNCTION:SQUare:DCYClE {<percent>|MINimum|MAXimum}
[SOURce[1|2]:]FUNCTION:SQUare:DCYClE? [{MINimum|MAXimum}]

Sets duty cycle percentage for square wave.

Parameter	Typical Return
0.01 to 99.99, subject to limitation of 16 ns minimum pulse width; default 50	+5.000000000000000E+01
Set duty cycle to 30%: FUNC:SQU:DCYC 30 Sets the duty cycle to its minimum value: FUNC:SQU:DCYC MIN	

- Duty cycle represents the amount of time per cycle that the square wave is at a high level (assuming normal polarity).
- For square waveforms, **APPLY:SQUare** replaces the current duty cycle setting with 50%. To set a duty cycle other than 50%, select the square wave with **FUNCTION SQUare**, then use **FUNCTION:SQUare:DCYClE**.
- The duty cycle setting is remembered when you change from square wave to another function. When you return to square wave, the previous duty cycle is used.
- Limits Due to Frequency: As frequency is increased, minimum and maximum duty cycle limits are adjusted to maintain a minimum pulse width of 16 ns (33500 Series), 5 ns (33600 Series up to 4 Vpp), or 8 ns (33600 Series up to 10 Vpp). For example, at 1 MHz the minimum duty cycle on the 33500 Series is 1.60% and maximum duty cycle is 98.40%. At 10 MHz, the minimum duty cycle is 16.00% and the maximum duty cycle is 84.00%.
- If you select a square waveform as the modulating waveform for AM, FM, PM, or PWM, the instrument always uses a square wave with 50% duty cycle.

[SOURCE[1|2]:]FUNCTION:SQUare:PERiod {<seconds>|MINimum|MAXimum|DEFAULT}
 [SOURCE[1|2]:]FUNCTION:SQUare:PERiod? [{MINimum|MAXimum}]

Sets period for square wave.

Parameter	Typical Return
From reciprocal of maximum square wave frequency to 1,000,000 s, default 1 ms	+5.000000000000000E-01
Set period to 500 ms (two methods): FUNC:SQUare:PER .5 FUNC:SQUare:PER 500 ms	

- Function Limitations: If you change to a function whose minimum period exceeds the value set by this command, the period is adjusted to the new function's minimum pulse. For example, if you set a period of 2 μ s and then change to the ramp function, the instrument adjusts the period to 5 μ s (the minimum for ramps). From the remote interface, a "Settings conflict" error will also be generated. From the remote interface, a "Settings conflict" error will also be generated.

The commands shown below all require the IQ player option.

FUNCTION:ARBitrary:BALance[:STATe] {ON|1|OFF|0}
 FUNCTION:ARBitrary:BALance[:STATe]?

(IQ Player option only)

Enables or disables channel balancing for dual arbitrary waveforms (**FUNCTION:ARBitrary:BALance:GAIN** and **FUNCTION:ARBitrary:BALance:OFFSet**).

Parameter	Typical Return
{ON 1 OFF 0}, default OFF	0 (OFF) or 1 (ON)
Load an arbitrary waveform from the USB drive and set up the balance gain (channel 2 down by 1.02%) and balance offsets (120 mV for channel 1 and -38 mV for channel 2): FUNC:ARB "USB:\qam32.barb" FUNC:ARB:BAL:GAIN 1.02 FUNC:ARB:BAL:OFFS1 0.12 FUNC:ARB:BAL:OFFS2 -0.038 FUNC:ARB:BAL ON	

- This feature can be used to compensate for minor variations in the load impedances on the two channels, or for minor differences between the two channels of information in the original dual arbitrary waveform file.
- When the <state> is on, both channels must stay on the same amplifier range.
- This setting is stored as part of the instrument state, and it is affected by ***RST**.

FUNCTION:ARbitrary:BALance:GAIN {<percent>|MINimum|MAXimum|DEFine}

FUNCTION:ARbitrary:BALance:GAIN? [{MINimum|MAXimum}]

(IQ Player option only)

Sets the gain balance ratio for dual arbitrary waveforms.

Parameter	Typical Return
-30 to +30	+1.02000000E+000
Load an arbitrary waveform from the USB drive and set up the balance gain (channel 2 down by 1.02%) and balance offsets (120 mV for channel 1 and -38 mV for channel 2): FUNC:ARB "USB:\qam32.barb" FUNC:ARB:BAL:GAIN 1.02 FUNC:ARB:BAL:OFFS1 0.12 FUNC:ARB:BAL:OFFS2 -0.038 FUNC:ARB:BAL ON	

- Both channels must stay on the same amplifier range.
- A value of 0 means that both channels use their current amplitude. A positive value means that the amplitude of channel 2 is pushed down, while the amplitude of channel 1 remains constant, a negative value pushes channel 1 down while holding channel 2 constant. See the following table for examples.

<percent>	Channel 1 Amplitude %	Channel 2 Amplitude %
-20	80	100
-10	90	100
0	100	100
10	100	90
20	100	80

- This command is enabled by **FUNCTION:ARbitrary:BALance ON**.
- This setting is stored as part of the instrument state, and it is affected by ***RST**.

FUNCTION:ARbitrary:BALance:OFFSet{1|2} {<volts>|MINimum|MAXimum|DEFAULT}

FUNCTION:ARbitrary:BALance:OFFSet{1|2}? [MINimum|MAXimum]

(IQ Player option only)

Specifies the offset (in volts) added to the dual arbitrary waveform offset for the specified channel.

Parameter	Typical Return
A floating point value, limited by the dual arbitrary waveform amplitude.	+1.000000000E+000
Load an arbitrary waveform from the USB drive and set up the balance gain (channel 2 down by 1.02%) and balance offsets (120 mV for channel 1 and -38 mV for channel 2): FUNC:ARB "USB:\qam32.barb" FUNC:ARB:BAL:GAIN 1.02 FUNC:ARB:BAL:OFFS1 0.12 FUNC:ARB:BAL:OFFS2 -0.038 FUNC:ARB:BAL ON	

- Both channels must stay on the same amplifier range.
- This command is enabled by **FUNCTION:ARbitrary:BALance ON**.
- This setting is stored as part of the instrument state, and it is affected by ***RST**.

FUNCTION:ARbitrary:SKEW[:STATe] {ON|1|OFF|0}

FUNCTION:ARbitrary:SKEW[:STATe]?

(IQ Player option only)

Enables or disables skew time compensation (**FUNCTION:ARbitrary:SKEW:TIME**). This is always OFF for modulated signals, sweeps, lists, and bursts.

Parameter	Typical Return
{ON 1 OFF 0}, default OFF	0 (OFF) or 1 (ON)
Set the skew time to compensate for channel 1 being behind channel 2 by 140 picoseconds: FUNCTION:ARbitrary:SKEW:TIME 1.4e-10 FUNCTION:ARbitrary:SKEW ON	

- Skew compensation is typically determined empirically, using an oscilloscope and then set one time. That one-time setup will then be valid until the DUT or test equipment configuration changes.
- The value specified by this command is not stored in the instrument state. It is stored in non-volatile memory and is not affected by ***RST**.

FUNCTION:ARBitrary:SKEW:TIME [{<time>|MINimum|MAXimum|DEFault}]

FUNCTION:ARBitrary:SKEW:TIME? [{MINimum|MAXimum}]

(IQ Player option only)

Sets a small time difference between the channels to compensate for minor variations in timing at the connector output plane or at the device under test (DUT). Note that **FUNC:ARB:SKEW[:STATe] OFF** for modulated signals, sweeps, lists, and bursts.

Parameter	Typical Return
A floating point value in the range of ± 4 ns. Default 0.	+1.40000000E-010
Set the skew time to compensate for channel 1 being behind channel 2 by 140 picoseconds: FUNCTION:ARBitrary:SKEW:TIME 1.4e-10 FUNCTION:ARBitrary:SKEW ON	

- Channels may exhibit slight timing variations at the output connector plane due to variations in internal circuitry between the two channels. They may exhibit slight timing variations at the device under test (DUT) due to variations in signal paths, including such things as switches and cable lengths.
- A positive value delays channel 2, and a negative value delays channel 1.
- The value specified by this command is not stored in the instrument state. It is stored in non-volatile memory and is not affected by ***RST**.

HCOPy Subsystem

The HCOPy subsystem produces screen images ("screen shots") of the front panel display.

Example

The following example captures and returns the front panel display image in BMP format.

```
HCOP:SDUM:DATA:FORM BMP
HCOP:SDUM:DATA?
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HCOPy:SDUMp:DATA?

Returns the front panel display image ("screen shot")

Parameter	Typical Return
(none)	<i>(A definite-length binary block containing the image.)</i> Definite-length block data allows any type of device-dependent data to be transmitted as a series of 8-bit binary data bytes. This is particularly useful for transferring large quantities of data or 8-bit extended ASCII codes.
Capture and return the display image: HCOP:SDUM:DATA?	

- The image format (PNG or BMP) is specified by **HCOPy:SDUMp:DATA:FORMat**.

HCOPy:SDUMp:DATA:FORMat {PNG|BMP}

HCOPy:SDUMp:DATA:FORMat?

Specifies the image format for images returned by **HCOPy:SDUMp:DATA?**.

Parameter	Typical Return
{ PNG BMP }, default PNG	PNG or BMP
Set the display image format to BMP HCOP:SDUM:DATA:FORM BMP	

IEEE-488 Common Commands

This subsystem contains commands and queries associated with the IEEE-488 standards:

***CLS** - Clear status

***ESE <enable_value>** - Event status enable

***ESR?** - Event status register query

***IDN?** - Instrument identification

***OPC** - Set operation complete bit

***OPC?** - Wait for current operation to complete

***OPT?** - Show installed options

***PSC {0|1}** - Power-on status clear

***RCL {0|1|2|3|4}** - Recall instrument state

***RST** - Reset instrument to **factory defaults**

***SAV {0|1|2|3|4}** - Save instrument state

***SRE <enable_value>** - Service request enable (enable bits in enable register of Status Byte Register group)

***STB?** - Read status byte

***TRG** - Trigger command

***TST?** - Self-test

***WAI** - Wait for all pending operations to complete

Registers

Some of the IEEE-488 commands are associated with various registers in the instrument. These registers are described below.

Standard Event Register

The following table describes the Standard Event Register.

Bit Number	Bit Name	Decimal Value	Definition
0	Operation Complete	1	All commands before and including *OPC have been executed.
1	(not used)	2	(Reserved for future use)
2	Query Error	4	The instrument tried to read the output buffer but it was empty. Or, a new command line was received before a previous query has been read. Or, both the input and output buffers are full.
3	Device-Specific Error	8	A device-specific error, including a self-test error, calibration error or other device-specific error occurred. See Error Messages .
4	Execution Error	16	An execution error occurred. Error Messages
5	Command	32	A command syntax error occurred. Error Messages
6	(not used)	64	(Reserved for future use)
7	Power On	128	Power has been cycled since the last time the event register was read or cleared.

Status Byte Register

The following table describes the Status Byte Register.

Bit Number	Bit Name	Decimal Value	Definition
0	(not used)	1	(Reserved for future use)
1	(not used)	2	(Reserved for future use)
2	Error Queue	4	One or more errors in the Error Queue. Use SYSTem:ERRor? to read and delete errors.
3	Questionable Data Summary	8	One or more bits are set in the Questionable Data Register (bits must be enabled, see STATus:QUEStionable:ENABLE).
4	Message Available	16	Data is available in the instrument's output buffer.
5	Standard Event Summary	32	One or more bits are set in the Standard Event Register (bits must be enabled, see *ESE).
6	Master Summary	64	One or more bits are set in the Status Byte Register and may generate a Request for Service (RQS). Bits must be enabled using *SRE .
7	Operation Register	128	One or more bits are set in the Operation Status Register. Bits are enabled using STATus:OPERation:ENABLE .

*CLS

Clear Status Command. Clears the event registers in all register groups. Also clears the error queue.

Parameter	Typical Return
(none)	(none)
Clear event register bits and error queue: *CLS	

***ESE <enable_value>**

***ESE?**

Event Status Enable Command and Query. Enables bits in the **enable register** for the **Standard Event Register** group. The selected bits are then reported to bit 5 of the Status Byte Register.

Parameter	Typical Return
Decimal sum of the bits in the register (table below), default 0. For example, to enable bit 2 (value 4), bit 3 (value 8), and bit 7 (value 128), the decimal sum would be 140 (4 + 8 + 128). Default 0.	+48
Enable bit 4 (value 16) and bit 5 (value 32) in the enable register: *ESE 48	

- Use ***PSC** to control whether the Standard Event enable register is cleared at power on. For example, ***PSC 0** preserves the enable register contents through power cycles.
- ***CLS** does not clear enable register, does clear event register.

***ESR?**

Standard Event Status Register Query. Queries the event register for the **Standard Event Register** group. Register is read-only; bits not cleared when read.

Parameter	Typical Return
(none)	+24
Read the event register (bits 3 and 4 are set). *ESR	

- Any or all conditions can be reported to the Standard Event summary bit through the enable register. To set the enable register mask, write a decimal value to the register using ***ESE**.
- Once a bit is set, it remains set until cleared by this query or ***CLS**.

*IDN?

Identification Query. Returns instrument's identification string.

Parameter	Typical Return
(none)	Keysight Technologies,33522B,XXXXXXXXXX,0.179-1.19-8.88-52-00
Return the instrument's identification string: *IDN?	

- Identification string contains four comma separated fields:
 - Manufacturer name
 - Model number
 - Serial number
 - Revision code
- Identification string is in the following format for the 33500 Series instruments:

Keysight Technologies,[Model Number],[10-char Serial Number],A.aaa-B.bb-C.cc-DD-EE

A.aaa = Firmware revision
B.bb = Front panel FW revision
C.cc = Power supply controller FW revision
DD = FPGA revision
EE = PCBA revision

- Identification string is in the following format for the 33600 Series instruments:

Keysight Technologies,[Model Number],[Serial Number],A.aa.aa-B.bb-CC-DD-EE

A.aa.aa = Firmware revision
B.bb = Front panel FW revision
CC = Main board revision
DD = FPGA revision
EE = PCBA revision

*OPC

Sets "Operation Complete" (bit 0) in the Standard Event register at the completion of the current operation.

Parameter	Typical Return
(none)	(none)
Set Operation Complete bit: *OPC	

- The purpose of this command is to synchronize your application with the instrument.
- Used in triggered sweep, triggered burst, list, or arbitrary waveform sequence modes to provide a way to poll or interrupt the computer when the *TRG or INITiate[:IMMediate] is complete.
- Other commands may be executed before Operation Complete bit is set.
- The difference between *OPC and *OPC? is that *OPC? returns "1" to the output buffer when the current operation completes. This means that no further commands can be sent after an *OPC? until it has responded. In this way an explicit polling loop can be avoided. That is, the IO driver will wait for the response.

*OPC?

Returns 1 to the output buffer after all pending commands complete.

Parameter	Typical Return
(none)	1
Return 1 when all previous commands complete: *OPC?	

- The purpose of this command is to synchronize your application with the instrument.
- Other commands cannot be executed until this command completes.
- The difference between *OPC and *OPC? is that *OPC? returns "1" to the output buffer when the current operation completes. This means that no further commands can be sent after an *OPC? until it has responded. In this way an explicit polling loop can be avoided. That is, the IO driver will wait for the response.

*OPT?

Returns a quoted string identifying any installed options.

Parameter	Typical Return
(none)	"0,MEM,SEC,IQP"
Returns installed options (example: standard timebase, extended memory, security, IQ player) *OPT?	

***PSC {0|1}**

***PSC?**

Power-On Status Clear. Enables (1) or disables (0) clearing of two specific registers at power on:

- Standard Event enable register (***ESE**).
- Status Byte condition register (***SRE**).
- Questionable Data Register
- Standard Operation Register

Parameter	Typical Return
{0 1}, default 1	0 or 1
Disables power-on clearing of affected registers: *PSC 0	

- This setting is non-volatile through a power-cycle. If it therefore useful for GPIB connection as follows:

***PSC 0** to disable enable clearing

***ESE 128** to enable power-on event

***SRE 32** to enable a SRQ on std event

This short program now provides a GPIB SRQ signal when the unit is turned on.

***RCL {0|1|2|3|4}**

***SAV {0|1|2|3|4}**

Recalls (*RCL) or saves (*SAV) instrument state in specified non-volatile location. Previously stored state in location is overwritten (no error is generated).

NOTE

For 33600 Series instruments, the state files associated with *SAV and *RCL are saved in files called STATE_0.STA through STATE_4.STA. These files are located in the Settings directory of internal memory. You can manage these files using **MMEMory commands**.

Parameter	Typical Return
{0 1 2 3 4}	(none)
Recall state from location 1: *RCL 1	

- The instrument has five non-volatile storage locations to store instrument states. Location 0 holds the instrument power down state. Use locations 1, 2, 3, and 4 to store other states. You can configure the instrument to recall the power-down state when power is restored (**MEM:STAT:REC:AUTO**).
- State storage "remembers" the selected function (including arbitrary waveforms), frequency, amplitude, DC offset, duty cycle, symmetry, as well as any modulation parameters in use. Also remembers front panel display state (**DISP**).
- When shipped from the factory, locations 1 through 4 are empty, and location 0 has power-on state.
- From the remote interface only, you can use location 0 to store a fifth instrument state (you cannot store to this location from the front panel). However, location 0 is overwritten when power is cycled.
- You can **assign a user-defined name** to each of locations 0 through 4.
- States stored in memory are not affected by ***RST**.
- If you delete an arbitrary waveform from non-volatile memory after storing the instrument state, the waveform data is lost and the instrument will not output the waveform when the state is recalled; it will output the built-in "exponential rise" instead.
- The front panel uses **MMEMory subsystem** for state storage.

*RST

Resets instrument to **factory default state**, independent of **MEMory:STATe:RECall:AUTO** setting.

Parameter	Typical Return
(none)	(none)
Reset the instrument: *RST	

- Does not affect stored instrument states, stored arbitrary waveforms, or I/O settings; these are stored in non-volatile memory.
- Aborts a sweep or burst in progress.

*SRE <enable_value>

*SRE?

Service Request Enable. This command enables bits in the **enable register** for the **Status Byte Register** group.

Parameter	Typical Return
Decimal sum of the bits in the register (table below), default 0. For example, to enable bit 2 (value 4), bit 3 (value 8), and bit 7 (value 128), the decimal sum would be 140 (4 + 8 + 128). Default 0.	+24
Enable bits 3 and 4 in the enable register: *SRE 24	

- To enable specific bits, specify the decimal value corresponding to the binary-weighted sum of the bits in the register. The selected bits are summarized in the "Master Summary" bit (bit 6) of the Status Byte Register. If any of the selected bits change from 0 to 1, the instrument generates a Service Request signal.
- ***CLS** clears the event register, but not the enable register.
- ***PSC** (power-on status clear) determines whether Status Byte enable register is cleared at power on. For example, ***PSC 0** preserves the contents of the enable register through power cycles.
- Status Byte enable register is not cleared by ***RST**.

*STB?

Read Status Byte Query. This command queries the condition register for the **Status Byte Register** group.

Parameter	Typical Return
(none)	+40
Read condition register (with bits 3 and 5 set): *STB?	

- Similar to a Serial Poll, but processed like any other instrument command. Register is read-only; bits not cleared when read.
- Returns same result as a Serial Poll, but "Master Summary" bit (bit 6) is not cleared by *STB?.
- Power cycle or ***RST** clears all bits in condition register.
- Returns a decimal value that corresponds to the binary-weighted sum of all bits set in the register. For example, with bit 3 (value 8) and bit 5 (value 32) set (and corresponding bits enabled), the query returns +40.

*TRG

Trigger Command. Triggers a sweep, burst, arbitrary waveform advance, or **LIST** advance from the remote interface if the bus (software) trigger source is currently selected (**TRIGger[1|2]:SOURce BUS**).

Parameter	Typical Return
(none)	(none)
Send immediate trigger to initiate a burst: BURS:STAT ON BURS:MODE TRIG TRIG:SOUR BUS *TRG	

*TST?

Self-Test Query. Performs a complete instrument self-test. If test fails, one or more error messages will provide additional information. Use **SYSTem:ERRor?** to read error queue.

Parameter	Typical Return
(none)	+0 (pass) or +1 (one or more tests failed)
Perform self-test: *TST?	

- A power-on self-test occurs when you turn on the instrument. This limited test assures you that the instrument is operational.
- A complete self-test (***TST?**) takes approximately 15 seconds. If all tests pass, you have high confidence that the instrument is fully operational.
- Passing ***TST** displays "Self-Test Passed" on the front panel. Otherwise, it displays "Self-Test Failed" and an error number. See **Service and Repair - Introduction** for instructions on contacting support or returning the instrument for service.

*WAI

Configures the instrument to wait for all pending operations to complete before executing any additional commands over the interface.

Parameter	Typical Return
(none)	(none)
Wait until all pending operations complete. *WAI	

- For example, you can use this with the ***TRG** command to ensure that the instrument is ready for a trigger:

```
*TRG;*WAI;*TRG
```

Registers

The instrument uses three different type of registers to enable, flag and track instrument features.

- An enable register defines which bits in the event register will be reported to the Status Byte register group. You can write to or read from an enable register.
- A condition register continuously monitors the state of the instrument. The bits in the condition register are updated in real time and the bits are not latched or buffered.

- An event register is a read-only register that latches the various events from the condition register. There is no buffering in this register; while an event bit is set, subsequent events corresponding to that bit are ignored.

INITiate Subsystem

The INITiate subsystem controls how the instrument moves from the "idle" state to the "wait for trigger" state. You may do this one channel at a time, or for both channels with the "ALL" keyword.

Example

This program uses **INITiate[1|2]:IMMediate** with **TRIGger[1|2]:SOURce** and **TRIGger[1|2]:COUNT**. The **TRIG:SOUR EXT** command configures the channel for external triggering, and **TRIG:COUNT** sets the trigger count to 10. The **INITiate** command places the instrument in the "wait-for-trigger" state. The trigger will occur when the rear-panel **Ext Trig** line is pulsed (high by default). The channel will return to idle after the trigger count of 10 has been satisfied. Another INIT command would then be necessary to restart the acceptance of triggers from the external trigger input line.

```
INIT:CONT OFF
TRIG:SOUR EXT
TRIG:COUNT 10
INIT
```

INITiate[1|2]:CONTInuous {ON|1|OFF|0}

INITiate[1|2]:CONTInuous?

INITiate:CONTInuous:ALL {ON|1|OFF|0}

Specifies whether the trigger system for one or both channels (ALL) always returns to the "wait-for-trigger" state (ON) or remains in the "idle" state (OFF), ignoring triggers until **INITiate:IMMediate** is issued.

Parameter	Typical Return
{ON 1 OFF 0}, default ON	0 (OFF) or 1 (ON)
Configure both channels for continuous trigger: INIT:CONT:ALL ON	

- Once the channel is triggered, it leaves the wait-for-trigger state and enters the "action-in-progress" state (for example, burst-in-progress or sweep-in-progress). The action-in-progress state can be lengthy, and during this state triggers are ignored (will not count against number of triggers specified by **TRIGger[1|2]:COUNT**).
- With **INIT:CONT ON**, the trigger count is meaningless because there is no way to distinguish the completion of one trigger count from the first trigger of the next trigger count. If you need counted triggers, you must set **INIT:CONT OFF**.

INITiate[1|2][:IMMEDIATE]

INITiate[:IMMEDIATE]:ALL

Changes state of triggering system for both channels (ALL) from "idle" to "wait-for-trigger" for the number of triggers specified by **TRIGger[1|2]:COUNT**.

- Once the channel is triggered, it leaves the wait-for-trigger state and enters the "action-in-progress" state (for example, burst-in-progress or sweep-in-progress). The action-in-progress state can be lengthy, and during this state triggers are ignored (will not count against number of triggers specified by **TRIGger[1|2]:COUNT**).

Parameter	Typical Return
(none)	(none)
Change both channels to the wait-for-trigger state: INIT:IMM:ALL	

- The trigger system is armed by **INITiate[:IMMEDIATE]**. Once the trigger count is satisfied, the trigger system returns to idle state and ignores further triggers. The triggered function will be left in whatever state is achieved with the count of triggers. Rearming the trigger system with another **INITiate[:IMMEDIATE]** allows further triggers to apply.
- Use **ABORT** to return instrument to idle.
- If the specified channel has **INIT:CONT** set ON, **INITiate[1|2]:IMMEDIATE** and **INIT[:IMMEDIATE]:ALL** have no effect on the trigger system and error -213 will be generated.

INPut:ATTenuation[:STATe] {ON|1|OFF|0}
 INPut:ATTenuation[:STATe]?

Specifies whether the modulation input on the 33600 Series works with signals up to the 5 V level (ON) or the 1 V level (OFF).

Parameter	Typical Return
{ON 1 OFF 0}, default ON	0 (OFF) or 1 (ON)
Specify that the modulation input is to work with signals up to 5 V: INP:ATT ON	

- You can set this from the front panel modulation parameters screen if the modulation source is set to External.

LIST Subsystem

Configures list of frequencies to be output by instrument. This permits faster frequency change to a predetermined list of frequencies. You may advance frequencies by either an external trigger, an internal trigger, or a BUS trigger. List is initiated by FREQuency:MODE LIST.

LIST_DWELL - sets amount of time each frequency in list is generated.

LIST_FREQuency - Specify up to 128 frequencies as a list (frequencies may also be read from or saved to a file using MMEMory:LOAD:LIST[1|2] and MMEMory:STORE:LIST.

LIST_FREQuency_POINts - Returns number of points in a frequency list.

For LIST programming example, see [Create a List of Frequencies](#).

[SOURce[1|2]:]LIST:DWELL {<seconds>|MINimum|MAXimum}
 [SOURce[1|2]:]LIST:DWELL? [{MINimum|MAXimum}]

Sets dwell time, the amount of time each frequency in a frequency list is generated.

Parameter	Typical Return
1 μ s to 1000 s, default 1 s	+1.2000000000000000E+01
Set dwell time for channel 1 to 12 s: LIST:DWEL 12	

- The instrument generates each frequency in a frequency list for the specified dwell time, when TRIGger [1|2]:SOURce is IMMEDIATE.

[SOURce[1|2]:]LIST:FREQuency <freq1>[, <freq2>, etc.]
[SOURce[1|2]:]LIST:FREQuency?

Specifies frequency values in a frequency list.

Parameter	Typical Return
List of 1 to 128 frequencies, each 1 µHz to maximum instrument frequency (up to 200 kHz for triangle and ramp). Default list: 100 Hz, 1000 Hz, and 550 Hz.	2.17800000E+006,3.14000000E+003,6.28318000E+006
Set channel 1 frequency list to three frequency values: LIST:FREQ 2.718E6, 3.14E3, 6.28318E6	

- This command overwrites the previous list with the new list.

[SOURce[1|2]:]LIST:FREQuency:POINts? [{MINimum|MAXimum}]

Returns number of frequencies in current frequency list.

Parameter	Typical Return
[{MINimum MAXimum}]	+17
Return number of entries in the channel 1 frequency list: LIST:FREQ:POIN?	

- The default list has three frequencies: 100 Hz, 1000 Hz, and 550 Hz.
- MINimum is 1, MAXimum is 128.

LXI Subsystem

The LXI subsystem supports LAN eXtensions for Instrumentation (LXI) functionality.

LXI:IDENtify[:STATE] {ON|1|OFF|0}
LXI:IDENtify[:STATE]?

Turns the LXI Identify Indicator on the display on or off.

Parameter	Typical Return
{ON 1 OFF 0}	0 (OFF) or 1 (ON)
Turn on the LXI Identify Indicator: LXI:IDEN ON	

- The LXI Identify indicator helps you identify the device associated with the LAN address.
- A *RST turns LXI Identify Indicator off.
- Pressing the LOCAL key turns off the LXI Identify Indicator.

LXI:MDNS:ENABle {ON|1|OFF|0}

LXI:MDNS:ENABle?

Disables or enables the Multicast Domain Name System (mDNS).

Parameter	Typical Return
{ON 1 OFF 0}, default ON	0 (OFF) or 1 (ON)
Turn mDNS ON: LXI:MDSN:ENAB ON	

- Setting is enabled after **SYSTem:SECurity:IMMEDIATE**, ***RST**, power-on, or LAN reset.

LXI:MDNS:HNAME[:RESolved]?

Returns the resolved (unique) mDNS hostname in the form *<mDNS Hostname>-N*. The *N* is an integer appended if necessary to make the name unique. The desired name may be truncated, if necessary, to make room for the appended integer.

Parameter	Typical Return
(none)	"A-335xxx-00107", where xxx is the last three characters of the model number, and 00107 is the last five digits of the serial number.
Return the resolved mDNS hostname: LXI:MDNS:HNAME:RESolved?	

LXI:MDNS:SNAME:DESired <name>

LXI:MDNS:SNAME:DESired?

Sets the desired mDNS service name.

Parameter	Typical Return
Quoted string of up to 63 characters, default is Keysight <i><Model_Name></i> Arbitrary Waveform Generator - <i><Serial_Number></i> .	"Keysight 33xxxx Arbitrary Waveform Generator - 99999", where xxxx is the last four characters of the model number, and 99999 is the last five digits of the serial number.
Set the mDNS service name to "Waveform Generator": LXI:MDNS:SNAM:DES "Waveform Generator"	

- This setting is non-volatile; it will not be changed by power cycling or ***RST**.
- Setting is set to default value after **SYSTem:SECurity:IMMEDIATE**.

LXI:MDNS:SNAME[:RESolved]?

Returns the resolved (unique) mDNS service name in the form *<Desired mDNS Service Name>(N)*. The *N* is an integer appended if necessary to make the name unique. The desired name may be truncated, if necessary, to make room for the appended integer.

Parameter	Typical Return
(none)	"Keysight 33xxxx Arbitrary Waveform Generator - 99999", where xxxx is the last four characters of the model number, and 99999 is the last five digits of the serial number.
Return resolved mDNS service name: LXI:MDNS:SNAME:RESolved?	

- The resolved mDNS service name is the desired service name (**LXI:MDNS:SNAME:DESired**), possibly with "(N)" appended, where N is an integer, only if it is necessary to make the name unique.

LXI:RESet

Resets LAN settings to a known operating state, beginning with DHCP. If DHCP fails, it uses AutoIP. It also clears the WebUI password, if set.

Parameter	Typical Return
(none)	(none)
Reset the LAN settings: LXI:RES	

- Depending on your network, the LAN interface may take several seconds to restart after this command is sent.
- If the LAN interface or specific LAN services (VXI-11, sockets, and so on) have been disabled by **SYSTem:COMMunicate:ENABLE**, you must separately re-enable the interface or services and cycle power on the instrument for the LAN to be operational.

LXI:REStart

Restarts the LAN with the current settings as specified by the **SYSTem:COMM:LAN commands**.

Parameter	Typical Return
(none)	(none)
Restart the LAN interface: LXI:REST	

- Depending on your network, the LAN interface may take several seconds to restart after this command is sent.
- If the LAN interface or specific LAN services (VXI-11, sockets, and so on) have been disabled by **SYSTem:COMMunicate:ENABLE**, you must separately re-enable the interface or services and cycle power on the instrument for the LAN to be operational.

MARKer Subsystem

The MARKer subsystem configures the point within an arbitrary waveform, sweep, or burst at which the front panel **Sync** signal goes low.

Commands and Queries

- `[SOURce[1|2]:]MARKer:CYCLE {<cycle_num>|MINimum|MAXimum|DEFAULT}` - cycle of a burst at which **Sync** signal goes low
- `[SOURce[1|2]:]MARKer:FREQuency {<frequency>|MINimum|MAXimum|DEFAULT}` - frequency at which **Sync** signal goes low
- `[SOURce[1|2]:]MARKer:POINt {<sample_number>|MINimum|MAXimum}` - point in an arbitrary waveform at which **Sync** signal goes low

If and only if the SYNC:MODE is set to MARKer, each of these commands causes sync/marker to transition to high at start of burst, sweep, or arbitrary waveform. `OUTPut:SYNC:POLarity` may reverse this.

`[SOURce[1|2]:]MARKer:CYCLE {<cycle_num>|MINimum|MAXimum|DEFAULT}`

`[SOURce[1|2]:]MARKer:CYCLE? [{MINimum|MAXimum}]`

Sets the marker cycle number at which the front panel **Sync** signal goes low in a burst mode operation. `OUTPut:SYNC:POLarity` may reverse this.

Parameter	Typical Return
Whole number from 2 to number of cycles in the burst plus one (NCYCles+1), default 2	+2.0000000000000000E+03
Set the marker cycle to 2000: MARK:CYCL 2000	

- This is valid only if burst is enabled and `OUTPut:SYNC:MODE` is MARKer.
- With burst enabled, the marker cycle must be less than or equal to the number of cycles in the burst plus one. Attempting to set the marker cycle outside this range will set marker cycle equal to middle of burst. From the remote interface, a "Settings conflict" error will also be generated.

[SOURce[1|2]:]MARKer:FREQuency {<frequency>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]MARKer:FREQuency? [{MINimum|MAXimum}]

Sets the marker frequency at which the front panel **Sync** signal goes low during a sweep.

OUTPut:SYNC:POLarity may reverse this.

Parameter	Typical Return
Any frequency between start and stop frequency, default 500 Hz	+2.000000000000000E+03
Set marker frequency to 2 kHz: MARK:FREQ 2000	

- This is valid only if sweep is enabled and OUTPut:SYNC:MODE is MARKer.
- When sweep is enabled, marker frequency must be between start frequency and stop frequency. Attempting to set the marker cycle outside this range will set marker frequency to start frequency or frequency (whichever is closer). From the remote interface, a "Settings conflict" error will also be generated.

[SOURce[1|2]:]MARKer:POINt {<sample_number>|MINimum|MAXimum}
[SOURce[1|2]:]MARKer:POINt? [{MINimum|MAXimum}]

Sets the sample number at which the front panel **Sync** signal goes low within the active arbitrary waveform. OUTPut:SYNC:POLarity may reverse this.

Parameter	Typical Return
Whole number from 4 to number of samples in waveform, minus 3; default is midpoint of arbitrary waveform	+1.000000000000000E+01
Set marker point to 10th sample in waveform: MARK:POIN 10	

- Command only sets marker point in currently active arbitrary waveform (FUNCTION:ARbitrary), not in a sequence.
- Command is valid only under these conditions:
 - OUTPut:SYNC:MODE set to MARK, FUNC set to ARB, FREQuency:MODE set to CW
 - OUTPut:SYNC:MODE set to CARR, FUNC set to ARB, BURSt ON.
 - OUTPut:SYNC:MODE set to CARR, FUNC set to ARB, FREQuency:MODE set to SWEEP
 - OUTPut:SYNC:MODE set to MARK, internal modulation active, and either FUNCTION set to ARB or a modulating waveform's internal function is set to ARB
 - OUTPut:SYNC:MODE set to MARK, external modulation active, and FUNCTION set to ARB

MEMory Subsystem

The MEMory subsystem works with instrument state files that are saved to (*SAV) and recalled from (*RCL) non-volatile storage locations numbered 0 through 4.

NOTE

For 33600 Series instruments, the state files associated with *SAV and *RCL are saved in files called STATE_0.STA through STATE_4.STA. These files are located in the Settings directory of internal memory. You can manage these files using **MMEMory commands**.

Example

```
MEM:STAT:DEL 3
*SAV 3
MEM:STAT:VAL? 3
MEM:STAT:NAME 3,PATS_STATE
MEM:STAT:CAT?
```

Commands and Queries

- **MEMory:NSTates?** - return total number of state storage memory locations
- **MEMory:STATe:CATalog?** - list the names associated with all five state storage locations
- **MEMory:STATe:DELeTe {0|1|2|3|4}** - delete the contents of a state storage location
- **MEMory:STATe:NAME {0|1|2|3|4} [, <name>]** - assign a custom name to a state storage locations
- **MEMory:STATe:RECall:AUTO {ON|1|OFF|0}** - specify whether the power-down state is recalled from location 0 on power-on
- **MEMory:STATe:VALid? {0|1|2|3|4}** - determine whether a storage location contains a valid state

MEMory:NSTates?

Returns the total number of memory locations available for state storage (always +5, including memory location 0).

Parameter	Typical Return
(none)	+5
Return number of state storage locations: MEM:NST?	

MEMory:STATe:CATalog?

Returns the names assigned to locations 0 through 4.

Parameter	Typical Return
(none)	"AUTO_RECALL","STATE_1","STATE_2","STATE_3","STATE_4"
Return location names: MEM:STAT:CAT?	

- Default names are "AUTO_RECALL", "STATE_1", "STATE_2", "STATE_3", and "STATE_4".
- You can name location 0, but the name is overwritten when power is cycled and a new power-down state is stored there.

MEMory:STATe:DELeTe {0|1|2|3|4}

Deletes a state storage location.

Parameter	Typical Return
{0 1 2 3 4}	(none)
Delete the contents of storage location 1: MEM:STAT:DEL 1	

- Default names are "AUTO_RECALL", "STATE_1", "STATE_2", "STATE_3", and "STATE_4".
- Although you may delete the state in location 0, the instrument will be restored to its power-down state at the next power up.
- Attempting to recall a state from an empty location generates an error.

MEMory:STAtE:NAME {0|1|2|3|4} [, <name>]

MEMory:STAtE:NAME? {0|1|2|3|4}

Names a storage location.

Parameter	Typical Return
An unquoted string of up to 12 characters. The first character must be a letter (A-Z). Others can be letters, numbers (0-9), or underscores ("_"). If name omitted, factory default name is used.	TEST_RACK_1
Rename location 1: MEM:STAT:NAME 1,TEST_RACK_1	

- Default names are "AUTO_RECALL", "STATE_1", "STATE_2", "STATE_3", and "STATE_4".
- You can name location 0, but the name is overwritten when power is cycled and a new power-down state is stored there.
- May assign same name to different locations.
- Deleting a storage location's contents (**MEMory:STAtE:DELeTe**) resets associated name to factory default ("AUTO_RECALL", "STATE_1", "STATE_2", "STATE_3", or "STATE_4").
- State names are unaffected by ***RST**.

MEMory:STAtE:RECall:AUTO {ON|1|OFF|0}

MEMory:STAtE:RECall:AUTO?

Disables or enables automatic recall of instrument state in storage location "0" at power on.

Parameter	Typical Return
{ON 1 OFF 0}, default ON	0 (OFF) or 1 (ON)
Disable automatic recall of power-down state: MEM:STAT:REC:AUTO OFF	

- OFF is equivalent to Factory Reset (***RST**) on power-up.

MEMory:STAtE:VALid? {0|1|2|3|4}

Indicates whether a valid state is currently stored in a storage location.

Parameter	Typical Return
{0 1 2 3 4}	0 (no valid state stored) or 1 (valid state stored)
Return state of memory location 3: MEM:STAT:VAL 3?	

- Use this before sending ***SAV** to avoid accidentally overwriting a state.

MMEMory Subsystem

The MMEMory subsystem manages the file system in the instrument or on an external USB file system. The file system can store and load several file formats.

The "INT:" flash memory file system inside the instrument is always present. If a USB file storage device (sometimes called a flash drive, thumb drive, or jump drive) is plugged into the front panel USB port, it appears as "USB:" to the instrument.

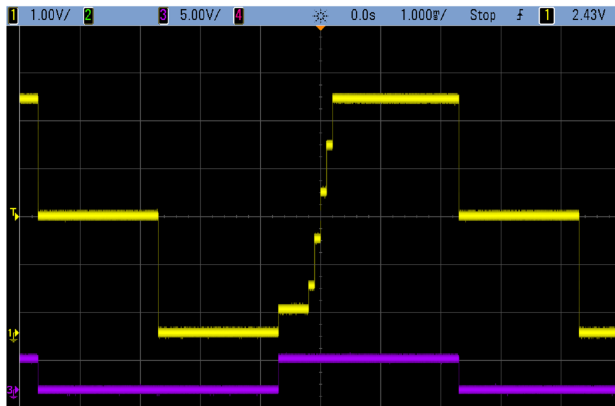
Example

The following code produces the sequence shown below. Note that the long **DATA:SEQuence** command splits across lines for readability purposes.

```
FUNC:ARB:SRATE 10E3
FUNC:ARB:FILTER OFF
FUNC:ARB:PTPEAK 10
DATA:ARB dc_ramp, 0.1, 0.1, 0.1, 0.1, 0.1, 0.2, 0.4, 0.6, 0.8, 1.0
DATA:ARB dc5v, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
DATA:ARB dc2_5v, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5
DATA:ARB dc0v, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
DATA:SEQuence #3128"seqExample","dc_
ramp",0,once,highAtStart,5,"dc5v",2,repeat,maintain,5,
      "dc2_v",2,repeat,lowAtStart,5,"dc0v",2,repeat,maintain,5
FUNC:ARB dc_ramp
MMEM:STORE:DATA "INT:\dc_ramp.arb"
FUNC:ARB dc5v
MMEM:STORE:DATA "INT:\dc5v.arb"
FUNC:ARB dc2_5v
MMEM:STORE:DATA "INT:\dc2_5.arb"
FUNC:ARB dc0v
MMEM:STORE:DATA "INT:\dc0v.arb"
FUNC:ARB seqExample
MMEM:STORE:DATA "INT:\seqExample.seq"
DATA:VOL:CLEAR <--- erase all waveforms to show LOAD will restore all
waveforms
MMEM:LOAD:DATA "INT:\seqExample.seq"
FUNC ARB
FUNC:ARB "INT:\seqExample.seq"
OUTPUT ON
```

The seqExample.seq file is as shown below:

```
File Format:1.10
Sample Rate:10000.000000
High Level:5.000000
Low Level:0.000000
Filter:"off"
Header:Arb Name, Repeat Count, Play Control,Marker Mode, Marker Point
dc_ramp.arb,1,"once","highAtStart",5
dc5v.arb,2,"repeat","maintain",5
dc2_5v.arb,2,"repeat","lowAtStart",5
dc0v.arb,2,"repeat","maintain",5
```



Commands and Queries

The MMEMory subsystem includes the following commands and queries.

MMEMory:CATalog[:ALL]? [*<folder>*] - lists available and used space and files on Mass Memory device

MMEMory:CATalog:DATA:ARbitrary? [*<folder>*] - lists arbitrary waveforms and sequences on Mass Memory device

MMEMory:CATalog:STATe? [*<folder>*] - lists available and used space and state (*.sta) files present on Mass Memory device

MMEMory:CDIRectory *<folder>* - changes to a directory

MMEMory:CDIRectory?

MMEMory:COpy *<file1>*,*<file2>* - copies a file on Mass Memory device

MMEMory:COpy:SEquence *<source>*,*<destination>* - copies a sequence and its associated arbitrary waveforms on Mass Memory device

MMEMory:DELeTe *<file>* - removes files from Mass Memory device

MMEMory:DOWNload:DATA *<binary_block>* - downloads data from the host computer to instrument's Mass Memory

MMEMory:DOWNload:FNAME *<filename>* - specifies file name for downloading data from the computer to instrument's Mass Memory

MMEMory:LOAD:ALL *<filename>* - loads instrument state file

MMEMory:LOAD:DATA[1|2] *<filename>* - loads arbitrary waveform from file

MMEMory:LOAD:LIST[1|2] *<filename>* - loads frequency list from file

MMEMory:LOAD:STATe *<filename>* - loads saved instrument state from file

MMEMory:MDIRectory *<folder>* - makes a new directory (folder)

MMEMory:MOVE *<file1>*,*<file2>* - moves a file on Mass Memory device

MMEMory:RDIRectory *<folder>* - removes a directory

MMEMory:STORe:ALL *<filename>* - saves instrument state file

MMEMory:STORe:DATA[1|2] *<filename>* - saves arbitrary waveform to file

MMEMory:STORe:LIST[1|2] *<filename>* - saves active frequency list to file

MMEMory:STORe:STATe *<filename>* - stores instrument state to file

MMEMory:UPLoad? *<filename>* - uploads contents of a file from instrument to host computer

Folder and file formats

Many MMEMory commands refer to folders and files. These have specific structures, described below.

Format for a <folder>

- The format for <folder> is "<drive>:<path>", where <drive> can be INTernal or USB, and <path> is an absolute folder path.
 - INTernal specifies the internal flash file system. USB specifies a front panel USB storage device.
 - Absolute paths begin with "\" or "/" and start at the root folder of <drive>.
 - The folder name specified in <path> cannot exceed 240 characters.
 - The specified folder must exist and cannot be marked hidden or system.
 - If <drive>:<path> is omitted, the folder specified by MMEMory:CDIRectory is used.
 - If <drive> is omitted:
 - The path is treated as a relative path and appended to the folder specified by MMEMory:CDIRectory.
 - Absolute paths are NOT allowed.

Format for a <file>

- The format for <file1> and <file2> is "[<drive>:<path>]<file_name>", where <drive> can be INTernal or USB, and <path> must be an absolute folder path.
 - INTernal specifies the internal flash file system. USB specifies a front panel USB storage device.
 - If <drive>:<path> is omitted, the folder specified by MMEMory:CDIRectory is used.
 - Absolute paths begin with "\" or "/" and start at the root folder of <drive>.
 - Folder and file names cannot contain the following characters: \ / : * ? " < > |
 - The combination of folder and file name cannot exceed 240 characters.
 - The source file and folder and the destination folder must exist and cannot be marked hidden or system.
 - If the destination file exists, it is overwritten, unless marked as hidden or system.
 - If <drive> is omitted:
 - The path is treated as a relative path and appended to the folder specified by MMEMory:CDIRectory.
 - Absolute paths are NOT allowed.

Mass Memory (MMEMory) and State Storage

The front panel uses the MMEM subsystem, not the MEM subsystem, to save states. If you save a state with the front panel, you can still access it with SCPI. However, a state saved into the MEM subsystem via SCPI using *SAV cannot be retrieved from the front panel.

For example, configure the instrument as desired and insert a USB drive into the front panel. Then enter the following commands. If you do not have a USB drive change "USB:\" to "INT:\" to use the instrument's internal flash drive instead.

```
MMEMory:CDIRectory "USB:\"  
MMEMory:MDIRerctory "States"  
MMEMory:STORe:STATE "USB:\States\State1"
```

To return to this state at any time:

```
MMEMory:LOAD:STATE "USB:\States\State1"
```

You can also recall a state file from the front panel by pressing **[System] > Store/Recall**.

MMEMory:CATalog[:ALL]? [<folder>]

Returns a list of all files in the current mass storage directory, including internal storage and the USB drive.

Parameter	Typical Return
Any valid folder name; defaults to folder selected by MMEMory:CDIRectory	+10000000000,+327168572, "command.exe,,375808", "MySetup.sta,STAT,8192", "MyWave.csv,ASC,11265"
List all files in the folder MyData on the front panel USB storage device: MMEM:CAT? "USB:\MyData"	

- The catalog takes the following form:

<mem_used>,<mem_free>{,"<file_listing>"}

The instrument returns two numeric values and a string for each file in the folder. The first numeric value indicates the number of bytes of storage used on the drive. The second indicates the number of bytes of storage available. Each *<file_listing>* is in the format "*<file_name>,<file_type>,<file_size>*" (the quotation marks are also returned), where *<file_name>* is the name of the file including file extension, if any; *<file_type>* is either STAT for STATE (.sta) files, ASC for DATA (.csv) files, FOLD for folders, or null for all other file extensions; *<file_size>* is the size of the file in bytes.

- If no files exist, only *<mem_used>,<mem_free>* is returned.
- Because the instrument uses a small amount of space in the flash file system for internal use, the *<mem_used>* value will not be zero even if no user files exist on the drive.

MMEMory:CATalog:DATA:ARbitrary? [<folder>]

Returns a list of all the arbitrary sequence (.seq) files and folders, as well as arbitrary waveform (.arb/.barb) files in a folder.

Parameter	Typical Return
Any valid folder name; defaults to folder selected by MMEMory:CDIRectory	(see below)
The following query lists all arbitrary waveform and sequence files in the BuiltIn directory of internal memory. MMEM:CAT:DATA:ARbitrary? "INT:\BuiltIn" Typical Response: 96256,1019770880,"EXP_RISE.arb,ARB,1868","EXP_FALL.arb,ARB,2064", "SINC.arb,ARB,1897","CARDIAC.arb,ARB,2410","NEG_RAMP.arb,ARB,1908", "HAVERSINE.arb,ARB,374","GAUSSIAN.arb,ARB,587","LORENTZ.arb,ARB,1254", "D_LORENTZ.arb,ARB,1373"	

- The instrument returns two numeric values and a string for each .seq and .arb/.barb file in the selected folder. The first numeric value indicates the number of bytes of storage used on the drive. The second indicates the number of bytes of storage available. Each <file listing> is in the format "<filename>,<file_type>,<file_size>" (the quotation marks are also returned), where <filename> is the name of the file including file extension, if any; <file_type> is FOLD for folders, ARB for arb segments, or SEQUENCE for arb sequence files; <file_size> is the size of the file in bytes.
- If no .seq, .arb, or .barb files exist, only <mem_used>,<mem_free> is returned.
- Because the instrument uses a small amount of space in the flash file system for internal use, the <mem_used> value will not be zero even if no user files exist on the drive.

MMEMory:CATalog:STATe? [<folder>]

Lists all state files (.sta file extension) in a folder.

Parameter	Typical Return
Any valid folder name; defaults to folder selected by MMEMory:CDIRectory	+10000000000,+327168572,"MySetup.sta,STAT,8192"
List all state files in MyData folder on front panel USB drive. MMEM:CAT:STAT? "USB:\MyData"	

- Format for returned catalog:

<mem_used>,<mem_free>{,"<file_listing>"}

- The instrument returns two numeric values and a string for each state file in the selected folder. The first numeric value indicates the number of bytes of storage used on the drive. The second indicates the number of bytes of storage available. Each *<file_listing>* is in the format "*<file_name>,<file_type>,<file_size>*" (the quotes are also returned), where *<file_name>* is the name of the file including file extension, if any; *<file_type>* is STAT for STATe (.sta) files; *<file_size>* is the size of the file in bytes.
- If no state files exist, only *<mem_used>,<mem_free>* is returned.
- Because the instrument uses a small amount of space in the flash file system for internal use, the *<mem_used>* value will not be zero even if no user files exist on the drive.

MMEMory:CDIRectory <folder>

MMEMory:CDIRectory?

MMEMory:MDIRectory <folder>

MMEMory:RDIRectory <folder>

MMEMory:CDIRectory selects the default folder for the MMEMory subsystem commands. This folder must exist and is used when folder or file names do not include a drive and folder name.

MMEMory:MDIRectory makes a new directory (folder) on the mass storage medium.

MMEMory:RDIRectory removes a directory (folder) on the mass storage medium.

Parameter	Typical Return
Any directory name, including the mass storage unit specifier, default INT:\	"INT:\"
Make and remove a new directory named "test" on the internal mass memory system: MMEM:MDIR "test" MMEM:RDIR "test" Return the default folder for MMEMory subsystem commands: MMEM:CDIR?	

- The instrument resets the default folder to the internal flash file system root directory ("INT:\") after ***RST**.
- You can only remove an empty folder (no files). Otherwise, the instrument generates a "Directory not empty" error.

MMEMory:COPY <file1>,<file2>

Copies <file1> to <file2>. The file names must include any file extension.

Parameter	Typical Return
Both files can be any valid file name	(none)
Copy the state file MyFreqMeas.sta from the root directory to the folder "Backup" on the internal flash file system. MMEM:COPY "INT:\MySetup.sta","INT:\Backup"	

- To copy a file to a file of the same name in a different folder, you can specify just the <drive> and/or <path> for <destination>.

MMEMory:COpy:SEQuence <source>,<destination>

Copies a sequence from <source> to <destination>. The file names must include any file extension. Use the extension .seq for text format.

Parameter	Typical Return
<source> and <destination> may be any valid sequence file name.	(none)
Copy the sequence file MySequence.seq and all associated segment files specified in the sequence file from internal drive to the folder "Backup" on internal storage. MMEM:COpy:SEQ "INT:\MySequence.seq", "INT:\Backup"	

- The format for <source> and <destination> is "[<drive>:]<path><file_name>", where <drive> can be INTernal or USB, and <path> is a file path.
 - INTernal specifies the internal flash file system. USB specifies a front panel USB storage device.
 - If <drive> is specified, <path> is interpreted as an absolute path. Absolute paths begin with "\" or "/" and start at the root folder of <drive>.
 - If <drive> is omitted, <path> is relative to the folder specified by MMEMory:CDIRectory. Relative paths must not begin with "\" or "/".
 - Folder and file names cannot contain the following characters: \ / : * ? " < > |
 - The combination of folder and file name cannot exceed 240 characters.
 - The source file and folder and the destination folder must exist and cannot be marked hidden or system.
 - If the destination file exists, it is overwritten, unless marked as hidden or system.
 - To copy a sequence file to a sequence file of the same name in a different folder, you can specify just the <drive> and/or <path> for <destination>.

MMEMory:DELeTe <file>

Deletes a file. To delete a folder, use MMEMory:RDIRectory.

Parameter	Typical Return
Any valid file name, including file extension.	(none)
Delete the indicated file from the root directory of the internal flash file system: MMEM:DEL "INT:\MySetup.sta"	

- You may also use wildcards with this command. For example, MMEM:DEL "INT:\MYDATA*.csv" will erase all of the CSV files in the specified directory.

MMEMory:DOWNload:DATA <binary_block>

Downloads data from the host computer to a file in the instrument. The filename must have been previously specified by **MMEMory:DOWNload:FNAME**.

The data in <binary_block> is written to the select file, and any data previously stored in the file is lost.

Parameter	Typical Return
Any IEEE-488 definite or indefinite block	(none)
Writes the word "Hello" to the file "\\Myfile" on internal storage. MMEM:DOWN:FNAME "INT:\\Myfile" MMEM:DOWN:DATA #15Hello	

MMEMory:DOWNload:FNAME <filename>

Creates or opens the specified filename prior to writing data to that file with **MMEMory:DOWNload:DATA**.

Parameter	Typical Return
Any valid file name	(none)
Write the word "Hello" to the file "\\Myfile" on the internal flash file system: MMEM:DOWN:FNAME "INT:\\Myfile"MMEM:DOWN:DATA #15Hello	

MMEMory:LOAD:ALL <filename>

MMEMory:STORE:ALL <filename>

Loads or saves a complete instrument setup, using a named file on the mass storage.

Parameter	Typical Return
Any valid file name on current mass storage directory	(none)
Store instrument setup to file named "completeSetup.all" on internal storage: MMEM:STORE:ALL "INT:\\completeSetup.all" Load a complete instrument setup from the file in internal mass memory. MMEM:LOAD:ALL "INT:\\completeSetup.all"	

- These commands allow you to duplicate instrument conditions from some previous time.
- This command loads the current instrument setup (such as is used by ***SAV** and ***RCL**).
- Instrument setup files used by these commands contain much more than the state files used by ***SAV** and ***RCL**. They also contain stored states and arbitrary waveforms, GPIB and LAN parameters, number format, beep on/off, display options, and help language.
- If the destination file exists, it is overwritten, unless marked as hidden or system.

MMEMory:LOAD:DATA[1|2] <filename>

Loads the specified arb segment(.arb/.barb) or arb sequence (.seq) file in INTERNAL or USB memory into volatile memory for the specified channel.

Parameter	Typical Return
Any valid file name, as described below.	(none)
Load an arbitrary waveform segment from the internal drive into volatile memory for channel 1 and selects it for use. MMEM:LOAD:DATA "Int:\Builtin\HAVERSINE.arb" FUNC:ARB "Int:\Builtin\HAVERSINE.ARB"	

- If a sequence file (.seq) is specified, all the arbitrary waveforms defined in the file are loaded.
- If the waveform referenced by <filename> has already been loaded, the instrument will generate error number +786, "Specified arb waveform already exists". Deleting an existing waveform requires clearing the waveform non-volatile memory with **DATA:VOLatile:CLEar**.

MMEMory:LOAD:LIST[1|2] <filename>

MMEMory:STORE:LIST[1|2] <filename>

Loads or stores a frequency list file (.lst).

Parameter	Typical Return
Any valid file name on the mass memory device	(none)
Store the current frequency list to a LIST file on internal storage: MMEM:STOR:LIST "INT:\FreqList.lst" Load a LIST file on the internal storage mass memory system (file named FreqList.lst). MMEM:LOAD:LIST "INT:\FreqList.lst"	

- A frequency list controls frequency in **FREQ:MODE LIST**, rapidly changing to the next frequency in the list when a trigger event is received.
- A frequency list file contains a comma-separated sequence of ASCII numbers, with the first number representing the number of frequencies in the list:

3, 100.000000, 1000.000000, 550.000000
- If the destination file exists, it is overwritten, unless marked as hidden or system.

MMEMory:LOAD:STATE <filename>

MMEMory:STORE:STATE <filename>

Stores the current instrument state to a state file. The file name optionally includes the folder name and the .sta file extension.

Parameter	Typical Return
Any valid file name on the current directory	(none)
Store the current instrument state to the state file MyFreqMeas.sta in the root directory of the internal flash file system. MMEM:STOR:STAT "INT:\MySetup"	
Load the instrument state from MySetup.sta in the root directory of the internal storage. MMEM:LOAD:STAT "INT:\MySetup.sta"	

MMEMory:MOVE <file1>,<file2>

Moves and/or renames <file1> to <file2>. The file names must include the file extension.

Parameter	Typical Return
Both files may be any valid file name	(none)
Move the state file MySetup.sta from the currently selected default directory to the folder "Backup" on the internal flash file system; MMEM:MOVE "MySetup.sta", "INT:\Backup"	
Rename the arbitrary waveform arbMonday on the USB drive to the name arbTuesday. MMEM:MOVE "USB:\arbMonday", "USB:\arbTuesday"	

- To simply rename a file, specify the same folder for <file1> and <file2>.
- To move a file to a file of the same name in a different folder, you can specify just the <drive>:<path> for <file2>.

MMEMory:STORe:DATA[1|2] <filename>

Stores the specified arb segment(.arb/.barb) or arb sequence (.seq) data in the channel specified volatile memory (default, channel 1) in INTERNAL or USB memory.

Parameter	Typical Return
Any valid file name	(none)
Store an arbitrary sequence loaded in volatile memory on channel 1 to the internal drive. MMEM:STOR:DATA "INT:\Sequence1.seq"	

- When you store an arbitrary waveform segment or sequence (MMEMory:STORe:DATA[1|2]), the instrument's current settings (voltage values, sample rate, filter type, and so on) are stored in the segment or sequence file. When you play the file for the first time with FUNCtion:ARBitrary, these settings are loaded and override the instrument's current settings. If you have manually edited a segment or sequence file such that the instrument settings have been removed, the instrument settings will not be changed when you execute FUNCtion:ARBitrary.
- If the destination file exists, it is overwritten, unless marked as hidden or system.
- If an arbitrary waveform sequence file (.seq) is specified, all the arbitrary waveform segment file names associated with the sequence are stored in the file.
- Command will error if the specified arbitrary waveform segment or arbitrary waveform sequence is not found in volatile memory.

MMEMory:UPLoad? <filename>

Uploads the contents of a file from the instrument to the host computer.

Parameter	Typical Return
Any valid file name	IEEE 488.2 definite-length block
The following command uploads the contents of the state file "Myfile.sta" in the root directory of the internal flash file system to the host computer: MMEM:UPL? "INT:\Myfile.sta"	

OUTPut Subsystem

The OUTPut subsystem controls the front panel channel output and **Sync** connectors and the rear-panel **Ext Trig** connector:

- OUTPut[1|2]{ON|1|OFF|0} - front panel channel output connector state
- OUTPut[1|2]:LOAD {<ohms>|INFinity|MINimum|MAXimum|DEFault} - output termination impedance
- OUTPut[1|2]:MODE {NORMAL|GATed} - channel output mode
- OUTPut[1|2]:POLarity {NORMAL|INVerted} - output waveform polarity
- OUTPut:SYNC {ON|1|OFF|0} - front panel **Sync** connector state

- **OUTPut[1|2]:SYNC:MODE?** - sync signal mode
- **OUTPut[1|2]:SYNC:POLarity {NORMAL|INVerted}** - sync waveform polarity
- **OUTPut:SYNC:SOURce {CH1|CH2}** - channel used to drive sync signal
- **OUTPut:TRIGger {ON|1|OFF|0}** - rear-panel **Ext Trig** connector state
- **OUTPut:TRIGger:SLOPe {POSitive|NEGative}** - "trigger out" polarity
- **OUTPut:TRIGger:SOURce {CH1|CH2}** - channel for driving output trigger

OUTPut[1|2] {ON|1|OFF|0}

OUTPut[1|2]?

Enables or disables the front panel output connector.

Parameter	Typical Return
{ON 1 OFF 0}, default OFF	0 (OFF) or 1 (ON)
Enable output connector for channel 1: OUTP ON	

- When output is enabled, the front panel channel output key is illuminated.
- The **APPLY** commands override current OUTPut setting and enable the channel output connector.
- If excessive external voltage is applied to the front panel channel output connector, an error message appears and output is disabled. To re-enable output, remove overload from the output connector and send OUTPut ON.
- OUTPut changes the state of the channel output connector by switching the output relay, without zeroing output voltage. Therefore, output may glitch for about a millisecond until signal stabilizes. Minimize glitching by first minimizing amplitude (**VOLTage MIN**) and setting offset to 0 (**VOLTage:OFFSet 0**) before changing output state.
- This command also toggles the output impedance between 50 Ω (ON) and high (> 1 M Ω) impedance (OFF).

OUTPut[1|2]:LOAD {<ohms>|INFinity|MINimum|MAXimum|DEFault}
OUTPut[1|2]:LOAD? [{MINimum|MAXimum}]

Sets expected output termination. Should equal the load impedance attached to the output.

Parameter	Typical Return
1 Ω to 10 k Ω , default 50 Ω	+5.000000000000000E+02
Set output impedance to 300 Ω : OUTP:LOAD 300 Set output impedance to "high impedance": OUTP:LOAD INF	

- The specified value is used for amplitude, offset, and high/low level settings.
- The instrument has a fixed series output impedance of 50 Ω to the front panel channel connectors. If the actual load impedance differs from the value specified, the displayed amplitude and offset levels will be incorrect. The load impedance setting is simply a convenience to ensure that the displayed voltage matches the expected load.
- If you change the output termination setting, the displayed output amplitude, offset, and high/low levels are adjusted (with no error generated). If the amplitude is 10 Vpp and you change the output termination setting from 50 Ω to "high impedance" (**OUTPut[1|2]:LOAD INF**), the displayed amplitude doubles to 20 Vpp. Changing from "high impedance" to 50 Ω halves the displayed amplitude. The output termination setting does not affect the actual output voltage; it only changes the values displayed and queried from the remote interface. Actual output voltage depends on the connected load.
- You cannot specify output amplitude in dBm if output termination is set to high impedance. The units are automatically converted to Vpp. See **VOLT:UNIT** for details.
- You cannot change the output termination setting with voltage limits enabled; the instrument cannot know which output termination settings the voltage limits apply to. To change the output termination setting, disable voltage limits, set the new termination value, adjust voltage limits, and re-enable voltage limits.
- If INF (high impedance) is selected, the query returns 9.9E+37.

OUTPut[1|2]:MODE {NORMal|GATed}
OUTPut[1|2]:MODE?

Enables (GATed) or disables (NORMal) gating of the output waveform signal on and off using the trigger input.

Parameter	Typical Return
{ NORMal GATed }, default NORMal	GAT or NORM
Enable gated output: OUTP:MODE GAT	

- The effect of gating is independent of waveform phase or timing of any sort. When trigger input is asserted, the output signal is generated. When trigger is not asserted, the waveform continues to be generated internally, but it is not routed to channel output connector.
- Gating does not change channel output termination (does not operate output on/off relay).

OUTPut[1|2]:POLarity {NORMal|INVerted}
OUTPut[1|2]:POLarity?

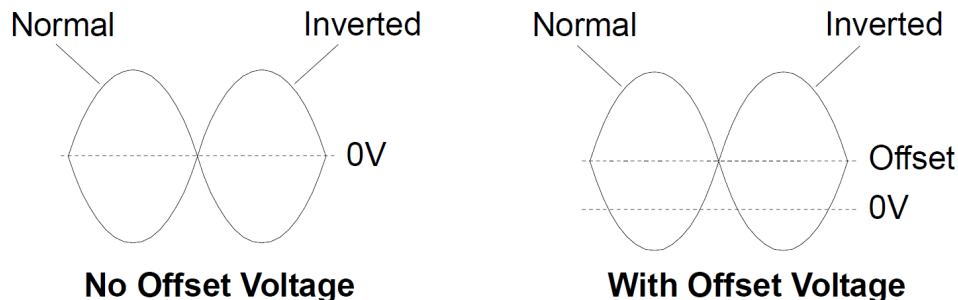
Inverts waveform relative to the offset voltage.

Parameter	Typical Return
{ NORMal INVerted }, default NORMal	NORM or INV
Set output polarity to INVerted: OUTP:POL INV	

- **NORMal**: waveform goes in one direction at the beginning of the cycle;

INVerted: waveform goes in other.

- As shown below, the waveform is inverted relative to the offset voltage. The offset voltage remains unchanged when the waveform is inverted.



- The **Sync** signal associated with an inverted waveform is not inverted.

OUTPut:SYNC {ON|1|OFF|0}

OUTPut:SYNC?

Disables or enables the front panel **Sync** connector.

Parameter	Typical Return
{ON 1 OFF 0}, default ON	0 (OFF) or 1 (ON)
Disable front panel Sync connector: OUTP:SYNC OFF	

- Disabling the **Sync** signal reduces output distortion at lower amplitudes.
- For more details on the **Sync** signal for each waveform function, see [Sync Output Signal](#).
- When **Sync** is disabled, the output level on the **Sync** connector is a logic "low."
- Inverting a waveform (OUTPut[1|2]:POLarity INV) does not invert the **Sync** signal.

OUTPut[1|2]:SYNC:MODE {NORMal|CARRier|MARKer}

OUTPut[1|2]:SYNC:MODE?

Specifies normal **Sync** behavior (NORMal), forces **Sync** to follow the carrier waveform (CARRier), or indicates marker position (MARKer).

Parameter	Typical Return
{ NORMal CARRier MARKer}, default NORMal	NORM, CARR, or MARK
Set output sync mode to CARRier: OUTPut:SYNC:MODE CARR	

- The following table details the command's behavior:

<mode>	Sync Behavior	Conditions
NORMal	Sync follows envelope of burst signal.	When BURSt is on
	Sync follows envelope of sweep signal.	When SWEEp is on
	Sync follows modulating signal.	When modulating and modulation source is internal
	Sync follows FUNC signal.	All other conditions
CARRier	Sync follows current SOURce:MARKer:POINT setting.	When BURSt or SWEEp is on and FUNC is ARB
	Sync follows FUNC signal while burst is on.	When BURSt is on and FUNC is not ARB
	Sync follows FUNC signal.	All other conditions
MARKer	Sync follows current SOURce:MARKer:POINT setting.	When in CW mode and FUNC is ARB When modulating, modulation source is internal, and FUNC is ARB or <modulation>:INT:FUNC is ARB When modulating, modulation source is external, and FUNC is ARB
	Sync follows current SOURce:MARKer:CYCLE setting.	When BURST is on
	Sync follows current SOURce:MARKer:FREQuency setting.	When SWEEP is on
	Sync follows modulating signal.	When modulating, modulation source is not external, FUNC is not ARB, and INT:FUNC is not ARB
	Sync follows FUNC signal.	All other conditions

OUTPut[1|2]:SYNC:POLarity {NORMal|INVerted}
OUTPut[1|2]:SYNC:POLarity?

Sets the desired output polarity of the **Sync** output to trigger external equipment that may require falling or rising edge triggers.

Parameter	Typical Return
{ NORMal INVerted }, default NORMal	NORM or INV
Set the instrument's output sync connector to normal behavior: OUTP:SYNC:POL NORM	

- **NORMal**: voltage on **Sync** output connector is near zero, and rises when a **Sync** event occurs. Voltage stays high (approximately 3.3 V into high impedance) until **Sync** signal is de-asserted, when it falls back to near zero.
- **INVerted**: opposite of NORMal.
- The **Sync** signal may be derived from either channel in a two-channel instrument (**OUTPut:SYNC:SOURce**), and from several operating modes of the **Sync** signal (**OUTPut:SYNC:MODE**).

OUTPut:SYNC:SOURce {CH1|CH2}
OUTPut:SYNC:SOURce?

Sets the source for the **Sync** output connector.

Parameter	Typical Return
{ CH1 CH2 }, default CH1	CH1 or CH2
Set sync source to channel 2: OUTP :SYNC:SOUR CH2	

OUTPut:TRIGger {ON|1|OFF|0}

OUTPut:TRIGger?

Disables or enables the "trigger out" signal for sweep and burst modes.

Parameter	Typical Return
{ON 1 OFF 0}, default OFF	0 (OFF) or 1 (ON)
Enable trigger out signal: OUTP:TRIG ON	

- When enabled, a pulse with the specified edge direction (**OUTPut:TRIGger:SLOPe**) is output from the rear-panel **Ext Trig** connector at the beginning of the burst or sweep.
- In triggered burst mode:
 - With **TRIGger[1|2]:SOURce IMMEDIATE**, instrument outputs square wave with 50% duty cycle from the **Ext Trig** connector. The waveform period equals the burst period (**BURSt:INTernal:PERiod**).
 - With **TRIGger[1|2]:SOURce EXTernal** or **BURSt:MODE GAT**, the instrument disables "trigger out." The rear-panel **Ext Trig** connector cannot be used for both operations simultaneously (an externally-triggered waveform uses the same connector to trigger sweep or burst).
 - With **TRIGger[1|2]:SOURce BUS**, the instrument outputs a pulse (>1 μ s pulse width on the 33500 Series and 100 ns on the 33600 Series) from the **Ext Trig** connector at the beginning of each sweep or burst.
- In frequency sweep mode:
 - With **TRIGger[1|2]:SOURce IMMEDIATE**, the instrument outputs a square wave with a 50% duty cycle (the rising edge is the sweep trigger) from the **Ext Trig** connector. Waveform period equals to the sweep time (**SWEep:TIME**).
 - With **TRIGger[1|2]:SOURce EXTernal**, instrument disables the "trigger out" signal. The rear-panel **Ext Trig** connector cannot be used for both operations simultaneously (an externally-triggered sweep uses the same connector to trigger the sweep).
 - With **TRIGger[1|2]:SOURce BUS**, the instrument outputs a pulse (>1 μ s pulse width on the 33500 Series and 100 ns on the 33600 Series) from the **Ext Trig** connector at the beginning of each sweep or burst.

OUTPut:TRIGger:SLOPe {POSitive|NEGative}

OUTPut:TRIGger:SLOPe?

Selects whether the instrument uses the rising edge or falling edge for the "trigger out" signal.

Parameter	Typical Return
{ POSitive NEGative}, default POSitive	POS or NEG
Set trigger slope to NEGative (falling edge): OUTP:TRIG:SLOP NEG	

- POSitive outputs a rising edge pulse; NEGative outputs a falling edge pulse.
- When enabled using OUTPut:TRIGger, a pulse with the specified edge direction is output from the rear-panel **Trig Out** connector at the beginning of a sweep or burst.

OUTPut:TRIGger:SOURce {CH1|CH2}

OUTPut:TRIGger:SOURce?

Selects the source channel used by trigger output on a two-channel instrument. The source channel determines what output signal to generate on the trigger out connector.

Parameter	Typical Return
{ CH1 CH2}, default CH1	CH1 or CH2
Set output trigger source to CH2: OUTP:TRIG:SOUR CH2	

- In a two-channel instrument, either channel may be source channel for the trigger output, but channel 2 is not valid for dual arbitrary (IQ) waveforms.

PHASe Subsystem

The PHASe subsystem allows you to adjust the waveform phase; this is useful in channel-to-channel and channel-to-Sync applications. This subsystem also allows you to use the **10 MHz Out** and **10 MHz In** rear-panel connectors to synchronize multiple instruments.

- **[SOURce[1|2]:]PHASe {<angle>|MINimum|MAXimum|DEFAULT}** - sets phase offset of output waveform (not available for arbitrary waveforms or noise)
- **[SOURce[1|2]:]PHASe:ARBitrary {<angle>|MINimum|MAXimum}** - sets the offset for the currently selected arbitrary waveform
- **[SOURce[1|2]:]PHASe:MODulation {<angle>|MINimum|MAXimum}** - sets the phase of the internal modulation source when modulating by the internal source
- **[SOURce[1|2]:]PHASe:REFeRence** - sets new zero-phase reference point without changing instrument output

- **[SOURce[1|2]:]PHASe:SYNChronize** - synchronizes phase of both internal channels on a two-channel instrument.
- **[SOURce[1|2]:]PHASe:UNLock:ERRor:STATe {ON|1|OFF|0}** - specifies whether instrument generates an error upon losing phase-lock

[SOURce[1|2]:]PHASe {<angle>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]PHASe? [{MINimum|MAXimum}]

Sets waveform's phase offset angle.

Parameter	Typical Return
-360 to +360 degrees, -2π to $+2\pi$ radians, or -(period) to +(period), as specified by UNIT:ANGLE . Default 0.	+1.5000000000000E+01
Set channel 1 phase offset to 15 degrees: UNIT:ANGL DEG PHAS 15	

- Phase offset is independent of burst phase (**BURSt:PHASe**).
- This command does not modify channel's primary phase generator; it simply adds phase offset.
- This command also useful for modifying phase relationship between channels in a two-channel instrument and between the channel and its sync signal.
- In a two-channel instrument, use **PHASe:SYNChronize** to synchronize the phases of the two internal channels. Each channel will retain its current phase offset, but the two channels will have a common reference point so the channel-to-channel phase difference will be known.
- When synchronizing the phase of multiple instruments (**ROSC commands**), the phase command allows adjustment of the phase relationship between the instruments.

[SOURce[1|2]:]PHASe:ARBitrary {<angle>|MINimum|MAXimum}
[SOURce[1|2]:]PHASe:ARBitrary?

Sets the offset for the currently selected arbitrary waveform in either degrees, radians, seconds or samples. The default units of the <angle> parameter are set by UNIT:ARbitrary:ANGLE.

NOTE

This command applies only to the 33600 Series and arbitrary waveforms of at least 64 samples.

Parameter	Typical Return
From -360 to 360 (DEGREE) From -2 π to 2 π (RADian) From -arbitrary waveform period to +arbitrary waveform period (SECond) From -(number of samples-1) to +(number of samples - 1) (SAMPLE)	+3.000000000000000E+01
UNIT:ARB:ANGL DEG PHAS:ARB 30	

- This parameter affects the phase of the currently selected arbitrary waveform only. For other functions, see [SOURce[1|2]:]PHASe.
- This parameter affects the phase of the arbitrary in normal continuous mode, modulation mode, and sweep mode. In burst mode, the arbitrary waveform phase is controlled by [SOURce[1|2] BURSt:PHASe.
- When an arbitrary waveform is loaded into memory, its initial phase is zero; it does not inherit the phase of the currently selected arbitrary waveform. Each arbitrary waveform retains its own phase setting while in memory.
- The phase of the arbitrary waveform is defined with respect to all the points in the arbitrary waveform record. For example, setting the arbitrary phase to 180 degrees on a 64-sample arbitrary waveform will rotate the play of the waveform such that it will begin (as indicated by the sync signal) with the 33rd sample and end with the 32nd.

[SOURce[1|2]:]PHASe:MODulation {<angle>|MINimum|MAXimum}
[SOURce[1|2]:]PHASe:MODulation?

Sets the phase of the internal modulation source when modulating by the internal source with shape SIN, SQU, RAMP, NRAMp, or TRI. This command applies to the 33600 Series only.

NOTE

This command applies only to the 33600 Series and arbitrary waveforms of at least 64 samples.

Parameter	Typical Return
From -360 to 360 (DEGree) From -2 π to 2 π (DEGree) From -arbitrary waveform period to +arbitrary waveform period (SECond)	+3.000000000000000E+01
Set the modulation phase to 30 degrees: UNIT:ANGL DEG PHAS:MOD 30	

- The default units of the <angle> parameter are set by UNIT:ANGLE.

[SOURce[1|2]:]PHASe:REference

Simultaneously removes the offset set by PHASe and adjusts the primary phase generator by an amount equivalent to the PHASe setting. This retains the phase relationship set with another instrument while realigning the sync signal with the output.

Parameter	Typical Return
(none)	(none)
Reset the zero-phase reference point for channel 1: PHAS:REF	

- The primary purpose of this command is to establish a zero-point between two connected instruments. For channel-to-channel operation on a two-channel instrument, use PHASe:SYNChronize.
- Setting a new zero-phase reference point means that the value subsequently returned by a PHASe? query command is reset to "0", but the output waveform itself does not change.

[SOURce[1|2]:]PHASe:SYNChronize

Simultaneously resets all phase generators in the instrument, including the modulation phase generators, to establish a common, internal phase zero reference point. This command does not affect PHASe setting of either channel; it simply establishes phase difference between channels as the sum of SOUR1:PHAS and SOUR2:PHAS instead of an arbitrary amount.

Parameter	Typical Return
(none)	(none)
Reset all phase generators: PHAS:SYNC	

- SOURce1 and SOURce2 mean nothing for this command.
- This command breaks the phase relation with another instrument, because it resets the phase generators.
- In single channel instruments, this synchronizes the main channel with the internal modulation generator.
- You can synchronize the phase between the primary signal and the **SUM** signal by sending [SOURce[1|2]:]PHASe:SYNChronize after setting the functions for the primary signal and the **SUM** signal. Otherwise, the phase between the two signals is arbitrary.

[SOURce[1|2]:]PHASe:UNLock:ERRor:STATe {ON|1|OFF|0}

[SOURce[1|2]:]PHASe:UNLock:ERRor:STATe?

Enables or disables the generation of an error if the phase-lock is ever lost by the instrument timebase. The instrument uses one timebase for both channels.

Parameter	Typical Return
{ON 1 OFF 0}, default OFF	0 (OFF) or 1 (ON)
Enable the generation of phase-lock errors: PHASe:UNLock:ERRor:STATe ON	

- SOURce1 and SOURce2 mean nothing for this command.
- If the phase-lock is lost and the error is enabled, a "Reference phase-locked loop is unlocked" error is generated.
- Volatile setting, lost on power cycle.
- A faulty reference signal applied to the **10 MHz In** connector may generate many error messages.

PM Subsystem

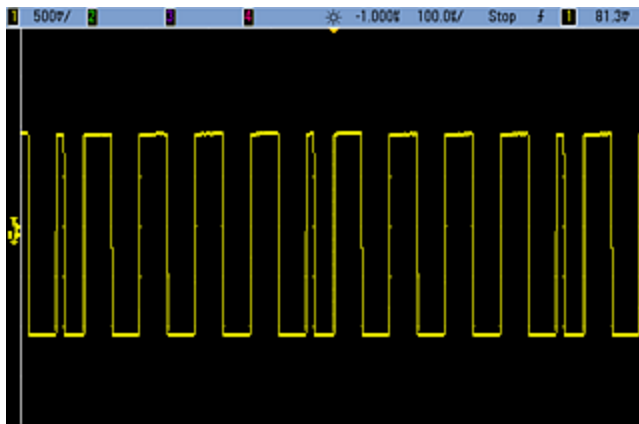
The PM subsystem allows you to phase modulate a waveform.

This summarizes the steps required to generate a phase modulated waveform.

1. **Configure carrier waveform:** Use **FUNCTION**, **FREQUENCY**, **VOLTage**, and **VOLTage:OFFSet** to specify the carrier waveform's function, frequency, amplitude, and offset.
2. **Select modulation source (internal, external, CH1 or CH2):** **PM:SOURce**. For an external modulation source, skip steps 3 and 4.
3. **Set modulating waveform:** **PM:INTernal:FUNCTION**
4. **Set modulating frequency:** **PM:INTernal:FREQUENCY**
5. **Set phase deviation:** **PM:DEViation**
6. **Enable PM:** **PM:STATe:ON**

The following code produces the oscilloscope image shown below.

```
FUNCTION SQU  
FREQUENCY +1.0E+04  
VOLTage +1.0  
VOLTage:OFFSet 0.0  
PM:SOURce INT  
PM:DEViation +90  
PM:INTernal:FREQUENCY +2500  
PM:INTernal:FUNCTION RAMP  
PM:STATe 1  
OUTPut1 1
```



[SOURce[1|2]:]PM:DEVIation {<deviation in degrees>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]PM:DEVIation? [{MINimum|MAXimum}]

Sets the phase deviation in degrees. This value represents the peak variation in phase of the modulated waveform from the carrier waveform.

Parameter	Typical Return
0 to 360, default 180	+9.000000000000000E+01
Set phase deviation to ± 90 degrees PM:DEV 90	

- With the External modulating source, deviation is controlled by the ± 5 V signal level (optionally ± 1 V on the 33600 Series) on the rear-panel **Modulation In** connector. For example, if you have set the frequency deviation to 180 degrees, then a +5 V signal level (optionally ± 1 V on the 33600 Series) corresponds to a +180 degree phase deviation. Lower external signal levels produce less deviation, and negative signal levels produce negative deviation.

[SOURce[1|2]:]PM:INTernal:FREQuency {<frequency>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]PM:INTernal:FREQuency? [{MINimum|MAXimum}]

Sets the frequency of the modulating waveform. The waveform chosen as the modulating source will operate at that frequency, within the frequency limits of that waveform.

Parameter	Typical Return
1 μ Hz to the maximum allowed for the internal function. Default 10 Hz.	+1.0000000000000000E-06
Set modulating frequency to 10 kHz: PM:INT:FREQ 10000	
Set modulating frequency to 1 μ Hz: PM:INT:FREQ MIN	

- When you select an arbitrary waveform as the modulating source, the frequency changes to the frequency of the arbitrary waveform, which is based on the sample rate and the number of points in the arbitrary waveform.
- When using an arbitrary waveform for the modulating source, changing this parameter also changes the cached metadata representing the arbitrary waveform's sample rate. You can also change the modulating frequency of an arbitrary waveform with **FUNCTION:ARbitrary:FREQuency**, **FUNCTION:ARbitrary:PERiod**, and **FUNCTION:ARbitrary:SRATe**. These commands and the modulation frequency command are directly coupled in order to keep the arbitrary waveform behaving exactly as it was last played. If you later turn modulation off and select that same arbitrary waveform as the current function, its sample rate (and corresponding frequency based upon the number of points) will be the same as it was when played as the modulation source.
- If the internal function is TRiangle, UpRamp, or DnRamp, the maximum frequency is limited to 200 kHz on the 33500 Series or 800 kHz on the 33600 Series. If the internal function is PRBS, the frequency refers to bit rate and is limited **as shown here**.
- This command should be used only with the internal modulation source (**PM:SOURce INTernal**).

[SOURce[1|2]:]PM:INTernal:FUNCtion <function>
[SOURce[1|2]:]PM:INTernal:FUNCtion?

Selects shape of modulating waveform.

Parameter	Typical Return
{SINusoid SQUare RAMP NRAMP TRIangle NOISe PRBS ARB}, default SINusoid View internal function waveforms.	SIN, SQU, RAMP, NRAM, TRI, NOIS, PRBS, or ARB
Select a sine wave as the modulating waveform: PM:INT:FUNC SIN	

- This command should be used only with the internal modulation source (**PM:SOURce INTernal**).
- You can use noise as the modulating waveform, but you cannot use noise, pulse, or DC as the carrier.

[SOURce[1|2]:]AM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]AM:SOURce?

[SOURce[1|2]:]BPSK:SOURce {INTernal|EXTernal}
[SOURce[1|2]:]BPSK:SOURce?

[SOURce[1|2]:]FM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]FM:SOURce?

[SOURce[1|2]:]FSKey:SOURce {INTernal|EXTernal}
[SOURce[1|2]:]FSKey:SOURce?

[SOURce[1|2]:]PM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]PM:SOURce?

[SOURce[1|2]:]PWM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]PWM:SOURce?

Selects the source of the modulating signal.

Parameter	Typical Return
{INTernal EXTernal CH1 CH2}, default INTernal. BPSK and FSKey cannot accept CH1 or CH2	INT, EXT, CH1, or CH2
Select external modulation source: AM:SOUR EXT (could also substitute FM, BPSK, FSK, PM, or PWM for AM)	

- If you select EXTERNAL, the carrier waveform is modulated with an external waveform. Specifically:
 - **AM:** The modulation depth is controlled by the ± 5 V signal level (or the optional ± 1 V signal level on the 33600 Series) on the rear-panel **Modulation In** connector. For example, if modulation depth (**AM[:DEPTH]**) is 100%, then when the modulating signal is at +5 V (or optionally +1 V on the 33600 Series), the output will be at the maximum amplitude. Similarly, a -5 V modulating signal (or optionally -1 V on the 33600 Series) produces output at minimum amplitude.
 - **FM:** If you select the *External* modulating source, the deviation is controlled by the ± 5 V signal level (optionally ± 1 V on the 33600 Series) on the rear-panel **Modulation In** connector. For example, if the frequency deviation is 100 kHz, then a +5 V signal level (optionally +1 V on the 33600 Series) corresponds to a 100 kHz increase in frequency. Lower external signal levels produce less deviation and negative signal levels reduce the frequency below the carrier frequency.
 - **PM:** With the External modulating source, deviation is controlled by the ± 5 V signal level (optionally ± 1 V on the 33600 Series) on the rear-panel **Modulation In** connector. For example, if you have set the frequency deviation to 180 degrees, then a +5 V signal level (optionally ± 1 V on the 33600 Series) corresponds to a +180 degree phase deviation. Lower external signal levels produce less deviation, and negative signal levels produce negative deviation.
 - **Pulse as Selected Function:** The pulse width or pulse duty cycle deviation is controlled by the ± 5 V signal level (optionally ± 1 V on the 33600 Series) present on the rear-panel **Modulation In** connector. For example, if you have set the pulse width deviation to 50 μ s using the **PWM:DEVIation** command, then a +5 V signal level (optionally +1 V on the 33600 Series) corresponds to a 50 μ s width increase. Lower external signal levels produce less deviation.
- With EXTERNAL source, the output phase (BPSK) or frequency (FSK) is determined by the signal level on the rear-panel **Ext Trig** connector. When a logic low is present, the carrier phase or carrier frequency is output. When a logic high is present, the phase shifted phase or hop frequency is output.
- The maximum external BPSK rate is 1 MHz, and the maximum FSK rate is 1 MHz.
- **Note:** the connector used for externally-controlled BPSK or FSK waveforms (**Trig In**) is not the same connector that is used for externally-modulated AM, FM, PM, and PWM waveforms (**Modulation In**). When used for BPSK or FSK, the **Trig In** connector does not have adjustable edge polarity and is not affected by the **TRIGger[1|2]:SLOPe** command.
- With INTERNAL source, the rate at which output phase (BPSK) or frequency (FSKey) "shifts" between the carrier phase or frequency and the alternate phase or frequency is determined by the BPSK rate (**BPSK:INTERNAL:RATE**) or FSK rate (**FSKey:INTERNAL:RATE**).
- A channel may not be its own modulation source.

See Also

INPut:ATTenuation[:STATE]

AM Subsystem

BPSK Subsystem

FM Subsystem

FSKey Subsystem

PM Subsystem

PWM Subsystem

[SOURce[1|2]:]AM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]AM:STATe?

[SOURce[1|2]:]BPSK:STATe {ON|1|OFF|0}
[SOURce[1|2]:]BPSK:STATe?

[SOURce[1|2]:]FM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]FM:STATe?

[SOURce[1|2]:]FSKey:STATe {ON|1|OFF|0}
[SOURce[1|2]:]FSKey:STATe?

[SOURce[1|2]:]PM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]PM:STATe?

[SOURce[1|2]:]PWM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]PWM:STATe?

Enables or disables modulation.

Parameter	Typical Return
{ON 1 OFF 0}, default OFF	0 (OFF) or 1 (ON)
Enable AM (could also substitute FM, BPSK, FSK, PM, or PWM): AM:STAT ON	

- To avoid multiple waveform changes, enable modulation after configuring the other modulation parameters.
- Only one modulation mode may be enabled at a time.
- The instrument will not enable modulation with sweep or burst enabled. When you enable modulation, the sweep or burst mode is turned off.
- PWM is allowed only when pulse is the selected function.

See Also

[AM Subsystem](#)

[BPSK Subsystem](#)

[FM Subsystem](#)

[FSKey Subsystem](#)

[PM Subsystem](#)

[PWM Subsystem](#)

PWM Subsystem

The PWM subsystem allows you to perform pulse width modulation (PWM) on a pulse waveform.

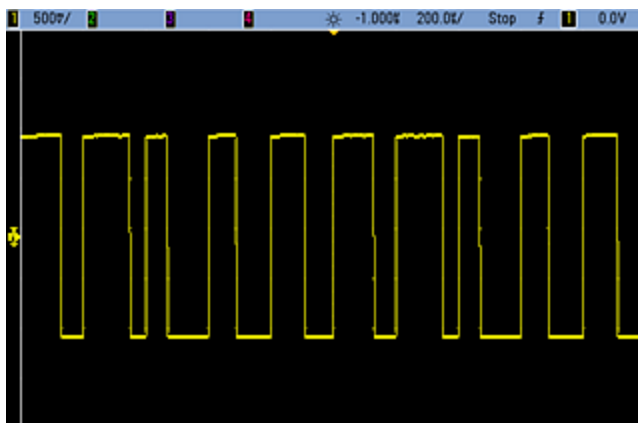
Example

This summarizes the steps required to generate a PWM waveform.

1. **Configure a pulse carrier waveform:** Use **FUNCTION**, **FREQUENCY**, **VOLTage**, and **VOLTage:OFFSet** to specify the carrier waveform's function, frequency, amplitude, and offset.
2. **Select modulation source (internal, external, CH1, or CH2):** **PWM:SOURce**. For an external modulation source, skip steps 3 and 4.
3. **Select modulating waveform:** **PWM:INTernal:FUNCTION**
4. **Set modulating frequency:** **PWM:INTernal:FREQUENCY**
5. **Set pulse width or duty cycle deviation:** **PWM:DEViation** or **PWM:DEViation:DCYCLE**
6. **Enable PWM:** **PWM:STATe:ON**

The following code produces the oscilloscope image shown below.

```
FUNCTION PULS
FREQUENCY +5000.0
VOLTage +1.0
VOLTage:OFFS +0.0
PWM:DEViation +5.0E-05
PWM:DEViation:DCYCLE +25.0
PWM:INTernal:FREQUENCY +1000.0
PWM:INTernal:FUNCTION RAMP
PWM:STATe 1
OUTPut1 1
```



[SOURce[1|2]:]PWM:DEVIation {<deviation>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]PWM:DEVIation? [{MINimum|MAXimum}]

Sets pulse width deviation; the $\pm$ variation in width (in seconds) from the pulse width of the carrier pulse waveform.

Parameter	Typical Return
0 to 500,000 (seconds); default 10 μ s	+1.0000000000000000E+00
Set pulse width deviation to 1 s: PWM:DEV 1 Set pulse width deviation to 0 s: PWM:DEV MIN	

- The deviation is a $\pm$ deviation, so if the pulse width is 10 ms and the deviation is 4 ms, the width can vary from 6 to 14 ms.
- The pulse width deviation cannot exceed the current pulse width, and is also limited by the minimum pulse width (Wmin):

$$\text{Width Deviation} < \text{Pulse Width} - W_{\text{min}}$$

and

$$\text{Width Deviation} < \text{Period} - \text{Pulse Width} - W_{\text{min}}$$

- The pulse width deviation is limited by the current edge time setting.

$$\text{Width Deviation} < \text{Pulse Width} - (0.8 \times \text{Leading Edge Time}) - (0.8 \times \text{Trailing Edge Time})$$

and

$$\text{Width Deviation} < \text{Period} - \text{Pulse Width} - (0.8 \times \text{Leading Edge Time}) - (0.8 \times \text{Trailing Edge Time})$$

- If you select the External modulating source (**PWM:SOURce EXTernal**), the deviation is controlled by the ± 5 V signal level (optionally ± 1 V on the 33600 Series) present on the rear-panel **Modulation In** connector. For example, if you have set the width deviation to 10 μ s, then a +5 V signal level (optionally +1 V on the 33600 Series) corresponds to a 10 μ s deviation. Lower external signal levels produce less deviation. Negative signal levels produce negative deviation.

[SOURce[1|2]:]PWM:DEViation:DCYCLE {<deviation_in_pct>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]PWM:DEViation:DCYCLE? [{MINimum|MAXimum}]

Sets duty cycle deviation in percent of period. This is the peak variation in duty cycle from the underlying pulse waveform. For example, if duty cycle is 10% and duty cycle deviation is 5%, the duty cycle of the modulated waveform will vary from 5% to 15%.

Parameter	Typical Return
Duty cycle in percent of period, from 0 to 50; default 1	+5.0000000000000000E+00
Set pulse width deviation to 5%: PWM:DEV:DCYC 5	

- Duty cycle deviation cannot exceed pulse duty cycle.
- Duty cycle deviation also limited by minimum pulse width (Wmin):

$$\text{Duty Cycle Deviation} < \text{Duty Cycle} - 100 \times W_{\min} \div \text{Period}$$

and

$$\text{Duty Cycle Deviation} < 100 - \text{Duty Cycle} - 100 \times W_{\min} \div \text{Period}$$

where Wmin = 16 ns on the 33500 Series and 5 ns up to 4 Vpp or 8 ns up to 10 Vpp on the 33600 Series.

- Duty cycle deviation limited by edge time.

$$\text{Duty Cycle Dev} < \text{Duty Cycle} - (80 \times \text{Leading Edge Time}) \div \text{Period} - (80 \times \text{Trailing Edge Time}) \div \text{Period}$$

and

$$\text{Duty Cycle Dev} < 100 - \text{Duty Cycle} - (80 \times \text{Leading Edge Time}) \div \text{Period} - (80 \times \text{Trailing Edge Time}) \div \text{Period}$$

- With **PWM:SOURce EXTERNAL**, deviation is controlled by the ± 5 V signal level (optionally ± 1 V on the 33600 Series) on rear-panel **Modulation In** connector. For example, with duty cycle deviation of 5 percent, a +5 V signal level (optionally +1 V on the 33600 Series) corresponds to 5% deviation, an additional 5% of period added to the pulse duty cycle. Lower external signal levels produce less deviation, and negative signal levels reduce the duty cycle.

[SOURce[1|2]:]PWM:INTernal:FREQuency {<frequency>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]PWM:INTernal:FREQuency? [{MINimum|MAXimum}]

Selects frequency at which output pulse width shifts through its pulse width deviation. The waveform used as the modulating source will operate at that frequency, within frequency limits of that waveform.

Parameter	Typical Return
1 µHz to the maximum allowed for the internal function . Default 10 Hz	+1.0000000000000000E+02
Set internal PWM frequency to 100 Hz: PWM:INT:FREQ 100	

- When you select an arbitrary waveform as the modulating source, the frequency changes to the frequency of the arbitrary waveform, which is based on the sample rate and the number of points in the arbitrary waveform.
- When using an arbitrary waveform for the modulating source, changing this parameter also changes the cached metadata representing the arbitrary waveform's sample rate. You can also change the modulating frequency of an arbitrary waveform with **FUNCTION:ARbitrary:FREQuency**, **FUNCTION:ARbitrary:PERiod**, and **FUNCTION:ARbitrary:SRATe**. These commands and the modulation frequency command are directly coupled in order to keep the arbitrary waveform behaving exactly as it was last played. If you later turn modulation off and select that same arbitrary waveform as the current function, its sample rate (and corresponding frequency based upon the number of points) will be the same as it was when played as the modulation source.
- If the internal function is TRiangle, UpRamp, or DnRamp, the maximum frequency is limited to 200 kHz on the 33500 Series or 800 kHz on the 33600 Series. If the internal function is PRBS, the frequency refers to bit rate and is limited **as shown here**.
- This command should be used only with the internal modulation source (**PWM:SOURce INTernal**).

[SOURce[1|2]:]PWM:INTernal:FUNCtion <function>
[SOURce[1|2]:]PWM:INTernal:FUNCtion?

Selects shape of the internal modulating waveform.

Parameter	Typical Return
{SINusoid SQUare RAMP NRAMP TRIangle NOISe PRBS ARB}, default SINusoid View internal function waveforms.	SIN, SQU, RAMP, NRAM, TRI, NOIS, PRBS, or ARB
Select a sine wave as the modulating waveform shape: PWM:INT:FUNC SIN	

- This command should be used only with the internal modulation source (**PWM:SOURce INTernal**).

[SOURce[1|2]:]AM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]AM:SOURce?

[SOURce[1|2]:]BPSK:SOURce {INTernal|EXTernal}
[SOURce[1|2]:]BPSK:SOURce?

[SOURce[1|2]:]FM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]FM:SOURce?

[SOURce[1|2]:]FSKey:SOURce {INTernal|EXTernal}
[SOURce[1|2]:]FSKey:SOURce?

[SOURce[1|2]:]PM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]PM:SOURce?

[SOURce[1|2]:]PWM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]PWM:SOURce?

Selects the source of the modulating signal.

Parameter	Typical Return
{INTernal EXTernal CH1 CH2}, default INTernal. BPSK and FSKey cannot accept CH1 or CH2	INT, EXT, CH1, or CH2
Select external modulation source: AM:SOUR EXT (could also substitute FM, BPSK, FSK, PM, or PWM for AM)	

- If you select EXTERNAL, the carrier waveform is modulated with an external waveform. Specifically:
 - **AM:** The modulation depth is controlled by the ± 5 V signal level (or the optional ± 1 V signal level on the 33600 Series) on the rear-panel **Modulation In** connector. For example, if modulation depth (**AM[:DEPTH]**) is 100%, then when the modulating signal is at +5 V (or optionally +1 V on the 33600 Series), the output will be at the maximum amplitude. Similarly, a -5 V modulating signal (or optionally -1 V on the 33600 Series) produces output at minimum amplitude.
 - **FM:** If you select the *External* modulating source, the deviation is controlled by the ± 5 V signal level (optionally ± 1 V on the 33600 Series) on the rear-panel **Modulation In** connector. For example, if the frequency deviation is 100 kHz, then a +5 V signal level (optionally +1 V on the 33600 Series) corresponds to a 100 kHz increase in frequency. Lower external signal levels produce less deviation and negative signal levels reduce the frequency below the carrier frequency.
 - **PM:** With the External modulating source, deviation is controlled by the ± 5 V signal level (optionally ± 1 V on the 33600 Series) on the rear-panel **Modulation In** connector. For example, if you have set the frequency deviation to 180 degrees, then a +5 V signal level (optionally ± 1 V on the 33600 Series) corresponds to a +180 degree phase deviation. Lower external signal levels produce less deviation, and negative signal levels produce negative deviation.
 - **Pulse as Selected Function:** The pulse width or pulse duty cycle deviation is controlled by the ± 5 V signal level (optionally ± 1 V on the 33600 Series) present on the rear-panel **Modulation In** connector. For example, if you have set the pulse width deviation to 50 μ s using the **PWM:DEVIation** command, then a +5 V signal level (optionally +1 V on the 33600 Series) corresponds to a 50 μ s width increase. Lower external signal levels produce less deviation.
- With EXTERNAL source, the output phase (BPSK) or frequency (FSK) is determined by the signal level on the rear-panel **Ext Trig** connector. When a logic low is present, the carrier phase or carrier frequency is output. When a logic high is present, the phase shifted phase or hop frequency is output.
- The maximum external BPSK rate is 1 MHz, and the maximum FSK rate is 1 MHz.
- **Note:** the connector used for externally-controlled BPSK or FSK waveforms (**Trig In**) is not the same connector that is used for externally-modulated AM, FM, PM, and PWM waveforms (**Modulation In**). When used for BPSK or FSK, the **Trig In** connector does not have adjustable edge polarity and is not affected by the **TRIGger[1|2]:SLOPe** command.
- With INTERNAL source, the rate at which output phase (BPSK) or frequency (FSKey) "shifts" between the carrier phase or frequency and the alternate phase or frequency is determined by the BPSK rate (**BPSK:INTERNAL:RATE**) or FSK rate (**FSKey:INTERNAL:RATE**).
- A channel may not be its own modulation source.

See Also

INPut:ATTenuation[:STATE]

AM Subsystem

BPSK Subsystem

FM Subsystem

FSKey Subsystem

PM Subsystem

PWM Subsystem

[SOURce[1|2]:]AM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]AM:STATe?

[SOURce[1|2]:]BPSK:STATe {ON|1|OFF|0}
[SOURce[1|2]:]BPSK:STATe?

[SOURce[1|2]:]FM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]FM:STATe?

[SOURce[1|2]:]FSKey:STATe {ON|1|OFF|0}
[SOURce[1|2]:]FSKey:STATe?

[SOURce[1|2]:]PM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]PM:STATe?

[SOURce[1|2]:]PWM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]PWM:STATe?

Enables or disables modulation.

Parameter	Typical Return
{ON 1 OFF 0}, default OFF	0 (OFF) or 1 (ON)
Enable AM (could also substitute FM, BPSK, FSK, PM, or PWM): AM:STAT ON	

- To avoid multiple waveform changes, enable modulation after configuring the other modulation parameters.
- Only one modulation mode may be enabled at a time.
- The instrument will not enable modulation with sweep or burst enabled. When you enable modulation, the sweep or burst mode is turned off.
- PWM is allowed only when pulse is the selected function.

See Also

[AM Subsystem](#)

[BPSK Subsystem](#)

[FM Subsystem](#)

[FSKey Subsystem](#)

[PM Subsystem](#)

[PWM Subsystem](#)

RATE Subsystem

The RATE subsystem allows you to couple the outputs' sample rates on a two-channel instrument by specifying the following items:

- `[SOURce[1|2]:]RATE:COUPle[:STATe] {ON|1|OFF|0}`
- `[SOURce[1|2]:]RATE:COUPle:MODE {OFFSet|RATio}`
- `[SOURce[1|2]:]RATE:COUPle:OFFSet {<sample_rate>|MINimum|MAXimum|DEFault}`
- `[SOURce[1|2]:]RATE:COUPle:RATio {<ratio>|MINimum|MAXimum}`

`[SOURce[1|2]:]RATE:COUPle[:STATe] {ON|1|OFF|0}`

`[SOURce[1|2]:]RATE:COUPle[:STATe]?`

Enables or disables sample rate coupling between channels, or allows one-time copying of one channel's sample rate into the other channel.

Parameter	Typical Return
{ON 1 OFF 0}, default OFF	0 (OFF) or 1 (ON)
Turn on sample rate coupled state: RATE:COUP ON	

- The ON value starts sample rate coupling in the mode specified by `RATE:COUPle:MODE`.
- If the current offset or ratio, combined with the current sample rate settings, would cause either sample rate to exceed instrument specifications, the instrument will generate an error and the exceeded sample rate will clip at its maximum or minimum value.
- If setting mode to `RATIO` and setting `RATIO` to 1.0 still exceeds the specifications of either channel, an error message will be generated and the `RATE:COUPle[:STATe]` will not be turned ON.
- Both channels must be configured for `FUNCTION ARB` in order to enable sample rate coupling.

[SOURce[1|2]:]RATE:COUPle:MODE {OFFSet|RATio}

[SOURce[1|2]:]RATE:COUPle:MODE?

Sets type of sample rate coupling to either a constant sample rate offset (OFFSet) or a constant ratio (RATio) between the channels' sample rates.

Parameter	Typical Return
{ OFFSet RATio }, default RATio	OFFS or RAT
Set the sample rate coupling mode to OFFSet. RATE:COUP:MODE OFFSet	

- The default RATio is 1.
- The default sample rate coupling is OFF.
- The SOURce[1|2] keyword is ignored; the setting applies to both channels.

[SOURce[1|2]:]RATE:COUPle:OFFSet {<sample_rate>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]RATE:COUPle:OFFSet?

Sets sample rate offset when a two-channel instrument is in sample rate coupled mode OFFSet.

Parameter	Typical Return
Valid values depend on FUNCTION:ARBITrary:FILTER setting. For NORMal and STEP, the range is between ± 250 MSa/s (33500 Series) or ± 1 GSa/s (33600 Series). For OFF, the range is between ± 62.5 MSa/s (33500 Series) or ± 250 MSa/s (33600 Series). In any case, default is 0.	+8.000000000000000E+02
Set sample rate offset of channel 2 to 10.3 kSa/s higher than sample rate of channel 1. RATE:COUPle:OFFSet 10300 Sets the sample rate offset of channel 1 to 45 kSa/s below the sample rate of channel 2. SOUR2:RATE:COUP:OFFS -45000	

- When specifying OFFSet or RATio, the SOURce channel (SOURce1 or SOURce2) is used as the reference channel and the offset or ratio is applied to the other channel. For example, suppose **RATE:COUPle[:STATe]** is ON and **RATE:COUPle:MODE** is OFFSet. Furthermore, suppose channel 1 is operating at 2 kSa/s, and channel 2 is at 10 kSa/s. The command **SOUR1:RATE:COUP:OFFS 2.5** causes Channel 1 to remain at 2 Sa/s, and Channel 2 to be set to 4.5 Sa/s. As one channel's sample rate changes, the other channel's sample rate changes to maintain the specified coupling.
- If the sample rate coupling would cause either channel to exceed sample rate specifications for the present functions, the command will result in an error, and the sample rate will be set to its maximum or minimum limit for the channel.

[SOURce[1|2]:]RATE:COUPle:RATio {<ratio>|MINimum|MAXimum}
[SOURce[1|2]:]RATE:COUPle:RATio? [{MINimum|MAXimum}]

Sets offset ratio between channel sample rates when a two-channel instrument is in sample rate coupled mode RATio.

Parameter	Typical Return
0.001 to 1000, default 1	+7.500000000000000E-1
Set channel 2's sample rate to twice that of channel 1. SOUR1:RATE:COUP:RATio 2	
Set channel 1's sample rate to 3.14 times that of channel 2. SOUR2:RATE:COUPle:RAT 3.14	

- When specifying OFFSet or RATio, the SOURce channel (SOURce1 or SOURce2) is used as the reference channel and the offset or ratio is applied to the other channel. For example, suppose the instrument is coupled in RATio mode. Furthermore, suppose channel 1 is operating at 2 kSa/s, and channel 2 is at 10 kSa/s. The command **SOUR1:RATE:COUP:RAT 2.5** causes Channel 1 to remain at 2 kSa/s, and Channel 2 to be set to 5 kSa/s. As one channel's sample rate changes, the other channel's sample rate changes to maintain the specified coupling.
- If the sample rate coupling would cause either channel to exceed sample rate specifications for the present functions, the command will result in an error, and the sample rate will be set to its maximum or minimum limit for the channel.

ROSCillator Subsystem

WARNING

The external 10 MHz reference input BNC connector, both the shell and center pin, on the rear panel of the instrument is isolated up to ± 42 Vpk from chassis. The shell of this BNC connector is isolated from the rest of the instrument. Internal circuitry will attempt to keep the isolated voltage to within ± 42 Vpk to chassis. Attempts to float this input beyond ± 42 Vpk from chassis may destroy the instrument and cause a hazard that could result in personal injury or death.

NOTE

The instrument 10 MHz output is chassis referenced.

The ROSCillator subsystem controls use of the 10 MHz reference oscillator and external reference oscillator input. The reference oscillator is the primary clock for all waveform synthesis. All waveforms are phase-locked to the reference oscillator, which therefore controls output signal frequency and phase.

- **ROSCillator:SOURce {INTERNAL|EXTERNAL}** - selects internal or external reference oscillator source
- **ROSCillator:SOURce:AUTO {ON|OFF}** - disables or enables automatic selection of reference oscillator signal source
- **ROSCillator:SOURce:CURREnt?** - returns INT or EXT to indicate current reference oscillator source

ROSC:SOURce sets ROSCillator:SOURce:AUTO to OFF, and ROSCillator:SOURce:AUTO ON overrides ROSC:SOURce. The more recent command (of these two) takes priority.

ROSCillator:SOURce INTernal uses the instrument's internal oscillator as the reference oscillator. This may be either standard Temperature Compensated Crystal Oscillator (TCXO) or the **optional Ovenized Crystal Oscillator (OCXO)**.

See ***OPT?** for details on determining whether OCXO is installed. If an external 10 MHz reference signal is on the rear-panel **10 MHz In** connector, the instrument uses the external signal. An icon also appears at the top right corner of the display to indicate the reference source change.

ROSCillator:SOURce {INTernal|EXTernal} ROSCillator:SOURce?

Selects the source for the reference oscillator used as the frequency/phase reference for signals generated by the instrument.

Parameter	Typical Return
{INTernal EXTernal}, default INT	INT or EXT
Use the external reference oscillator source: ROSC:SOUR EXT	

- **EXTernal:** instrument uses signal on the rear-panel **10 MHz In** connector as reference, and generates an error if this signal is absent or the instrument cannot lock to it. In such error cases, instrument output continues, but the frequency will be unstable.
- **INTernal:** instrument uses the internal reference oscillator and ignores the signal at the **10 MHz In** connector.

ROSCillator:SOURce:AUTO {ON|OFF} ROSCillator:SOURce:AUTO?

Disables or enables automatic selection of the reference oscillator.

Parameter	Typical Return
{ON OFF}, default ON	ON or OFF
Select reference source automatically: ROSC:SOUR:AUTO ON	

- **ON:** the instrument preferentially selects a 10 MHz signal from the rear-panel **10 MHz In** connector.
- **OFF:** the instrument selects the reference oscillator based on the **ROSC:SOURce** setting.

ROSCillator:SOURce:CURRent?

Indicates which reference oscillator signal is currently in use when **ROSC:SOURce:AUTO** is ON.

Parameter	Typical Return
(none)	INT (internal) or EXT (10 MHz connector on rear panel)
Determine reference signal source: ROSC:SOUR:CURR?	

- INT refers to the basic internal TCXO or the **optional ovenized OCXO oscillator**, whichever is installed.

SOURce Subsystem

The SOURce keyword is optional in many commands that set parameters for a source or output channel.

Example

The SOURce keyword and the channel number are optional in the [SOURce[1|2]:]AM[:DEPTH]? query, and if it is omitted, the source defaults to channel 1. The following table shows how various forms of the query are interpreted.

Parameter	Typical Return
AM:DEPTH?	returns the modulation depth of channel 1
SOUR1:AM:DEPTH?	returns the modulation depth of channel 1
SOUR2:AM:DEPTH?	returns the modulation depth of channel 2 (two-channel instruments only)

Subsystems Using the Optional SOURce Keyword

Because SOURce subsystem commands are often used without the SOURce keyword, these commands are listed by their individual subsystems, below:

AM

APPLy

BPSK

BURSt

DATA

FM

FREQuency

FSKey

FUNCTION

LIST

MARKer

PHASe

PM

PWM

ROSCillator

SUM

SWEep

VOLTage

Commands Using the Optional SOURce Keyword

The following commands, which are not part of any subsystem, also have the optional SOURce keyword:

COMBine:FEED

TRACk

STATus Subsystem Introduction

The instrument's SCPI status system records various instrument conditions and states in several register groups.

In this subsystem, an event is something that occurred, even though it may not still be occurring. A condition is something that is currently present. A condition will appear in the event register, but the event register is read destructive; it is cleared (set to 0) when read.

The **STATus commands** manipulate bits in two of the enable registers. You can:

- Enable bits in the **Questionable Data enable** register (**STATus:QUEStionable:ENABle <enable_value>**). Query: **STATus:QUEStionable:ENABle?**
- Enable bits in the **Operation enable** register (**STATus:OPERation:ENABle <enable_value>**). Query: **STATus:OPERation:ENABle?**
- Clear all bits in the **Questionable Data** enable register and the Standard Operation enable register (**STATus:PRESet**).

The **STATus queries** accesses information about the status bits in the **Questionable Data** registers, including:

- The binary-weighted sum of all bits enabled in the Questionable Data **condition** register (**STATus:QUEStionable:CONDition?**)
- The binary-weighted sum of all bits enabled in the Questionable Data **event** register (**STATus:QUEStionable[:EVENT]?**)
- The binary-weighted sum of all bits enabled in the Questionable Data **enable** register (**STATus:QUEStionable:ENABle <enable_value>**).

The **STATus queries** also allow you to access information about the status bits in the **Operation** registers, including:

- The binary-weighted sum of all bits enabled in the Operation **condition** register (**STATus:OPERation:CONDition?**).
- The binary-weighted sum of all bits enabled in the Operation **event** register (**STATus:OPERation[:EVENT]?**).

Standard Operation Register Group

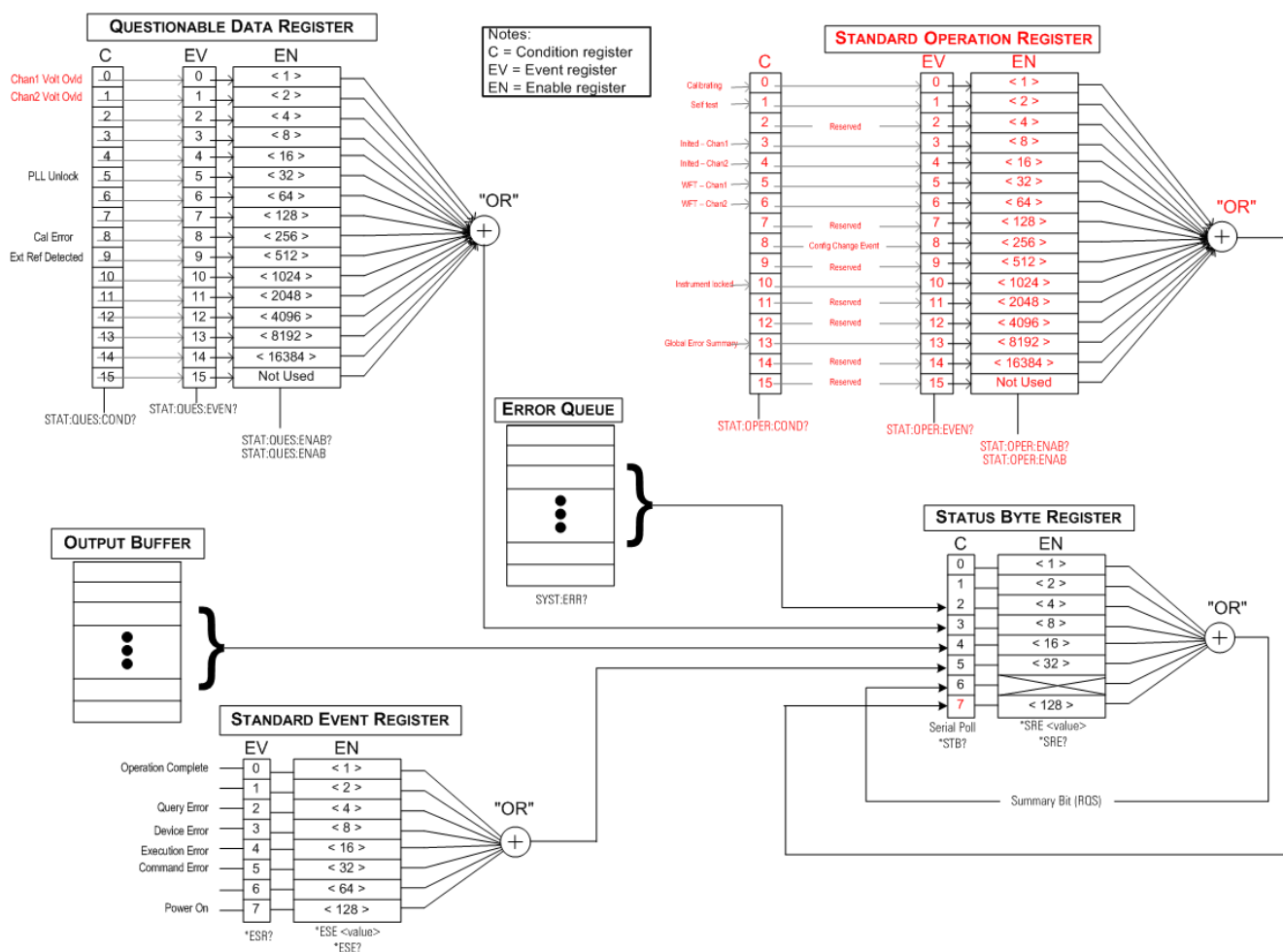
The following table describes the Standard Operation Register group.

Bit Number	Bit Name	Decimal Value	Definition
0	Calibrating	1	The instrument is performing a calibration.
1	Self-test	2	A self-test is running.
2	(Reserved)	4	(Reserved for future use)
3	Channel 1 Initiated	8	Channel is initiated and outputting the desired waveform. In INIT[1 2]:CONT OFF, this bit is set after receiving an INIT and not cleared until channel goes to IDLE (trigger count satisfied and not busy.) This bit is 0 if the channel is in INIT[1 2]:CONT ON mode.
4	Channel 2 Initiated	16	
5	Waiting for Trigger, Channel 1	32	Instrument is waiting for a trigger. In INIT[1 2]:CONT OFF, this bit is set after receiving an INIT and while waiting for a trigger. It is cleared after receiving the trigger. This bit is 0 if the channel is in INIT[1 2]:CONT ON mode.
6	Waiting for Trigger, Channel 2	64	
7	(Reserved)	128	(Reserved for future use)
8	Configuration Changed Event	256	This bit is always 0 in the condition register, as it reflects an event, not a condition.
9	(Reserved)	512	(Reserved for future use)
10	Instrument Locked	1024	If a remote interface (USB or LAN) has a lock (SYSTEM:LOCK:REQuest?), this bit will be set. When a remote interface releases the lock (SYSTEM:LOCK:RELease), this bit will be cleared.
11	(Reserved)	2048	(Reserved for future use)
12	(Reserved)	4096	(Reserved for future use)
13	Global Error	8192	This is set if any remote interface has an error in its error queue, and cleared otherwise.
14-15	(Reserved)	16,384 - 32,768	(Reserved for future use)

Questionable Data Register Group

The following table describes the Questionable Data Register group.

Bit Number	Bit Name	Decimal Value	Definition
0	Channel 1 Voltage Overload	1	Voltage overload on channel 1 output connector. The output has been disabled.
1	Channel 2 Voltage Overload	2	Voltage overload on channel 2 output connector. The output has been disabled.
2	(Reserved)	4	(Reserved for future use)
3	(Reserved)	8	(Reserved for future use)
4	(Reserved)	16	(Reserved for future use)
5	Loop Unlocked	32	Function generator has lost phase lock. Frequency accuracy will be affected.
6	(Reserved)	64	(Reserved for future use)
7	(Reserved)	128	(Reserved for future use)
8	Calibration Error	256	Error occurred during calibration, calibration is unsecured, or calibration memory has been lost
9	External Reference	512	External timebase has been detected.
10-15	(Reserved)	1024 - 32,768	(Reserved for future use)



STATus:OPERation:CONDition?

Queries the condition register for the **Standard Operation Register** group. Register is read-only; bits not cleared when read.

Parameter	Typical Return
(none)	+32
Read the condition register (bit 5 is set): STAT:OPER:COND?	

- The condition register bits reflect the current condition. If a condition goes away, the corresponding bit is cleared.
- *RST** clears this register, other than those bits where the condition still exists after *RST.
- The command reads the condition register and returns a decimal value equal to the binary-weighted sum of all bits set in the register. For example, if bit 5 (decimal value = 32) and bit 9 (decimal value = 512) are set, the command will return +544.

STATus:OPERation:ENABLE <enable_value>

STATus:OPERation:ENABLE?

Enables bits in the **enable register** for the **Standard Operation Register** group. The selected bits are then reported to the Status Byte as the standard operation summary bit.

Parameter	Typical Return
Sum of the bits' decimal values in the register.	+256
Enable bit 8 (decimal value 256) in the enable register: STAT:OPER:ENAB 256	

- Use <enable_value> to specify which bits are reported to the Status Byte. The specified value corresponds to the binary-weighted sum of the register bits to enable. For example, to enable bit 5 (value 32) and bit 9 (value 512), the decimal value would be 544.
- ***CLS** does not clear the enable register, but does clear the event register.
- This register is cleared at power-on unless ***PSC** is set to 0.

See Also

***STB?**

STATus:OPERation[:EVENT]?

Queries the event register for the **Standard Operation Register** group. This is a read-only register; the bits are cleared when you read the register.

Parameter	Typical Return
(none)	+32
Read event register: STAT:OPER:EVEN?	

- A set bit remains set until cleared by reading the event register or ***CLS**.
- ***RST** does not affect this register.
- Query reads the event register and returns a decimal value equal to the binary-weighted sum of all bits set in the register. For example, if bit 5 (value 32) and bit 9 (value 512) are set, the command returns +544.

STATus:PRESet

Clears **Questionable Data** enable register and **Standard Operation** enable register.

Parameter	Typical Return
(none)	(none)
Clear enable register bits: STAT:PRES	

STATus:QUESTIONable:CONDition?

Queries the condition register for the **Questionable Data Register group**.

Parameter	Typical Return
(none)	+512
Read the condition register (bit 9 is set): STAT:QUES:COND?	

- The Questionable Data register group provides information about the instrument's quality or integrity.
- Any or all conditions can be reported to the Questionable Data summary bit through the enable register.
- Register is read-only; bits not cleared when read.
- The condition register bits reflect the current condition. If a condition goes away, the corresponding bit is cleared.
- ***RST** clears the condition register.
- The query reads the condition register and returns a decimal value equal to the binary-weighted sum of all bits set in the register. For example, if bit 12 (decimal value = 4096) is set, the query returns "+4096".

STATus:QUESTIONable:ENABLE <enable_value>

STATus:QUESTIONable:ENABLE?

Enables bits in the **enable register** for the **Questionable Data Register group**. The selected bits are then reported to the Status Byte.

Parameter	Typical Return
Decimal value equal to the sum of the bit decimal values in the register.	+512
Enable bit 9 (value 512) in the enable register: STAT:QUES:ENAB 512	

- Use <enable_value> to specify which bits are reported to the Status Byte. The specified value corresponds to the binary-weighted sum of the register bits to enable. For example, to enable bit 5 (value 32) and bit 9 (value 512), the decimal value would be 544.
- Enable register cleared by:
 - STATus:Questionable:ENABLE 0
 - **STATus:PRESet**
 - Power cycle (unless ***PSC** is set to 0)
- ***CLS** does not clear enable register but it does clear event register.
- ***RST** does not affect this register.
- The Query reads the enable register and returns a decimal value equal to the binary-weighted sum of all bits set in the register. For example, if bit 0 (value 1) and bit 1 (value 2) are enabled, the query returns +3.

STATus:QUESTIONable[:EVENT]?

Queries the event register for the **Questionable Data Register group**. This is a read-only register; the bits are cleared when you read the register.

Parameter	Typical Return
(none)	+512
Read the event register (bit 9 set): STAT:QUES?	

- Once a bit is set, it remains set until cleared by this query or ***CLS**.
- ***RST**, **STATus:PRESet**, and ***PSC** have no effect on this register.
- Query reads the event register and returns a decimal value equal to the binary-weighted sum of all bits set in the register. For example, if bit 1 (value 2) and bit 9 (value 512) are set, the query returns "+514".

SUM Subsystem Introduction

The SUM subsystem adds a modulation source signal to a channel's primary signal. This allows you to generate a two-tone signal on one channel, or to add noise to a primary signal. The SUM function uses the **same secondary sources** as used by the modulation subsystems.

Only one modulation or SUM function may be active on a channel at a time, so you cannot add noise to an FM signal using only one channel. For this operation, use **COMBine:FEED**, which combines both channels of a two-channel instrument into one channel output connector.

When signals are SUMmed:

- Their peak amplitude may not exceed the instrument's output rating.
- No other internal or external modulation is possible on that channel.

You can synchronize the phase between the primary signal and the **SUM** signal by sending **[SOURce[1|2]:] PHASe:SYNChronize** after setting the functions for the primary signal and the **SUM** signal. Otherwise, the phase between the two signals is arbitrary.

NOTE

When the source is the other channel, there is a noticeable delay (as much as 350 ns) relative to the carrier even after PHAS:SYNC. Use the Combine feature for the other channel whenever possible.

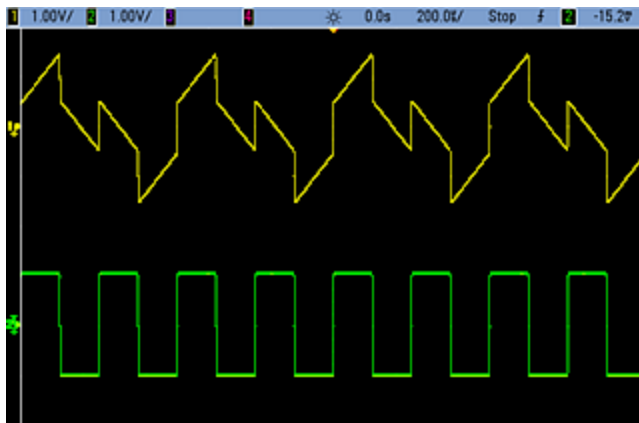
Example

To create a SUM waveform:

1. **Configure carrier waveform:** Use **FUNCTION**, **FREQuency**, **VOLTage**, and **VOLTage:OFFSet** to specify the carrier waveform's function, frequency, amplitude, and offset.
2. **Select the summing source:** The instrument accepts an internal or external modulation source (EXT, Channel 1, or Channel 2). Select the modulation source with **SUM:SOURce**. *For an external modulation source, skip steps 3 and 4.*
3. **Configure the summing waveform:** Use **FUNCTION**, **FREQuency**, **VOLTage**, and **VOLTage:OFFSet** commands to configure the summing waveform.
4. **Set the amplitude percentage to sum:** **SUM:AMPLitude**.
5. **Enable SUM Modulation:** **SUM:STATe:ON**.
6. **If using the other channel of a two-channel instrument, synchronize the channels:** **PHASe:SYNChronize**.

The following code produces the oscilloscope image shown below.

```
SOURce1:FUNCTION RAMP
SOURce1:FREQuency +2000.0
SOURce1:VOLTage +1.0
SOURce1:VOLTage:OFFS +0.0
SOURce1:FUNCTION:RAMP:SYMMetry +50.0
SOURce2:FUNCTION SQU
SOURce2:FREQuency +4000.0
SOURce2:VOLTage +1.0
SOURce2:VOLTage:OFFS +0.0
SOURce1:SUM:AMPLitude +50.0
SOURce1:SUM:SOURce CH2
SOURce1:SUM:STATE 1
SOURce1:PHASe:SYNC
OUTPut1 1
OUTPut2 1
```



[SOURce[1|2]:]SUM:AMPLitude {<amplitude>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]SUM:AMPLitude? [{MINimum|MAXimum}]

Sets internal modulation depth (or "percent modulation") in percent.

Parameter	Typical Return
Desired SUM signal amplitude in percent of carrier amplitude, from 0 to 100; default 0.1	+3.200000000000000E+00
Set the internal SUM signal amplitude to 1.0% of the signal amplitude: SUM:AMPL 1.0 PHAS:SYNC Set the internal sum signal amplitude on channel 2 to 0.15% of the signal amplitude: SOUR2:SUM:AMPL 0.15	

- You can synchronize the phase between the primary signal and the **SUM** signal by sending [SOURce[1|2]:]PHASe:SYNChronize after setting the functions for the primary signal and the **SUM** signal. Otherwise, the phase between the two signals is arbitrary.
- Summed output cannot exceed ± 5 V peak output (into a 50 Ω load).
- If you select the External SUM source (SUM:SOURce EXTERNAL), the carrier waveform is added to the external waveform. The summing signal is the ± 5 V signal level (optionally ± 1 V on the 33600 Series) on the rear-panel **Modulation In** connector. For example, if you have the carrier amplitude of a sine wave set to 4 Vpp and set the Sum Amplitude to 20% (resulting in a maximum sum contribution of 800 mVpp) using SUM:AMPLitude, then when the EXT signal is at +5 V (optionally +1 V on the 33600 Series), the additive signal output will be at the maximum amplitude of 4.8 Vpp. When the modulating signal is at -5 V (optionally -1 V on the 33600 Series), the additive signal will be at the minimum amplitude of -4.8 Vpp. A modulation input of 0 V would result in a signal equal to the carrier amplitude.

[SOURce[1|2]:]SUM:INTernal:FREQuency {<frequency>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]SUM:INTernal:FREQuency? [{MINimum|MAXimum}]

Sets the frequency of the summing waveform when internal sum source is selected (**SUM:SOURce:INTernal**). The modulating source waveform operates at that frequency, within the frequency limits of that waveform.

Parameter	Typical Return
1 µHz to the maximum allowed for the internal function . Default 100 Hz	+1.0000000000000000E-06
The following command sets the summing frequency to 10 kHz on Channel 2: SOUR2:SUM:INT:FREQ 10000 SOUR2:PHAS:SYNC The following command sets the summing frequency to 1 µHz on Channel 1: SUM:INT:FREQ MIN PHAS:SYNC	

- You can synchronize the phase between the primary signal and the **SUM** signal by sending **[SOURce[1|2]:]PHASe:SYNChronize** after setting the functions for the primary signal and the **SUM** signal. Otherwise, the phase between the two signals is arbitrary.
- When you select an arbitrary waveform as the modulating source, the frequency changes to the frequency of the arbitrary waveform, which is based on the sample rate and the number of points in the arbitrary waveform.
- When using an arbitrary waveform for the modulating source, changing this parameter also changes the cached metadata representing the arbitrary waveform's sample rate. You can also change the modulating frequency of an arbitrary waveform with **FUNCTION:ARbitrary:FREQuency**, **FUNCTION:ARbitrary:PERiod**, and **FUNCTION:ARbitrary:SRATe**. These commands and the modulation frequency command are directly coupled in order to keep the arbitrary waveform behaving exactly as it was last played. If you later turn modulation off and select that same arbitrary waveform as the current function, its sample rate (and corresponding frequency based upon the number of points) will be the same as it was when played as the modulation source.
- If the internal function is TRlangle, UpRamp, or DnRamp, the maximum frequency is limited to 200 kHz on the 33500 Series or 800 kHz on the 33600 Series. If the internal function is PRBS, the frequency refers to bit rate and is limited **as shown here**.

[SOURce[1|2]:]SUM:INTernal:FUNctIon <function>

[SOURce[1|2]:]SUM:INTernal:FUNctIon?

Selects the summing waveform (the waveform added to the primary waveform).

Parameter	Typical Return
{SINusoid SQUare RAMP NRAmp TRIangle NOISe PRBS ARB}, default SINusoid	SIN, SQU, RAMP, NRAM, TRI, NOIS, PRBS, or ARB
Select a sine wave as the summing waveform shape for channel 2: SOUR2:SUM:INT:FUNC SIN	

- You can synchronize the phase between the primary signal and the **SUM** signal by sending [SOURce[1|2]:]PHASe:SYNChronize after setting the functions for the primary signal and the **SUM** signal. Otherwise, the phase between the two signals is arbitrary.
- This command is applicable only with internal sum source (SUM:SOURce INTernal).
- You cannot use SUM when DC is the carrier.
- An arbitrary waveform may not simultaneously be a carrier and a sum waveform.

The following table shows which carriers can be associated with which internal functions.

Modulating Signal							
Carrier	Sine	Square	Tri / Ramp	Noise	PRBS	Arb	External
Sine	•	•	•	•	•	•	•
Square/Pulse	•	•	•	•	•	•	•
Ramp/Triangle	•	•	•	•	•	•	•
Gaussian Noise	•	•	•		•	•	•
PRBS	•	•	•	•		•	•
Arbitrary	•	•	•	•	•		•
Sequenced Arbitrary	•	•	•	•	•		•

[SOURCE[1|2]:]SUM:SOURce {INTernal|EXTernal|CH1|CH2}
 [SOURCE[1|2]:]SUM:SOURce?

Selects source of summing signal.

Parameter	Typical Return
{INTernal EXTernal CH1 CH2}, default INTernal	INT, EXT, CH1, or CH2
Set the sum source to EXTernal: SUM:SOUR EXT	

- You can synchronize the phase between the primary signal and the **SUM** signal by sending [SOURCE[1|2]:]PHASe:SYNChronize after setting the functions for the primary signal and the **SUM** signal. Otherwise, the phase between the two signals is arbitrary.
- SUM:SOURce EXTernal:** carrier waveform is summed with external waveform. The amplitude and polarity of the sum signal is determined by the ± 5 V signal level on the rear-panel **Modulation In** connector (optionally ± 1 V on the 33600 Series). For example, if you have set the SUM Amplitude to 2.0 Vpp using SUM:AMPLitude, then when EXT signal is at +5 V, the sum signal will be at 2 Vpp. When the modulating signal is at -5 V, the sum signal will be at full amplitude and opposite polarity.

[SOURCE[1|2]:]SUM:STATe {ON|1|OFF|0}
 [SOURCE[1|2]:]SUM:STATe?

Disables or enables SUM function.

Parameter	Typical Return
{ON 1 OFF 0}, default OFF	0 (OFF) or 1 (ON)
Enable SUM SUM:STAT ON	

- You can synchronize the phase between the primary signal and the **SUM** signal by sending [SOURCE[1|2]:]PHASe:SYNChronize after setting the functions for the primary signal and the **SUM** signal. Otherwise, the phase between the two signals is arbitrary.
- To avoid multiple waveform changes, enable SUM after you have configured the other sum parameters.
- Only one modulation mode may be enabled at a time.
- The instrument will not allow SUM to be enabled when sweep or burst is enabled. When you enable SUM, the sweep or burst mode is turned off.
- With SUM:STATe ON, the sum amplitude plus the carrier amplitude may not exceed either the programmed limits or the instrument's output rating. If setting SUM:STATe ON would cause either the output rating or the limits to be exceeded, SUM:STATe will be set OFF and the instrument will report a settings conflict error.

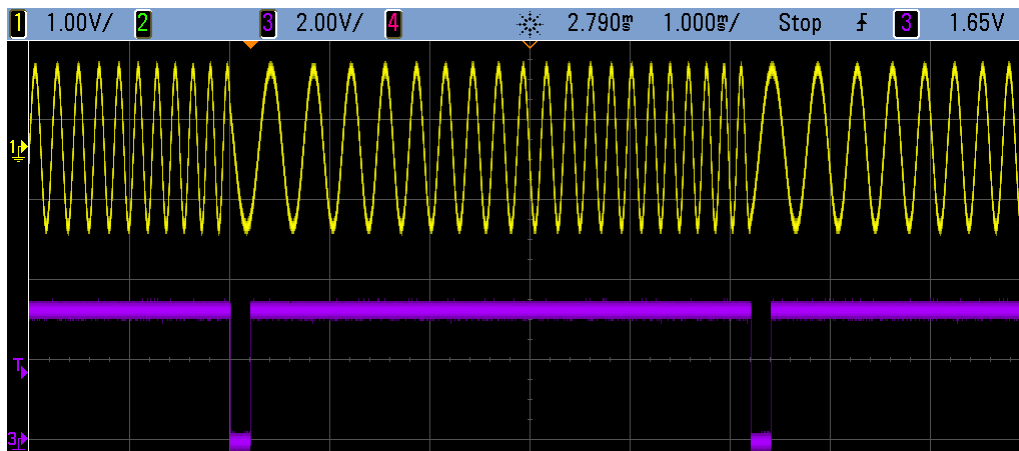
SWEEP Subsystem Introduction

To generate a frequency sweep:

1. **Select the waveform shape, amplitude and offset:** Use **APPLY** or the equivalent **FUNCTION**, **FREQUENCY**, **VOLTage**, and **VOLTage:OFFSet** commands to select the function, frequency, amplitude, and offset. You can select a sine, square, ramp, pulse, or arbitrary waveform (noise, PRBS, and DC are not allowed).
2. **Select sweep's frequency boundaries:** **FREQUENCY:START** and **FREQUENCY:STOP**, or **FREQUENCY:CENTer** and **FREQUENCY:SPAN**
3. **Select linear or logarithmic sweep mode:** **SWEEP:SPACing**
4. **Set sweep time:** **SWEEP:TIME**
5. **Set sweep hold and return times:** **SWEEP:HTIME** and **SWEEP:RTIME**
6. **Select sweep trigger source:** **TRIGGER[1|2]:SOURCE**
7. **Set the marker frequency (optional):** **MARKEr:FREQUENCY**
8. **Enable sweep:** **SWEEP:STATE ON**

The following code produces the waveform shown below.

```
SOURce1:FUNCTION SINE
SOURce1:FREQUENCY +2.0E+03
SOURce1:FREQUENCY:START +2.0E+03
SOURce1:FREQUENCY:STOP +6.0E+03
SOURce1:VOLTage +1.0
SOURce1:VOLTage:OFFS +0.0
SOURce1:SWEEP:TIME +5.0E-03
TRIGGER1:SOURCE IMM
SOURce1:FREQUENCY:MODE SWE
OUTPut1 1
```



[SOURCE[1|2]:]SWEep:HTIME {<hold_time>|MINimum|MAXimum|DEFAULT}
 [SOURCE[1|2]:]SWEep:HTIME? [{MINimum|MAXimum}]

Sets number of seconds the sweep holds (pauses) at the stop frequency before returning to the start frequency.

Parameter	Typical Return
0 to 3600, default 0	+3.4000000000000000E+00
Set sweep hold time to 3.4 seconds: SWE:HTIM 3.4	

[SOURCE[1|2]:]SWEep:RTIME {<return_time>|MINimum|MAXimum|DEFAULT}
 [SOURCE[1|2]:]SWEep:RTIME? [{MINimum|MAXimum}]

Sets number of seconds the sweep takes to return from stop frequency to start frequency.

Parameter	Typical Return
0 to 3600, default 0	+5.6000000000000000E+00
Set sweep return time to 5.6 s: SWE:RTIM 5.6	

- The return sweep is always a linear sweep, regardless of the setting of **SWEep:SPACing**.

[SOURCE[1|2]:]SWEep:SPACing {LINear|LOGarithmic}
 [SOURCE[1|2]:]SWEep:SPACing?

Selects linear or logarithmic spacing for sweep.

Parameter	Typical Return
{LINear LOGarithmic}, default LIN	LIN or LOG
Set logarithmic sweep spacing: SWE:SPAC LIN	

- **LINear**: output frequency varies linearly (from start frequency to stop frequency) during sweep.
- **LOGarithmic**: output frequency varies logarithmically (from start frequency to stop frequency) during sweep.

[SOURce[1|2]:]SWEep:STATe {ON|1|OFF|0}
[SOURce[1|2]:]SWEep:STATe?

Enables or disables the sweep.

Parameter	Typical Return
{ON 1 OFF 0}, default OFF	0 (OFF) or 1 (ON)
Enable sweep: SWE:STAT ON	

[SOURce[1|2]:]SWEep:TIME {<seconds>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]SWEep:TIME? [{MINimum|MAXimum}]

Sets time (seconds) to sweep from start frequency to stop frequency.

Parameter	Typical Return
1 ms to 250,000 s for linear sweep, up to 500 s for logarithmic sweep; default 1 s	+2.500000000000000E+01
Set sweep time to 25 s: SWE:TIME 25	

- The number of discrete frequency points in the sweep is calculated based on the sweep time.

SYSTEM Subsystem

The SYSTEM subsystem manages instrument state storage, power-down recall, error conditions, self test, front panel display control and remote interface configuration.

NOTE

The instrument uses LAN port 5024 for SCPI Telnet sessions, and port 5025 for SCPI Socket sessions.

- **SYSTEM:BEEPer[:IMMediate]** - issues a single beep
- **SYSTEM:BEEPer:STATe {ON|1|OFF|0}** - disables or enables beeper
- **SYSTEM:CLICk:STATe** - disables or enables keypress click
- **SYSTEM:COMMunicate:ENABle {ON|1|OFF|0}, <interface>** - disables or enables GPIB, USB, LAN interface, and remote services
- **SYSTEM:COMMunicate:GPIB:ADDRes <address>** - assigns instrument's GPIB (IEEE-488) address
- **SYSTEM:DATE <yyyy>, <mm>, <dd>** - sets system clock date
- **SYSTEM:ERRor?** - reads and clears one error from error queue
- **SYSTEM:LIcense:CATalog?** - lists installed, licensed options
- **SYSTEM:LIcense:DELeTe "<option_name>"** - deletes a license
- **SYSTEM:LIcense:DELeTe:ALL** - deletes all licenses

- **SYSTem:LIcense:DEScRiption? "<option_name>"** - returns description of a **licensed option**
- **SYSTem:LIcense:ERROr?** - lists errors generated during license installation
- **SYSTem:LIcense:ERROr:COUnT?** - returns number of errors generated during license installation
- **SYSTem:LIcense:INSTall "<file>"** - installs licenses from a file or folder
SYSTem:LIcense:INSTall? "<option>" - indicates whether a license is installed
- **SYSTem:LOCK:NAME?** - returns current I/O interface
- **SYSTem:LOCK:OWNeR?** - returns interface that has the lock
- **SYSTem:LOCK:RELease** - releases lock and decrements lock count by 1
- **SYSTem:LOCK:REQueSt?** - requests lock of current interface
- **SYSTem:SECurity:IMMediate** - sanitizes user-accessible instrument memory
- **SYSTem:TIME <hh>, <mm>, <ss>** - sets system clock time
- **SYSTem:VERSiOn?** - returns version of SCPI used by instrument

SYSTem:BEEPer[:IMMediate]

Issues a single beep.

Parameter	Typical Return
(none)	(none)
Issue a single beep: SYST:BEEP	

- Sending a programmed beep may be useful for program development and troubleshooting.
- This command overrides the current beeper state (the **SYSTem:BEEPer:STATe**). This means that you can issue a single beep even if the beeper is turned off.

SYSTem:BEEPer:STATe {ON|1|OFF|0}

SYSTem:BEEPer:STATe?

Disables or enables the beeper tone heard when an error is generated from the front panel or remote interface.

Parameter	Typical Return
{ON 1 OFF 0}, default ON	0 (OFF) or 1 (ON)
Disable beeper state: SYST:BEEP:STAT OFF	

- Turning off the beeper does not disable the front panel key click.
- A beep is always emitted (even with beep state OFF) when **SYSTem:BEEPer** is sent.
- This setting is non-volatile; it will not be changed by power cycling or ***RST**.

SYSTem:CLICk:STATe {ON|1|OFF|0}

SYSTem:CLICk:STATe?

Disables or enables the click heard when a front panel key or softkey is pressed.

Parameter	Typical Return
{ON 1 OFF 0}, default ON	0 (OFF) or 1 (ON)
Disable keyboard click: SYST:CLIC:STAT OFF	

- This command does not affect the beeper that indicates errors.
- This setting is non-volatile; it is not changed by power cycling or a Factory Reset (*RST).

SYSTem:COMMunicate:ENABle {ON|1|OFF|0}, <interface>

SYSTem:COMMunicate:ENABle? <interface>

Disables or enables the GPIB, USB, or LAN remote interface. Also disables or enables available remote services such as Sockets, Telnet, VXI11, and the built-in Web Interface.

Parameter	Typical Return
{ON 1 OFF 0}, default ON for all interfaces	0 (OFF) or 1 (ON)
{GPIB USB LAN SOCKets TELNet VXI11 WEB}	
Disable the USB interface: SYST:COMM:ENAB OFF,USB Returns the state of the USB interface: SYST:COMM:ENAB? USB	

NOTE

When you disable or re-enable any interface or LAN service, you must cycle power to activate the new setting.

- If you disable the LAN interface, all associated LAN services will not be started when you power on the instrument.
- This setting is non-volatile; it will not be changed by power cycling or *RST.
- **SYSTem:SECurity:IMMediate** enables all interfaces.

SYSTem:COMMunicate:GPIB:ADDRess <address>

SYSTem:COMMunicate:GPIB:ADDRess?

Assigns instrument's GPIB (IEEE-488) address, which is displayed at power-on. Each device on the GPIB interface must have a unique address.

Parameter	Typical Return
0 to 30, default 10	+15
Set GPIB address to 15: SYST:COMM:GPIB:ADDR 15	

- Your computer's GPIB interface card address must not conflict with any instrument on the interface bus.
- This setting is non-volatile; it will not be changed by power cycling or ***RST**.
- **SYSTem:SECurity:IMMediate** sets GPIB address to 10.
- Must cycle power for this command to take effect.

SYSTem:DATE <yyyy>, <mm>, <dd>

SYSTem:DATE?

Sets system clock date.

Parameter	Typical Return
<yyyy> 2000 to 2100 <mm> 1 to 12 <dd> 1 to 31	+2011,+7,+26
Set system date to July 26, 2011: SYST:DAT 2011,7,26	

SYSTem:ERRor?

Reads and clears one error from error queue.

Parameter	Typical Return
(none)	-113,"Undefined header"
Read and clear first error in error queue: SYST:ERR?	

- Up to 20 command syntax or hardware errors can be stored in each interface-specific error queue (one each for GPIB, USB, VXI-11, and Telnet/Sockets.)
- Error retrieval is first-in-first-out (FIFO), and errors are cleared as you read them. The instrument beeps once each time an error is generated (unless disabled by **SYSTem:BEEPer:STATe OFF**).
- If more than 20 errors have occurred, the last error stored in the queue (the most recent error) is replaced with -350,"Error queue overflow". No additional errors are stored until you remove errors from the queue. If no errors have occurred when you read the error queue, the instrument responds with +0,"No error".
- The error queue is cleared by the *CLS and when power is cycled. It is not cleared by ***RST**.
- Errors have the following format (the error string may contain up to 255 characters).

<error code>,<error string>

Where:

<error code> = a three-digit code, sometimes preceded by a dash

<error string> = a quoted ASCII string up to 255 characters

Licensed Options

The following commands are associated with licensed options. The licensed options are named as shown below.

Option Code	Description
ARB	Arbitrary waveforms
BW30	Increase bandwidth to 30 MHz (33500 Series)
BW120	Increase bandwidth to 120 MHz (33600 Series)
IQP	IQ Player (2-channel instruments only)
MEM	16 MSa Arb Memory (33500 Series) or 64 MSa Arb Memory (33600 Series)
SEC	Enable NISPOM & File Security

SYSTem:LiCense:CATalog?

Returns a comma separated list of installed, **licensed options**.

Parameter	Typical Return
(none)	"SEC", "IQP", "MEM"
Return currently licensed options: SYST:LIC:CAT?	

- Only those installed options that require a license are returned.

SYSTem:LiCense:DELeTe "<option_name>"

Deletes a license.

CAUTION

Exercise caution before executing this command. The only way to undo a license deletion is to re-install the license.

Parameter	Typical Return
{ARB BW30 BW120 IQP MEM SEC}	(none)
Delete license for IQ Player: SYST:LIC:DEL "IQP"	

- Valid option names are double quoted strings representing the installed **licensed options**. They can be easily identified using **SYSTem:LiCense:CATalog?**.

SYSTem:LiCense:DELeTe:ALL

Deletes all licenses.

CAUTION

Exercise caution before executing this command. The only way to undo a license deletion is to re-install the license.

Parameter	Typical Return
(none)	(none)
Delete all licenses: SYST:LIC:DEL:ALL	

SYSTem:LiCense:DESCription? "<option_name>"

Returns a description of specified option, regardless of whether it is currently licensed.

Parameter	Typical Return
See list of licensed options	"Extended Memory Option: 16 MSa/channel waveform memory"
Return description for option 002: SYST:LIC:DESC? "MEM"	

- Option names are quoted strings representing options that may be licensed. Installed licensed items can be identified with **SYSTem:LiCense:CATalog?**.

SYSTem:LiCense:ERRor?

Returns a string of all the errors produced by **SYSTem:LiCense:INSTall**.

Parameter	Typical Return
(none)	#279File: MyFile.lic<CR><LF>[Ignored - The license file is not formatted correctly.]<CR><LF>
Return the license installation error string: SYST:LIC:ERR?	

- String can be up to 2096 characters.
- Returns a definite-length block containing multi-line ASCII text, including carriage returns and line feeds.

SYSTem:LiCense:ERRor:COUNT?

Returns the number of license errors generated by **SYSTem:LiCense:INSTall**.

Parameter	Typical Return
(none)	+0
Return number of license errors: SYST:LIC:ERR:COUN?	

SYSTem:LIcense:INSTall "<file>"

SYSTem:LIcense:INSTall? "<option>"

This command installs all licenses from a specified file or from all license files in the specified folder. The query returns 0 or 1 to indicate whether the specified license is installed.

Parameter	Typical Return
<folder> may be any valid folder name. Default is root directory of a front panel USB storage device. <file> may be any valid license file name <option> is one of the licensed options	0 (license not installed) or 1 (license installed)
Install licenses from a file: SYST:LIC:INSTALL "USB:\33522B_LICENSE071.lic"	

- License files must have a ".lic" file extension.
- The format for <file> is "[<drive>:<path>]<file_name>", where <drive> can be INTERNAL or USB, and <path> must be an absolute folder path.
 - INTERNAL specifies the internal flash file system. USB specifies a front panel USB storage device.
 - If <drive>:<path> is omitted, the folder specified by the MMEMory:CDIRectory command is used.
 - Absolute paths begin with "\" or "/" and start at the root folder of <drive>.
 - Folder and file names cannot contain the following characters: \ / : * ? " < > |
 - The combination of folder and file name cannot exceed 240 characters.
 - The specified folder must exist and cannot be marked hidden or system.

SYSTem:LOCK:NAME?

Returns the current I/O interface (the I/O interface in use by the querying computer).

Parameter	Typical Return
(none)	"LAN169.254.149.35"
See Interface Locking Examples	

- After using this command to determine the name of the interface that you are using, use SYSTem:LOCK:OWNer? to determine which interface, if any, has the lock.
- Returns "USB", "VXI11", "GPIB", or "LAN <IP Address>" indicating the I/O interface being used by the querying computer.

SYSTem:LOCK:OWNer?

Returns the I/O interface that currently has a lock.

Parameter	Typical Return
(none)	"LAN169.254.149.35"
See Interface Locking Examples	

- When a lock is active, Bit 10 in the Standard Operation Register will be set (**STATus:OPERation:CONDition?**). When the lock is released on all I/O interfaces, this bit will be cleared.
- Returns "USB", "VXI11", "GPIB", or "LAN <IP Address>" indicating the I/O interface that currently has a lock. If no interfaces have a lock, "NONE" is returned.

SYSTem:LOCK:RELease

Decrements the lock count by 1 and may release the I/O interface from which the command is executed.

Parameter	Typical Return
(none)	(none)
See Interface Locking Examples	

- When a lock is active, Bit 10 in the Standard Operation Register will be set (**STATus:OPERation:CONDition?**). When the lock is released on all I/O interfaces, this bit will be cleared.

SYSTem:LOCK:REQuest?

Requests a lock of the current I/O interface. This allows you to lock the instrument's configuration or cooperatively share the instrument with other computers.

Parameter	Typical Return
(none)	0 (denied) or 1 (granted)
See Interface Locking Examples	

- Lock requests can be nested; each request increases lock count by 1. For every request, you will need a release (SYSTem:LOCK:RELease) from the same I/O interface.
- Locks are handled at the I/O interface level (USB, LAN, etc.) and you are responsible for all coordination between threads and/or programs on that interface.
- When a request is granted, only I/O sessions from the present interface will be allowed to change the state of the instrument. You can only query the instrument state from other I/O interfaces.
- LAN sessions locks are automatically released when a LAN disconnect is detected.
- Granting a lock sets Bit 10 in the Standard Operation Register (**STATus:OPERation:CONDition?**).

Interface Locking Examples

The following series of commands illustrates usage.

Initial State = unlocked, Count = 0

```
<FROM USB> SYST:LOCK:REQ? returns 1 (request successful)
```

State = locked, Count = 1

```
<FROM LAN> SYST:LOCK:REQ? returns 0 because USB has lock
```

State = locked, Count = 1

```
<FROM USB> SYST:LOCK:REQ? returns 1 (request successful)
```

State = locked, Count = 2

```
<FROM USB> SYST:LOCK:REL
```

State = locked, Count = 1

```
<FROM USB> SYST:LOCK:REL
```

State = unlocked, Count = 0

Note that for each successful lock request, a lock release is required. Two requests require two releases.

SYSTem:SECurity:IMMediate

Sanitizes all user-accessible instrument memory. This command complies with requirements in chapter 8 of the National Instrument Security Program Operating Manual (NISPOM).

Parameter	Typical Return
(none)	(none)
Sanitize all user-accessible instrument memory: SYST:SEC:IMM	

CAUTION

This command is recommended for customers, such as military contractors, who must comply with NISPOM. Excessive use of this command may cause premature failure of the flash memory.

This command destroys all user-defined state information, user-defined arbitrary waveforms, and user-defined I/O settings such as the IP address.

- Typically used before removing an instrument from a secure area.
- Initializes all instrument settings to their Factory Reset (***RST**) values.

SYSTem:TIME <hh>, <mm>, <ss>

SYSTem:TIME?

Sets system clock time.

Parameter	Typical Return
<hh> 0 to 23 <mm> 0 to 59 <ss> 0 to 60	20,15,30.000
Set system Time to 20:15:30 (8:15:30 PM) SYST:TIM 20,15,30	

- This time is used for file timestamps in the Mass Memory (MMEMory) system.

SYSTem:VERSion?

Returns version of the SCPI (Standard Commands for Programmable Instruments) that the instrument complies with. Cannot be determined from front panel.

Parameter	Typical Return
(none)	1994.0
Return the SCPI version: SYST:VERS?	

LAN Configuration

Configures instrument for remote operation via the local area network (LAN).

NOTE

The instrument uses LAN port 5024 for SCPI Telnet sessions, and port 5025 for SCPI Socket sessions.

Dot Notation Details

Dot-notation addresses ("nnn.nnn.nnn.nnn" where "nnn" is a byte value from 0 to 255) must be expressed with care, as most PC web software interprets byte values with leading zeros as octal (base 8) numbers. For example, "192.168.020.011" is actually equivalent to decimal "192.168.16.9" because ".020" is interpreted as "16" expressed in octal, and ".011" as "9". To avoid confusion, use only decimal values from 0 to 255, with no leading zeros.

SYSTem:COMMunicate:LAN:CONTRol?

Reads the initial Control connection port number for Sockets communications. This connection is used to send and receive commands and queries.

Parameter	Typical Return
(none)	5000 (0 if the interface does not support sockets)
Return the Control connection port number: SYST:COMM:LAN:CONT?	

- Use the Control socket connection to send a Device Clear to the instrument or to detect pending Service Request (SRQ) events. The Device Clear command is "DCL".

SYSTem:COMMunicate:LAN:DHCP {ON|1|OFF|0}

SYSTem:COMMunicate:LAN:DHCP?

Disables or enables instrument's use of DHCP. The acronym DHCP stands for Dynamic Host Configuration Protocol, a protocol for assigning dynamic IP addresses to networked devices. With dynamic addressing, a device can have a different IP address every time it connects to the network.

ON: instrument tries to obtain an IP address from a DHCP server. If a DHCP server is found, it assigns a dynamic IP address, Subnet Mask, and Default Gateway to the instrument.

OFF or DHCP unavailable: instrument uses the static IP address, Subnet Mask, and Default Gateway during power-on.

NOTE

If you change this setting, you must send **SYSTem:COMMunicate:LAN:UPDate** to activate the new setting.

Parameter	Typical Return
{ON 1 OFF 0}, default ON	0 (OFF) or 1 (ON)
Disable DHCP: SYST:COMM:LAN:DHCP OFF SYST:COMM:LAN:UPDate	

- Most corporate LANs have a DHCP server.
- If DHCP LAN address not assigned by DHCP server, static IP is assumed after approximately two minutes.
- This setting is non-volatile; it will not be changed by power cycling or ***RST**.
- Enabled when the instrument is shipped from the factory or after SYSTem:SECurity:IMMediate.

SYSTem:COMMunicate:LAN:DNS[1|2] "<address>"
SYSTem:COMMunicate:LAN:DNS[1|2]? [{CURRENT|STATIC}]

Assigns static IP addresses of Domain Name System (DNS) servers. A primary and a secondary server address may be assigned. Contact your LAN administrator for details. If DHCP is available and enabled, DHCP will auto-assign the DNS server addresses. These auto-assigned DNS server addresses take precedence over the static DNS addresses assigned with this command.

NOTE If you change this setting, you must send **SYSTem:COMMunicate:LAN:UPDate** to activate the new setting.

Parameter	Typical Return
Command: " nnn.nnn.nnn.nnn ", default "0.0.0.0" Query: {CURRENT STATIC}, default CURRENT	"198.105.232.4"
Set a static primary DNS address: SYST:COMM:LAN:DNS "198.105.232.4" SYST:COMM:LAN:UPD	

- CURRENT: read address currently being used by the instrument.
- STATIC: read static address from non-volatile memory. This address is used if DHCP is disabled or unavailable.
- This setting is non-volatile; it will not be changed by power cycling or ***RST**.
- Set to "0.0.0.0" by SYSTem:SECurity:IMMEDIATE.

SYSTem:COMMunicate:LAN:DOMain?

Returns the domain name of the LAN to which the instrument is connected.

Parameter	Typical Return
(none)	"example.com"
Return domain name being used by instrument: SYST:COMM:LAN:DOM?	

- If Dynamic domain name System (DNS) is available on your network and your instrument uses DHCP, the domain name is registered with the Dynamic DNS service at power-on.
- A null string ("") indicates that no domain name is assigned.

SYSTem:COMMunicate:LAN:GATeway "<address>"
SYSTem:COMMunicate:LAN:GATeway? [{CURRENT|STATIC}]

Assigns a default gateway for the instrument. The specified IP Address sets the default gateway which allows the instrument to communicate with systems that are not on the local subnet. Thus, this is the default gateway where packets are sent which are destined for a device not on the local subnet, as determined by the Subnet Mask setting. If DHCP is enabled (SYSTem:COMMunicate:LAN:DHCP), the specified default gateway is not used. However, if the DHCP server fails to assign a valid IP address, the currently configured default gateway will be used. Contact your LAN administrator for details.

NOTE

If you change this setting, you must send **SYSTem:COMMunicate:LAN:UPDate** to activate the new setting.

Parameter	Typical Return
Command: " nnn.nnn.nnn.nnn ", default "0.0.0.0" Query: {CURRENT STATIC}, default CURRENT	"198.105.232.1"
Set default gateway address: SYST:COMM:LAN:GATEWAY "198.105.232.1" SYST:COMM:LAN:UPD	

- CURRENT: read address currently being used by the instrument.
- STATic: read static address from non-volatile memory. This address is used if DHCP is disabled or unavailable.
- Set to "0.0.0.0" when instrument is shipped from factory or after SYSTem:SECurity:IMMediate.

SYSTem:COMMunicate:LAN:HOSTname "<name>"
SYSTem:COMMunicate:LAN:HOSTname? [{CURRENT|STATIC}]

Assigns a hostname to the instrument. A hostname is the host portion of the domain name, which is translated into an IP address. If Dynamic Domain Name System (DNS) is available on your network and your instrument uses DHCP, the hostname is registered with the Dynamic DNS service at power-on. If DHCP is enabled (SYSTem:COMMunicate:LAN:DHCP), the DHCP server can change the specified hostname.

NOTE

If you change this setting, you must send **SYSTem:COMMunicate:LAN:UPDate** to activate the new setting.

Parameter	Typical Return
String of up to 15 characters. Must start with letter (A-Z) May contain letters, numbers (0-9), or dashes ("-")	"LAB1-33522A"
Define a hostname: SYST:COMM:LAN:HOST "LAB1" SYST:COMM:LAN:UPD	

- Set to "A-33521A-nnnnn" or "A-33522A-nnnnn", where nnnnn is the last five digits of the instrument's serial number, when the instrument is shipped from the factory or after **SYSTem:SECurity:IMMediate**.
- If no hostname exists, a null string ("") is returned.

SYSTem:COMMunicate:LAN:IPADdress "<address>"
SYSTem:COMMunicate:LAN:IPADdress? [{CURRent|STATic}]

Assigns a static Internet Protocol (IP) address for the instrument. If DHCP is enabled (SYSTem:COMMunicate:LAN:DHCP), the specified static IP address is not used. Contact your LAN administrator for details.

NOTE

If you change this setting, you must send **SYSTem:COMMunicate:LAN:UPDate** to activate the new setting.

Parameter	Typical Return
Command: " nnn.nnn.nnn.nnn ", default "0.0.0.0" Query: {CURRent STATic}, default CURRent	"169.254.149.35"
Set a static IP address: SYST:COMM:LAN:IPAD "169.254.149.35" SYST:COMM:LAN:UPD	

- CURRent: read address currently being used by the instrument.
- STATic: read static address from non-volatile memory. This address is used if DHCP is disabled or unavailable.
- This setting is non-volatile; it will not be changed by power cycling or ***RST**.
- Set to "169.254.5.21" when the instrument is shipped from the factory or after **SYSTem:SECurity:IMMediate**.

SYSTem:COMMunicate:LAN:MAC?

Reads the instrument's Media Access Control (MAC) address.

NOTE

Your LAN administrator may need the MAC address to assign a static IP address for this device.

Parameter	Typical Return
(none)	"0030D3001041"
Return the MAC address: SYST:COMM:LAN:MAC?	

- The MAC address is also known as the link-layer address, the Ethernet (station) address, LANIC ID, or Hardware Address. This is an unchangeable 48-bit address assigned by the manufacturer to each unique Internet device.
- The instrument's MAC address is set at the factory and cannot be changed.
- This setting is non-volatile; it will not be changed by power cycling or ***RST**.

SYSTem:COMMunicate:LAN:SMASk "<mask>"
SYSTem:COMMunicate:LAN:SMASK? [{CURRENT|STATic}]

Assigns a subnet mask for the instrument. The instrument uses the subnet mask to determine whether a client IP address is on the same local subnet. When a client IP address is on a different subnet, all packets must be sent to the Default Gateway. Contact your LAN administrator for details.

NOTE If you change this setting, you must send **SYSTem:COMMunicate:LAN:UPDate** to activate the new setting.

Parameter	Typical Return
Command: " nnn.nnn.nnn.nnn ", default "0.0.0.0" Query: {CURRENT STATic}, default CURRENT	"255.255.0.0"
Set the subnet mask: SYST:COMM:LAN:SMAS "255.255.255.0" SYST:COMM:LAN:UPD	

- If DHCP is enabled (SYSTem:COMMunicate:LAN:DHCP), the specified subnet mask is not used. However, if the DHCP server fails to assign a valid IP address, the instrument uses the AutoIP subnet mask.
- A value of "0.0.0.0" or "255.255.255.255" indicates that subnetting is not being used.
- This setting is non-volatile; it will not be changed by power cycling or ***RST**.
- The subnet mask is set to "255.255.0.0" when the instrument is shipped from the factory or after a SYSTem:SECurity:IMMediate command.
- CURRENT: read address currently being used by the instrument.
- STATic: read static address from non-volatile memory. This address is used if DHCP is disabled or unavailable.

SYSTem:COMMunicate:LAN:TELNet:PROMpt "<string>"
 SYSTem:COMMunicate:LAN:TELNet:PROMpt?

Sets the command prompt seen when communicating with the instrument via Telnet.

Parameter	Typical Return
String of up to 15 characters	"Command>"
Set the command prompt: SYST:COMM:LAN:TELN:PROM "Command>"	

- A Telnet session is typically started from a host computer shell:

```
telnet <IP_address> <port>
```

For example: telnet 169.254.4.10 5024

To exit a Telnet session, press <Ctrl-D>.

- This setting is non-volatile; it will not be changed by power cycling or *RST.
- This is set to "33521A>" (model 33521A), "33522A>" (model 33522A), "33500>" (other 33500 Series models), or "33600>" (33600 Series models) when the instrument is shipped from the factory or after SYSTem:SECurity:IMMediate.

SYSTem:COMMunicate:LAN:TELNet:WMESsage "<string>"
 SYSTem:COMMunicate:LAN:TELNet:WMESsage?

Sets welcome message seen when communicating with instrument via Telnet.

Parameter	Typical Return
String of up to 63 characters	"Welcome to the Telnet Session"
Define a welcome message: SYST:COMM:LAN:TELN:WMES "Welcome to the Telnet Session"	

- This setting is non-volatile; it will not be changed by power cycling or *RST.
- This is set to "Welcome to Keysight's 33521A Waveform Generator" (model 33521A), "Welcome to Keysight's 33522A Waveform Generator" (model 33522A), "Welcome to Keysight's 33500-Series Waveform Generator" (other 33500 Series models), or "Welcome to Keysight's 33600-Series Waveform Generator" (33600 Series models) when the instrument is shipped from the factory or after SYSTem:SECurity:IMMediate.

SYSTem:COMMunicate:LAN:UPDate

Stores any changes made to the LAN settings into non-volatile memory and restarts the LAN driver with the updated settings.

Parameter	Typical Return
(none)	(none)
(see below)	

- This command must be sent after changing the settings for DHCP, DNS, gateway, hostname, IP address, subnet mask, WINS.
- Make all changes to the LAN settings before sending this command.

Example

The following example configures the instrument to use statically assigned LAN settings.

```
SYST:COMM:LAN:DHCP OFF
SYST:COMM:LAN:DNS "198.105.232.4"
SYST:COMM:LAN:DNS2 "198.105.232.5"
SYST:COMM:LAN:GATEWAY "198.105.232.1"
SYST:COMM:LAN:HOST "LAB1-33522A"
SYST:COMM:LAN:IPAD "198.105.232.101"
SYST:COMM:LAN:SMAS "255.255.255.0"
SYST:COMM:LAN:WINS "198.105.232.4"
SYST:COMM:LAN:WINS "198.105.232.5"
SYST:COMM:LAN:UPD
```

The following example configures the instrument back to use DHCP.

```
SYST:COMM:LAN:DHCP ON
SYST:COMM:LAN:UPD
```

SYSTem:COMMunicate:LAN:WINS[1|2] "<address>"
 SYSTem:COMMunicate:LAN:WINS[1|2]? [{CURRENT|STATIC}]

Assigns the static IP addresses of the Windows Internet Name System (WINS) servers. A primary and a secondary server address may be assigned. Contact your LAN administrator for details. If DHCP is available and enabled, DHCP will auto-assign the WINS server addresses. These auto-assigned WINS server addresses take precedence over the static WINS addresses assigned with this command.

NOTE If you change this setting, you must send **SYSTem:COMMunicate:LAN:UPDate** to activate the new setting.

Parameter	Typical Return
Command: " nnn.nnn.nnn.nnn ", default "0.0.0.0" Query: {CURRENT STATIC}, default CURRENT	"198.105.232.4"
Set a static primary WINS address: SYST:COMM:LAN:WINS "198.105.232.4" SYST:COMM:LAN:UPD	

- The assigned WINS addresses are used if DHCP is disabled or unavailable. Otherwise, the WINS server addresses are auto-assigned by DHCP.
- This setting is non-volatile; it will not be changed by power cycling or ***RST**.
- Set to "0.0.0.0" (no servers) after SYSTem:SECurity:IMMEDIATE.
- CURRENT: read address currently being used by the instrument.
- STATIC: read static address from non-volatile memory. This address is used if DHCP is disabled or unavailable.

[SOURce[1|2]:]TRACK {ON|OFF|INVerted}
TRACK?

Causes channels 1 and 2 of a two-channel instrument to output the same signal, or an inverted polarity signal.

Parameter	Typical Return
{ON OFF INVerted}	ON, OFF, or INV
Set channel 2 to output a signal identical to that of channel 1: TRACK ON	

- Causes all settings of the named channel to be copied to the other channel with exceptions noted below. This does include frequency list settings and any arbitrary waveforms loaded in memory.
- With the INVerted option, the tracking channel's amplitude will be inverted, forming a signal similar to a differential output between Channel 1 and Channel 2. DC Offset is not inverted.
- When TRACK is ON, voltage limits on both channels apply. If voltage limits on either channel would prevent the other channel's setup from being applied, the instrument will generate a settings conflict error and channel tracking will remain OFF.
- When TRACK is ON, changes to either channel are reflected in both channels. When TRACK is changed from ON or INV to OFF, the channels will remain in their present setup (frequency, amplitude, and so on), but you may now change one channel without affecting the other channel.
- Voltage limits may be adjusted in tracking mode, but cannot be set in violation of the current signal.
- Turning tracking ON sets COMBine:FEED to NONE, turns off FREQuency:COUPle, VOLTage:COUPle, and RATE:COUPle.
- TRACK is not allowed if the internal modulation source for the channel being tracked is the other channel.
- The OUTPut:SYNC:SOURce is set to the channel being tracked.

TRIGger Subsystem Introduction

NOTE

The rear-panel external trigger BNC connector is chassis referenced.

Configures triggering for sequence, list, burst, and sweep:

TRIGger[1|2] - immediate trigger

TRIGger[1|2]:COUNT {<number>MINimum|MAXimum|DEFAULT} - trigger count

TRIGger[1|2]:DELAY {<seconds>|MINimum|MAXimum} - trigger delay

TRIGger[1|2]:LEVEL {<level>|MINimum|MAXimum} - trigger level

TRIGger[1|2]:SLOPe {POSitive|NEGative} - slope of trigger signal at the rear-panel **Ext Trig** connector

TRIGger[1|2]:SOURCE {IMMediate|EXTernal|TImeR|BUS} - source (internal, external, timer, or bus) from which instrument accepts trigger

TRIGger[1|2]:TImeR {<seconds>|MINimum|MAXimum} - timer used when **TRIGger[1|2]:SOURCE** is TImeR.

TRIGger[1|2]

Forces immediate trigger to initiate sequence, sweep, list, or burst.

Parameter	Typical Return
(none)	(none)
Send an immediate trigger on channel 2: TRIG	

- Can be used with IMMediate, EXTernal, TImeR, or BUS trigger source (**TRIGger[1|2]:SOURCE**). For example, you can use TRIGger to issue an immediate trigger while waiting for an external trigger.
- Intended as an override. For general, software controlled triggering, use ***TRG**.

TRIGger[1|2]:COUNT {<number>MINimum|MAXimum|DEFAULT}

TRIGger[1|2]:COUNT? [{MINimum|MAXimum}]

Sets trigger count.

Parameter	Typical Return
1 to 1,000,000; default, 1	10000
Set channel 2 trigger count to 10000: TRIG2:COUN 10000	

- Can be used with IMMediate, EXTernal, TImeR, or BUS trigger source (**TRIGger[1|2]:SOURCE**).
- Applies only when INITiate[1|2]:CONTinuous is OFF.

TRIGger[1|2]:DElay {<seconds>|MINimum|MAXimum}

TRIGger[1|2]:DElay? [{MINimum|MAXimum}]

Sets trigger delay, (time from assertion of trigger to occurrence of triggered event).

Parameter	Typical Return
0 to 1000 s, in resolution of 4 ns; default 0	+1.0500000000000000E-01
Set channel 1 trigger delay to 105 ms: TRIG:DEL 105e-3	

- Can be used with IMMEDIATE, EXTERNAL, TIMER, or BUS trigger source (TRIGger[1|2]:SOURCE).

TRIGger[1|2]:LEVel {<level>|MINimum|MAXimum}

TRIGger[1|2]:LEVel? [{MINimum|MAXimum}]

Sets the output trigger level and input trigger threshold in volts. The trigger threshold is one-half of the trigger level.

Parameter	Typical Return
0.9 to 3.8 V	+3.3000000000000000E+00
Set the trigger level to 2 V: TRIG:LEV 2	

TRIGger[1|2]:SLOPe {POSitive|NEGative}

TRIGger[1|2]:SLOPe?

Specifies polarity of trigger signal on rear-panel **Trig In** connector for any externally-triggered mode.

Parameter	Typical Return
{ POSitive NEGative }, default POS (rising edge)	POS or NEG
Set trigger slope to falling edge: TRIG:SLOP NEG	

TRIGger[1|2]:SOURce {IMMEDIATE|EXTERNAL|TIMER|BUS}
TRIGger[1|2]:SOURce?

Selects the trigger source for sequence, list, burst or sweep. The instrument accepts an immediate or timed internal trigger, an external hardware trigger from the rear-panel **Ext Trig** connector, or a software (bus) trigger.

Parameter	Typical Return
{IMMEDIATE EXTERNAL TIMER BUS}, default IMMEDIATE	IMM, EXT, TIM, BUS
Select external trigger source (trigger each time a low-true TTL pulse is received on the rear-panel trigger input): TRIG:SOUR EXT	

In triggered burst mode:

- The instrument outputs a waveform of the specified number of cycles (burst count) when a trigger is received. After the specified number of cycles have been output, the instrument stops and waits for next trigger.
- **IMMEDIATE (internal)**: the instrument outputs continuously when burst mode is enabled. The rate at which the burst is generated is determined by **BURSt:INTernal:PERiod**.
- **EXTERNAL**: the instrument accepts a hardware trigger at the rear-panel **Ext Trig** connector. The instrument outputs one burst of the specified number of cycles each time **Ext Trig** receives a level transition with the proper polarity (**TRIGger[1|2]:SLOPe**). External trigger signals during a burst are ignored.
- **BUS (software)**: the instrument initiates one burst each time a bus trigger (***TRG**) is received. The front panel **[Trigger]** key is illuminated when the instrument is waiting for a bus trigger.
- **EXTERNAL or BUS**: burst count and burst phase remain in effect, but burst period is ignored.
- **TIMER**: trigger events are spaced by a timer, with the first trigger as soon as **INIT** occurs.

In frequency sweep mode:

- **IMMEDIATE (internal)**: the instrument outputs continuously when the sweep is enabled. The period at which the sweep is generated is the sweep time (**SWEep:TIME**) plus 1 ms.
- **EXTERNAL**: the instrument accepts a hardware trigger at the rear-panel **Ext Trig** connector. The instrument initiates one sweep each time **Trig In** receives a TTL pulse of proper edge polarity (**TRIGger[1|2]:SLOPe**). The trigger period must be at least sweep time (**SWEep:TIME**) plus 1 ms.
- **BUS (software)**: the instrument initiates one sweep each time a bus trigger (***TRG**) is received. The front panel **[Trigger]** key is illuminated when the instrument is waiting for a bus trigger.
- **APPLY** sets trigger source to IMMEDIATE.

- To ensure synchronization with BUS source, send ***WAI** (wait) so the instrument waits for all pending operations to complete before executing any additional commands. For example, the following command string guarantees that the first trigger is accepted and the operation is executed before second trigger is recognized.

TRIG:SOUR BUS;*TRG;*WAI;*TRG;*WAI

- Use ***OPC?** or ***OPC** to determine when the sweep or burst is complete. The ***OPC?** query returns 1 to the output buffer when the sweep or burst is complete. The ***OPC** command sets the Operation Complete bit (bit 0) in the Standard Event register when the sweep or burst is complete.

TRIGger[1|2]:TIme {<seconds>|MINimum|MAXimum}

TRIGger[1|2]:TIme? [{MINimum|MAXimum}]

Sets timer used when **TRIGger[1|2]:SOURce** is TIme.

Parameter	Typical Return
1 μ s to 8,000 s	+3.0000000000000000E-01
Set trigger timer to 300 ms on channel 2: TRIG2:TIme 0.3	

- In triggered burst mode (**BURSt:MODE TRIG**), this command supersedes **BURSt:INTernal:PERiod**.

UNIT:ANGLE {DEGREE|RADIAN|SECOND|DEFAULT}

UNIT:ANGLE?

Specifies the angle units that displayed on the screen and used for specifying angles. The selected units are used for setting the starting phase for a burst (**BURSt:PHASe**) and for setting the phase offset (**PHASe**). The associated queries are also affected.

Parameter	Typical Return
{ DEGREE RADIAN SECOND DEFAULT}, default DEGREE	DEG, RAD, or SEC
Set angle units to radians: UNIT:ANGL RAD	

- The SECond option is only available for the 33600 Series.
- The setting may be overridden by adding units to numeric parameter in command. For example, PHASE 90 DEG specifies 90 degrees, regardless of this setting.
- The front panel display always shows degrees, regardless of the UNIT:ANGLE setting.

UNIT:ARbitrary:ANGLE {DEGREE|RADIAN|SECOND|SAMPLE|DEFAULT}
UNIT:ARbitrary:ANGLE?

Sets the units for specifying arbitrary waveform phase. The front panel will display the phase parameter in the selected units.

Parameter	Typical Return
{ DEGREE RADIAN SECOND SAMPLE DEFAULT }, default DEGREE	DEG, RAD, SEC, or SAMP
Set the arbitrary waveform angle units to samples: UNIT:ARB:ANGL SAMP	

- The SECond and SAMPlE options are only available for the 33600 Series models.
- You can also specify units by adding units to the numeric parameter: ARB:PHAS 10 DEG.

VOLTage Subsystem Introduction

The VOLTage subsystem sets parameters related to output voltage.

Example

The following is a typical procedure using the VOLTage subsystem.

1. **Select the waveform shape, amplitude and offset:** Use **APPLY** or the equivalent **FUNCTION**, **FREQUENCY**, **VOLTage**, and **VOLTage:OFFSet** commands to select the function, frequency, amplitude, and offset.
2. **Set units for output amplitude:** **VOLTage:UNIT**
3. **Set output amplitude:** **VOLTage**
4. **Set DC offset voltage:** **VOLTage:OFFSet**
5. **Set high and low voltage level:** **VOLTage:HIGH** and **VOLTage:LOW**
6. **Select output voltage limits to protect device under test (DUT):** **VOLTage:LIMit:HIGH**, **VOLTage:LIMit:LOW**, and **VOLTage:LIMit:STATe**
7. **Select status of auto-ranging for all output functions:** **VOLTage:RANGe:AUTO**
8. **Set voltage coupling to lock amplitude and offset of the channels together (2-channel instruments only):** **VOLTageLCOUPlE[:STATe]**

This example demonstrates the procedure outlined above:

```
SOURce1:FUNCTION SQU
SOURce1:FREQUENCY +1.0E+06
SOURce1:VOLTage +0.5
SOURce1:VOLTage:OFFSet +0.5
SOURce1:FUNCTION:SQUare:PERiod +1.0E-06
SOURce1:FUNCTION:PULSe:PERiod +1.0E-06
SOURce1:VOLTage:LIMit:LOW +0.0
```

```
SOURce1:VOLTage:LIMit:HIGH +1.0
SOURce1:VOLTage:LIMit:STATe 1
OUTP1 ON
SOURce2:FUNCTion SIN
SOURce2:FREQuency +1.0E+06
SOURce2:VOLTage +2.0
SOURce2:VOLTage:OFFSet +0.0
SOURce2:VOLTage:LIMit:LOW -1.0
SOURce2:VOLTage:LIMit:HIGH +1.0
SOURce2:VOLTage:LIMit:STATe 1
OUTP2 ON
```

[SOURce[1|2]:]VOLTage {<amplitude>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]VOLTage? [{MINimum|MAXimum}]

Sets output amplitude.

Parameter	Typical Return
1 mVpp to maximum allowed for waveform and model , default 100 mVpp	+5.0000000000000E+00
Set output amplitude to 5 Vpp: VOLT 5 Vpp	

- The relationship between offset voltage and output amplitude is shown below. Vmax is the maximum peak voltage for the selected output termination (5 V for a 50 Ω load or 10 V for a high-impedance load).

$$|V_{\text{offset}}| < V_{\text{max}} - V_{\text{pp}}/2$$

If the specified offset voltage is not valid, the instrument will adjust it to the maximum DC voltage allowed with the specified amplitude. From the remote interface, a "Data out of range" error will also be generated.

- *Differences between remote and front panel operation:*
 - **Remote Interface:** Setting amplitude from the remote interface can change the offset in order to achieve the desired amplitude. The instrument will generate either a "Data out of range" or "Settings conflict" error. If the specified offset voltage is not valid, the instrument adjusts it to the maximum allowed with the specified amplitude.
 - **Front Panel:** Setting amplitude from the front panel will not change the offset setting. If the specified amplitude is not valid, the instrument clips it to the maximum amplitude allowed with the current offset and generates a "Data out of range" error.
- *Limits Due to Output Termination:* If the amplitude is 10 Vpp and you change the output termination setting from 50 Ω to "high impedance" (**OUTPut[1|2]:LOAD INF**), the displayed amplitude doubles to 20 Vpp. Changing from "high impedance" to 50 Ω halves the displayed amplitude. The output termination setting does not affect the actual output voltage; it only changes the values displayed and queried from the remote interface. Actual output voltage depends on the connected load.
- *Limits due to Output Coupling:*
 - *Differences between remote and front panel operation:* If two channels are coupled, both channels' amplitude limitations will be checked before a change in amplitude is executed. If a change in output amplitude would exceed a LIMIT for either channel, or exceed the instrument's output specifications for either channel:
 - **Remote interface:** The instrument will first adjust the offset, then if necessary, the amplitude of that channel to comply with the voltage limits or specification. The instrument will generate either a "Data out of range" or "Settings conflict" error.
 - **Front panel:** The instrument will clip the amplitude value to the maximum value with the current offset setting. A "Data out of range" error will be generated.

- *Specifying Voltage Units:* You can set the output amplitude in Vpp, Vrms, or dBm by specifying the units as part of the VOLTage command VOLT 3.0 VRMS.

Use **VOLTage:UNIT** to specify output units for all subsequent commands.

You cannot specify output amplitude in dBm if output termination is set to high impedance. The units are automatically converted to Vpp.

- **Limits Due to Units Selection:** Amplitude limits are sometimes determined by the output units selected. This may occur when the units are Vrms or dBm due to the differences in various functions' crest factors. For example, if you change a 5 Vrms square wave (into 50 Ω) to a sine wave, the instrument will adjust the amplitude to 3.536 Vrms (the upper limit for sine in Vrms). The remote interface will also generate a "Settings conflict" error.
- **Arbitrary Waveform Limitations:** For arbitrary waveforms, amplitude is limited if the waveform data points do not span the full range of the output DAC (Digital-to-Analog Converter). For example, the built-in "Sinc" waveform does not use the full range of values, so its maximum amplitude is limited to 6.087 Vpp (into 50 Ω).
- **Changing amplitude may briefly disrupt output at certain voltages due to output attenuator switching.** The amplitude is controlled, however, so the output voltage will never exceed the current setting while switching ranges. To prevent this disruption, disable voltage autoranging using **VOLTage:RANGe:AUTO OFF**. The **APPLy** command automatically enables autoranging.
- You can also set the amplitude (with an associated offset voltage) by specifying a high level (**VOLTage:HIGH**) and low level (**VOLTage:LOW**). For example, if you set the high level to +2 V and the low level to -3 V, the resulting amplitude is 5 Vpp, with a -500 mV offset.
- To output a DC voltage level, select the DC voltage function (**FUNCTION DC**) and then set the offset voltage (**VOLTage:OFFSet**). Valid values are between ± 5 VDC into 50 Ω or ± 10 VDC into an open circuit. While the instrument is in DC mode, setting amplitude has no effect.

[SOURce[1|2]:]VOLTage:COUPle[:STATe] {ON|1|OFF|0}

[SOURce[1|2]:]VOLTage:COUPle[:STATe]?

Enables or disables the maintaining of the same amplitude, offset, range, load, and units on both channels of a two-channel instrument. The command applies to both channels; the SOURce keyword is ignored.

Parameter	Typical Return
{ON 1 OFF 0}, default OFF	0 (OFF) or 1 (ON)
Enable voltage coupling: VOLT:COUP ON	

[SOURce[1|2]:]VOLTage:HIGH {<voltage>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]VOLTage:HIGH? [{MINimum|MAXimum}]

[SOURce[1|2]:]VOLTage:LOW {<voltage>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]VOLTage:LOW? [{MINimum|MAXimum}]

Set the waveform's high and low voltage levels.

Parameter	Typical Return
±5 VDC into 50 Ω, as long as HIGH is at least 1 mV greater than LOW. Defaults: HIGH +50 mV, LOW -50 mV.	+4.000000000000000E+00
Set high voltage level to 4 V: VOLT:HIGH 4	

- **Limits Due to Amplitude:** You can set the voltage levels to a positive or negative value with the restrictions shown below. Vpp is the maximum peak-to-peak amplitude for the selected output termination (10 Vpp into 50 Ω or 20 Vpp into an open circuit).

$$V_{\text{high}} - V_{\text{low}} \leq V_{\text{pp}} (\text{max}) \text{ and } V_{\text{high}}, V_{\text{low}} \leq V_{\text{pp}} (\text{max})/2$$

- **Differences between remote and front panel operation:**
 - **Remote Interface:** Setting the high or low level from the remote interface can change the high level or low level to achieve the desired setting. In this case either a "Data out of range" or "Settings conflict" error will occur. If the high level is set below the low level, the instrument will set the low level 1 mV less than the high level. If the high level is set below the LOW limit or the instrument output specifications, the low level will be set to the LOW limit or instrument output specification and the high level will be set 1 mV above the low level. A similar set of rules applies if the low level is set incorrectly.
 - **Front Panel:** Setting the high or low level from the front panel may clip that level setting in order to achieve the desired level setting, and a "Data out of range" error will be generated. The high level cannot be set below the low level from the front panel.
- Setting the high and low levels also sets the waveform amplitude and offset. For example, if you set the high level to +2 V and the low level to -3 V, the resulting amplitude is 5 Vpp, with a -500 mV offset.
- **Limits Due to Output Termination:** If the amplitude is 10 Vpp and you change the output termination setting from 50 Ω to "high impedance" (OUTPut[1|2]:LOAD INF), the displayed amplitude doubles to 20 Vpp. Changing from "high impedance" to 50 Ω halves the displayed amplitude. The output termination setting does not affect the actual output voltage; it only changes the values displayed and queried from the remote interface. Actual output voltage depends on the connected load.
- **Limits due to VOLTage:LIMit:STAtE:** If voltage limits are enabled, the level settings are checked against the specified limits (VOLTage:LIMit:HIGH, VOLTage:LIMit:LOW) before a level change is executed. If an output level change would exceed a LIMIT setting, the level is clipped to the maximum (or minimum) value allowed that will not exceed the LIMit setting and a "Settings conflict" error will be generated.

- *Limits due to Output Coupling:* If two channels are coupled, limitations are checked on both channels before a change in level is executed. If a change in level would exceed a LIMIT setting or exceed the instrument's output specifications for either channel, the level is clipped to the maximum (or minimum) value allowed that will not exceed the LIMIT setting and a "Settings conflict" error will be generated.
- To invert the waveform relative to the offset voltage, use **OUTPut[1|2]:POLarity**.

[SOURce[1|2]:]VOLTage:LIMit:HIGH {<voltage>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]VOLTage:LIMit:HIGH? [{MINimum|MAXimum}]

[SOURce[1|2]:]VOLTage:LIMit:LOW {<voltage>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]VOLTage:LIMit:LOW? {MINimum|MAXimum}?

Sets the high and low limits for output voltage.

Parameter	Typical Return
±5 VDC into 50 Ω, as long as HIGH is at least 1 mV greater than LOW. Defaults: HIGH +50 mV, LOW -50 mV.	+5.00000000000000E+00
Set channel 1 output high limit to 5 V: VOLT:LIMIT:HIGH 5.0 VOLT:LIMIT:STATE ON	

- For voltage limits to be in effect, **VOLTage:LIMit:STATe** must be ON. If this is the case, and the high limit is set below the high value of the signal or the low limit is set above the low value of the signal, the relevant limit will be clipped to the high or low value of the signal. The instrument will generate either a "Data out of range" or "Settings conflict" error.
- The high limit sets the highest output voltage allowed to be set, including DC Offset and peak amplitude. It is set in reference to the current **OUTPUT[1|2]:LOAD** setting. If the specified LOAD impedance is not present at the instrument's output, then the output limit may not represent the actual voltages at the output connector. For example, if the output impedance is set to 50 Ω, but the actual load is high impedance, then the actual output peak voltage may be up to twice the specified limit voltage.
- *Specifying Voltage Units:* You can set the output limit voltage only in volts.
- When **VOLTage:COUPle[:STATe]** is ON, and **VOLTage:LIMit:STATe** is ON, voltage limit settings on both channels affect maximum amplitude and offset voltage settings on both channels. The most restrictive combination of high and low limits from either channel is used.

[SOURce[1|2]:]VOLTage:LIMit:STATe {ON|1|OFF|0}
[SOURce[1|2]:]VOLTage:LIMit:STATe?

Enables or disables output amplitude voltage limits.

Parameter	Typical Return
{ON 1 OFF 0}, default OFF	0 (OFF) or 1 (ON)
Set and enable ± 2.5 V output limits on channel 1: VOLT:LIM:HIGH 2.5 VOLT:LIM:LOW -2.5 VOLT:LIM:STAT ON	

- When this is turned ON, if the present settings of amplitude and offset exceed the limits, then the limits will be disabled. The instrument will generate either a "Settings conflict" error.
- When **VOLTage:COUPle[:STATe]** is ON, and **VOLTage:LIMit:STATe** is ON, voltage limit settings on both channels affect maximum amplitude and offset voltage settings on both channels. The most restrictive combination of high and low limits from either channel is used.
- Limits are set in reference to the current setting of **OUTPut[1|2]:LOAD**. If the specified LOAD impedance is not present at the instrument's output, then the output limit may not represent the actual voltages at the output connector. For example, if the output impedance is set to 50 Ω , but the actual load is high impedance, then the actual output peak voltage may be up to twice the specified limit voltage.

[SOURce[1|2]:]VOLTage:OFFSet {<offset>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]VOLTage:OFFSet? [{MINimum|MAXimum}]

Sets DC offset voltage.

Parameter	Typical Return
± 5 VDC into 50 Ω, default 0	+1.00000000000000E-01
Set offset voltage to 100 mV: VOLT:OFFS 100 mV	

- The relationship between offset voltage and output amplitude is shown below.

$$|V_{\text{offset}}| < V_{\text{max}} - V_{\text{pp}}/2$$

- Differences between remote and front panel operation:
 - **Remote Interface:** Setting the offset from the remote interface can change the amplitude in order to achieve the desired offset setting. The instrument will generate either a "Data out of range" or "Settings conflict" error.
 - **Front Panel:** Setting the offset from the front panel will not change the amplitude in order to achieve the desired offset setting. If the specified offset is not valid, the instrument will clip it to the maximum offset allowed with the current amplitude and generate a "Data out of range" error.
- Limits Due to Output Termination: The offset range depends on the output termination setting. For example, if you set offset to 100 mVDC and then change output termination from 50 Ω to "high impedance," the offset voltage displayed on the front panel doubles to 200 mVDC (no error is generated). If you change from "high impedance" to 50 Ω, the displayed offset voltage will be halved. See **OUTPut[1|2]:LOAD** for details. Changing the output termination setting does not change the voltage present at the output terminals of the instrument. This only changes the displayed values on the front panel and the values queried from the remote interface. The voltage present at the instrument's output depends on the load connected to the instrument. See **OUTPut[1|2]:LOAD** for details.
- Limits due to Output Coupling: If two channels are coupled, limitations of setting offset will be checked on both channels before a change in offset is executed. If a change in offset would exceed a LIMIT setting, or exceed the instrument's output specifications for either channel:
 - **Remote Interface:** First the amplitude and then if necessary, the offset of that channel will be adjusted to comply with the voltage limits or specification. The instrument will generate either a "Data out of range" or "Settings conflict" error.
 - **Front panel:** The offset value is clipped to the maximum value allowed that will not exceed the LIMIT setting, and a "Data out of range" error will be generated.
- Arbitrary Waveform Limitations: For arbitrary waveforms, amplitude is limited if the waveform data points do not span the full range of the output DAC (Digital-to-Analog Converter). For example, the built-in "Sinc" waveform does not use the full range of values, so its maximum amplitude is limited to 6.087 Vpp (into 50 Ω).

- Changing amplitude may briefly disrupt output at certain voltages due to output attenuator switching. The amplitude is controlled, however, so the output voltage will never exceed the current setting while switching ranges. To prevent this disruption, disable voltage autoranging using **VOLTage:RANGe:AUTO OFF**. The **APPLY** command automatically enables autoranging.
- Setting the high and low levels also sets the waveform amplitude and offset. For example, if you set the high level to +2 V and the low level to -3 V, the resulting amplitude is 5 Vpp, with a -500 mV offset.
- To output a DC voltage level, select the DC voltage function (**FUNCTION DC**) and then set the offset voltage (**VOLTage:OFFSet**). Valid values are between ± 5 VDC into 50 Ω or ± 10 VDC into an open circuit. While the instrument is in DC mode, setting amplitude has no effect.

[SOURCE[1|2]:]VOLTage:RANGe:AUTO {OFF|0|ON|1|ONCE}
[SOURCE[1|2]:]VOLTage:RANGe:AUTO?

Disables or enables voltage autoranging for all functions. Selecting ONCE performs an immediate autorange and then turns autoranging OFF

Parameter	Typical Return
{OFF 0 ON 1 ONCE}, default ON	0 (OFF) or 1 (ON)
Turn voltage autoranging OFF: VOLT:RANG:AUTO 0	

- In the default mode, autoranging is enabled and the instrument automatically selects the optimal settings for the output waveform generator and attenuator.
- With autoranging disabled (OFF), the instrument uses the instrument's current gain and attenuator settings.
- The **APPLY** command overrides the voltage autorange setting and automatically enables autoranging (ON).
- Disabling autoranging eliminates momentary disruptions caused by attenuator switching while changing amplitude. However, the amplitude and offset accuracy and resolution (and waveform fidelity) may be adversely affected when reducing the amplitude below the expected range change.
- If a **VOLTage:COUPLe[:STATe]** is ON, changing this setting on either channel changes it on both.

[SOURce[1|2]:]VOLTage:UNIT {VPP|VRMS|DBM}
[SOURce[1|2]:]VOLTage:UNIT?

Selects the units for output amplitude.

Parameter	Typical Return
{VPP VRMS DBM}, default VPP	VPP, VRMS, or DBM
Set output amplitude units to Vrms: VOLT:UNIT VRMS	

- Does not affect offset voltage (VOLTage:OFFSet), high level (VOLTage:HIGH) or low level (VOLTage:LOW). They all use units of volts.
- The instrument uses the current units selection for both front panel and remote interface operations. For example, if you select "VRMS" from the remote interface (VOLTage:UNIT VRMS), the units are displayed as "VRMS" on the front panel.
- Command applies to VOLTage? query results.
- Output units for amplitude cannot be set to dBm if the output termination is set to "high impedance." The units are automatically converted to Vpp.
- Arbitrary waveform sequences do not accept units of Vrms or dBm.
- Unless you specify the units as part of either the VOLTage command or one of the APPLY commands, the VOLTage:UNIT command takes precedence. For example, if you select VOLTage:UNIT VRMS and do not include units with an APPLY command, the <amplitude> in the APPLY command will be in "Vrms".

Programming Examples

These programming examples help you get started with common tasks.

[Configure a Sine Wave](#)

[Configure a Square Wave](#)

[Configure a Ramp Wave](#)

[Configure a Pulse Wave](#)

[Create a List of Frequencies](#)

[Configure an Arbitrary Waveform](#)

Configure a Sine Wave

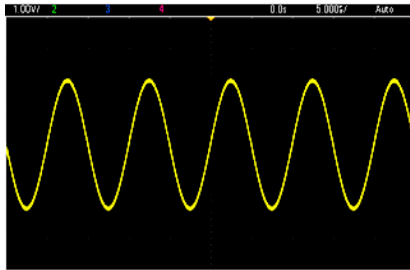
This section describes the configuration of a sine wave function.

Description

A sine wave has amplitude, offset, and phase relative to sync pulse. Its amplitude and offset can also be set using high and low voltage values.

Example

The following waveform can be set up with the series of SCPI commands, where high and low can be used in place of **SOUR:VOLT** and **SOUR:VOLT:OFFS**.



The following commands produce the sine wave shown above.

```
FUNCTION SIN
FREQUENCY +1.0E+05
VOLTage:HIGH +2.0
VOLTage:LOW +0.0
OUTPut ON
PHASe +90.0
```

Remarks

- Although period can be adjusted from the front panel, there is no **SOUR:FUNC:SIN:PER** or **SOUR:PER** command that can be used in addition to **SOUR:FREQ**.

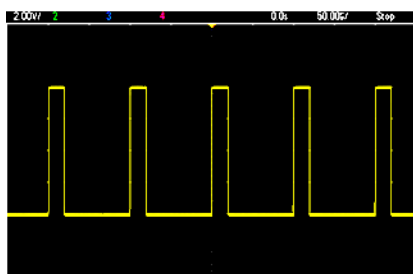
Configure a Square Wave

Description

A square wave has amplitude, offset, and phase relative to sync pulse. It also has duty cycle and period. Its amplitude and offset can also be set using high and low voltage values.

Example

The following waveform can be set up with the series of SCPI commands, where high and low can be used in place of **SOUR:VOLT** and **SOUR:VOLT:OFFS**.



The following commands produce the square wave shown above.

```
FUNC SQU
FUNC:SQU:DCYC +20.0
FREQ +1.0E+04
VOLT:HIGH +4.0
VOLT:LOW +0.0
OUTP 1
```

Remarks

- For Square Wave, if you change **SOUR:FREQ**, the **SOUR:FUNC:SQU:PER** will change. For example, **SOUR:FREQ +2.0E+03** is equivalent to **SOUR:FUNC:SQU:PER +5.0E-04**.

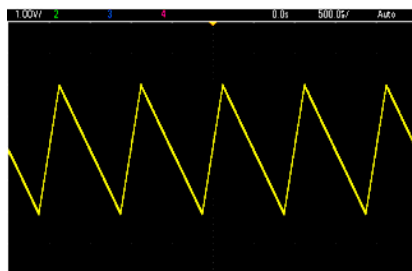
Configure a Ramp Wave

Description

A ramp wave has amplitude, offset, and phase relative to sync pulse. It also has symmetry for creating triangular and other similar waveforms. Its amplitude and offset can also be set using high and low voltage values.

Example

The following waveform can be set up with the series of SCPI commands, where high and low can be used in place of **SOUR:VOLT** and **SOUR:VOLT:OFFS**.



The following commands produce the ramp wave shown above.

```
FUNCTION RAMP
FUNCTION:RAMP:SYMMetry 25
FREQ +1.0E+03
VOLTage +2.0
```

```
VOLTage:OFFSet +1.0  
OUTP 1
```

Remarks

- Ramp frequency is limited to 200 kHz.
- Although period can be adjusted from the instrument's front panel, there is no SOUR:FUNC:RAMP:PER or SOUR:PER command that can be used in addition to SOUR:FREQ.

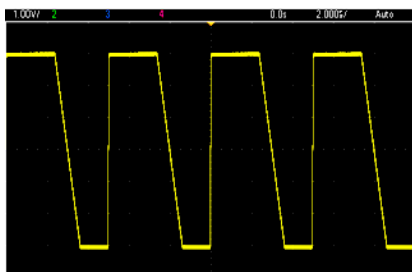
Configure a Pulse Wave

Description

A pulse wave has amplitude, offset, and phase relative to sync pulse. It also adds edge slope, period, and duty cycle (or pulse width, depending on the FUNC:PULSe:HOLD configuration). Its amplitude and offset can also be set using high and low voltage values.

Example

The following waveform can be set up with the series of SCPI commands, where high and low can be used in place of SOUR:VOLT and SOUR:VOLT:OFFS.



The following commands produce the pulse wave shown above.

```
FUNC PULS  
FUNC:PULS:TRAN:LEAD 4E-8  
FUNC:PULS:TRAN:TRA 1E-6  
FUNC:PULS:WIDT 3E-6  
FREQ 2E5  
VOLT 3  
OUTP ON
```

Remarks

- You can use FUNC:PULS:PER instead of FREQ. These commands are paired; changing one changes the other.
- Pulse can be specified by width or duty cycle, which are also coupled. Use FUNCTION:PULSe:HOLD DCYC to specify that duty cycle is held constant value as frequency or period changes. Use FUNCTION:PULSe:HOLD WIDTH to specify that pulse width is held constant as frequency or period changes.

Create a List of Frequencies

Description

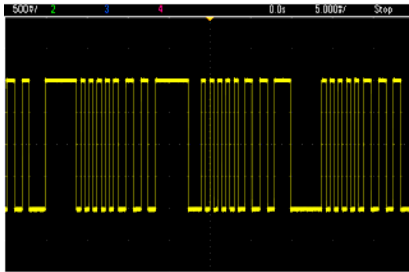
The **LIST** commands set the instrument's output frequency according to entries in a frequency list, which allows fast changing to frequencies in a list of up to 128 frequencies. The frequencies to be used are entered using the **LIST:FREQUENCY** command, or they may be read from a file using **MMEMORY:LOAD:LIST [1|2]**.

Examples

The following code demonstrates the **LIST:FREQUENCY** method.

```
FUNCTION SQU
TRIGGER:SOURCE IMMEDIATE
FREQUENCY:MODE LIST
LIST:DWELL +5.0E-03
LIST:FREQUENCY +1.0E+03,+3.0E+03,+7.0E+03
VOLTAGE +1.0
OUTPUT 1
```

The results of this code are shown below.



Configure an arbitrary waveform

This section describes the configuration of an arbitrary waveform.

Description

A user-created arbitrary waveform has amplitude, offset, sample rate, and filter type. These can be set when the arbitrary waveform file (.arb or .barb extension) is loaded into waveform memory. The beginning of a typical arbitrary waveform is shown below; note that amplitude and offset are represented by high and low voltage values:

```
File Format:1.10
Checksum:0
Channel Count:1
Sample Rate:20000.000000
High Level:2.000000
Low Level:0.000000
Marker Point:50
```

```
Data Type:"short"  
Filter:"off"  
Data Points:100  
Data:  
23259  
23114
```

The **23259** and **23114** lines after the **Data:** line are ASCII DAC codes representing the first two waveform data values. If the waveform's DAC codes do not range from -32767 to + 32767, the output amplitude is asymmetric.

In firmware revisions 1.12 and before, the instrument did not update waveform metadata (sample rate, voltage range, and filter setting) when switching from one arbitrary waveform to another. The new arbitrary waveform adopted the metadata of the waveform already in memory. Therefore, an arbitrary waveform designed to play at one voltage range, sample rate, and filter setting (as specified in the waveform's metadata) was changed to another set of metadata. After firmware revision 1.12, arbitrary waveforms load any metadata present in the arbitrary waveform file, so that they play the way they previously played.

Built-in waveforms make few or no changes when loaded into waveform memory. They play according to the instrument's current configuration. For example, see the beginning of Haversine.arb, shown below.

```
Copyright: Keysight Technologies, 2010  
File Format:1.0  
Channel Count:1  
Data Points:40  
Data:  
0  
202  
802
```

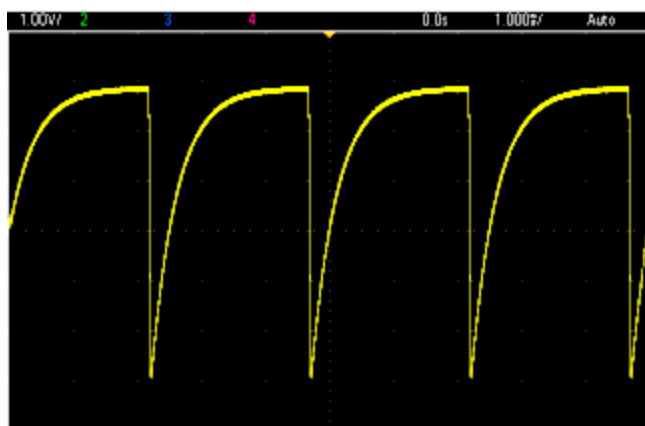
Because of the missing metadata, the current settings for voltage range, sample rate, and filter setup are used.

Example

The following code loads and modifies a built-in arbitrary waveform.

```
FUNCTION ARB  
VOLTage +3  
VOLTage:OFFSet +1  
FUNC:ARB:SRAT 1E5  
FUNCTION:ARbitrary "INT:\BUILTIN\EXP_RISE.ARB"  
OUTPut 1
```

The waveform resulting from these commands is shown below.



Keysight Trueform Series Command Quick Reference

See the [Syntax Conventions](#) for SCPI.

APPLy Commands

[SOURce[1|2]:]APPLy?

[SOURce[1|2]:]APPLy:ARbitrary [{<sample_rate>|MIN|MAX|DEF} [, {<amplitude>|MIN|MAX|DEF} [, {<offset>|MIN|MAX|DEF}]]]

[SOURce[1|2]:]APPLy:DC [{<frequency>|MIN|MAX|DEF} [, {<amplitude>|MIN|MAX|DEF} [, {<offset>|MIN|MAX|DEF}]]]

[SOURce[1|2]:]APPLy:NOISe [{<frequency>|MIN|MAX|DEF} [, {<amplitude>|MIN|MAX|DEF} [, {<offset>|MIN|MAX|DEF}]]]

[SOURce[1|2]:]APPLy:PRBS [{<frequency>|MIN|MAX|DEF} [, {<amplitude>|MIN|MAX|DEF} [, {<offset>|MIN|MAX|DEF}]]]

[SOURce[1|2]:]APPLy:PULSe [{<frequency>|MIN|MAX|DEF} [, {<amplitude>|MIN|MAX|DEF} [, {<offset>|MIN|MAX|DEF}]]]

[SOURce[1|2]:]APPLy:RAMP [{<frequency>|MIN|MAX|DEF} [, {<amplitude>|MIN|MAX|DEF} [, {<offset>|MIN|MAX|DEF}]]]

[SOURce[1|2]:]APPLy:SINusoid [{<frequency>|MIN|MAX|DEF} [, {<amplitude>|MIN|MAX|DEF} [, {<offset>|MIN|MAX|DEF}]]]

[SOURce[1|2]:]APPLy:SQUare [{<frequency>|MIN|MAX|DEF} [, {<amplitude>|MIN|MAX|DEF} [, {<offset>|MIN|MAX|DEF}]]]

[SOURce[1|2]:]APPLy:TRIangle [{<frequency>|MIN|MAX|DEF} [, {<amplitude>|MIN|MAX|DEF} [, {<offset>|MIN|MAX|DEF}]]]

DATA Commands

[SOURce[1|2]:]DATA:ARBitrary2:FORMat {AABB|ABAB}

[SOURce[1|2]:]DATA:ARBitrary[1|2] <arb_name>, {<binary_block>|<value>, <value>, ...}

[SOURce[1|2]:]DATA:ARBitrary[1|2]:DAC <arb_name>, {<binary_block>|<value>, <value>, ...}

[SOURce[1|2]:]DATA:ATTRibute:AVERage? [<arb_name>]

[SOURce[1|2]:]DATA:ATTRibute:CFACTOR? [<arb_name>]

[SOURce[1|2]:]DATA:ATTRibute:POINTS? [<arb_name>]

[SOURce[1|2]:]DATA:ATTRibute:PTPeak? [<arb_name>]

[SOURce[1|2]:]DATA:SEQUence <block_descriptor>

[SOURce[1|2]:]DATA:VOLatile:CATalog?

[SOURce[1|2]:]DATA:VOLatile:CLEar

[SOURce[1|2]:]DATA:VOLatile:FREE?

Output Configuration Commands

[SOURce[1|2]:]FUNCTION <function>
[SOURce[1|2]:]FUNCTION?

FREQUENCY CONTROL

[SOURce[1|2]:]FREQuency {<frequency>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FREQuency? [{MINimum|MAXimum}]

[SOURce[1|2]:]FREQuency:CENTer {<frequency>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FREQuency:CENTer? [{MINimum|MAXimum}]

[SOURce[1|2]:]FREQuency:COUPle:MODE {OFFSet|RATio}
[SOURce[1|2]:]FREQuency:COUPle:MODE?

[SOURce[1|2]:]FREQuency:COUPle:OFFSet {<frequency>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FREQuency:COUPle:OFFSet?

[SOURce[1|2]:]FREQuency:COUPle:RATio <ratio>
[SOURce[1|2]:]FREQuency:COUPle:RATio?

[SOURce[1|2]:]FREQuency:COUPle[:STATe] {ON|1|OFF|0}
[SOURce[1|2]:]FREQuency:COUPle[:STATe]?

[SOURce[1|2]:]FREQuency:MODE {CW|LIST|SWEep|FIXed}
[SOURce[1|2]:]FREQuency:MODE?

[SOURce[1|2]:]FREQuency:SPAN {<frequency>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FREQuency:SPAN? [{MINimum|MAXimum}]

[SOURce[1|2]:]FREQuency:STARt {<frequency>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FREQuency:STARt? [{MINimum|MAXimum}]

[SOURce[1|2]:]FREQuency:STOP {<frequency>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FREQuency:STOP? [{MINimum|MAXimum}]

FREQUENCY LIST MODE

[SOURce[1|2]:]LIST:DWELL {<seconds>|MINimum|MAXimum}
[SOURce[1|2]:]LIST:DWELL? [{MINimum|MAXimum}]

[SOURce[1|2]:]LIST:FREQuency <freq1>[, <freq2>, etc.]
[SOURce[1|2]:]LIST:FREQuency?

[SOURce[1|2]:]LIST:FREQuency:POINts? [{MINimum|MAXimum}]

MMEMory:LOAD:LIST[1|2] <filename>
MMEMory:STORe:LIST[1|2] <filename>

VOLTAGE

[SOURce[1|2]:]VOLTage {<amplitude>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]VOLTage? [{MINimum|MAXimum}]

[SOURce[1|2]:]VOLTage:COUPle[:STATe] {ON|1|OFF|0}
[SOURce[1|2]:]VOLTage:COUPle[:STATe]?

[SOURce[1|2]:]VOLTage:HIGh {<voltage>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]VOLTage:HIGh? [{MINimum|MAXimum}]

[SOURce[1|2]:]VOLTage:LOW {<voltage>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]VOLTage:LOW? [{MINimum|MAXimum}]

[SOURce[1|2]:]VOLTage:LIMit:HIGh {<voltage>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]VOLTage:LIMit:HIGh? [{MINimum|MAXimum}]

[SOURce[1|2]:]VOLTage:LIMit:LOW {<voltage>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]VOLTage:LIMit:LOW? [{MINimum|MAXimum}]

[SOURce[1|2]:]VOLTage:LIMit:STATe {ON|1|OFF|0}
[SOURce[1|2]:]VOLTage:LIMit:STATe?

[SOURce[1|2]:]VOLTage:OFFSet {<offset>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]VOLTage:OFFSet? [{MINimum|MAXimum}]

[SOURce[1|2]:]VOLTage:RANGe:AUTO {OFF|0|ON|1|ONCE}
[SOURce[1|2]:]VOLTage:RANGe:AUTO?

[SOURce[1|2]:]VOLTage:UNIT {VPP|VRMS|DBM}
[SOURce[1|2]:]VOLTage:UNIT?

SQUARE WAVE

[SOURce[1|2]:]FUNCTion:SQUare:DCYClE {<percent>|MINimum|MAXimum}
[SOURce[1|2]:]FUNCTion:SQUare:DCYClE? [{MINimum|MAXimum}]

[SOURce[1|2]:]FUNCTion:SQUare:PERiod {<seconds>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FUNCTion:SQUare:PERiod? [{MINimum|MAXimum}]

RAMP

[SOURce[1|2]:]FUNCTion:RAMP:SYMMetry {<percent>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FUNCTion:RAMP:SYMMetry? [{MINimum|MAXimum}]

NOISE

[SOURce[1|2]:]FUNCTion:NOISe:BANDwidth {<bandwidth>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FUNCTion:NOISe:BANDwidth? [{MINimum|MAXimum}]

PRBS

[SOURce[1|2]:]FUNction:PRBS:BRATe {<*bit_rate*>| MINimum|MAXimum|DEFault}

[SOURce[1|2]:]FUNction:PRBS:BRATe? [{MINimum|MAXimum}]

[SOURce[1|2]:]FUNction:PRBS:DATA <*sequence_type*>

[SOURce[1|2]:]FUNction:PRBS:DATA?

[SOURce[1|2]:]FUNction:PRBS:TRANSition[:BOTH] {<*seconds*>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]FUNction:PRBS:TRANSition[:BOTH]? [{MINimum|MAXimum}]

ARBITRARY WAVEFORM

[SOURce[1|2]:]FUNCTION:ARBitrary {<filename>}

[SOURce[1|2]:]FUNCTION:ARBitrary?

[SOURce[1|2]:]FUNCTION:ARBitrary:ADVance {TRIGger|SRATe}

[SOURce[1|2]:]FUNCTION:ARBitrary:ADVance?

[SOURce[1|2]:]FUNCTION:ARBitrary:FILTer {NORMAl|STEP|OFF}

[SOURce[1|2]:]FUNCTION:ARBitrary:FILTer?

[SOURce[1|2]:]FUNCTION:ARBitrary:FREQUency {<frequency>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]FUNCTION:ARBitrary:FREQUency? {MINimum|MAXimum}

[SOURce[1|2]:]FUNCTION:ARBitrary:PERiod {<period>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]FUNCTION:ARBitrary:PERiod? {MINimum|MAXimum}

[SOURce[1|2]:]FUNCTION:ARBitrary:POINts?

[SOURce[1|2]:]FUNCTION:ARBitrary:PTPeak {<voltage>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]FUNCTION:ARBitrary:PTPeak? [{MINimum|MAXimum}]

[SOURce[1|2]:]FUNCTION:ARBitrary:SRATe {<sample_rate>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]FUNCTION:ARBitrary:SRATe? {MINimum|MAXimum}

FUNCTION:ARBitrary:BALance[:STATe] {ON|1|OFF|0} **(IQ Player option only)**

FUNCTION:ARBitrary:BALance[:STATe]? **(IQ Player option only)**

FUNCTION:ARBitrary:BALance:GAIN {<percent>|MINimum|MAXimum|DEFine} **(IQ Player option only)**

FUNCTION:ARBitrary:BALance:GAIN? [{MINimum|MAXimum}] **(IQ Player option only)**

FUNCTION:ARBitrary:BALance:OFFSet{1|2} {<volts>|MINimum|MAXimum|DEFault} **(IQ Player option only)**

FUNCTION:ARBitrary:BALance:OFFSet{1|2}? [MINimum|MAXimum] **(IQ Player option only)**

FUNCTION:ARBitrary:SKEW[:STATe] {ON|1|OFF|0} **(IQ Player option only)**

FUNCTION:ARBitrary:SKEW[:STATe]? **(IQ Player option only)**

FUNCTION:ARBitrary:SKEW:TIME [{<time>|MINimum|MAXimum|DEFault}] **(IQ Player option only)**

FUNCTION:ARBitrary:SKEW:TIME? [{MINimum|MAXimum}] **(IQ Player option only)**

[SOURce[1|2]:]FUNCTION:ARBitrary:SYNChronize

[SOURce[1|2]:]RATE:COUPle[:STATe] {ON|1|OFF|0}

[SOURce[1|2]:]RATE:COUPle[:STATe]?

[SOURce[1|2]:]RATE:COUPle:MODE {OFFSet|RATio}

[SOURce[1|2]:]RATE:COUPle:MODE?

[SOURce[1|2]:]RATE:COUPle:OFFSet {<sample_rate>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]RATE:COUPle:OFFSet?

[SOURce[1|2]:]RATE:COUPle:RATio {<ratio>|MINimum|MAXimum}

[SOURce[1|2]:]RATE:COUPle:RATio? [{MINimum|MAXimum}]

OUTPUT

OUTPut[1|2] {ON|1|OFF|0}
OUTPut[1|2]?

OUTPut[1|2]:LOAD {<ohms>|INFinity|MINimum|MAXimum|DEFault}
OUTPut[1|2]:LOAD? [{MINimum|MAXimum}]

OUTPut[1|2]:MODE {NORMal|GATed}
OUTPut[1|2]:MODE?

OUTPut[1|2]:POLarity {NORMal|INVerted}
OUTPut[1|2]:POLarity?

OUTPut:SYNC {ON|1|OFF|0}
OUTPut:SYNC?

OUTPut[1|2]:SYNC:MODE {NORMal|CARRier|MARKer}
OUTPut[1|2]:SYNC:MODE?

OUTPut[1|2]:SYNC:POLarity {NORMal|INVerted}
OUTPut[1|2]:SYNC:POLarity?

OUTPut:SYNC:SOURce {CH1|CH2}
OUTPut:SYNC:SOURce?

OUTPut:TRIGger {ON|1|OFF|0}
OUTPut:TRIGger?

OUTPut:TRIGger:SLOPe {POSitive|NEGative}
OUTPut:TRIGger:SLOPe?

OUTPut:TRIGger:SOURce {CH1|CH2}
OUTPut:TRIGger:SOURce?

Pulse Configuration Commands

[SOURce[1|2]:]FUNCTION:PULSe:DCYCLE {<percent>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FUNCTION:PULSe:DCYCLE? [{MINimum|MAXimum}]

[SOURce[1|2]:]FUNCTION:PULSe:HOLD {WIDTh|DCYCLE}
[SOURce[1|2]:]FUNCTION:PULSe:HOLD?

[SOURce[1|2]:]FUNCTION:PULSe:PERiod {<seconds>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FUNCTION:PULSe:PERiod? [{MINimum|MAXimum}]

[SOURce[1|2]:]FUNCTION:PULSe:TRANSition[:BOTH] {<seconds>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]FUNCTION:PULSe:TRANSition:LEADing {<seconds>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FUNCTION:PULSe:TRANSition:LEADing? [{MINimum|MAXimum}]

[SOURce[1|2]:]FUNCTION:PULSe:TRANSition:TRAILing {<seconds>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FUNCTION:PULSe:TRANSition:TRAILing? [{MINimum|MAXimum}]

[SOURce[1|2]:]FUNCTION:PULSe:WIDTh {<seconds>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FUNCTION:PULSe:WIDTh? [{MINimum|MAXimum}]

Modulation Commands

AM

[SOURce[1|2]:]AM[:DEPT] {<depth_in_percent>|MINimum|MAXimum}
[SOURce[1|2]:]AM[:DEPT]? [{MINimum|MAXimum}]

[SOURce[1|2]:]AM:DSSC {ON|1|OFF|0}
[SOURce[1|2]:]AM:DSSC?

[SOURce[1|2]:]AM:INTernal:FREQuency {<frequency>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]AM:INTernal:FREQuency? [{MINimum|MAXimum}]

[SOURce[1|2]:]AM:INTernal:FUNCTion <function>
[SOURce[1|2]:]AM:INTernal:FUNCTion?

[SOURce[1|2]:]AM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]AM:SOURce?

[SOURce[1|2]:]AM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]AM:STATe?

FM

[SOURce[1|2]:]FM[:DEViation] {<peak_deviation_in_Hz>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FM[:DEViation]? [{MINimum|MAXimum}]

[SOURce[1|2]:]FM:INTernal:FREQuency {<frequency>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]FM:INTernal:FREQuency? [{MINimum|MAXimum}]

[SOURce[1|2]:]FM:INTernal:FUNCTion <function>
[SOURce[1|2]:]FM:INTernal:FUNCTion?

[SOURce[1|2]:]FM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]FM:SOURce?

[SOURce[1|2]:]FM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]FM:STATe?

BPSK Commands

[SOURce[1|2]:]BPSK:SOURce {INTernal|EXTernal}
[SOURce[1|2]:]BPSK:SOURce?

[SOURce[1|2]:]BPSK:STATe {ON|1|OFF|0}
[SOURce[1|2]:]BPSK:STATe?

[SOURce[1|2]:]BPSK:INTernal:RATE {<modulating_frequency>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]BPSK:INTernal:RATE? [{MINimum|MAXimum}]

[SOURce[1|2]:]BPSK[:PHASe] {<angle>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]BPSK[:PHASe]? [{MINimum|MAXimum}]

PM

[SOURce[1|2]:]PM:DEVIation {<deviation in degrees>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]PM:DEVIation? [{MINimum|MAXimum}]

[SOURce[1|2]:]PM:INTernal:FREQuency {<frequency>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]PM:INTernal:FREQuency? [{MINimum|MAXimum}]

[SOURce[1|2]:]PM:INTernal:FUNCTion <function>
[SOURce[1|2]:]PM:INTernal:FUNCTion?

[SOURce[1|2]:]PM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]PM:SOURce?

[SOURce[1|2]:]PM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]PM:STATe?

FSK

[SOURce[1|2]:]FSKey:FREQuency {<frequency>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]FSKey:FREQuency? [{MINimum|MAXimum}]

[SOURce[1|2]:]FSKey:INTernal:RATE {<rate_in_Hz>|MINimum|MAXimum}
[SOURce[1|2]:]FSKey:INTernal:RATE? [{MINimum|MAXimum}]

[SOURce[1|2]:]FSKey:SOURce {INTernal|EXTernal}
[SOURce[1|2]:]FSKey:SOURce?

[SOURce[1|2]:]FSKey:STATe {ON|1|OFF|0}
[SOURce[1|2]:]FSKey:STATe?

PWM

[SOURce[1|2]:]PWM:DEVIation {<deviation>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]PWM:DEVIation? [{MINimum|MAXimum}]

[SOURce[1|2]:]PWM:DEVIation:DCYClE {<deviation_in_pct>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]PWM:DEVIation:DCYClE? [{MINimum|MAXimum}]

[SOURce[1|2]:]PWM:INTernal:FREQuency {<frequency>|MINimum|MAXimum|DEFAULT}
[SOURce[1|2]:]PWM:INTernal:FREQuency? [{MINimum|MAXimum}]

[SOURce[1|2]:]PWM:INTernal:FUNCTion <function>
[SOURce[1|2]:]PWM:INTernal:FUNCTion?

[SOURce[1|2]:]PWM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]PWM:SOURce?

[SOURce[1|2]:]PWM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]PWM:STATe?

SUM

[SOURce[1|2]:]SUM:AMPLitude {<amplitude>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]SUM:AMPLitude? [{MINimum|MAXimum}]

[SOURce[1|2]:]SUM:INTernal:FREQuency {<frequency>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]SUM:INTernal:FREQuency? [{MINimum|MAXimum}]

[SOURce[1|2]:]SUM:INTernal:FUNCTion <function>
[SOURce[1|2]:]SUM:INTernal:FUNCTion?

[SOURce[1|2]:]SUM:SOURce {INTernal|EXTernal|CH1|CH2}
[SOURce[1|2]:]SUM:SOURce?

[SOURce[1|2]:]SUM:STATe {ON|1|OFF|0}
[SOURce[1|2]:]SUM:STATe?

Frequency Sweep

[SOURce[1|2]:]SWEep:HTIME {<hold_time>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]SWEep:HTIME? [{MINimum|MAXimum}]

[SOURce[1|2]:]SWEep:RTIME {<return_time>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]SWEep:RTIME? [{MINimum|MAXimum}]

[SOURce[1|2]:]SWEep:SPACing {LINear|LOGarithmic}
[SOURce[1|2]:]SWEep:SPACing?

[SOURce[1|2]:]SWEep:STATe {ON|1|OFF|0}
[SOURce[1|2]:]SWEep:STATe?

[SOURce[1|2]:]SWEep:TIME {<seconds>|MINimum|MAXimum|DEFault}
[SOURce[1|2]:]SWEep:TIME? [{MINimum|MAXimum}]

Burst Mode

[SOURce[1|2]:]BURSt:GATE:POLarity {NORMAL|INVERTed}
[SOURce[1|2]:]BURSt:GATE:POLarity?

[SOURce[1|2]:]BURSt:INTernal:PERiod {<seconds>|MINimum|MAXimum}
[SOURce[1|2]:]BURSt:INTernal:PERiod? [{MINimum|MAXimum}]

[SOURce[1|2]:]BURSt:MODE {TRIGgered|GATed}
[SOURce[1|2]:]BURSt:MODE?

[SOURce[1|2]:]BURSt:NCYCles {<num_cycles>|INFinity|MINimum|MAXimum}
[SOURce[1|2]:]BURSt:NCYCles? [{MINimum|MAXimum}]

[SOURce[1|2]:]BURSt:PHASe {<angle>|MINimum|MAXimum}
[SOURce[1|2]:]BURSt:PHASe? [{MINimum|MAXimum}]

[SOURce[1|2]:]BURSt:STATe {ON|1|OFF|0}
[SOURce[1|2]:]BURSt:STATe?

Marker

[SOURce[1|2]:]MARKer:CYCle {<*cycle_num*>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]MARKer:FREQuency {<*frequency*>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]MARKer:POINt {<*sample_number*>|MINimum|MAXimum}

Trigger Setup

TRIGger[1|2]

TRIGger[1|2]:COUNT {<*number*>|MINimum|MAXimum|DEFault}

TRIGger[1|2]:COUNT? [{MINimum|MAXimum}]

TRIGger[1|2]:DELay {<*seconds*>|MINimum|MAXimum}

TRIGger[1|2]:DELay? [{MINimum|MAXimum}]

TRIGger[1|2]:LEVel {<*level*>|MINimum|MAXimum}

TRIGger[1|2]:LEVel? [{MINimum|MAXimum}]

TRIGger[1|2]:SLOPe {POSitive|NEGative}

TRIGger[1|2]:SLOPe?

TRIGger[1|2]:SOURce {IMMediate|EXTernal|TIMER|BUS}

TRIGger[1|2]:SOURce?

TRIGger[1|2]:TIMER {<*seconds*>|MINimum|MAXimum}

TRIGger[1|2]:TIMER? [{MINimum|MAXimum}]

State Storage

MEMory:NSTates?

MEMory:STATe:CATalog?

MEMory:STATe:DELeTe {0|1|2|3|4}

MEMory:STATe:NAME {0|1|2|3|4} [,<*name*>]

MEMory:STATe:NAME? {0|1|2|3|4}

MEMory:STATe:RECall:AUTO {ON|1|OFF|0}

MEMory:STATe:RECall:AUTO?

MEMory:STATe:VALId? {0|1|2|3|4}

Mass Memory

MMEMory:CATalog[:ALL]? [<folder>]

MMEMory:CATalog:DATA:ARbitrary? [<folder>]

MMEMory:CATalog:STATe? [<folder>]

MMEMory:CDIRectory <folder>

MMEMory:CDIRectory?

MMEMory:COpy <file1>,<file2>

MMEMory:COpy:SEquence <source>,<destination>

MMEMory:DElete <file>

MMEMory:DOWNload:DATA <binary_block>

MMEMory:DOWNload:FNAME <filename>

MMEMory:LOAD:ALL <filename>

MMEMory:LOAD:DATA[1|2] <filename>

MMEMory:LOAD:LIST[1|2] <filename>

MMEMory:LOAD:STATe <filename>

MMEMory:MDIRectory <folder>

MMEMory:MOVE <file1>,<file2>

MMEMory:RDIRectory <folder>

MMEMory:STORe:ALL <filename>

MMEMory:STORe:DATA[1|2] <filename>

MMEMory:STORe:LIST[1|2] <filename>

MMEMory:STORe:STATe <filename>

MMEMory:UPLoad? <filename>

Display

DISPlay {ON|1|OFF|0}

DISPlay?

DISPlay:TEXT "<*string*>"

DISPlay:TEXT?

DISPlay:TEXT:CLEAr

DISPlay:UNIT:ARBRate {SRATe|FREQuency|PERiod}

DISPlay:UNIT:PULSe {WIDTh|DUTY}

DISPlay:UNIT:RATE {FREQuency|PERiod}

DISPlay:UNIT:SWEep {STARtstop|CENTerspan}

DISPlay:UNIT:VOLT {AMPLitudeoff|HIGHlow}

DISPlay:VIEW {STANDard|TEXT|GRAPH|DUAL}

Screen Shots

HCOPy:SDUMp:DATA?

HCOPy:SDUMp:DATA:FORMAt {PNG|BMP}

HCOPy:SDUMp:DATA:FORMAt?

LXI

LXI:IDENtify[:STATE] {ON|1|OFF|0}

LXI:IDENtify[:STATE]?

LXI:MDNS:ENABLe {ON|1|OFF|0}

LXI:MDNS:ENABLe?

LXI:MDNS:HNAME:RESolved?

LXI:MDNS:SNAME:DESired <*name*>

LXI:MDNS:SNAME:DESired?

LXI:MDNS:SNAME[:RESolved]?

LXI:RESet

LXI:REStArt

Remote Interface Configuration

SYSTem:COMMunicate:ENABle {ON|1|OFF|0}, <interface>

SYSTem:COMMunicate:ENABle? <interface>

SYSTem:COMMunicate:GPIB:ADDRes <address>

SYSTem:COMMunicate:GPIB:ADDRes?

SYSTem:COMMunicate:LAN:CONTRol?

SYSTem:COMMunicate:LAN:DHCP {ON|1|OFF|0}

SYSTem:COMMunicate:LAN:DHCP?

SYSTem:COMMunicate:LAN:DNS[1|2] "<address>"

SYSTem:COMMunicate:LAN:DNS[1|2]? [{CURRENT|STATIC}]

SYSTem:COMMunicate:LAN:DOMain?

SYSTem:COMMunicate:LAN:GATeway "<address>"

SYSTem:COMMunicate:LAN:GATeway? [{CURRENT|STATIC}]

SYSTem:COMMunicate:LAN:HOSTname "<name>"

SYSTem:COMMunicate:LAN:HOSTname? [{CURRENT|STATIC}]

SYSTem:COMMunicate:LAN:IPADdress "<address>"

SYSTem:COMMunicate:LAN:IPADdress? [{CURRENT|STATIC}]

SYSTem:COMMunicate:LAN:MAC?

SYSTem:COMMunicate:LAN:SMASK "<mask>"

SYSTem:COMMunicate:LAN:SMASK? [{CURRENT|STATIC}]

SYSTem:COMMunicate:LAN:TELNet:PROMpt "<string>"

SYSTem:COMMunicate:LAN:TELNet:PROMpt?

SYSTem:COMMunicate:LAN:TELNet:WMESsage "<string>"

SYSTem:COMMunicate:LAN:TELNet:WMESsage?

SYSTem:COMMunicate:LAN:UPDate

SYSTem:COMMunicate:LAN:WINS[1|2] "<address>"

SYSTem:COMMunicate:LAN:WINS[1|2]? [{CURRENT|STATIC}]

System

SYSTem:BEEPer[:IMMediate]

SYSTem:BEEPer:STATe {ON|1|OFF|0}

SYSTem:BEEPer:STATe?

SYSTem:CLICk:STATe{ON|1|OFF|0}

SYSTem:CLICk:STATe?

SYSTem:DATE <yyyy>, <mm>, <dd>

SYSTem:DATE?

SYSTem:ERRor?

SYSTem:LICense:CATalog?

SYSTem:LICense:DELeTe "<option_name>"

SYSTem:LICense:DELeTe:ALL

SYSTem:LICense:DESCRiption? "<option_name>"

SYSTem:LICense:ERRor?

SYSTem:LICense:ERRor:COUNT?

SYSTem:LICense:INSTall "<file>"

SYSTem:LICense:INSTall? "<option>"

SYSTem:LOCK:NAME?

SYSTem:LOCK:OWNer?

SYSTem:LOCK:RELease

SYSTem:LOCK:REQuest?

SYSTem:SECurity:IMMediate

SYSTem:TIME <hh>, <mm>, <ss>

SYSTem:TIME?

SYSTem:VERSion?

Phase

[SOURce[1|2]:]PHASe {<angle>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]PHASe? [{MINimum|MAXimum}]

[SOURce[1|2]:]PHASe:ARBitrary {<angle>|MINimum|MAXimum}

[SOURce[1|2]:]PHASe:MODulation {<angle>|MINimum|MAXimum}

[SOURce[1|2]:]PHASe:MODulation?

[SOURce[1|2]:]PHASe:REFerence

[SOURce[1|2]:]PHASe:SYNChronize

[SOURce[1|2]:]PHASe:UNLock:ERRor:STATe {ON|1|OFF|0}

[SOURce[1|2]:]PHASe:UNLock:ERRor:STATe?

Reference oscillator

ROSCillator:SOURce {INTernal|EXTernal}

ROSCillator:SOURce?

ROSCillator:SOURce:AUTO {ON|OFF}

ROSCillator:SOURce:AUTO?

ROSCillator:SOURce:CURREnt?

Calibration

CALibration[:ALL]?

CALibration:COUNt?

CALibration:SECure:CODE <new_code>

CALibration:SECure:STATe {ON|1|OFF|0} [, <code>]

CALibration:SECure:STATe?

CALibration:SETup <step>

CALibration:SETup?

CALibration:STORe

CALibration:STRing "<string>"

CALibration:STRing?

CALibration:VALue <value>

CALibration:VALue?

IEEE-488

*CLS

*ESE <enable_value>

*ESE?

*ESR?

*IDN?

*OPC

*OPC?

*OPT?

*PSC {0|1}

*PSC?

*RCL {0|1|2|3|4}

*RST

*SAV {0|1|2|3|4}

*SRE <enable_value>

*SRE?

*STB?

*TRG

*TST?

*WAI

Status

STATus:OPERation:CONDition?

STATus:OPERation:ENABle <enable_value>

STATus:OPERation:ENABle?

STATus:OPERation[:EVENT]?

STATus:PRESet

STATus:QUEStionable:CONDition?

STATus:QUEStionable:ENABle <enable_value>

STATus:QUEStionable:ENABle?

STATus:QUEStionable[:EVENT]?

Miscellaneous

ABORt

[SOURce[1|2]:]PHASe:ARBitrary {<angle>|MINimum|MAXimum}

[SOURce[1|2]:]PHASe:ARBitrary?

[SOURce[1|2]:]COMBine:FEED {CH1|CH2|NONE}

[SOURce[1|2]:]COMBine:FEED?

FORMat:BORDer {NORMal|SWAPped}

FORMat:BORDer?

INITiate[1|2]:CONTInuous {ON|1|OFF|0}

INITiate[1|2]:CONTInuous?

INITiate:CONTInuous:ALL {ON|1|OFF|0}

INITiate[1|2]:IMMediate]

INITiate[:IMMediate]:ALL

[SOURce[1|2]:]MARKer:CYCLe {<cycle_num>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]MARKer:CYCLe? [{MINimum|MAXimum}]

INPut:ATTenuation[:STATe] {ON|1|OFF|0}

INPut:ATTenuation[:STATe]?

[SOURce[1|2]:]MARKer:FREQuency {<frequency>|MINimum|MAXimum|DEFault}

[SOURce[1|2]:]MARKer:FREQuency? [{MINimum|MAXimum}]

[SOURce[1|2]:]MARKer:POINt {<sample_number>|MINimum|MAXimum}

[SOURce[1|2]:]MARKer:POINt? [{MINimum|MAXimum}]

[SOURce[1|2]:]TRACk {ON|OFF|INVerted}

TRACk?

UNIT:ANGLe {DEGREE|RADian|SECond|DEFault}

UNIT:ANGLe?

UNIT:ARBitrary:ANGLe {DEGREE|RADian|SECond|SAMPLE|DEFault}

UNIT:ARBitrary:ANGLe?

Factory Reset State

The following tables show factory default settings. Parameters marked with a bullet (•) are non-volatile, and are not affected by power cycling or *RST. Other parameters are volatile and reset to the indicated values at power-on or after *RST.

NOTE

The power-on/reset state may differ from that shown below if you have enabled power-on state recall mode from the [System] menu. See [Instrument State Storage](#).

Output Channel Configuration

Function	Sine
Tracking	Off
Frequency	1 kHz
Frequency Mode	CW
Frequency Couple State	OFF
Frequency Couple Mode	Ratio
Frequency Couple Ratio	1
Frequency Couple Offset	0
Amplitude	100 mVpp
Offset	0 VDC
Voltage Couple State	OFF
Voltage Limit State	OFF
Voltage Limit High	5 V
Voltage Limit Low	-5 V
Voltage Unit	VPP
Voltage Range	AUTO
State	OFF
Load	50 Ω
Polarity	Normal
Mode (Normal vs. Gated)	Normal
Sync Polarity	Normal
Sync Mode	Normal
Output Channel Configuration	
Sync State	ON
Sync Source	CH1
Trigger Source	CH1
Trigger Slope	Positive
Trigger State	OFF
Noise	

Bandwidth	100 kHz
PRBS	
Data	PN7
Bit Rate	1 kbps
Transition	8.4E-09
Pulse	
Duty Cycle	10%
Period	1 ms
Leading/Trailing Edge	10 ns
Width	0.1 ms
Ramp	
Symmetry	100
Square	
Duty Cycle	50%
Period	1 ms
Arbitrary Waveforms	
Arb	Exponential Rise
Filter	STEP
Sample Rate	40 kSa/sec
Advance	SRATE
Marker Point	Mid point of arb
Amplitude Modulation	
State	OFF
Modulation Source	Internal
Internal Function	Sine
Internal Frequency	100 Hz
Depth	100%
DSSC	OFF
Frequency Modulation	
State	OFF

Modulation Source	Internal
Internal Function	Sine
Internal Frequency	10 Hz
Deviation	100 Hz
FSK Modulation	
State	OFF
Modulation Source	Internal
Internal Rate	10 Hz
Frequency	100 Hz
Phase Modulation	
State	OFF
Modulation Source	Internal
Function	Sine
Frequency	10 Hz
Deviation	180 degrees
BPSK Modulation	
State	OFF
Modulation Source	Internal
Internal Rate	10 Hz
Phase	180 degrees
Pulse Width Modulation	
State	OFF
Modulation Source	Internal
Function	Sine
Frequency	10 Hz
Deviation	1% or 1E-5 sec, depending on how specified
SUM	
State	OFF
Source	Internal

Function	Sine
Frequency	100 Hz
Sum Amplitude	0.10%
Phase Control	
Phase Adjust	0 degrees
Unlock Error State	OFF
Units	degrees
Reference Oscillator	
Source Auto	ON
Source	Internal
Burst	
State	OFF
Gate Polarity	Normal
Mode	Triggered
Cycles	1
Period	10 ms
Phase	0 degrees
Marker Cycle	2
Sweep	
State	OFF
Spacing	Linear
Start Freq	100 Hz
Stop Freq	1 kHz
Center Freq	550 Hz
Span	900 Hz
Marker Freq	500 Hz
Sweep Time	1 sec
Hold Time	0 sec
Return Time	0 sec
List	

Frequency	100, 1000, 550 Hz
Points	3
Dwell	1 sec
Trigger	
Delay	0 sec
Slope	Positive
Source	Immediate
Timer	1 sec
Init Continuous	ON
Count	1
Channel Independent Trigger Configuration	
Init Continuous All	ON
Miscellaneous	
Format Byte Order	Normal
Combine Feed	NONE
The following items do not relate to channel configuration.	
Display	
State	ON
Text	""
Hcopy Format	PNG
Remote Interface Communication	
GPIB Address •	10
DHCP •	Enabled
IP Address static •	169.254.5.21
Subnet Mask static •	255.255.0.0
Gateway static •	0.0.0.0
DNS primary server •	0.0.0.0

DNS secondary server •	0.0.0.0
Hostname static •	"A-33xxxx-nnnnn" or "A-33xxxx-nnnnn", where xxxx is the last three digits of the model number, and nnnnn is the last 5 digits of the instrument's serial number
Telnet Prompt •	33xxxx>, where xxxx is the last four digits of the model number.
Telnet Welcome Message •	Welcome to Keysight's 33xxxx Waveform Generator, where xxxx is the last four digits of the model number.
WINS primary server •	0.0.0.0
WINS secondary server •	0.0.0.0
System	
Beep State	ON
Power Down Recall •	OFF
LXI	
Identify	OFF
Calibration	
Calibration State	Secured

NOTE

The instrument uses LAN port 5024 for SCPI Telnet sessions, and port 5025 for SCPI Socket sessions.

SCPI Error Messages

The instrument returns error messages in accord with the SCPI standard.

- Up to 20 command syntax or hardware errors can be stored in each interface-specific error queue (one each for GPIB, USB, VXI-11, and Telnet/Sockets.) Errors appear in the error queue of the I/O session that caused the error.
- The instrument beeps once each time an error is generated (unless disabled by **SYSTem:BEEPer:STATe OFF**). The front panel **ERROR** annunciator turns on when one or more errors are in the error queue.
- A special global error queue holds all power-on and hardware-related errors (for example, overtemperature).
- Error retrieval is first-in-first-out (FIFO), and errors are cleared as you read them. Once you have read all interface-specific errors, the errors in the global error queue are retrieved. When you have read all errors from the global error queue, the **ERROR** annunciator turns off.

- If more than 20 errors have occurred, the last error stored in the queue (the most recent error) is replaced with -350, "Error queue overflow". No additional errors are stored until you remove errors from the queue. If no errors have occurred when you read the error queue, the instrument responds with +0, "No error".
- The front panel reports errors from all I/O sessions and the global error queue. To read the error queue from the front panel, press the [**System**] button, then the **Help** softkey. Then select "View remote command error queue" in the Help menu.
- Error conditions are also summarized in the Status Byte Register. See [Status Subsystem Introduction](#) for details
- The interface-specific error queues are cleared by power cycles and *CLS. The error queue is not cleared by *RST.
- **SCPI:**

SYSTem:ERRor? *Read and clear one error from the queue*

Errors have the following format (the error string may contain up to 255 characters):

- 113, "Undefined header"
- 315 Configuration memory lost; due to firmware revision change
- 315 Configuration memory lost; memory corruption detected
- 314 Save/recall memory lost; due to firmware revision change
- 314 Save/recall memory lost; memory corruption detected
- 313 Calibration memory lost
- 313 Calibration memory lost; due to firmware revision change
- 313 Cannot read file; due to corrupt data
- 313 Cannot read file; due to file revision change
- 313 Invalid number of channels for operation
- 310 System error; internal software error
- 310 System error; out of memory
- 310 System error; software initialization failed
- 292 Referenced name does not exist
- 257 File name error;
 - access denied
 - drive name missing or not recognized
 - file or folder already exists
 - file too large

folder is default folder
folder not empty
invalid character in name
not a folder name
path is a folder name
path name missing
path too long
relative path not allowed
unknown file extension

-256 File or folder name not found

-254 Media full

-252 Missing media

-250 Mass storage error: file read/write error

-241 Hardware missing

-241 Hardware missing; Command not valid in one channel instrument.

-240 Hardware error; GPIB interface failed

-230 Data corrupt or stale

-222 Data out of range;

AM depth
amplitude
arb frequency
arb period
burst count
burst count limited by length of burst
burst period
burst period limited by length of burst
cannot combine channel with itself. Combine disabled
duty cycle
duty cycle limited by frequency
FM deviation
FM deviation limited by maximum frequency

FM deviation limited by minimum frequency
frequency
frequency in burst mode
frequency in FM
high level limited by high soft limit
high level limited by low level
high level limited by low soft limit
high limit value limited by high signal level
large period limits minimum pulse width
low level limited by high level
low level limited by high soft limit
low level limited by low soft limit
low limit value limited by low signal level
marker confined to burst cycles
marker confined to sweep span
offset
period
PRBS edge time
PRBS edge time limited by bit rate
pulse duty cycle limited by period
pulse edge at maximum
pulse edge at minimum
pulse edge time
pulse edge time limited by duty cycle
pulse edge time limited by period
pulse edge time limited by width
pulse frequency
pulse period
pulse width
pulse width limited by period
PWM deviation

PWM deviation limited by pulse parameters

ramp frequency

ramp Symmetry

Sample rate

sample rate clipped to lower limit

sample rate clipped to upper limit

square edge time

square edge time limited by duty cycle

square edge time limited by period

square edge time limited by width

square period

square width

sum amplitude limited by channel or combine amplitudes

sum amplitude value clipped to lower limit

sweep time

Track exceeds limits on channel 1. Tracking disabled

Track exceeds limits on channel 2. Tracking disabled

trigger count clipped to lower limit

trigger count clipped to upper limit

trigger delay

trigger delay clipped to lower limit

trigger delay clipped to upper limit

trigger delay limited by length of burst

trigger level clipped to lower limit (33600 Series only)

trigger level clipped to upper limit (33600 Series only)

trigger level (33600 Series only)

trigger timer clipped to lower limit

trigger timer clipped to upper limit

trigger timer limited by length of burst

user frequency

USER setting only valid for channel 1

- value clipped to dwell time's lower limit
 - value clipped to dwell time's upper limit
 - value clipped to lower limit
 - value clipped to sweep time's lower limit
 - value clipped to upper limit
 - value limited due to coupling
- 222 List Data out of range; Arb frequency : Mode is changed to Normal (33600 Series only)
 - 222 List Data out of range; Pulse frequency : Mode is changed to Normal
 - 222 List Data out of range; Ramp frequency : Mode is changed to Normal
 - 222 List Data out of range; Sine frequency : Mode is changed to Normal
 - 222 List Data out of range; Square frequency : Mode is changed to Normal
 - 222 List Data out of range; User frequency : Mode is changed to Normal
 - 221 Setting the advance mode to trigger forced the trigger source to external.
 - 221 Setting the Arb Filter OFF changed the maximum sample rate value to 6.25e7.
 - 221 Setting the trigger source changed the arb advance mode.
 - 221 Settings conflict;
 - 50V input range not compatible with 50 ohm input impedance; impedance set to 1 Mohm
 - AM depth forced amplitude change
 - AM turned off by selection of other mode or modulation
 - amplitude changed due to function
 - amplitude changed due to offset
 - amplitude units changed to Vpp due to high-Z load
 - amplitude units changed to Vpp, dBm and Vrms not applicable to arb sequences
 - amplitude units unchanged, dBm and Vrms not applicable to arb sequences
 - arb advance changed to SRATE due to filter (33600 Series only)
 - arb advance changed to SRATE due to mode
 - arb voltage reduced due to output load or limits
 - Balance gain limited due to amplitude.
 - Balance offset changed due to amplitude
 - both edge times decreased due to period

both edge times decreased due to pulse duty cycle

both edge times decreased due to pulse width

BPSK turned off by selection of other mode or modulation

burst count reduced to fit entire burst

Burst mode has caused output phase to be set to zero degrees

burst period increased to fit entire burst

burst phase inapplicable for arbs larger than 1M. burst phase set to 0 (33500 Series only)

burst turned off by selection of other mode or modulation

Cannot combine DC function

cannot delete state selected and enabled for automatic power-on recall

Cannot modulate ARB carrier with ARB as modulation function. Modulation turned off.

Cannot modulate ARB carrier with ARB modulation function. Function unchanged.

Cannot modulate ARB carrier with USER as modulation function. Modulation turned off.

Cannot modulate ARB carrier with USER modulation function. Function unchanged.

Cannot modulate by a two-channel Arb

Cannot modulate Noise carrier with Noise as modulation function. Modulation turned off.

Cannot modulate Noise carrier with Noise modulation function. Function unchanged.

Cannot modulate PRBS carrier with PRBS as modulation function. Modulation turned off.

Cannot modulate PRBS carrier with PRBS modulation function. Function unchanged.

Cannot modulate USER carrier with ARB as modulation function. Modulation turned off.

Cannot modulate USER carrier with ARB modulation function. Function unchanged.

Cannot modulate USER carrier with USER as modulation function. Modulation turned off.

Cannot modulate USER carrier with USER modulation function. Function unchanged.

Cannot select channel as modulating source

Cannot use filter in advance arb trigger mode. (33600 Series only)

combine amplitude exceeds limit. Combine disabled

Combine turned off by selection of DC function

coupling cannot be ON with this function, coupling turned off

coupling violates settings, coupling turned off

edge time decreased due to bit rate

external gating not compatible with gate output; gate output disabled

FM deviation cannot exceed carrier

FM deviation exceeds maximum frequency

FM turned off by selection of other mode or modulation

frequency changed for pulse function

frequency changed for sine function (33600 Series only)

frequency changed for square function (33600 Series only)

frequency forced duty cycle change

frequency made compatible with burst mode (33500 Series only)

frequency reduced for ramp function

frequency reduced for user function

FSK turned off by selection of other mode or modulation

Function or modulation source cannot be USER. Tracking disabled

Function selection limited the FSK frequency.

Gated output not available for gated burst. Output mode changed to normal.

high level changed due to low level

high limit less than low limit. Limits disabled

infinite burst changed trigger source to BUS

input threshold voltage > input range; threshold clipped to range

leading edge time decreased due to period

leading edge time decreased due to pulse width

leading edge times decreased due to pulse duty cycle

limited frequency to 1 MHz when sync mode carrier, burst ON, and function sine (33500 Series only)

list turned off by selection of other mode or modulation

low level changed due to high level

low reference >= high reference

marker forced into sweep span

marker off forced sync to normal mode

marker on forced sync to marker mode

marker point changed to fit arb length

modulation frequency made compatible with modulation shape

must stop operation to update trigger count

must stop operation to update trigger delay

not able to adjust phase for arb < 64 samples (33600 Series only)

not able to adjust phase in this function

not able to adjust phase in this mode

not able to burst DC, burst turned off

not able to burst this function

not able to change output load with limits enabled

not able to list arb, list turned off

not able to list DC, list turned off

not able to list noise, list turned off

not able to list PRBS, list turned off

not able to list this function

not able to modulate arb, modulation turned off

not able to modulate DC, modulation turned off

not able to modulate noise, modulation turned off

not able to modulate PRBS, modulation turned off

not able to modulate this function

not able to sweep arb, sweep turned off

not able to sweep DC, sweep turned off

not able to sweep noise, sweep turned off

not able to sweep PRBS, sweep turned off

not able to sweep this function

offset changed due to amplitude

offset changed on exit from DC function

PM turned off by selection of other mode or modulation

prbs edge time increased due to amplitude (33600 Series only)

pulse duty cycle and edge times increased due to amplitude (33600 Series only)

pulse duty cycle decreased due to period

pulse duty cycle increased due to amplitude (33600 Series only)

pulse duty cycle increased due to period

pulse edge times increased due to amplitude (33600 Series only)

pulse width and edge times increased due to amplitude (33600 Series only)

pulse width decreased due to period

pulse width increased due to amplitude (33600 Series only)

pulse width increased due to large period

PWM deviation decreased due to pulse parameters

PWM only available in pulse function

PWM turned off by selection of other mode or modulation

Range hold turned off by selection of new function (33600 Series only)

selected arb is missing, changing selection to default

selecting a sequence turned off modulation

sequences not supported, changing selection to default

signal exceeds high limit. Limits disabled

signal exceeds low limit. Limits disabled

Skew time between channels not available in Burst, Modulation, or Sweep

sum amplitude exceeds limit or range. Sum disabled

SUM turned off by selection of other mode or modulation

Sweep + Hold + Return time larger than trigger TIMER. Trig timer increased.

Sweep + Hold + Return time max (8000s) limited time setting.

Sweep + Hold + Return time max (8000s) limited time setting.

Sweep + Hold + Return time too large for IMM or TIMER trigger. Sweep turned off.

Sweep + Hold + Return time too large for IMM or TIMER trigger. Trig source unchanged.

Sweep time reduced due to log sweep setting.

sweep turned off by selection of other mode or modulation

Tracking turned off by selection of USER function or modulation source

trailing edge decreased due to leading edge

trailing edge time decreased due to period

trailing edge time decreased due to pulse width

trailing edge times decreased due to pulse duty cycle

trigger delay reduced to fit entire burst

trigger output connector used by BPSK

trigger output connector used by burst gate

trigger output connector used by FSK

trigger output connector used by trigger external

trigger output disabled

trigger output disabled by trigger external

Trigger source limited the sweep time; value clipped to upper limit

triggered burst not available for noise

turned off infinite burst to allow immediate trigger source

Use FUNC:ARB to select an ARB before selecting ARB as modulation function. Function unchanged.

Use FUNC:ARB to select an ARB before selecting ARB as modulation function. Modulation disabled.

Use FUNC:USER to select a user arb before selecting USER as modulation function. Function unchanged.

Use FUNC:USER to select a user arb before selecting USER as modulation function. Modulation disabled.

-213 INIT ignored

-203 Command protected; Enter calibration password from front panel calibration menu (33500 Series only)

-203 Command protected; instrument must be unsecured (33600 Series only)

-203 Command protected; requires license BWD (33600 Series only)

-203 Command protected; requires license SEC (33600 Series only)

-203 Secure option: Instrument security is unlocked

-115 Invalid parameter; Parameter not supported on one channel instrument

-114 Header suffix out of range

100 Network Error

110 LXI mDNS Error

201 Memory lost: stored state

202 Memory lost: power-on state

203 Memory lost: stored measurements

263 Not able to execute while instrument is measuring

291 Not able to recall state: it is empty

292 State file size error

293 State file corrupt

301 Cannot reset input protection; high voltage present

305 Not able to perform requested operation

514 Not allowed

514 Not allowed; Instrument locked by another I/O session

521 Communications: input buffer overflow

522 Communications: output buffer overflow

532 Not able to achieve requested resolution

540 Cannot use overload as math reference

550 Not able to execute command in local mode

560 No valid external timebase

561 High voltage present on input channel

570 DDS Processor is not responding

580 Reference phase-locked loop is unlocked

581 Waveform DAC Timing is unlocked (33600 Series only)

581 Waveform DAC Timing regained lock (33600 Series only)

582 The DATA controller failed to lock for WFDAC (33600 Series only)

582 The MU controller failed to lock for WFDAC (33600 Series only)

582 The SYNC controller failed to lock for WFDAC (33600 Series only)

600 Internal licensing error

601 License file corrupt or empty

602 No valid licenses found for this instrument

603 Some licenses could not be installed

604 License not found

605 License already installed

NOTE

Most error codes between 600 and 699 refer to self-test errors. See [Self-Test Procedures](#) for details.

701 Calibration error; security defeated by hardware jumper

702 Calibration error; calibration memory is secured

703 Calibration error; secure code provided was invalid

704 Calibration error: secure code too long

705 Calibration error; calibration aborted

706 Calibration error; provided value is out of range

707 Calibration error: computed correction factor out of range

707 Calibration error; signal input is out of range

708 Calibration error: signal measurement out of range

709 Calibration error: no calibration for this function/range

710 Calibration error: full scale correction out of range

710 Self-calibration failed

711 Calibration error: calibration string too long

711 Self-calibration failed

712 Calibration failed

712 Self-calibration failed

715 Self-calibration failed

720 Self-calibration failed

740 Calibration data lost: secure state

741 Calibration data lost: string data

742 Calibration data lost: corrections

748 Calibration memory write failure

770 Nonvolatile arb waveform memory corruption detected

781 Not enough memory to store new arb waveform; bad sectors

781 Not enough memory to store new arb waveform; use DATA:DELETE

782 Cannot overwrite a built-in arb waveform

784 Name of source arb waveform for copy must be VOLATILE

785 Specified arb waveform does not exist

786 Not able to delete a built-in arb waveform

786 Specified arb waveform already exists

787 Not able to delete the currently selected active arb waveform

787 Specified arb not loaded in waveform memory

788 Could not load specified arb; Loaded Built-in default arb

791 Firmware update error; unable to begin download

792 Firmware update error; programming operation failed

793 Firmware update error; data record invalid character

794 Firmware update error; data record length mismatch

795 Firmware update error; data record checksum mismatch
796 Firmware update error; bad checksum for download start
797 Firmware update error; bad checksum for download complete
798 Firmware update error; download in progress
799 Firmware update error; unable to complete download
800 Firmware update error; invalid programming address
810 State has not been stored
850 Calibration error; set up is invalid
851 Calibration error; set up is out of order
870 Arb: Text File Format error; invalid format
871 Arb: Segment name is too long
872 Arb: File name is too long
873 Arb: Too many sequence steps
874 Arb: Too many segments defined
875 Arb: Too many sequences defined
876 Arb: Sequence already defined
877 Arb: Segment not found
878 Arb: Sequence not found
879 Arb: Segment edit too large
880 Arb: Out of memory
881 Arb: Channel count mismatch
881 Arb: Values are out of range
882 Arb: Segment too small
883 Arb: Error in closing file
884 Arb: Seek too large
885 Arb: Arb file cannot be stored as sequence file
886 Arb: Sequence file cannot be stored as arb file
887 File name error; not a valid extension
888 Arb: Could not create built in arb directory
889 Arb: Could not copy built in arb
890 enable combine forced tracking off

- 891 enable coupling forced tracking off
- 892 enable tracking forced coupling off
- 893 enable tracking forced combine off
- 894 Enable tracking forced range hold off (33600 Series only)

Service and Repair - Introduction

This section contains basic service information for your instrument.

Types of Service Available

Cleaning

Electrostatic Discharge (ESD) Precautions

Additional service information is found here:

Block Diagram - 33500 Series

Block Diagram - 33600 Series

Power Supplies - 33500 Series

Power Supplies - 33600 Series

Troubleshooting - 33500 Series

Troubleshooting - 33600 Series

Self-Test Procedures

Replaceable Parts

Disassembly - 33500 Series

Disassembly - 33600 Series

Battery Replacement

Installing the Optional GPIB Interface

Types of Service Available

If your instrument fails during the warranty period, Keysight Technologies will repair or replace it under the terms of your warranty. After your warranty expires, Keysight offers repair services at competitive prices.

Extended Service Contracts

Many Keysight products have optional service contracts that extend coverage after the standard warranty expires.

Obtaining Repair Service (Worldwide)

To obtain service for your instrument, [contact your nearest Keysight Technologies Service Center](#). They will arrange to have your unit repaired or replaced, and can provide warranty or repair-cost information where applicable. Ask the Keysight Technologies Service Center for shipping instructions, including what components to ship. Keysight recommends that you retain the original shipping carton for return shipments.

Repackaging for Shipment

To ship the unit to Keysight for service or repair:

- Attach a tag to the unit identifying the owner and indicating the required service or repair. Include the model number and full serial number.
- Place the unit in its original container with appropriate packaging material.
- Secure the container with strong tape or metal bands.
- If the original shipping container is unavailable, use a container that will ensure at least 10 cm (4 in.) of compressible packaging material around the entire instrument. Use static-free packaging materials.

Keysight suggests that you always insure shipments.

Cleaning

Clean the outside of the instrument with a soft, lint-free cloth slightly dampened with water only. Do not use detergent or any form of spray. Disassembly is not required or recommended for cleaning.

Electrostatic Discharge (ESD) Precautions

Almost all electrical components can be damaged by electrostatic discharge (ESD) during handling. Component damage can occur at electrostatic discharge voltages as low as 50 V.

The following guidelines will help prevent ESD damage during service operations:

- Disassemble instruments only in a static-free work area.
- Use a conductive work area to reduce static charges.
- Use a conductive wrist strap to reduce static charge accumulation.
- Minimize handling.
- Keep replacement parts in original static-free packaging.
- Remove all plastic, foam, vinyl, paper, and other static-generating materials from the immediate work area.
- Use only anti-static solder suckers.

Introduction to Calibration – 33500 Series

This chapter contains procedures for verifying the instrument's performance and adjustment (calibration).

The instrument uses closed-case electronic calibration; no internal mechanical adjustments are required. The instrument calculates correction factors based on input reference values that you set and stores correction factors in non-volatile memory until the next calibration adjustment is performed. This data is not changed by cycling power or ***RST**.

Keysight Technologies Calibration Services

Your local Keysight Technologies Service Center offers low-cost recalibration. The service center uses automated calibration systems that allow Keysight to provide calibration at competitive prices.

Calibration Table of Contents

The section includes the following sections:

Calibration Overview

- Calibration Interval
- Adjustment is Recommended
- Time Required for Calibration
- Automating Calibration Procedures
- Recommended Test Equipment
- Test Considerations
- Calibration Count
- Calibration Message

Calibration Security

Performance Verification Tests

- Self-Test
- Quick Performance Check
- Performance Verification Tests
- Amplitude and Flatness Verification Procedures

Internal Timebase Verification

AC Amplitude (high-impedance) Verification

DC Offset Voltage Verification

-8 dB Range Flatness Verification

-24 dB Range Flatness Verification

General Calibration/Adjustment Procedure

Aborting a Calibration in Progress

Sequence of Adjustments

Self-Test

Frequency (Internal Timebase) Adjustment

Internal ADC Adjustment

Self Calibration Adjustment

Output Impedance Adjustment

AC Amplitude (high-impedance) Adjustment

-24 dB Range Flatness Adjustment

-8 dB Range Flatness Adjustment

Adjust Channel 2 (if necessary)

- Self Calibration Adjustment (Channel 2)
- Output Impedance Adjustment (Channel 2)
- AC Amplitude (high-impedance) Adjustment (Channel 2)
- -24 dB Range Flatness Adjustment (Channel 2)
- -8 dB Range Flatness Adjustment (Channel 2)

Calibration Errors

Next Calibration Topic

Calibration Overview - 33500 Series

This section introduces the instrument's calibration features. For more detailed calibration information, see [Introduction to Calibration](#).

Calibration Interval

The instrument should be calibrated on a regular interval determined by the accuracy requirements of your application. A one-year interval is adequate for most applications. Accuracy specifications are warranted only if adjustment is made at regular calibration intervals. Accuracy specifications are not warranted beyond the one-year calibration interval. Keysight Technologies does not recommend calibration intervals beyond two years for any application.

Adjustment is Recommended

Whatever calibration interval you select, Keysight Technologies recommends that complete re-adjustment should always be performed at the calibration interval. This ensures that the instrument will remain within specifications for the next calibration interval and provides the best long-term stability. Performance data measured using this method can be used to extend future calibration intervals. Use the Calibration Count to verify that all adjustments have been performed.

Time Required for Calibration

For incoming instrument verification, do performance verification tests first. Then perform adjustments and re-run the performance verification tests. Each of these steps, if done manually, takes approximately 30 minutes per channel to perform.

The instrument can also be automatically calibrated under computer control. With computer control you can perform the complete calibration procedure and performance verification tests in approximately 30 minutes (one channel) or 60 minutes (two channels) once the instrument is warmed-up (see [Test Considerations](#)).

Automating Calibration Procedures

You can use programmable test equipment to automate the complete verification and adjustment procedures. You can program each test's instrument configuration over the remote interface. Then enter read-back verification data into a test program and compare the results to the appropriate test limit.

You can also adjust the instrument from the remote interface, which is similar to the front panel procedure. Use a computer to perform the adjustment by first selecting the required function and range on the measurement equipment. Send the calibration value to the instrument and then initiate calibration over the remote interface.

You must [unsecure the instrument](#) before calibration.

A typical programming sequence for a single calibration setup is as follows:

1. **CAL:SETup 2** (configures instrument for calibration step 2)
2. Measure the output frequency with the external frequency counter
3. **CAL:VALue 9.99994321E6** (send the measured value to the instrument)
4. **CAL?** (initiates the calibration adjustment for setup 2)
5. Read **CAL?** query value to determine the failure (+1) or success (+0) of adjustment
6. **CAL:SETup 3** (configures instrument for calibration step 3)

For further information on instrument programming, see [Introduction to SCPI Language](#).

Recommended Test Equipment

The test equipment recommended for the performance verification and adjustment procedures is listed below. If the exact instrument is not available, substitute calibration standards of equivalent accuracy.

Instrument	Requirements	Recommended Model	Use *
Digital Multimeter (DMM)	ACV, true rms, AC coupled accuracy: $\pm 0.02\%$ to 1 MHz DCV accuracy: 50 ppm resolution: 100 μ V Resistance Offset-compensated accuracy: $\pm 0.1 \Omega$	Keysight 3458A	Q, P, T
Precision AC Voltmeter	1000 Hz to 30 MHz, 0.1 Vrms to 2 Vrms (-7 dBm to $+20$ dBm) accuracy: 0.02 dB resolution: 0.01 dB	Fluke 5790A	Q, P, T
Frequency Counter	accuracy: 0.1 ppm	Keysight 53132A Opt 012 (high stability)	Q, P, T
Oscilloscope	1 GHz 4 Gs/second 50 Ω input termination	Keysight MSO6104A	T
Adapter	N type (m) to BNC (m)	Keysight E9623A	Q, P, T

Instrument	Requirements	Recommended Model	Use *
Cable (2 required)	Dual banana (m) to dual banana (m)	Keysight 11000-60000	Q, P, T
Cable	RG58, BNC (m) to dual banana OR RG58 coaxial cable with BNC (m) to dual banana adapter	Keysight 11001-60001	Q, P, T
Cable	RG58, BNC (m) to BNC (m)	Keysight 11170C	Q, P, T

* Q = Quick Verification P = Performance Verification T = Troubleshooting

Test Considerations

For optimal performance, all procedures should comply with the following recommendations:

- Calibration ambient temperature is stable, between 18 and 28 °C. Ideally, it should be 23 ±1 °C.
- Ambient relative humidity is less than 80%.
- One-hour warm-up period before verification or adjustment.
- Measurement cables as short as possible, consistent with the impedance requirements.
- RG-58 or equivalent 50 Ω cable.

Calibration Count

You can query the instrument to determine how many calibrations have been performed. The instrument was calibrated at the factory. When you receive your instrument, be sure to read the count to determine its initial value.

- This setting is non-volatile; it will not be changed by power cycling or ***RST**.
- Because the value increments for each calibration point that stores a value, a complete calibration increases the value by many counts.



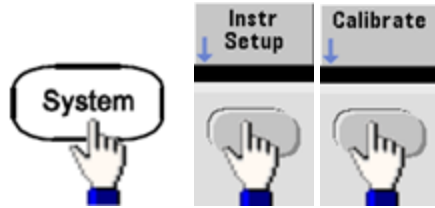
- Front Panel:
- SCPI: **CAL:COUNT?**

Calibration Message

You can store one message of up to 40 characters in calibration memory. For example, you can store the date when the last calibration was performed, the date when the next calibration is due, the instrument's serial number, or contact information for your calibration experts.

Unsecure the instrument to record a calibration message. You can read the message from either the front panel or over the remote interface, regardless of whether the instrument is secured.

- Storing a calibration message overwrites any message previously stored.
- This setting is non-volatile; it will not be changed by power cycling or ***RST**.



- **Front Panel:**
- **SCPI:** **CAL:STR "Cal Due: 01 August 2012"**

[Previous Calibration Topic](#) [Next Calibration Topic](#)

Calibration Security - 33500 Series

This section describes the instrument's calibration security system.

Security Overview

A security code prevents accidental or unauthorized instrument adjustments. On the 33500 Series, the factory default security code varies by model:

Models	Security Code
33521A and 33522A	AT33520A
335XXB	AT33500

- Once you enter a security code, that code must be used for both front panel and remote operation. If you secure the instrument from the front panel, you must use that same code to unsecure it from the remote interface.
- This setting is non-volatile; it will not be changed by power cycling or ***RST**.
- Security code rules:
 - Unquoted string up to 12 characters
 - Must start with letter (A-Z)
 - May contain letters, numbers (0-9) and underscores

- **Front Panel:**

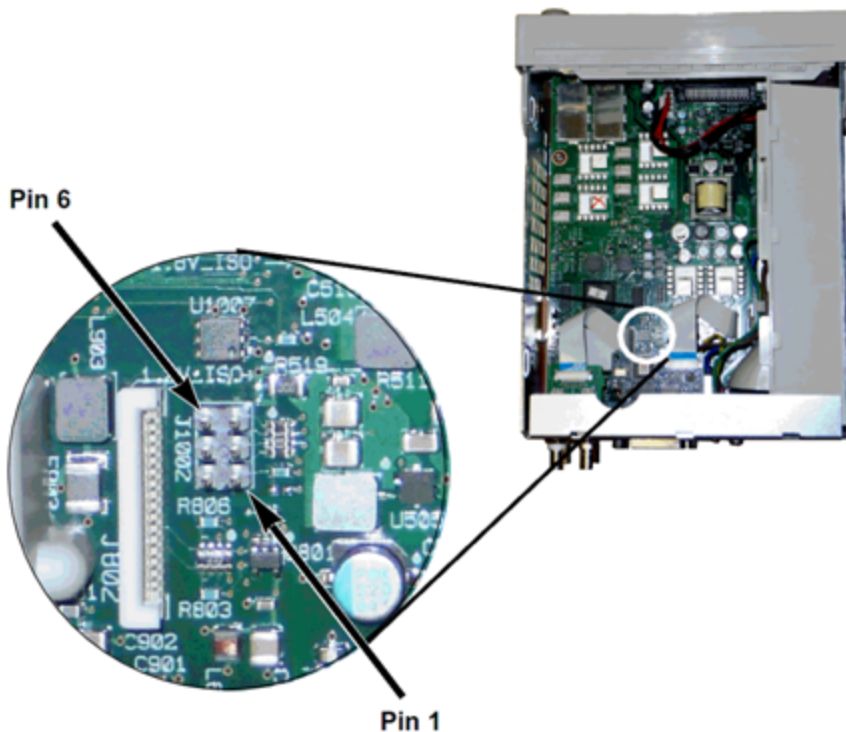


- **SCPI:** **CALibration_SECurity:STATe**

Unsecure Instrument Without Security Code

CAUTION See [Electrostatic Discharge \(ESD\) Precautions](#) before beginning this procedure.

1. Disconnect power cord and all input and output connections.
2. Disassemble the instrument (see [Disassembly - 33500 Series](#)).
3. Apply a temporary short between pin 1 and pin 6 of the header on the main board, shown below.



4. Attach power and turn on the instrument.

WARNING Be careful not to touch the power line connections or high voltages on the power supply module. Power is present even if the instrument is turned off.

5. The error queue will show the message "Calibration security has been disabled."

Calibration security is unlocked, with password reset to its factory default value. Calibration count is incremented because jumper was connected during power-up, and error message **+701,"Calibration error; security defeated by hardware jumper"** is issued. Nonvolatile calibration storage is updated to reflect these operations.

6. Turn off the instrument, remove temporary short, and remove power cord.
7. Reassemble the instrument.
8. Enter a new security code as described above, and record the security code in a safe location.

[Previous Calibration Topic](#) [Next Calibration Topic](#)

Verification - 33500 Series

The following topics describe the verification portion of the calibration procedure:

- [Performance Verification Tests](#)
- [Internal Timebase Verification](#)
- [AC Amplitude \(high-impedance\) Verification](#)
- [DC Offset Voltage Verification](#)
- [-8 dB Range Flatness Verification](#)
- [-24 dB Range Flatness Verification](#)

[Previous Calibration Topic](#) [Next Calibration Topic](#)

Performance Verification Tests - 33500 Series

Use the Performance Verification Tests to verify the measurement performance of the instrument. The performance verification tests use the instrument's specifications listed on the product datasheet.

You can perform three levels of performance verification tests:

- **Self-Test** A series of internal verification tests that give high confidence that the instrument is operational.
- **Quick Verification** A combination of the internal self-tests and selected verification tests.
- **Performance Verification Tests** An extensive set of tests that are recommended as an acceptance test when you first receive the instrument or after performing adjustments.

Self-Test

A brief power-on self-test occurs automatically whenever you turn on the instrument. This limited test assures that the instrument is operational. For details, see [Self-Test Procedures](#).

Quick Performance Check

The quick performance check is a combination of internal self-test and an abbreviated performance test (specified by the letter Q in the performance verification tests). This test provides a simple method to achieve high confidence in the instrument's ability to functionally operate and meet specifications. These tests represent the absolute minimum set of performance checks recommended following any service activity. Auditing the instrument's performance for the quick check points (designated by a Q) verifies performance for normal accuracy drift mechanisms. This test does not check for abnormal component failures.

To perform the quick performance check, do the following:

1. Perform a [complete self-test](#).
2. Perform only the performance verification tests indicated with the letter Q.

3. If the instrument fails the quick performance check, adjustment or repair is required.

Performance Verification Tests

The performance verification tests are recommended as acceptance tests when you first receive the instrument. The acceptance test results should be compared against the specifications on the product datasheet. After acceptance, you should repeat the performance verification tests at every calibration interval.

If the instrument fails performance verification, adjustment or repair is required.

Adjustment is recommended at every calibration interval. If adjustment is not made, you must guard band, using no more than 80% of the specifications listed in the datasheet, as the verification limits.

Amplitude and Flatness Verification Procedures

The flatness verification procedures use a precision AC voltmeter and a power meter. You may substitute Thermal Voltage Converters (TVCs) to make measurements using appropriate operating procedures and test equipment.

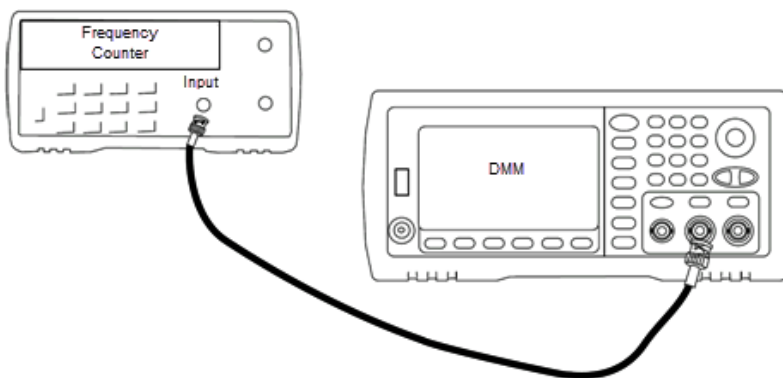
Flatness measurements for the -24 dB and -8 dB attenuator ranges are measured during the verification procedure. Other attenuator ranges are verified as a part of -24 dB and -8 dB attenuation range verification procedures. No separate verification procedure is given for these ranges.

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Internal Timebase Verification - 33500 Series

Verifies output frequency accuracy. All output frequencies are derived from a single generated frequency.

1. Connect a frequency counter to the channel 1 output as shown below (the frequency counter input should be terminated at 50 Ω).



2. Set the instrument to the output described in the table below and measure the output frequency. *Be sure the instrument output is enabled.*

Use	Waveform Generator			Measurement	
	Function	Amplitude	Frequency	Nominal	Error*

Use	Waveform Generator			Measurement	
	Q	Sine	1.00 Vpp	10.0000000 MHz	10.000 MHz ±10 Hz

* With the optional high-stability OCXO timebase, the measurement error is ± 1 Hz.

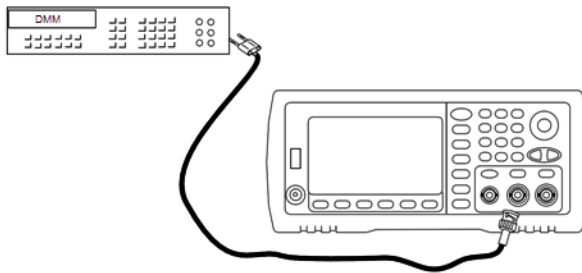
3. Compare the measured value to the test limits shown in the table.

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AC Amplitude (high-impedance) Verification - 33500 Series

Checks AC amplitude output accuracy at 1 kHz frequency using each attenuator.

1. Set the DMM to measure Vrms. Connect the DMM to the channel output as shown below.



2. Set the instrument to each output in the table below and measure the output voltage with the DMM. Be sure the output impedance is set to High-Z and the output is enabled.

Use	Waveform Generator				Measurement	
	Output Setup	Function	Frequency	Amplitude	Nominal	Error*
Q	High Z**	Sine	1.000 kHz	400.0 mVrms	400.0 mVrms	± 0.004707 Vrms
Q	High Z	Sine	1.000 kHz	400.0 mVrms	400.0 mVrms	± 0.004707 Vrms
Q	High Z	Sine	1.000 kHz	1.00 Vrms	1.00 Vrms	± 0.010707 Vrms
Q	High Z	Sine	1.000 kHz	2.500 Vrms	2.500 Vrms	± 0.025707 Vrms
Q	High Z	Sine	1.000 kHz	7.000 Vrms	7.000 Vrms	± 0.070707 Vrms

* Based upon 1% of setting ± 1 mVpp (50 Ω); converted to Vrms for High-Z.

** Use the following sequence to set this output:

- a. Set amplitude to 400.0 mVrms
- b. Set DC Offset to 1.0 VDC
- c. Set Auto-Range to OFF
- d. Set DC Offset Voltage to 0.0 VDC
- e. After the measurement, set autorange ON for remaining measurements.

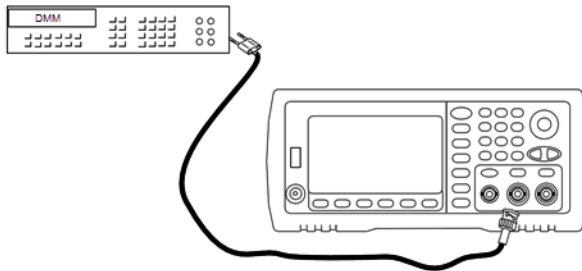
3. Compare the measured value to the test limits shown in the table.
4. Two-channel instruments only: connect DMM to channel 2 output and repeat steps 2 and 3.

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DC Offset Voltage Verification - 33500 Series

Checks the DC Offset Voltage on two attenuator ranges:

1. Set the DMM to measure DCV. Connect the DMM to the channel output as shown below.



2. Set the instrument to each output in the table below and measure the output voltage with the DMM.

Use	Waveform Generator			Measurement	
	Output Setup	Function	Voltage	Nominal	Error*
Q	High Z	DC	0.0 V	0.0 VDC	±0.002 VDC
Q	High Z	DC	500 mV	0.500 VDC	±0.007 VDC
Q	High Z	DC	10.0 V	10.0 VDC	±0.102 VDC

* Based upon 1% of setting ±2 mVDC for High-Z.

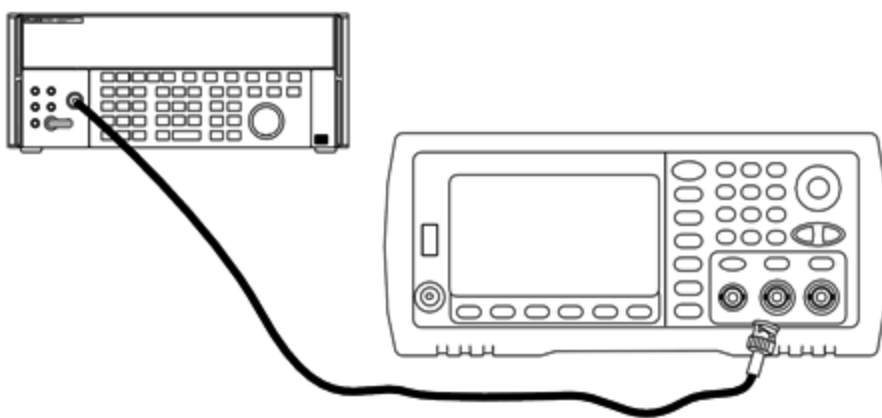
3. Compare the measured value to the test limits shown in the table.
4. Two-channel instruments only: connect DMM to channel 2 output and repeat steps 2 and 3.

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-8 dB Range Flatness Verification - 33500 Series

Checks high frequency AC amplitude flatness on the -8 dB attenuator range. Also checks flatness for all other ranges excluding the -24 dB and 0 dB attenuator ranges.

1. Connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A. If you are using substitute test equipment, verify that the input impedance is 50 Ω, because load accuracy directly affects measurement quality.



2. Set the precision AC Voltmeter to "Medium, Medium" Digital Filter and Filter Restart.
3. Set the instrument to each output described in the table below and measure the output amplitude with the AC voltmeter. This will become the reference measurement. Set the output impedance to 50 Ω . Be sure the output is enabled.

Use	Waveform Generator				Measurement	
	Output Load	Function	Amplitude	Frequency	Nominal	Error
Q	50 Ω	Sine	1.200 Vrms	1.000 kHz	1.200 Vrms	± 0.0127 Vrms

4. Set the measured value in Step 3 to be the reference value on the AC voltmeter.
5. Set the instrument to each output described in the table below and measure the output amplitude relative to the source as a percent with the AC voltmeter. Note that the table also lists the output in dB if you are using a power meter to perform this test.

Use	Waveform Generator				Measurement			
	Output Load	Function	Amplitude	Frequency	Nominal	Error	Nominal	Error
	50 Ω	Sine	1.200 Vrms	100.000 kHz	100%	$\pm 1.15\%$	0 dB	± 0.10 dB
				500.000 kHz		$\pm 1.74\%$		± 0.15 dB
				1.000 MHz		$\pm 1.74\%$		± 0.15 dB
Q	50 Ω	Sine	1.200 Vrms	2.000 MHz	100%	$\pm 1.74\%$	0 dB	± 0.15 dB

Use	Waveform Generator				Measurement			
	50 Ω	Sine	1.200 Vrms	5.000 MHz	100%	$\pm 1.74\%$	0 dB	± 0.15 dB
				10.00 MHz		$\pm 3.51\%$		± 0.30 dB
				15.00 MHz		$\pm 3.51\%$		± 0.30 dB
				20.00 MHz		$\pm 3.51\%$		± 0.30 dB
				22.00 MHz (unnecessary for 20 MHz instruments)		$\pm 4.71\%$		± 0.40 dB
				27.00 MHz (unnecessary for 20 MHz instruments)		$\pm 4.71\%$		± 0.40 dB
				30.00 MHz (unnecessary for 20 MHz instruments)		$\pm 4.71\%$		± 0.40 dB

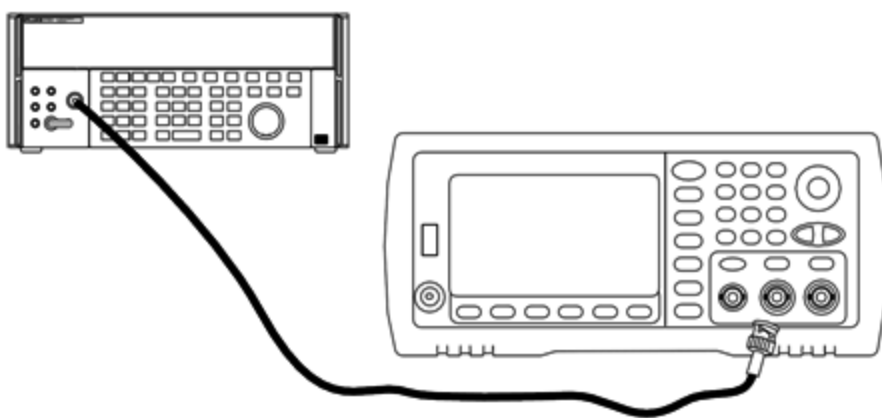
6. Compare the measured value to the test limits shown in the table.
7. Two-channel instruments only: Connect the AC voltmeter to channel 2 and repeat steps 2 through 6.

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-24 dB Range Flatness Verification – 33500 Series

Checks high frequency AC amplitude flatness on the - 24 dB attenuator range. Also checks flatness for the 0 dB attenuator range.

1. Connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A. If you are using substitute test equipment, verify that the input impedance is 50 Ω , because load accuracy directly affects measurement quality.



2. Set the precision AC Voltmeter to "Medium, Medium" Digital Filter and Filter Restart.
3. Set the instrument to each output described in the table below and measure the output amplitude with the AC voltmeter. This will become the reference measurement. Set the output impedance to 50 Ω . Be sure the output is enabled.

Use	Waveform Generator				Measurement	
	Output Load	Function	Amplitude	Frequency	Nominal	Error
Q	50 Ω	Sine	0.190 Vrms	1.000 kHz	0.190 Vrms	± 0.0026 Vrms

4. Set the measured value in Step 3 to be the reference value on the AC voltmeter.
5. Set the instrument to each output described in the table below and measure the output amplitude relative to the source as a percent with the AC voltmeter. Note that the table also lists the output in dB if you are using a power meter to perform this test.

Use	Waveform Generator				Measurement			
	Output Load	Function	Amplitude	Frequency	Nominal	Error	Nominal	Error
	50 Ω	Sine	0.190 Vrms	100.000 kHz	100%	$\pm 1.15\%$	0 dB	± 0.10 dB
				500.000 kHz		$\pm 1.74\%$		± 0.15 dB
				1.000 MHz		$\pm 1.74\%$		± 0.15 dB
Q	50 Ω	Sine	0.190 Vrms	2.000 MHz	100%	$\pm 1.74\%$	0 dB	± 0.15 dB

Use	Waveform Generator				Measurement			
	50 Ω	Sine	0.190 Vrms	5.000 MHz	100%	$\pm 1.74\%$	0 dB	± 0.15 dB
				10.00 MHz		$\pm 3.51\%$		± 0.30 dB
				15.00 MHz		$\pm 3.51\%$		± 0.30 dB
				20.00 MHz		$\pm 3.51\%$		± 0.30 dB
				22.00 MHz (unnecessary for 20 MHz instruments)		$\pm 4.71\%$		± 0.40 dB
				27.00 MHz (unnecessary for 20 MHz instruments)		$\pm 4.71\%$		± 0.40 dB
				30.00 MHz (unnecessary for 20 MHz instruments)		$\pm 4.71\%$		± 0.40 dB

6. Compare the measured value to the test limits shown in the table.
7. Two-channel instruments only: Connect the AC voltmeter to channel 2 and repeat steps 2 through 6.

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General Calibration/Adjustment Procedure - 33500 Series

Recommended method for a complete instrument calibration:

1. Read **Test Considerations**.
2. **Perform the verification tests** to characterize the instrument (incoming data).
3. Press [**System** > **Instr Setup** > **Calibrate**]. If the instrument is secured from calibration, **unsecure it**.
4. Enter the Setup Number for the procedure being performed. The default setup number is "1" and, from the front panel, the number will increment as the procedures are performed.
5. Select **BEGIN**.
6. For setups that require an input, adjust the value shown in the display to the measured value and select **ENTER VALUE**.
7. The setup automatically advances to the next required value.

To cancel the adjustment procedure, select **CANCEL STEP**. The display will return to the setup number entry.

8. When finished, select **END CAL**.
9. (Optional) Set a new calibration message using the remote interface. The message (up to 40 characters) is stored with the calibration coefficients.
10. Secure the instrument against calibration.
11. Note the new security code and calibration count in the instrument's maintenance records.

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Aborting a Calibration in Progress - 33500 Series

Sometimes it may be necessary to abort a calibration in progress. You can abort a calibration at any time by turning off the power or by issuing a remote interface device clear message followed by ***RST**.

The instrument stores calibration constants at the end of each adjustment procedure. If you lose power, or otherwise abort an adjustment in progress, you will only need to perform the interrupted adjustment procedure again.

CAUTION

If power is lost when the instrument is attempting to write new calibration constants to memory, you may lose all calibration constants for the function. Typically, upon re-applying power, the instrument will report error **"-313, Calibration Memory Lost"**.

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Sequence of Adjustments - 33500 Series

The adjustment sequence in the numbered steps minimizes the number of test equipment setups and connection changes.

You may perform individual adjustments as necessary, but setups 1 through 7 must be performed in order, before any other setup procedure.

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Self-Test - 33500 Series

Run self-test to ensure that the instrument is in working order before beginning any additional adjustments.

Be sure to unlock the instrument and follow the requirements listed in [Test Considerations](#) before beginning any adjustments.

1. Press **[System > Instr Setup > Calibrate]**. Enter setup number 1 and select **BEGIN**.

Setup	
1	Performs the self-test. The Main Output is disabled during test.

2. If the instrument fails any self-test, you must repair the instrument before continuing the adjustment procedures.

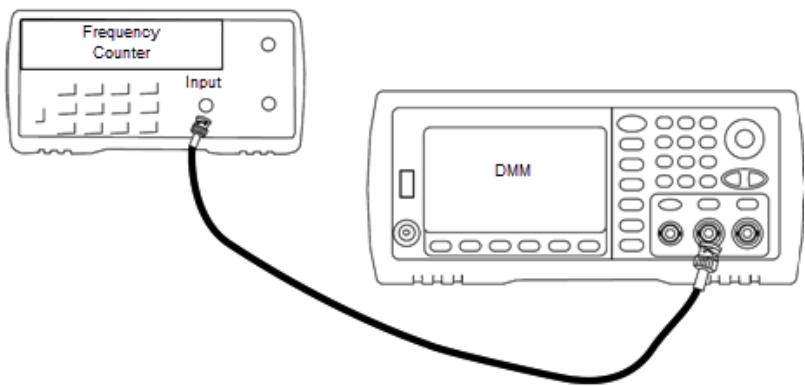
A complete self-test (*TST?) takes approximately 15 seconds.

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Frequency (Internal Timebase) Adjustment - 33500 Series

The instrument stores a calibration constant that sets the crystal oscillator to put out exactly 10 MHz. The instrument should have been running continuously for 30 minutes prior to this calibration adjustment to ensure timebase stability.

1. Set the frequency counter resolution to better than 0.01 ppm and the input termination to 50 Ω (if your frequency counter does not have a 50 Ω input termination, you must provide an external termination). Make the connections shown below.



2. Use the frequency counter to measure the output frequency for each setup in the following table.

Nominal Signal			
Setup	Frequency	Amplitude	
2	<10 MHz	~1 Vpp	Output frequency is slightly less than 10 MHz
3	>10 MHz		Output frequency is slightly more than 10 MHz
4	~10 MHz		Output frequency should be near 10 MHz
5*	10 MHz		Output frequency should be 10 MHz ± 1 ppm

* Constants are stored after completing this setup.

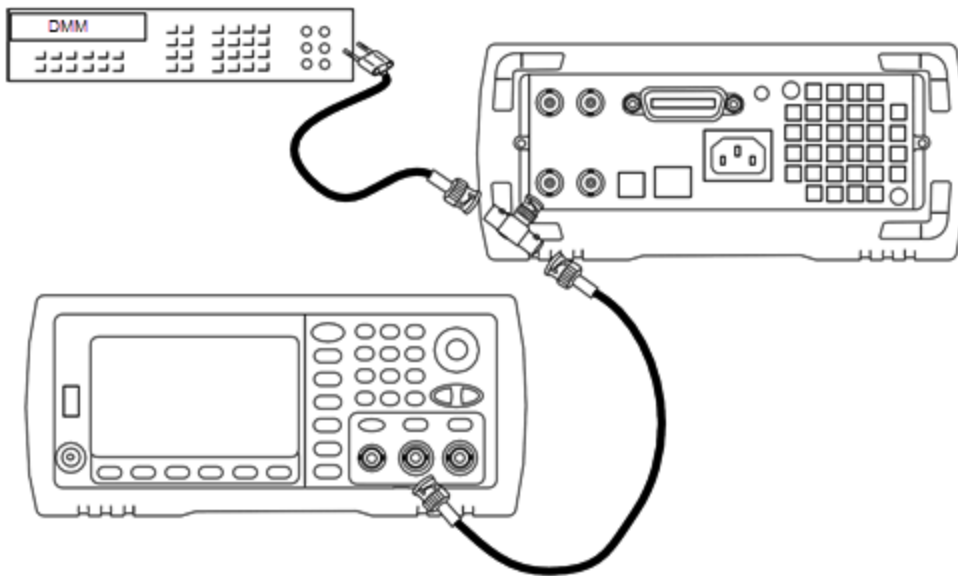
3. Using the numerical keypad or knob, adjust the displayed frequency at each setup to match the measured frequency. Select **ENTER VALUE**.
4. To proceed:
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **Internal Timebase Verification**.
 - b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

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Internal ADC Adjustment - 33500 Series

The instrument stores calibration constants related to the gain and offset of the internal ADC. Setup 6 must always be performed before any other amplitude adjustments are attempted. The internal ADC is then used as a source for the calibration constants generated in self calibration (setup 7).

1. Connect the channel 1 output to the instrument's rear panel Modulation Input and DMM as shown below.



2. Set the DMM to display 5½ digits and set the function to DCV.
3. Enter the following setup.

	Nominal Signal	
Setup	DC level	
6*	~1.0 VDC ±10%	Calibrates the internal ADC.

* Constants are stored after completing this setup.

4. Use the numeric keypad or knob to enter the value measured on the DMM.

NOTE

This setup requires approximately 15 seconds to complete.

5. Disconnect all cables from the instrument.

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Self Calibration Adjustment - 33500 Series

1. Enter and begin the following setup.

Setup	
7*	Self-calibration. The output is disabled.

* Constants are stored after completing this setup.

2. To proceed:
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform [DC Offset Voltage Verification](#).
 - b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

NOTE

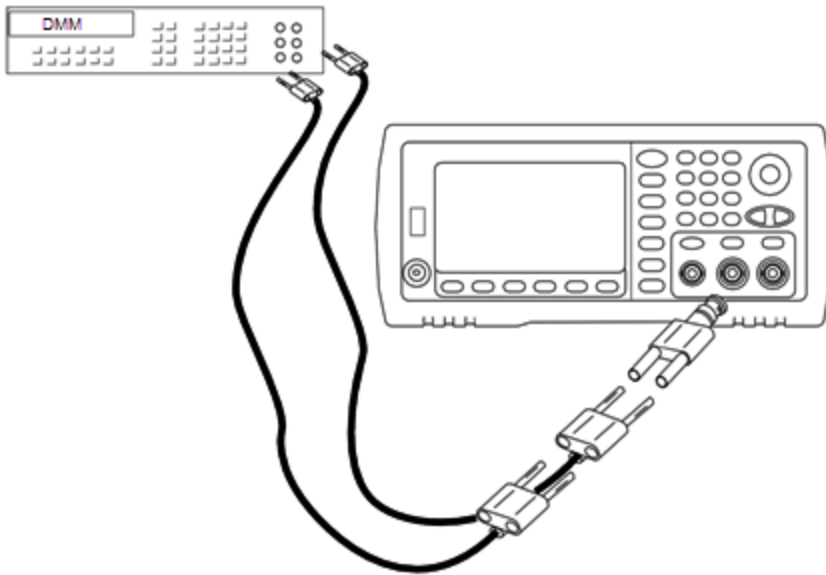
This setup requires approximately 15 seconds to complete.

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Output Impedance Adjustment - 33500 Series

The instrument stores calibration constants for the channels' output impedance. These constants are generated with and without the post-amplifier attenuator.

1. Set the DMM to measure offset-compensated, four-wire Ohms. Set the DMM to use 100 NPLC integration. Connect the Ohms Source and Ohms Sense DMM inputs to the channel output as shown below.



2. Use the DMM to make a 4-wire resistance measurement at the front panel output connector for each setup in the following table. The expected measured value is approximately 50 Ω .

Setup	
8*	-24 dB post-attenuator range
9*	0 dB

* Constants are stored after completing this setup.

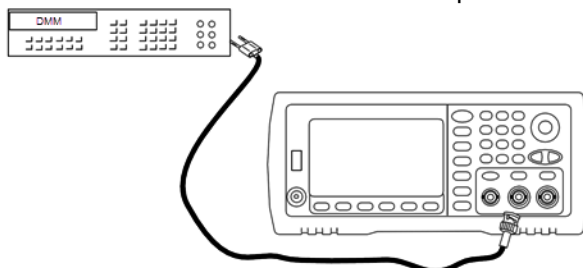
3. Using the numeric keypad or knob, adjust the displayed impedance at each setup to match the measured impedance. Select **ENTER VALUE**.
4. There are no specific operational verification tests for output impedance. Continue with the next adjustment procedure in this section.

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AC Amplitude (high-impedance) Adjustment - 33500 Series

The instrument stores a calibration constant for each high-impedance attenuator path. Each path's gain coefficient is calculated using two measurements: one with the waveform DAC at + output and one with waveform DAC at – output. The setups, therefore, must be performed in pairs.

1. Connect the DMM to the channel output as shown below.



2. Use the DMM to measure the DC voltage at the front panel connector for each setup in the following table.

Setup	Nominal Signal	
	DC Level	
10	+0.0028 V	Output of -72 dB range
11*	-0.0028 V	Output of -72 dB range
12	+0.007 V	Output of -64 dB range
13*	-0.007 V	Output of -64 dB range
14	+0.017 V	Output of -56 dB range
15*	-0.017 V	Output of -56 dB range
16	+0.044 V	Output of -48 dB range
17*	-0.044 V	Output of -48 dB range
18	+0.11 V	Output of -40 dB range
19*	-0.11 V	Output of -40 dB range
20	+0.28 V	Output of -32 dB range
21*	-0.28 V	Output of -32 dB range
22	+0.68 V	Output of -24 dB range
23*	-0.68 V	Output of -24 dB range
24	+1.7 V	Output of -16 dB range
25*	-1.7 V	Output of -16 dB range
26	+4.3 V	Output of -8 dB range
27*	-4.3 V	Output of -8 dB range
28	+10.8 V	Output of 0 dB range
29*	-10.8 V	Output of 0 dB range
30	+0.044V	Output of -48 dB High DC range
31*	-0.044V	Output of -48 dB High DC range
32	+0.11 V	Output of -40 dB High DC range
33*	-0.11 V	Output of -40 dB High DC range
34	+0.28 V	Output of -32 dB High DC range

Setup	Nominal Signal	
	DC Level	
35*	-0.28 V	Output of -32 dB High DC range
36	+0.68 V	Output of -24 dB High DC range
37*	-0.68 V	Output of -24 dB High DC range

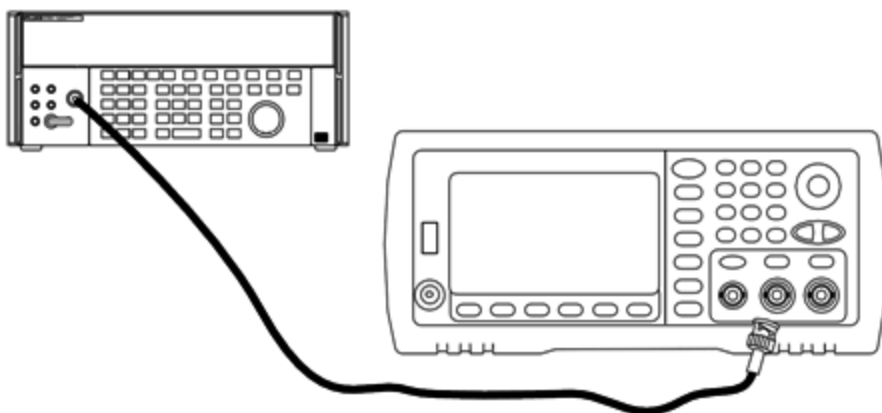
* Constants are stored after completing this setup.

3. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
4. To proceed:
 - a. If your calibration procedures require you to verify this adjustment, exit the calibration menu and perform **AC Amplitude (high-impedance) Verification**.
 - b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

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-24 dB Range Flatness Adjustment - 33500 Series

1. Connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



2. Use the precision AC voltmeter to measure the output amplitude for each setup in the table below.

Setup	Nominal Signal		
	Frequency	Amplitude	
38*	1 kHz	0.192 Vrms	Flatness for -24 dB range
39*	100 kHz		
40*	1 MHz		
41*	5 MHz		
42*	10 MHz		
43*	20 MHz		
44*	25 MHz		
45*	30 MHz		

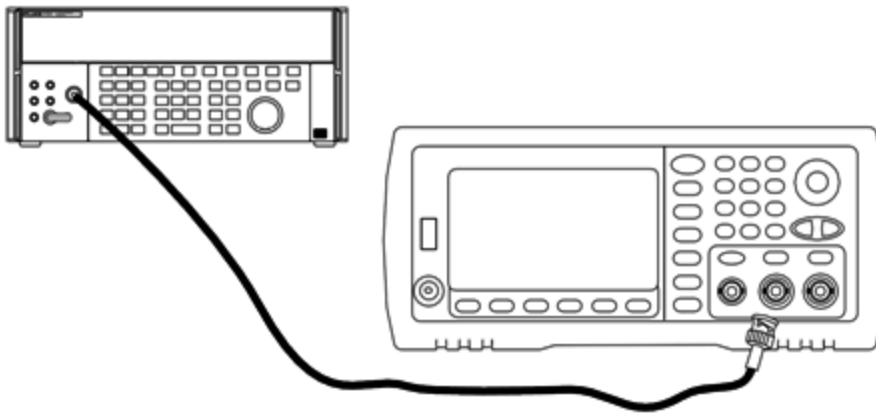
* Constants are stored after completing this setup.

3. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
4. To proceed:
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **-24 dB Range Flatness Verification**.
 - b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

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-8 dB Range Flatness Adjustment - 33500 Series

1. Connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



2. Use the precision AC voltmeter to measure the output amplitude for each setup in the table below.

Setup	Nominal Signal		
	Frequency	Amplitude	
46*	1 kHz	1.22 Vrms	Flatness for -8 dB range
47*	100 kHz		
48*	1 MHz		
49*	5 MHz		
50*	10 MHz		
51*	20 MHz		
52*	25 MHz		
53*	30 MHz		

* Constants are stored after completing this setup.

3. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.

4. To proceed:

- If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **-8 dB Range Flatness Verification**.
- If you are making all the adjustments and then verifying the instrument's performance, verify the output specifications of the instrument with the **Performance Verification Tests**.

This completes the adjustment procedures for the one-channel instrument. Verification of the output specifications is recommended.

If you are making adjustments to a two-channel instrument, continue with the next procedure in this section.

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Channel 2 Adjustments - 33500 Series

The following topics describe calibration adjustments on channel 2.

- [Self Calibration Adjustment \(Channel 2\)](#)
- [Output Impedance Adjustment \(Channel 2\)](#)
- [AC Amplitude \(high-impedance\) Adjustment \(Channel 2\)](#)
- [-24 dB Range Flatness Adjustment \(Channel 2\)](#)
- [-8 dB Range Flatness Adjustment \(Channel 2\)](#)

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Self Calibration Adjustment (Channel 2) - 33500 Series

1. Enter and begin the following setup.

Setup	
54*	Self-calibration. The output is disabled.

* Constants are stored after completing this setup.

2. To proceed:
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform [DC Offset Voltage Verification](#). Be sure to do this for channel 2.
 - b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

NOTE

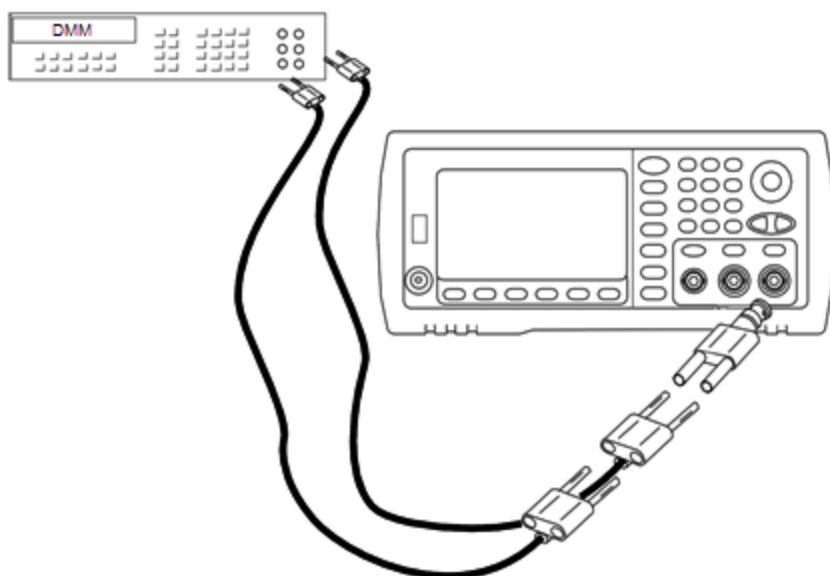
This setup requires approximately 15 seconds to complete.

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Output Impedance Adjustment (Channel 2) - 33500 Series

The instrument stores calibration constants for the channels' output impedance. These constants are generated with and without the post-amplifier attenuator.

1. Set the DMM to measure offset-compensated, four-wire Ohms. Set the DMM to use 100 NPLC integration. Connect the Ohms Source and Ohms Sense DMM inputs to the channel output as shown below.



2. Use the DMM to make a 4-wire resistance measurement at the front panel output connector for each setup in the following table. The expected measured value is approximately 50 Ω .

Setup	
55*	-24 dB post-attenuator range
56*	0 dB

* Constants are stored after completing this setup.

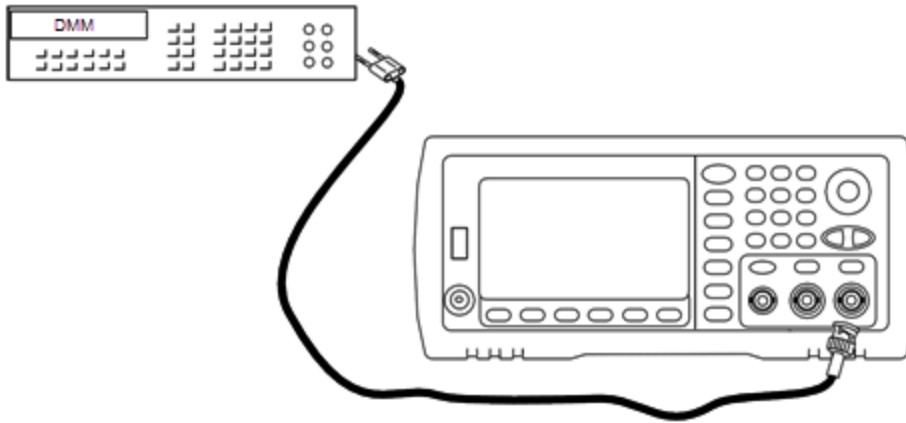
3. Using the numeric keypad or knob, adjust the displayed impedance at each setup to match the measured impedance. Select **ENTER VALUE**.
4. There are no specific operational verification tests for output impedance. Continue with the next adjustment procedure in this section.

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AC Amplitude (high-impedance) Adjustment (Channel 2) - 33500 Series

The instrument stores a calibration constant for each high-impedance attenuator path. Each path's gain coefficient is calculated using two measurements: one with the waveform DAC at + output and one with waveform DAC at – output. The setups, therefore, must be performed in pairs.

1. Connect the DMM to the channel output as shown below.



2. Use the DMM to measure the DC voltage at the front panel connector for each setup in the following table.

	Nominal Signal	
Setup	DC Level	
57	+0.0028 V	Output of -72 dB range
58*	-0.0028 V	Output of -72 dB range
59	+0.007 V	Output of -64 dB range
60*	-0.007 V	Output of -64 dB range
61	+0.017 V	Output of -56 dB range
62*	-0.017 V	Output of -56 dB range
63	+0.044 V	Output of -48 dB range
64*	-0.044 V	Output of -48 dB range
65	+0.11 V	Output of -40 dB range
66*	-0.11 V	Output of -40 dB range
67	+0.28 V	Output of -32 dB range
68*	-0.28 V	Output of -32 dB range
69	+0.68 V	Output of -24 dB range
70*	-0.68 V	Output of -24 dB range
71	+1.7 V	Output of -16 dB range
72*	-1.7 V	Output of -16 dB range
73	+4.3 V	Output of -8 dB range
74*	-4.3 V	Output of -8 dB range
75	+10.8 V	Output of 0 dB range
76*	-10.8 V	Output of 0 dB range
77	+0.044 V	Output of -48 dB High DC range
78*	-0.044 V	Output of -48 dB High DC range
79	+0.11 V	Output of -40 dB High DC range
80*	-0.11 V	Output of -40 dB High DC range
81	+0.28 V	Output of -32 dB High DC range

	Nominal Signal	
Setup	DC Level	
82*	-0.28 V	Output of -32 dB High DC range
83	+0.68 V	Output of -24 dB High DC range
84*	-0.68 V	Output of -24 dB High DC range

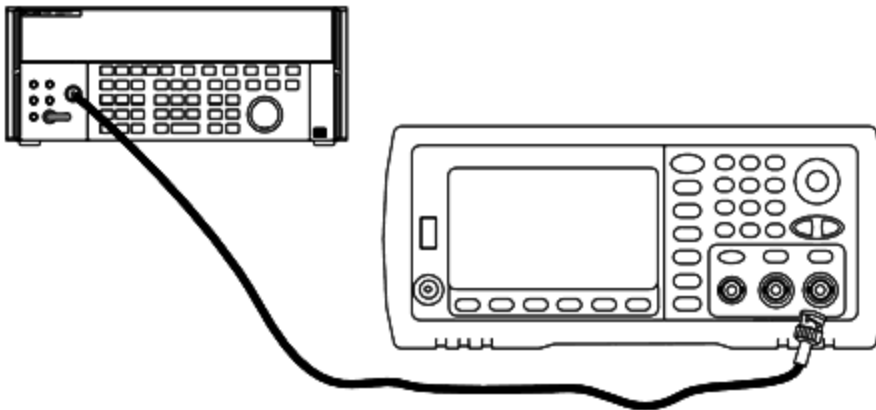
* Constants are stored after completing this setup.

3. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
4. To proceed:
 - a. If your calibration procedures require you to verify this adjustment, exit the calibration menu and perform **AC Amplitude (high-impedance) Verification**.
 - b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

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-24 dB Range Flatness Adjustment (Channel 2) - 33500 Series

1. Connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



2. Use the precision AC voltmeter to measure the output amplitude for each setup in the table below.

Setup	Nominal Signal		
	Frequency	Amplitude	
85*	1 kHz	0.192 Vrms	Flatness for -24 dB range
86*	100 kHz		
87*	1 MHz		
88*	5 MHz		
89*	10 MHz		
90*	20 MHz		
91*	25 MHz		
92*	30 MHz		

* Constants are stored after completing this setup.

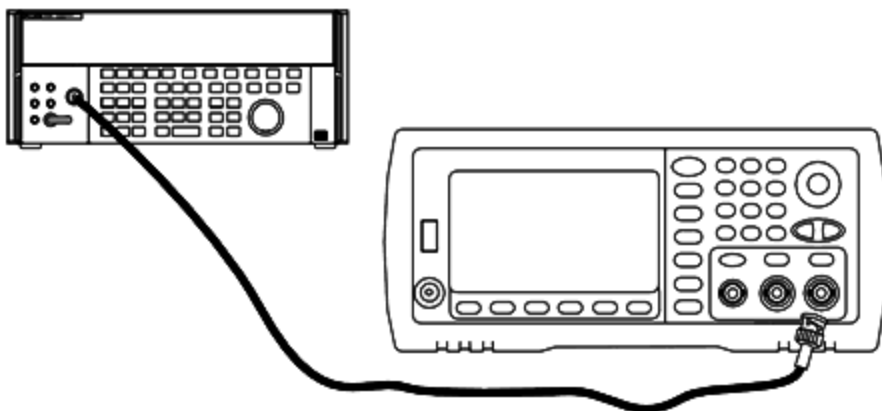
3. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
4. To proceed:
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **-24 dB Range Flatness Verification**. Be sure that you do this for Channel 2.
 - b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

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-8 dB Range Flatness Adjustment (Channel 2) - 33500 Series

This section applies to channel 2. It checks high frequency AC amplitude flatness on the -8 dB attenuator range. It also checks flatness for all other ranges excluding the -24 dB and 0 dB attenuator ranges.

1. Connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



2. Use the precision AC voltmeter to measure the output amplitude for each setup in the table below.

Setup	Nominal Signal		
	Frequency	Amplitude	
93*	1 kHz	1.22 Vrms	Flatness for -8 dB range
94*	100 kHz		
95*	1 MHz		
96*	5 MHz		
97*	10 MHz		
98*	20 MHz		
99*	25 MHz		
100	30 MHz		

* Constants are stored after completing this setup.

3. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
4. You have now completed the recommended adjustment procedures. Verification of the output specifications is recommended.
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **-8 dB Range Flatness Verification**.

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Calibration Errors - 33500 Series

The following errors may occur during calibration. There are also **system errors** and **self-test errors**. Some error messages include a failing channel number (1 or 2), shown as n in the messages below.

701 Calibration error; security defeated by hardware jumper

If you short the calibration secure jumper (CAL ENABLE) while turning the instrument on, this error indicates the security password has been overwritten. See [Calibration Security](#) for details.

702 Calibration error; calibration memory is secured

To perform calibration, unsecure the instrument. See [Calibration Security](#) for details.

703 Calibration error; secure code provided was invalid

Specified security code was invalid.

706 Calibration error; value out of range

Value entered was outside valid range.

707 Calibration error; signal input is out of range

Occurs during the ADC Adjustment, setup 6, if the 1 V input voltage is too high. May also occur during self-calibration (setup 7). Run self-test to diagnose problem.

710 Self-calibration failed; Chan n, null DAC cal, invalid self cal

Self-calibration failed; Chan n, offset DAC cal with attenuator, invalid self cal

Self-calibration failed; Chan n, offset DAC cal no attenuator, invalid self cal

Error occurred while performing internal calibration of specified DAC. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.

711 Self-calibration failed; Chan n, null DAC cal gain too low (too high), <meas_value>

Self-calibration failed; Chan n, offset DAC cal with attenuator gain too low (too high), <meas_value>

Self-calibration failed; Chan n, offset DAC cal no attenuator gain too low (too high), <meas_value>

Computed gain calibration factor for specified DAC was out of limits. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.

712 Self-calibration failed; Chan n, null DAC cal zero too low (too high), <meas_value>

Self-calibration failed; Chan n, offset DAC cal with attenuator zero too low (too high), <meas_value>

Self-calibration failed; Chan n, offset DAC cal no attenuator zero too low (too high), <meas_value>

Self-calibration failed; Chan n, GND measurement out of limits, <meas_value>

Computed zero calibration factor for specified DAC was out of limits. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.

715 Self-calibration failed; Chan n, null DAC cal, convergence error sub attenuator value dB

Internal null DAC calibration failed to converge during internal calibration. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.

720 Self-calibration failed; Chan n, offset DAC cal with attenuator, convergence error

Self-calibration failed; Chan n, offset DAC cal no attenuator, convergence error

Internal offset DAC calibration failed to converge internal calibration. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.

850 Calibration error; set up is invalid

Invalid calibration setup number selected.

850 Calibration error; set up is out of order

Certain calibration steps require a specific beginning and ending. Do not enter into the middle of a calibration sequence.

[Previous Calibration Topic](#)

Introduction to Calibration – 33600 Series

This chapter contains procedures for verifying the instrument's performance and adjustment (calibration).

The instrument uses closed-case electronic calibration; no internal mechanical adjustments are required. The instrument calculates correction factors based on input reference values that you set and stores correction factors in non-volatile memory until the next calibration adjustment is performed. This data is not changed by cycling power or *RST.

Keysight Technologies Calibration Services

Your local Keysight Technologies Service Center offers low-cost recalibration. The service center uses automated calibration systems that allow Keysight to provide calibration at competitive prices.

Calibration Table of Contents

The section includes the following sections:

Calibration Overview

- Calibration Interval
- Adjustment is Recommended
- Time Required for Calibration
- Automating Calibration Procedures
- Recommended Test Equipment
- Test Considerations
- Calibration Count
- Calibration Message

Calibration Security

Verification

Performance Verification Tests

- Self-Test
- Quick Performance Check
- Performance Verification Tests
- Amplitude and Flatness Verification Procedures

Internal Timebase Verification

AC Amplitude (high-impedance) Verification

DC Offset Voltage Verification

1 Vpp Range Flatness Verification

4 Vpp Range Flatness Verification

8 Vpp Range Flatness Verification

General Calibration/Adjustment Procedure

Aborting a Calibration in Progress

Sequence of Adjustments

Self-Test

Frequency (Internal Timebase) Adjustment

Internal ADC Adjustment

Self Calibration Adjustment

Output Impedance Adjustment

AC Amplitude (high-impedance) Adjustment

1 Vpp Flatness Adjustment

4 Vpp Flatness Adjustment

8 Vpp Flatness Adjustment

Adjust Channel 2 (if necessary)

- Self Calibration Adjustment (Channel 2)
- Output Impedance Adjustment (Channel 2)
- AC Amplitude (high-impedance) Adjustment (Channel 2)
- 1 Vpp Flatness Adjustment (Channel 2)
- 4 Vpp Flatness Adjustment (Channel 2)
- 8 Vpp Flatness Adjustment

Calibration Errors

Next Calibration Topic

Calibration Overview - 33600 Series

This section introduces the instrument's calibration features. For more detailed calibration information, see [Introduction to Calibration](#).

Calibration Interval

The instrument should be calibrated on a regular interval determined by the accuracy requirements of your application. A one-year interval is adequate for most applications. Accuracy specifications are warranted only if adjustment is made at regular calibration intervals. Accuracy specifications are not warranted beyond the one-year calibration interval. Keysight Technologies does not recommend calibration intervals beyond two years for any application.

Adjustment is Recommended

Whatever calibration interval you select, Keysight Technologies recommends that complete re-adjustment should always be performed at the calibration interval. This ensures that the instrument will remain within specifications for the next calibration interval and provides the best long-term stability. Performance data measured using this method can be used to extend future calibration intervals. Use the Calibration Count to verify that all adjustments have been performed.

Time Required for Calibration

For incoming instrument verification, do performance verification tests first. Then perform adjustments and re-run the performance verification tests. Each of these steps, if done manually, takes approximately 30 minutes per channel to perform.

The instrument can also be automatically calibrated under computer control. With computer control you can perform the complete calibration procedure and performance verification tests in approximately 30 minutes (one channel) or 60 minutes (two channels) once the instrument is warmed-up (see [Test Considerations](#)).

Automating Calibration Procedures

You can use programmable test equipment to automate the complete verification and adjustment procedures. You can program each test's instrument configuration over the remote interface. Then enter read-back verification data into a test program and compare the results to the appropriate test limit.

You can also adjust the instrument from the remote interface, which is similar to the front panel procedure. Use a computer to perform the adjustment by first selecting the required function and range on the measurement equipment. Send the calibration value to the instrument and then initiate calibration over the remote interface.

You must [unsecure the instrument](#) before calibration.

A typical programming sequence for a single calibration setup is as follows:

1. [CAL:SETup 2](#) (configures instrument for calibration step 2)
2. Measure the output frequency with the external frequency counter
3. [CAL:VALue 9.99994321E6](#) (send the measured value to the instrument)
4. [CAL?](#) (initiates the calibration adjustment for setup 2)
5. Read [CAL?](#) query value to determine the failure (+1) or success (+0) of adjustment
6. [CAL:SETup 3](#) (configures instrument for calibration step 3)

For further information on instrument programming, see [Introduction to SCPI Language](#).

Recommended Test Equipment

The test equipment recommended for the performance verification and adjustment procedures is listed below. If the exact instrument is not available, substitute calibration standards of equivalent accuracy.

Instrument	Requirements	Recommended Model	Use *
Digital Multimeter (DMM)	ACV, true rms, AC coupled accuracy: $\pm 0.02\%$ to 1 MHz DCV accuracy: 50 ppm resolution: 100 μV Resistance Offset-compensated accuracy: $\pm 0.1 \Omega$	Keysight 3458A	Q, P, T
Precision AC Voltmeter	1000 Hz to 30 MHz, 0.1 Vrms to 2 Vrms (-7 dBm to $+20 \text{ dBm}$) accuracy: 0.02 dB resolution: 0.01 dB	Fluke 5790A	Q, P, T
Frequency Counter	Accuracy: 0.1 ppm	Keysight 53230A Opt 010 (OCXO)	Q, P, T
Power Sensor	Specific model	Keysight N8482A	Q, P, T
Power Meter	Specific model (pick one of four)	Keysight N1911A, N1912A, N1913A, or N1914A	Q, P, T
Oscilloscope	1 GHz 4 Gs/second 50 Ω input termination	Keysight MSO6104A	T
Adapter	N type (m) to BNC (m)	Keysight E9623A	Q, P, T
Cable (2 required)	Dual banana (m) to dual banana (m)	Keysight 11000-60000	Q, P, T
Cable	RG58, BNC (m) to dual banana OR RG58 coaxial cable with BNC (m) to dual banana adapter		Q, P, T
Cable	RG58, BNC (m) to BNC (m)	Keysight 11170C	Q, P, T
Low-loss cable	Used for connecting to Type N attenuator, Fluke 5790A, and N8482A. Flatness verified by Precision Network Analyzer (PNA)	(Any as long as verified by PNA)	Q, P, T
10 to 20 dB Attenuator	Flatness verified by Precision Network Analyzer (PNA)	(Any as long as verified by PNA)	Q, P, T

* Q = Quick Verification P = Performance Verification T = Troubleshooting

Test Considerations

For optimal performance, all procedures should comply with the following recommendations:

- Calibration ambient temperature is stable, between 18 and 28 °C. Ideally, it should be 23 ± 1 °C.
- Ambient relative humidity is less than 80%.
- One-hour warm-up period before verification or adjustment.
- Measurement cables as short as possible, consistent with the impedance requirements.
- RG-58 or equivalent 50 Ω cable.

Calibration Count

You can query the instrument to determine how many calibrations have been performed. The instrument was calibrated at the factory. When you receive your instrument, be sure to read the count to determine its initial value.

- This setting is non-volatile; it will not be changed by power cycling or ***RST**.
- Because the value increments for each calibration point that stores a value, a complete calibration increases the value by many counts.



- **Front Panel:**
- **SCPI: `CAL:COUNT?`**

Calibration Message

You can store one message of up to 40 characters in calibration memory. For example, you can store the date when the last calibration was performed, the date when the next calibration is due, the instrument's serial number, or contact information for your calibration experts.

Unsecure the instrument to record a calibration message. You can read the message from either the front panel or over the remote interface, regardless of whether the instrument is secured.

- Storing a calibration message overwrites any message previously stored.
- This setting is non-volatile; it will not be changed by power cycling or ***RST**.



- **Front Panel:**
- **SCPI: `CAL:STR "Cal Due: 01 August 2012"`**

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Calibration Security - 33600 Series

This section describes the instrument's calibration security system.

Security Overview

A security code prevents accidental or unauthorized instrument adjustments. The factory default security code for 33600 Series instruments is **AT33600**.

- Once you enter a security code, that code must be used for both front panel and remote operation. If you secure the instrument from the front panel, you must use that same code to unsecure it from the remote interface.
- This setting is non-volatile; it will not be changed by power cycling or ***RST**.
- Security code rules:
 - Unquoted string up to 12 characters
 - Must start with letter (A-Z)
 - May contain letters, numbers (0-9) and underscores
- Front Panel:**



- SCPI:** **CALibration_SECURITY:STATe**

Unsecure Instrument Without Security Code

CAUTION See **Electrostatic Discharge (ESD) Precautions** before beginning this procedure.

1. Disconnect power cord and all input and output connections.
2. Disassemble the instrument (see **Disassembly - 33600 Series**).
3. On the 33600 Series, apply a temporary short across pins A1 and B1 on the front panel PCBA, as shown below.



4. Attach power and turn on the instrument.

WARNING Be careful not to touch the power line connections or high voltages on the power supply module. Power is present even if the instrument is turned off.

5. The error queue will show the message "Calibration security has been disabled."

Calibration security is unlocked, with password reset to its factory default value. Calibration count is incremented because jumper was connected during power-up, and error message **+701,"Calibration error; security defeated by hardware jumper"** is issued. Nonvolatile calibration storage is updated to reflect these operations.

6. Turn off the instrument, remove temporary short, and remove power cord.
7. Reassemble the instrument.
8. Enter a new security code as described above, and record the security code in a safe location.

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Verification - 33600 Series

The following topics describe the verification portion of the calibration procedure:

- [Performance Verification Tests](#)
- [Internal Timebase Verification](#)
- [AC Amplitude \(high-impedance\) Verification](#)
- [DC Offset Voltage Verification](#)
- [1 Vpp Range Flatness Verification](#)
- [4 Vpp Range Flatness Verification](#)
- [8 Vpp Range Flatness Verification](#)

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Performance Verification Tests - 33600 Series

Use the Performance Verification Tests to verify the measurement performance of the instrument. The performance verification tests use the instrument's specifications listed on the product datasheet.

You can perform three levels of performance verification tests:

- **Self-Test** A series of internal verification tests that give high confidence that the instrument is operational.
- **Quick Verification** A combination of the internal self-tests and selected verification tests.
- **Performance Verification Tests** An extensive set of tests that are recommended as an acceptance test when you first receive the instrument or after performing adjustments.

Self-Test

A brief power-on self-test occurs automatically whenever you turn on the instrument. This limited test assures that the instrument is operational. For details, see [Self-Test Procedures](#).

Quick Performance Check

The quick performance check is a combination of internal self-test and an abbreviated performance test (specified by the letter Q in the performance verification tests). This test provides a simple method to achieve high confidence in the instrument's ability to functionally operate and meet specifications. These tests represent the absolute minimum set of performance checks recommended following any service activity. Auditing the instrument's performance for the quick check points (designated by a Q) verifies performance for normal accuracy drift mechanisms. This test does not check for abnormal component failures.

To perform the quick performance check, do the following:

1. Perform a [complete self-test](#).
2. Perform only the performance verification tests indicated with the letter Q.
3. If the instrument fails the quick performance check, adjustment or repair is required.

Performance Verification Tests

The performance verification tests are recommended as acceptance tests when you first receive the instrument. The acceptance test results should be compared against the specifications on the product datasheet. After acceptance, you should repeat the performance verification tests at every calibration interval.

If the instrument fails performance verification, adjustment or repair is required.

Adjustment is recommended at every calibration interval. If adjustment is not made, you must guard band, using no more than 80% of the specifications listed in the datasheet, as the verification limits.

Amplitude and Flatness Verification Procedures

The flatness verification procedures use a precision AC voltmeter and a power meter. You may substitute Thermal Voltage Converters (TVCs) to make measurements using appropriate operating procedures and test equipment.

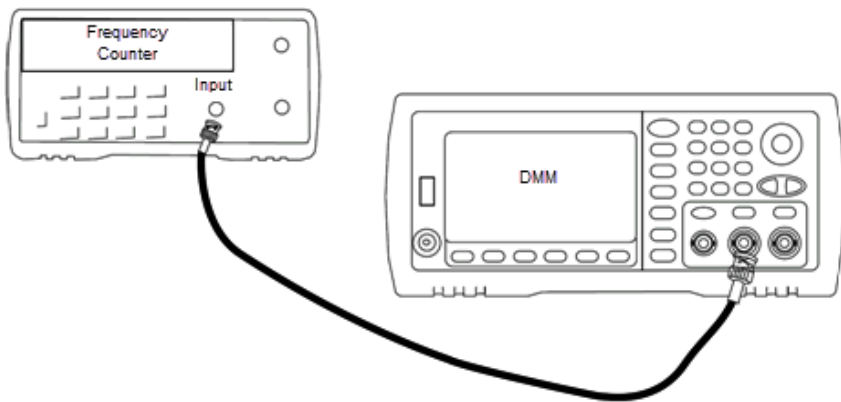
The Fluke 5790A precision AC voltmeter is used to measure the amplitude from 1 kHz to 20 MHz. From 20 to 120 MHz, a power meter with the Keysight N8482A power sensor is used. Measurements of amplitudes from both the 5790A and the N8482A at 1 MHz to 20 MHz are used to scale the N8482A to the 5790A.

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Internal Timebase Verification - 33600 Series

Verifies output frequency accuracy. All output frequencies are derived from a single generated frequency.

1. Connect a frequency counter to the channel 1 output as shown below (the frequency counter input should be terminated at 50 Ω).



2. Set the instrument to the output described in the table below and measure the output frequency. *Be sure the instrument output is enabled.*

Use	Waveform Generator			Measurement	
	Function	Amplitude	Frequency	Nominal	Error*
Q	Sine	1.00 Vpp	10.0000000 MHz	10.000 MHz	± 10 Hz

* With the optional high-stability OCXO timebase, the measurement error is ± 1 Hz.

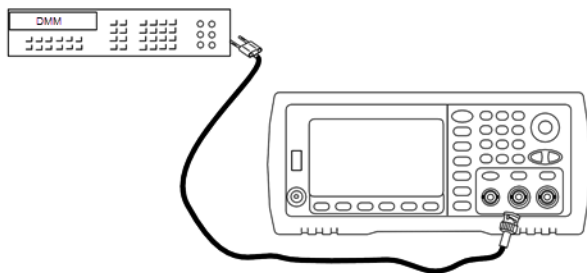
3. Compare the measured value to the test limits shown in the table.

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AC Amplitude (high-impedance) Verification - 33600 Series

Checks AC amplitude output accuracy at 1 kHz frequency using each attenuator.

1. Set the DMM to measure Vrms. Connect the DMM to the channel output as shown below.



2. Set the instrument to each output in the table below and measure the output voltage with the DMM. Be sure the output impedance is set to High-Z and the output is enabled.

Use	Waveform Generator				Measurement	
	Output Setup	Function	Frequency	Amplitude	Nominal	Error*
Q	High Z**	Sine	1.000 kHz	400.0 mVrms	400.0 mVrms	± 0.004707 Vrms
Q	High Z	Sine	1.000 kHz	400.0 mVrms	400.0 mVrms	± 0.004707 Vrms
Q	High Z	Sine	1.000 kHz	1.00 Vrms	1.00 Vrms	± 0.010707 Vrms
Q	High Z	Sine	1.000 kHz	2.500 Vrms	2.500 Vrms	± 0.025707 Vrms
Q	High Z	Sine	1.000 kHz	7.000 Vrms	7.000 Vrms	± 0.070707 Vrms

* Based upon 1% of setting ± 1 mVpp (50 Ω); converted to Vrms for High-Z.

** Use the following sequence to set this output:

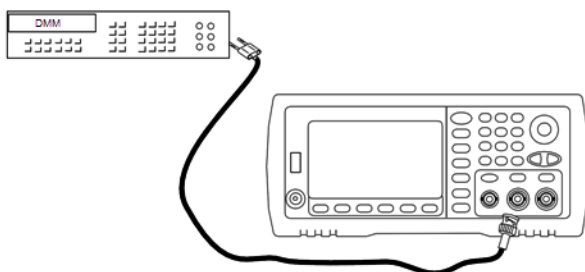
- Set amplitude to 400.0 mVrms
 - Set DC Offset to 1.0 VDC
 - Set Auto-Range to OFF
 - Set DC Offset Voltage to 0.0 VDC
 - After the measurement, set autorange ON for remaining measurements.
- Compare the measured value to the test limits shown in the table.
 - Two-channel instruments only: connect DMM to channel 2 output and repeat steps 2 and 3.

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DC Offset Voltage Verification - 33600 Series

Checks the DC Offset Voltage on two attenuator ranges:

- Set the DMM to measure DCV. Connect the DMM to the channel output as shown below.



- Set the instrument to each output in the table below and measure the output voltage with the DMM.

Use	Waveform Generator			Measurement	
	Output Setup	Function	Voltage	Nominal	Error*
Q	High Z	DC	0.0 V	0.0 VDC	± 0.002 VDC

Use	Waveform Generator			Measurement	
	Output Load	Function	Amplitude	Frequency	Measured Result
Q	High Z	DC	500 mV	0.500 VDC	±0.007 VDC
Q	High Z	DC	10.0 V	10.0 VDC	±0.102 VDC

* Based upon 1% of setting ±2 mVDC for High-Z.

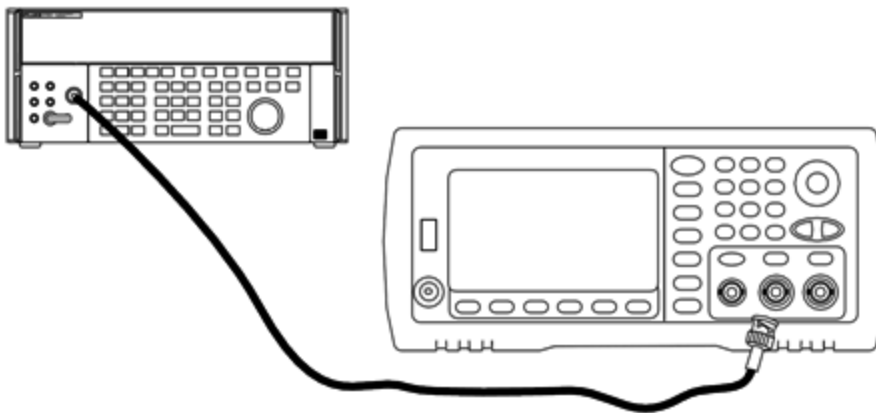
3. Compare the measured value to the test limits shown in the table.
4. Two-channel instruments only: connect DMM to channel 2 output and repeat steps 2 and 3.

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1 Vpp Range Flatness Verification - 33600 Series

Checks high frequency AC amplitude flatness on the 1 Vpp range.

1. Connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A. If you are using substitute test equipment, verify that the input impedance is 50 Ω, because load accuracy directly affects measurement quality.



2. Set the precision AC Voltmeter to "Medium, Medium" Digital Filter and Filter Restart.
3. Set the output impedance to 50 Ω. Be sure the output is enabled. Configure the instrument as described in the table below and measure the output amplitude with the AC voltmeter. This will become the reference measurement. Record this Vrms value in the table below and also record its dBm equivalent by using the formula $\text{dBm} = 10 \times \log_{10}(20 \times V_{\text{rms}}^2)$.

Use	Waveform Generator				Measurement
	Output Load	Function	Amplitude	Frequency	Measured Result
Q	50 Ω	Sine	0.354 Vrms (3.990 dBm)	1.000 kHz	Vrms dBm

4. Set the waveform generator function, amplitude, and frequency as described in the table below. Measure the amplitude and record the results in the table below.

Waveform Generator					Measurement	
Use	Output Load	Function	Amplitude	Frequency	Error Relative to Step 3 Reference (Vrms)	Measured Result (Vrms)
	50 Ω	Sine	0.354 Vrms	100.000 kHz	$\pm 1.15\%$	
				500.000 kHz		
				1.000 MHz*		
				5.000 MHz*		
	50 Ω	Sine	0.354 Vrms	10.00 MHz*	$\pm 2.92\%$	
				20.00 MHz*		

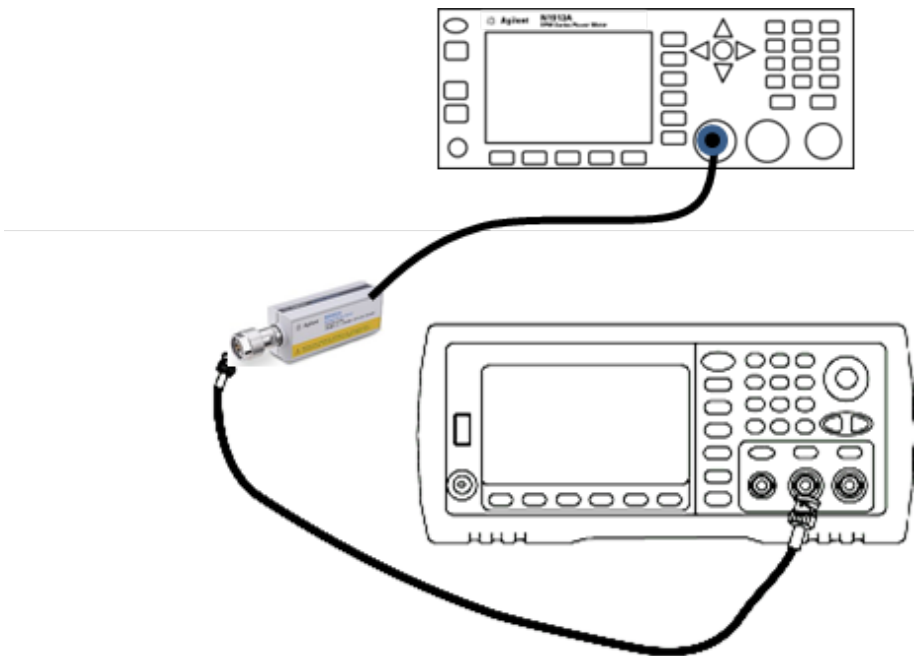
* These values are used in the Correction Factor Table below.

5. In order to scale the power meter to the Fluke 5790A, a correction factor is calculated using the table below. The measurements of amplitudes from both the 5790A and the power meter at 1 MHz to 20 MHz are used. Enter the measured values for 1, 5, 10, and 20 MHz made with the Fluke 5790A into the Correction Factor table below. Then use the following formula to convert the Vrms results to dBm:

$$\text{dBm} = 10 \times \log_{10}(20 \times \text{Vrms}^2)$$

Compute the average (arithmetic mean) of the four dBm results and enter the result into the table at the bottom of the Fluke 5790A dBm column.

6. Connect the N8482A to the channel 1 output of the waveform generator using a Type N connector as shown below. Repeat the 1, 5, 10, and 20 MHz measurements and enter the dBm results into the table below. Compute the average (arithmetic mean) of the four dBm results and enter the result into the table at the bottom of the Power Meter dBm column.



7. Subtract the Power Meter dBm average from the Fluke 5790A dBm average to compute the correction factor. Record the result in the lower right corner of the Correction Factor table. Add this correction factor to all of your Power Meter measurements.

Correction Factor Table

	Fluke 5790A		Power Meter	
Frequency	Vrms (measured)	dBm (see formula)		dBm (measured)
1 MHz				
5 MHz				
10 MHz				
20 MHz				
	Average (mean):		Average (mean):	
Correction Factor (Fluke 5790A Average minus Power Meter average):				

8. Make the following measurements using the power meter. Set the 33600 Series instrument to the function, amplitude, and frequencies shown below. Record the measured dBm (remembering to add the correction factor) for each frequency in the table below.

Use	Waveform Generator				Measurement		
	Output Load	Function	Amplitude	Frequency	Error Relative to Step 3 Reference	Measured Result (dBm)	Corrected Result (dBm)
	50 Ω	Sine	0.354 Vrms	30.00 MHz	± 0.25 dB		
				40.00 MHz			
				50.00 MHz			
				60.00 MHz			
	50 Ω	Sine	0.354 Vrms	70.00 MHz	± 0.40 dB		
				80.00 MHz			
	50 Ω	Sine	0.354 Vrms	90.00 MHz	± 0.50 dB		
				100.00 MHz			
				110.00 MHz			
				120.00 MHz			

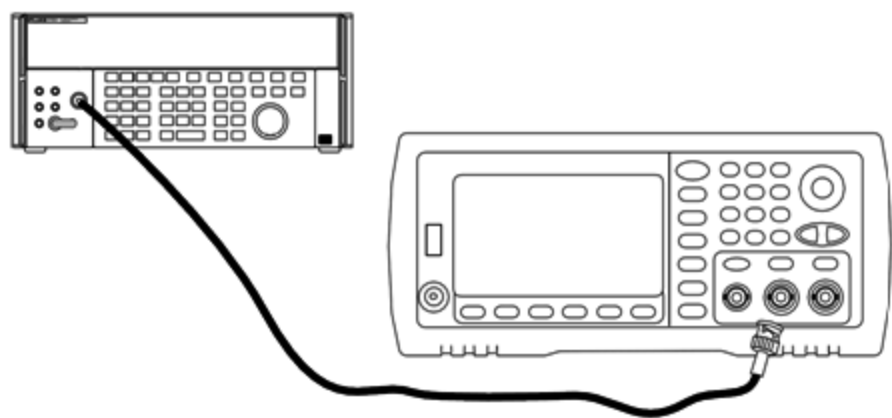
9. Compare the measured values to the test limits shown in both tables.
10. Two-channel instruments only: Connect the AC voltmeter to channel 2 and repeat steps 2 through 6.

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4 Vpp Range Flatness Verification - 33600 Series

Checks high frequency AC amplitude flatness on the 4 Vpp range.

1. Connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A. If you are using substitute test equipment, verify that the input impedance is 50 Ω , because load accuracy directly affects measurement quality.



- 2. Set the precision AC Voltmeter to "Medium, Medium" Digital Filter and Filter Restart.
- 3. Set the output impedance to 50 Ω. Be sure the output is enabled. Configure the instrument as described in the table below and measure the output amplitude with the AC voltmeter. This will become the reference measurement. Record this Vrms value in the table below and also record its dBm equivalent by using the formula $\text{dBm} = 10 \times \log_{10}(20 \times V_{\text{rms}}^2)$.

Use	Waveform Generator				Measurement
	Output Load	Function	Amplitude	Frequency	Measured Result
Q	50 Ω	Sine	1.414 Vrms (16.019 dBm)	1.000 kHz	Vrms dBm

4. Set the waveform generator function, amplitude, and frequency as described in the table below. Measure the amplitude and record the results in the table below.

Use	Waveform Generator				Measurement	
	Output Load	Function	Amplitude	Frequency	Error Relative to Step 3 Reference (Vrms)	Measured Result (Vrms)
	50 Ω	Sine	1.414 Vrms	100.000 kHz	$\pm 1.15\%$	
				500.000 kHz		
				1.000 MHz*		
				5.000 MHz*		
	50 Ω	Sine	1.414 Vrms	10.00 MHz*	$\pm 2.92\%$	
				20.00 MHz*		

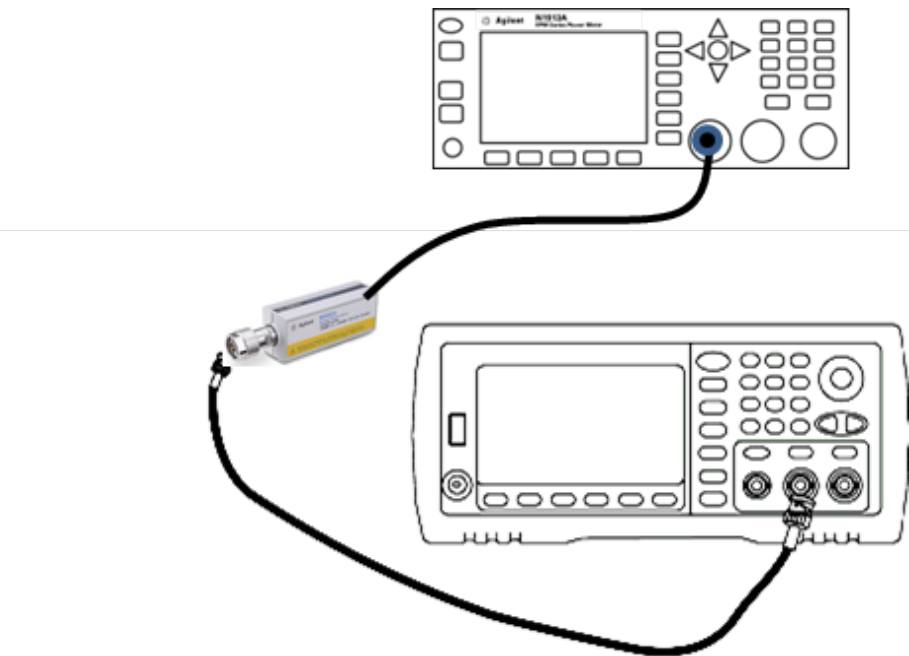
* These values are used in the Correction Factor Table below.

5. In order to scale the power meter to the Fluke 5790A, a correction factor is calculated using the table below. The measurements of amplitudes from both the 5790A and the power meter at 1 MHz to 20 MHz are used. Enter the measured values for 1, 5, 10, and 20 MHz made with the Fluke 5790A into the Correction Factor table below. Then use the following formula to convert the Vrms results to dBm:

$$\text{dBm} = 10 \times \log_{10}(20 \times \text{Vrms}^2)$$

Compute the average (arithmetic mean) of the four dBm results and enter the result into the table at the bottom of the Fluke 5790A dBm column.

6. Connect the N8482A to the channel 1 output of the waveform generator using a Type N connector as shown below. Repeat the 1, 5, 10, and 20 MHz measurements and enter the dBm results into the table below. Compute the average (arithmetic mean) of the four dBm results and enter the result into the table at the bottom of the Power Meter dBm column.



7. Subtract the Power Meter dBm average from the Fluke 5790A dBm average to compute the correction factor. Record the result in the lower right corner of the Correction Factor table. Add this correction factor to all of your Power Meter measurements.

Correction Factor Table

	Fluke 5790A		Power Meter	
Frequency	Vrms (measured)	dBm (see formula)		dBm (measured)
1 MHz				
5 MHz				
10 MHz				
20 MHz				
	Average (mean):		Average (mean):	
Correction Factor (Fluke 5790A Average minus Power Meter average):				

8. Make the following measurements using the power meter. Set the 33600 Series instrument to the function, amplitude, and frequencies shown below. Record the measured dBm (remembering to add the correction factor) for each frequency in the table below.

Use	Waveform Generator				Measurement		
	Output Load	Function	Amplitude	Frequency	Error Relative to Step 3 Reference	Measured Result (dBm)	Corrected Result (dBm)
	50 Ω	Sine	1.414 Vrms	30.00 MHz	± 0.25 dB		
				40.00 MHz			
				50.00 MHz			
				60.00 MHz			
	50 Ω	Sine	1.414 Vrms	70.00 MHz	± 0.40 dB		
				80.00 MHz			
	50 Ω	Sine	1.414 Vrms	90.00 MHz	± 0.50 dB		
				100.00 MHz			
				110.00 MHz			
				120.00 MHz			

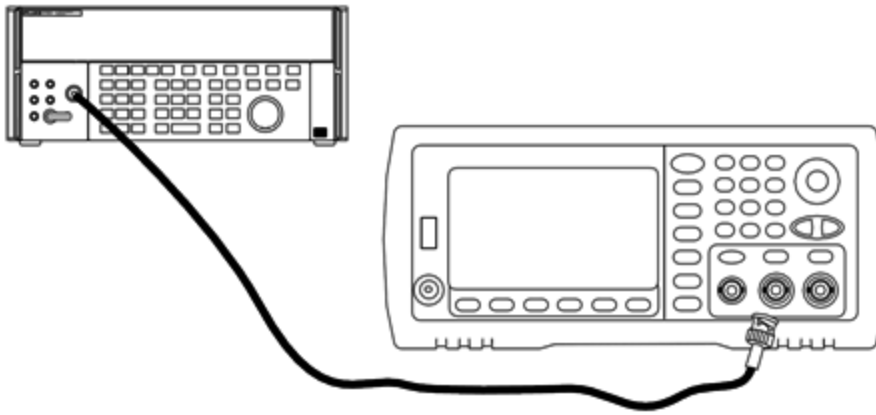
9. Compare the measured values to the test limits shown in both tables.
10. Two-channel instruments only: Connect the AC voltmeter to channel 2 and repeat steps 2 through 6.

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8 Vpp Range Flatness Verification - 33600 Series

Checks high frequency AC amplitude flatness on the 8 Vpp range.

1. Connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A. If you are using substitute test equipment, verify that the input impedance is 50 Ω , because load accuracy directly affects measurement quality.



2. Set the precision AC Voltmeter to "Medium, Medium" Digital Filter and Filter Restart.
3. Set the output impedance to 50 Ω . Be sure the output is enabled. Configure the instrument as described in the table below and measure the output amplitude with the AC voltmeter. This will become the reference measurement. Record this Vrms value in the table below and also record its dBm equivalent by using the formula $\text{dBm} = 10 \times \log_{10}(20 \times \text{Vrms}^2)$.

Use	Waveform Generator				Measurement
	Output Load	Function	Amplitude	Frequency	Measured Result
Q	50 Ω	Sine	2.828 Vrms (22.040 dBm)	1.000 kHz	Vrms dBm

4. Set the waveform generator function, amplitude, and frequency as described in the table below. Measure the amplitude and record the results in the table below.

Waveform Generator					Measurement	
Use	Output Load	Function	Amplitude	Frequency	Error Relative to Step 3 Reference (Vrms)	Measured Result (Vrms)
	50 Ω	Sine	2.828 Vrms	100.000 kHz	$\pm 1.15\%$	
				500.000 kHz		
				1.000 MHz*		
				5.000 MHz*		
	50 Ω	Sine	2.828 Vrms	10.00 MHz*	$\pm 2.92\%$	
				20.00 MHz*		

* These values are used in the Correction Factor Table below.

5. In order to scale the power meter to the Fluke 5790A, a correction factor is calculated using the table below. The measurements of amplitudes from both the 5790A and the power meter at 1 MHz to 20 MHz are used. Enter the measured values for 1, 5, 10, and 20 MHz made with the Fluke 5790A into the Correction Factor table below. Then use the following formula to convert the Vrms results to dBm:

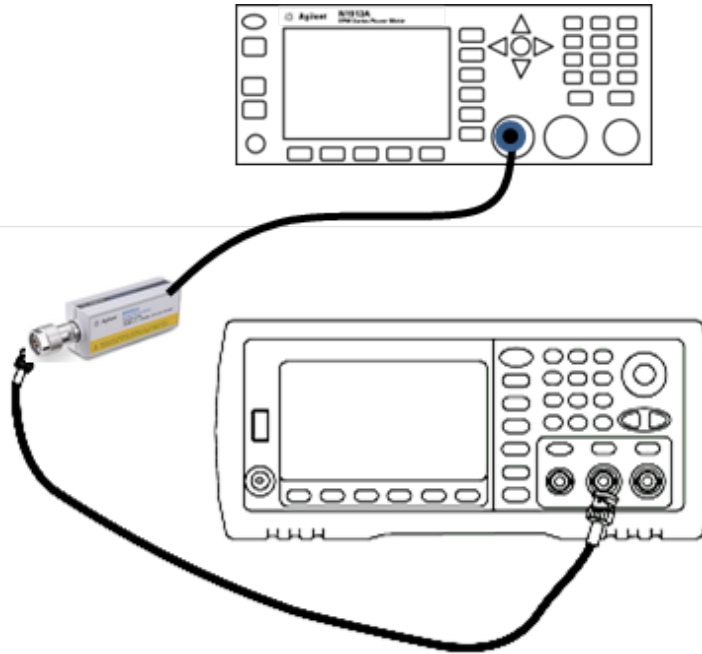
$$\text{dBm} = 10 \times \log_{10}(20 \times \text{Vrms}^2)$$

Compute the average (arithmetic mean) of the four dBm results and enter the result into the table at the bottom of the Fluke 5790A dBm column.

6. Connect the N8482A to the channel 1 output of the waveform generator using a Type N connector as shown below. Repeat the 1, 5, 10, and 20 MHz measurements and enter the dBm results into the table below. Compute the average (arithmetic mean) of the four dBm results and enter the result into the table at the bottom of the Power Meter dBm column.

CAUTION

To avoid damaging the N8482A power sensor, be sure to insert the 10 to 20 dB attenuator in series with the measurement.



7. Subtract the Power Meter dBm average from the Fluke 5790A dBm average to compute the correction factor. Record the result in the lower right corner of the Correction Factor table. Add this correction factor to all of your Power Meter measurements.

Correction Factor Table

	Fluke 5790A		Power Meter	
Frequency	Vrms (measured)	dBm (see formula)		dBm (measured)
1 MHz				
5 MHz				
10 MHz				
20 MHz				
	Average (mean):		Average (mean):	
Correction Factor (Fluke 5790A Average minus Power Meter average):				

8. Make the following measurements using the power meter. Set the 33600 Series instrument to the function, amplitude, and frequencies shown below. Record the measured dBm (remembering to add the correction factor) for each frequency in the table below.

	Waveform Generator				Measurement		
Use	Output Load	Function	Amplitude	Frequency	Error Relative to Step 3 Reference	Measured Result (dBm)	Corrected Result (dBm)
	50 Ω	Sine	2.828 Vrms	30.00 MHz	± 0.25 dB		
				40.00 MHz			
				50.00 MHz			
				60.00 MHz			
	50 Ω	Sine	2.828 Vrms	70.00 MHz	± 0.40 dB		
				80.00 MHz			

9. Compare the measured values to the test limits shown in both tables.
10. Two-channel instruments only: Connect the AC voltmeter to channel 2 and repeat steps 2 through 6.

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General Calibration/Adjustment Procedure - 33600 Series

Recommended method for a complete instrument calibration:

1. Read **Test Considerations**.
2. **Perform the verification tests** to characterize the instrument (incoming data).
3. Press [**System > Instr Setup > Calibrate**]. If the instrument is secured from calibration, **unsecure it**.
4. Enter the Setup Number for the procedure being performed. The default setup number is "1" and, from the front panel, the number will increment as the procedures are performed.
5. Select **BEGIN**.
6. For setups that require an input, adjust the value shown in the display to the measured value and select **ENTER VALUE**.
7. The setup automatically advances to the next required value.

To cancel the adjustment procedure, select **CANCEL STEP**. The display will return to the setup number entry.

8. When finished, select **END CAL**.
9. (Optional) Set a new calibration message using the remote interface. The message (up to 40 characters) is stored with the calibration coefficients.
10. Secure the instrument against calibration.
11. Note the new security code and calibration count in the instrument's maintenance records.

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Aborting a Calibration in Progress - 33600 Series

Sometimes it may be necessary to abort a calibration in progress. You can abort a calibration at any time by turning off the power or by issuing a remote interface device clear message followed by ***RST**.

The instrument stores calibration constants at the end of each adjustment procedure. If you lose power, or otherwise abort an adjustment in progress, you will only need to perform the interrupted adjustment procedure again.

CAUTION

If power is lost when the instrument is attempting to write new calibration constants to memory, you may lose all calibration constants for the function. Typically, upon re-applying power, the instrument will report error **"-313, Calibration Memory Lost"**.

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Sequence of Adjustments – 33600 Series

The adjustment sequence in the numbered steps minimizes the number of test equipment setups and connection changes.

You may perform individual adjustments as necessary, but setups 1 through 7 must be performed in order, before any other setup procedure.

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Self-Test – 33600 Series

Run self-test to ensure that the instrument is in working order before beginning any additional adjustments.

Be sure to unlock the instrument and follow the requirements listed in [Test Considerations](#) before beginning any adjustments.

1. Press [**System** > **Instr Setup** > **Calibrate**. Enter setup number 1 and select **BEGIN**.

Setup	
1	Performs the self-test. The Main Output is disabled during test.

2. If the instrument fails any self-test, you must repair the instrument before continuing the adjustment procedures.

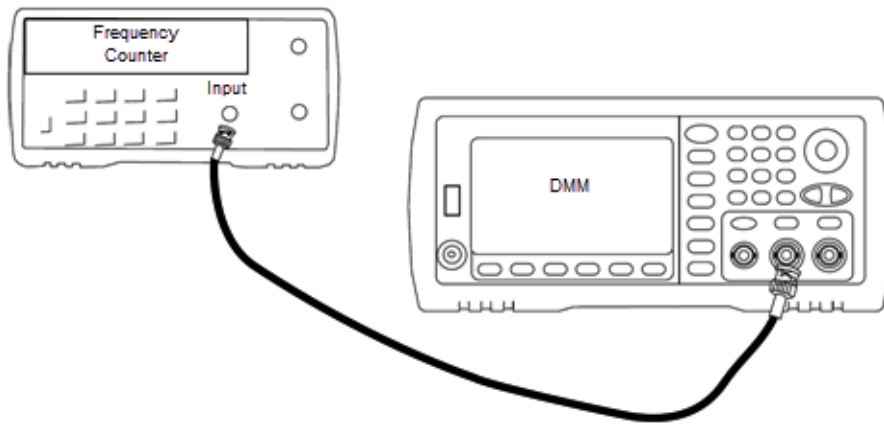
A complete self-test (*TST?) takes approximately 15 seconds.

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Frequency (Internal Timebase) Adjustment – 33600 Series

The instrument stores a calibration constant that sets the crystal oscillator to put out exactly 10 MHz. The instrument should have been running continuously for 30 minutes prior to this calibration adjustment to ensure timebase stability

1. Set the frequency counter resolution to better than 0.01 ppm and the input termination to 50 Ω (if your frequency counter does not have a 50 Ω input termination, you must provide an external termination). Make the connections shown below.



2. Use the frequency counter to measure the output frequency for each setup in the following table.

Setup	Nominal Signal		
	Frequency	Amplitude	
2	<10 MHz	~1 Vpp	Output frequency is slightly less than 10 MHz
3	>10 MHz		Output frequency is slightly more than 10 MHz
4	~10 MHz		Output frequency should be near 10 MHz
5*	10 MHz		Output frequency should be 10 MHz $\pm$ 1 ppm

* Constants are stored after completing this setup.

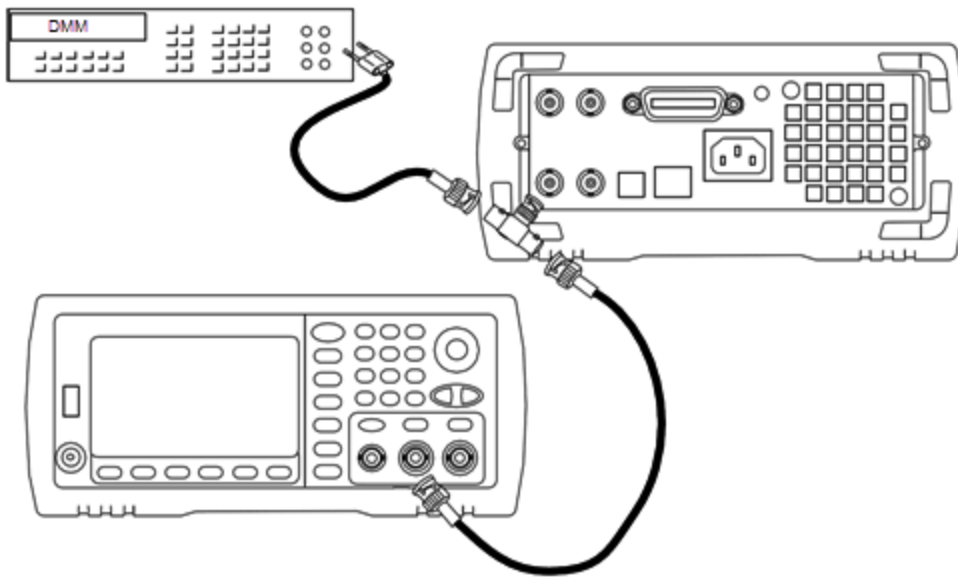
3. Using the numerical keypad or knob, adjust the displayed frequency at each setup to match the measured frequency. Select **ENTER VALUE**.
4. To proceed:
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **Internal Timebase Verification**.
 - b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

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Internal ADC Adjustment - 33600 Series

The instrument stores calibration constants related to the gain and offset of the internal ADC. Setup 8 must always be performed before any other amplitude adjustments are attempted. The internal ADC is then used as a source for the calibration constants generated in self calibration (Setup9). (Setup 6 and Setup 7 are not used.)

1. Connect the channel 1 output to the instrument's rear panel Modulation Input and DMM as shown below.



2. Set the DMM to display 5½ digits and set the function to DCV.
3. Enter the following setup.

	Nominal Signal	
Setup	DC level	
8*	~1.1 VDC ±10%	Calibrates the internal ADC.

* Constants are stored after completing this setup.

4. Use the numeric keypad or knob to enter the value measured on the DMM.

NOTE This setup requires approximately 15 seconds to complete.

5. Disconnect all cables from the instrument.

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Self Calibration Adjustment - 33600 Series

1. Enter and begin the following setup.

Setup	
9*	Self-calibration. The output is disabled.

* Constants are stored after completing this setup.

2. To proceed:
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **DC Offset Voltage Verification**.

- b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

NOTE

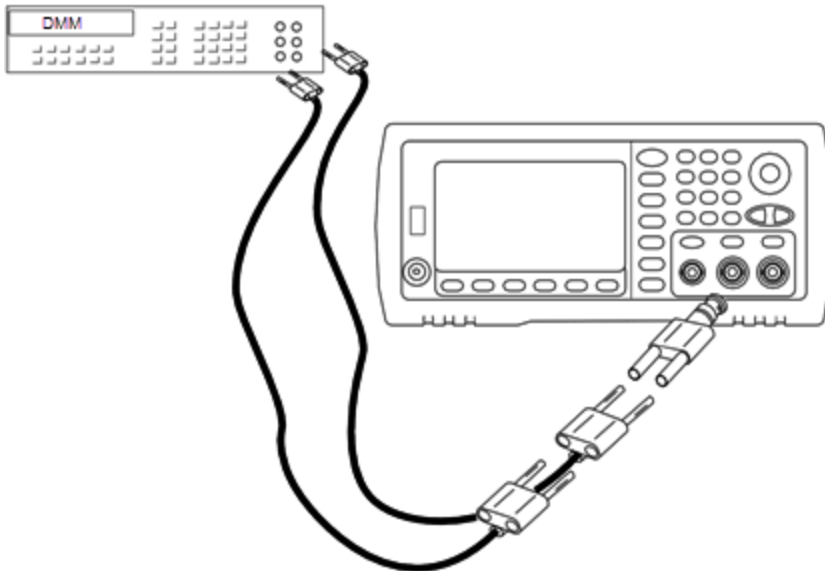
This setup requires approximately 15 seconds to complete.

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Output Impedance Adjustment - 33600 Series

The instrument stores calibration constants for the channels' output impedance. These constants are generated with and without the post-amplifier attenuator.

1. Set the DMM to measure offset-compensated, four-wire Ohms. Set the DMM to use 100 NPLC integration. Connect the Ohms Source and Ohms Sense DMM inputs to the channel output as shown below.



2. Use the DMM to make a 4-wire resistance measurement at the front panel output connector for each setup in the following table. The expected measured value is approximately 50 Ω .

Setup	
10*	Amplifier direct
11*	Amplifier plus 100 MHz filter
12*	Amplifier plus 150 MHz filter
13*	24 dB post attenuator
14*	24 dB post attenuator plus 150 MHz filter

* Constants are stored after completing this setup.

3. Using the numeric keypad or knob, adjust the displayed impedance at each setup to match the measured impedance. Select **ENTER VALUE**.

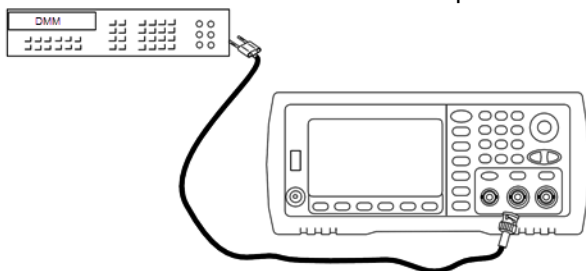
- There are no specific operational verification tests for output impedance. Continue with the next adjustment procedure in this section.

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AC Amplitude (high-impedance) Adjustment - 33600 Series

The instrument stores a calibration constant for each high-impedance attenuator path. Each path's gain coefficient is calculated using two measurements: one with the waveform DAC at + output and one with waveform DAC at – output. The setups, therefore, must be performed in pairs.

- Connect the DMM to the channel output as shown below.



2. Use the DMM to measure the DC voltage at the front panel connector for each setup in the following table.

Setup	Nominal Signal	
	DC Level	
15	+0.0028 V	Output of -72 dB range
16*	-0.0028 V	Output of -72 dB range
17	+0.0068 V	Output of -64 dB range
18*	-0.0068 V	Output of -64 dB range
19	+0.0170 V	Output of -56 dB range
20*	-0.0170 V	Output of -56 dB range
21	+0.0430 V	Output of -48 dB range
22*	-0.0430 V	Output of -48 dB range
23	+0.1060 V	Output of -40 dB range
24*	-0.1060 V	Output of -40 dB range
25	+0.2680 V	Output of -32 dB range
26*	-0.2680 V	Output of -32 dB range
27	+0.6600 V	Output of -24 dB range
28*	-0.6600 V	Output of -24 dB range
29	+1.6500 V	Output of -16 dB range
30*	-1.6500 V	Output of -16 dB range
31	+4.2000 V	Output of -8 dB range
32*	-4.2000 V	Output of -8 dB range
33	+10.4000 V	Output of 0 dB range
34*	-10.4000 V	Output of 0 dB range
35	+0.0430 V	Output of -48 dB High DC range
36*	-0.0430V	Output of -48 dB High DC range
37	+0.1060 V	Output of -40 dB High DC range
38*	-0.1060 V	Output of -40 dB High DC range
39	+0.2680 V	Output of -32 dB High DC range

Setup	Nominal Signal	
	DC Level	
40*	-0.2680 V	Output of -32 dB High DC range
41	+0.6600 V	Output of -24 dB High DC range
42*	-0.6600 V	Output of -24 dB High DC range

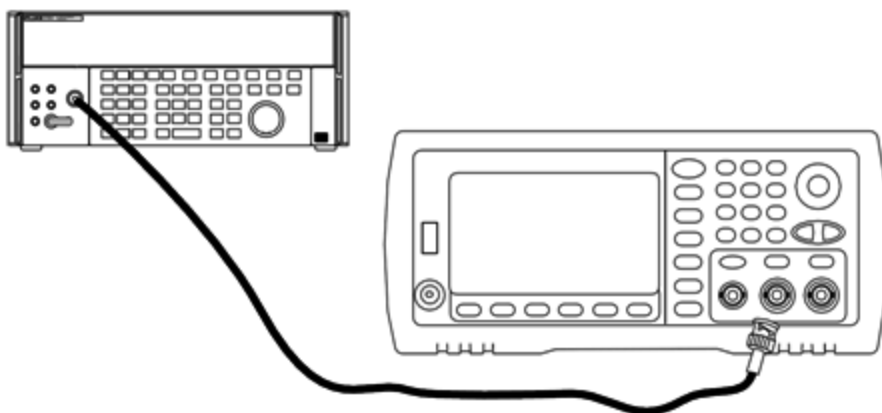
* Constants are stored after completing this setup.

- 3.
4. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
5. To proceed:
 - a. If your calibration procedures require you to verify this adjustment, exit the calibration menu and perform **AC Amplitude (high-impedance) Verification**.
 - b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

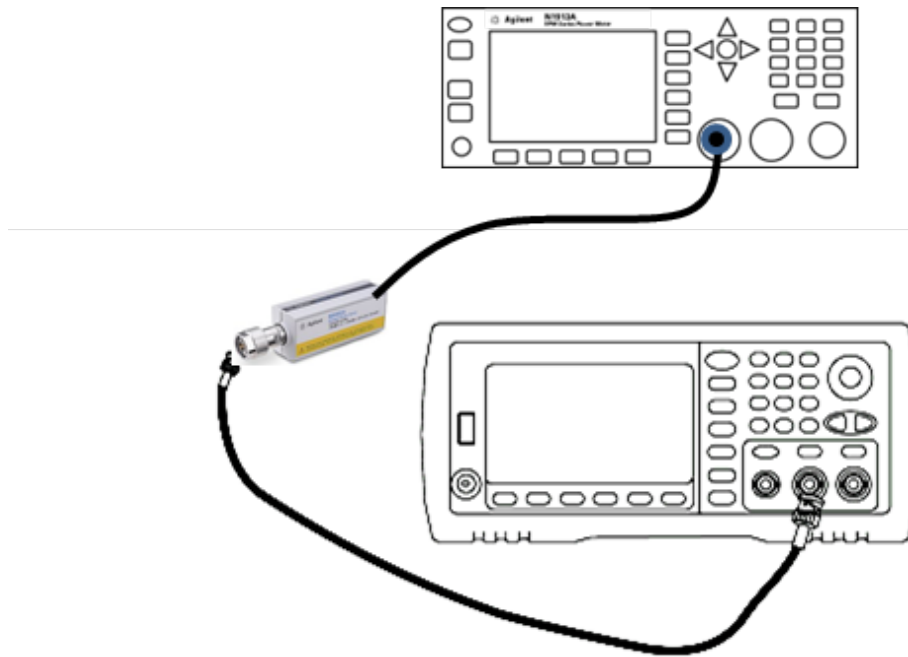
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1 Vpp Flatness Adjustment - 33600 Series

1. For frequencies up to and including 20 MHz, connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



For frequencies above 20 MHz, connect a precision power sensor and power meter to measure the output amplitude as shown below.



2. Use the precision AC voltmeter to measure the output amplitude for each setup in the table below.

Setup	Nominal Signal		
	Frequency	Amplitude	
43*	1 kHz	380 mVrms	Flatness for 1 Vpp range
44*	100 kHz		
45*	1 MHz		
46*	5 MHz		
47*	10 MHz		
48*	20 MHz		
49*	25 MHz		
50*	30 MHz		
51	40 MHz		
52	50 MHz		
53	60 MHz		
54	70 MHz		
55	80 MHz		
56	90 MHz		
57	100 MHz		
58	110 MHz		
59	120 MHz		

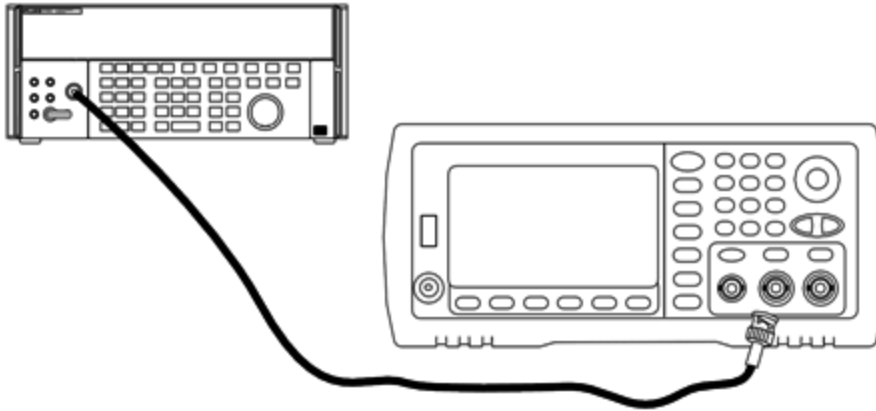
* Constants are stored after completing this setup.

3. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
4. To proceed:
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **1 Vpp Range Flatness Verification**.
 - b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

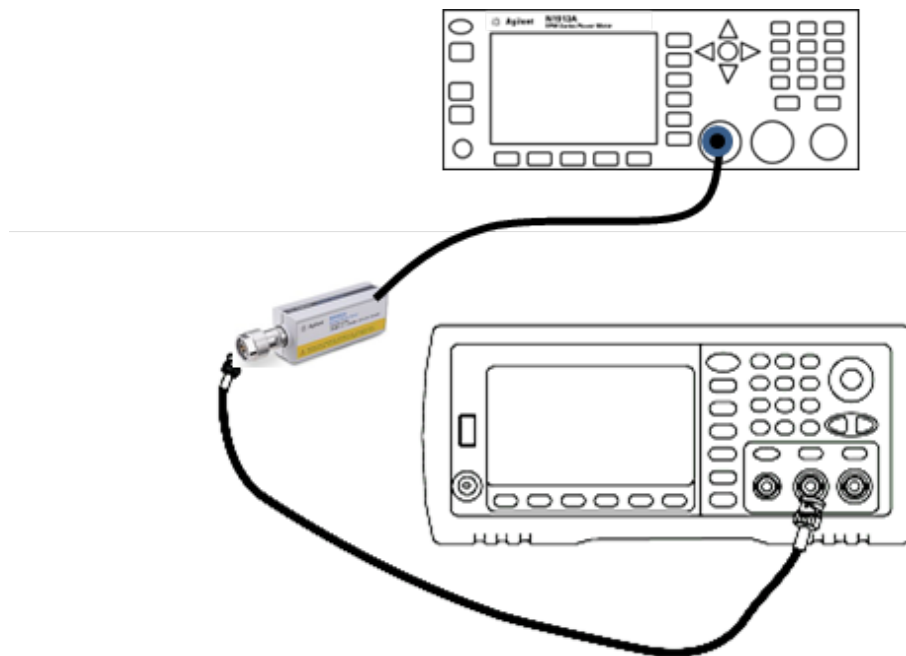
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4 Vpp Flatness Adjustment - 33600 Series

1. For frequencies up to and including 20 MHz, connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



For frequencies above 20 MHz, connect a precision power sensor and power meter to measure the output amplitude as shown below.



2. Use the precision AC voltmeter to measure the output amplitude for each setup in the table below.

Setup	Nominal Signal		
	Frequency	Amplitude	
60*	1 kHz	960 mVrms	Flatness for -8 dB range
61*	100 kHz		
62*	1 MHz		
63*	5 MHz		
64*	10 MHz		
65*	20 MHz		
66*	25 MHz		
67*	30 MHz		
68	40 MHz		
69	50 MHz		
70	60 MHz		
71	70 MHz		
72	80 MHz		
73	90 MHz		
74	100 MHz		
75	110 MHz		
76	120 MHz		

* Constants are stored after completing this setup.

3. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
4. To proceed:
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **4 Vpp Range Flatness Verification**.
 - b. If you are making all the adjustments and then verifying the instrument's performance, verify the output specifications of the instrument with the **Performance Verification Tests**.

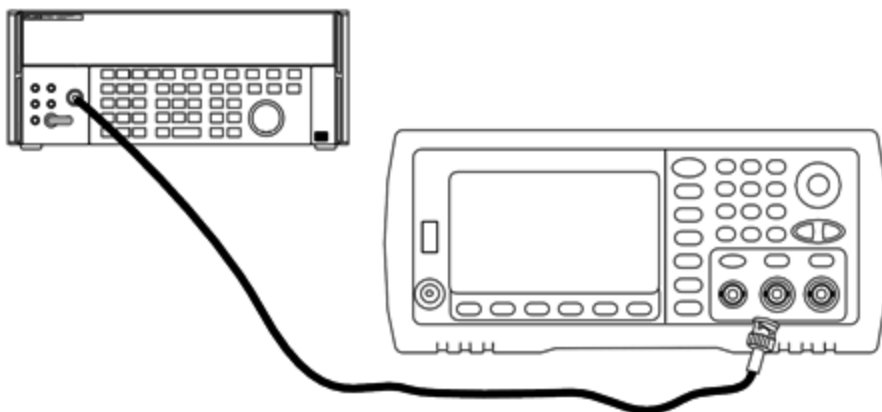
This completes the adjustment procedures for the one-channel instrument. Verification of the output specifications is recommended.

If you are making adjustments to a two-channel instrument, continue with the next procedure in this section.

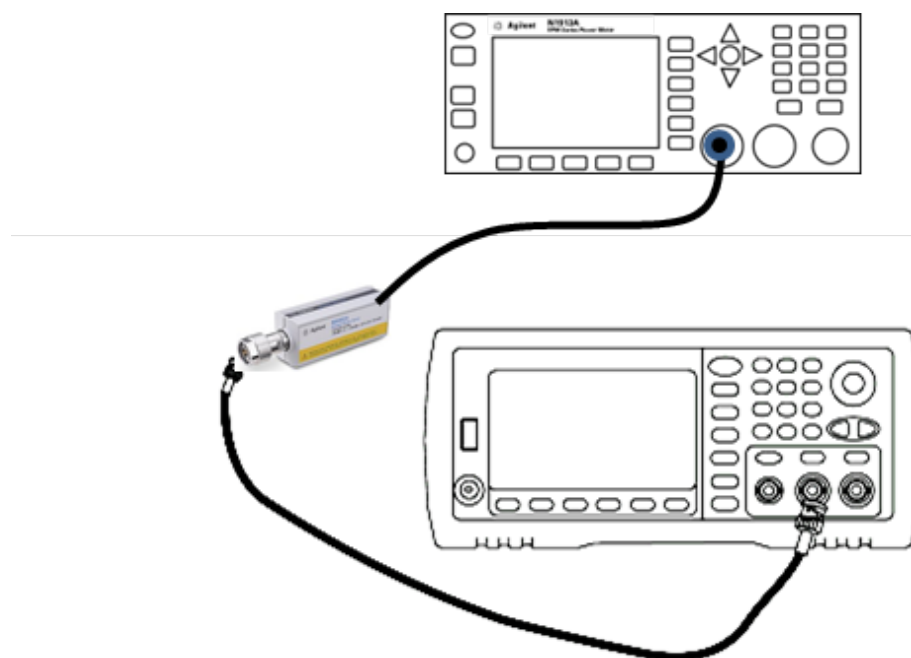
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8 Vpp Flatness Adjustment - 33600 Series

1. For frequencies up to and including 20 MHz, connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



For frequencies above 20 MHz, connect a precision power sensor and power meter to measure the output amplitude as shown below.



2. Use the precision AC voltmeter to measure the output amplitude for each setup in the table below.

Setup	Nominal Signal		
	Frequency	Amplitude	
77*	1 kHz	2.4 Vrms	Flatness for 0 dB range
78*	100 kHz		
79*	1 MHz		
80*	5 MHz		
81*	10 MHz		
82*	20 MHz		
83*	25 MHz		
84*	30 MHz		
85	40 MHz		
86	50 MHz		
87	60 MHz		
88	70 MHz		
89	80 MHz		

* Constants are stored after completing this setup.

3. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
4. To proceed:
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **8 Vpp Range Flatness Verification**.
 - b. If you are making all the adjustments and then verifying the instrument's performance, verify the output specifications of the instrument with the **Performance Verification Tests**.

This completes the adjustment procedures for the one-channel instrument. Verification of the output specifications is recommended.

If you are making adjustments to a two-channel instrument, continue with the next procedure in this section.

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Channel 2 Adjustments - 33600 Series

The following topics describe calibration adjustments on channel 2.

- [Self Calibration Adjustment \(Channel 2\)](#)
- [Output Impedance Adjustment \(Channel 2\)](#)
- [AC Amplitude \(high-impedance\) Adjustment \(Channel 2\)](#)
- [-16 dB Range Flatness Adjustment \(Channel 2\)](#)
- [-8 dB Range Flatness Adjustment \(Channel 2\)](#)
- [0 dB Range Flatness Adjustment](#)

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Self Calibration Adjustment (Channel 2) - 33600 Series

1. Enter and begin the following setup.

Setup	
90*	Self-calibration. The output is disabled.

* Constants are stored after completing this setup.

2. To proceed:
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform [DC Offset Voltage Verification](#). Be sure to do this for channel 2.
 - b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

NOTE

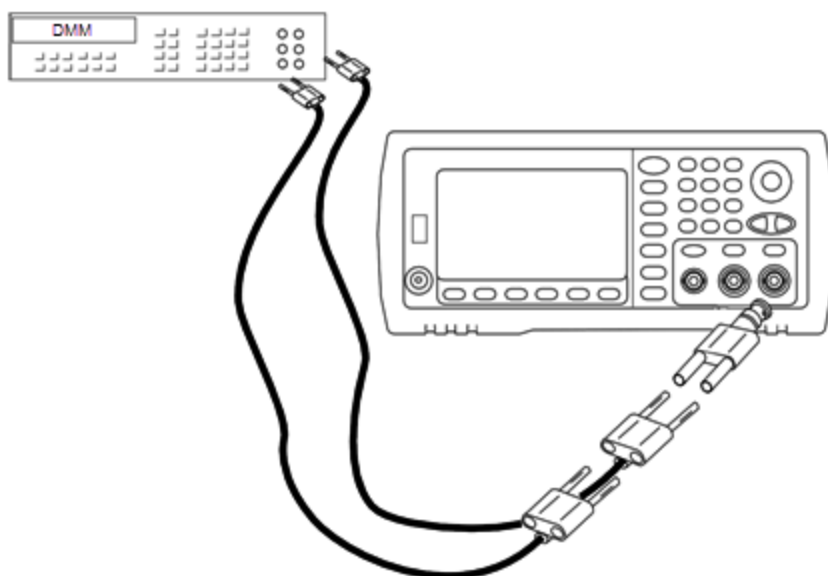
This setup requires approximately 15 seconds to complete.

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Output Impedance Adjustment (Channel 2) - 33600 Series

The instrument stores calibration constants for the channels' output impedance. These constants are generated with and without the post-amplifier attenuator.

1. Set the DMM to measure offset-compensated, four-wire Ohms. Set the DMM to use 100 NPLC integration. Connect the Ohms Source and Ohms Sense DMM inputs to the channel output as shown below.



2. Use the DMM to make a 4-wire resistance measurement at the front panel output connector for each setup in the following table. The expected measured value is approximately 50 Ω .

Setup	
91*	Amplifier direct
92*	Amplifier plus 100 MHz filter
93*	Amplifier plus 150 MHz filter
94*	24 dB post attenuator
95*	24 dB post attenuator plus 150 MHz filter

3.

* Constants are stored after completing this setup.

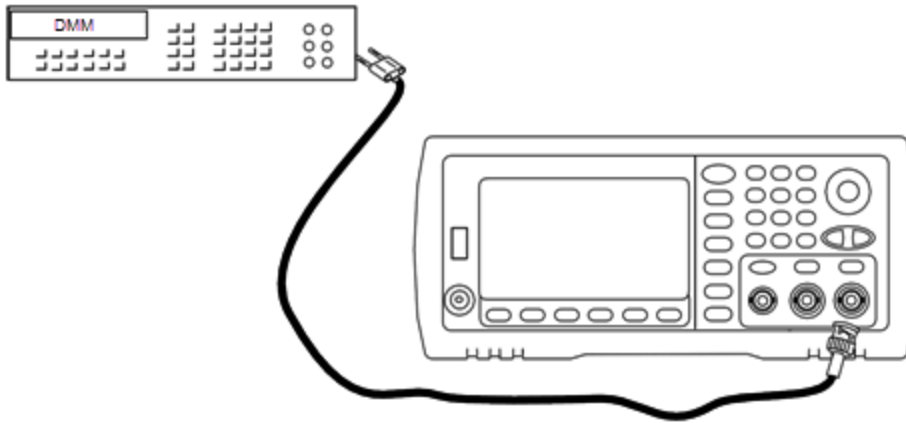
4. Using the numeric keypad or knob, adjust the displayed impedance at each setup to match the measured impedance. Select **ENTER VALUE**.
5. There are no specific operational verification tests for output impedance. Continue with the next adjustment procedure in this section.

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AC Amplitude (high-impedance) Adjustment (Channel 2) - 33600 Series

The instrument stores a calibration constant for each high-impedance attenuator path. Each path's gain coefficient is calculated using two measurements: one with the waveform DAC at + output and one with waveform DAC at - output. The setups, therefore, must be performed in pairs.

1. Connect the DMM to the channel output as shown below.



2. Use the DMM to measure the DC voltage at the front panel connector for each setup in the following table.

Setup	Nominal Signal	
	DC Level	
96	+0.0028 V	Output of -72 dB range
97*	-0.0028 V	Output of -72 dB range
98	+0.0068 V	Output of -64 dB range
99*	-0.0068 V	Output of -64 dB range
100	+0.0170 V	Output of -56 dB range
101*	-0.0170 V	Output of -56 dB range
102	+0.0430 V	Output of -48 dB range
103*	-0.0430 V	Output of -48 dB range
104	+0.1060 V	Output of -40 dB range
105*	-0.1060 V	Output of -40 dB range
106	+0.2680 V	Output of -32 dB range
107*	-0.2680 V	Output of -32 dB range
108	+0.6600 V	Output of -24 dB range
109*	-0.6600 V	Output of -24 dB range
110	+1.6500 V	Output of -16 dB range
111*	-1.6500 V	Output of -16 dB range
112	+4.2000 V	Output of -8 dB range
113*	-4.2000 V	Output of -8 dB range
114	+10.4000 V	Output of 0 dB range
115*	-10.4000 V	Output of 0 dB range
116	+0.0430 V	Output of -48 dB High DC range
117*	-0.0430V	Output of -48 dB High DC range
118	+0.1060 V	Output of -40 dB High DC range
119*	-0.1060 V	Output of -40 dB High DC range
120	+0.2680 V	Output of -32 dB High DC range
121*	-0.2680 V	Output of -32 dB High DC range
122	+0.6600 V	Output of -24 dB High DC range
123*	-0.6600 V	Output of -24 dB High DC range

3.
4.

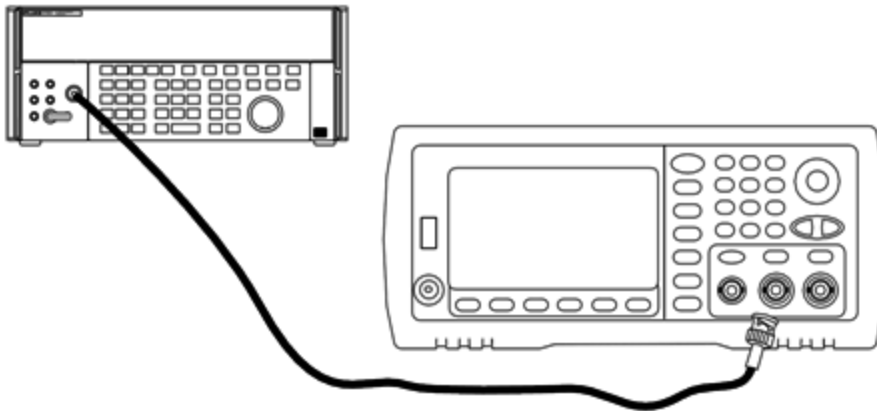
* Constants are stored after completing this setup.

5. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
6. To proceed:
 - a. If your calibration procedures require you to verify this adjustment, exit the calibration menu and perform **AC Amplitude (high-impedance) Verification**.
 - b. If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

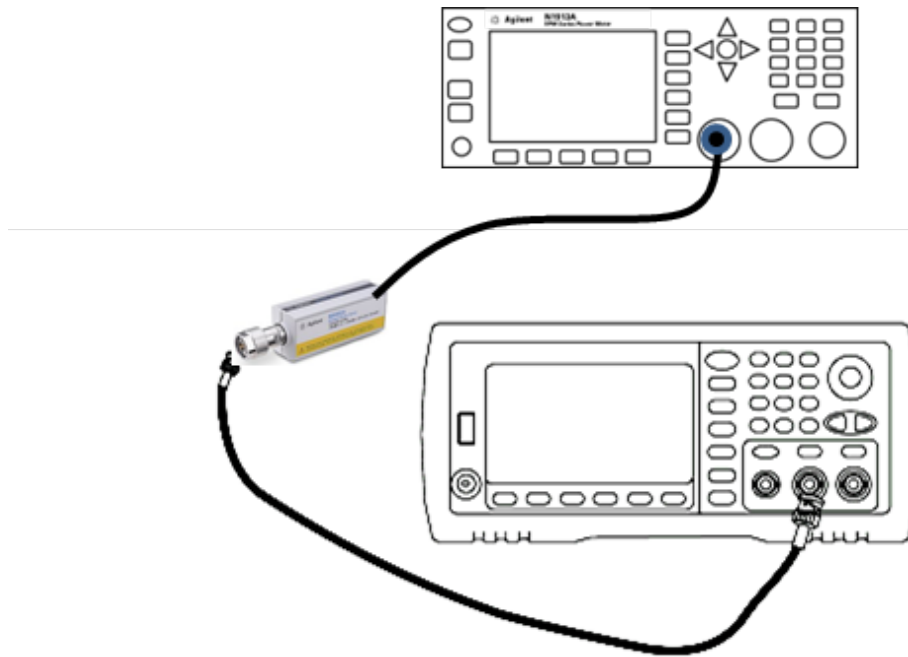
[Previous Calibration Topic](#) [Next Calibration Topic](#)

1 Vpp Flatness Adjustment (Channel 2) - 33600 Series

1. For frequencies up to and including 20 MHz, connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



For frequencies above 20 MHz, connect a precision power sensor and power meter to measure the output amplitude as shown below.



2. Use the precision AC voltmeter to measure the output amplitude for each setup in the table below.

Setup	Nominal Signal		
	Frequency	Amplitude	
124*	1 kHz	380 mVrms	Flatness for 1 Vpp range
125*	100 kHz		
126*	1 MHz		
127*	5 MHz		
128*	10 MHz		
129*	20 MHz		
130*	25 MHz		
131*	30 MHz		
132	40 MHz		
133	50 MHz		
134	60 MHz		
135	70 MHz		
136	80 MHz		
137	90 MHz		
138	100 MHz		
139	110 MHz		
140	120 MHz		

* Constants are stored after completing this setup.

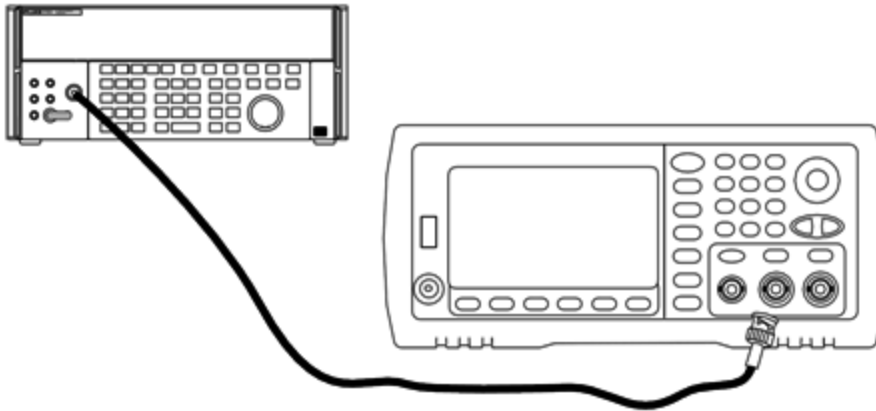
3. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
4. To proceed:
- If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **1 Vpp Range Flatness Verification**. Be sure that you do this for Channel 2.
 - If you are making all of the adjustments and then verifying the instrument's performance, continue with the next procedure in this section.

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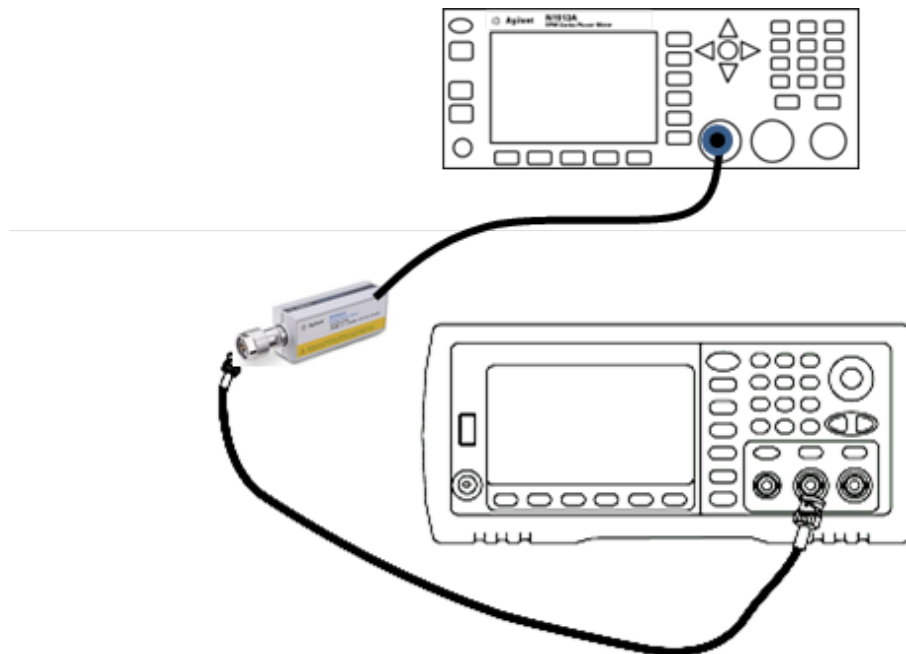
4 Vpp Flatness Adjustment (Channel 2) - 33600 Series

This section applies to channel 2. It checks high frequency AC amplitude flatness on the -8 dB attenuator range. It also checks flatness for all other ranges excluding the -24 dB and 0 dB attenuator ranges.

1. For frequencies up to and including 20 MHz, connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



For frequencies above 20 MHz, connect a precision power sensor and power meter to measure the output amplitude as shown below.



2. Use the precision AC voltmeter to measure the output amplitude for each setup in the table below.

Setup	Nominal Signal		
	Frequency	Amplitude	
141*	1 kHz	960 mVrms	Flatness for -8 dB range
142*	100 kHz		
143*	1 MHz		
144*	5 MHz		
145*	10 MHz		
146*	20 MHz		
147*	25 MHz		
148*	30 MHz		
149	40 MHz		
150	50 MHz		
151	60 MHz		
152	70 MHz		
153	80 MHz		
154	90 MHz		
155	100 MHz		
156	110 MHz		
157	120 MHz		

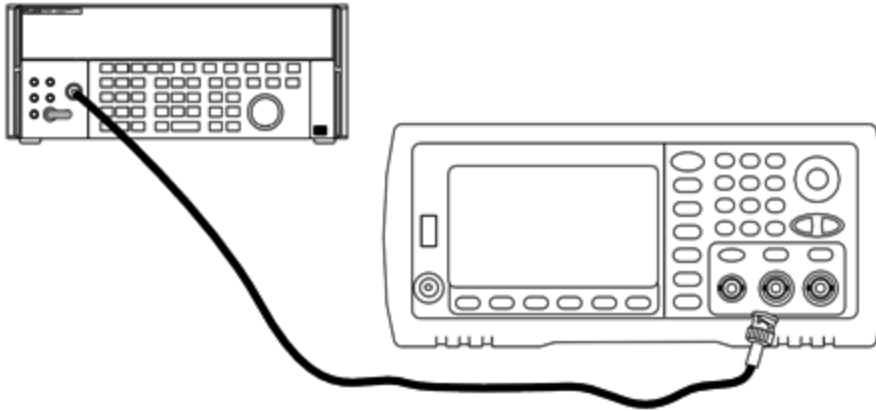
* Constants are stored after completing this setup.

3. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
4. You have now completed the recommended adjustment procedures. Verification of the output specifications is recommended.
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **4 Vpp Range Flatness Verification**.

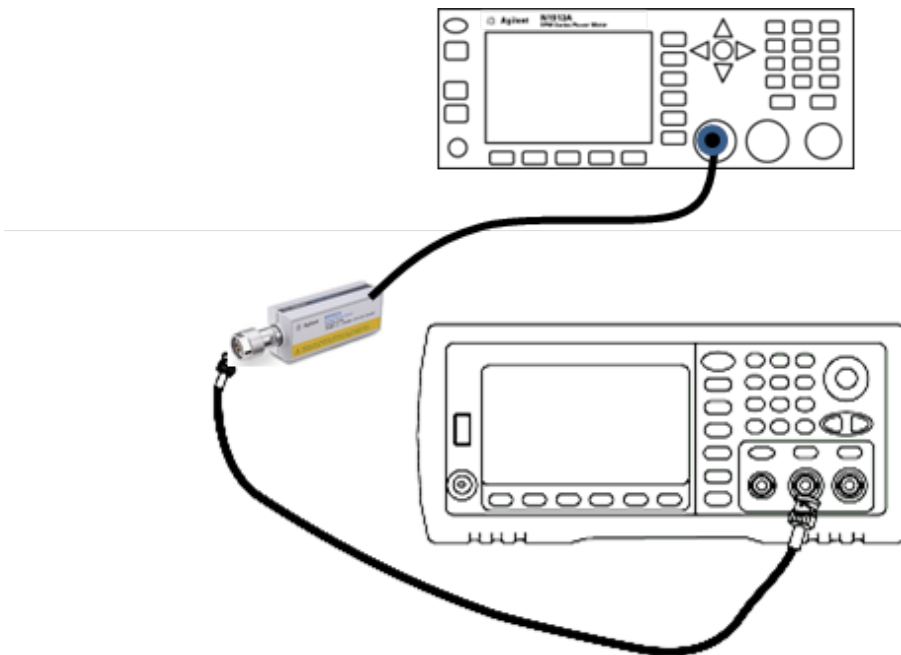
[Previous Calibration Topic](#) [Next Calibration Topic](#)

8 Vpp Flatness Adjustment - 33600 Series

1. For frequencies up to and including 20 MHz, connect a precision AC voltmeter to measure the output amplitude as shown below. Connect the BNC cable to the Wide Band input of the Fluke 5790A.



For frequencies above 20 MHz, connect a precision power sensor and power meter to measure the output amplitude as shown below.



2. Use the precision AC voltmeter to measure the output amplitude for each setup in the table below.

Setup	Nominal Signal		
	Frequency	Amplitude	
158*	1 kHz	2.4 Vrms	Flatness for 0 dB range
159*	100 kHz		
160*	1 MHz		
161*	5 MHz		
162*	10 MHz		
163*	20 MHz		
164*	25 MHz		
165*	30 MHz		
166	40 MHz		
167	50 MHz		
168	60 MHz		
169	70 MHz		
170	80 MHz		

* Constants are stored after completing this setup.

3. Using the numeric keypad or knob, adjust the displayed voltage at each setup to match the measured voltage. Select **ENTER VALUE**.
4. To proceed:
 - a. If your calibration procedures require you to verify the adjustment just made, exit the calibration menu and perform **8 Vpp Range Flatness Verification**.
 - b. If you are making all the adjustments and then verifying the instrument's performance, verify the output specifications of the instrument with the **Performance Verification Tests**.

This completes the adjustment procedures for the one-channel instrument. Verification of the output specifications is recommended.

If you are making adjustments to a two-channel instrument, continue with the next procedure in this section.

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Calibration Errors - 33600 Series

The following errors may occur during calibration. There are also **system errors** and **self-test errors**. Some error messages include a failing channel number (1 or 2), shown as n in the messages below.

701 Calibration error; security defeated by hardware jumper

If you short the calibration secure jumper (CAL ENABLE) while turning the instrument on, this error indicates the security password has been overwritten. See [Calibration Security](#) for details.

702 Calibration error; calibration memory is secured

To perform calibration, unsecure the instrument. See [Calibration Security](#) for details.

703 Calibration error; secure code provided was invalid

Specified security code was invalid.

706 Calibration error; value out of range

Value entered was outside valid range.

707 Calibration error; signal input is out of range

Occurs during the ADC Adjustment, setup 6, if the 1 V input voltage is too high. May also occur during self-calibration (setup 7). Run self-test to diagnose problem.

710 Self-calibration failed; Chan n, null DAC cal, invalid self cal

Self-calibration failed; Chan n, offset DAC cal with attenuator, invalid self cal

Self-calibration failed; Chan n, offset DAC cal no attenuator, invalid self cal

Error occurred while performing internal calibration of specified DAC. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.

711 Self-calibration failed; Chan n, null DAC cal gain too low (too high), <meas_value>

Self-calibration failed; Chan n, offset DAC cal with attenuator gain too low (too high), <meas_value>

Self-calibration failed; Chan n, offset DAC cal no attenuator gain too low (too high), <meas_value>

Computed gain calibration factor for specified DAC was out of limits. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.

712 Self-calibration failed; Chan n, null DAC cal zero too low (too high), <meas_value>

Self-calibration failed; Chan n, offset DAC cal with attenuator zero too low (too high), <meas_value>

Self-calibration failed; Chan n, offset DAC cal no attenuator zero too low (too high), <meas_value>

Self-calibration failed; Chan n, GND measurement out of limits, <meas_value>

Computed zero calibration factor for specified DAC was out of limits. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.

715 Self-calibration failed; Chan n, null DAC cal, convergence error sub attenuator value dB

Internal null DAC calibration failed to converge during internal calibration. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.

720 Self-calibration failed; Chan n, offset DAC cal with attenuator, convergence error

Self-calibration failed; Chan n, offset DAC cal no attenuator, convergence error

Internal offset DAC calibration failed to converge internal calibration. Self-calibration exited without changing self-calibration constants. Run self-test to diagnose problem.

850 Calibration error; set up is invalid

Invalid calibration setup number selected.

850 Calibration error; set up is out of order

Certain calibration steps require a specific beginning and ending. Do not enter into the middle of a calibration sequence.

Previous Calibration Topic

Block Diagram - 33500 Series

The instrument has four main assemblies:

- Processor
- Main board
- Front panel
- Main power supply

A **simplified block diagram** appears at the bottom of this section.

The processor is a single board computer that contains the CPU, RAM, ROM, and circuits used to drive the GPIB, LAN, and USB ports. The built in web interface is contained in the ROM. The processor circuitry is earth referenced.

When the power switch is pressed, the processor communicates with and loads the FPGA. This communication uses three asynchronous serial data lines and one serial clock line. These four lines are isolated.

The FPGA stores all waveforms except arbitrary waveforms. Arbitrary waveforms are loaded into SDRAM on the main board. All control of waveforms, triggers, sync signals, output path, attenuation, and offset is provided by the FPGA.

The main waveform for each channel (only one channel is shown in the **block diagram**) is loaded into the waveform DAC and clocked by the timebase. The DAC output passes through an elliptical filter before the main attenuators. There are three attenuators available in the path, -7.96 dB, -15.91 dB, and -23.87 dB.

The signal is applied to the output amplifier. The DC offset is summed at the output amplifier. A post amplifier -23.87 dB attenuator is available for low level signals. The table below show the attenuators that create the output signal amplitude.

Output Range DC Offset < 320 mV	-7.96 dB	-15.91 dB	-23.87 dB	-23.87 dB (post)
10 Vpp - 3.6 Vpp	Out	Out	Out	Out
4 Vpp - 1.44 Vpp	In	Out	Out	Out
1.6 Vpp - 576 mVpp	Out	In	Out	Out

Output Range DC Offset < 320 mV	-7.96 dB	-15.91 dB	-23.87 dB	-23.87 dB (post)
640 mVpp - 230 mVpp	Out	Out	Out	In
256 mVpp - 92 mVpp	In	Out	Out	In
102.4 mVpp - 36.86 mVpp	Out	In	Out	In
40.96 mVpp - 14.75 mVpp	Out	Out	In	In
16.38 mVpp - 5.90 mVpp	In	Out	In	In
6.55 mVpp - 2.36 mVpp	Out	In	In	In
2.62 mVpp - 1.00 mVpp	In	In	In	In

Output Range DC Offset ≥ 320 mV	-7.96 dB	-15.91 dB	-23.87 dB	-23.87 dB (post)
9.36 Vpp - 3.6 Vpp	Out	Out	Out	Out
4 Vpp - 1.44 Vpp	In	Out	Out	Out
1.6 Vpp - 576 mVpp	Out	In	Out	Out
640 mVpp - 230 mVpp	Out	Out	In	Out
256 mVpp - 92 mVpp	In	Out	In	Out
102.4 mVpp - 36.86 mVpp	Out	In	In	Out
40.96 mVpp - 1.00 mVpp	In	In	In	Out

The output relay when enabled provides the waveform to the front panel BNC connector. Additionally, this relay, when disabled, routes the signal to the Modulation ADC for internal self-test and calibration routines.

The output relay is controlled by the FPGA. Two circuits provide overvoltage and over current protection, primarily from an external circuit. The instrument can source very low output impedances.

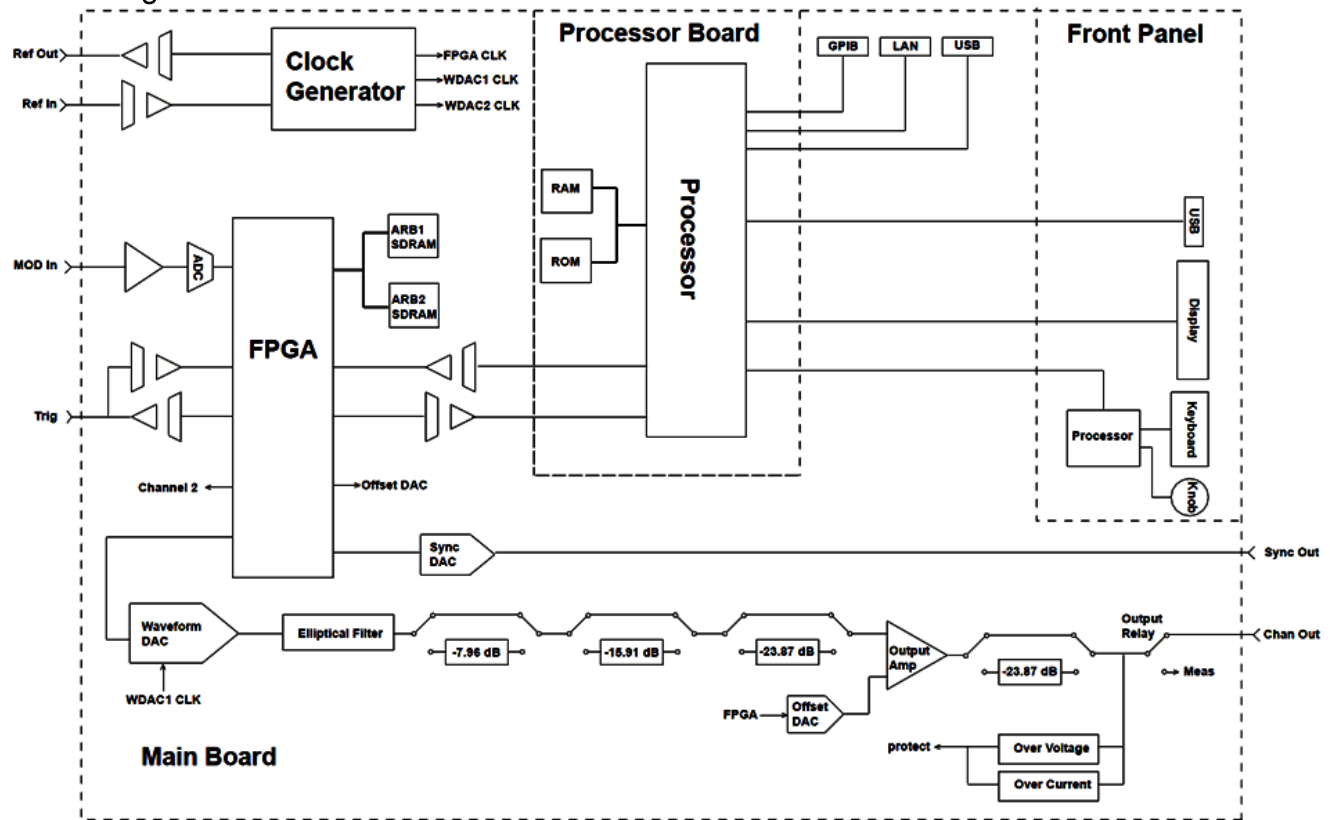
The **Sync** output signal is generated as a waveform from the FPGA to the **Sync** DAC.

External trigger in and out is chassis referenced at the BNC connector but is isolated before the FPGA.

Modulation in is an isolated input to the A/D converter. The FPGA applies the modulation signal to the output waveform.

The instrument's clock generator employs a 10-MHz crystal oscillator and a phase-locked loop to generate the 250-MHz clocks used by the FPGA and Waveform DACs. When an external 10-MHz frequency reference is used, a digital phase-locked loop in the FPGA keeps the crystal oscillator in sync.

Block Diagram - 33500 Series



Block Diagram - 33600 Series

The instrument has four main assemblies:

- Processor
- Main board
- Front panel
- Main power supply

A **simplified block diagram** appears at the bottom of this section.

The processor is contained within the Front Panel Assembly, and contains the CPU, RAM, and ROM, as well as circuits used to drive the GPIB, LAN, and USB ports. The built in web interface is contained in the ROM. The processor circuitry is earth referenced.

When the power switch is pressed, the processor communicates with and loads the FPGA on the Mezzanine Assembly. This communication uses three asynchronous serial data lines and one serial clock line. These four lines are isolated.

The FPGA stores all waveforms except arbitrary waveforms. Arbitrary waveforms are loaded into SDRAM on the Mezzanine Assembly. All control of waveforms, triggers, sync signals, output path, attenuation, and offset is provided by the FPGA.

The main waveform for each channel (only one channel is shown in the **block diagram**) is loaded into the waveform DAC and clocked by the Clock Generator. The DAC output passes through an Anti-Alias Filter before the main attenuators. There are three attenuators available in the path, -7.96 dB, -15.91 dB, and -23.87 dB.

The signal is applied to the output amplifier. The DC offset is summed at the output amplifier. A post amplifier -23.87 dB attenuator is available for low level signals. The table below show the attenuators that create the output signal amplitude.

Output Range DC Offset < 320 mV	-7.96 dB	-15.91 dB	-23.87 dB	-23.87 dB (post)
10 Vpp - 4.0001 Vpp	Out	Out	Out	Out
4.1 Vpp - 1.44 Vpp	In	Out	Out	Out
1.6 Vpp - 576 mVpp	Out	In	Out	Out
640 mVpp - 230 mVpp	Out	Out	Out	In
256 mVpp - 92 mVpp	In	Out	Out	In
102.4 mVpp - 36.86 mVpp	Out	In	Out	In
40.96 mVpp - 14.75 mVpp	Out	Out	In	In
16.38 mVpp - 5.90 mVpp	In	Out	In	In
6.55 mVpp - 2.36 mVpp	Out	In	In	In
2.62 mVpp - 1.00 mVpp	In	In	In	In

Output Range DC Offset ≥ 320 mV	-7.96 dB	-15.91 dB	-23.87 dB	-23.87 dB (post)
9.36 Vpp - 3.6 Vpp	Out	Out	Out	Out
4 Vpp - 1.44 Vpp	In	Out	Out	Out
1.6 Vpp - 576 mVpp	Out	In	Out	Out
640 mVpp - 230 mVpp	Out	Out	In	Out
256 mVpp - 92 mVpp	In	Out	In	Out
102.4 mVpp - 36.86 mVpp	Out	In	In	Out
40.96 mVpp - 1.00 mVpp	In	In	In	Out
DC Volts function < 320 mV	In	In	In	In

Output Range DC Offset $\geq$ 320 mV	-7.96 dB	-15.91 dB	-23.87 dB	-23.87 dB (post)
DC Volts function $\geq$ 320 mV	In	In	In	Out

Two relays in the Output Switching and Filters block provide three paths to the front panel BNC connector (one straight-through and two through filters that reduce output distortion) as well as an open path to disable the output. An attenuated version of the output is fed to the Modulation ADC to be used for internal self-test and calibration.

The output relays are controlled by the FPGA. Two circuits provide overvoltage and over current protection, primarily from an external circuit. The instrument can source very low output impedances.

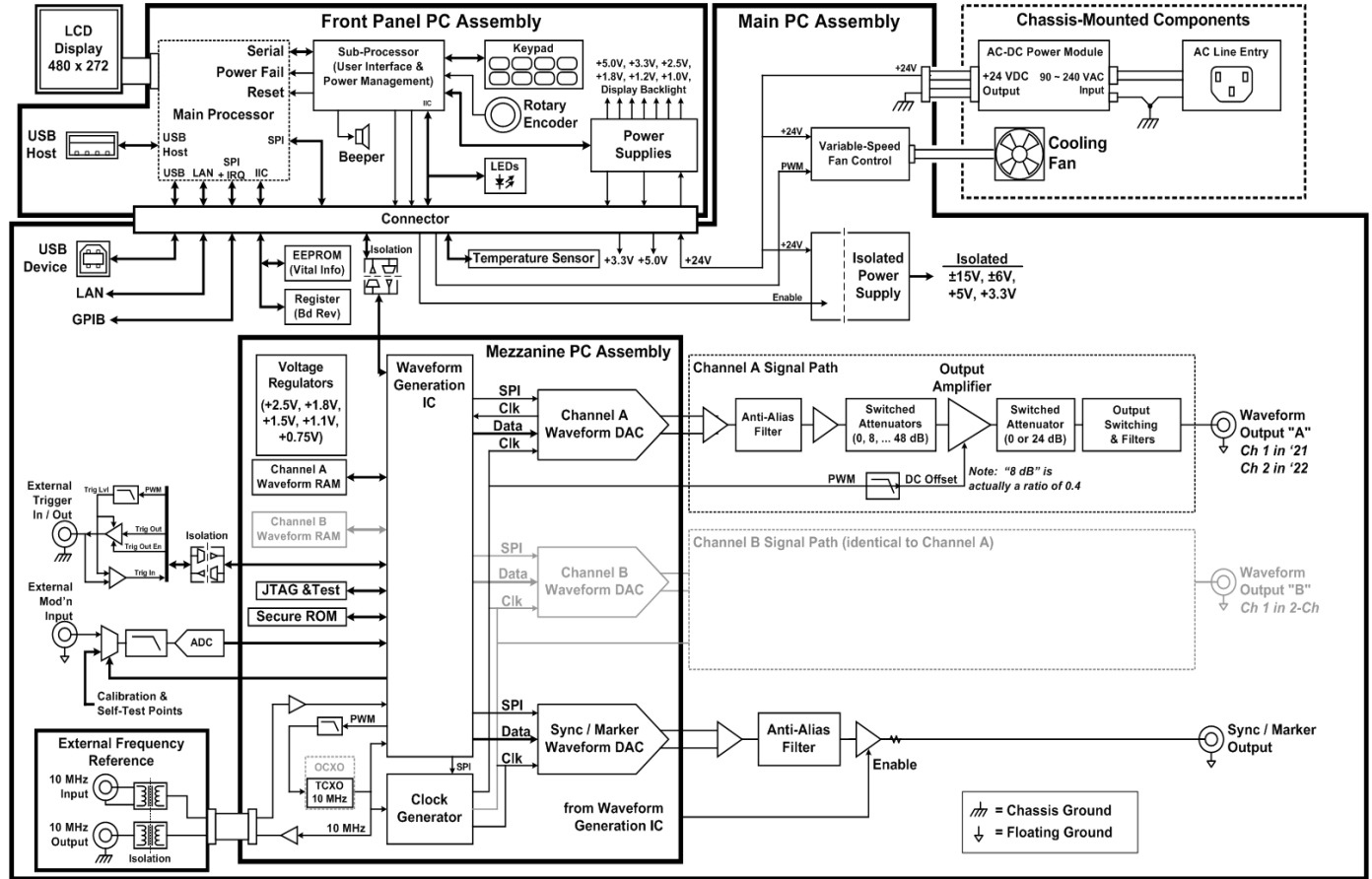
The **Sync** output signal is generated as a waveform from the FPGA to the **Sync** DAC.

External trigger in and out is chassis referenced at the BNC connector but is isolated before the FPGA.

Modulation In is an input to the A/D converter. The FPGA applies the modulation signal to the output waveform.

The instrument's clock generator employs a 10-MHz crystal oscillator and a phase-locked loop to generate the 2-GHz clocks used by the FPGA and Waveform DACs. When an external 10-MHz frequency reference is used, a phase-locked loop in the FPGA keeps the crystal oscillator in sync.

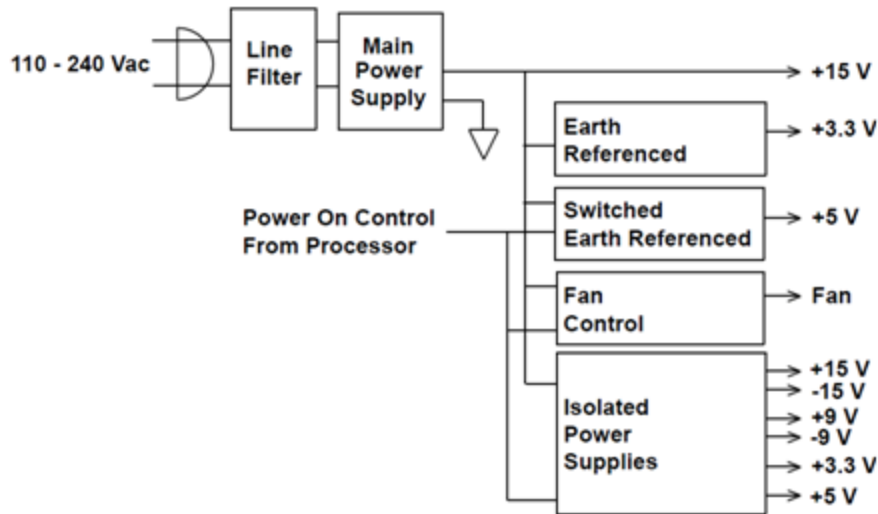
Block Diagram - 33600 Series



Power Supplies - 33500 Series

The line voltage is filtered and applied to the main power supply, a +15 V supply that is always on when line power is applied. A regulator creates an earth referenced +3.3 V supply from the main supply, and this is also always active when line power is applied.

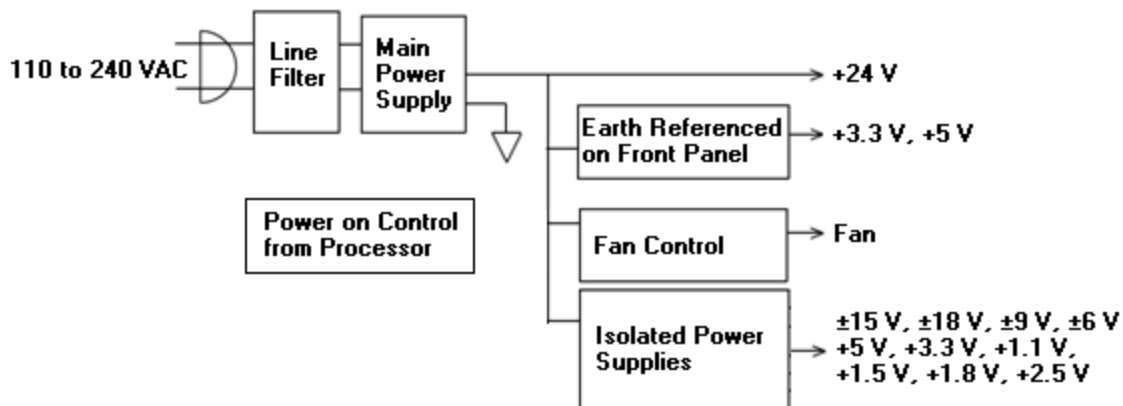
A small microprocessor on the main board senses the power switch and enables all other supplies.



Power Supplies - 33600 Series

The line voltage is filtered and applied to the main power supply, a +24 V supply that is always on when line power is applied. A regulator creates an earth referenced +5 V supply from the main supply, and this is also always active when line power is applied.

A small microprocessor on the front panel senses the power switch and enables all other supplies.



Troubleshooting - 33500 Series

A brief list of common failures appears below. Before troubleshooting or repairing the instrument, make sure the failure is in the instrument rather than any external connections. Also make sure that the instrument was accurately calibrated within the last year. The instrument's circuits allow troubleshooting and repair with basic test equipment.

Unit is Inoperative

Verify that:

- the AC power cord is securely connected to the instrument and plugged into a live outlet
- the front panel Power On/Standby switch has been pushed

Unit Fails Self-Test

Ensure that all connections (front and rear) are removed when self-test is performed. During self-test, errors may be induced by signals present on external wiring, such as long test leads that can act as antennas.

CAUTION

DO NOT swap the motherboard, the processor board, or the front panel board from one instrument to another. These boards contain model number and serial number information that uniquely identifies a specific unit, and boards that are mismatched to the instrument may result in problems with its performance, licensing, serviceability, importability/exportability or warranty.

Power Supplies

Verify the main power supply.

WARNING

Shock Hazard. To check the power supplies, remove the instrument cover as described in [Disassembly](#).

The main power supply provides a +15 VDC (± 0.3 VDC) supply to the main circuit board. All other supplies are derived from this supply. This supply is energized at all times while the line power cord is connected.

Test the supply at the connector to the main board. Note that the supply is not referenced to the chassis when disconnected from the main board.

- Circuit failure can cause heavy supply loads which may pull down the supply output voltage. Disconnect the main supply from the main board to test.
- Always check the supply is free of oscillations using an oscilloscope.
- The main power supply contains a fuse. Replacing this fuse is not recommended. Replace the entire main power supply assembly. Note that power supply failures are often caused by other instrument failures.

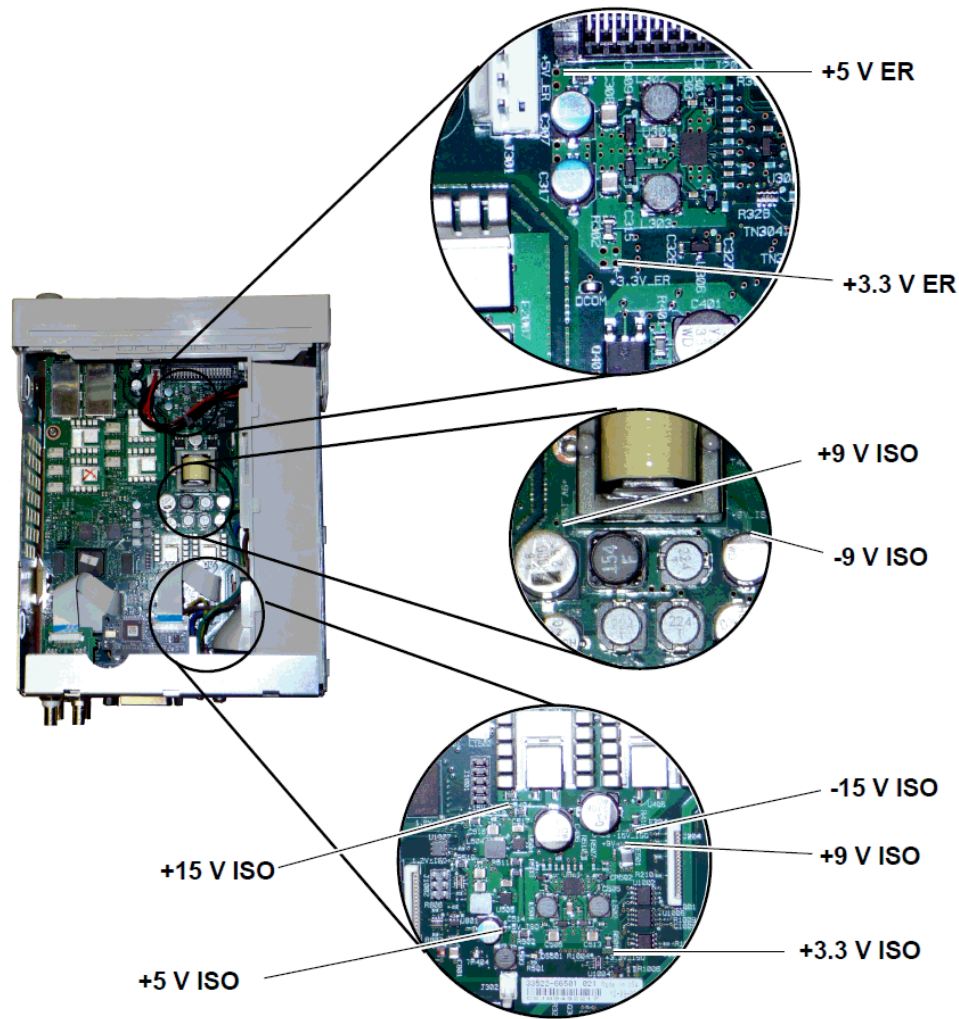
CAUTION

The heat sinks on the main board are at different potentials. Damage may occur if any of the heat sinks are shorted together. Use care when probing the main board.

Verify the power supplies listed in the table below and shown in the [power supply block diagram](#). Earth referenced supplies may be tested using the chassis as ground. Isolated supplied may be tested by using one of the heat sinks shown in the figure.

Supply			
+3.3 V ER*	+15 V Isolated	+9 V Isolated	+3.3 V Isolated
+5 ER	-15 V Isolated	-9 V Isolated	+5 V Isolated

* This supply is active whenever AC power is applied to the instrument.



Self-Test Errors 605 - 609

Self-test errors 605-609 indicate that the processor board is unable to correctly program or communicate with the waveform FPGA (U1005) on the main board. In this case, further troubleshooting is required. The problem could be due to out of date firmware, or a failing or unseated processor board or main board. Before troubleshooting these errors, ensure that the instrument firmware is up to date. If the errors are still being reported, continue with the following procedure.

Reseat the Boards

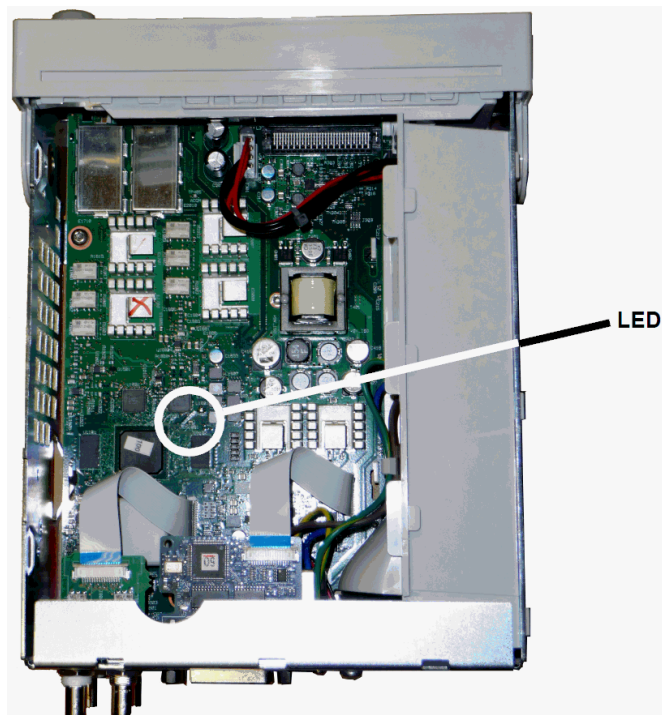
Power off the unit, remove the cover. Reseat the processor board and the main board. Power up the unit and see if the errors 605-609 are still reported at power-on.

Check Power Supplies

Probe the system power supplies and verify they are operating within limits. If any of the power supplies are out of limit, diagnose the power supply. Otherwise, continue on to check SPI communications.

Check SPI Communications

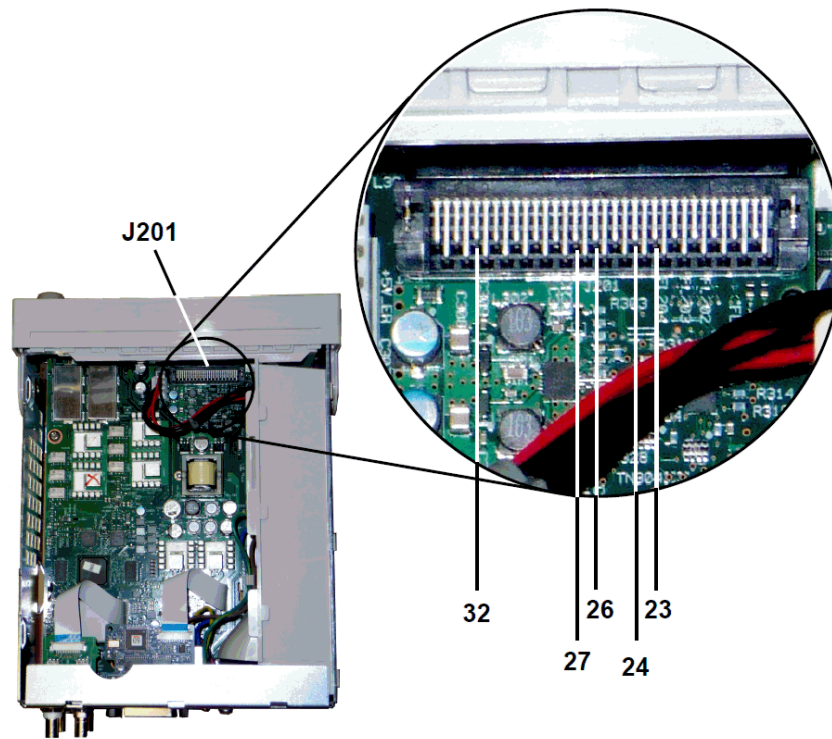
If you still see errors after reseating the boards, the next step is to probe the SPI communications lines between the processor board and the main board. First, locate LED DS1001 on the main board as shown below. Cycle power on the unit, wait until it fully boots, and see whether the main board LED illuminates. The main board LED indicates whether the FPGA was successfully programmed. The following sections indicate which signal lines to probe on the main board connector (J201).



Main Board LED Lights up after Boot

This indicates that the FPGA is programmed and running. Most likely there is a communications failure from the main board to the processor board. Probe the J201, pin 27 line with an oscilloscope, and cycle power on the unit (wait for full boot) to see if there is activity on the line. Activity should be +3.3 V pulses (isolated). Note that activity ceases once the instrument is booted.

- If there is no activity on the line even after the LED lights up, then most likely the main board is the cause of the failure.
- If there is activity on the line, then the processor board is the most likely cause of the failure.



Main Board LED Does not Light up after Boot

This indicates that the processor was unable to program the FPGA. Most likely there is a communications failure from the processor board to the main board. Probe the following serial data lines at power up with an oscilloscope:

- J201, pin 23
- J201, pin 24
- J201, pin 26
- J201, pin 32

If all of the above SPI lines show activity during FPGA programming, then the main board is the most likely cause of the failure. Otherwise, the processor board is the most likely cause.

10 MHz Out

If the power supplies are functional and self-test passes, check the 10 MHz output at the rear panel. This output is present whenever the instrument has powered on and the processor and main board are operational. If the 10 MHz is present, but the display is not working, suspect the front panel board or display assembly.

Troubleshooting - 33600 Series

A brief list of common failures appears below. Before troubleshooting or repairing the instrument, make sure the failure is in the instrument rather than any external connections. Also make sure that the

instrument was accurately calibrated within the last year. The instrument's circuits allow troubleshooting and repair with basic test equipment.

Unit is Inoperative

Verify that:

- the AC power cord is securely connected to the instrument and plugged into a live outlet
- the front panel Power On/Standby switch has been pushed

Unit Fails Self-Test

Ensure that all connections (front and rear) are removed when self-test is performed. During self-test, errors may be induced by signals present on external wiring, such as long test leads that can act as antennas.

CAUTION

DO NOT swap the motherboard, the processor board, or the front panel board from one instrument to another. These boards contain model number and serial number information that uniquely identifies a specific unit, and boards that are mismatched to the instrument may result in problems with its performance, licensing, serviceability, importability/exportability or warranty.

Power Supplies

Verify the main power supply.

WARNING

Shock Hazard. To check the power supplies, remove the instrument cover as described in [Disassembly](#).

The main power supply assembly provides a +24 VDC supply to the main circuit board. All other supplies are derived from this supply. This supply is energized at all times while the line power cord is connected.

CAUTION

Test the supply at the connector to the main board. Note that the supply is not referenced to the chassis when disconnected from the main board. If the connector is connected to the main board, ensure that the main board mounting screw is in place and the AC inlet ground (green/yellow wire) is connected to the chassis.

- Circuit failure can cause heavy supply loads which may pull down the supply output voltage. Disconnect the main supply from the main board to test.
- Always check the supply output is free of oscillations using an oscilloscope.

CAUTION

The main power supply contains two fuses. Replacing these fuses is not recommended. Replace the entire main power supply assembly. Note that power supply failures are often caused by other instrument failures.

CAUTION

The heat sinks on the main board are at different potentials. Damage may occur if any of the heat sinks are shorted together. Use care when probing the main board.

Main Board Power Supplies

Verify the power supplies listed in the table below and shown in the **power supply block diagram**. Earth referenced supplies may be tested using the chassis as ground. Isolated supplies may be tested by using one of the heat sinks.

The line voltage is filtered and applied to the main power supply, a +24 V (± 0.3 VDC) supply that is always on when line power is applied. Regulators on the front panel board create earth referenced +5 V and +3.3 V supplies from the main supply, which are also always active when line power is applied.

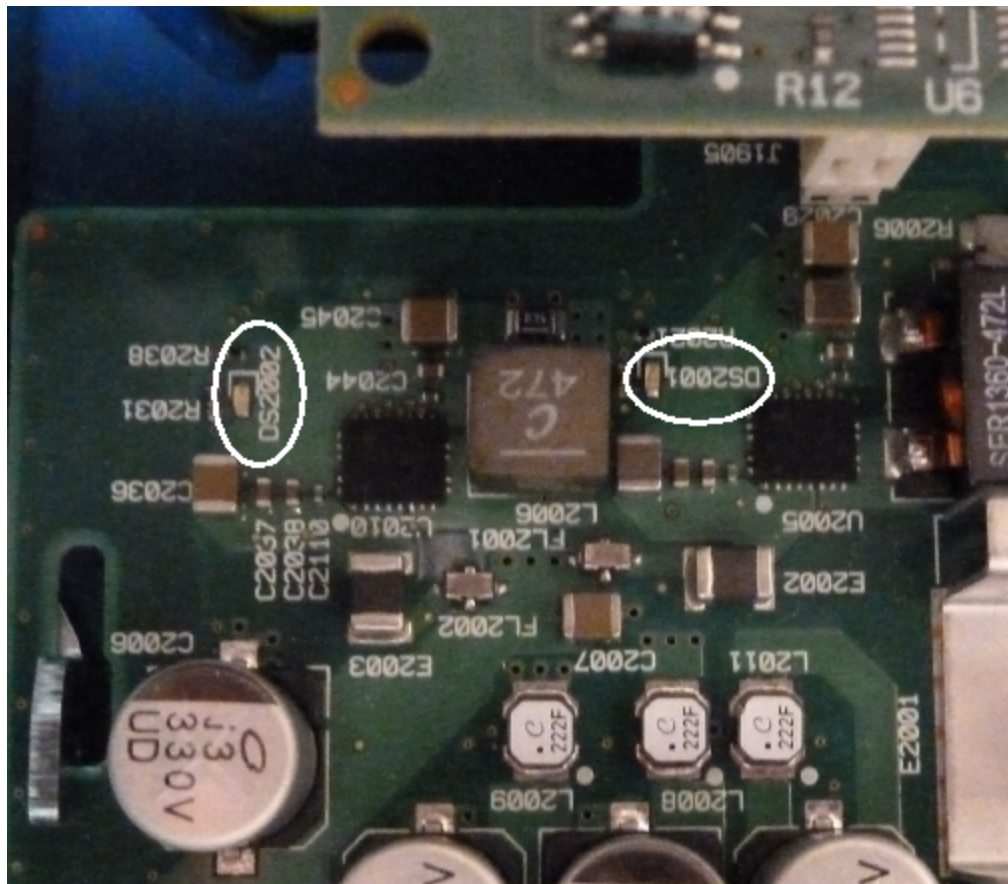
Main board LEDs illuminate at power-on to indicate that the +5 V Isolated and +3.3 V Isolated power supplies are good. On the main board, LED DS2001 illuminates to indicate the +3.3 V Isolated power supply is operating, and LED DS2002 illuminates to indicate the +5 V Isolated power supply is operating.

Power Supplies on Main Board			
+3.3 V ER*	+15 V Isolated	+9 V Isolated	+3.3 V Isolated*** DS2001
+5 ER	-15 V Isolated	-9 V Isolated	+5 V Isolated**, *** DS2002

* This supply is active whenever AC power is applied to the instrument.

** This supply also provides power to the Mezzanine Board power supplies.

*** This supply has a "power-good" indicator LED as indicated in the picture below.



Mezzanine Board Power Supplies

Power Supplies on Mezzanine Board			
+1.1 V*** DS1501	+1.5 V*** DS1501	+1.8 V*** DS1501	+2.5 V*** DS1501

*** This supply has a "power-good" indicator LED as indicated in the picture below.



Self-Test Errors 607 through 611

Self-test errors 607–611 indicate that the processor board is unable to correctly program or communicate with the waveform FPGA (U301) on the mezzanine board. In this case, further troubleshooting is required. The problem could be due to out of date firmware, or a failing or unseated processor board or main board. Before troubleshooting these errors, ensure that the instrument firmware is up to date. If the errors are still reported, continue with the following procedure.

Reseat the Boards

Power off the unit and remove the cover. Reseat the mezzanine board and the main board. Power up the unit and see whether errors 607 through 611 are still reported. Check all power good LEDs to see if the power supplies are operating. Not all power supplies have an LED.

Check SPI Communications

If you still see self-test errors after reseating the boards, the next step is to probe the SPI communications lines between the processor board and the main board. First, locate LED DS1501 on the mezzanine board as shown above. Cycle power on the unit, wait until it fully boots, and see whether the main board "power good" LEDs (DS2001, DS2002) illuminate. Check whether the mezzanine board "power good" LED DS1501 illuminates, indicating the mezzanine board power supplies are good.

Check FPGA programming success

The DS401 LED on the mezzanine board (to the left of DS1501 in the picture above) indicates whether the FPGA was successfully programmed. If illuminated, it indicates that the FPGA is programmed and running. If it fails to light and all power supplies are good, most likely there is a SPI communications failure from the processor board to the main board or from the main board to the mezzanine board.

Check SPI Communications

Probe the front panel to main board connector J201 pins 23, 24, 26 and 27 to check for activity during bootup between the main board and the front panel board. Activity should be +3.3 V pulses (isolated). Note that activity ceases or becomes infrequent once the instrument is booted. If there is no activity, the fault most likely lies in the front panel board.

