FLUKE®

5520A-SC1100

Oscilloscope Calibrator Option

Service Manual

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Safety Information

This Calibrator complies 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 manual contains information, warnings, and cautions that must be followed to ensure safe operation and to maintain the Calibrator in a safe condition. Use of this Calibrator in a manner not specified herein may impair the protection provided by the Calibrator.

This Calibrator 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 THE CALIBRATOR

WARNING Risk of electric shock. Refer to the manual (see the Index for references).

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 Calibrator 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 CALIBRATOR

The Calibrator uses controlled overvoltage techniques that require the Calibrator 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 CHASSIS GROUND binding post.

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 Calibrator in an atmosphere of explosive gas.

CHECK INSULATION RATINGS

Verify that the voltage applied to the unit under test does not exceed the insulation rating of the UUT and the interconnecting cables.

DO NOT REMOVE COVER DURING OPERATION

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

DO NOT ATTEMPT TO OPERATE IF PROTECTION MAY BE IMPAIRED

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

Table of Contents

Title	Page
Introduction	1
Maintenance	2
SC1100 Specifications	2
Volt Specifications	3
Edge Specifications	4
Leveled Sine Wave Specifications	5
Time Marker Specifications	6
Wave Generator Specifications	6
Pulse Generator Specifications	7
Trigger Signal Specifications (Pulse Function)	7
Trigger Signal Specifications (Time Marker Function)	7
Trigger Signal Specifications (Edge Function)	7
Trigger Signal Specifications (Square Wave Voltage Function)	8
Trigger Signal Specifications	8
Oscilloscope Input Resistance Measurement Specifications	8
Oscilloscope Input Capacitance Measurement Specifications	8
Overload Measurement Specifications	8
Theory of Operation	9
Voltage Mode	9
Edge Mode	9
Leveled Sine Wave Mode	9
Time Marker Mode	10
Wave Generator Mode	10
Pulse Generator Modes	10
Input Impedance Mode (Resistance)	10
Input Impedance Mode (Capacitance)	10
Overload Mode	10
Equipment Required for Calibration and Verification	12
SC1100 Calibration Setup	15
Calibration and Verification of Square Wave Voltage Functions	15
Overview of HP3458A Operation	16
Setup for SC1100 Voltage Square Wave Measurements	16
Setup for SC1100 Edge and Wave Gen Square Wave Measurements	17
DC Voltage Calibration	18
AC Voltage Calibration	19

Wave Generator Calibration 19
Edge Amplitude Calibration 20
Leveled Sine Wave Amplitude Calibration 20
Leveled Sine Wave Flatness Calibration 21
Low Frequency Calibration 22
High Frequency Calibration 22
Pulse Width Calibration 23
MeasZ Calibration 24
Verification 25
DC Voltage Verification 26
Verification at 1 MΩ 26
Verification at 50 Ω 27
AC Voltage Amplitude Verification 29
Verification at 1 MΩ 29
Verification at 50 Ω 31
AC Voltage Frequency Verification 32
Edge Amplitude Verification 33
Edge Frequency Verification 34
Edge Duty Cycle Verification 34
Edge Rise Time Verification 35
Edge Abberation Verification 37
Tunnel Diode Pulser Drive Amplitude Verification 37
Leveled Sine Wave Amplitude Verification 38
Leveled Sine Wave Frequency Verification 39
Leveled Sine Wave Harmonics Verification 40
Leveled Sine Wave Flatness Verification 42
Equipment Setup for Low Frequency Flatness 42
Equipment Setup for High Frequency Flatness 42
Low Frequency Verification 44
High Frequency Verification 44
Time Marker Verification 55
Wave Generator Verification 56
Verification at 1 MΩ 56
Verification at 50 Ω 57
Pulse Width Verification 60
Pulse Period Verification 61
MeasZ Resistance Verification 61
MeasZ Capacitance Verification 62
Overload Function Verification 63
SC1100 Hardware Adjustments 64
Equipment Required 64
Adjusting the Leveled Sine Wave Function 64
Equipment Setup 65
Adjusting the Leveled Sine Wave VCO Balance 65
Adjusting the Leveled Sine Wave Harmonics 66
Adjusting the Aberrations for the Edge Function 67
Equipment Setup 67
Adjusting the Edge Aberrations 67
Adjusting Frequency 68

Index

List of Tables

Table	Title	Page
1.	Volt Specifications	3
2.	Edge Specifications	4
3.	Leveled Sine Wave Specifications	5
4.	Time Marker Specifications	6
5.	Wave Generator Specifications	6
6.	Pulse Generator Specifications	7
7.	Trigger Signal Specifications (Pulse Function)	7
8.	Trigger Signal Specifications (Time Marker Function)	7
9.	Trigger Signal Specifications (Edge Function)	7
10.	Trigger Signal Specifications (Square Wave Voltage Function)	8
11.	TV Trigger Signal Specifications	8
12.	Oscilloscope Input Resistance Measurement Specifications	8
13.	Oscilloscope Input Capacitance Measurement Specifications	8
14.	Overload Measurement Specifications	8
15.	SC1100 Calibration and Verification Equipment	12
16.	Voltage HP3458A Settings	16
17.	Edge and Wave Generator HP3458A Settings	17
18.	Verification Methods for SC1100 Functions	26
19.	DC Voltage Verification at 1 MΩ	28
20.	DC Voltage Verification at 50 Ω	29
21.	AC Voltage Verification at 1 MΩ	30
22.	AC Voltage Verification at 50 Ω	31
23.	AC Voltage Frequency Verification	32
24.	Edge Amplification Verification	33
25.	Edge Frequency Verification	34
26.	Edge Rise Time Verification	36
27.	Edge Aberrations	37
28.	Tunnel Diode Pulser Amplitude Verification	38
29.	Leveled Sine Wave Amplitude Verification	39
30.	Leveled Sine Wave Frequency Verification	40
31.	Leveled Sine Wave Harmonics Verification	41
32.	Low Frequency Flatness Verification at 5.5 V	44
33.	High Frequency Flatness Verification	46
34.	Time Marker Verification	55
35.	Wave Generator Verification at 1 MΩ	58

36. Wave Generator Verification at 50 Ω 59
37. Pulse Width Verification 60
38. Pulse Period Verification 61
39. MeasZ Resistance Verification 62
40. MeasZ Capacitance Verification 63

List of Figures

Figure	Title	Page
1.	SC1100 Block Diagram	11
2.	Equipment Setup for SC1100 Voltage Square Wave Measurements	17
3.	Equipment Setup for SC1100 Edge and Wave Gen Square Wave Measurements	18
4.	Connecting the Calibrator to the 5790A AC Measurement Standard	21
5.	MeasZ Function Calibration Setup	24
6.	AC Voltage Frequency Verification Setup	32
7.	Edge Rise Time Verification Setup	35
8.	Edge Rise Time	36
9.	Leveled Sine Wave Harmonics Verification Setup	40
10.	Connecting the Calibrator to the 5790A AC Measurement Standard	42
11.	Connecting the HP 437B Power Meter to the HP 8482A or 8481D Power Sensor	43
12.	Connecting the Calibrator to the HP Power Meter and Power Sensor	43
13.	Wave Generator Verification Setup	56
14.	Overload Function Verification Setup	63
15.	Adjusting the Leveled Sine Wave Balance	65
16.	Adjusting the Leveled Sine Wave Harmonics	66
17.	Adjusting Short-Term Edge	68

5520A-SC1100 Option

Introduction

This manual contains the following information and service procedures for the SC1100 Oscilloscope Calibration Option functions.

- Specifications
- Theory of operation
- Calibration procedures
- Verification procedures
- Hardware adjustments made after repair

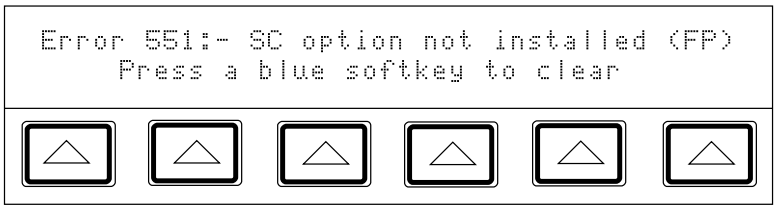
The calibration and verification procedures in this manual provide traceable results for all of the SC1100 functions as long as they are performed using the recommended equipment. All of the required equipment along with the minimum specifications, are provided in Table 15 under “Equipment Required for Calibration and Verification.”

The calibration and verification procedures in this manual are not those Fluke uses at the factory. These procedures have been developed to provide the ability to calibrate and verify the SC1100 at a user’s own site. Review all of the procedures in advance to make sure the resources to complete them are present. It is strongly recommended that, if possible, return the unit to Fluke for calibration and verification.

Hardware adjustments that are made after repair, at the factory or designated Fluke service centers, are provided in detail.

Maintenance

There are no maintenance techniques or diagnostic remote commands for the SC1100 that are available to users. If the SC1100 is not installed or not receiving power, the following error message appears on the display when SCOPE is pressed to access the oscilloscope calibration menus.



om030i.eps

If this message is displayed, and the SC1100 is installed in the Calibrator Mainframe (hereafter referred to as "the Calibrator"), return the Calibrator to Fluke for repair. To purchase the SC1100, contact a Fluke sales representative.

SC1100 Specifications

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

- The Calibrator is operated under the conditions specified in Chapter 1 of the *5520A Service Manual*.
- The Calibrator has completed a warm-up 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.

Volt Specifications

Table 1. 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 1 mV to 24.999 mV 25 mV to 109.99 mV 110 mV to 2.1999 V 2.2 V to 10.999 V 11 V to 130 V		Resolution 1 µV 10 µV 100 µV 1 mV 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 2. 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]	1 kHz to 10 MHz	± (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 rise time specification < 350 ps. [2] All edge aberration measurements made with Tektronix 11801 mainframe with SD26 input module.		

Leveled Sine Wave Specifications

Table 3. Leveled Sine Wave Specifications

Leveled Sine Wave Characteristics into 50 Ω	**Frequency Range**				
	50 kHz/10 MHz (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				4 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 µV)
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 4. Time Marker Specifications

Time Marker into 50 Ω	**5 s 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 [3]	± 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 [1]	> 1 V p-p [1]	> 1 V p-p [1]	>1 V p-p [1]	> 1 V p-p
Typical Jitter (rms)	< 10 ppm	< 1 ppm	< 1 ppm	< 1 ppm	< 1 ppm
Sequence	5-2-1 from 5 s to 2 ns (e.g., 500 ms, 200 ms, 100 ms)				
Adjustment Range [2]	At least ± 10 % around each sequence value indicated above.				
Frequency Resolution	4 digits				

[1] Typical rise time of square wave and 20 %-pulse (20 % duty cycle pulse) is < 1.5 ns.
[2] Time marker uncertainty is ± 50 ppm away from the cardinal points.
[3] As an example, a 0.5 second period would have uncertainty of $\pm(25 + 0.5 \times 10^{3}) \times 10^{-6} = 525$ ppm.

Wave Generator Specifications

Table 5. 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 6. 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 [2]	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 7. 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 8. 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 9. 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 10. 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

Trigger Signal Specifications

Table 11. 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 12. 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 13. 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. SC1100 option must be selected for at least five minutes prior to any capacitance measurement, including the zero process.	

Overload Measurement Specifications

Table 14. 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

Theory of Operation

The following discussion provides a brief overview of the following SC1100 operating modes: voltage, edge, leveled sine wave, time marker, wave generator, video, pulse generator, input impedance, and overload. This discussion will help to identify which of the main plug-in boards of the Calibrator are defective. Figure 1 shows a block diagram of the SC1100 Option, also referred to as the A45 board. Functions that are not depicted in the figure are generated from the DDS Assembly (A6 board).

Voltage Mode

All signals for the voltage function are generated from the A41 Voltage/Video board, a daughter card to the A45 board. A dc reference voltage is supplied to the A41 board from the A6 DDS board; all dc and ac oscilloscope output voltages are derived from this signal and generated on the A41 board. The output of the A41 board is passed to the A45 Signal board (also attached to the A45 board) and attenuator module and is then cabled to the output connectors on the front panel. The reference dc signal is used to generate both positive and negative dc and ac signals that are amplified or attenuated to provide the complete range of output signals.

Edge Mode

The edge clock originates on the DDS A6 board and is passed to the A45 board. The signal is then shaped and split to generate the fast edge and external trigger signals. The edge signal is passed from the A45 board first to the attenuator assembly (where range attenuation occurs) and then to the SCOPE connector N-BNC on the front panel. If turned on, the trigger is connected to the Trig Out BNC on the front panel.

Leveled Sine Wave Mode

All leveled sine wave signals (from 50 kHz to 1100 MHz) are produced on the A45 and A92 assemblies. For frequencies 50 kHz to 600 MHz, the A45 PLL and output amplifier is used. For 600 MHz and above, the A92 PLL and output amplifier is used. The leveled sine wave signal is passed from the A45 module to the on-board A91 attenuator assembly. The attenuator assembly provides range attenuation and contains a power detector which maintains amplitude flatness across the frequency range. The signal is then passed to the SCOPE N connector on the front panel.

Time Marker Mode

There are 3 primary "ranges" of time marker operation: 5 s to 50 ms, 10 ms to 2 µs, and 1 µs to 1 ns.

The 5 s to 20 ms markers are generated on the A6 DDS board and passed to the A45 board. The signal path is also split to drive the external trigger circuitry on the A45 board. If turned on, the trigger is connected to the Trig Out BNC on the front panel. The marker signal passing through the A45 board is connected to the attenuator assembly. The signal is then passed to the SCOPE N-connector on the front panel.

The 10 ms to 2 µs markers are derived from a square wave signal that is generated on the A6 board and passed to the A45 board for wave shaping and external trigger generation. If the trigger is turned on, the signal is connected to the Trig Out BNC on the front panel. The marker signal is passed from the A45 board to the attenuator assembly and then to the SCOPE N-connector on the front panel.

The 1 µs to 1 ns markers are generated from the leveled sine wave generator on the A45 board. This signal is also split to drive the external trigger circuits. If the trigger is turned on, the signal is then connected to the Trig Out BNC on the front panel. The other path routes the signal to the marker circuits on the A45 board, where the signal is shaped into the other marker waveforms. The marker signals are passed from the A45 board to the attenuator assembly and on to the SCOPE N-BNC connector on the front panel.

Wave Generator Mode

All signals for the wavegen function are generated from the A6 board and are passed to the A45 board. They are then sent to the attenuator assembly, where range attenuation occurs. Wavegen signals are then sent to the SCOPE N-connector on the front panel.

Pulse Generator Modes

Video and pulse generator mode signals are derived from dedicated circuitry on the A45 board. If there are faults associated only with these functions, the A45 board most likely needs replacement.

Input Impedance Mode (Resistance)

The reference resistors for this mode are on the A45 board, while the DCV reference signal and measuring signals are on the A6 DDS board.

Input Impedance Mode (Capacitance)

Capacitance measurement circuits are contained on the A45 board, utilizing signals from the leveled sine wave source. If there are faults associated only with capacitance measurement, the A45 board most likely needs replacement.

Overload Mode

The source voltage for the overload mode is generated on the A41 Voltage/Video board of the A45 board. The voltage is applied to the external 50 Ω load, and the circuit current is monitored by the A6 DDS board.

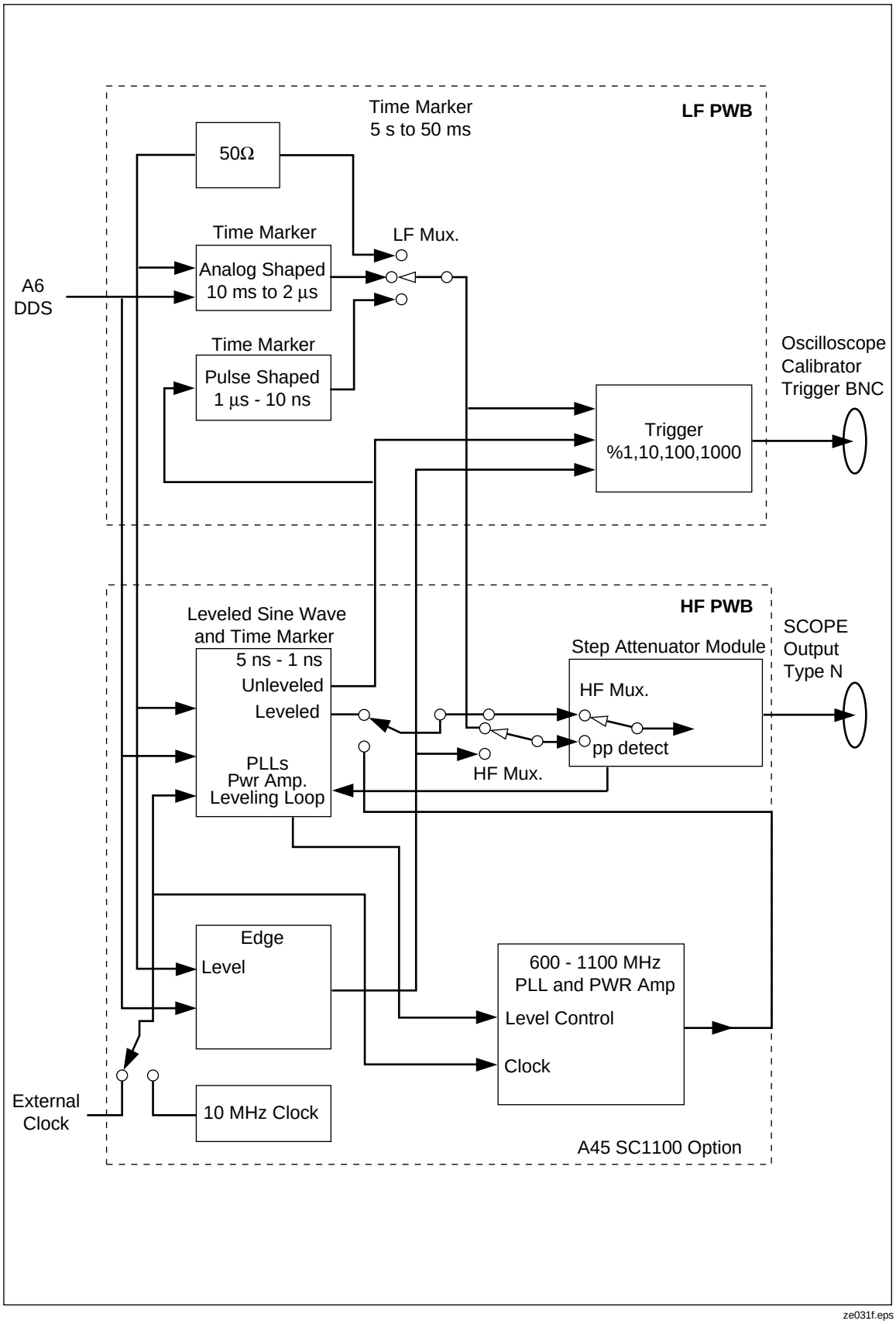


Figure 1. SC1100 Block Diagram

Equipment Required for Calibration and Verification

Table 15 lists the equipment, recommended models, and minimum specifications required for each calibration and verification procedure.

Table 15. SC1100 Calibration and Verification Equipment

Wave Generator and Edge Amplitude Calibration, AC Voltage and TD Pulser Verification			
Instrument	**Model**	**Minimum Use Specifications**	
Digital Multimeter	HP 3458A	Voltage	1.8 mV to ± 130 V p-p Uncertainty: 0.06 %
		Edge	4.5 mV to 2.75 V p-p Uncertainty: 0.06 %
Adapter	Pomona #1269	BNC(f) to Double Banana Plug	
Termination		Feedthrough 50 Ω ± 1 % (used with Edge Amplitude Calibration and AC Voltage Verification)	
SC1100 Cable (N-BNC)	(supplied with SC1100)		
BNC-BNC Cable		For Trigger Out Connection	
Edge Rise Time and Aberrations Verification			
High-Frequency Digital Storage Oscilloscope	Tektronix 11801 with Tektronix SD-22/26 sampling head, or Tektronix TDS 820 with 8 GHz bandwidth	Frequency	12.5 GHz
		Resolution	4.5 mV to 2.75 V
Attenuator	Weinschel 9-10 (SMA) or Weinschel 18W-10 or equivalent	10 dB, 3.5 mm (m/f)	
Adapter		BNC(f) to 3.5 mm(m)	
SC1100 Cable (N-BNC)	(supplied with SC1100)		
BNC-BNC Cable		For Trigger Out Connection	
Leveled Sine Wave Amplitude Calibration and Verification			
AC Measurement Standard	Fluke 5790A	Range	5 mV p-p to 5.5 V p-p
		Frequency	50 kHz
Adapter	Pomona #1269	BNC(f) to Double Banana Plug	
Termination		Feedthrough 50 Ω ± 1 %.	
SC1100 Cable (N-BNC)	(supplied with SC1100)		
DC and AC Voltage Calibration and Verification, DC Voltage Verification			
Digital Multimeter	HP 3458A		
Adapter	Pomona #1269	BNC(f) to Double Banana Plug	
Termination		Feedthrough 50 Ω ± 1 %.	
SC1100 Cable (N-BNC)	(supplied with SC1100)		
BNC-BNC Cable		For Trigger Out Connection	

Table 15. SC1100 Calibration and Verification Equipment (cont.)

Pulse Width Calibration and Verification			
High-Frequency Digital Storage Oscilloscope	Tektronix 11801 with Tektronix SD-22/26 sampling head		
Attenuator			3 dB, 3.5 mm (m/f)
Adapter (2)			BNC(f) to 3.5 mm(m)
SC1100 Cable (N-BNC)	(supplied with SC1100)		
BNC-BNC Cable			For Trigger Out Connection
Leveled Sine Wave Frequency Verification			
Frequency Counter	PM 6680 with option (PM 9621, PM 9624, or PM 9625) and (PM 9690 or PM 9691)		50 kHz to 600 MHz, < 0.15 ppm uncertainty
Adapter	Pomona #3288		BNC(f) to Type N(m)
SC1100 Cable (N-BNC)	(supplied with SC1100)		
Leveled Sine Wave Flatness (Low Frequency) Calibration and Verification			
AC Measurement Standard	Fluke 5790A with -03 option	Range Frequency	5 mV p-p to 5.5 V p-p 50 kHz to 10 MHz
Adapter	Pomona #3288	BNC(f) to Type N(m)	
SC1100 Cable (N-BNC)	(supplied with SC1100)		
Leveled Sine Wave Harmonics Verification			
Spectrum Analyzer	HP 8590A or equivalent		
Adapter	Pomona #3288		BNC(f) to Type N(m)
SC1100 Cable (N-BNC)	(supplied with SC1100)		
Pulse Period, Edge Frequency, AC Voltage Frequency Verification			
Frequency Counter	PM 6680 with option (PM 9690 or PM 9691)		20 ms to 150 ns, 10 Hz to 10 MHz: < 0.15 ppm uncertainty
SC1100 Cable (N-BNC)	(supplied with SC1100)		
Edge Duty Cycle			
Frequency Counter	PM 6680		
SC1100 Cable (N-BNC)	(supplied with SC1100)		
Overload Functional Verification			
Termination			Feedthrough 50 Ω ± 1 %.
SC1100 Cable (N-BNC)	(supplied with SC1100)		
MeasZ Resistance, Capacitance Verification			
Resistors			1 MΩ and 50 Ω nominal values
Capacitors			50 pF nominal value at the end of BNC(f) connector
Adapters			to connect resistors and capacitors to BNC(f) connector
SC1100 Cable (N-BNC)	(supplied with SC1100)		

Table 15. SC1100 Calibration and Verification Equipment (cont.)

Leveled Sine Wave Flatness (High Frequency) Calibration and Verification			
Instrument	**Model**	**Minimum Use Specifications**	
Power Meter	Hewlett-Packard 437B or equivalent	Range	-42 to +5.6 dBm
		Frequency	10 - 1100 MHz
Power Sensor	Hewlett-Packard 8482A	Range	-20 to +19 dBm
		Frequency	10 - 1100 MHz
Power Sensor	Hewlett-Packard 8481D	Range	-42 to -20 dBm
		Frequency	10 - 1100 MHz
30 dB Reference Attenuator	Hewlett-Packard 11708A (supplied with HP 8481D)	Range	30 dB
		Frequency	50 MHz
Adapter	Hewlett-Packard PN 1250-1474	BNC(f) to Type N(f)	
SC1100 Cable (N-BNC)	(supplied with SC1100)		
Leveled Sine Wave Frequency, Time Marker Verification			
Frequency Counter	PM 6680 with option (PM 9621, PM 9624, or PM 9625) and (PM 9690 or PM 9691)	2 ns to 5 s, 50 kHz to 1000 MHz: < 0.15 ppm uncertainty	
Adapter	Pomona #3288	BNC(f) to Type N(m)	
SC1100 Cable (N-BNC)	(supplied with SC1100)		
Wave Generator Verification			
AC Measurement Standard	Fluke 5790A	Range	1.8 mV p-p to 55 V p-p
		Frequency	10 Hz to 100 kHz
Adapter	Pomona #1269	BNC(f) to Double Banana	
Termination		Feedthrough 50 Ω ± 1%.	
SC1100 Cable (N-BNC)	(supplied with SC1100)		

SC1100 Calibration Setup

The procedures in this manual have been developed to provide users the ability to calibrate the SC1100 at their own site if they are required to do so. It is strongly recommended that, if possible, return the unit to Fluke for calibration and verification. The Calibrator must be fully calibrated prior to performing any of the SC1100 calibration procedures.

Calibration must be performed after any hardware adjustments. See “Hardware Adjustments” in this manual. The hardware adjustments are intended to be one-time adjustments performed in the factory, however, adjustment may be required after repair. Hardware adjustments must be performed prior to calibration.

The AC Voltage function is dependent on the DC Voltage function. Calibration of the AC Voltage function is required after the DC Voltage is calibrated.

The Calibrator must complete a warm-up and the SC1100 must be enabled for at least 5 minutes prior to calibration to allow internal components to thermally stabilize. The Calibrator warm-up is at least twice the length of time the calibrator was powered off, up to a maximum of 30 minutes. The SC1100 is enabled by pressing the front panel **SCOPE** key. The green indicator on the **SCOPE** key will be illuminated when the SC1100 is enabled.

Much of the SC1100 can be calibrated interactively from the front panel. Enable the SC1100 and wait at least 5 minutes. Enter Scope Cal mode by pressing the front panel **SETUP** key, **CAL** blue softkey, second **CAL** blue softkey, and **SCOPE CAL** blue softkey. Entering Scope Cal mode prior to having the SC1100 enabled for at least 5 minutes will cause a warning message to be displayed.

All equipment specified for SC1100 calibration must be calibrated, certified traceable if traceability is to be maintained, and operating within their normal specified operating environment. It is also important to ensure that the equipment has had sufficient time to warm up prior to its use. Refer to each equipment’s operating manual for details.

Before beginning calibration, review all of the procedures in advance to ensure the resources to complete them are present.

The Calibrator first prompts the user to calibrate the DC Voltage function. If another function is to be calibrated, alternately press the **OPTIONS** and **NEXT SECTION** blue softkeys until the desired function is reached.

Calibration and Verification of Square Wave Voltage Functions

The Voltage, Edge, and Wave Generator functions have square wave voltages that need to be calibrated or verified. The HP3458A digital multimeter can be programmed from either the front panel or over the remote interface to make these measurements.

Overview of HP3458A Operation

The Hewlett-Packard 3458A digital multimeter is setup as a digitizer to measure the peak-to-peak value of the signal. It is set to DCV, using various analog-to-digital integration times and triggering commands to measure the topline and baseline of the square wave signal.

Setup for SC1100 Voltage Square Wave Measurements

By controlling the HP 3458A's integration and sample time, it can be used to make accurate, repeatable measurements of both the topline and baseline of the Voltage Square Wave up to 10 kHz. To make these measurements, the HP 3458A's External Trigger function is used in conjunction with the SC1100's External Trigger output. In general, the HP 3458A is setup to make an analog-to-digital conversion after receiving the falling edge of an external trigger. The conversion does not take place until a time determined by the 3458A "DELAY" command. The actual integration time is set according to the frequency that the digital multimeter (hereafter referred to as "DMM") is measuring. Table 16 summarizes the DMM settings required to make topline and baseline measurements. Figure 2 illustrates the proper connections for this setup.

Table 16. Voltage HP3458A Settings

Voltage Input Frequency	HP 3458A Settings		
	NPLC	DELAY (topline)	DELAY (baseline)
100 Hz	.1	.007 s	.012 s
1 kHz	.01	.0007 s	.0012 s
5 kHz	.002	.00014	.00024
10 kHz	.001	.00007	.00012

For all measurements, the HP 3458A is in DCV, manual ranging, with external trigger enabled. A convenient method to make these measurements from the HP 3458A's front panel is to program these settings into several of the user defined keys on its front panel. For example, to make topline measurements at 1 kHz, set the DMM to "NPLC .01; DELAY .0007; TRIG EXT". To find the average of multiple readings, it is possible to program one of the keys to "MATH OFF; MATH STAT" and then use the "RMATH MEAN" function to recall the average or mean value.

Note

For this application, if making measurements of a signal > 1 kHz, the HP 3458A has been known to have .05 % to 0 .1 % peaking. For these signals, lock the HP 3458A to the 1 V range.

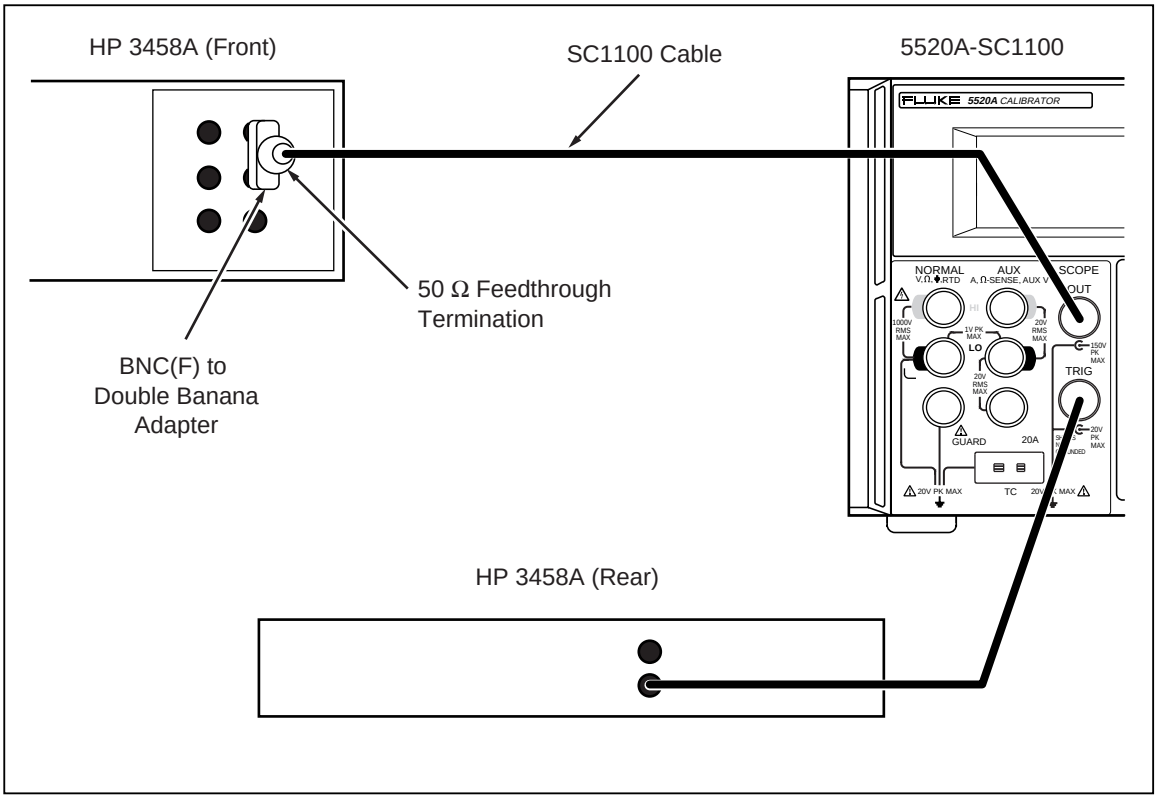


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Figure 2. Equipment Setup for SC1100 Voltage Square Wave Measurements

Setup for SC1100 Edge and Wave Gen Square Wave Measurements

The setup to measure the topline and baseline of Edge and Wave Generator signals differs slightly from the Voltage Square Wave method described above. The HP 3458A is triggered by a change in input level instead of an external trigger. The trigger level is set to 1% of the DCV range, with ac coupling of the trigger signal. The delay after the trigger event is also changed for the Edge and Wave Generator functions. See Table 17 and Figure 3.

Table 17. Edge and Wave Generator HP3458A Settings

	HP 3458A Settings		
Input Frequency	**NPLC**	**DELAY (topline)**	**DELAY (baseline)**
1 kHz	.01	.0002 s	.0007 s
10 kHz	.001	.00002 s	.00007 s

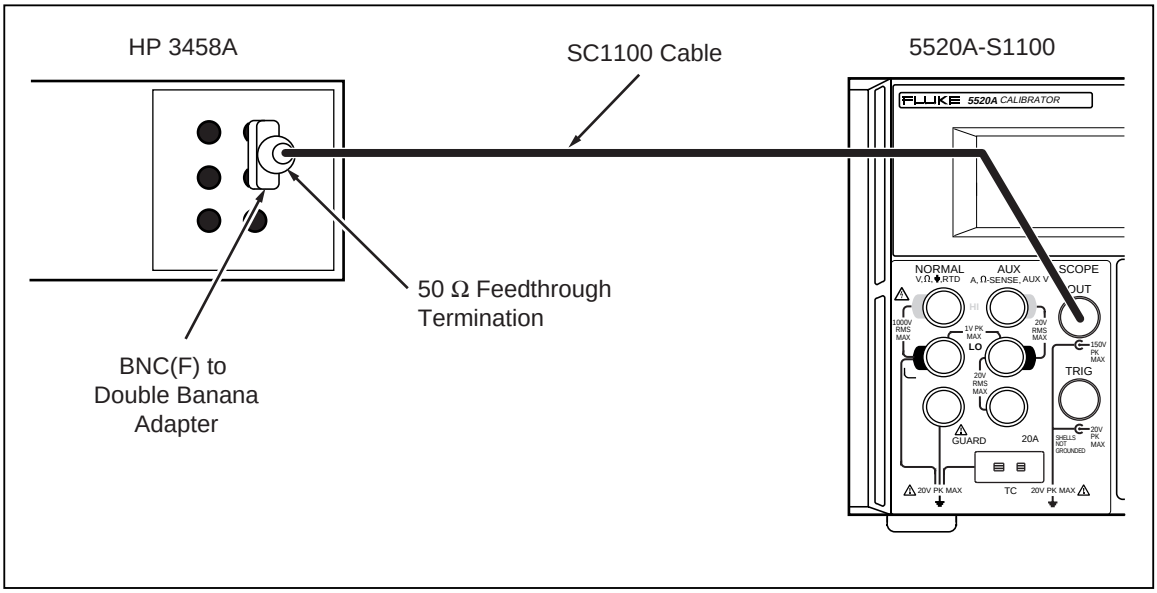

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Figure 3. Equipment Setup for SC1100 Edge and Wave Gen Square Wave Measurements.

For all measurements, the HP 3458A is in DCV, manual ranging, with level triggering enabled. A convenient method to make these measurements from the HP 3458A's front panel is to program these settings into several of the user defined keys on its front panel. For example, to make topline measurements at 1 kHz, set the DMM to "NPLC .01; LEVEL 1; DELAY .0002; TRIG LEVEL". To find the average of multiple readings, it is possible to program one of the keys to "MATH OFF; MATH STAT" and then use the "RMATH MEAN" function to recall the average or mean value. Refer to Figure 3 for the proper connections.

DC Voltage Calibration

This procedure uses the following equipment:

- Hewlett-Packard 3458A Digital Multimeter
- BNC(f) to Double Banana adapter
- SC1100 Cable
- BNC-BNC cable

Note

Calibrating dc voltage requires ac voltage calibration.

Refer to Figure 3 for the proper setup connections.

Set the Calibrator in Scope Cal mode, DC Voltage section. Follow these steps to calibrate DC Voltage.

1. Connect the Calibrator's SCOPE connector to the HP 3458A input, using the SC1100 cable and the BNC(f) to Double Banana adapter.
2. Set the HP 3458A to DCV, Auto Range, NPLC = 10, FIXEDZ = on.
3. Press the **GO ON** blue softkey.
4. Ensure the HP 3458A reading is 0.0 V DC ± 10 µV. If not, adjust R121 (the square resistor potentiometer near Q29 at the top left of A41).

5. Press the **GO ON** blue softkey.
6. Calibration voltages 33 V and greater will automatically put the Calibrator output in standby. When this occurs, press [OPR] on the Calibrator to activate the output. Allow the HP 3458A DC voltage reading to stabilize. Enter the reading via the Calibrator front panel keypad, then press **ENTER**.

Note

The Calibrator will warn when the entered value is out of bounds. If this warning occurs recheck the setup and carefully re-enter the reading insuring proper multiplier (i.e., m, μ, n, p). If the warning still occurs, repair may be necessary.

7. Repeat steps 6 until the Calibrator display indicates that the next steps calibrate ac voltage. Press the **OPTIONS**, then **STORE CONSTS** blue softkeys to store the new calibration constants.

AC voltage must now be calibrated; continue with the next section.

AC Voltage Calibration

This procedure uses the same equipment and setup as dc voltage calibration. Refer to Figure 3. DC voltages are measured and entered in the Calibrator to calibrate the ac voltage function.

Set up the Calibrator to Cal ACV. Press **OPTIONS** and **NEXT SECTION** blue softkeys until the display reads “The next steps calibrate -SC1100 ACV”. Follow these steps to calibrate ac voltage.

1. Press the **GO ON** blue softkey.
2. Allow the HP 3458A dc voltage reading to stabilize. Enter the reading via the Calibrator front panel keypad, then press **ENTER**.

Note

The Calibrator will warn when the entered value is out of bounds. If this warning occurs recheck the setup and carefully re-enter the reading insuring proper multiplier (i.e., m, u, n, p). If the warning still occurs, repair may be necessary.

3. Repeat step 2 until the Calibrator display indicates that the next steps calibrate WAVEGEN. Press the **OPTIONS**, then **STORE CONSTS** blue softkeys to store the new calibration constants.

Wave Generator Calibration

This procedure uses the following equipment:

- Hewlett-Packard 3458A Digital Multimeter
- BNC(f) to Double Banana adapter
- SC1100 cable

Within the calibration menu, press the **OPTIONS** and **NEXT SECTION** blue softkeys until the display reads “WAVEGEN Cal:”. Follow these steps to calibrate the Wave Generator:

1. Connect the Calibrator’s SCOPE connector to the HP 3458A input, using the SC1100 cable and the BNC(f) to Double Banana adapter.

2. Set the HP 3458A to DCV, NPLC = .01, LEVEL 1, TRIG LEVEL, and the DELAY to .0002 for measuring the upper part of the wave form (i.e. topline), and the DELAY to .0007 for measuring the lower part of the wave form (i.e. baseline). Manually range lock the HP 3458A to the range that gives the most resolution for the topline measurements. Use this same range for the corresponding baseline measurements at each step.
3. For each calibration step, take samples for at least two seconds, using the HP 3458A MATH functions to retrieve the average or mean value. See "Setup for SC1100 Edge and Wave Generator Measurements" for more details.

Edge Amplitude Calibration

This procedure uses the following equipment:

- Hewlett-Packard 3458A Digital Multimeter
- BNC(f) to Double Banana adapter
- SC1100 cable
- 50 Ω feedthrough termination

Refer to Figure 3 for the proper setup connections. Press the **OPTIONS** and **NEXT SECTION** blue softkeys until the display reads "Set up to measure fast edge amplitude". Follow these steps to calibrate edge amplitude:.

1. Connect the Calibrator's SCOPE connector to the HP 3458A input, using the SC1100 cable and the BNC(f) to Double Banana.
2. Set the HP 3458A to DCV, NPLC = .01, LEVEL 1, TRIG LEVEL, and the DELAY to .0002 for measuring the upper part of the wave form (i.e. topline), and the DELAY to .0007 for measuring the lower part of the wave form (i.e. baseline). Manually lock the HP 3458A to the range that gives the most resolution for the baseline measurements. Use this same range for the corresponding baseline measurements at each step. Note that in the EDGE function, the topline is very near 0 V, and the baseline is a negative voltage.
3. For each calibration step, take samples for at least two seconds, using the HP 3458A MATH functions to enter the average or mean value. See "Setup for SC1100 Edge and Wave Generator Measurements" for more details.

The "true amplitude" of the wave form is the difference between the topline and baseline measurements, correcting for the load resistance error. Make this correction by multiplying the readings by (0.5 * (50 + Rload)/Rload), where Rload = actual feedthrough termination resistance.

Leveled Sine Wave Amplitude Calibration

This procedure uses the following equipment:

- 5790A AC Measurement Standard
- BNC(f) to Double Banana Plug Adapter
- 50 Ω feedthrough termination
- SC1100 cable

Press the **OPTIONS** and **NEXT SECTION** blue softkeys until the display reads "Set up to measure leveled sine amplitude". Follow these steps to calibrate Leveled Sine Wave amplitude.

1. Connect the SC1100 cable to the Calibrator's SCOPE connector. Connect the other end of the SC1100 cable to the 50 Ω feedthrough termination then to the 5790A INPUT 2 using the BNC(f) to Double Banana adapter.
2. Set the 5790A to AUTORANGE, digital filter mode to FAST, restart fine, and Hi Res on.
3. Press the **GO ON** blue softkey.
4. Press OPR to activate the operating mode on the Calibrator.
5. Allow the 5790A rms reading to stabilize. Multiply the 5790A reading by (0.5 * (50 + Rload) / Rload), where Rload = the actual feedthrough termination resistance, to correct for the resistance error. Enter the corrected rms reading via the Calibrator front panel keypad, then press **ENTER**.

   Note

   The Calibrator will warn when the entered value is out of bounds. If this warning occurs recheck the setup and calculation and carefully re-enter the corrected rms reading insuring proper multiplier (i.e., m, u, n, p). If the warning still occurs, repair may be necessary.

6. Repeat step 5 until the Calibrator display indicates that the next steps calibrate Leveled Sine flatness. Press the **OPTIONS**, then **STORE CONSTS** blue softkeys to store the new calibration constants.

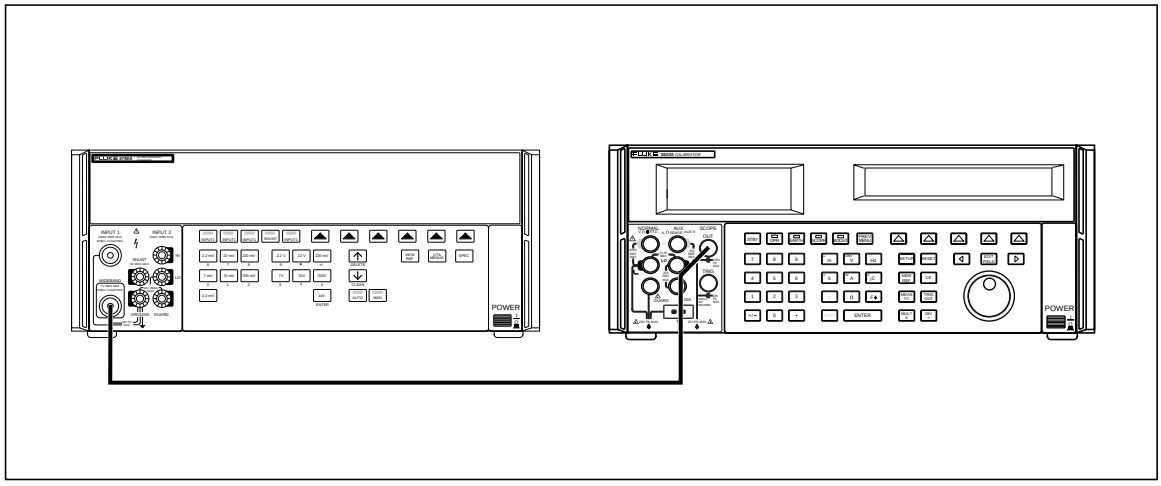

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Figure 4. Connecting the Calibrator to the 5790A AC Measurement Standard

Leveled Sine Wave Flatness Calibration

Leveled Sine Wave flatness calibration is divided into two frequency bands: 50 kHz to 10 MHz (low frequency) and >10 MHz to 600 MHz (high frequency). The equipment setups are different for each band. Flatness calibration of the low frequency band is made relative to 50 kHz. Flatness calibration of the high frequency band is made relative to 10 MHz.

Leveled Sine Wave flatness is calibrated at multiple amplitudes. Both low and high frequency bands are calibrated at each amplitude. Calibration begins with the low frequency band, then the high frequency band for the first amplitude, followed by the low frequency band, then the high frequency band for the second amplitude, and so on, until the flatness calibration is complete.

Press the **OPTIONS** and **NEXT SECTION** blue softkeys until the display reads "Set up to measure leveled sine flatness".

Low Frequency Calibration

Connect the Calibrator SCOPE connector to the 5790A WIDEBAND input described under "Equipment Setup for Low Frequency Flatness".

Follow these steps to calibrate low frequency Leveled Sine Wave flatness for the amplitude being calibrated.

1. Press the **GO ON** blue softkey.
2. Establish the 50 kHz reference:
   - Allow the 5790A rms reading to stabilize.
   - Press the 5790A **Set Ref** blue softkey. (Clear any previous reference by pressing the 5790A **Clear Ref** blue softkey prior to setting the new reference if required.)
3. Press the **GO ON** blue softkey.
4. Adjust the amplitude using the Calibrator front panel knob until the 5790A reference deviation matches the 50 kHz reference within 1000 ppm.
5. Repeat steps 1 through 4 until the Calibrator display indicates the reference frequency is now 10 MHz. Continue with the high frequency calibration.

High Frequency Calibration

Connect the Calibrator SCOPE connector to the power meter and power sensor as described under "Equipment Setup for High Frequency Flatness".

Follow these steps to calibrate high frequency Leveled Sine Wave flatness for the amplitude being calibrated.

1. Press the **GO ON** blue softkey.
2. Establish the 10 MHz reference:
   - Press the power meter **SHIFT** key, then **FREQ** key and use the arrow keys to enter the power sensor's 10 MHz Cal Factor. Ensure that the factor is correct, press the power meter **ENTER** key.
   - Allow the power meter reading to stabilize.
   - Press the power meter **REL** key.
3. Press the **GO ON** blue softkey.
4. Press the power meter **SHIFT** key, then **FREQ** key and use the arrow keys to enter the power sensor's Cal Factor for the frequency displayed on the Calibrator. Ensure that the factor is correct, then press the power meter **ENTER** key.
5. Adjust the amplitude using the Calibrator front panel knob until the power sensor reading matches the 10 MHz reference within 0.1%.
6. Repeat steps 1 through 5 until the Calibrator display indicates that either the reference frequency is now 50 kHz or the next steps calibrate pulse width. Repeat low frequency calibration for the next amplitude unless the Calibrator display indicates that the next steps calibrate pulse width. Press the **OPTIONS**, then **STORE CONSTS** blue softkeys to store the new calibration constants.

Pulse Width Calibration

This procedure uses the following equipment:

- High Frequency Digital Storage Oscilloscope: Tektronix 11801 with Tektronix SD-22/26 sampling head
- 3 dB attenuator, 3.5 mm (m/f)
- BNC(f) to 3.5 mm(m) adapter (2)
- SC1100 cable
- BNC cable

Press the **OPTIONS** and **NEXT SECTION** blue softkeys until the display reads "Set up to measure Pulse Width". Follow these steps to calibrate pulse width:

1. Connect the SC1100 cable to the Calibrator's SCOPE connector. Connect the other end of the SC1100 cable to one BNC(f) to 3.5 mm(m) adapter then to the DSO's sampling head through the 3 dB attenuator.
2. Using the second BNC(f) to 3.5 mm(m) adapter and SC1100 cable, connect the Calibrator's TRIG OUT connector to the 11801's Trigger Input.
3. Set the DSO to these parameters:
   - Main Time Base position (initial): 40 ns
   - Vertical scale: 200 mV/div, +900 mV offset
   - Trigger: source = ext; level = 0.5 V; ext atten = x10; slope = +; mode = auto
   - Measurement Function: positive width
4. Press the **GO ON** blue softkey.
5. Adjust the DSO horizontal scale and main time base position until the pulse signal spans between half and the full display. If no pulse is output, increase the pulse width using the Calibrator front panel knob until a pulse is output.
6. If the Calibrator prompts to adjust the pulse width, adjust the pulse width to as close to 4 ns as possible using the Calibrator front panel knob, then press the **GO ON** blue softkey.
7. Allow the DSO width reading to stabilize. Enter the reading via the Calibrator front panel keypad, then press **ENTER**.

Note

The Calibrator issues a warning when the entered value is out of bounds. If this warning occurs, recheck the setup and carefully re-enter the reading with the proper multiplier (i.e., m, u, n, p). If the warning still occurs, enter a value between the displayed pulse width and the previously entered value. Keep attempting this, moving closer and closer to the displayed pulse width, until the value is accepted. Complete the pulse width calibration procedure. The pulse width calibration procedure must now be repeated until all entered values are accepted the first time without warning.

8. Repeat steps 5 through 7 until the Calibrator prompts to connect a resistor. Press the **OPTIONS**, then **STORE CONSTS** blue softkeys to store the new calibration constants.

MeasZ Calibration

The MeasZ function is calibrated using resistors and a capacitor of known values. The actual resistance and capacitance values are entered while they are being measure by the Calibrator.

The resistors and capacitor must make a solid connection to a BNC(f) to enable a connection to the end of the SC1100 cable. The resistance and capacitance values must be known at this BNC(f) connector. Fluke uses an HP 3458A DMM to make a 4-wire ohms measurement at the BNC(f) connector to determine the actual resistance values and an HP 4192A Impedance Analyzer at 10 MHz to determine the actual capacitance value.

This procedure uses the following equipment:

- Resistors of known values: 1 MΩ and 50 Ω nominal
- adapters to connect resistors to BNC(f) connector
- adapters and capacitor to achieve 50 pF nominal value at the end of BNC(f) connector
- SC1100 cable

Refer to Figure 5 for setup connections.

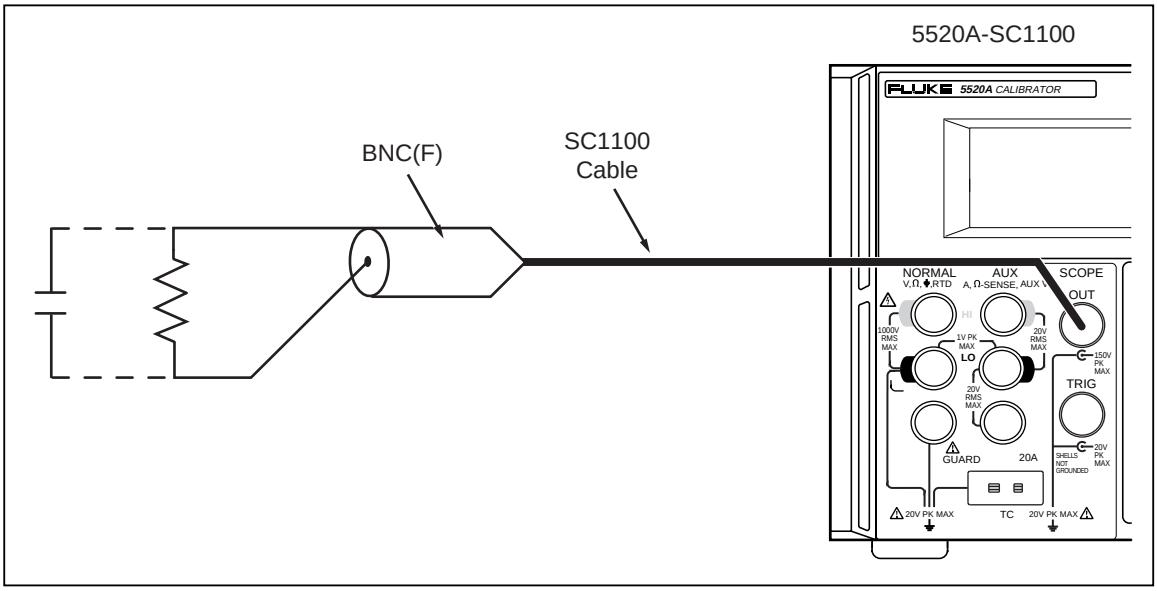

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Figure 5. MeasZ Function Calibration Setup

Set the Calibrator in Scope Cal mode at the prompt to connect a 50 Ω resistor. Follow these steps to calibrate MeasZ:

1. Connect the SC1100 cable to the SCOPE connector. Connect the other end of the cable to the BNC(f) connector attached to the 50 Ω resistance.
2. Press the **GO ON** blue softkey.
3. Enter the actual 50 Ω resistance.

Note

The Calibrator will warn when the entered value is out of bounds. If this warning occurs, recheck the setup and carefully re-enter the actual resistance insuring proper multiplier (i.e., m, u, n, p). If the warning still occurs, repair may be necessary.

4. When prompted by the Calibrator, disconnect the 50 Ω resistance and connect the 1MΩ resistance to the end of the SC1100 cable.
5. Press the **GO ON** blue softkey.
6. Enter the actual 1 MΩ resistance.
7. When prompted for the first reference capacitor by the Calibrator, disconnect the 1MΩ resistance and leave nothing attached to the end of the SC1100 cable.
8. Press the **GO ON** blue softkey.
9. Enter 0.
10. When prompted for the second reference capacitor by the Calibrator, connect the 50 pF capacitance to the end of the SC1100 cable.
11. Press the **GO ON** blue softkey.
12. Enter the actual 50 pF capacitance.
13. The Calibrator will prompt that the calibration is complete. Press the **OPTIONS**, then **STORE CONSTS** blue softkeys to store the new calibration constants.

Verification

All of the oscilloscope calibration functions should be verified at least once per year, or each time the SC1100 is calibrated. The verification procedures in this section provide traceable results; however the factory uses different procedures and instruments of higher precision than those described here. The procedures in this manual have been developed to provide users the ability to verify the SC1100 at their own site if they are required to do so. Fluke strongly recommends that, if possible, return the unit to Fluke for calibration and verification.

All equipment specified for SC1100 verification must be calibrated, certified traceable if traceability is to be maintained, and operating within their normal specified operating environment. It is also important to ensure that the equipment has had sufficient time to warm up prior to its use. Refer to each equipment’s operating manual for details.

Before beginning verification, review all of the procedures in advance to ensure the resources to complete them are present.

All of the SC1100 functions are listed in Table 18, with the verification technique indicated.

Table 18. Verification Methods for SC1100 Functions

Function	Verification Method
DC Voltage	Procedure provided in this manual.
AC Voltage amplitude	Procedure provided in this manual.
AC Voltage frequency	Procedure provided in this manual.
Edge amplitude	Procedure provided in this manual.
Edge frequency, duty cycle, rise time	Procedure provided in this manual.
Tunnel Diode Pulser amplitude	Procedure provided in this manual. See "Voltage and Edge Calibration and Verification" for details.
Leveled sine wave amplitude, frequency, harmonics, and flatness	Procedures provided in this manual.
Time marker period	Procedure provided in this manual.
Wave generator amplitude	Procedure provided in this manual.
Pulse width, period	Procedure provided in this manual.
MeasZ resistance, capacitance	Procedure provided in this manual.
Overload functionality	Procedure provided in this manual.

DC Voltage Verification

This procedure uses the following equipment:

- Hewlett-Packard 3458A Digital Multimeter
- BNC(f) to Double Banana adapter
- 50 Ω feedthrough termination
- SC1100 cable

For DC voltage verification, refer to Figure 3 for the proper setup connections.

Set the Calibrator to SCOPE mode, with the volt menu on the display. Follow these steps to verify the wave generator function.

Verification at 1 MΩ

For the 1 MΩ verification, connect the Calibrator's SCOPE connector to the HP 3458A input, using the cable and the BNC(f) to Double Banana adapter.

Make sure the Calibrator impedance is set to 1 MΩ (The blue softkey under **Output @** toggles the impedance between 50 Ω and 1 MΩ).

1. Set the HP 3458A to DCV, Auto Range, NPLC = 10, FIXEDZ = on.
2. Program the Calibrator to output the voltage listed in Table 19. Press OPR on the Calibrator to activate the output.
3. Allow the HP 3458A reading to stabilize, then record the HP 3458A reading for each voltage in Table 19.
4. Compare result to the tolerance column.

Verification at 50 Ω

For the 50 Ω verification, connect the SCOPE connector to the HP 3458A input, using the cable and the 50 Ω termination connected to the BNC to Banana Plug adapter.

Make sure the Calibrator impedance is set to 50 Ω (The blue softkey under **Output @** toggles the impedance between 50 Ω and 1 MΩ).

1. Set the HP 3458A to DCV, Auto Range, NPLC = 10, FIXEDZ = on.
2. Program the Calibrator to output the voltage listed in Table 20. Press OPR on the Calibrator to activate the output.
3. Allow the HP 3458A reading to stabilize, then record the HP 3458A reading for each voltage in Table 20.
4. Multiply the readings by (0.5 * (50 + Rload) / Rload), where Rload = the actual feedthrough termination resistance, to correct for the resistance error. Compare result to the tolerance column.

Table 19. DC Voltage Verification at 1 MΩ

Calibrator Output	HP 3458A Reading (V DC)	Tolerance (V DC)
0 mV		0.00004 V
1.25 mV		4.063E-05 V
-1.25 mV		4.063E-05 V
2.49 mV		4.125E-05 V
-2.49 mV		4.125E-05 V
2.5 mV		4.125E-05 V
-2.5 mV		4.125E-05 V
6.25 mV		4.313E-05 V
-6.25 mV		4.313E-05 V
9.90 mV		4.495E-05 V
-9.90 mV		4.495E-05 V
10.0 mV		0.000045 V
-10.0 mV		0.000045 V
17.5 mV		4.875E-05 V
-17.5 mV		4.875E-05 V
24.9 mV		5.245E-05 V
-24.9 mV		5.245E-05 V
25.0 mV		0.0000525 V
-25.0 mV		0.0000525 V
67.5 mV		7.375E-05 V
-67.5 mV		7.375E-05 V
109.9 mV		9.495E-05 V
-109.9 mV		9.495E-05 V
110 mV		0.000095 V
-110 mV		0.000095 V
305 mV		0.0001925 V
-305 mV		0.0001925 V
499 mV		0.0002895 V
-499 mV		0.0002895 V
0.50 V		0.00029 V
-0.50 V		0.00029 V
1.35 V		0.000715 V
-1.35 V		0.000715 V
2.19 V		0.001135 V
-2.19 V		0.001135 V
2.20 V		0.00114 V
-2.20 V		0.00114 V
6.60 V		0.00334 V
-6.60 V		0.00334 V
10.99 V		0.005535 V
-10.99 V		0.005535 V
11.0 V		0.00554 V
-11.0 V		0.00554 V
70.5 V		0.03529 V
-70.5 V		0.03529 V
130.0 V		0.06504 V
-130.0 V		0.06504 V

Table 20. DC Voltage Verification at 50 Ω

Calibrator 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 Amplitude Verification

This procedure uses the following equipment:

- Hewlett-Packard 3458A Digital Multimeter
- BNC(f) to Double Banana adapter
- 50 Ω feedthrough termination
- SC1100 cable
- BNC cable to connect the Calibrator TRIG OUT to the HP 3458A Ext Trig

For ac voltage amplitude verification, refer to Figure 2 for the proper setup connections.

Set the Calibrator to SCOPE mode, with the volt menu on the display. Follow these steps to verify the ac voltage function.

Verification at 1 MΩ

For the 1 MΩ verification, connect the Calibrator's SCOPE connector to the HP 3458A input, and the BNC(f) to Double Banana adapter. Connect the Calibrator TRIG OUT connector to the HP 3458A Ext Trig connector located on the rear of that instrument.

Make sure the Calibrator impedance is set to 1 MΩ. (The blue softkey under Output @ toggles the impedance between 50 Ω and 1 MΩ.)

1. When making measurements at 1 kHz, set the HP 3458A to DCV, NPLC = .01, TRIG EXT, and the DELAY to .0007 for measuring the topline of the wave form, and the DELAY to .0012 for measuring the baseline of the wave form. Manually lock the HP 3458A to the range that gives the most resolution for the topline measurements. Use this same range for the corresponding baseline measurements at each step.
2. Enable the Calibrator external trigger by toggling the blue softkey under TRIG to /1.
3. Measure the topline first, as indicated in Table 21. For each measurement, take samples for at least two seconds, using the HP 3458A MATH functions to determine the average or mean value. See "Setup for SC1100 Voltage Square Wave Measurements" for more details.
4. Measure the baseline of each output after the corresponding topline measurement, as indicated in Table 21. The peak-to-peak value is the difference between the topline and baseline measurements. Compare the result to the tolerance column.
5. When making measurements at the other frequencies, set up the HP 3458A (NPLC and topline and baseline DELAY) per Table 16. (See "Setup for SC1100 Voltage Square Wave Measurements.")

Table 21. AC Voltage Verification at 1 MΩ

Calibrator Output (1 kHz, or as Noted)	HP 3458A Range	Topline Reading	Baseline Reading	Peak-to-Peak	Tolerance (±V)
1 mV	100 mV dc				0.000041
-1 mV	100 mV dc				0.000041
10 mV	100 mV dc				0.00005
-10 mV	100 mV dc				0.00005
25 mV	100 mV dc				0.000065
-25 mV	100 mV dc				0.000065
110 mV	100 mV dc				0.00015
-110 mV	100 mV dc				0.00015
500 mV	1 V dc				0.00054
-500 mV	1 V dc				0.00054
2.2 V	10 V dc				0.00224
-2.2 V	10 V dc				0.00224
11 V	10 V dc				0.01104
-11 V	10 V dc				0.01104
130 V	1000 V dc				0.13004
-130 V	1000 V dc				0.13004
200 mV, 100 Hz	1 V dc				0.00024
200 mV, 1 kHz	1 V dc				0.00024
200 mV, 5 kHz	1 V dc				0.00054
200 mV, 10 kHz	1 V dc				0.00054
2.2 V, 100 Hz	10 V dc				0.00224
2.2 V, 5 kHz	10 V dc				0.00554
2.2 V, 10 kHz	10 V dc				0.00554

Verification at 50 Ω

For the 50 Ω verification, connect the Calibrator's SCOPE connector to the HP 3458A input, using the cable supplied with the Calibrator, the external 50 Ω termination, and the BNC(f) to Double Banana adapter. (The 50 Ω termination is closest to the HP 3458A input.) Connect the Calibrator TRIG OUT connector to the HP 3458A Ext Trig connector located on the rear of that instrument. Make sure the Calibrator impedance is set to 50 Ω. (The blue softkey under Output @ toggles the impedance between 50 Ω and 1 MΩ). Proceed with the following steps:

1. Set the HP 3458A to DCV, NPLC = .01, TRIG EXT, and the DELAY to .0007 for measuring the topline of the wave form, and the DELAY to .0012 for measuring the baseline of the wave form. Manually lock the HP 3458A to the range that gives the most resolution for the topline measurements. Use this same range for the corresponding baseline measurements at each step. See Table 22.
2. Enable the Calibrator external trigger by toggling the blue softkey under TRIG to /1.
3. Measure the topline first, as indicated in Table 22. For each measurement, take samples for at least two seconds, using the HP 3458A MATH functions to determine the average or mean value. See "Setup for SC1100 Voltage Square Wave Measurements" for more details.
4. Measure the baseline of each output after the corresponding topline measurement, as indicated in Table 22. The peak-to-peak value is the difference between the topline and baseline measurements. Compare the result to the tolerance column.

Table 22. AC Voltage Verification at 50 Ω

Calibrator 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

This procedure uses the following equipment:

- PM 6680 Frequency Counter with an ovenized timebase (Option PM 9690 or PM 9691)
- SC1100 cable

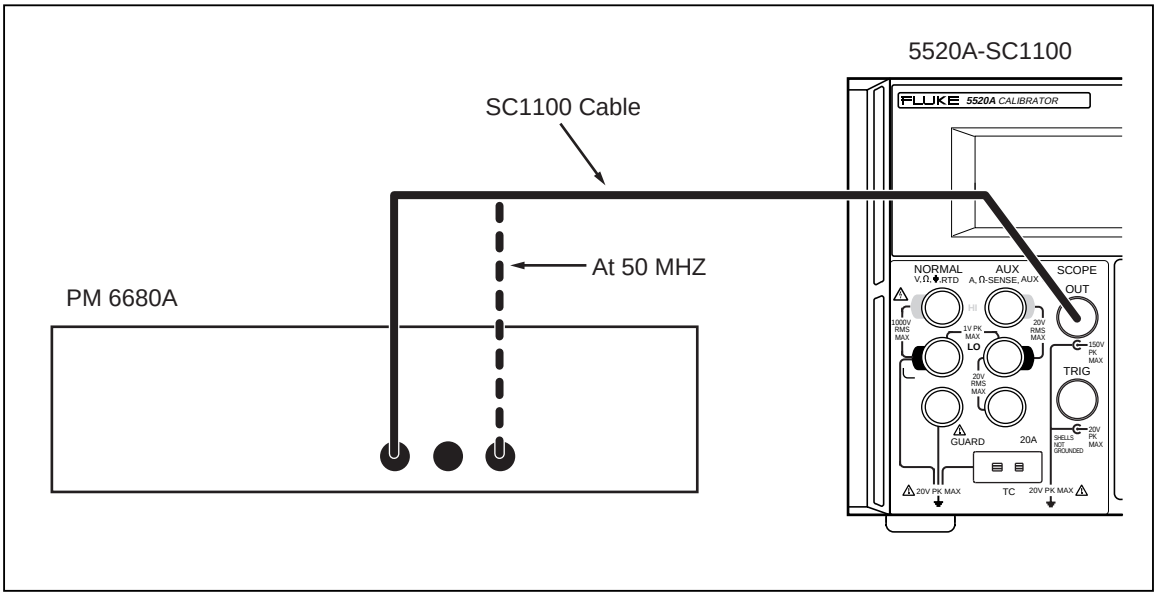

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Figure 6. AC Voltage Frequency Verification Setup

Set the Calibrator to SCOPE mode, with the volt menu on the display. Press OPR on the Calibrator to activate the output. Follow these steps to verify ac voltage frequency:

1. Set the PM 6680's FUNCTION to measure frequency on channel A with auto trigger, measurement time set to 1 second or longer, 1 MΩ impedance, and filter off.
2. Using the SC1100 cable, connect the SCOPE connector on the Calibrator to PM 6680 channel A.
3. Program the Calibrator to output 2.1 V at each frequency listed in Table 23.
4. Allow the PM 6680 reading to stabilize, then record the PM 6680 reading for each frequency listed in Table 23. Compare to the tolerance column of Table 23.

Table 23. AC Voltage Frequency Verification

Calibrator Frequency (Output @ 2.1 V p-p)	PM 6680 Reading (Frequency)	Tolerance
10 Hz		0.000025 Hz
100 Hz		0.00025 Hz
1 kHz		0.0025 Hz
10 kHz		0.025 Hz

Edge Amplitude Verification

To verify edge amplitude, connect the Calibrator's SCOPE connector to the HP 3458A input, using the SC1100 cable, the external 50 Ω termination, and the BNC(f) to Double Banana adapter. (The 50 Ω termination is closest to the HP 3458A input.)

1. For measurements of a 1 kHz signal, set the HP 3458A to DCV, NPLC = .01, LEVEL 1, TRIG LEVEL, and the DELAY to .0002 for measuring the upper part of the wave form (i.e. topline), and the DELAY to .0007 for measuring the lower part of the wave form (i.e. baseline). For measurements of a 10 kHz signal, set the HP 3458A to DCV, NPLC = .001, LEVEL 1, TRIG LEVEL, and the DELAY to .00002 for measuring the topline, and the DELAY to .00007 for measuring the baseline.
2. Manually lock the HP 3458A to the range that gives the most resolution for the baseline measurements. Use this same range for the corresponding baseline measurements at each step. Note that in the EDGE function, the topline is very near 0 V, and the baseline is a negative voltage. See Table 24.
3. For each calibration step, take samples for at least two seconds, using the HP 3458A MATH functions to enter the average or mean value. See "Setup for SC1100 Edge and Wave Generator Measurements" for more details.
4. The peak-to-peak value of the wave form is the difference between the topline and baseline measurements, correcting for the load resistance error. To make this correction, multiply the readings by (0.5 * (50 + Rload)/Rload), where Rload = actual feedthrough termination resistance. Record each reading as indicated in Table 24.

Table 24. Edge Amplification Verification

Calibrator Edge Output	HP 3458A Range	Topline Reading	Baseline Reading	Peak-to-Peak	Peak-to-Peak x Correction	Tolerance (±V)
100 mV, 1 kHz	100 mV dc					0.0022
1.00V, 1 kHz	1 V dc					0.0202
5 mV, 10 kHz	100 mV dc					0.0003
10 mV, 10 kHz	100 mV dc					0.0004
25 mV, 10 kHz	100 mV dc					0.0007
50 mV, 10 kHz	100 mV dc					0.0012
100 mV, 10 kHz	1 V dc					0.0022
500 mV, 10 kHz	1 V dc					0.0102
1.00 V, 10 kHz	1 V dc					0.0202
2.5 V, 10 kHz	10 V dc					0.0502

Edge Frequency Verification

This procedure uses the following equipment:

- PM 6680 Frequency Counter with an ovenized timebase (Option PM 9690 or PM 9691)
- SC1100 cable

Refer to Figure 6 for proper setup connections. Set the Calibrator to SCOPE mode, with the edge menu on the display. Press OPR on the Calibrator to activate the output. Follow these steps to verify edge frequency.

1. Set the PM 6680's FUNCTION to measure frequency on channel A with auto trigger, measurement time set to 1 second or longer, 50 Ω impedance, and filter off.
2. Using the SC1100 cable, connect the SCOPE connector on the Calibrator to PM 6680 channel A.
3. Program the Calibrator to output 2.5 V at each frequency listed in Table 25.
4. Allow the PM 6680 reading to stabilize, then record the PM 6680 reading for each frequency listed in Table 25. Compare to the tolerance column of Table 25.

Table 25. Edge Frequency Verification

Calibrator Frequency (Output @ 2.5 V p-p)	PM 6680 Reading (Frequency)	Tolerance
1 kHz		0.0025 Hz
10 kHz		0.025 Hz
100 kHz		0.25 Hz
1 MHz		2.5 Hz
10 MHz		25 Hz

Edge Duty Cycle Verification

This procedure uses the following equipment:

- PM 6680 Frequency Counter
- SC1100 cable

Refer to Figure 6 for proper setup connections. Set the Calibrator to SCOPE mode, with the edge menu on the display. Press OPR on the Calibrator to activate the output. Follow these steps to verify Edge duty cycle.

1. Set the PM 6680's FUNCTION to measure duty cycle on channel A with auto trigger, measurement time set to 1 second or longer, 50 Ω impedance, and filter off.
2. Using the SC1100 cable, connect the SCOPE connector on the Calibrator to PM 6680 channel A.
3. Program the Calibrator to output 2.5 V at 1 MHz.
4. Allow the PM 6680 reading to stabilize. Compare the duty cycle reading to 50 % ± 5 %.

Edge Rise Time Verification

This procedure tests the edge function's rise time. Aberrations are also checked with the Tektronix 11801 oscilloscope and SD-22/26 sampling head.

The following equipment is used to verify the edge rise time.

- High Frequency Digital Storage Oscilloscope: Tektronix 11801 with Tektronix SD-22/26 sampling head
- 3 dB attenuator, 3.5 mm (m/f)
- BNC(f) to 3.5 mm(m) adapter (2)
- SC1100 cable
- BNC-BNC cable

Connect the SC1100 cable to the Calibrator's SCOPE connector. Connect the other end of the SC1100 cable to one BNC(f) to 3.5 mm(m) adapter then to the DSO's sampling head through the 3 dB attenuator.

Using the second BNC(f) to 3.5 mm(m) adapter and the BNC-BNC cable, connect the Calibrator's TRIG OUT connector to the 11801's Trigger Input. Refer to Figure 7.

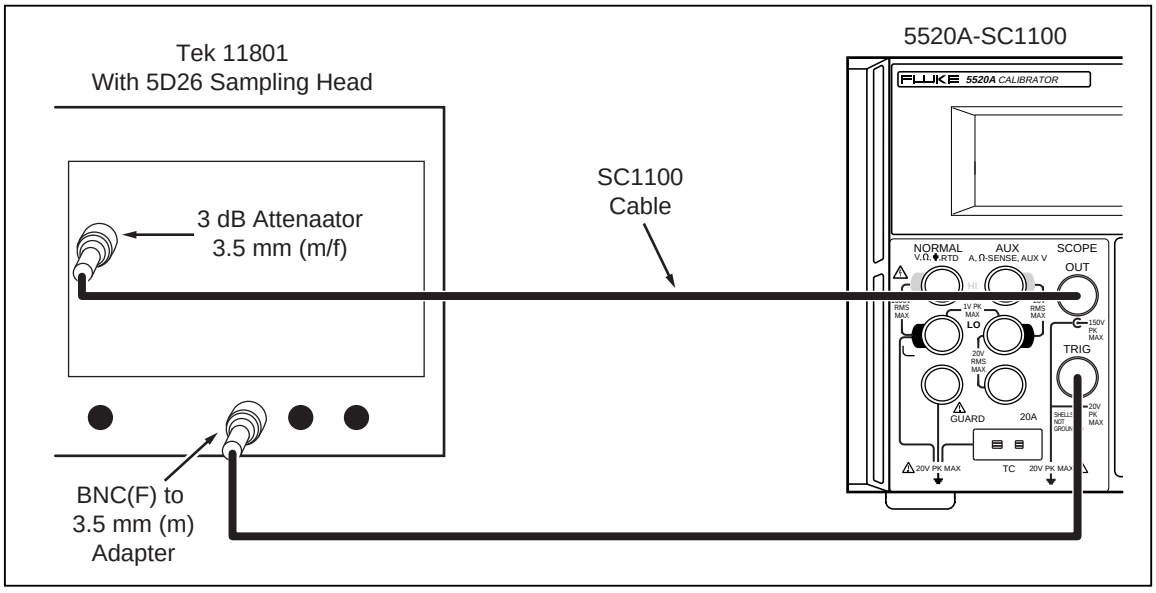

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Figure 7. Edge Rise Time Verification Setup

The Calibrator should be in SCOPE mode, with the edge menu on the display. Press OPR on the Calibrator to activate the output. Press the softkey under TRIG to select the TRIG/1 External Trigger output. Program the Calibrator to output 250 mV @ 1 kHz. Set the DSO to these parameters:

Digital Storage Oscilloscope Setup

Main Time Base position (initial)	40 ns
Horizontal scale	500 ps/div
Measurement Function	Rise Time

1. Program the Calibrator to output the voltage and frequency listed in Table 26. Press OPR on the Calibrator to activate the output.

2. Change the vertical scale of the DSO to the value listed in the table. Adjust the main time base position and vertical offset until the edge signal is centered on the display. Record the rise time measurement in column A of Table 26.
3. Correct the rise time measurement by accounting for the SD-22/26 sampling head's rise time. The SD-22/26 rise time is specified as < 28 ps. Column B = sqrt((Column A)^2 - (SD-22/26 rise time)^2).
4. The edge rise time measured should be less than the time indicated in Table 26.

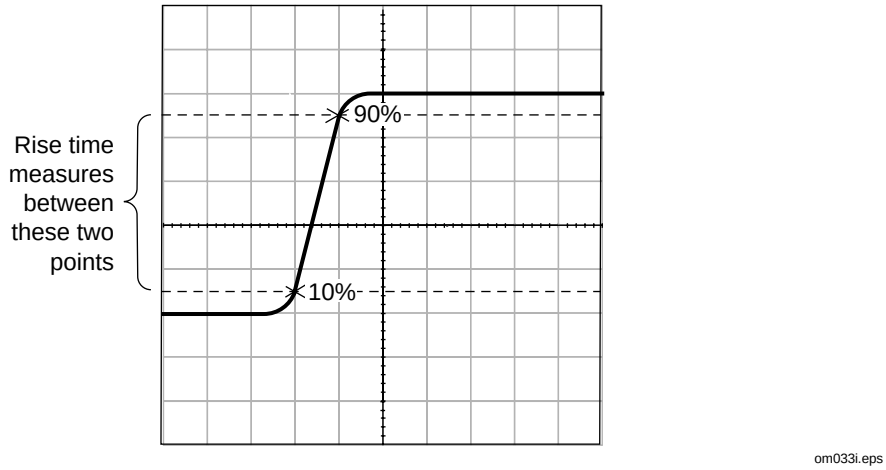


Figure 8. Edge Rise Time

Table 26. Edge Rise Time Verification

Calibrator Output		DSO Vertical Axis (mV/div)	A 11801 Reading	B Corrected Reading	Tolerance
Voltage	Frequency				
250 mV	1 kHz	20.0			< 300 ps
250 mV	1 MHz	20.0			< 300 ps
250 mV	10 MHz	20.0			< 350 ps
500 mV	1 kHz	50.0			< 300 ps
500 mV	1 MHz	50.0			< 300 ps
500 mV	10 MHz	50.0			< 350 ps
1 V	1 kHz	100.0			< 300 ps
1 V	1 MHz	100.0			< 300 ps
1 V	10 MHz	100.0			< 350 ps
2.5 V	1 kHz	200.0			< 300 ps
2.5 V	1 MHz	200.0			< 300 ps
2.5 V	10 MHz	200.0			< 350 ps

Edge Abberation Verification

The following equipment is needed for this procedure:

- Tektronix 11801 oscilloscope with SD22/26 sampling head
- Output cable provided with the SC1100

Before beginning, verify that the 5520A-SC1100 is in the edge mode (the edge menu is displayed), and program it to output 1 V p-p @ 1 MHz. Press OPR to activate the output.

Referring to Figure 7, connect the Calibrator to the oscilloscope. Set the oscilloscope vertical to 10 mV/div and horizontal to 1 ns/div. Set the oscilloscope to look at the 90% point of the edge signal; use this point as the reference level. Set the oscilloscope to look at the first 10 ns of the edge signal with the rising edge at the left edge of the oscilloscope display.

With these settings, each vertical line on the oscilloscope represents a 1% aberration. Determine that the SC1100 falls within the typical specifications shown in Table 27.

Table 27. Edge Aberrations

Time from 50% of Rising Edge	Typical Edge Aberrations
0 - 2 ns	< 32 mV (3.2 %)
2 - 5 ns	< 22 mV (2.2 %)
5 - 15 ns	< 12 mV (1.2 %)
> 15 ns	< 7 mV (0.7 %)

Tunnel Diode Pulser Drive Amplitude Verification

This procedure uses the following equipment:

- Hewlett-Packard 3458A Digital Multimeter
- BNC(f) to Double Banana adapter
- SC1100 cable

Set the Calibrator in Scope Cal mode, Edge. Proceed with the following steps:

1. Connect the Calibrator's SCOPE connector to the HP 3458A input, using the SC1100 cable and the BNC(f) to Double Banana adapter. Refer to Figure 2 for the proper setup connections.
2. Activate the TD Pulser output by pushing the **TDPULSE** blue softkey. The output should now be at 80 V peak-to-peak, 100 kHz, STANDBY.
3. Set the HP 3458A to DCV, NPLC = .001, LEVEL 1, TRIG LEVEL, and the DELAY to .00012 for measuring the topline and DELAY to .00007 for measuring the baseline. Manually range lock the HP 3458A to the 100 V dc range.
4. Change the Calibrator output frequency to 10 kHz. Push OPR, and use the HP 3458A to measure the topline and baseline.
5. The peak-to-peak value is the difference between the topline and baseline. Record these values in Table 28, and compare against the listed tolerance.

Table 28. Tunnel Diode Pulser Amplitude Verification

Calibrator Output	HP 3458A Range	Topline Reading	Baseline Reading	Peak-to-Peak	Tolerance (±V)
11	100 V dc				0.2202
11	100 V dc				0.2202
55	100 V dc				1.1002
55	100 V dc				1.1002
100	100 V dc				2.002
100	100 V dc				2.002

Leveled Sine Wave Amplitude Verification

This procedure uses the following equipment:

- 5790A AC Measurement Standard
- BNC(f) to Double Banana Plug adapter
- 50 Ω feedthrough termination
- SC1100 cable

Refer to Figure 17 for the proper setup connections.

Set the Calibrator to SCOPE mode, with the levsine menu on the display. Press OPR on the Calibrator to activate the output. Follow these steps to verify the leveled sine wave amplitude.

1. Connect the SC1100 cable to the Calibrator's SCOPE connector. Connect the other end of the SC1100 cable to the 50 Ω feedthrough termination then to the 5790A INPUT 2 using the BNC(f) to Double Banana adapter.
2. Set the 5790A to AUTORANGE, digital filter mode to FAST, restart fine, and Hi Res on.
3. Program the Calibrator to output the voltage listed in Table 29.
4. Allow the 5790A reading to stabilize, then record the 5790A's rms reading for each voltage listed in Table 29.
5. Multiply the rms reading by the conversion factor of 2.8284 to convert it to the peak-to-peak value.
6. Multiply the peak-to-peak value by (0.5 * (50 + Rload) / Rload), where Rload = the actual feedthrough termination resistance, to correct for the resistance error. Compare result to the tolerance column.

Table 29. Leveled Sine Wave Amplitude Verification

Calibrator output (@ 50 kHz)	5790A Reading (V rms)	5790A Reading x 2.8284 (V p-p)	V p-p value x correction	Tolerance
5.0 mV				400 µV
7.5 mV				450 µV
9.9 mV				498 µV
10.0 mV				500 µV
25.0 mV				800 µV
39.0 mV				1.08 mV
40.0 mV				1.10 mV
70.0 mV				1.70 mV
99.0 mV				2.28 mV
100.0 mV				2.30 mV
250.0 mV				5.30 mV
399.0 mV				8.28 mV
0.4 V				8.3 mV
0.8 V				16.3 mV
1.2 V				24.3 mV
1.3 V				26.3 mV
3.4 V				68.3 mV
5.5 V				110.3 mV

Leveled Sine Wave Frequency Verification

This procedure uses the following equipment:

- PM 6680 Frequency Counter with a prescaler for the Channel C input (Option PM 9621, PM 9624, or PM 9625) and ovenized timebase (Option PM 9690 or PM 9691)
- BNC(f) to Type N(m) adapter
- SC1100 cable

Refer to Figure 6 for the proper setup connections. Set the Calibrator to SCOPE mode, with the levsine menu on the display. Follow these steps to verify the leveled sine wave amplitude.

1. Set the PM 6680's FUNCTION to measure frequency with auto trigger, measurement time set to 1 second or longer, and 50 Ω impedance.
2. Using the SC1100 cable, connect the SCOPE connector on the Calibrator to the PM 6680 at the channel indicated in Table 30. The BNC-N adapter is needed for the connection to Channel C.
3. Set the filter on the PM 6680 as indicated in the table.
4. Program the Calibrator to output as listed in Table 30. Press OPR on the Calibrator to activate the output.
5. Allow the PM 6680 reading to stabilize, then record the PM 6680 reading for each frequency listed in Table 30.

Table 30. Leveled Sine Wave Frequency Verification

Calibrator Frequency (Output @ 5.5 V p-p)	PM 6680 Settings		PM 6680 Reading (Frequency)	Tolerance
	Channel	Filter		
50 kHz	A	On		0.125 Hz
500 kHz	A	Off		1.25 Hz
5 MHz	A	Off		12.5 Hz
50 MHz	A	Off		125 Hz
500 MHz	C	Off		1250 Hz

Leveled Sine Wave Harmonics Verification

This procedure uses the following equipment:

- Hewlett-Packard 8590A Spectrum Analyzer
- BNC(f) to Type N(m) adapter
- SC1100 cable

Refer to Figure 9 for proper setup connections.

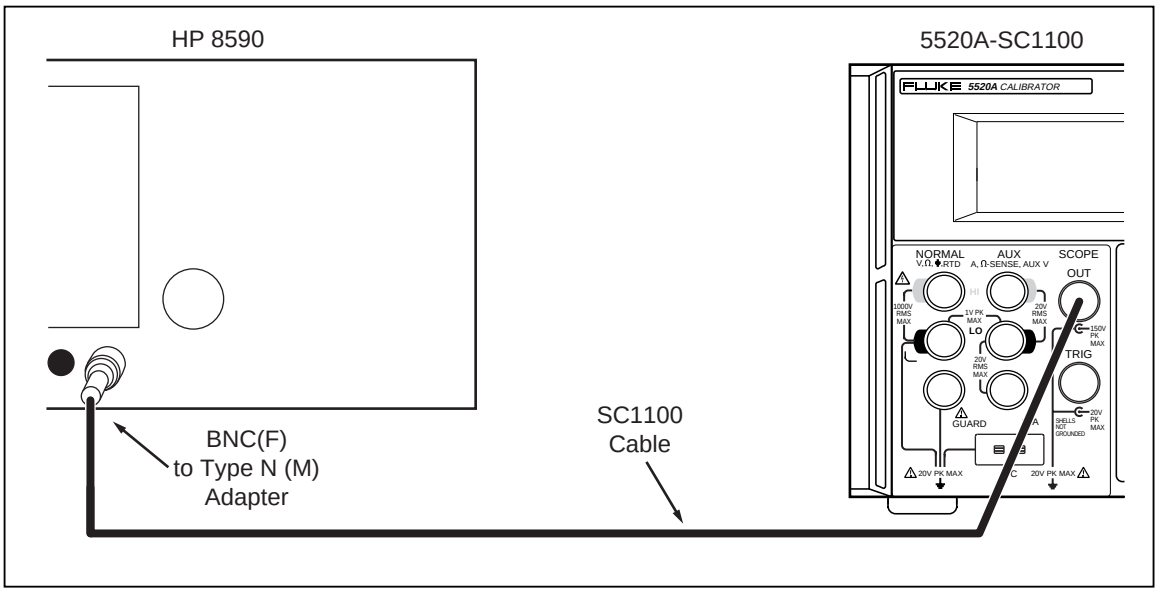


Figure 9. Leveled Sine Wave Harmonics Verification Setup

Set the Calibrator to SCOPE mode, with the levsine menu on the display. Follow these steps to verify the leveled sine wave harmonics.

1. Using the SC1100 cable and BNC(f) to Type N(m) adapter, connect the SCOPE connector on the Calibrator to the HP 8590A.
2. Program the Calibrator to 5.5 V p-p at each frequency listed in Table 31. Press OPR on the Calibrator to activate the output.

3. Set HP 8590A start frequency to the Calibrator output frequency. Set HP 8590A stop frequency to 10 times the Calibrator output frequency. Set the HP 8590A reference level at +19 dBm.
4. Record the harmonic level reading for each frequency and harmonic listed in Table 31. For harmonics 3, 4, and 5, record the highest harmonic level of the three measured. Harmonics should be below the levels listed in the tolerance column of Table 31.

Table 31. Leveled Sine Wave Harmonics Verification

Calibrator Output Frequency (@ 5.5 V p-p)	Harmonic	HP 8590A Reading (dB)	Tolerance
50 kHz	2		-33 dB
50 kHz	3, 4, 5		-38 dB
100 kHz	2		-33 dB
100 kHz	3, 4, 5		-38 dB
200 kHz	2		-33 dB
200 kHz	3, 4, 5		-38 dB
400 kHz	2		-33 dB
400 kHz	3, 4, 5		-38 dB
800 kHz	2		-33 dB
800 kHz	3, 4, 5		-38 dB
1 MHz	2		-33 dB
1 MHz	3, 4, 5		-38 dB
2 MHz	2		-33 dB
2 MHz	3, 4, 5		-38 dB
4 MHz	2		-33 dB
4 MHz	3, 4, 5		-38 dB
8 MHz	2		-33 dB
8 MHz	3, 4, 5		-38 dB
10 MHz	2		-33 dB
10 MHz	3, 4, 5		-38 dB
20 MHz	2		-33 dB
20 MHz	3, 4, 5		-38 dB
40 MHz	2		-33 dB
40 MHz	3, 4, 5		-38 dB
80 MHz	2		-33 dB
80 MHz	3, 4, 5		-38 dB
100 MHz	2		-33 dB
100 MHz	3, 4, 5		-38 dB
200 MHz	2		-33 dB
200 MHz	3, 4, 5		-38 dB
400 MHz	2		-33 dB
400 MHz	3, 4, 5		-38 dB
600 MHz	2		-33 dB
600 MHz	3, 4, 5		-38 dB
1000 @ 3.5 V	2		-33 dB
1000 @ 3.5 V	3, 4, 5		-39 dB

Leveled Sine Wave Flatness Verification

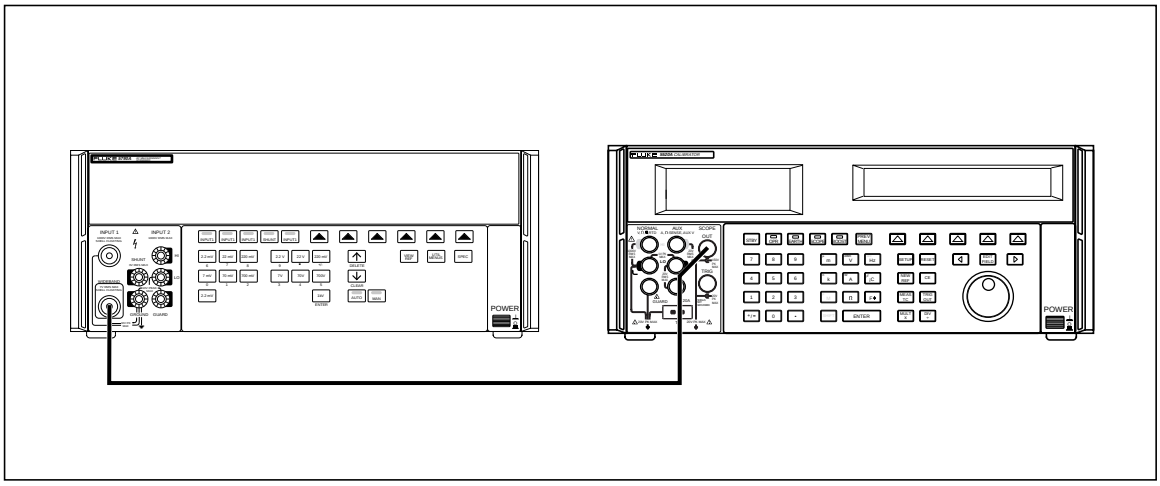
Leveled Sine Wave flatness verification is divided into two frequency bands: 50 kHz to 10 MHz (low frequency) and > 10 MHz to 1.1 GHz (high frequency). The equipment setups are different for each band. Leveled Sine Wave flatness is measured relative to 50 kHz. This is determined directly in the low frequency band. The high frequency band requires a "transfer" measurement be made at 10 MHz to calculate a flatness relative to 50 kHz.

Equipment Setup for Low Frequency Flatness

All low frequency flatness procedures use the following equipment.

- 5790A/03 AC Measurement Standard with Wideband option
- BNC(f) to Type N(m) adapter
- SC1100 cable

Connect the Calibrator SCOPE connector to the 5790A WIDEBAND input with the BNC(f) to Type N(m) adapter as shown in Figure 10. Set the 5790A to AUTORANGE, digital filter mode to FAST, restart fine, and Hi Res on.



yg034f.eps

Figure 10. Connecting the Calibrator to the 5790A AC Measurement Standard

Equipment Setup for High Frequency Flatness

All high frequency flatness procedures use the following equipment.

- Hewlett-Packard 437B Power Meter or equivalent
- Hewlett-Packard 8482A and 8481D Power Sensors
- BNC(f) to Type N(f) adapter
- SC1100 cable

Note

When high frequencies at voltages below 63 mV p-p are verified, use the 8481D Power Sensor. Otherwise, use the 8482A Power Sensor.

Connect the HP 437B Power Meter to either the 8482A or the 8481D Power Sensor as shown in Figure 11. For more information on connecting the two instruments, see the power meter and power sensor operators manuals.

Connect the power meter/power sensor combination to the SCOPE connector on the Calibrator, as shown in Figure 12.

The Hewlett-Packard 437B Power Meter must be configured by setting the parameters listed below. Zero and self-calibrate the power meter with the power sensor being used. Refer to the Hewlett-Packard 437B operators manual for details.

- PRESET
- RESOLN 3
- AUTO FILTER
- WATTS
- SENSOR TABLE 0 (default)

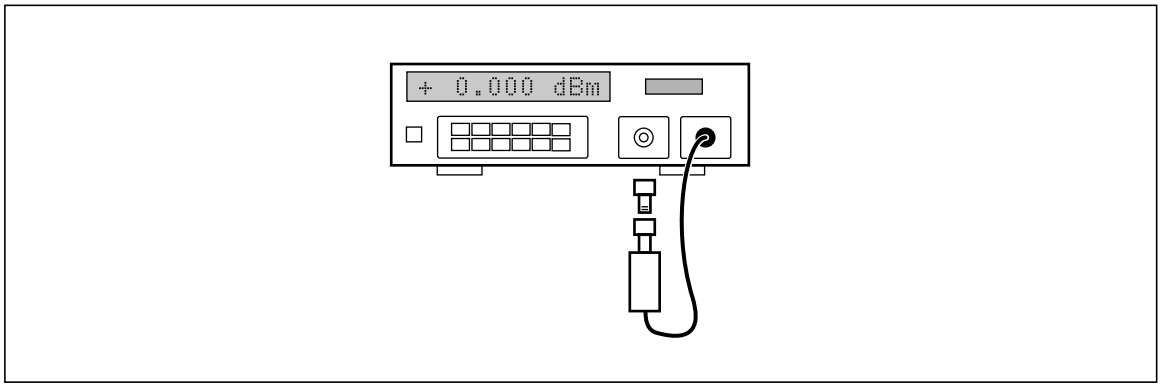


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Figure 11. Connecting the HP 437B Power Meter to the HP 8482A or 8481D Power Sensor

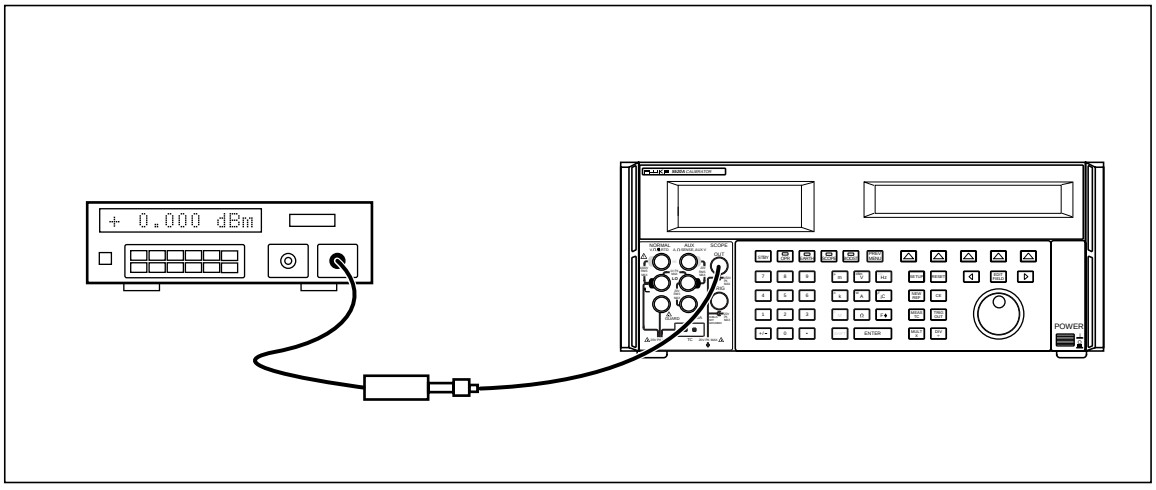

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Figure 12. Connecting the Calibrator to the HP Power Meter and Power Sensor

Low Frequency Verification

This procedure provides an example of testing low frequency flatness using a 5.5 V output. Follow the same procedure for testing other amplitudes, only compare results against the flatness specification listed in Table 32.

1. Program the Calibrator for an output of 5.5 V @ 500 kHz. Press [OPR] on the Calibrator to activate the output.
2. Allow the 5790A reading to stabilize. The 5790A should display approximately 1.94 V rms. Enter the 5790A reading in Column A of Table 32.
3. Enter 50 kHz into the Calibrator. Allow the 5790A reading to stabilize, then enter the 5790A reading in Column B of Table 32.
4. Enter the next frequency listed in Table 32. Allow the 5790A reading to stabilize, then enter the reading into Column A of the table.
5. Enter 50 kHz into the Calibrator. Allow the 5790A reading to stabilize, then enter the 5790A reading in Column B of Table 32.
6. Repeat steps 4 and 5 for all of frequencies listed in Table 32. Continue until Columns A and B are completed.
7. Press [STBY] to remove the Calibrator's output. Complete Table 32 by performing the calculations for column C. Compare Column C to the specifications listed in the final column.

Table 32. Low Frequency Flatness Verification at 5.5 V

Calibrator Frequency	A	B 50 kHz	C	Calibrator Flatness Specification (%)
500 kHz				± 1.50
1 MHz				± 1.50
2 MHz				± 1.50
5 MHz				± 1.50
10 MHz				± 1.50

Complete Columns A-C as follows:

A Enter 5790A Reading (mV) for the present frequency.

B Enter 5790A Reading (mV) for 50 kHz.

C Compute and enter the Calibrator Flatness Deviation (%): 100 * ((Column A entry)-(Column B entry))/ (Column B entry)

High Frequency Verification

This procedure provides an example of testing high frequency flatness using a 5.5 V output. Follow the same procedure for testing other amplitudes, only compare results against the flatness specification listed in Table 33. For this voltage range, use the model HP 8482A Power Sensor.

1. Program the Calibrator for an output of 5.5 V @ 30 MHz. Press [OPR] on the Calibrator to activate the output.
2. Allow the power meter reading to stabilize. The power meter should display approximately 75 mW. Enter the power meter's reading in Column A of Table 33.
3. Enter 10 MHz into the Calibrator. Allow the power meter reading to stabilize, then enter the power meter's reading in Column B of Table 33.

4. Enter the next frequency listed in Table 33. Allow the power meter's reading to stabilize, then enter the reading into Column A of the table.
5. Enter 10 MHz into the Calibrator. Allow the power meter reading to stabilize, then enter the power meter's reading in Column B of Table 33.
6. Repeat steps 4 and 5 for all of frequencies listed in Table 33. Continue until Columns A and B are completed.
7. Press STBY to remove the Calibrator's output. Complete Table 33 by performing the calculations for each column. Compare Column E to the specifications listed in the final column.

Table 33. High Frequency Flatness Verification

Amplitude (V)	Calibrator Freq. (MHz)	A	B 10 MHz	C	D	E	Calibrator Flatness Spec. (%)
0.005	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00
0.0075	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00

Complete Columns A-E as follows:

A Enter the 437B present frequency Reading (W).

B Enter the 437B 10 MHz Reading (W).

C Apply power sensor correction factor for present frequency (W): CF * (Column A entry)

D Apply power sensor correction factor for 10 MHz (W): CF * (Column B entry)

E Compute and enter Error relative to 10 MHz (%): 100 * (sqrt(Column C entry) - sqrt(Column D entry)) / sqrt(Column D entry)

Table 33. High Frequency Flatness Verification (cont.)

Amplitude (V)	Calibrator Freq. (MHz)	A	B 10 MHz	C	D	E	Calibrator Flatness Spec. (%)
0.0099	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00
0.01	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00

Complete Columns A-E as follows:

A Enter the 437B present frequency Reading (W).

B Enter the 437B 10 MHz Reading (W).

C Apply power sensor correction factor for present frequency (W): CF * (Column A entry)

D Apply power sensor correction factor for 10 MHz (W): CF * (Column B entry)

E Compute and enter Error relative to 10 MHz (%): 100 * (sqrt(Column C entry) - sqrt(Column D entry)) / sqrt(Column D entry)

Table 33. High Frequency Flatness Verification (cont.)

Amplitude (V)	Calibrator Freq. (MHz)	A	B 10 MHz	C	D	E	Calibrator Flatness Spec. (%)
0.025	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00
0.039	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00

Complete Columns A-E as follows:

- A Enter the 437B present frequency Reading (W).
- B Enter the 437B 10 MHz Reading (W).
- C Apply power sensor correction factor for present frequency (W): CF * (Column A entry)
- D Apply power sensor correction factor for 10 MHz (W): CF * (Column B entry)
- E Compute and enter Error relative to 10 MHz (%): 100 * (sqrt(Column C entry) - sqrt(Column D entry)) / sqrt(Column D entry)

Table 33. High Frequency Flatness Verification (cont.)

Amplitude (V)	Calibrator Freq. (MHz)	A	B 10 MHz	C	D	E	Calibrator Flatness Spec. (%)
0.04	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00
0.07	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00

Complete Columns A-E as follows:

- A Enter the 437B present frequency Reading (W).
- B Enter the 437B 10 MHz Reading (W).
- C Apply power sensor correction factor for present frequency (W): CF * (Column A entry)
- D Apply power sensor correction factor for 10 MHz (W): CF * (Column B entry)
- E Compute and enter Error relative to 10 MHz (%): 100 * (sqrt(Column C entry) - sqrt(Column D entry)) / sqrt(Column D entry)

Table 33. High Frequency Flatness Verification (cont.)

Amplitude (V)	Calibrator Freq. (MHz)	A	B 10 MHz	C	D	E	Calibrator Flatness Spec. (%)
0.099	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00
0.01	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00

Complete Columns A-E as follows:

- A Enter the 437B present frequency Reading (W).
- B Enter the 437B 10 MHz Reading (W).
- C Apply power sensor correction factor for present frequency (W): CF * (Column A entry)
- D Apply power sensor correction factor for 10 MHz (W): CF * (Column B entry)
- E Compute and enter Error relative to 10 MHz (%): 100 * (sqrt(Column C entry) - sqrt(Column D entry)) / sqrt(Column D entry)

Table 33 . High Frequency Flatness Verification (cont.)

Amplitude (V)	Calibrator Freq. (MHz)	A	B 10 MHz	C	D	E	Calibrator Flatness Spec. (%)
0.25	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00
0.399	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00

Complete Columns A-E as follows:

A Enter the 437B present frequency Reading (W).

B Enter the 437B 10 MHz Reading (W).

C Apply power sensor correction factor for present frequency (W): CF * (Column A entry)

D Apply power sensor correction factor for 10 MHz (W): CF * (Column B entry)

E Compute and enter Error relative to 10 MHz (%): 100 * (sqrt(Column C entry) - sqrt(Column D entry)) / sqrt(Column D entry)

Table 33. High Frequency Flatness Verification (cont.)

Amplitude (V)	Calibrator Freq. (MHz)	A	B 10 MHz	C	D	E	Calibrator Flatness Spec. (%)
0.4	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00
0.8	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00

Complete Columns A-E as follows:

- A Enter the 437B present frequency Reading (W).
- B Enter the 437B 10 MHz Reading (W).
- C Apply power sensor correction factor for present frequency (W): CF * (Column A entry)
- D Apply power sensor correction factor for 10 MHz (W): CF * (Column B entry)
- E Compute and enter Error relative to 10 MHz (%): 100 * (sqrt(Column C entry) - sqrt(Column D entry)) / sqrt(Column D entry)

Table 33. High Frequency Flatness Verification (cont.)

Amplitude (V)	Calibrator Freq. (MHz)	A	B 10 MHz	C	D	E	Calibrator Flatness Spec. (%)
1.2	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
1.3	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						±3 .50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00

Complete Columns A-E as follows:

- A Enter the 437B present frequency Reading (W).
- B Enter the 437B 10 MHz Reading (W).
- C Apply power sensor correction factor for present frequency (W): CF * (Column A entry)
- D Apply power sensor correction factor for 10 MHz (W): CF * (Column B entry)
- E Compute and enter Error relative to 10 MHz (%): 100 * (sqrt(Column C entry) - sqrt(Column D entry)) / sqrt(Column D entry)

Table 33. High Frequency Flatness Verification (cont.)

Amplitude (V)	Calibrator Freq. (MHz)	A	B 10 MHz	C	D	E	Calibrator Flatness Spec. (%)
3.4	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00
	1000 MHz						± 5.00
5.5	50 MHz						± 1.50
	100 MHz						± 1.50
	150 MHz						± 2.00
	200 MHz						± 2.00
	250 MHz						± 2.00
	300 MHz						± 2.00
	350 MHz						± 3.50
	400 MHz						± 3.50
	450 MHz						± 3.50
	500 MHz						± 3.50
	550 MHz						± 4.00
	600 MHz						± 4.00

Complete Columns A-E as follows:

- A Enter the 437B present frequency Reading (W).
- B Enter the 437B 10 MHz Reading (W).
- C Apply power sensor correction factor for present frequency (W): CF * (Column A entry)
- D Apply power sensor correction factor for 10 MHz (W): CF * (Column B entry)
- E Compute and enter Error relative to 10 MHz (%): 100 * (sqrt(Column C entry) - sqrt(Column D entry)) / sqrt(Column D entry)

Time Marker Verification

This procedure uses the following equipment:

- PM 6680 Frequency Counter with a prescaler for the Channel C input (Option PM 9621, PM 9624, or PM 9625) and ovenized timebase (Option PM 9690 or PM 9691)
- BNC(f) to Type N(m) adapter
- SC1100 cable

Refer to Figure 6 for the proper setup connections. Set the PM 6680's FUNCTION to measure frequency with auto trigger, measurement time set to 1 second or longer, and 50 Ω impedance.

Set the Calibrator to SCOPE mode, with the marker menu on the display. Press OPR on the Calibrator to activate the output. Follow these steps to for each period listed in Table 34.

1. Program the Calibrator to the output as listed in Table 34.
2. Using the SC1100 cable, connect the SCOPE connector on the Calibrator to the PM 6680 at the channel indicated in Table 34. The BNC-N adapter is needed for the connection to Channel C.
3. Set the filter on the PM 6680 as indicated in the table. Allow the PM 6680 reading to stabilize, then record the PM 6680 reading for each frequency listed for the Calibrator.
4. Invert the PM 6680's frequency reading to derive the period. For example, a reading of 1.000006345 kHz has a period of:

   1/1.000006345 kHz = 0.999993655 ms.

Record the period in the table and compare to the tolerance column.

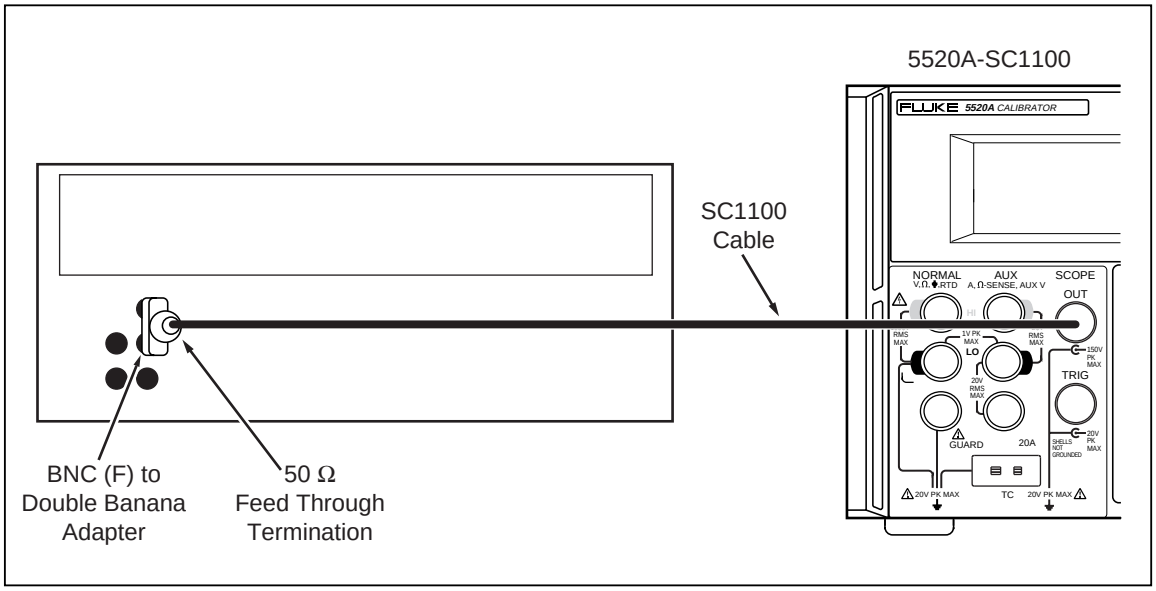
Table 34. Time Marker Verification

Calibrator Period	PM 6680 Settings		PM 6680 Reading	$\frac{1}{\text{PM 6680 Reading}}$	Tolerance
Seconds	Channel	Filter	(Frequency)	(Period)	1-Year Spec. (s)
5	A	On			25.1E-3
2	A	On			4.1E-3
0.05	A	Off			3.8E-6
0.02	A	Off			50.0E-9
0.01	A	Off			25.0E-9
100.0E-9	A	Off			250.0E-15
50.0E-9	A	Off			125.0E-15
20.0E-9	A	Off			50.0E-15
10.0E-9	A	Off			25.0E-15
5.0E-9	A	Off			12.5E-15
2.0E-9	C	Off			5.0E-15
1.0E-9	C	Off			2.5E-15

Wave Generator Verification

This procedure uses the following equipment:

- 5790A AC Measurement Standard
- BNC(f) to Double Banana adapter
- 50 Ω feedthrough termination
- SC1100 cable



ze060f.eps

Figure 13. Wave Generator Verification Setup

For wave generation verification procedures, refer to Figure 13 for the proper setup connections.

Set the Calibrator to SCOPE mode, with the wavegen menu on the display. Press OPR on the Calibrator to activate the output. Set the offset to 0 mV, and the frequency to 1 kHz. Follow these steps to verify the wave generator function.

Verification at 1 MΩ

Set the Calibrator impedance to 1 MΩ (The blue softkey under **SCOPE Z** toggles the impedance between 50 Ω and 1 MΩ).

1. Connect the SC1100 cable to the Calibrator's SCOPE connector. Connect the other end of the BNC cable to the 5790A INPUT 2 using the BNC(f) to Double Banana adapter.
2. Set the 5790A to AUTORANGE, digital filter mode to FAST, restart fine, and Hi Res on.
3. Program the Calibrator to output the wave type and voltage listed in Table 35.
4. Allow the 5790A reading to stabilize, then record the 5790A rms reading for each wave type and voltage in Table 35.
5. Multiply the rms reading by the conversion factor listed to convert it to the peak-to-peak value. Compare result to the tolerance column.

Verification at 50 Ω

Set the Calibrator impedance to 50 Ω (The blue softkey under **SCOPE Z** toggles the impedance between 50 Ω and 1 MΩ).

1. Connect the SC1100 cable to the Calibrator's SCOPE connector. Connect the other end of the SC1100 cable to the 50 Ω feedthrough termination then to the 5790A INPUT 2 using the BNC(f) to Double Banana adapter.
2. Set the 5790A to AUTORANGE, digital filter mode to FAST, restart fine, and Hi Res on.
3. Program the Calibrator to output the wave type and voltage listed in Table 36.
4. Allow the 5790A reading to stabilize, then record the 5790A rms reading for each wave type and voltage in Table 36.
5. Multiply the rms reading by the conversion factor listed to convert it to the peak-to-peak value.

Multiply the peak-to-peak value by (0.5 * (50 + Rload) / Rload), where Rload = the actual feedthrough termination resistance, to correct for the resistance error. Compare result to the tolerance column.

Table 35. Wave Generator Verification at 1 MΩ

Calibrator Wave Type	Calibrator output (@ 1 kHz unless noted)	5790A Reading (V rms)	Conversion Factor	5790A Reading x Conversion Factor (V p-p)	Tolerance (V p-p)
square	1.8 mV		2.0000		0.000154 V
square	11.9 mV		2.0000		0.000457 V
square	21.9 mV		2.0000		0.00075 V
square	22.0 mV		2.0000		0.00076 V
square	56.0 mV		2.0000		0.00178 V
square	89.9 mV		2.0000		0.002797 V
square	90 mV		2.0000		0.0028 V
square	155 mV		2.0000		0.00475 V
square	219 mV		2.0000		0.00667 V
square	220 mV		2.0000		0.0067 V
square	560 mV		2.0000		0.0169 V
square	899 mV		2.0000		0.02707 V
square	0.90 V		2.0000		0.0271 V
square	3.75 V		2.0000		0.1126 V
square	6.59 V		2.0000		0.1978 V
square	6.6 V		2.0000		0.1981 V
square	30.8 V		2.0000		0.9241 V
square	55.0 V		2.0000		1.6501 V
square	55.0 V @ 10 Hz		2.0		1.6501 V
square	55.0 V @ 100 Hz		2.0		1.6501 V
square	55.0 V @ 10,000 Hz		2.0		1.6501 V
sine	1.8 mV		2.8284		0.000154 V
sine	21.9 mV		2.8284		0.000757 V
sine	89.9 mV		2.8284		0.002797 V
sine	219 mV		2.8284		0.00667 V
sine	899 mV		2.8284		0.02707 V
sine	6.59 V		2.8284		0.1978 V
sine	55 V		2.8284		1.6501 V
triangle	1.8 mV		3.4641		0.000154 V
triangle	21.9 mV		3.4641		0.000757 V
triangle	89.9 mV		3.4641		0.002797 V
triangle	219 mV		3.4641		0.00667 V
triangle	899 mV		3.4641		0.02707 V
triangle	6.59 V		3.4641		0.1978 V
triangle	55 V		3.4641		1.6501 V

Table 36. Wave Generator Verification at 50 Ω

Calibrator Wave Type	Calibrator Output (10 kHz)	5790A Reading (V rms)	Conversion Factor	5790A Rdg x Conversion Factor (V p-p)	V p-p value x Correction	Tolerance (V p-p)
square	1.8 mV		2.0000			0.000154 V
square	6.4 mV		2.0000			0.000292 V
square	10.9 mV		2.0000			0.000427 V
square	11.0 mV		2.0000			0.00043 V
square	28.0 mV		2.0000			0.00094 V
square	44.9 mV		2.0000			0.001447 V
square	45 mV		2.0000			0.00145 V
square	78 mV		2.0000			0.00244 V
square	109 mV		2.0000			0.00337 V
square	110 mV		2.0000			0.0034 V
square	280 mV		2.0000			0.0085 V
square	449 mV		2.0000			0.01357 V
square	450 mV		2.0000			0.0136 V
square	780 mV		2.0000			0.0235 V
square	1.09 V		2.0000			0.0328 V
square	1.10 V		2.0000			0.0331 V
square	1.80 V		2.0000			0.0541 V
square	2.50 V		2.0000			0.0751 V
sine	1.8 mV		2.8284			0.000154 V
sine	10.9 mV		2.8284			0.000427 V
sine	44.9 mV		2.8284			0.001447 V
sine	109 mV		2.8284			0.00337 V
sine	449 mV		2.8284			0.01357 V
sine	1.09 V		2.8284			0.0328 V
sine	2.50 V		2.8284			0.0751 V
triangle	1.8 mV		3.4641			0.000154 V
triangle	10.9 mV		3.4641			0.000427 V
triangle	44.9 mV		3.4641			0.001447 V
triangle	109 mV		3.4641			0.00337 V
triangle	449 mV		3.4641			0.01357 V
triangle	1.09 V		3.4641			0.0328 V
triangle	2.50 V		3.4641			0.0751 V

Pulse Width Verification

The following equipment is used to verify the pulse width.

- High Frequency Digital Storage Oscilloscope: Tektronix 11801 with Tektronix SD-22/26 sampling head
- 3 dB attenuator, 3.5 mm (m/f)
- BNC(f) to 3.5 mm(m) adapter (2)
- SC1100 cable
- BNC- BNC cable

Refer to Figure 7 for proper setup connections.

Connect the SC1100 cable to the Calibrator's SCOPE connector. Connect the other end of the SC1100 cable to one BNC(f) to 3.5 mm(m) adapter then to the DSO's sampling head through the 3 dB attenuator.

Using the second BNC(f) to 3.5 mm(m) adapter and BNC cable, connect the Calibrator's TRIG OUT connector to the 11801's Trigger Input. The Calibrator should be in SCOPE mode, with the edge menu on the display. Press OPR on the Calibrator to activate the output. Press the softkey under TRIG to select the TRIG/1 External Trigger output.

Set the DSO to these parameters:

Digital Storage Oscilloscope Setup

Main Time Base position (initial)	40 ns
Vertical scale	200 mV/div
Trigger	source = ext; level = 0.5 V; ext atten = x10; slope = +; mode = auto
Measurement Function	positive width

1. Program the Calibrator to output the pulse width and period at 2.5 V as listed in Table 37.
2. Change the horizontal scale of the DSO to the value listed in the table. Adjust the main time base position and vertical offset until the pulse signal is centered on the display. Record the width measurement. Compare to the tolerance column of Table 37.

Table 37. Pulse Width Verification

Calibrator Output		DSO horizontal scale	11801	
Width	Period	(time/div)	Reading	Tolerance
4.0 ns	2E-6	1 ns		700 ps
4 ns	2E-5	1 ns		700 ps
4 ns	2E-4	1 ns		700 ps
40 ns	2E-3	10 ns		4000 ps

Pulse Period Verification

This procedure uses the following equipment:

- PM 6680 Frequency Counter with an ovenized timebase (Option PM 9690 or PM 9691)
- SC1100 cable

Refer to Figure 6 for the proper setup connections. Set the Calibrator to SCOPE mode, with the pulse menu on the display. Press OPR on the Calibrator to activate the output. Follow these steps to verify the Pulse period.

1. Set the PM 6680's FUNCTION to measure period on channel A with auto trigger, measurement time set to 1 second or longer, 50 Ω impedance, and filter off.
2. Using the SC1100 cable, connect the SCOPE connector on the Calibrator to PM 6680 channel A.
3. Program the Calibrator to output the pulse width and period (at 2.5 V) as listed in Table 38.
4. Allow the PM 6680 reading to stabilize, then record the PM 6680 reading for each period listed for the Calibrator. Compare to the tolerance column of Table 38.

Table 38. Pulse Period Verification

Calibrator Output		PM 6680 Reading	
Width	**Period**	**(Period)**	**Tolerance**
80 ns	2 µs		5E-12 s
500 ns	10 µs		2.5E-08 s
500 ns	20 ms		5.0E-08 s

MeasZ Resistance Verification

The MeasZ resistance function is verified by measuring resistors of known values. The measurement value is then compared to the resistor actual value.

The resistors must make a solid connection to a BNC(f) to enable a connection to the end of the SC1100 cable. The resistance values must be known at this BNC(f) connector. Fluke uses an HP 3458A DMM to make a 4-wire ohms measurement at the BNC(f) connector to determine the actual resistance values.

This procedure uses the following equipment:

- Resistors of known values: 1.5 MΩ, 1 MΩ, 60 Ω, 50 Ω, 40 Ω nominal
- adapters to connect resistors to BNC(f) connector
- SC1100 cable

Refer to Figure 17 for the proper setup connections.

Set the Calibrator to SCOPE mode, with the MeasZ menu on the display. Follow these steps to verify the MeasZ resistance function.

1. Set the Calibrator MeasZ resistance range as indicated in Table 39. (The blue softkey under **MEASURE** toggles the MeasZ ranges).
2. Using the SC1100 cable, connect the SCOPE connector to the BNC(f) connector attached to the nominal resistance values indicated in Table 39. The 600 KΩ

nominal value can be achieved by connecting the 1.5 MΩ and 1 MΩ resistors in parallel.

3. Allow the Calibrator reading to stabilize, then record the Calibrator resistance reading for each nominal value listed in Table 39. Compare the Calibrator resistance readings to the actual resistance values and the tolerance column of Table 39.

Table 39. MeasZ Resistance Verification

Calibrator MeasZ Range	Nominal Resistance Value	Calibrator Resistance Reading	Actual Resistance Value	Tolerance
res 50 Ω	40 Ω			0.04 Ω
res 50 Ω	50 Ω			0.05 Ω
res 50 Ω	60 Ω			0.06 Ω
res 1 MΩ	600 kΩ			600 Ω
res 1 MΩ	1 MΩ			1 kΩ
res 1 MΩ	1.5 MΩ			1.5 kΩ

MeasZ Capacitance Verification

The MeasZ capacitance function is verified by measuring capacitors of known values. The measurement value is then compared to the capacitor actual value.

The capacitors must make a solid connection to a BNC(f) to enable a connection to the end of the SC1100 cable. Due to the small capacitance values, care must be taken to know the actual capacitance at this BNC(f) connector. The capacitance values must be determined at a 10 MHz oscillator frequency. Fluke uses an HP 4192A Impedance Analyzer at 10 MHz to determine the actual capacitance values.

This procedure uses the following equipment:

- Adapters and capacitors to achieve 5 pF, 29 pF, 49 pF nominal values at the end of BNC(f) connector
- SC1100 cable

Refer to Figure 17 for the proper setup connections.

Set the Calibrator to SCOPE mode, with the MeasZ menu on the display. Follow these steps to verify the MeasZ capacitance function.

1. Set the Calibrator MeasZ capacitance range to **cap**. (The blue softkey under **MEASURE** toggles the MeasZ ranges).
2. Connect the SC1100 cable to the Calibrator SCOPE connector, but do not connect any thing to the end of this cable.
3. Allow the Calibrator reading to stabilize, then press the **SET OFFSET** blue softkey to zero the capacitance reading.
4. Connect the end of the SC1100 cable to the BNC(f) connector attached to the nominal capacitor values indicated in Table 40.
5. Allow the Calibrator reading to stabilize, then record the Calibrator capacitance reading for each nominal value listed in Table 40. Compare the Calibrator capacitance readings to the actual capacitance values and the tolerance column of Table 40.

Table 40. MeasZ Capacitance Verification

Nominal Capacitance Value	Calibrator Capacitance Reading	Actual Capacitance Value	Tolerance
5 pF			0.75 pF
29 pF			1.95 pF
49 pF			2.95 pF

Overload Function Verification

This procedure uses the following equipment:

- 50 Ω feedthrough termination
- SC1100 cable

Refer to Figure 14 for setup connections.

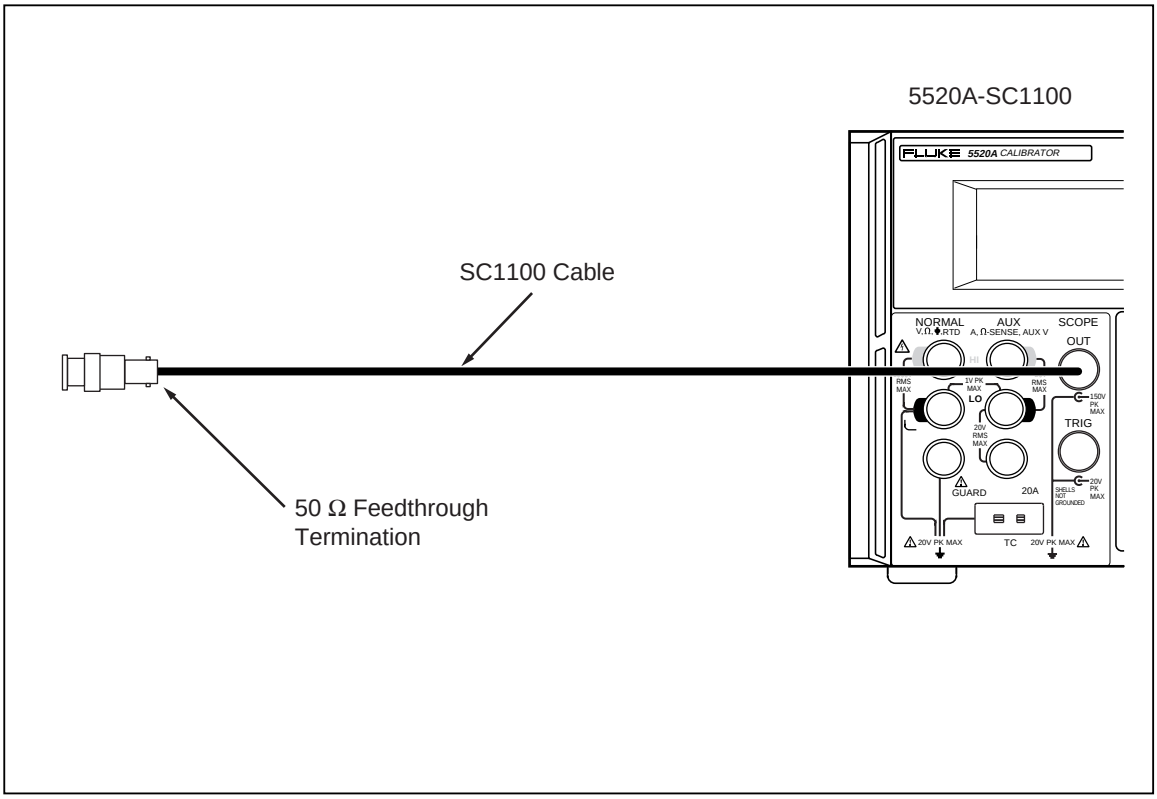


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Figure 14. Overload Function Verification Setup

Set the Calibrator to SCOPE mode, with the overload menu on the display. Connect the SC1100 cable to the Calibrator SCOPE connector. Follow these steps to verify the overload function.

1. Connect the 50 Ω feedthrough termination to the end of the SC1100 cable.
2. Program the Calibrator output for 5.000 V, DC (**OUT VAL** blue softkey), and time limit = 60 s (**T LIMIT** blue softkey).

3. Press OPR on the Calibrator to activate the output and verify that the **OPR** display timer increments.
4. Remove the 50 Ω feedthrough termination before 60 seconds and verify that Calibrator goes to **STBY**.
5. Reconnect the 50 Ω feedthrough termination to the end of the SC1100 cable.
6. Program the Calibrator output for 5.000 V, ac (**OUT VAL** blue softkey).
7. Press OPR on the Calibrator to activate the output and verify that the **OPR** display timer increments.
8. Remove the 50 Ω feedthrough termination before 60 seconds and verify that Calibrator goes to **STBY**.

SC1100 Hardware Adjustments

Hardware adjustments must be made to the leveled sine and edge functions each time the SC1100 is repaired. In addition to the adjustment procedures, this section provides lists of the required equipment and some recommendations on models that have the capabilities required by these procedures. Equivalent models can be substituted if necessary.

The hardware adjustments are intended to be one-time adjustments performed in the factory, however, adjustment may be required after repair. Hardware adjustments must be performed prior to calibration.

Equipment Required

The following equipment is necessary for performing the hardware adjustments described in this section. The models listed are recommended for providing accurate results.

- Standard adjustment tool for adjusting the pots and trimmer caps
- Extender Card
- Oscilloscope and Sampling Head (Tektronix 11801 with SD-22/26 or Tektronix TDS 820 with 8 GHz bandwidth)
- 10 dB Attenuator (Weinschel 9-10 (SMA), or Weinschel 18W-10, or equivalent)
- Cable provided with SC1100
- Spectrum Analyzer (Hewlett-Packard 8590A)

Adjusting the Leveled Sine Wave Function

There are two adjustment procedures that need to be made for the leveled sine wave function. The first procedure adjusts the balance out of the LO VCO so that the signal is balanced between the two VCOs. The second procedure adjusts the harmonics.

Equipment Setup

This procedure uses the spectrum analyzer. Before beginning this procedure, verify that the Calibrator is in leveled sine wave mode (the levsine menu is displayed), and program it to output 5.5 V p-p @ 600 MHz. Press OPR to activate the output.

Refer to Figure 9 for setup connections and connect the Calibrator to the spectrum analyzer. Adjust the spectrum analyzer so that it displays one peak across its horizontal center line. The far right of the peak is fixed at the far right of the center line, as shown in Figure 15.

Adjusting the Leveled Sine Wave VCO Balance

Once the setup described above is completed, perform the following procedure to adjust the VCO balance for the leveled sine wave function.

1. Program the Calibrator for an output of 5.5 V @ 600 MHz.
2. Set the Spectrum Analyzer to the parameters listed below.

Spectrum Analyzer Setup

Start Frequency	10 MHz
Stop Frequency	800 MHz
Resolution Bandwidth	30 kHz
Video Bandwidth	3 kHz
Reference Level	20 dBm

The spectrum analyzer will display a spur at 153 MHz. Refer to Figure 15 to identify the spur.

3. Adjust the wave until the spur is at a minimum by slowly rotating R1 (shown in the diagram) counterclockwise until the spur is at a minimum. As it is adjusted, the spur will move down the waveform, towards the right. As soon as the spur is minimized, stop rotating R1. If rotated too far, the spur will reappear.

   Once R1 has been turned to the point at which the spur is at a minimum, the signal is balanced between the VCOs, and the adjustment is complete.

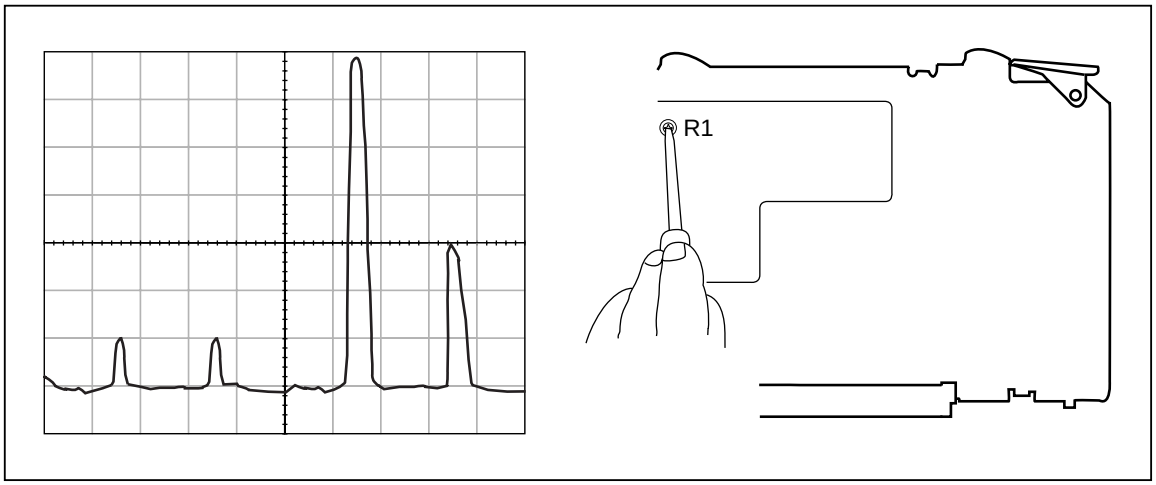

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Figure 15. Adjusting the Leveled Sine Wave Balance

Adjusting the Leveled Sine Wave Harmonics

The following procedure adjusts the harmonics for the leveled sine wave function.

Note

This procedure should only be used for adjusting the leveled sine wave harmonics. Do not use this procedure as a verification test. The specifications in this procedure are not valid for verification.

1. Set the SC1100 output to 150 MHz @ 5.5 V.
2. Set the Spectrum Analyzer to the parameters listed below.

Spectrum Analyzer Setup

Start Frequency	50 MHz
Stop Frequency	500 MHz
Resolution Bandwidth	3 MHz
Video Bandwidth	3 kHz
Reference Level	20 dBm

2. Use the spectrum analyzer's peak search function to find the desired reference signal. The analyzer should show the fundamental, and second and third harmonics. The harmonics need to be adjusted so that the second harmonic is at 40 dBc and third harmonic should typically be at 50 dBc as shown in Figure 16.
3. To adjust the harmonics, adjust R8, as shown in Figure 16 until the peaks of the second and third harmonic are at the correct dB level. It may be possible to place the second harmonic at 40 dBc but the third harmonic is not at 50 dBc. If this is the case, continue adjusting R8. The second harmonic will fluctuate, but there is a point at which both harmonics will be at the correct decibel level.

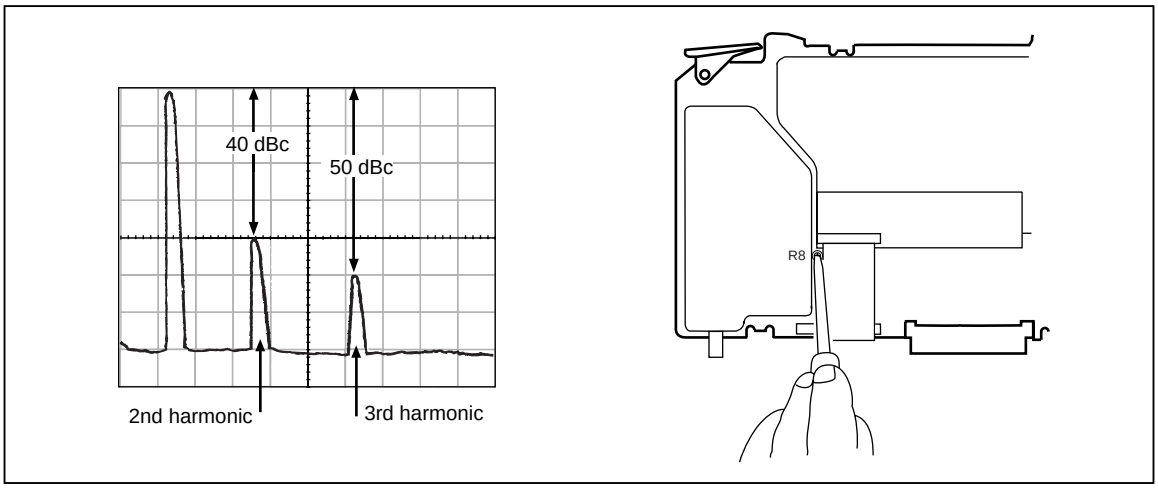

Figure 16. Adjusting the Leveled Sine Wave Harmonics

Adjusting the Aberrations for the Edge Function

Adjustments need to be made after repair to the edge function to adjust the edge aberrations.

Note

To verify the edge aberrations back to national standards, send the Calibrator to Fluke, or other facility that has established traceability for aberrations. Fluke, for example, has a reference pulse that is sent to the National Institute of Standards and Technology (NIST) for characterization. This information is then transferred to high speed sampling heads, which are used to adjust and verify the SC1100.

Equipment Setup

The following equipment is needed for this procedure:

- Oscilloscope: Tektronix 11801 with SD22/26 input module or Tektronix TDS 820 with 8 GHz bandwidth.
- 10 dB Attenuator: Weinschel 9-10 (SMA) or Weinschel 18W-10 or equivalent
- Output cable provided with the SC1100

Before beginning this procedure, verify that the SC1100 is in the edge mode (the edge menu is displayed), and program it to output 1 V p-p @ 1 MHz. Press OPR to activate the output.

Refer to Figure 7 for the proper setup connections and connect the Calibrator to the oscilloscope. Set the oscilloscope vertical to 10 mV/div and horizontal to 1 ns/div. Set the oscilloscope to look at the 90% point of the edge signal; use this point as the reference level. Set the oscilloscope to look at the first 10 ns of the edge signal with the rising edge at the left edge of the oscilloscope display.

Adjusting the Edge Aberrations

Refer to Figure 17 while making the following adjustments:

1. Adjust A90R13 to set the edge signal at the right edge of oscilloscope display, at 10 ns, to the reference level set above.
2. Adjust A90R36 so the first overshoot is the same amplitude as the next highest aberration.
3. Adjust A90R35 so that the second and third overshoot aberrations are the same amplitude as the first aberration.
4. Adjust A90R12 to set the edge signal occurring between 2 ns and 10 ns to the reference level set above.
5. Readjust A90R36 and A90R35 to obtain equal amplitudes for the first, second, and third aberrations.
6. Adjust A90R13 to set the edge signal occurring between 0 ns and 2 ns to the reference point set above. Center any aberrations so the peaks are equal above and below the reference level.
7. Readjust A90R12 if necessary to keep the edge signal occurring between 2 ns and 10 ns at the reference level.
8. Readjust A90R13 if necessary to keep the edge signal occurring between 0 ns and 2 ns at the reference level.

9. Set the UUT output to 250 mV and the oscilloscope vertical to 2 mV/div. Check the aberrations.
10. Connect the 10 dB attenuator to the oscilloscope input. Connect the UUT to the attenuator and program the UUT output to 2.5 V.
11. Set the oscilloscope vertical to 5 mV/div. Check the aberrations.
12. Check for rise time < 300 ps at 250 mV, 1 V, and 2.5 V outputs.

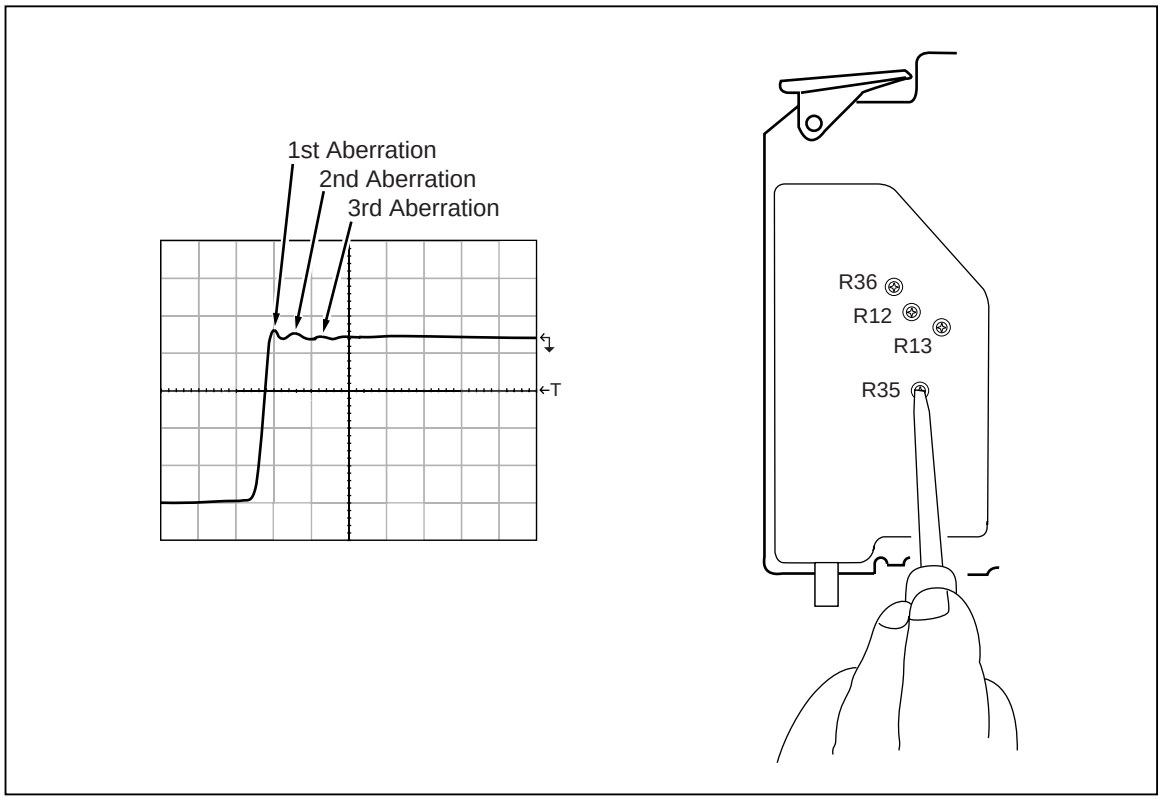

Figure 17. Adjusting Edge Aberrations

Adjusting Frequency

The 10 MHz crystal oscillator (U60) on the A45 board may need adjustment. Make the adjustment by turning the pot on top of U60.

Index

—A—

AC voltage frequency function
  verification, 32

—C—

calibration
  SC1100, 1, 15
    measZ, 24
    Pulse Width, 23

—D—

DC voltage function
  verification, 18, 26

—E—

edge duty cycle function
  verification, 34
edge frequency function
  verification, 34
edge function
  rise time verification, 35
  specifications, 4
  theory of operation, 9
  trigger specifications, 7
error messages
  SC option not installed, 2

—H—

hardware adjustments for SC1100, 64

—L—

leveled sine wave function
  adjusting harmonics, 66
  adjusting VCO balance, 65
  amplitude verification, 38
    equipment setup, 21
  flatness verification
    high frequency, 22
    high frequency at 5.5 V, 44
    low frequency, 22
    low frequency at 5.5 V, 44
    low frequency equipment setup, 38
    Low frequency equipment setup, 42
  frequency verification, 39
  harmonics verification, 40
  specifications, 5
  theory of operation, 9

—M—

measZ capacitance
  verification, 62
measZ function
  calibration, 24
  capacitance specifications, 8
  resistance specifications, 8
measZ resistance
  verification, 61

—O—

overload function
  specifications, 8
  verification, 63

—P—

pulse function
  trigger specifications, 7
pulse generator function
  specifications, 7
pulse period verification, 61
pulse width function
  calibration
    equipment setup, 23
  Calibration, 23

verification
equipment setup, 60
pulse width verification, 60

—S—

SC1100. *See* also entry under specific function
calibration, 1, 15
error message indicating not installed, 2
hardware adjustments, 64
maintenance, 2
user's servicing abilities, 1
verification, 25
scope calibration. *See* SC1100
specifications
SC1100, 2
square wave voltage function
trigger specifications, 8

—T—

time marker function
specifications, 6
theory of operation, 10
trigger specifications, 7
verification, 55
TV trigger specifications, 8

—V—

verification
SC1100, 25
AC voltage frequency, 32
DC voltage, 18, 26
edge duty cycle, 34
edge frequency, 34
edge rise time, 35
leveled sine wave amplitude, 38
leveled sine wave frequency, 39
leveled sine wave harmonics, 40
measZ capacitance, 62
measZ resistance, 61
overload function, 63
pulse period, 61
pulse width, 60
time marker, 55
wave generator, 56
volt function
specifications, 3

—W—

wave generator function
specifications, 6
theory of operation, 10
verification, 56