FLUKE®

5520A-SC1100

Oscilloscope Calibrator Option

Operators Manual

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5520A-SC1100 Option

⚠Warning

Read the Safety Information section of this document before performing the procedures in this section.

Introduction

The 5520A-SC1100 Option (hereafter referred to as the SC1100) provides functions that help you maintain your oscilloscope's accuracy by verifying and calibrating the following oscilloscope characteristics:

- Vertical deflection characteristics are calibrated and verified. The VOLT function lets you compare the voltage gain to the graticule lines on the oscilloscope.
- Pulse transient response is checked and calibrated, verifying the accuracy of the oscilloscope's measurement of pulse transitions using the EDGE function. Also, the calibrator supports even faster pulse response checks using an external tunnel diode pulser.
- Frequency response is checked by verifying the bandwidth using the Leveled Sine Wave (LEVSINE) function. Vertical deflection is monitored until the -3 dB point is observed on the oscilloscope.
- Horizontal (time base) deflection characteristics are calibrated and verified using the Time MARKER function. This calibration procedure is similar to the one for verifying the vertical deflection characteristics, except that it checks the horizontal axis.
- The oscilloscope's ability to display, capture, and measure pulse width is checked using the PULSE function. This function allows you to vary both the pulse width and the period.
- The oscilloscope's ability to trigger on different waveforms is checked using the Wave Generator (WAVEGEN) function.
- The oscilloscope's ability to trigger on and capture complex TV Trigger signals is checked using the VIDEO function.
- The oscilloscope's input characteristics can be measured using the Input Resistance and Capacitance (MEAS Z) function.

- The oscilloscope's input protection circuit can be tested using the Overload (OVERLD) function.

The menus that implement these functions also include parameters for altering the way the output signal responds to voltage, frequency, and time settings, giving you control of the signal during calibration, and providing more methods for observing the signal's characteristics.

Safety Information

This instrument has been designed and tested in accordance with IEC publication 1010-1 (1992-1), Safety Requirements for Electrical Measuring, Control and Laboratory Equipment, and ANSI/ISA-S82.01-1994, and CAN/CSA-C22.2 No. 1010.1-92. This User Manual contains information, warning, and cautions that must be followed to ensure safe operation and to maintain the instrument in a safe condition. Use of this equipment in a manner not specified herein may impair the protection provided by the equipment.

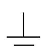
This instrument is designed for IEC 1010-1 Installation Category II use. It is not designed for connection to circuits rated over 4800 VA.

Warning statements identify conditions or practices that could result in personal injury or loss of life.

Caution statements identify conditions or practices that could result in damage to equipment.

Symbols Marked on Equipment

Warning Risk of electric shock.



Ground Ground terminal to chassis (earth).

Attention Refer to the manual (see the Index for references). This symbol indicates that information about usage of a feature is contained in the manual.

AC Power Source

The instrument is intended to operate from an ac power source that will not apply more than 264V ac rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is required for safe operation.

Use the Proper Fuse

To avoid fire hazard, use only the specified replacement fuse:

- For 100 V or 120 V operation, use a 5A/250V time delay fuse (Fluke PN 109215).
- For 220 V or 240 V operation, use a 2.5A/250V time delay fuse (Fluke PN 851931).

Grounding the Instrument

The instrument utilizes controlled overvoltage techniques that require the instrument to be grounded whenever normal mode or common mode ac voltages or transient voltages may occur. The enclosure must be grounded through the grounding conductor of the power cord, or through the rear panel ground binding post.

Safety Information (continued)

Use the Proper Power Cord

Use only the power cord and connector appropriate for the voltage and plug configuration in your country.

Use only a power cord that is in good condition.

Refer power cord and connector changes to qualified service personnel.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate the instrument in an atmosphere of explosive gas.

Do Not Remove Cover During Operation

To avoid personal injury or death, do not remove the instrument cover without first removing the power source connected to the rear panel. Do not operate the instrument without the cover properly installed. Normal calibration is accomplished with the cover closed. Access procedures and the warnings for such procedures are contained both in this manual and in the Service Manual. Service procedures are for qualified service personnel only.

Do Not Attempt to Operate if Protection May be Impaired

If the instrument appears damaged or operates abnormally, protection may be impaired. Do not attempt to operate the instrument under these conditions. Refer all questions of proper instrument operation to qualified service personnel.

SC1100 Option Specifications

These specifications apply only to the SC1100 Option. General specifications that apply to the 5520A (hereafter termed the Calibrator) can be found in Chapter 1 of the *5520A Operators Manual*. The specifications are valid under the following conditions:

- The Calibrator is operated under the conditions specified in Chapter 1 of the *5520A Operators Manual.*
- The Calibrator has completed a warm-up period of at least twice the length of time the calibrator was powered off, up to a maximum of 30 minutes.
- The SC1100 Option has been active longer than 5 minutes.

SC1100 General Specifications

Table 1. SC1100 General Specifications

Warmup Time	Twice the time since last warmed up, to a maximum of 30 minutes
Settling Time	5 seconds or faster for all functions and ranges
Temperature Performance	Operating: 0 °C to 50 °C
	Calibration (tcal): 15 °C to 35 °C
	Storage: -20 °C to 70 °C
Electromagnetic Compatibility	Designed to operate in Standard Laboratory environments where the Electromagnetic environment is highly controlled. If used in areas with Electromagnetic fields >1 V/m, there could be errors in output values. All testing for this specification used new cables and connectors.
Temperature Coefficient	Temperature Coefficient for temperatures outside tcal ±5 °C is 10 % per °C of 1-year specification.
Relative Humidity	Operating: <80 % to 30 °C, <70 % to 40 °C,<40 % to 50 °C
	Storage: <95 %, noncondensing
Altitude	Operating: 3,050 m (10,000 ft) maximum Nonoperating: 12,200 m (40,000 ft) maximum
Safety	Designed to comply with IEC 1010-1 (1992-1); ANSI/ISA-S82.01-1994; CAN/CSA-C22.2 No. 1010.1-92
Analog Low Isolation	20 V
EMC	Complies with EN 61326-1/1997, Class A

Volt Specifications

Table 2. Volt Specifications

	Volt Function			
	DC Signal		**Square Wave Signal [1]**	
	50 Ω Load	**1 MΩ Load**	**50 Ω Load**	**1 MΩ Load**
Amplitude Characteristics				
Range	0 V to ± 6.6 V	0 V to ± 130 V	± 1 mV to ± 6.6 V p-p	± 1 mV to ± 130 V p-p
Resolution	Range		Resolution	
	1 mV to 24.999 mV		1 µV	
	25 mV to 109.99 mV		10 µV	
	110 mV to 2.1999 V		100 µV	
	2.2 V to 10.999 V		1 mV	
	11 V to 130 V		10 mV	
Adjustment Range	Continuously adjustable			
1-Year Absolute Uncertainty, tcal ± 5 °C	± (0.25 % of output + 40 µV)	± (0.05 % of output + 40 µV)	± (0.25 % of output + 40 µV)	± (0.1% of output + 40 µV) [2]
Sequence	1-2-5 (e.g., 10 mV, 20 mV, 50 mV)			
Square Wave Frequency Characteristics				
Range	10 Hz to 10 kHz			
1-Year Absolute Uncertainty, tcal ± 5 °C	± (2.5 ppm of setting)			
Typical Aberration within 4 µs from 50 % of leading/trailing edge	< (0.5 % of output + 100 µV)			

[1] Selectable positive or negative, zero referenced square wave.

[2] For square wave frequencies above 1 kHz, ± (0.25 % of output + 40 µV).

Edge Specifications

Table 3. Edge Specifications

Edge Characteristics into 50 Ω Load		1-Year Absolute Uncertainty, tcal ± 5 °C
Rise Time	≤ 300 ps	(+0 ps / -100 ps)
Amplitude Range (p-p)	5.0 mV to 2.5 V	± (2 % of output + 200 µV)
Resolution	4 digits	
Adjustment Range	± 10 % around each sequence value (indicated below)	
Sequence Values	5 mV, 10 mV, 25 mV, 50 mV, 60 mV, 80 mV, 100 mV, 200 mV, 250 mV, 300 mV, 500 mV, 600 mV, 1 V, 2.5 V	
Frequency Range	1 kHz to 10 MHz [1]	± (2.5 ppm of setting)
Typical Jitter, edge to trigger	< 5 ps (p-p)	
Leading Edge Aberrations [2]	within 2 ns from 50 % of rising edge	< (3 % of output + 2 mV)
	2 to 5 ns	< (2 % of output + 2 mV)
	5 to 15 ns	< (1 % of output + 2 mV)
	after 15 ns	< (0.5 % of output + 2 mV)
Typical Duty Cycle	45 % to 55 %	
Tunnel Diode Pulse Drive	Square wave at 100 Hz to 100 kHz, with variable amplitude of 60 V to 100 V p-p.	

[1] Above 2 MHz, the rise time specification is < 350 ps.

[2] All edge aberration measurements are made with a Tektronix 11801 mainframe with an SD26 input module.

Leveled Sine Wave Specifications

Table 4. Leveled Sine Wave Specifications

Leveled Sine Wave Characteristics into 50 Ω	Frequency Range				
	50 kHz (reference)	**50 kHz to 100 MHz**	**100 MHz to 300 MHz**	**300 MHz to 600 MHz**	**600 MHz to 1100 MHz**
Amplitude Characteristics (for measuring oscilloscope bandwidth)					
Range (p-p)	5 mV to 5.5 V				5 mV to 3.5 V
Resolution	< 100 mV: 3 digits ≥ 100 mV: 4 digits				
Adjustment Range	continuously adjustable				
1-Year Absolute Uncertainty, tcal ± 5 °C	± (2 % of output + 300 µV)	± (3.5 % of output + 300 µV)	± (4 % of output + 300 µV)	± (6 % of output + 300 µV)	± (7 % of output + 300 mV)
Flatness (relative to 50 kHz)	not applicable	± (1.5 % of output + 100 µV)	± (2 % of output + 100 µV)	± (4 % of output + 100 µV)	± (5 % of output ± 100 µV)
Short-Term Amplitude Stability	≤ 1 % [1]				
Frequency Characteristics					
Resolution	10 kHz				100 kHz
1-Year Absolute Uncertainty, tcal ± 5 °C	± 2.5 ppm				
Distortion Characteristics					
2nd Harmonic	≤ -33 dBc				
3rd and Higher Harmonics	≤ -38 dBc				
[1] Within one hour after reference amplitude setting, provided temperature varies no more than ± 5°C.					

Time Marker Specifications

Table 5. Time Marker Specifications

Time Marker into 50 Ω	5s to 50 ms	20 ms to 100 ns	50 ns to 20 ns	10 ns	5 ns to 1 ns
1-Year Absolute Uncertainty at Cardinal Points, tcal ± 5 °C	± (25 + t x 1000) ppm [1]	± 2.5 ppm	± 2.5 ppm	± 2.5 ppm	± 2.5 ppm
Wave Shape	spike or square	spike, square, or 20 %-pulse	spike or square	square or sine	sine
Typical Output Level	> 1 V p-p [2]	> 1 V p-p [2]	> 1 V p-p [2]	>1 V p-p [2]	> 1 V p-p
Typical Jitter (rms)	< 10 ppm	< 1 ppm	< 1 ppm	< 1 ppm	< 1 ppm
Sequence	5-2-1 from 5s to 2 ns (e.g., 500 ms, 200 ms, 100 ms)				
Adjustment Range [3]	At least ± 10 % around each sequence value indicated above.				
Amplitude Resolution	4 digits				

[1] t is the time in seconds.

[2] Typical rise time of square wave and 20 %-pulse (20 % duty cycle pulse) is < 1.5 ns.

[3] Time marker uncertainty is ± 50 ppm away from the cardinal points.

Wave Generator Specifications

Table 6. Wave Generator Specifications

Wave Generator Characteristics	Square Wave, Sine Wave, and Triangle Wave into 50 Ω or 1 MΩ
Amplitude	
Range	into 1 MΩ: 1.8 mV to 55 V p-p into 50 Ω: 1.8 mV to 2.5 V p-p
1-Year Absolute Uncertainty, tcal ± 5 °C, 10 Hz to 10 kHz	± (3 % of p-p output + 100 µV)
Sequence	1-2-5 (e.g., 10 mV, 20 mV, 50 mV)
Typical DC Offset Range	0 to ± (≥40 % of p-p amplitude) [1]
Frequency	
Range	10 Hz to 100 kHz
Resolution	4 or 5 digits depending upon frequency
1-Year Absolute Uncertainty, tcal ± 5 °C	± (25 ppm + 15 mHz)

[1] The dc offset plus the wave signal must not exceed 30 V rms.

Pulse Generator Specifications

Table 7. Pulse Generator Specifications

Pulse Generator Characteristics	**Positive pulse into 50 Ω**
Typical rise/fall times	< 1.5 ns
Available Amplitudes	2.5 V, 1 V, 250 mV, 100 mV, 25 mV, 10 mV
Pulse Width	
Range	4 ns to 500 ns [1]
Uncertainty (typical)	5 % ± 2 ns
Pulse Period	
Range	20 ms to 200 ns (50 Hz to 5 MHz)
Resolution	4 or 5 digits depending upon frequency and width
1-Year Absolute Uncertainty at Cardinal Points, tcal ± 5 °C	± 2.5 ppm
[1] Pulse width not to exceed 40 % of period. [2] Pulse width uncertainties for periods below 2 µs are not specified.	

Trigger Signal Specifications (Pulse Function)

Table 8. Trigger Signal Specifications (Pulse Function)

Time Marker Period	**Division Ratio**	**Amplitude into 50 Ω (p-p)**	**Typical Rise Time**
20 ms to 150 ns	off/1/10/100	≥ 1 V	≤ 2 ns

Trigger Signal Specifications (Time Marker Function)

Table 9. Trigger Signal Specifications (Time Marker Function)

Pulse Period	**Division Ratio**	**Amplitude into 50 Ω (p-p)**	**Typical Rise Time**
5 s to 750 ns	off/1	≥ 1 V	≤ 2 ns
34.9 ms to 7.5 ns	off/10	≥ 1 V	≤ 2 ns
34.9 ms to 2 ns	off/100	≥ 1 V	≤ 2 ns

Trigger Signal Specifications (Edge Function)

Table 10. Trigger Signal Specifications (Edge Function)

Edge Signal Frequency	**Division Ratio**	**Typical Amplitude into 50 Ω (p-p)**	**Typical Rise Time**	**Typical Lead Time**
1 kHz to 10 MHz	off/1	≥ 1 V	≤ 2 ns	40 ns

Trigger Signal Specifications (Square Wave Voltage Function)

Table 11. Trigger Signal Specifications (Square Wave Voltage Function)

Edge Signal Frequency	Division Ratio	Typical Amplitude into 50 Ω (p-p)	Typical Rise Time	Typical Lead Time
10 Hz to 10 kHz	off/1	≥ 1 V	≤ 2 ns	2 µs

TV Trigger Signal Specifications

Table 12. TV Trigger Signal Specifications

Trigger Signal Type	Parameters
Field Formats	Selectable NTSC, SECAM, PAL, PAL-M
Polarity	Selectable inverted or uninverted video
Amplitude into 50 Ω (p-p)	Adjustable 0 to 1.5 V p-p into 50 ohm load, (± 7 % accuracy)
Line Marker	Selectable Line Video Marker

Oscilloscope Input Resistance Measurement Specifications

Table 13. Oscilloscope Input Resistance Measurement Specifications

Scope input selected	50 Ω	1 MΩ
Measurement Range	40 Ω to 60 Ω	500 kΩ to 1.5 MΩ
Uncertainty	0.1 %	0.1 %

Oscilloscope Input Capacitance Measurement Specifications

Table 14. Oscilloscope Input Capacitance Measurement Specifications

Scope input selected	1 MΩ
Measurement Range	5 pF to 50 pF
Uncertainty	± (5 % of input + 0.5 pF) [1]

[1] Measurement made within 30 minutes of capacitance zero reference. Scope option must be selected for at least five minutes prior to any capacitance measurement, including the zero process.

Overload Measurement Specifications

Table 15. Overload Measurement Specifications

Source Voltage	Typical ‘On’ current indication	Typical ‘Off’ current indication	Maximum Time Limit DC or AC (1 kHz)
5 V to 9 V	100 mA to 180 mA	10 mA	setable 1 s to 60 s

Oscilloscope Connections

Using the cable supplied with the SC1100 Option, connect the SCOPE output on the Calibrator to one of the channel connectors on your oscilloscope (see Figure 1).

To use the external trigger, connect the TRIG OUT output on the Calibrator to the external trigger connection on your oscilloscope. To use the external trigger and view its signal with the calibration signal, connect the TRIG OUT output to another channel. See your oscilloscope manual for details on connecting and viewing an external trigger.

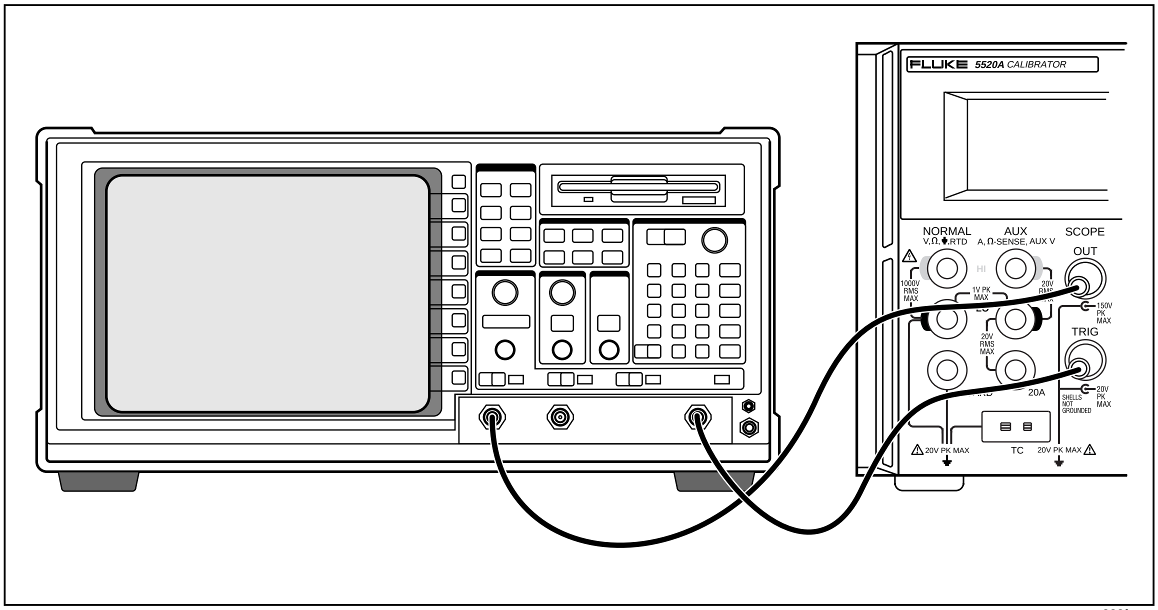


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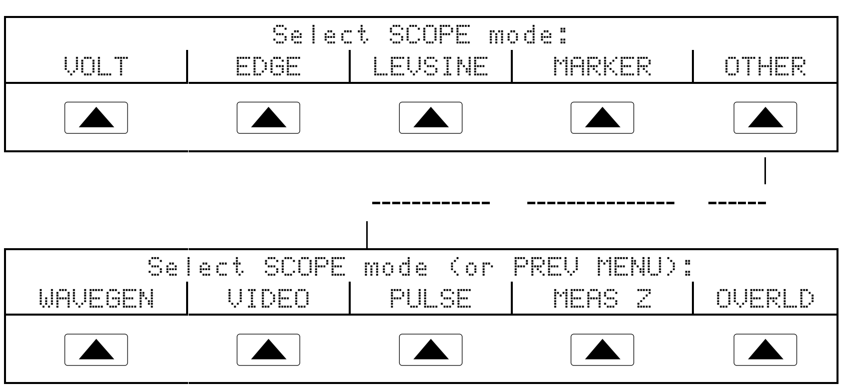
Figure 1. Oscilloscope Connection: Channel and External Trigger

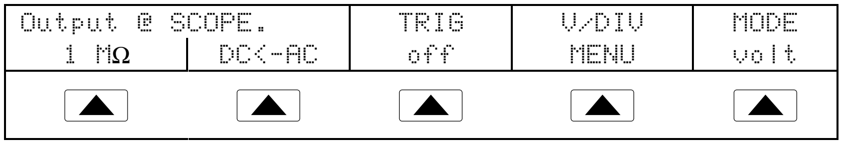
Starting the SC1100 Option

Press SCOPE (LED lit) to select the SC1100 Option. The SCOPE menu, shown below, appears in the Control Display. You can press any of the first four softkeys to go directly to the VOLT, EDGE, LEVSINE, and MARKER calibration menus. Press the last softkey to go to the OTHER menu (also shown below), allowing access to WAVEGEN, VIDEO, PULSE, Impedance/Capacitance measurement (MEAS Z), and Overload (OVERLD) menus. Press PREV MENU to return to the SCOPE menu from the OTHER menu. This manual describes each of these menus in detail.



The Output Signal

The following description assumes that you have selected VOLT mode from the SCOPE menu. The Control Displays appears as follows with VOLT mode selected:



The location of the output signal is indicated on the Control Display (the display on the right side). If your Calibrator is connected, but the output does not appear on the oscilloscope, you may have the Calibrator in standby mode. The settings for the output signal are indicated in the Output Display (the display on the left side).

If STBY is displayed, press the OPR key. The Output Display will show OPR and the output should appear on the oscilloscope.

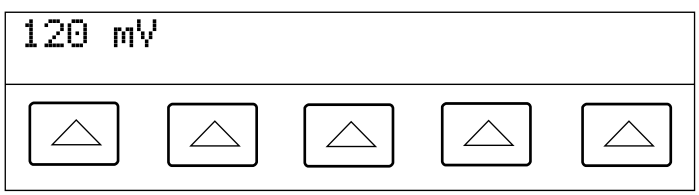
Adjusting the Output Signal

The Calibrator provides several ways to change the settings for the output signal during calibration. Since oscilloscope calibration requires many adjustments of the output signal, the three available methods for changing these settings for oscilloscope calibration are summarized below. These methods provide the means of jumping to a new value or sweeping through a range of values.

Keying in a Value

The following example is for use in the LEVSINE mode. To key a specific value directly into the Calibrator from its front panel:

1. Key in the value you want to enter, including the units and prefixes. For example to enter 120 mV press 1 2 0 μ m dBm V. The Control Display will show:



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Note

Units and prefixes printed in red in the upper left corner of the keys are accessed through the SHIFT *key. For example, to enter 200 μs, press* 2 0 0 SHIFT μ m SHIFT sec Hz.

If you make an error, press CE to clear the Control Display and return to the menu.

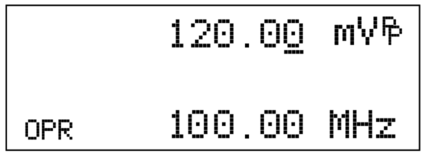
2. Press ENTER to activate the value and move it to the Output Display.

   Other settings in the display will remain unaltered unless you key in an entry and specify the units for that setting.

Adjusting Values with the Rotary Knob

To adjust values in the Output Display using the rotary knob:

1. Turn the rotary knob. A cursor appears in the Output Display under the lowest digit and begins changing that digit. If you wish to place the cursor in the field without changing the digit, press [EDIT FIELD].



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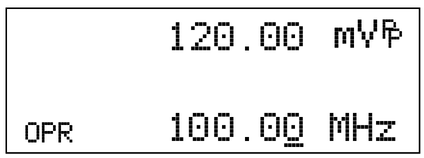
2. To move the cursor between the voltage and frequency fields, press [EDIT FIELD].



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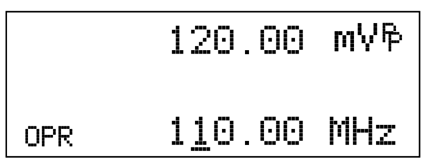
3. Use the [◀] and [▶] keys to move the cursor to the digit you want to change.
4. Turn the rotary knob to change the value.

   When you use the rotary knob in either VOLT mode or MARKER mode, the Control Display shows the new value's percentage change from the reference value. This is useful for determining the percentage of error on the oscilloscope. You can set the reference value to the new value by pressing [NEW REF] .



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5. Press [ENTER] to remove the cursor from the Output Display and save the new value as the reference value.

Note

If you attempt to use the rotary knob to adjust a value to an amount that is invalid for the function you are using, or is outside the value's range limit, the value will not change and the Calibrator will beep.

Using [MULT X] and [DIV ÷]

The [MULT X] and [DIV ÷] keys cause the current value of the signal to jump to a pre-determined cardinal value, whose amount is determined by the current function. These keys are described in more detail under the descriptions for each function.

Resetting the SC1100 Option

You can reset all parameters in the Calibrator to their default settings at any time during front panel operations by pressing the RESET key on the front panel.

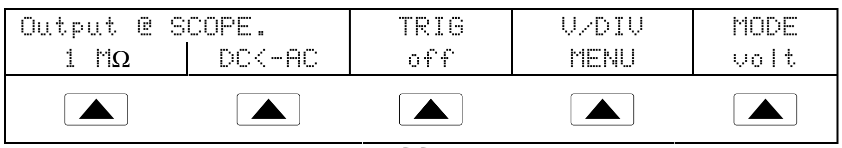
After resetting the Calibrator, press SCOPE to return to the SC1100 Option (the SCOPE menu appears.) Press OPR to reconnect the signal output.

Calibrating the Voltage Amplitude on an Oscilloscope

The oscilloscope voltage (vertical) gain is calibrated by applying a dc or low frequency square wave signal and adjusting its gain to meet the height specified for different voltage levels, as designated by the graticule line divisions on the oscilloscope. The signal is applied from the Calibrator in VOLT mode. The specific voltages that you should use for calibration, and the graticule line divisions that need to be matched, vary for different oscilloscopes and are specified in your oscilloscope's service manual.

The VOLT Function

You can calibrate the Voltage gain using the VOLT function. Access this function through the VOLT menu, which appears when you press SCOPE, or when you press the VOLT softkey from the SCOPE menu.



1 MΩ 50 Ω	**DC<-AC** DC->AC	**off** /1	(see "The V/DIV Menu")	**volt** edge levsine marker wavegen video pulse meas Z overld

You can press the MODE softkey to cycle through the functions in the order shown, or you can press PREV MENU to return directly to the SCOPE menu.

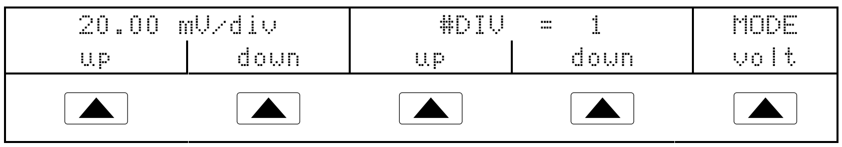
Each menu item is described below:

- **OUTPUT @ SCOPE** Indicates the location of the signal output. If the signal does not appear on the oscilloscope, press OPR. To disconnect the signal, press STBY.
- **1 MΩ** Toggles between 1 MΩ and 50 Ω to match the input impedance of the oscilloscope.
- **DC<-AC** Toggles from ac to dc, producing the dc equivalent output. **DC->AC** Toggles from dc to ac.
- **TRIG** If you are using square wave to calibrate the external trigger, use this key to toggle the trigger off and on. When on, the reading will show "/1", which indicates that the external trigger is at the same frequency as the volt output. The external trigger can be useful for many oscilloscopes that have difficulty triggering on low amplitude signals. You can also toggle the trigger off and on by pressing TRIG OUT.

- **V/DIV MENU** Opens the voltage scaling menu, which lets you select the scale of the signal in volts per division. This menu is described below in detail, under "The V/DIV Menu."
- **MODE** Indicates you are in VOLT mode. Use the softkey to change modes and open menus for other oscilloscope calibration modes.

The V/DIV Menu

The V/DIV menu, shown below, sets the number of volts denoted by each division on the oscilloscope. This menu provides alternative methods for changing the output amplitude that may be more convenient for certain oscilloscope applications. To access the V/DIV menu, press V/DIV from the VOLT menu.




```
     |         |         |         |      volt
     -----------         -----------      edge
          |                   |           levsine
  1 mV       0.5 V            1           marker
  2 mV       1 V              2           wavegen
  5 mV       2 V              3           video
 10 mV       5 V              4           pulse
 20 mV      10 V              5           meas Z
 50 mV      20 V              6           overld
100 mV      50 V              7
200 mV     100 V              8
```

Each item in the V/DIV menu is described below:

- **V/div** Changes the number of volts per division in the Output Display so that the values selected correspond to the oscilloscope's input sensitivity (VOLTS/DIV.) The available settings, shown in the figure above, are provided in 1-2-5 step increments. Press the softkey under UP to increase the volts per division. Press the softkey under DOWN to decrease the volts per division.
- **#DIV** Specifies the number of divisions that establish the peak-to-peak value of the waveform. The value can be adjusted from one to eight divisions. The amount denoted by each division is displayed in the V/div field. Press the softkey under UP to increase the signal's height, and press the softkey under DOWN to decrease it.

Shortcuts for Setting the Voltage Amplitude

The [MULT X] and [DIV ÷] keys step the voltages through cardinal point values of an oscilloscope in a 1-2-5 step sequence. For example, if the voltage is 40 mV, pressing [MULT X] increases the voltage to the nearest cardinal point, which is 50 mV. Pressing [DIV ÷] decreases the voltage to the nearest cardinal point, which is 20 mV.

Oscilloscope Amplitude Calibration Procedure

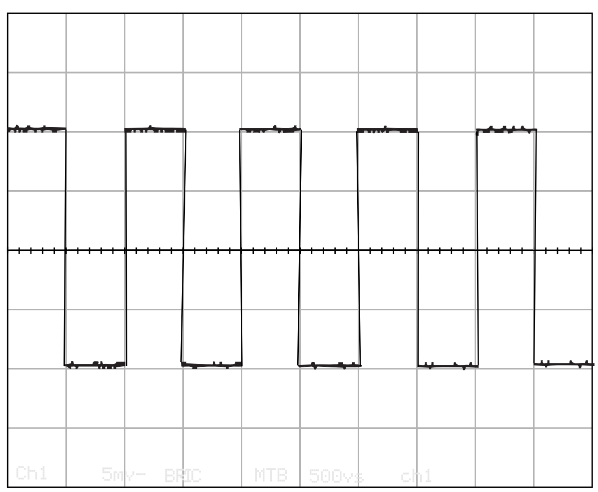
The following example describes how to use the VOLT menu to calibrate the oscilloscope's amplitude gain. During calibration, you will need to set different voltages and verify that the gain matches the graticule lines on the oscilloscope according to the specifications for your particular oscilloscope. See your oscilloscope manual for the recommended calibration settings and appropriate gain values.

Before you start this procedure, verify that you are running the SC1100 Option in VOLT mode. If you are, the Control Display shows the following menu.

Output @ SCOPE.		TRIG	V/DIV	MODE
1 MΩ	DC<-AC	off	MENU	volt
▲	▲	▲	▲	▲

Perform the following sample procedure to calibrate the vertical gain:

1. Connect the calibrator to Channel 1 on the oscilloscope, making sure the oscilloscope is terminated at the proper impedance (1 MΩ for this example). Verify that the [OPR] key on the Calibrator is lit, indicating that the signal is connected.
2. Key in the voltage level that is recommended for your oscilloscope. For example to enter 20 mV, press [2] [0] [µ m] [dBm V], then press [ENTER]. See "Keying in a Value" earlier in this manual.
3. Adjust the oscilloscope as necessary. The waveform should be similar to the one shown below, with the gain at exactly the amount specified for the calibration settings for your oscilloscope. This example shows the gain at 20 mV to be 4 divisions, at 5 mV per division.



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4. Change the voltage to the next value recommended for calibrating your oscilloscope model, and repeat this procedure at the new voltage level, verifying the gain is correct according to the specifications in your manual.
5. Repeat the procedure for each channel.

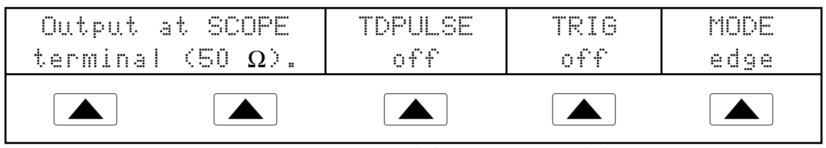
Calibrating the Pulse and Frequency Response on an Oscilloscope

The pulse response is calibrated with a square-wave signal that has a fast leading edge rise-time. Using this signal, you adjust the oscilloscope as necessary until it meets its particular specifications for rise time and pulse aberrations.

Following pulse verification, the frequency response is checked by applying a leveled sine wave and acquiring a frequency reading at the -3 dB point, when the amplitude drops approximately 30 %.

The Edge Function

The EDGE function is used for calibrating the pulse response for your oscilloscope. To reach the EDGE menu, press the softkey under MODE until "edge" appears.



TDPULSE	TRIG	MODE
off	**off**	volt
on	/1	**edge**
		levsine
		marker
		wavegen
		video
		pulse
		meas Z
		overld

You can press the MODE softkey to cycle through the functions in the order shown, or you can press PREV MENU to return directly to the SCOPE menu.

Each option in the EDGE menu is described below:

- **OUTPUT @ SCOPE terminal (50Ω)** Indicates the location and impedance of the signal output. If the signal does not appear on the oscilloscope, press OPR. To disconnect the signal, press STBY.

  You cannot change the output impedance in EDGE mode.

- **TD PULSE** Press once to turn the Tunnel Diode Pulser drive signal on, again to turn the Pulser drive off. This signal sources up to 100 V p-p to drive a Tunnel Diode Pulser (Fluke Part Number 606522, Tektronix 067-0681-01, or equivalent.)

- **TRIG** If you are using the external trigger, use this key to toggle the trigger off and on. When on, the reading will show "/1" which indicates that the external trigger is at the same frequency as the edge output. The external trigger can be useful for many oscilloscopes that have difficulty triggering on low amplitude signals.

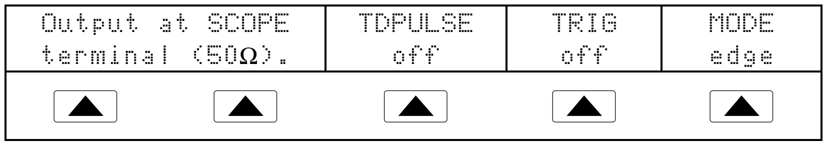
  You can also toggle the trigger off and on by pressing TRIG OUT.

- **MODE** Indicates you are in EDGE mode. Use the softkey to change modes and open menus for other oscilloscope calibration modes.

Oscilloscope Pulse Response Calibration Procedure

This sample procedure shows how to check the oscilloscope's pulse response. Before you check your oscilloscope, see your oscilloscope's manual for the recommended calibration settings.

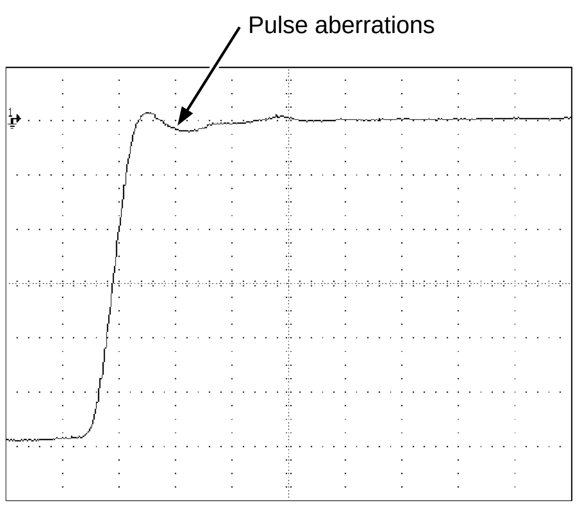
Before you start this procedure, verify that you are running the SC1100 Option in EDGE mode. If you are, the Control Display shows the following menu.



Perform the following sample procedure to calibrate the pulse response:

1. Connect the Calibrator to Channel 1 on the oscilloscope. Select 50 Ω impedance or use a 50 Ω termination directly at the oscilloscope input. Verify that the OPR key is lit, indicating that the signal is connected.
2. Alter the voltage setting for the signal so it matches the amplitude value recommended by your oscilloscope manufacturer for calibrating the edge response. The default setting is 25.00 mV p-p, 1.0000 MHz.

   For example, on an HP 54522C oscilloscope, start with a signal of 1 V @ 1 MHz.
3. Adjust the scale on your oscilloscope to achieve a good picture of the edge.
4. Adjust the time base on your oscilloscope to the fastest position available (20.0 or 50.0 ns/div).



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5. Verify that your oscilloscope exhibits the proper rise time and pulse aberration characteristics.
6. Remove the input signal by pressing STBY.

Pulse Response Calibration Using a Tunnel Diode Pulser

You can use the calibrator to drive a tunnel diode pulser (Fluke Part Number 606522, or Tektronix 067-0681-01, or equivalent), allowing you to check for pulse edge rise times as fast as 125 ps.

The calibrator sources a maximum pulser drive signal of 100 V p-p at 100 kHz. The recommended (and default) output setting is 80 V p-p at 100 kHz.

Perform the following procedure to use a tunnel diode pulser:

1. Connect the calibrator, tunnel diode pulser, and oscilloscope as shown in Figure 2.
2. With the SC1100 Option in EDGE mode, press the TDPULSE softkey to “on”.
3. Press OPR.
4. Rotate the control on the pulser box to the minimum setting necessary to trigger a reading.

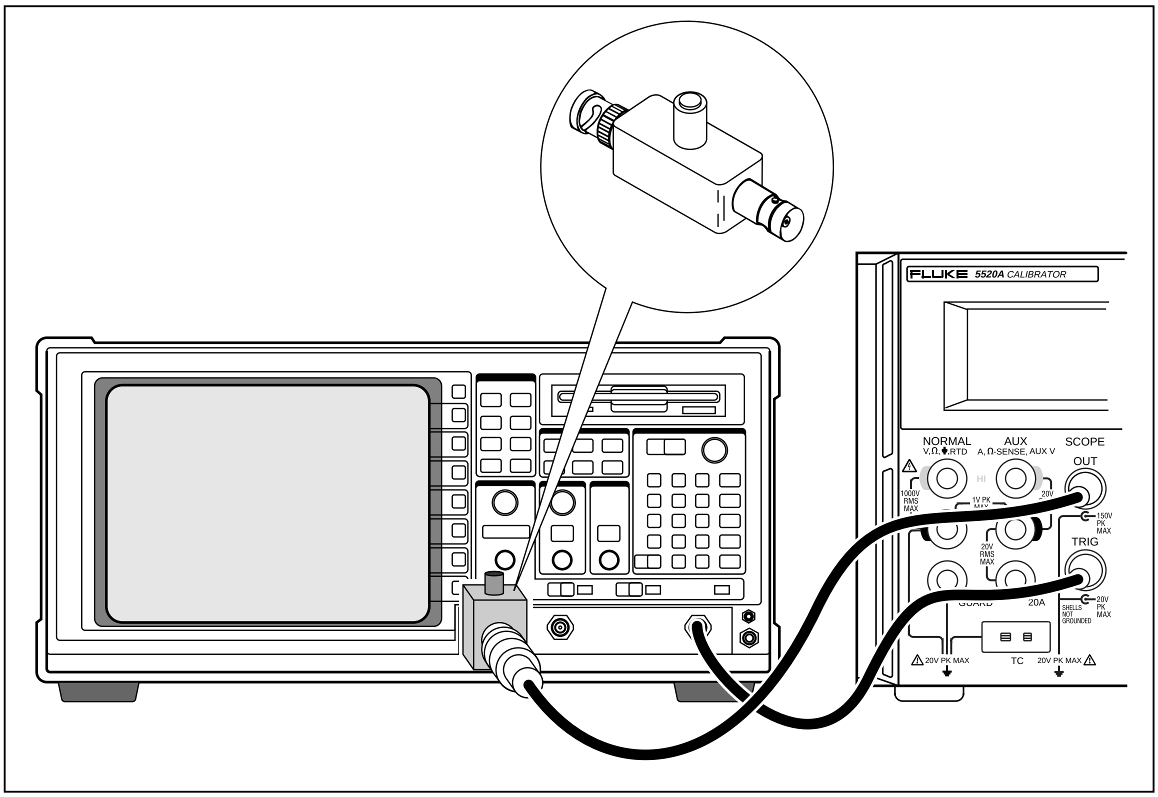

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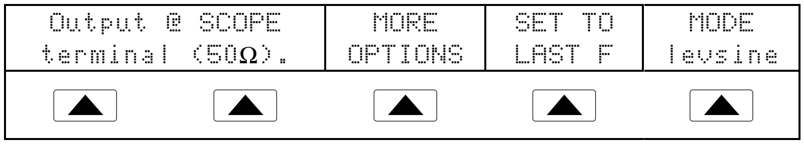
Figure 2. Tunnel Diode Pulser Connections

The Leveled Sine Wave Function

The Leveled Sine Wave (LEVSINE) function uses a leveled sine wave, whose amplitude remains relatively constant over a range of frequencies, to check the oscilloscope’s bandwidth. When you check your oscilloscope, you change the wave’s frequency until the amplitude displayed on the oscilloscope drops 30 %, which is the amplitude that corresponds to the -3 dB point. Default values are 30 mV p-p, 50 kHz.

To access the LEVSINE menu, press the softkey under MODE until “levsine” appears.



(see “The MORE OPTIONS Menu”)	**LAST F** 50 kHz	volt edge **levsine** marker wavegen video pulse meas Z overld

You can press the MODE softkey to cycle through the functions in the order shown, or you can press PREV MENU to return directly to the SCOPE menu.

Each option in the LEVSINE menu is described below:

- **OUTPUT @ SCOPE terminal (50Ω)** Indicates the location and impedance of the signal output. If the signal does not appear on the oscilloscope, press OPR. To disconnect the signal, press STBY. You cannot change the impedance while you are in LEVSINE mode.
- **MORE OPTIONS** Opens additional menu items, which are described in detail under “The MORE OPTIONS Menu.”
- **SET TO LAST F** Toggles between the current frequency setting and the reference value of 50 kHz. This option is useful for reverting to the reference to check the output after you make adjustments at another frequency.
- **MODE** Indicates you are in LEVSINE mode. Use the softkey to change modes and open menus for other calibration modes.

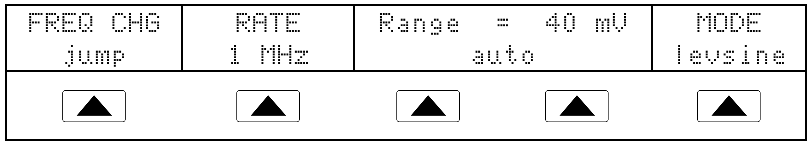
Shortcuts for Setting the Frequency and Voltage

The following three options are available for controlling the sine wave settings:

- **SET TO LAST F** toggles between the last frequency used and the reference frequency of 50 kHz, letting you check the output at the reference after you make adjustments at a different frequency.
- **MORE OPTIONS** lets you use an automatic frequency sweep and lock the voltage range, if necessary. The following section provides details on this menu.
- **The MULT X and DIV ÷ keys** step frequencies up or down in amounts that let you quickly access a new set of frequencies. For example, if the value is 250 kHz, MULT X changes it to 300 kHz, and DIV ÷ changes it to 200 kHz. For voltage values, MULT X and DIV ÷ step through cardinal point values in a 1.2-3-6 sequence.

The MORE OPTIONS Menu

When you select MORE OPTIONS, you open options that give you more control over the frequency and voltage. To access the MORE OPTIONS menu, press the softkey under MORE OPTIONS in the LEVSINE menu.




```
jump      1 MHz     |------------|   volt
sweep     10 MHz        auto         edge
          100 kHz       locked       levsine
                                     marker
                        10 mV        wavegen
                        40 mV        video
                        100 mV       pulse
                        400 mV       meas Z
                        1.3 V        overld
                        5.5 V
```

Each option in the MORE OPTIONS menu is described below:

- **FREQ CHG** Toggles between two settings that control the way the output signal adjusts to a new frequency. “Jump” is the default setting.

  “Jump” causes the output signal to jump immediately to a new frequency setting. “Sweep” causes the signal to sweep through a series of frequency values, over a range you set. Use the sweep function to watch the signal gradually change over a given bandwidth and see the point at which its amplitude changes. Details for using the sweep function are provided under “Sweeping Through a Frequency Range.”

- **RATE** Used when FREQ CHANGE is set to “sweep” to select a sweep speed of 100 kHz, 1 MHz, or 10 MHz.

  A slower sweep rate lets you watch the frequency change very slowly. After a faster sweep, you may want to pinpoint a certain frequency with a slower sweep over a subset of your previous frequency range.

- **RANGE** The softkeys toggle between two settings. The first setting (“auto”) changes the range limit automatically in accordance with the voltage level. The second setting (“locked”) freezes the present range limit; subsequent changes in voltage level are then measured with this range limit.

  There are six range limits in LEVSINE mode: 10 mV, 40 mV, 100 mV, 400 mV, 1.3 V, and 5.5 V (note: 3.5 V maximum above 600 MHz). When set to “auto” the calibrator uses your voltage setting to automatically set the range limit that provides the most accurate output.

  When set to “locked” the range limit remains fixed and you can decrease the voltage down to the bottom of the range.

  For example, assume the range limit is 40 mV. If you enter 5 mV with “auto” selected, the calibrator will automatically change the range limit to 10 mV and output 5 mV from within the 10 mV range. However, if you start with the 40 mV range “locked” and then enter 5 mV, the calibrator will output 5 mV from within the 40 mV range.

The default range setting is "auto," which should always be used unless you are troubleshooting discontinuities in your oscilloscope's vertical gain. The range setting will always return to "auto" after you leave LEVSINE mode.

- **MODE** Indicates you are in LEVSINE mode. Use the softkey to change modes and open menus for other calibration modes.

Sweeping Through a Frequency Range

When you change frequencies using the sweep method, the output sine wave sweeps through a specified range of frequencies. This feature lets you identify the frequency at which the oscilloscope's signal exhibits certain behavior; you can quickly see the frequency response of the oscilloscope. Before you start this procedure, make sure you are in the MORE OPTIONS menu and the sine wave is displayed on the oscilloscope.

Perform the following procedure to sweep through frequencies:

1. Make sure the output signal shows the starting frequency. If not, key in the starting frequency; then press ENTER.
2. Toggle FREQ CHANGE to "sweep." Toggle the RATE to a lower frequency if you want to observe a very slow sweep over a small range.
3. Key in the end frequency; then press ENTER. After you press ENTER, the signal sweeps through frequencies between the two values you entered, and the Sweep menu ("Sweeping from previous to displayed frequency") appears on the Control Display.
4. You can let the signal sweep through the entire range, or you can halt the sweep if you need to record the frequency at a certain point.

   To interrupt the sweep, press the softkey under HALT SWEEP. The current frequency will appear on the Output Display and the MORE OPTIONS menu will reappear on the Control Display.

   Note

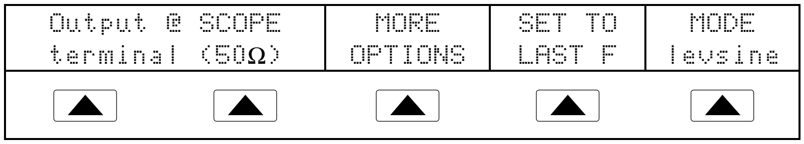
   When you interrupt the frequency sweep by pressing HALT SWEEP, the FREQ CHANGE method switches back to "jump."
5. Repeat the procedure if necessary. For example, if you did a fast sweep, you may want to pinpoint a certain frequency with a slow sweep over a subset of your previous frequency range.

Oscilloscope Frequency Response Calibration Procedure

This sample procedure, which verifies the frequency response on your oscilloscope, is usually performed after the pulse response is verified.

This procedure checks the bandwidth by finding the frequency at the -3 dB point for your oscilloscope. The reference sine wave in this procedure has an amplitude of 6 divisions, so that the -3 dB point can be found when the amplitude drops to 4.2 divisions.

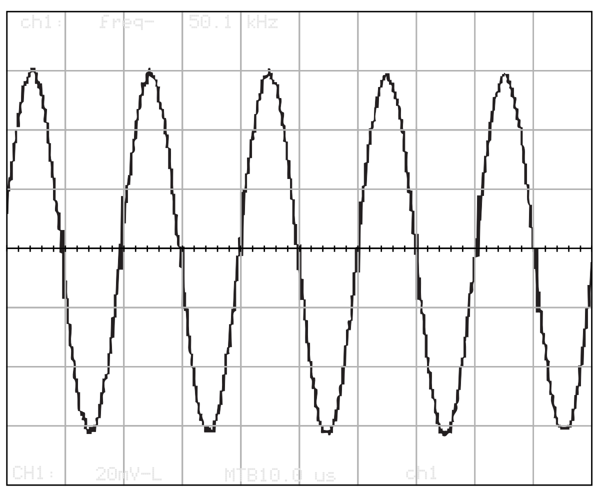
Before you start this example procedure, verify that you are running the SC1100 Option in LEVSINE mode. If you are, the Control Display shows the following menu.



Perform the following sample procedure to calibrate the frequency response:

1. Reconnect the signal by pressing the [OPR] key on the Calibrator. Select 50 Ω impedance or use a 50 Ω external termination directly at the oscilloscope input.
2. Adjust the sine wave settings in the Output Display according to the calibration recommendations in your oscilloscope manual. For example, for the HP 54522C oscilloscope, start at 600 mV @ 1 MHz. To enter 600 mV, press [6] [0] [0] [μ m] [dBm V]; then press [ENTER].
3. Adjust the oscilloscope as necessary. The sine wave should appear at exactly six divisions, peak-to-peak, as shown below.

   If necessary, make small adjustments to the voltage amplitude until the wave reaches exactly six divisions. To fine-tune the voltage, press [EDIT FIELD] to bring a cursor into the Output Display, move the cursor with the [◀] key, and turn the rotary knob to adjust the value. (See "Adjusting Values with the Rotary Knob" earlier in this manual.)



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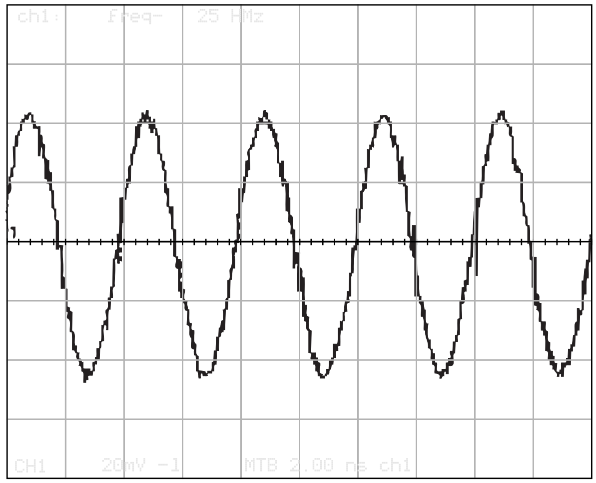
4. Increase the frequency to 400 MHz (for 400-MHz instruments), or 500 MHz (for 500-MHz instruments). To enter 400 MHz, press [4] [0] [0] [p M] [sec Hz]; then press [ENTER].
5. Continue to increase the frequency slowly until the waveform decreases to 4.2 divisions, as shown below.

   To increase the frequency slowly, fine-tune it using the rotary knob. To do this, press [EDIT FIELD] to place a cursor in the Output Display. Press [EDIT FIELD] again to place it in the frequency field, and use the [◀] and [▶] keys to move it to the digit you want to change. Then change the value by turning the rotary knob. Continue making small increments in the frequency until the signal drops to 4.2 divisions. At 4.2 divisions, the signal is at the frequency that corresponds to the -3 dB point.



gl010i.eps

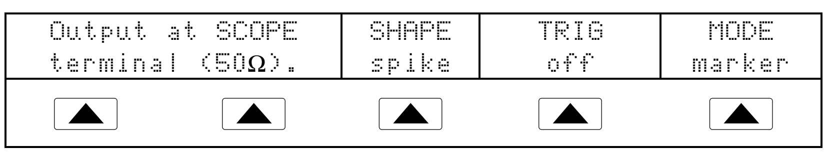
6. Remove the input signal by pressing STBY.
7. Repeat this procedure for the remaining channels on your oscilloscope.

Calibrating the Time Base of an Oscilloscope

The horizontal deflection (time base) of an oscilloscope is calibrated using a method similar to the vertical gain calibration. A time marker signal is generated from the Calibrator and the signal's peaks are matched to the graticule line divisions on the oscilloscope.

The Time Marker Function

The Time MARKER function, which is available through the MARKER menu, lets you calibrate the timing response of your oscilloscope. To access the MARKER menu, press the softkey under MODE until "marker" appears.



SHAPE	TRIG	MODE
sine	**off**	volt
spike	/1	edge
square	/10	levsine
sq20 %	/100	**marker**
		wavegen
		video
		pulse
		meas Z
		overld

You can press the MODE softkey to cycle through the functions in the order shown, or you can press PREV MENU to return directly to the SCOPE menu.

Each option in the MARKER menu is described below:

- **OUTPUT @ SCOPE terminal (50Ω)** Indicates the location of the signal output. If the signal does not appear on the oscilloscope, press [OPR]. To disconnect the signal, press [STBY].
- **SHAPE** Indicates the type of waveform. Depending on frequency setting, possible selections are sine, spike, square (50 % duty cycle square wave), and sq20 % (20 % duty cycle square wave.) Note that selections available under SHAPE depend on the selected marker period (frequency), as follows:

Selection	Period (Frequency)
`sine`	10 ns - 1 ns (100 MHz – 1 GHz)
`spike`	5s - 20 ns (0.2 Hz - 50 MHz)
`square`	5s - 10 ns (0.2 Hz - 100 MHz)
`sq20 %`	20 ms - 100 ns (50 kHz - 10 MHz)

- **TRIG** If you are using the external trigger, use this key to cycle through the trigger settings. The available trigger settings are: off, /1 (trigger signal appears on each marker), /10 (trigger signal appears on every tenth marker), and /100 (trigger signal appears at every 100th marker).

You can also toggle the trigger off and on by pressing [TRIG OUT].

- **MODE** Indicates you are in MARKER mode. Use the softkey to change modes and open menus for other oscilloscope calibration modes.

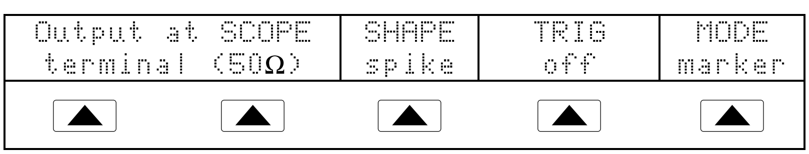
Default marker values are 1.000 ms, SHAPE = spike.

The [MULT X] and [DIV ÷] keys step the voltages through cardinal point values of an oscilloscope in a 1-2-5 step sequence. For example, if the period is 1.000 ms, pressing [MULT X] increases the period to the nearest cardinal point, which is 2.000 ms. Pressing [DIV ÷] decreases the voltage to the nearest cardinal point, which is 500 μs.

Time Base Marker Calibration Procedure for an Oscilloscope

This sample procedure uses the Time MARKER function to check the horizontal deflection (time base) of your oscilloscope. See your oscilloscope's manual for the exact time base values recommended for calibration.

Before you begin this procedure, verify that you are in MARKER mode. If you are, the Control Display shows the following menu.



Perform the following sample procedure to calibrate the time base:

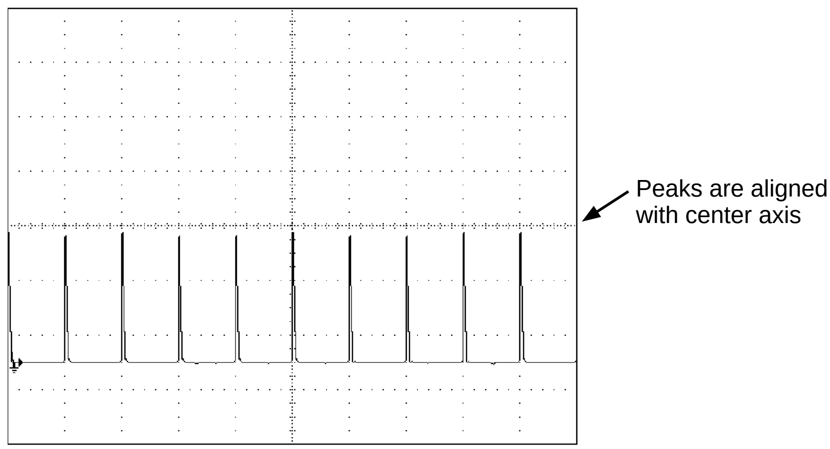
1. Connect the calibrator to Channel 1 on the oscilloscope. Select 50 Ω impedance or use an external 50 Ω termination. Make sure the oscilloscope is dc-coupled.
2. Apply a time marker value according to the recommended calibration settings in your oscilloscope manual. For example, to enter 200 ns, press [2] [0] [0] [SHIFT] [n K] [SHIFT] [sec Hz], then press [ENTER].

Note

You may enter the equivalent frequency instead of the time marker value. For example, instead of entering 200 ns, you may enter 5 MHz.

3. Set your oscilloscope's time base to show 10 time markers. The time markers should align with the oscilloscope divisions, as shown in the example below.

For an accurate reading, align the signal's peaks with the horizontal center axis.



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4. Repeat this procedure for all time marker values recommended for your oscilloscope. Repeat for digital and analog mode as required. Some oscilloscopes may need the magnification changed while calibrating in analog mode.
5. Remove the signal by pressing STBY.

Testing the Trigger functions of an oscilloscope

The oscilloscope's ability to trigger on different waveforms can be tested using the wave generator. When the wave generator is used, a square, sine, or triangle wave is transmitted and the wave's output impedance, offset, and voltage can be varied in order to test the triggering capability at different levels.

Note

The wave generator should not be used for checking the accuracy of your oscilloscope.

The wave generator is available through the WAVEGEN menu, shown below. To access this menu, press the softkey under MODE until “wavegen” appears.

Output @ SCOPE	WAVE square	SCOPE Z 1 MΩ	OFFSET +0.0 V	MODE wavegen
▲	▲	▲	▲	▲
	square	**1 MΩ**		volt
	sine	50Ω		edge
	tri			levsine
				marker
				wavegen
				video
				pulse
				meas Z
				overld

You can press the MODE softkey to cycle through the functions in the order shown, or you can press PREV MENU to return directly to the OTHER modes menu.

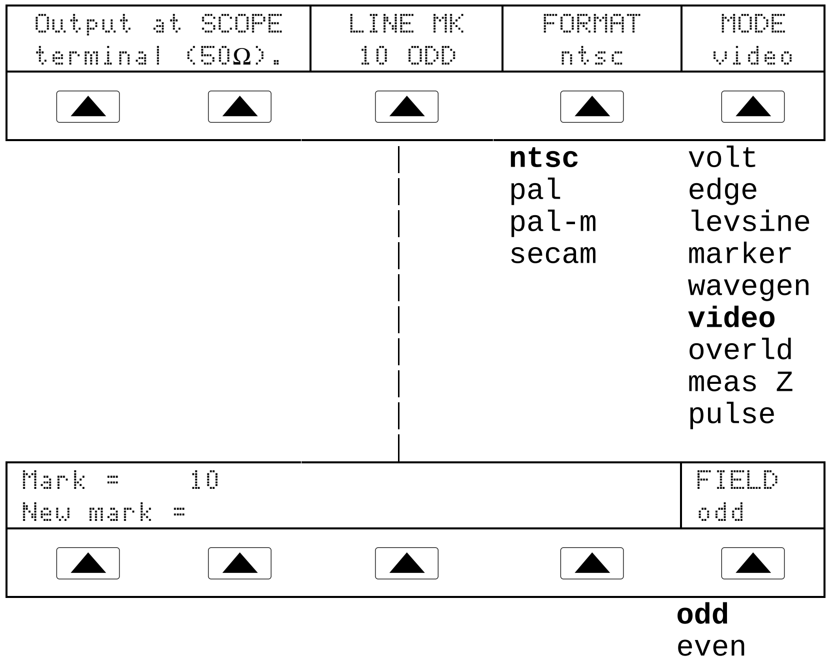
Each option in the WAVEGEN menu is described below:

- **OUTPUT @ SCOPE** Indicates the location of the signal output. If the signal does not appear on the oscilloscope, press OPR. To disconnect the signal, press STBY.
- **WAVE** Scrolls through the three types of waveforms that are available. You can select a square, sine, or triangle wave as the output.
- **SCOPE Z** Toggles the calibrator’s output impedance setting between 50 Ω and 1 MΩ.
- **OFFSET** Displays the offset of the generated wave. To change the offset, key in the new value, and press ENTER. Using the rotary knob does not change the offset; it changes the actual voltage output.

  When you change the offset, you must remain within certain limits to avoid clipping the peaks. The limit depends on the wave’s peak-to-peak value. Specifically, the peak excursion equals the absolute value of the offset plus half of the wave’s peak-to-peak value. See “Wave Generator Specifications” at the beginning of this manual.
- **MODE** Indicates you are in WAVEGEN mode. Use the softkey to change modes and open menus for other oscilloscope calibration modes.

Default Wavegen settings are 20 mV p-p, 1000.0 Hz, WAVE = square, and offset = 0.0 V.

Testing Video Triggers



The video mode generates video signals in various formats. The mode is used to test the video trigger capability of an oscilloscope. You can press the MODE softkey to cycle through the functions in the order shown, or you can press PREV MENU to return directly to the OTHER modes menu.

Each option in the VIDEO menu is described below:

- **Output @ SCOPE terminal (50Ω)** Indicates the location of the signal output. If the signal does not appear on the oscilloscope, press OPR. To disconnect the signal, press STBY.
- **LINE MK** Allows you to select the marker line number. For ntsc and pal-m formats, you can also select field (“odd” or “even”). For pal and secam formats, the field (“ODD” or “EVEN”) is selected automatically based on marker line number.
- **FORMAT** Scrolls through the available formats. You can select ntsc, pal, pal-m, and secam.
- **MODE** Indicates the calibrator is in VIDEO mode. Use the softkey to change modes and open menus for other oscilloscope calibration modes.

Default video settings are + 100 %, format = NTSC, and videomark = 10.

Verifying Pulse Capture

Output @ SCOPE		AMPL 2.5 V	TRIG off	MODE pulse
		2.5 V	**off**	volt
		1.0 V	/1	edge
		250 mV	/10	levsine
		100 mV	/100	marker
		25 mV		wavegen
		10 mV		video
				pulse
				meas Z
				overld

The pulse mode is a general-purpose pulse generator with pulse widths from 4 ns to 500 ns. It can be used to check many of the advanced trigger functions of an oscilloscope, such as pulse capture. You can press the MODE softkey to cycle through the functions in the order shown, or you can press [PREV MENU] to return directly to the OTHER modes menu.

Each option in the PULSE menu is described below:

- **OUTPUT @ SCOPE** Indicates the location of the signal output. If the signal does not appear on the oscilloscope, press [OPR]. To disconnect the signal, press [STBY].
- **AMPL** Indicates the output level. You can select 2.5 V, 1.0 V, 250 mV, 100 mV, 25 mV, or 10 mV.
- **TRIG** If you are using the external trigger, use this key to cycle through the trigger settings. The available trigger settings are: off, /1 (trigger signal appears on each marker), /10 (trigger signal appears on every tenth marker), and /100 (trigger signal appears at every 100th marker).

You can also toggle the trigger off and on by pressing [TRIG OUT].

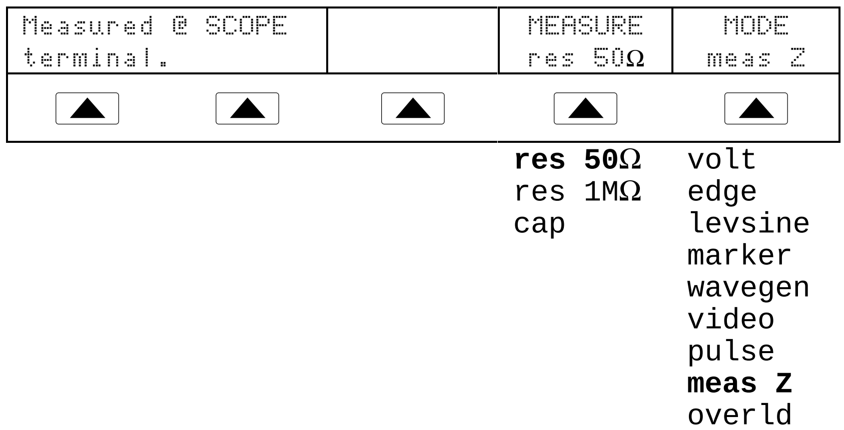
- **MODE** Indicates you are in PULSE mode. Use the softkey to change modes and open menus for other oscilloscope calibration modes.

Default Pulse settings are 100.0 ns width and 1.000 ms period. To change these values, you have several options. Usually, you will enter values for both pulse width and period. Do this by entering the pulse width value with units first, followed immediately by the period value and units, followed by [ENTER]. For example, you could enter a pulse width of 50 ns and a period of 200 ns with the following sequence:

[5] [0] [SHIFT] [n K] [SHIFT] [sec Hz] [2] [0] [0] [SHIFT] [n K] [SHIFT] [sec Hz] [ENTER]

To change only the pulse width, enter a value in seconds. You can enter this value with units (e.g., 200 ns) or without units (e.g., 0.0000002). To change only the period, enter a frequency with units (e.g., 20 MHz, changing the period to 50 ns).

Measuring Input Resistance and Capacitance

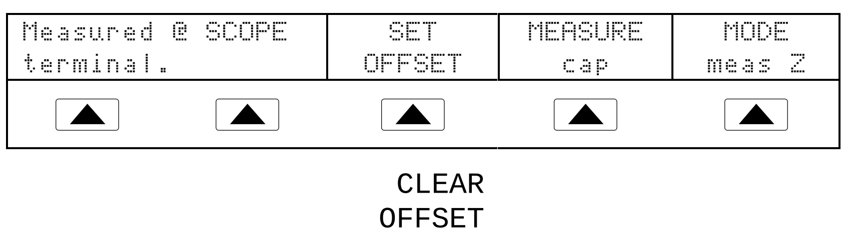


You can press the MODE softkey to cycle through the functions in the order shown, or you can press PREV MENU to return directly to the OTHER modes menu.

Each option in the Impedance/Capacitance (MEAS Z) menu is described below:

- **Measured @ SCOPE terminal** Indicates the location of the measured input.
- **MEASURE** Indicates the type of test. You can select res 50Ω or res 1 MΩ termination (for impedance) or cap (capacitance).
- **MODE** Indicates the Calibrator is in MEAS Z mode. Use the softkey to change modes and open menus for other oscilloscope calibration modes.

If you have selected Capacitance measurement, the menu appears as follows:



- **SET OFFSET** With the cable disconnected at the oscilloscope but still connected at the Calibrator, press to cancel the capacitance of the Calibrator. Press again to **CLEAR OFFSET** and return to the capacitance reading.

Default Impedance Measurement range = 50 Ω.

Input Impedance Measurement

With MEAS Z mode selected, perform the following procedure to measure the input impedance of an oscilloscope:

1. Use the MEASURE softkey to select “res 50Ω“ or “res 1 MΩ“ termination.
2. Connect the SCOPE terminal on the calibrator to Channel 1 on the oscilloscope.
3. Press OPR to initiate the measurement.

Input Capacitance Measurement

With MEAS Z mode selected, perform the following procedure to measure the input capacitance of an oscilloscope:

1. Set the oscilloscope for 1 MΩ input impedance. Note that input capacitance testing cannot be done with 50 Ω input impedance.
2. Use the MEASURE softkey to select “cap”.
3. With the output cable connected to the Calibrator but not connected to the oscilloscope, press the SET OFFSET softkey to cancel stray capacitances.
4. Connect the output cable to Channel 1 on the oscilloscope.
5. Press OPR to initiate the measurement.

Testing Overload Protection

Caution

This test checks the power handling capability of the 50 Ω input of your oscilloscope. Before proceeding, ensure that the power rating of your oscilloscope can handle the voltages and currents that this test can output. Failing to do so could damage your oscilloscope.

Output @ SCOPE	UUTTRIP in 4.1s	T LIMIT 10s	OUT VAL DC	MODE overld

OUT VAL: DC, AC

MODE: volt, edge, levsine, marker, wavegen, video, pulse, meas Z, overld

You can press the MODE softkey to cycle through the functions in the order shown, or you can press PREV MENU to return directly to the OTHER modes menu.

Each option in the OVERLD menu is described below:

- **OUTPUT @ SCOPE** Indicates the location of the output signal.
- **UUTTRIP** Indicates test results. “NO” appears if the overload protection did not trip within the selected time limit. A value in seconds appears (e.g. “4.1s”) if the overload protection has tripped within the time limit.
- **T LIMIT** Indicates the selected time limit for application of the output value. Press this softkey to key in or edit a different time limit (1s to 60s allowed.)
- **OUT VAL** Indicates the output voltage type. You can select DC or AC and a value ranging from 5 V to 9 V (shown in Output Display). Key in or edit this value.
- **MODE** Indicates you are in OVERLD (Overload) mode. Use the softkey to change modes and open menus for other oscilloscope calibration modes.

Default overload settings are + 5.000 V and DC.

At any time, you can also set the overload time limit with the following command sequence:

	INSTMT SETUP	OTHER SETUP	TLIMDEF	
SETUP	▲	▲	▲	(Choose 1 s to 60 s.)

Perform the following procedure to test the overload protection of an oscilloscope:

1. Connect the calibrator to Channel 1 on the oscilloscope.
2. Select the voltage type (DC or AC) using the OUT VAL softkey.
3. Key in the voltage level. (The default value is 5 V.)
4. If necessary, change the duration. (Refer to the procedure described above.) The default duration is 10s.
5. Check for test results displayed with the UUTTRIP softkey.

Remote Commands and Queries

This section describes commands and queries that are used specifically for the SC1100 Option. Each command description indicates whether it can be used with IEEE-488 and RS-232 remote interfaces and identifies it as a Sequential, Overlapped, or Coupled command.

IEEE-488 (GPIB) and RS-232 Applicability Each command and query has a check box indicating applicability to IEEE-488 (general purpose interface bus, or GPIB) and RS-232 remote operations.

Sequential Commands Commands executed immediately as they are encountered in the data stream are called sequential commands. For more information, see “Sequential Commands” in Chapter 5 of the *5520A Operators Manual*.

Overlapped Commands Commands `SCOPE`, `TRIG`, and `OUT_IMP` are designated as overlapped commands because they may be overlapped (interrupted) by the next command before they have completed execution. When an overlapped command is interrupted, it may take longer to execute while it waits for other commands to be completed. To prevent an overlapped command from being interrupted during execution, use `*OPC`, `*OPC?`, or `*WAI.` These commands prevent interruptions until they detect the command’s completion. For more information, see “Overlapped Commands” in Chapter 5 of the *5520A Operators Manual*.

Coupled Commands `SCOPE` and `OUT_IMP` are coupled commands because they can be coupled (combined) with other commands to form a compound command sequence. Care must be taken to ensure that commands are not coupled in a way that may cause them to disable each other, since this may result in a fault. For more information, see “Coupled Commands” in Chapter 5 of the *5520A Operators Manual*.

General Commands

SCOPE

(IEEE-488, RS-232, Sequential)

Programs the SC1100 oscilloscope calibration hardware, if installed. The instrument settings are determined by this command's parameter. Once in SCOPE mode, use the OUT command to program new output in all functions except Impedance Measurement and the RANGE command as required (in OVERLD, PULSE, and MEAS Z functions only.) `OPER`, `STBY`, `*OPC`, `*OPC?`, and `*WAI` all operate as described in Chapter 6 of the *5520A Operators Manual*. The state of the oscilloscope's output while in SCOPE mode is reflected by the bit in the ISR that is assigned to SETTLED.

Table 16. SCOPE Command Parameters

Parameter	Description/Example	
OFF	Turns the oscilloscope hardware off. Programs 0 V, 0 Hz, output at the NORMAL terminals, standby.	
VOLT	Oscilloscope ac and dc VOLT mode. Programs 20 mV peak-to-peak, 1 kHz, output at the SCOPE BNC, output impedance 1 MΩ, standby if from OFF or previously in standby. FUNC? returns SACV (for ac) or SDCV (for dc).	
	Example:	SCOPE VOLT; OUT 4 V, 1 kHz (ac voltage, 4 V peak-to-peak, 1 kHz.)
EDGE	Oscilloscope EDGE mode. Programs 25 mV peak-to-peak, 1 MHz, output at the SCOPE BNC, standby if from OFF or previously in standby. FUNC? returns EDGE.	
	Example:	SCOPE EDGE; OUT 0.5 V, 5 kHz (Edge, 0.5 V peak-to-peak, 5 kHz.)
LEVSINE	Oscilloscope LEVSINE mode. Programs 30 mV peak-to-peak, 50 kHz, output at the SCOPE BNC, standby if from OFF or previously in standby. FUNC? returns LEVSINE.	
	Example:	SCOPE LEVSINE; OUT 1 V, 50 kHz (Leveled sine wave, 1 V peak-to-peak, 50 kHz.)
MARKER	Oscilloscope MARKER mode. Programs the period to 1 ms, output at the SCOPE BNC, standby if from OFF or previously in standby. FUNC? returns MARKER.	
	Example:	SCOPE MARKER; OUT 2 MS (Marker, period of 2 ms.)
WAVEGEN	Oscilloscope WAVEGEN mode. Programs 20 mV peak-to-peak, square wave, 1 kHz, no offset, output impedance 1 MΩ, standby if from OFF or previously in standby. FUNC? returns WAVEGEN.	
	Example:	SCOPE WAVEGEN; OUT 1 V, 1 kHz (Wave Generator, 1 V peak-to-peak, 1 kHz.)

Table 15. SCOPE Command Parameters (cont.)

Parameter	Description/Example	
VIDEO	Oscilloscope VIDEO mode. Programs 100 % output (1 V p-p), line marker 10, format NTSC. FUNC? returns VIDEO.	
	Examples:	SCOPE VIDEO; OUT 90 (Video, 90 % output) SCOPE VIDEO; OUT -70 (Video, -70 % output, inverse video)
PULSE	Oscilloscope PULSE mode. Programs 100 ns pulse width, 1.000 µs period, 2.5 V range. FUNC? returns PULSE.	
	Example:	SCOPE PULSE; OUT 50 ns, 500 ns; RANGE TP8DB (Pulse, 50 ns pulse width, 500 ns period, 1.5 V range)
MEASZ	Oscilloscope Impedance/Capacitance measurement (MEAS Z) mode. Programs 50 Ω range. FUNC? returns MEASZ.	
	Example:	SCOPE MEASZ; RANGE TZCAP (MEAS Z mode, capacitance range)
OVERLD	Oscilloscope Overload mode. Programs 5 V dc range. FUNC? returns OVERLD.	
	Example:	SCOPE OVERLD; OUT 7 V; RANGE TOLAC (Overload, 7 V output, ac range)

SCOPE?

(IEEE-488, RS-232, Sequential)

Returns the oscilloscope's current mode of operation. Returns `OFF` if the oscilloscope is off.

Parameter: (None)

Response: <character> (Returns `OFF`, `VOLT`, `EDGE`, `LEVSINE`, `MARKER`, `WAVEGEN`, `VIDEO`, `PULSE`, `MEASZ`, or `OVERLD`.)

TRIG

(IEEE-488, RS-232, Overlapped)

Programs the oscilloscope's trigger output BNC.

Parameters:
- `OFF` (Turns the trigger output off.)
- `DIV1` (Turns the trigger output on. Frequency is the same as the signal at `SCOPE` output.)
- `DIV10` (Turns the trigger output on. Frequency is 1/10 of the signal at `SCOPE` output.)
- `DIV100` (Turns the trigger output on. Frequency is 1/100 of the signal at `SCOPE` output.)

Example: `TRIG DIV10`

TRIG?

(IEEE-488, RS-232, Sequential)

Returns the output setting of the oscilloscope's trigger.

Parameters: (None)

Response: <character> (Returns `OFF`, `DIV1`, `DIV10`, or `DIV100`.)

_OUT_IMP_

(IEEE-488, RS-232, Sequential)

Programs the oscilloscope's output impedance.

Parameters: `Z50` (Programs the oscilloscope's output impedance to 50 Ω.)

`Z1M` (Programs the oscilloscope's output impedance to 1 MΩ.)

Example: `OUT_IMP Z50`

_OUT_IMP?_

(IEEE-488, RS-232, Sequential)

Returns the impedance setting of the oscilloscope's output.

Parameters: (None)

RANGE

(IEEE-488, RS-232, Sequential)

Programs the instrument range in PULSE, MEAS Z, OVERLD modes.

Parameters:

Pulse	TP0DB	TP8DB	TP20DB	TP28DB	TP40DB	TP48DB
Range	2.5 V	1.0 V	250 mV	100 mV	25 mV	10 mV

Impedance Measure	TZ50OHM	TZ1MOHM	TZCAP
Range	res 50 Ω	res 1MΩ	cap

Overload	TOLDC	TOLAC
Range	DC	AC

Example: `RANGE TP20DB`

Edge Function Commands

TDPULSE

(IEEE-488, RS-232, Sequential)

Turns tunnel diode pulse drive on/off in EDGE mode.

Parameters: ON (or non-zero) or OFF (or zero)

Example: `TDPULSE ON`

Returns the tunnel diode pulse drive setting in EDGE mode.

Parameters: None

Response: 1 if ON, 0 if OFF.

Marker Function Commands

TMWAVE

(IEEE-488, RS-232, Sequential)

Selects the waveform for MARKER mode.

Parameters:	SINE	Sine wave (2 ns to 15 ns)
	SPIKE	Triangular/sawtooth pulse (15 ns to 5s)
	SQUARE	Square wave (50 % duty cycle) (4 ns to 5s)
	SQ20PCT	Square wave (20 % duty cycle) (85 ns to 5s)

Example: `TMWAVE SPIKE`

TMWAVE?

(IEEE-488, RS-232, Sequential)

Returns the MARKER mode waveform setting.

Parameters: None

Response: <character> (Returns `SINE`, `SPIKE`, `SQUARE`, or `SQ20PCT`.)

Video Function Commands

VIDEOFMT

(IEEE-488, RS-232, Sequential)

Selects the format for VIDEO mode.

Parameters: NTSC, PAL, PALM (for PAL-M), or SECAM

Example: `VIDEOFMT SECAM`

VIDEOFMT?

(IEEE-488, RS-232, Sequential)

Returns the VIDEO mode format.

Parameters: None

Response: NTSC, PAL, PALM (for PAL-M), or SECAM

VIDEOMARK

(IEEE-488, RS-232, Sequential)

Programs the VIDEO mode line marker location.

Parameters: Line marker number.

Example: `VIDEOMARK 10`

VIDEOMARK?

(IEEE-488, RS-232, Sequential)

Returns the VIDEO mode line marker setting.

Parameters: None.

Response: <character> SINE, SPIKE, SQUARE or SQ20PCT

Overload Function Commands

OL_TRIP?

(IEEE-488, RS-232, Sequential)

Returns the detected state of scope overload protection.

Parameters: (None)

Response: Returns the number of seconds before protection was tripped. Returns 0 if protection has not been tripped or if OVERLD mode not active.

TLIMIT

(IEEE-488, RS-232, Sequential)

Sets the OPERATE time limit for the OVERLD mode signal. The Calibrator automatically returns to STANDBY if the UUT protection trips within this interval or at the end of this interval if the protection has not tripped.

Parameters: 1 to 60 (seconds)

Example: `TLIMIT 30`

TLIMIT?

(IEEE-488, RS-232, Sequential)

Returns the programmed OPERATE time limit for the OVERLD mode signal.

Response: <Integer> Time limit in seconds.

TLIMIT_D

(IEEE-488, RS-232, Sequential)

Sets the default OPERATE time limit for the OVERLD mode signal.

Parameters: 1 to 60 (seconds)

Example: `TLIMIT_D 15`

TLIMIT_D?

(IEEE-488, RS-232, Sequential)

Returns the default overload time limit.

Response: <Integer> Default time limit in seconds.

Impedance/Capacitance Function Commands

ZERO_MEAS

(IEEE-488, RS-232, Sequential)

Sets the measurement offset to the capacitance value.

Parameters: (boolean) ON or OFF.

**TRG*

(IEEE-488, RS-232, Sequential)

Triggers and returns a new impedance measurement value when used with the SC1100 option in MEAS Z mode. (See Chapter 6 of the *5520A Operators Manual* for *TRG use in all cases except MEAS Z mode with the SC1100 option.)

Responses:	<measurement value>, `OHM`	(input impedance value in ohms)
	<measurement value>, `F`	(input capacitance value in farads)
	<measurement value>, `NONE`	(no measurement is available)

Example: `*TRG` returns `1.00E+03,OHM` (1 kΩ input impedance).

Note

*You can also use the VAL? query to return an impedance measurement value with the SC1100 option. VAL? returns the last measurement, whereas *TRG gets a new measurement. Responses are the same as shown above for the *TRG command. (See Chapter 6 of the* 5520A Operators Manual *for VAL? use with thermocouple measurements.)*

Verification Tables

The verification test points are provided here as a guide when verification to one-year specifications is desired.

DC Voltage Verification

Table 17. DC Voltage Verification

(1 MΩ output impedance unless noted)			
Nominal Value (V dc)	**Measured Value (V dc)**	**Deviation (V dc)**	**1-Year Spec. (V dc)**
0			0.00004
0.00125			0.000040625
-0.00125			0.000040625
0.00249			0.000041245
-0.00249			0.000041245
0.0025			0.00004125
-0.0025			0.00004125
0.00625			0.000043125
-0.00625			0.000043125
0.0099			0.00004495
-0.0099			0.00004495
0.01			0.000045
-0.01			0.000045
0.0175			0.00004875
-0.0175			0.00004875
0.0249			0.00005245
-0.0249			0.00005245
0.025			0.0000525
-0.025			0.0000525
0.0675			0.00007375
-0.0675			0.00007375
0.1099			0.00009495
-0.1099			0.00009495
0.11			0.000095
-0.11			0.000095
0.305			0.0001925
-0.305			0.0001925
0.499			0.0002895
-0.499			0.0002895
0.5			0.00029
-0.5			0.00029
1.35			0.000715
-1.35			0.000715
2.19			0.001135
-2.19			0.001135
2.2			0.00114
-2.2			0.00114
6.6			0.00334
-6.6			0.00334

Table 16. DC Voltage Verification (cont.)

Nominal Value (V dc)	Measured Value (V dc)	Deviation (V dc)	1-Year Spec. (V dc)
10.99			0.005535
-10.99			0.005535
11			0.00554
-11			0.00554
70.5			0.03529
-70.5			0.03529
130			0.06504
-130			0.06504

Table 18. DC Voltage Verification at 50 Ω

Calibrator Mainframe Output	HP 3458A Rdg (V DC)	Reading x correction	Tolerance (V DC)
0 mV			0.00004 V
2.49 mV			4.623E-05 V
-2.49 mV			4.623E-05 V
9.90 mV			6.475E-05 V
-9.90 mV			6.475E-05 V
24.9 mV			0.0001023 V
-24.9 mV			0.0001023 V
109.9 mV			0.0003148 V
-109.9 mV			0.0003148 V
499 mV			0.0012875 V
-499 mV			0.0012875 V
2.19 V			0.005515 V
-2.19 V			0.005515 V
6.599 V			0.0165375 V
-6.599 V			0.0165375 V

AC Voltage Verification

Table 19. AC Voltage Verification

(1 MΩ output impedance unless noted)				
Nominal Value (V p-p)	**Frequency (Hz)**	**Measured Value (V p-p)**	**Deviation (V p-p)**	**1-year Spec. (V p-p)**
0.001	1000			0.000041
-0.001	1000			0.000041
0.01	1000			0.00005
-0.01	1000			0.00005
0.025	1000			0.000065
-0.025	1000			0.000065
0.11	1000			0.00015
-0.11	1000			0.00015
0.5	1000			0.00054
-0.5	1000			0.00054

Table 18. AC Voltage Verification (cont)

(1 MΩ output impedance unless noted)				
Nominal Value (V p-p)	**Frequency (Hz)**	**Measured Value (V p-p)**	**Deviation (V p-p)**	**1-year Spec. (V p-p)**
2.2	1000			0.00224
-2.2	1000			0.00224
11	1000			0.01104
-11	1000			0.01104
130	1000			0.13004
-130	1000			0.13004
200 mV	100			0.00024
200 mV	1000			0.00024
200 mV	5000			0.00054
200 mV	10000			0.00054
2.2 V	100			0.00224
2.2 V	5000			0.00554
2.2 V	10000			0.00554

Table 20. AC Voltage Verification at 50 Ω

Calibrator Mainframe Output (1 kHz)	HP 3458A Range	Topline Reading	Baseline Reading	Peak-to-Peak	Peak-to-Peak x Correction	Tolerance (±V)
1 mV	100 mV dc					0.000043
-1 mV	100 mV dc					0.000043
10 mV	100 mV dc					0.000065
-10 mV	100 mV dc					0.000065
25 mV	100 mV dc					0.000103
-25 mV	100 mV dc					0.000103
110 mV	100 mV dc					0.000315
-110 mV	100 mV dc					0.000315
500 mV	1 V dc					0.00129
-500 mV	1 V dc					0.00129
2.2 V	10 V dc					0.00554
-2.2 V	10 V dc					0.00554
6.6 V	10 V dc					0.01654
-6.6 V	10 V dc					0.01654

AC Voltage Frequency Verification

Table 21. AC Voltage Frequency Verification

(1 MΩ output impedance unless noted)				
Nominal Value (V p-p)	**Frequency (Hz)**	**Measured Value (Hz)**	**Deviation (Hz)**	**1-year Spec. (Hz)**
2.1	10			0.000025
2.1	100			0.00025
2.1	1000			0.0025
2.1	10000			0.025

Wave Generator Amplitude Verification: 1 MΩ Output Impedance

Table 22. Wave Generator Amplitude Verification (1 MΩ output impedance)

Wave Shape	Nominal Value (V p-p)	Frequency (Hz)	Measured Value (V p-p)	Deviation (V p-p)	1-Year Spec. (V p-p)
square	0.0018	1000			0.000154
square	0.0119	1000			0.000457
square	0.0219	1000			0.000757
square	0.022	1000			0.00076
square	0.056	1000			0.00178
square	0.0899	1000			0.002797
square	0.09	1000			0.0028
square	0.155	1000			0.00475
square	0.219	1000			0.00667
square	0.22	1000			0.0067
square	0.56	1000			0.0169
square	0.899	1000			0.02707
square	0.9	1000			0.0271
square	3.75	1000			0.1126
square	6.59	1000			0.1978
square	6.6	1000			0.1981
square	30.8	1000			0.9241
square	55	10			1.6501
square	55	100			1.6501
square	55	1000			1.6501
square	55	10000			1.6501
sine	0.0018	1000			0.000154
sine	0.0219	1000			0.000757
sine	0.0899	1000			0.002797
sine	0.219	1000			0.00667
sine	0.899	1000			0.02707
sine	6.59	1000			0.1978
sine	55	1000			1.6501
triangle	0.0018	1000			0.000154
triangle	0.0219	1000			0.000757
triangle	0.0899	1000			0.002797
triangle	0.219	1000			0.00667
triangle	0.899	1000			0.02707
triangle	6.59	1000			0.1978
triangle	55	1000			1.6501

Wave Generator Amplitude Verification: 50 Ω Output Impedance

Table 23. Wave Generator Amplitude Verification (50 Ω output impedance)

Wave Shape	Nominal Value (V p-p)	Frequency (Hz)	Measured Value (V p-p)	Deviation (V p-p)	1-Year Spec. (V p-p)
square	0.0018	1000			0.000154
square	0.0064	1000			0.000292
square	0.0109	1000			0.000427
square	0.011	1000			0.00043
square	0.028	1000			0.00094
square	0.0449	1000			0.001447
square	0.045	1000			0.00145
square	0.078	1000			0.00244
square	0.109	1000			0.00337
square	0.11	1000			0.0034
square	0.28	1000			0.0085
square	0.449	1000			0.01357
square	0.45	1000			0.0136
square	0.78	1000			0.0235
square	1.09	1000			0.0328
square	1.1	1000			0.0331
square	1.8	1000			0.0541
square	2.5	10			0.0751
square	2.5	100			0.0751
square	2.5	1000			0.0751
square	2.5	10000			0.0751
sine	0.0018	1000			0.000154
sine	0.0109	1000			0.000427
sine	0.0449	1000			0.001447
sine	0.109	1000			0.00337
sine	0.449	1000			0.01357
sine	1.09	1000			0.0328
sine	2.5	1000			0.0751
triangle	0.0018	1000			0.000154
triangle	0.0109	1000			0.000427
triangle	0.0449	1000			0.001447
triangle	0.109	1000			0.00337
triangle	0.449	1000			0.01357
triangle	1.09	1000			0.0328
triangle	2.5	1000			0.0751

Edge Verification: Amplitude

Table 24. Edge Verification: Amplitude

Nominal Value (V p-p)	Frequency (Hz)	Measured Value (V p-p)	Deviation (V p-p)	1-Year Spec. (V p-p)
0.005	1 kHz			0.0003
0.005	10 kHz			0.0003
0.005	100 kHz			0.0003
0.01	100 kHz			0.0004
0.025	100 kHz			0.0007
0.05	100 kHz			0.0012
0.1	100 kHz			0.0022
0.25	100 kHz			0.0052
0.5	100 kHz			0.0102
1	100 kHz			0.0202
2.5	100 kHz			0.0502
2.5	10 kHz			0.0502
2.5	1 kHz			0.0502

Edge Verification: Frequency

Table 25. Edge Verification: Frequency

Nominal Value (V p-p)	Frequency	Measured Value (Hz)	Deviation (Hz)	1-Year Spec. (Hz)
2.5	1 kHz			0.0025
2.5	10 kHz			0.025
2.5	100 kHz			0.25
2.5	1 MHz			2.5
2.5	10 MHz			25

Edge Verification: Duty Cycle

Table 26. Edge Verification: Duty Cycle

Nominal Value (V p-p)	Frequency	Measured Value (%)	Deviation (from 50 %)	1-Year Spec. (%)
2.5	1 MHz			5

Edge Verification: Rise Time

Table 27. Edge Verification: Rise Time

Nominal Value (V p-p)	Frequency	Measured Value (s)	Deviation (ns)	1-Year Spec. (ns)
0.25	1 kHz			0.3 ns
0.25	100 kHz			0.3 ns
0.25	10 MHz			0.3 ns
0.5	1 kHz			0.3 ns
0.5	100 kHz			0.3 ns
0.5	10 MHz			0.3 ns
1	1 kHz			0.3 ns
1	100 kHz			0.3 ns
1	10 MHz			0.3 ns
2.5	1 kHz			0.3 ns
2.5	100 kHz			0.3 ns
2.5	10 MHz			0.3 ns

Tunnel Diode Pulser Verification

Table 28. Tunnel Diode Pulser Verification

Nominal Value (V p-p)	Frequency (Hz)	Measured Value (V p-p)	Deviation (V p-p)	1-Year Spec. (V p-p)
11	100			0.2202
11	10000			0.2202
55	100			1.1002
55	10000			1.1002
100	100			2.0002
100	10000			2.0002

Leveled Sinewave Verification: Amplitude

Table 29. Leveled Sinewave Verification: Amplitude

Nominal Value (V p-p)	Frequency	Measured Value (V p-p)	Deviation (V p-p)	1-Year Spec. (V p-p)
0.005	50 kHz			0.0004
0.0075	50 kHz			0.00045
0.0099	50 kHz			0.000498
0.01	50 kHz			0.0005
0.025	50 kHz			0.0008
0.039	50 kHz			0.00108
0.04	50 kHz			0.0011
0.07	50 kHz			0.0017
0.099	50 kHz			0.00228
0.1	50 kHz			0.0023
0.25	50 kHz			0.0053
0.399	50 kHz			0.00828
0.4	50 kHz			0.0083
0.8	50 kHz			0.0163
1.2	50 kHz			0.0243
1.3	50 kHz			0.0263
3.4	50 kHz			0.0683
5.5	50 kHz			0.1103

Leveled Sinewave Verification: Frequency

Table 30. Leveled Sinewave Verification: Frequency

Nominal Value (V p-p)	Frequency	Measured Value (Hz)	Deviation (Hz)	1-Year Spec. (Hz)
5.5	50 kHz			0.125
5.5	500 kHz			1.25
5.5	5 MHz			12.5
5.5	50 MHz			125
5.5	500 MHz			1250
3.5	1000 MHz			2500

Leveled Sinewave Verification: Harmonics

Table 31. Leveled Sinewave Verification: Harmonics

Harmonic	Nominal Value (V p-p)	Frequency	Measured Value (dB)	Deviation (dB)	1-Year Spec. (dB)
2nd harmonic	0.0399	50 kHz			-33
3rd+ harmonic	0.0399	50 kHz			-38
2nd harmonic	0.099	50 kHz			-33
3rd+ harmonic	0.099	50 kHz			-38
2nd harmonic	0.399	50 kHz			-33
3rd+ harmonic	0.399	50 kHz			-38
2nd harmonic	1.2	50 kHz			-33
3rd+ harmonic	1.2	50 kHz			-38
2nd harmonic	5.5	50 kHz			-33
3rd+ harmonic	5.5	50 kHz			-38
2nd harmonic	5.5	100 kHz			-33
3rd+ harmonic	5.5	100 kHz			-38
2nd harmonic	5.5	200 kHz			-33
3rd+ harmonic	5.5	200 kHz			-38
2nd harmonic	5.5	400 kHz			-33
3rd+ harmonic	5.5	400 kHz			-38
2nd harmonic	5.5	800 kHz			-33
3rd+ harmonic	5.5	800 kHz			-38
2nd harmonic	5.5	1 MHz			-33
3rd+ harmonic	5.5	1 MHz			-38
2nd harmonic	5.5	2 MHz			-33
3rd+ harmonic	5.5	2 MHz			-38
2nd harmonic	5.5	4 MHz			-33
3rd+ harmonic	5.5	4 MHz			-38
2nd harmonic	5.5	8 MHz			-33
3rd+ harmonic	5.5	8 MHz			-38
2nd harmonic	5.5	10 MHz			-33
3rd+ harmonic	5.5	10 MHz			-38
2nd harmonic	5.5	20 MHz			-33
3rd+ harmonic	5.5	20 MHz			-38
2nd harmonic	5.5	40 MHz			-33
3rd+ harmonic	5.5	40 MHz			-38
2nd harmonic	5.5	80 MHz			-33
3rd+ harmonic	5.5	80 MHz			-38
2nd harmonic	5.5	100 MHz			-33
3rd+ harmonic	5.5	100 MHz			-38
2nd harmonic	5.5	200 MHz			-33
3rd+ harmonic	5.5	200 MHz			-38
2nd harmonic	5.5	400 MHz			-33
3rd+ harmonic	5.5	400 MHz			-38
2nd harmonic	5.5	600 MHz			-33
3rd+ harmonic	5.5	600 MHz			-38
2nd harmonic	3.5	1000 MHz			-33
3rd+ harmonic	3.5	1000 MHz			-38

Leveled Sinewave Verification: Flatness

Table 32. Leveled Sinewave Verification: Flatness

Nominal Value (V p-p)	Frequency	Measured Value (V p-p)	Deviation (V p-p)	1-Year Spec. (V p-p)
0.005	10 MHz		na	na
0.005	30 MHz			0.000175
0.005	70 MHz			0.000175
0.005	120 MHz			0.0002
0.005	290 MHz			0.0002
0.005	360 MHz			0.0003
0.005	390 MHz			0.0003
0.005	400 MHz			0.0003
0.005	480 MHz			0.0003
0.005	570 MHz			0.0003
0.005	580 MHz			0.0003
0.005	590 MHz			0.0003
0.005	600 MHz			0.0003
0.0075	10 MHz		na	na
0.0075	30 MHz			0.0002125
0.0075	70 MHz			0.0002125
0.0075	120 MHz			0.00025
0.0075	290 MHz			0.00025
0.0075	360 MHz			0.0004
0.0075	390 MHz			0.0004
0.0075	400 MHz			0.0004
0.0075	480 MHz			0.0004
0.0075	570 MHz			0.0004
0.0075	580 MHz			0.0004
0.0075	590 MHz			0.0004
0.0075	600 MHz			0.0004
0.0099	10 MHz		na	na
0.0099	30 MHz			0.0002485
0.0099	70 MHz			0.0002485
0.0099	120 MHz			0.000298
0.0099	290 MHz			0.000298
0.0099	360 MHz			0.000496
0.0099	390 MHz			0.000496
0.0099	400 MHz			0.000496
0.0099	480 MHz			0.000496
0.0099	570 MHz			0.000496
0.0099	580 MHz			0.000496
0.0099	590 MHz			0.000496
0.0099	600 MHz			0.000496

Table 31. Leveled Sinewave Verification: Flatness (cont.)

Nominal Value (V p-p)	Frequency	Measured Value (V p-p)	Deviation (V p-p)	1-Year Spec. (V p-p)
0.01	10 MHz		na	na
0.01	30 MHz			0.00025
0.01	70 MHz			0.00025
0.01	120 MHz			0.0003
0.01	290 MHz			0.0003
0.01	360 MHz			0.0005
0.01	390 MHz			0.0005
0.01	400 MHz			0.0005
0.01	480 MHz			0.0005
0.01	570 MHz			0.0005
0.01	580 MHz			0.0005
0.01	590 MHz			0.0005
0.01	600 MHz			0.0005
0.01	1000 MHz			0.0005
0.025	10 MHz		na	na
0.025	30 MHz			0.000475
0.025	70 MHz			0.000475
0.025	120 MHz			0.0006
0.025	290 MHz			0.0006
0.025	360 MHz			0.0011
0.025	390 MHz			0.0011
0.025	400 MHz			0.0011
0.025	480 MHz			0.0011
0.025	570 MHz			0.0011
0.025	580 MHz			0.0011
0.025	590 MHz			0.0011
0.025	600 MHz			0.0011
0.025	1000 MHz			0.0011
0.039	10 MHz		na	na
0.039	30 MHz			0.000685
0.039	70 MHz			0.000685
0.039	120 MHz			0.00088
0.039	290 MHz			0.00088
0.039	360 MHz			0.00166
0.039	390 MHz			0.00166
0.039	400 MHz			0.00166
0.039	480 MHz			0.00166
0.039	570 MHz			0.00166
0.039	580 MHz			0.00166
0.039	590 MHz			0.00166
0.039	600 MHz			0.00166
0.039	1000 MHz			0.00166
0.04	10 MHz		na	na
0.04	30 MHz			0.0007

Table 31. Leveled Sinewave Verification: Flatness (cont.)

Nominal Value (V p-p)	Frequency	Measured Value (V p-p)	Deviation (V p-p)	1-Year Spec. (V p-p)
0.04	70 MHz			0.0007
0.04	120 MHz			0.0009
0.04	290 MHz			0.0009
0.04	360 MHz			0.0017
0.04	390 MHz			0.0017
0.04	400 MHz			0.0017
0.04	480 MHz			0.0017
0.04	570 MHz			0.0017
0.04	580 MHz			0.0017
0.04	590 MHz			0.0017
0.04	600 MHz			0.0017
0.04	1000 MHz			0.0017
0.07	10 MHz		na	na
0.07	30 MHz			0.00115
0.07	70 MHz			0.00115
0.07	120 MHz			0.0015
0.07	290 MHz			0.0015
0.07	360 MHz			0.0029
0.07	390 MHz			0.0029
0.07	400 MHz			0.0029
0.07	480 MHz			0.0029
0.07	570 MHz			0.0029
0.07	580 MHz			0.0029
0.07	590 MHz			0.0029
0.07	600 MHz			0.0029
0.07	1000 MHz			0.0029
0.099	10 MHz		na	na
0.099	30 MHz			0.001585
0.099	70 MHz			0.001585
0.099	120 MHz			0.00208
0.099	290 MHz			0.00208
0.099	360 MHz			0.00406
0.099	390 MHz			0.00406
0.099	400 MHz			0.00406
0.099	480 MHz			0.00406
0.099	570 MHz			0.00406
0.099	580 MHz			0.00406
0.099	590 MHz			0.00406
0.099	600 MHz			0.00406
0.099	1000 MHz			0.00406
0.1	10 MHz		na	na
0.1	30 MHz			0.0016
0.1	70 MHz			0.0016
0.1	120 MHz			0.0021

Table 31. Leveled Sinewave Verification: Flatness (cont.)

Nominal Value (V p-p)	Frequency	Measured Value (V p-p)	Deviation (V p-p)	1-Year Spec. (V p-p)
0.1	290 MHz			0.0021
0.1	360 MHz			0.0041
0.1	390 MHz			0.0041
0.1	400 MHz			0.0041
0.1	480 MHz			0.0041
0.1	570 MHz			0.0041
0.1	580 MHz			0.0041
0.1	590 MHz			0.0041
0.1	600 MHz			0.0041
0.1	1000 MHz			0.0041
0.25	10 MHz		na	na
0.25	30 MHz			0.00385
0.25	70 MHz			0.00385
0.25	120 MHz			0.0051
0.25	290 MHz			0.0051
0.25	360 MHz			0.0101
0.25	390 MHz			0.0101
0.25	400 MHz			0.0101
0.25	480 MHz			0.0101
0.25	570 MHz			0.0101
0.25	580 MHz			0.0101
0.25	590 MHz			0.0101
0.25	600 MHz			0.0101
0.25	1000 MHz			0.0101
0.399	10 MHz		na	na
0.399	30 MHz			0.006085
0.399	70 MHz			0.006085
0.399	120 MHz			0.00808
0.399	290 MHz			0.00808
0.399	360 MHz			0.01606
0.399	390 MHz			0.01606
0.399	400 MHz			0.01606
0.399	480 MHz			0.01606
0.399	570 MHz			0.01606
0.399	580 MHz			0.01606
0.399	590 MHz			0.01606
0.399	600 MHz			0.01606
0.399	1000 MHz			0.01606
0.4	10 MHz		na	na
0.4	30 MHz			0.0061
0.4	70 MHz			0.0061
0.4	120 MHz			0.0081
0.4	290 MHz			0.0081
0.4	360 MHz			0.0161

Table 31. Leveled Sinewave Verification: Flatness (cont.)

Nominal Value (V p-p)	Frequency	Measured Value (V p-p)	Deviation (V p-p)	1-Year Spec. (V p-p)
0.4	390 MHz			0.0161
0.4	400 MHz			0.0161
0.4	480 MHz			0.0161
0.4	570 MHz			0.0161
0.4	580 MHz			0.0161
0.4	590 MHz			0.0161
0.4	600 MHz			0.0161
0.4	1000 MHz			0.0161
0.8	10 MHz		na	na
0.8	30 MHz			0.0121
0.8	70 MHz			0.0121
0.8	120 MHz			0.0161
0.8	290 MHz			0.0161
0.8	360 MHz			0.0321
0.8	390 MHz			0.0321
0.8	400 MHz			0.0321
0.8	480 MHz			0.0321
0.8	570 MHz			0.0321
0.8	580 MHz			0.0321
0.8	590 MHz			0.0321
0.8	600 MHz			0.0321
0.8	1000 MHz			0.0321
1.2	10 MHz		na	na
1.2	30 MHz			0.0181
1.2	70 MHz			0.0181
1.2	120 MHz			0.0241
1.2	290 MHz			0.0241
1.2	360 MHz			0.0481
1.2	390 MHz			0.0481
1.2	400 MHz			0.0481
1.2	480 MHz			0.0481
1.2	570 MHz			0.0481
1.2	580 MHz			0.0481
1.2	590 MHz			0.0481
1.2	600 MHz			0.0481
1.2	1000 MHz			0.0481
1.3	10 MHz		na	na
1.3	30 MHz			0.0196
1.3	70 MHz			0.0196
1.3	120 MHz			0.0261
1.3	290 MHz			0.0261
1.3	360 MHz			0.0521
1.3	390 MHz			0.0521
1.3	400 MHz			0.0521

Table 31. Leveled Sinewave Verification: Flatness (cont.)

Nominal Value (V p-p)	Frequency	Measured Value (V p-p)	Deviation (V p-p)	1-Year Spec. (V p-p)
1.3	480 MHz			0.0521
1.3	570 MHz			0.0521
1.3	580 MHz			0.0521
1.3	590 MHz			0.0521
1.3	600 MHz			0.0521
1.3	1000 MHz			0.0521
3.4	10 MHz		na	na
3.4	30 MHz			0.0511
3.4	70 MHz			0.0511
3.4	120 MHz			0.0681
3.4	290 MHz			0.0681
3.4	360 MHz			0.1361
3.4	390 MHz			0.1361
3.4	400 MHz			0.1361
3.4	480 MHz			0.1361
3.4	570 MHz			0.1361
3.4	580 MHz			0.1361
3.4	590 MHz			0.1361
3.4	600 MHz			0.1361
3.4	1000 MHz			0.1361
5.5	10 MHz		na	na
5.5	30 MHz			0.0826
5.5	70 MHz			0.0826
5.5	120 MHz			0.1101
5.5	290 MHz			0.1101
5.5	360 MHz			0.2201
5.5	390 MHz			0.2201
5.5	400 MHz			0.2201
5.5	480 MHz			0.2201
5.5	570 MHz			0.2201
5.5	580 MHz			0.2201
5.5	590 MHz			0.2201
5.5	600 MHz			0.2201

Marker Generator Verification

Table 33. Marker Generator Verification

Period (s)	Measured Value (s)	Deviation (s)	1-Year Spec. (s)
5			25.1E-3
2			4.1E-3
0.05			3.8E-6
0.02			50.0E-9
0.01			25.0E-9
100.0E-9			250.0E-15
50.0E-9			125.0E-15
20.0E-9			50.0E-15
10.0E-9			25.0E-15
5.0E-9			12.5E-15
2.0E-9			5.0E-15
1.0E-9			2.5E-15

Pulse Generator Verification: Period

Table 34. Pulse Generator Verification: Period

Nominal Value (V p-p)	Pulse Width (s)	Period (s)	Measured Value (s)	Deviation (s)	1-Year Spec. (s)
2.5	80 ns	2E-06			5 ps
2.5	500 ns	0.01			25 ns
2.5	500 ns	0.02			50 ns

Pulse Generator Verification: Pulse Width

Table 35. Pulse Generator Verification: Pulse Width

Nominal Value (V p-p)	Pulse Width (s)	Period (s)	Measured Value (s)	Deviation (s)	1-Year Spec. Typical (s)
2.5	4.0E-09	2.0E-06			700 ps
2.5	4.0E-09	2.0E-05			700 ps
2.5	4.0E-09	2.0E-04			700 ps
2.5	4.0E-08	2.0E-03			4,000 ps

Input Impedance Verification: Resistance

Table 36. Input Impedance Verification: Resistance

Nominal Value (Ω)	Measured Value (Ω)	Deviation (Ω)	1-Year Spec. (Ω)
40			0.04
50			0.05
60			0.06
600000			600
1000000			1000
1,500,000			1500

Input Impedance Verification: Capacitance

Table 37. Input Impedance Verification: Capacitance

Nominal Value (pF)	Measured Value (pF)	Deviation (pF)	1-Year Spec. (pF)
5 pF			0.75 pF
29 pF			1.95 pF
49 pF			2.95 pF

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