FLUKE®

USER'S HANDBOOK

Model 9100

Universal Calibration System

Volume 3 — Option 250: 250 MHz Oscilloscope Calibration Module
Option 600: 600 MHz Oscilloscope Calibration Module

Operation and Performance

Final Width = 215mm

User's Handbook

For

The Model 9100
Universal Calibration System

Volume 3

Option 250: 250 MHz Oscilloscope Calibration Module
Option 600: 600 MHz Oscilloscope Calibration Module

Operation and Performance

This product complies with the requirements of the following European Community Directives:
89/336/EEC (Electromagnetic Compatibility) and **73/23/EEC (Low Voltage)**
as amended by **93/68/EEC (CE Marking)**.

However, noisy or intense electromagnetic fields in the vicinity of the equipment can disturb the measurement circuit. Users should exercise caution and use appropriate connection and cabling configurations to avoid misleading results when making precision measurements in the presence of electromagnetic interference.

 P/N 850306 Issue 5.0 (July 2005)

Contents

Model 9100 Universal Calibration System Handbooks

Operation — *refer to **Volume 1, Sections 1 to 5***
Performance — *refer to **Volume 2, Sections 6 to 10***

Volume 3 — Model 9100 Universal Calibration System
(This Volume)
Option 250: 250MHz Oscilloscope Calibration Module
Option 600: 600MHz Oscilloscope Calibration Module
Operation and Performance

Contents Sections 16 to 20 overleaf →

DANGER

HIGH VOLTAGE

THIS INSTRUMENT IS CAPABLE OF DELIVERING

A LETHAL ELECTRIC SHOCK !

Model 9100: I+, I-, Hi, Lo, sHi and sLo Terminals
Model 9105: H (Red), sH (Red), sL (Black) LI- (Black)
and I+20 (Yellow) Leads carry the Full Output Voltage

THIS CAN KILL !

Avoid damage to your instrument !

Refer to User's Handbook, Volume 2, Section 7; for Maximum Output Voltages and Currents.

Unless **you** are **sure** that it is **safe** to do so,

DO NOT TOUCH ANY of the following:

Model 9100: I+ I- Hi Lo sHi or **SLo leads** and **terminals**

'SIG OUT' BNC inner conductor

Model 9105: H sH sL LI- or **I+20 leads**

DANGER

Section 11 The Model 9100 Options 250 & 600:

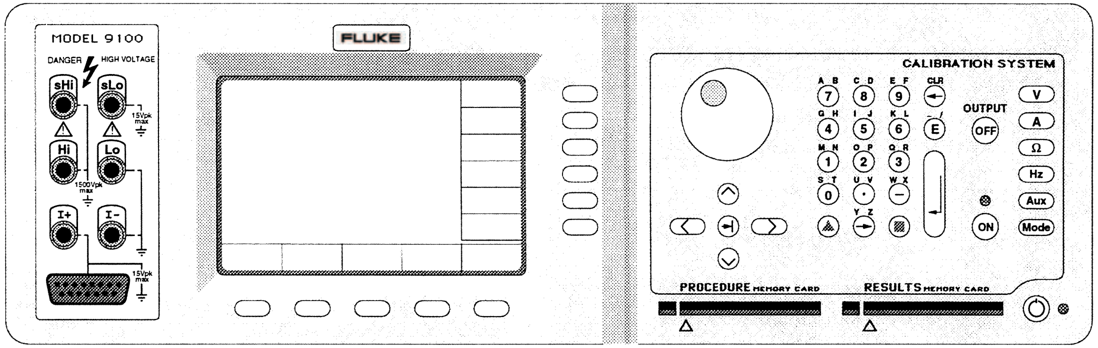
250MHz and 600MHz Oscilloscope Calibration Modules

11.1 About Section 11

Section 11 introduces the Model 9100 Universal Calibration System, Options 250 & 600: 250MHz and 600MHz Oscilloscope Calibration Modules. It is divided into the following sub-sections:

This handbook is supplementary to the User's Handbook Volumes 1 and 2 for the Model 9100 Universal Calibration System. For details of the basic 9100 instrument refer to those volumes.

11.2 Introduction to the Model 9100 Options 250 & 600: 250MHz and 600MHz Oscilloscope Calibration Modules



11.2.1 Functions

Option 250 *or* Option 600 is implemented by the addition of an internal module, at manufacture or by retro-fit. The 9100 front panel functionality changes in only one respect when one of the options is fitted. The 'Aux' key on the right of the panel is now also used to access the following Oscilloscope Calibration functions:

- **Square**:

Frequency	1kHz	
Output Voltage	(pk-pk into 1MΩ load):	4.44mV to 133.44V
	(pk-pk into 50Ω load):	4.44mV to 3.336V

- **DC**:

Output Voltage	(into 1MΩ load):	±(4.44mV to 133.44V)
	(into 50Ω load):	±(4.44mV to 2.78V)

- **Sine**:

Frequencies	10Hz to 49.999kHz	
Output Voltage	(pk-pk into 1MΩ load):	4.44mV to 133.44V
	(pk-pk into 50Ω load):	4.44mV to 5.56V
Frequencies	50kHz to 250MHz	
Output Voltage	(pk-pk into 50Ω load):	10.656mV to 5.56V
Frequencies	250MHz to 600MHz (Option 600 only)	
Output Voltage	(pk-pk into 50Ω load):	10.656mV to 3.336V

- **Edge**:

Load	50Ω
Edge Type	Selectable Rising/Falling edge
Period	100ns to 10ms
Output Voltage	88.8mV to 1.112V pk-pk.
Rise Time	≤1ns (fixed)
Fall Time	≤1ns (fixed)
Load	1MΩ
Edge Type	Rising edge only
Period	10μs to 10ms
Output Voltage	888mV to 55.6V pk-pk.
Rise Time	≤100ns (fixed)

- **Markers**:

Load	50Ω only	
Period	4ns to 5.5s (Option 250)	
Period	2ns to 5.5s (Option 600)	
Output Voltage	0.1V, 0.2V, 0.5V, 1.0V;	pk-pk.
Waveshape	4ns to 8.88ns:	Sine (Option 250)
	2ns to 8.88ns:	Sine (Option 600)
	8.88ns to 5.5s:	Square

Note: In functions where users can choose to convert from period to frequency, and vice-versa, an exact equivalence is prevented by the need to restrict the resolution.

11.2.2 Operating Modes

In order to be able to calibrate a wide range of different UUTs, the 9100 has had flexibility built into its design. There are five modes, only two of which, 'Manual' and 'Procedure' determine the everyday use of the instrument. The other three are concerned with system configuration, 9100 calibration and 9100 selftest. For further details, refer to *Volume 1 of the 9100 User's Handbook.*

11.2.3 System Operation

The instrument can form part of an automated system by means of the IEEE-488 standard digital interface. The method of connecting to the system controller and the IEEE-488.2 SCPI command codes are described in *Volume 2 of the 9100 User's Handbook, Section 6.*

The additional SCPI codes, required for remote operation of the functions provided by Option 250 and Option 600, can be found in this *Volume 3 of the 9100 User's Handbook, section 16.*

The interface has been included mainly for automatic calibration of the 9100 itself. In normal operation, the degree of automation available will generally be determined by the manual operation characteristics of the UUT.

11.3 Associated Products

The following associated products are provided with Option 250 *or* Option 600:

630441	Special BNC-BNC 50Ω Co-axial Trigger lead.
630442	Special BNC-BNC 50Ω Co-axial Signal lead.
630444	2 x BNC-BNC 50Ω Co-axial leads.
630445	BNC 50Ω T Adaptor.
630446	Through Terminator BNC 50Ω.
630447	Precision Through Terminator BNC 50Ω HF.

The following associated products are available:

PLC-XXX Procedure Library Cards *(Sub-section 11.4).*

Model 9105 Comprehensive Lead Set.

Portocal II / Model 9010

Memory Card Procedure Generator, inventory management software and memory card drive, suitable for integral or external mount format. (Minimum hardware requirements: 100% IBM compatible, 80486 25MHz DX or better with 4MBytes of extended memory. 15MBytes of hard disk space is required for installation; further hard disk space will be required for generation of procedures, etc. One full-size expansion slot will be required.)

11.4 UUT Calibration Procedure Library

In 'Procedure' Mode, UUT calibration procedures are driven from memorized sequences. These are supplied on FLASH memory cards, each usually holding up to three manufacturer models with three procedure types. For further details, refer to the *Procedure Library Document.*

The library contains procedures for some of the equipment available from manufacturers worldwide. For a complete updated listing of the Fluke Procedure Library, including oscilloscope calibration procedures, contact your local sales representative or Fluke Service Center.

11.5 Printer Support

9010 and Portocal II software both support around 170 different models of printer. Paper sizes and margins are programmable, allowing text and data to be positioned anywhere on a page. For further details, contact your local sales representative or Fluke Service Center.

11.6 UUT Calibration Certificates

11.6.1 Procedure Mode Results Printouts

ISO 9000 requires that calibration records be maintained for later inspection. Whether or not Portocal II / Model 9010 is purchased, the Model 9100 Procedure Mode supports two formats for recording results. For either a basic certificate of results, or a simple pass-fail format for each test, a printer can be connected directly to the 25-way Centronics™ printer port on the rear panel. The printer is configured from the screen menu. For further details, refer to *Volume 1 of the 9100 User's Handbook, section 1, paras 1.6.*

11.7 Inventory Management

9010 and Portocal II software both include an inventory database which need not be limited to handheld Multimeters: any item requiring periodic calibration or maintenance can be added. For further information, contact your local sales representative or Fluke Service Center.

11.8 Documentation

For reasons of size, the 9100 User's Handbook is divided into three volumes:

Volume 1 (pt. no. 850300) relates to the operation of the 9100.

Volume 2 (pt. no. 850301) deals with 9100 performance, containing information related to: IEEE-488/SCPI remote command performance, 9100 specifications, routine maintenance, specification verification and calibration.

This **Volume 3** (pt. no. 850306) deals exclusively with Options 250 and 600, (the Oscilloscope Calibration Modules), one of which can be fitted and connected internally to the 9100.

Operator's Guide includes the interconnections and example calibration procedures for the basic functions, documented in the form of a pocket booklet (pt. no. 850299).

Portocal II / Model 9010 version 1.7 is documented in the form of a User's Handbook (pt. no. 850315).

Section 12 Installing Option 250 or 600 of the Model 9100

Caution:
The ⚠ symbol, shown on elements of the 9100 instrument and 9105 leadset, draws attention to information contained in this handbook regarding maximum output voltages and currents.

For details, refer to *Volume 2 of the User's Handbook: Section 7 — Specifications; page 7-1.*

Caution:
The supplied BNC trigger and signal cables are clearly identified. Do ***not*** cross-connect these cables between 9100 and UUT oscilloscope — this can damage the trigger input circuitry of certain oscilloscopes.

E-M Interference:
Noisy or intense electric, magnetic or electromagnetic fields close to instruments or connectors can disturb the measurement circuit.

Some typical sources are:
- Proximity of large electric fields
- Fluorescent lighting
- Inadequate screening, filtering or grounding of power lines
- Transients from local switching
- Induction and radiation fields of local E-M transmitters
- Excessive common mode voltages between source and load

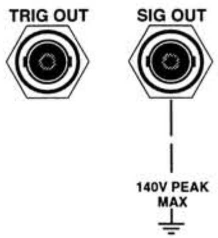
The disturbances may be magnified by the user's hand capacitance. Electrical interference has greatest effect in high impedance circuits. Separation of leads and creation of loops in the circuit can intensify the disturbances.

12.1 About Section 12

General instructions for unpacking and installing the Model 9100 Universal Calibration System are contained in *Section 2 of Volume 1.*

Option 250 *or* 600 is installed either at the factory during manufacture of the 9100, or by retrofit. No further installation instructions are necessary, other than to note the designations of the two BNC sockets on the rear panel and their connections.

12.2 Oscilloscope Connections (Rear Panel)



These two BNC sockets are located at the upper center of the rear panel, providing both a trigger output (TRIG OUT) and signal output (SIG OUT).

12.2.1 SIG OUT

All outputs from Option 250 or 600 pass out of the 9100 via the SIG OUT BNC socket. The outputs are specified into either 1MΩ or 50Ω loading.

Use the supplied 50Ω BNC cable labelled 'SIGNAL' with ***red*** sleeves (Fluke part no. 630442) to connect the 9100 SIG OUT socket (angled end) to the input of the UUT Signal Channel to be calibrated (straight end).

(12.2 Continued overleaf)

12.2.2 TRIG OUT

The trigger output runs at all times, and cannot be switched off. The trigger signal is specified as follows:

Trigger Amplitude:	Not less than 1V±10% into 50Ω, Not less than 2V±20% into 1MΩ,
Trigger Rate:	The frequency of output up to 11.2MHz 1/32 of output frequency above 11.2MHz (Option 250) 1/64 of output frequency above 11.2MHz (Option 600) 64Hz when DC function selected
Pulse Polarity	Positive transition
Timing	When Markers or Low Edge function is selected, the trigger edge leads the positive-going marker edge by (typically) 25ns, depending on output frequency. In High Edge function, the lead is typically 300ns. For outputs in other functions, the amount of lead is unspecified.

Caution:
The supplied BNC trigger and signal cables are clearly identified. Do ***not*** cross-connect these cables between 9100 and UUT oscilloscope — this can damage the trigger input circuitry of certain oscilloscopes.

Use the supplied 50Ω BNC trigger cable labelled 'TRIGGER' with ***black*** sleeves (Fluke part no. 630441) to connect the 9100 TRIG OUT socket (angled end) to the UUT Oscilloscope Trigger In socket (straight end).

12.2.3 50Ω Terminations

Option 250 or 600 provides two 50Ω through-terminators.

BNC 50Ω (Part No. 630446) is used for general purpose (e.g. trigger) terminations when the UUT input load is high.

BNC 50Ω (Part No. 630447) is a precision terminator used for high accuracy (e.g. HF signal) terminations when the UUT signal input load is high.

12.2.4 50Ω T-connector and Extra Cables

Option 250 or 600 provides one 50Ω BNC T-connector and two 150mm 50Ω BNC cables.

The BNC 50Ω T-connector (Part No. 630445) and two 150mm 50Ω BNC cables (Part No. 630444) are used to split one signal source into trigger and signal. This ensures equal losses and delays between two channels where one is used as a trigger and one as a signal, to check trigger levels and delays.

Note that this is ***not*** a high-accuracy signal technique, and the use of the trigger channel supplied is better practice where amplitude and aberration are under test.

Section 13 Options 250 and 600 Controls

13.1 About Section 13

A detailed description of the 9100 operating controls is given in *Section 3* of the *9100 User's Handbook Volume 1*; including a general description of the front panel, a brief description of Mode selection, followed by a more detailed treatment of 'Configuration' mode. Finally a course of tutorials gives practice in manipulating the controls in 'Manual' mode.

The treatment of Section 3 in Volume 1 will be sufficient to introduce new users to the front panel, in preparation for manual operation of the oscilloscope calibration function as described in Section 14 of this Volume 3. There is therefore no need for further description.

DANGER

HIGH VOLTAGE

THIS INSTRUMENT IS CAPABLE OF DELIVERING

A LETHAL ELECTRIC SHOCK !

Model 9100: I+, I-, Hi, Lo, sHi and sLo Terminals
Model 9105: H (Red), sH (Red), sL (Black) LI- (Black)
and I+20 (Yellow) Leads carry the Full Output Voltage

THIS CAN KILL !

Avoid damage to your instrument !

Refer to User's Handbook, Volume 2, Section 7; for
Maximum Output Voltages and Currents.

Unless **you** are **sure** that it is **safe** to do so,

DO NOT TOUCH ANY of the following:

Model 9100: I+ I- Hi Lo sHi or **SLo leads** and **terminals**

'SIG OUT' BNC inner conductor

Model 9105: H sH sL LI- or **I+20 leads**

DANGER

Section 14 Using the Model 9100 — Manual Mode

14.1 About Section 14

Section 3, in Volume 1, should have given you practice at manipulating the front-panel controls. In Section 14 we shall guide you, in a general way, through the phases of operating Options 250 and 600 from the 9100 front panel, to calibrate a manually-operated oscilloscope. For a guide to using memory cards in Procedure Mode, please turn to the *User's Handbook, Volume 1, Section 5.*

Section 14 is divided into the following sub-sections:

Caution:
The ⚠ symbol, shown on elements of the 9100 instrument and 9105 leadset, draws attention to information contained in this handbook regarding maximum output voltages and currents.

For details, refer to *Volume 2 of the User's Handbook: Section 7 — Specifications; page 7-1.*

Caution:
The supplied BNC trigger and signal cables are clearly identified. Do ***not*** cross-connect these cables between 9100 and UUT oscilloscope — this can damage the trigger input circuitry of certain oscilloscopes.

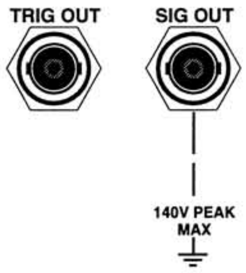
14.2 Interconnections

14.2.1 Introduction

This sub-section deals with the leads used to connect the 9100 to a UUT oscilloscope, and suggests the advantages of using the special 50Ω lead for external connections.

14.2.2 External Interconnections

14.2.2.1 9100 TRIG OUT and SIG OUT



Two BNC sockets are located at the upper center of the 9100 rear panel, providing both a trigger output (TRIG OUT) and signal output (SIG OUT).

14.2.2.2 Interconnections

a. Use the supplied BNC cable marked 'TRIGGER' with ***black*** sleeves (Fluke part no. 630441) to connect the 9100 TRIG OUT socket (angled end) to the UUT Trigger In socket (straight end).

b. Use the supplied BNC cable marked 'SIGNAL' with ***red*** sleeves (Fluke part no. 630442) to connect the 9100 SIG OUT socket (angled end) to the input of the UUT Signal Channel to be calibrated (straight end).

14.2.3 UUT Oscilloscope Signal

All outputs from Option 250 or Option 600 pass out of the 9100 via the 'SIG OUT' BNC socket. The outputs are specified into either $1M\Omega$ or 50Ω loading.

14.2.3.1 External Leads - Specification Degradation

Degradation of the specification at the output point can occur if care is not taken to select the correct type, length and terminations for the external signal lead. This applies particularly to Sine function signals at frequencies up to 600MHz, and Low Edge signals at frequencies up to 10MHz wth risetimes of $\leq$1ns.

Therefore it is highly recommended that the supplied BNC cable marked 'SIGNAL' with ***red*** sleeves (Fluke part no. 630442) be used to connect the 9100 output signal for all UUT oscilloscopes. If this is not possible, please consult the factory.

14.2.4 UUT Oscilloscope Trigger

Trigger pulses for the UUT oscilloscope are provided at the 'TRIG OUT' BNC socket on the 9100 rear panel. The trigger output runs at all times, and cannot be turned off. Characteristics are as follows:

Trigger Rate:	Up to 11.2MHz:	Output Frequency
	Above 11.2MHz:	1/32 of Output Frequency (Option 250), 1/64 of Output Frequency (Option 600)
	DC Function:	64Hz
Polarity:	Positive transition	
Amplitude:	into 50Ω:	Not less than 1V
	into 1MΩ:	Not less than 2V
Timing	When Markers or Low Edge function is selected, the trigger edge leads the positive-going marker edge by (typically) 25ns, depending on output frequency. In High Edge function, the lead is typically 300ns. For outputs in other functions, the amount of lead is unspecified.	

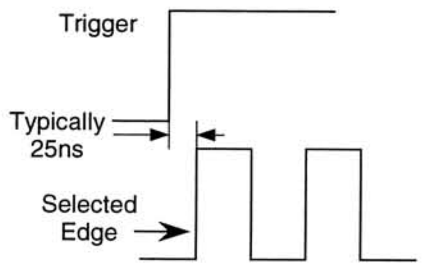


Fig. 14.2.4.1 Markers and Low Edge Functions — Trigger Timing Relationship

It is highly recommended that the supplied BNC cable marked 'TRIGGER' with ***black*** sleeves (Fluke part no. 630441) be used to connect the 9100 TRIG OUT to the Trigger in for all UUT oscilloscopes.

For oscilloscopes with more than one input channel, or for operations where two devices need to be triggered simultaneously from the 9100 Option 250 or 600, a BNC 'T' connector and two short BNC cables (Fluke part nos. 630445 and 630444 respectively) are provided.

14.3 'Auxiliary' Oscilloscope Functions

14.3.1 Introduction

If neither Option 250 nor Option 600 is fitted, refer to sub-section 4.12 in the *9100 User's Handbook Vol 1.*

With Option 250 or Option 600 fitted, the Oscilloscope calibration feature introduces five new auxiliary functions.

This sub-section is a guide to selecting the Auxiliary Functions (including the Oscilloscope functions). The following topics are covered:

14.3.2 Selection of Auxiliary & Oscilloscope Functions

(Option 250 or 600 fitted, Manual Mode selected)

14.3.2.1 'Aux' Key

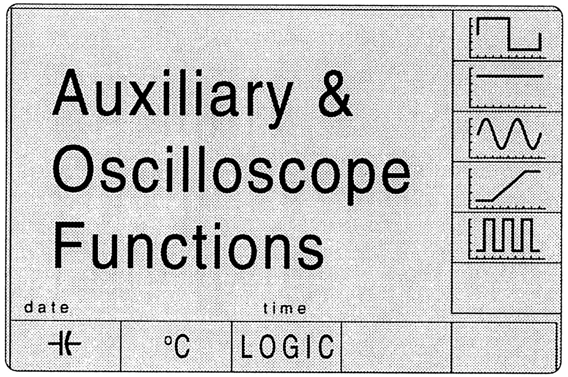
Auxiliary and Oscilloscope functions are accessed by pressing the 'Aux' key at the right of the 'CALIBRATION SYSTEM' panel.

14.3.2.2 Default Settings

At power-on, the system defaults into DC Voltage function. Each time the 'Aux' key is pressed, the system defaults to show the Auxiliary menu screen for selection of one of the auxiliary functions:

Capacitance, Temperature, Logic Pulse / Logic Level or Oscilloscope

Whenever the Auxiliary menu screen is opened, it will appear with the following icons:



14.3.3 Screen Keys — Function Selection

14.3.3.1 Bottom Screen Keys

 Selects 'Capacitance' Function.

°C Selects 'Temperature' Function.

LOGIC Selects 'Logic Pulse / Logic Level' Function.

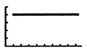
As soon as a bottom screen key is pressed, the Auxiliary menu screen will disappear, to be replaced by the default screen of the selected function.

For further details refer to the following sub-sections in *Section 4 in Volume 1 of the User's Handbook for the 9100*:

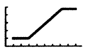
4.13	Capacitance
4.14	Temperature (Thermocouple)
4.15	Temperature (PRT)
4.16	Logic Pulses
4.17	Logic Levels

14.3.3.2 Right Side Screen Keys select Oscilloscope Functions

 Selects 'Square'.

 Selects 'DC'.

 Selects 'Sine'

 Selects 'Edge'.

 Selects 'Markers'.

As soon as a right-side screen key is pressed, the Auxiliary menu screen will disappear, to be replaced by the default screen of the selected oscilloscope function.

For further details refer to the following sub-sections in this *Volume 3 of the User's Handbook for the 9100.*

14.4	Square Function
14.5	DC Function
14.6	Sine Function
14.7	Edge Function
14.8	Markers Function

14.4 Square Function

14.4.1 Introduction

This sub-section is a guide to the use of the 9100 for generating a square wave for use for amplitude calibration of oscilloscopes, at a fixed frequency of 1kHz, and fixed duty cycle of 50%. The following topics are covered:

In this sub-section, we deal with the full range of 'Square' function facilities. For those who require more detailed instructions for manipulating the front panel controls, the DC Voltage function was used as an example for the general familiarization tutorials in the *User's Handbook Volume 1, Section 3.*

14.4.2 Auxiliary and Oscilloscope Functions Selection

(Manual Mode selected)

14.4.2.1 'Aux' Key

The Oscilloscope function is an 'Auxiliary' function. The Auxiliary menu screen is viewed by pressing the 'Aux' key at the right of the 'CALIBRATION SYSTEM' panel. Then pressing any one of the right-side screen keys will select a particular aspect of oscilloscope calibration.

14.4.2.2 Default Settings

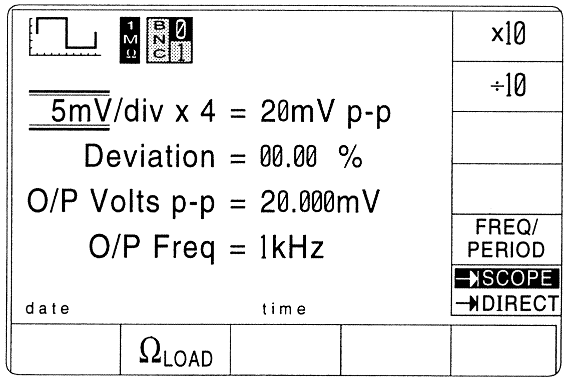
At power-on the system defaults into DC Voltage function. Each time the '**Aux**' key is pressed, the system shows the 'Auxiliary Functions' menu *(Sub-section 14.3)*.

14.4.3 Square Function

The Square function is included primarily for Amplitude calibration of UUT oscilloscopes. For this purpose the Frequency is fixed at 1kHz (Period 1ms) and cannot be altered. The Duty Cycle is also fixed at 50%.

The  key will select the Square function.

Whenever the  menu screen is opened, except on recovery from a standby period, it will appear with the following default settings:



14.4.4 Screen Keys

14.4.4.1 Bottom Screen Keys

Ω_{LOAD} Toggles the indicated output load matching indicator (top left of the screen) between 1MΩ and 50Ω, adjusting the internal circuitry as required. For output voltages greater than 3.336V p-p, the 50Ω option is not available.

14.4.4.2 Right Side Screen Keys

A. Digit Edit Facility Keys operate on the value marked by the cursor.

X10 Multiplies the marked value by ten.

÷10 Divides the marked value by ten.

± Inverts the polarity of the marked value (cursor on Deviation value) .

ZERO Sets the marked Deviation value to zero.

FREQ/ PERIOD Where the presentation shows the fixed signal *frequency* of 1kHz in the default display, pressing this screen key will switch to show the fixed signal *period* of 1ms. A second press reverts to show frequency.

⇥SCOPE (highlighted) / ⇥DIRECT With the toggle SCOPE highlighted, the tab ⇥ key can be used to move the cursor between 'V/div'; the multiplier (in this case '4'); and the Deviation percentage value. Note that these are the only variables on the default display.

⇥SCOPE / ⇥DIRECT (highlighted) With the toggle DIRECT highlighted, the cursor transfers to the 'O/P Volts p-p' value only.

B. Direct Edit Facility With ⇥SCOPE highlighted, Direct Edit is available only when the cursor is with the 'Deviation' value.
With ⇥DIRECT highlighted, Direct Edit is available only for the 'O/P Volts p-p' value.

Right side screen keys operate on the value in the edit box, and acting in place of the ↵ key, exit from Direct Edit back to Digit Edit; then set the value as evaluated in the box:

i. Deviation Value (⇥SCOPE highlighted)

% Evaluates the number in the box in **Deviation Percentage**.

The selected Deviation Percentage value is set into a resolution of four significant digits with two decimal places.

ii. 'O/P Volts p-p' Value (⇥DIRECT highlighted)

mV Evaluates the number in the box in **millivolts**.

V Evaluates the number in the box in **Volts**.

The 'O/P Volts p-p' value is set into a resolution of five significant digits.

Help Available!

User's Handbook Volume 1, Section 3: Editing Tutorials.

14.4.5 Value Editing

14.4.5.1 Elements Contributing to the Output Voltage Value

At maximum and minimum output voltages, the screen settings of the contributors' values (scaling factor, multiplier and deviation) are limited by the output voltage itself. For example:

Contributor	Minimum Output Voltage	Maximum Output Voltage Ω_{LOAD} = 1MΩ	Maximum Output Voltage Ω_{LOAD} = 50Ω
Scaling Factor	1mV/div	20V/div	0.5V/div
Multiplier	5	6	6
Deviation	-11.20%	+11.20%	+11.20%
Output Voltage	4.4400mV p-p	133.44V p-p	3.3360V p-p

Between the output voltage limits, the contributors can be adjusted as follows:

a. Scaling Factor in Volts/division (adjustable sequence: 1,2,5; default 5mV);
b. Scaling Multiplier (adjustable through integers 1 to 10; default 4);
c. Percentage Deviation (a maximum range of ±11.20% about the value of (a) x (b), at a resolution of four significant digits, with two decimal places; default zero);
d. Output Voltage (adjustable by manipulation of (a), (b) and (c) with ➔SCOPE highlighted, and itself with ➔DIRECT highlighted; default 20.000mV).

When the Output Voltage value is being adjusted directly, the values of the other three variables (a), (b), and (c) are also changed automatically to provide the required Output Voltage value. These changes are shown on the screen as they occur.

14.4.5.2 Output Voltage Editing

The 'Digit' and 'Direct' editing processes follow the same general rules as for editing voltages described in Section 3.

Tab (→|) Key and Cursors (→|SCOPE highlighted)
Repeatedly pressing this key moves the cursor from the default Scaling Factor to the Multiplier, then to the Deviation and back to the Scaling Factor. The type of cursor at each position indicates the type of adjustment possible to that value.

Scaling Factor (→|SCOPE highlighted)
The type of cursor (lines) used for the scaling factor signifies that the value can be adjusted only as a whole value using the (^) and (v) keys. The (<) and (>) keys are inactive.

From the default '5mV/div', the value can be raised using the (^) key by increments through 10mV/div, 20mV/div, 50mV/div and so on up to 20V/div, providing that the other contributors will not take the output voltage value above 133.44V p-p. Similarly, the (v) key will reduce the scaling factor down to 1mV/div, unless the output voltage would fall below 4.4400mV p-p.

Multiplier (→|SCOPE highlighted)
Again the (<) and (>) keys are inactive.

From the default 'x 4', the value can be changed using the (^) and (v) keys, by single integer increments to values between 1 and 10, providing that the other contributors do not take the output voltage value out of its limits. The product of the scaling factor and multiplier are shown on the right side of the '=' sign.

Deviation (→|SCOPE highlighted)
The triangular type of cursor indicates that all the cursor keys can be used as in other functions.

From the default 00.00%, the deviation percentage can be changed to any value within its resolution between -11.20% and +11.20%, providing that the other contributors do not take the output voltage value out of its limits. The result of combining the scaling factor, multiplier and deviation are shown as the value of 'O/P Volts p-p'.

Output Voltage (→|DIRECT highlighted)
The triangular type of cursor indicates that all the cursor keys can be used.

From the default 20.000mV, the output voltage can be changed to any value within its resolution between 4.4400mV and 133.4400V. The software ensures that the contributors' values remain within their limits. The contributors' values are altered on the screen for each change in output voltage.

14.4.6 Using the 9100 Square Function to Calibrate the Amplitude Response of a UUT Oscilloscope

14.4.6.1 Introduction

Two types of procedures for amplitude calibration are given:

a. Using the 9100 as a fixed source, where the oscilloscope can be adjusted;

b. Using the 9100 as an adjustable source, reading oscilloscope deviations via the 9100 screen.

14.4.6.2 Interconnections

Caution The BNC trigger and signal cables are clearly identified. Do ***not*** cross-connect these cables between 9100 and UUT oscilloscope — this can damage the trigger input circuitry of certain oscilloscopes.

a. Use the supplied BNC cable marked 'TRIGGER' with ***black*** sleeves (Fluke part no. 630441) to connect the 9100 TRIG OUT socket (angled end) to the UUT Trigger In socket (straight end).

b. Use the supplied BNC cable marked 'SIGNAL' with ***red*** sleeves (Fluke part no. 630442) to connect the 9100 SIG OUT socket (angled end) to the input of the UUT Signal Channel to be calibrated (straight end).

14.4.6.3 UUT Oscilloscope — Amplitude Calibration at 1kHz using the 9100 as a Fixed Source

The following procedure assumes that the 9100 instrument is in Manual Mode. It is also assumed that the user will be familiar with the methods of editing screen values. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.*

9100 and UUT Oscilloscope Setup

1. **Connections** — Connect the 9100 to the UUT Oscilloscope as in *para 14.4.6.2*, and ensure that both instruments are powered ON and warmed up.
2. **UUT 'Scope** — Select the required function for amplitude calibration.
3. **9100** — Ensure that the 9100 is in Square Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the  soft key at the top right of the screen.

Sequence of Operations at 1kHz

Refer to the table or list of UUT Oscilloscope amplitude calibration points in the *UUT Oscilloscope Manufacturer's Calibration Guide.*

Follow the correct sequence of calibration stages as directed by the guide, and carry out the following operations *(1)* to *(6)* at each stage.

1. **9100** — Use the front panel controls to set the 9100 Output to the required square wave p-p voltage and load impedance for the UUT 'Scope amplitude cal point:
2. **UUT 'Scope**
   - **a.** Select the correct channel for the cal point.
   - **b.** Select the correct range for the cal point.
3. **9100** — Set Output **ON**.
4. **UUT 'Scope**
   - **a.** Adjust the sweep speed and trigger level for a stable display.
   - **b.** Observe and note the amplitude response.
5. **Calibration**
   - **a.** If a calibration adjustment is provided, adjust the UUT's response to be appropriate to the settings on the 9100 screen, as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
   - **b.** If no adjustment is provided on the UUT 'Scope, record its response at the calibration point as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
6. **9100** — Set Output **OFF**.

14.4.6 continued overleaf

14.4.6.4 UUT Oscilloscope — Amplitude Calibration at 1kHz using the 9100 as an Adjustable Source

The following procedure assumes that the 9100 instrument is in Manual Mode. It is also assumed that the user will be familiar with the methods of editing screen values. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.*

9100 and UUT Oscilloscope Setup

1. **Connections** Connect the 9100 to the UUT Oscilloscope as in *para 14.4.6.2*, and ensure that both instruments are powered ON and warmed up.
2. **UUT 'Scope** Select the required function for amplitude calibration.
3. **9100** Ensure that the 9100 is in Square Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the ⎍ soft key at the top right of the screen.

Sequence of Operations at 1kHz

Refer to the table or list of UUT Oscilloscope amplitude calibration points in the *UUT Oscilloscope Manufacturer's Calibration Guide.*

Follow the correct sequence of calibration stages as directed by the guide, and carry out the following operations *(1)* to *(6)* at each stage.

1. **9100** Use the front panel controls to set the 9100 Output to the required square wave p-p voltage and load impedance for the UUT 'Scope amplitude cal point:
2. **UUT 'Scope**
   - **a.** Select the correct channel for the cal point.
   - **b.** Select the correct range for the cal point.
3. **9100** Set Output **ON**.
4. **UUT 'Scope**
   - **a.** Adjust the sweep speed and trigger level for a stable display.
   - **b.** Observe and note the amplitude response.
5. **Calibration**
   - **a.** Use the 9100 Deviation control to slew the 9100 Output voltage until the UUT's response is appropriate to the 9100 settings, as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
   - **b.** Record the 9100 screen output voltage as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
6. **9100** Set Output **OFF**.

14.5 DC Function

14.5.1 Introduction

This sub-section is a guide to the use of the 9100 for generating a DC Voltage for use for amplitude calibration of oscilloscopes. The following topics are covered:

In this sub-section, we deal with the full range of DC facilities. For those who require more detailed instructions for manipulating the front panel controls, the DC Voltage function was used as an example for the general familiarization tutorials in *Section 3 of the User's Handbook, Volume 1.*

14.5.2 Auxiliary and Oscilloscope Functions Selection

(Manual Mode selected)

14.5.2.1 'Aux' Key

The Oscilloscope function is an 'Auxiliary' function. The Auxiliary menu screen is viewed by pressing the 'Aux' key at the right of the 'CALIBRATION SYSTEM' panel. Then pressing any one of the right-side screen keys will select a particular aspect of oscilloscope calibration.

14.5.2.2 Default Settings

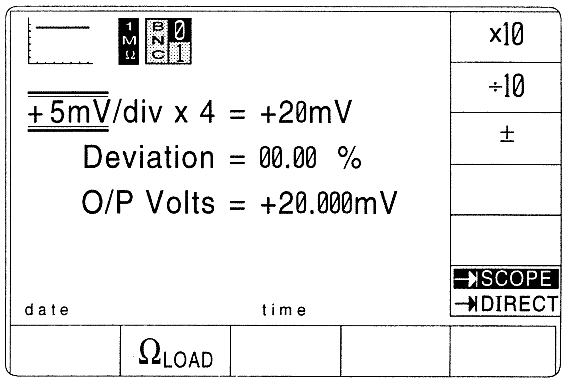
At power-on the system defaults into DC Voltage function. Each time the '**Aux**' key is pressed, the system shows the 'Auxiliary Functions' menu *(Sub-section 14.3)*.

14.5.3 DC Function

The DC function is included primarily for Voltage Amplitude calibration of UUT oscilloscopes with DC-coupling.

The key will select the DC function.

Whenever the menu screen is opened, except on recovery from a standby period, it will appear with the following default settings:



14.5.4 Screen Keys

14.5.4.1 Bottom Screen Keys

Ω_{LOAD}	Toggles the indicated output load matching indicator (top left of the screen) between 1MΩ and 50Ω, adjusting the internal circuitry as required. For output voltages greater than ±2.78VDC, the 50Ω option is not available.

14.5.4.2 Right Side Screen Keys

A. Digit Edit Facility Keys operate on the value marked by the cursor.

X10	Multiplies the marked value by ten.
÷10	Divides the marked value by ten.
±	Inverts the polarity of the marked value.
ZERO	Sets the marked Deviation value to zero.
→SCOPE (highlighted) →DIRECT	With the toggle SCOPE highlighted, the tab (→) key can be used to move the cursor between 'V/div'; the multiplier (in this case '4'); and the Deviation percentage value. Note that these are the only variables on the display.
→SCOPE →DIRECT (highlighted)	With the toggle DIRECT highlighted, the cursor transfers to the 'O/P Volts' value.

B. Direct Edit Facility With →SCOPE highlighted, Direct Edit is available only when the cursor is with the 'Deviation' value.
With →DIRECT highlighted, Direct Edit is available only for the 'O/P Volts' value.

Right side screen keys operate on the value in the edit box, and acting in place of the ↵ key, exit from Direct Edit back to Digit Edit; then set the value as evaluated in the box:

i. Deviation Value (→SCOPE highlighted)

%	Evaluates the number in the box in **Deviation Percentage**.

The selected Deviation Percentage value is set into a resolution of four significant digits with two decimal places.

ii. 'O/P Volts' Value (→DIRECT highlighted)

mV	Evaluates the number in the box in **millivolts**.
V	Evaluates the number in the box in **Volts**.

The 'O/P Volts' value is set into a resolution of five significant digits.

Help Available!

User's Handbook Volume 1, Section 3: Editing Tutorials.

14.5.5 Value Editing

14.5.5.1 Elements Contributing to the Output Voltage Value

At maximum and minimum output voltages, the screen settings of the contributors' values (scaling factor, multiplier and deviation) are limited by the output voltage itself. For example:

Contributor	Minimum Value	Maximum Value $\Omega_{LOAD} = 1M\Omega$	Maximum Value $\Omega_{LOAD} = 50\Omega$
Scaling Factor (+ve)	+1mV/div	+20V/div	+0.5V/div
Scaling Factor (-ve)	-1mV/div	-20V/div	-0.5V/div
Multiplier	5	6	5
Deviation	-11.20%	+11.20%	+11.20%
Output Voltage (+ve)	+4.4400mV	+133.44V	+2.7800V
Output Voltage (-ve)	-4.4400mV	-133.44V	-2.7800V

Between the output voltage limits, the contributors can be adjusted as follows:

a. Scaling Factor in ±Volts/division (adjustable sequence: 1,2,5; default +5mV);
b. Scaling Multiplier (adjustable through integers 1 to 10; default 4);
c. Percentage Deviation (a maximum range of ±11.20% about the value of (a) x (b), at a resolution of four significant digits, with two decimal places; default zero);
d. Output Voltage (adjustable by manipulation of (a) x (b) x (c) with ⇥SCOPE highlighted, and itself with ⇥DIRECT highlighted; default +20.000mV).

When the Output Voltage value is being adjusted directly, the values of the other three variables (a), (b), and (c) are also changed automatically to provide the required Output Voltage value. These changes are shown on the screen as they occur.

14.5.5.2 Output Voltage Editing

The 'Digit' and 'Direct' editing processes follow the same general rules as for editing voltages described in Section 3.

Tab ⇥ Key and Cursors (⇥SCOPE highlighted)
Repeatedly pressing this key moves the cursor from the default Scaling Factor to the Multiplier, then to the Deviation and back to the Scaling Factor. The type of cursor at each position indicates the type of adjustment possible to that value.

Scaling Factor (→SCOPE highlighted)

The type of cursor (lines) used for the scaling factor signifies that the value can be adjusted only as a whole value using the (∧) and (∨) keys. The (<) and (>) keys are inactive.

For example: from the default '+5mV/div', the value can be raised using the (∧) key by increments through +10mV/div, +20mV/div, +50mV/div and so on up to +20V/div, providing that the other contributors will not take the output voltage value above +133.44V. Similarly, the (∨) key will reduce the scaling factor down to +1mV/div, unless the output voltage would fall below +4.4400mV.

At +1mV/div, pressing the (∨) key will cause the scaling factor to jump to -1mV/div, then progress through the 1, 2, 5 sequence down to -20mV/div, providing that the other contributors will not take the output voltage value above -4.4400mV, or below -133.44V.

The ± screen key reverses the polarity of the scaling factor at its existing value, unless the output voltage would fall above -4.4400mV, or below -133.44V (depending on the polarity and value of the Deviation percentage).

Multiplier (→SCOPE highlighted)

Again the (<) and (>) keys are inactive. The multiplier is a scalar value, and so is not given a polarity sign.

From the default 'x 4', the value can be changed using the (∧) and (∨) keys, by single integer increments to values between 1 and 10, providing that the other contributors do not take the output voltage value out of its limits. The product of the scaling factor and multiplier are shown on the right side of the '=' sign, accompanied by its polarity sign.

Deviation (→SCOPE highlighted)

The triangular type of cursor indicates that all the cursor keys can be used as in other functions.

From the default 00.00%, the deviation percentage can be changed to any value within its resolution between -11.20% and +11.20%, providing that the other contributors do not take the output voltage value out of its limits. The result of combining the scaling factor, multiplier and deviation are shown as the value of 'O/P Volts'.

Output Voltage (→DIRECT highlighted)

The type of cursor indicates that all the cursor keys can be used. The ± screen key reverses the polarity of the output voltage.

From the default +20.000mV, the output voltage can be changed to any value within its resolution between +4.4400mV and +133.44.00V or between -4.4400mV and -133.44.00V. The software ensures that the contributors' values remain within their limits. The contributors' values are altered on the screen for each change in output voltage.

14.5.6 Using the 9100 Option 250 or 600 DC Function to Calibrate the DC-Coupled Amplitude Response of a UUT Oscilloscope

14.5.6.1 Introduction

Two types of procedures for amplitude calibration are given:

a. Using the 9100 as a fixed source, where the oscilloscope can be adjusted;
b. Using the 9100 as an adjustable source, reading oscilloscope deviations via the 9100 screen.

14.5.6.2 Interconnections

Caution The BNC trigger and signal cables are clearly identified. Do ***not*** cross-connect these cables between 9100 and UUT oscilloscope — this can damage the trigger input circuitry of certain oscilloscopes.

a. Use the supplied BNC cable marked 'TRIGGER' with ***black*** sleeves (Fluke part no. 630441) to connect the 9100 TRIG OUT socket (angled end) to the UUT Trigger In socket (straight end).

b. Use the supplied BNC cable marked 'SIGNAL' with ***red*** sleeves (Fluke part no. 630442) to connect the 9100 SIG OUT socket (angled end) to the input of the UUT Signal Channel to be calibrated (straight end).

14.5.6.3 UUT Oscilloscope — DC-Coupled Amplitude Calibration using the 9100 as a Fixed Source

The following procedure assumes that the 9100 instrument is in Manual Mode. It is also assumed that the user will be familiar with the methods of editing screen values. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.*

9100 and UUT Oscilloscope Setup

1. **Connections** — Connect the 9100 to the UUT Oscilloscope as in *para 14.5.6.2*, and ensure that both instruments are powered ON and warmed up.
2. **UUT 'Scope** — Select the required function for amplitude calibration.
3. **9100** — Ensure that the 9100 is in DC Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the [ ] soft key on the right of the screen.

Sequence of Operations

Refer to the table or list of UUT Oscilloscope amplitude calibration points in the *UUT Oscilloscope Manufacturer's Calibration Guide.*

Follow the correct sequence of calibration stages as directed by the guide, and carry out the following operations *(1)* to *(6)* at each stage.

1. **9100** — Set the 9100 Output to the required DC p-p voltage and load impedance for the UUT 'Scope amplitude cal point:
2. **UUT 'Scope**
   - **a.** Select the correct channel for the cal point.
   - **b.** Select 'DC-Coupled', if required.
   - **c.** Select the correct range for the cal point.
   - **d.** With reference zero input, set the Y controls to put the trace onto graticule zero. Remove the zero reference.
3. **9100** — Set Output **ON**.
4. **UUT 'Scope**
   - **a.** Adjust the sweep speed and trigger level for a stable display.
   - **b.** Observe and note the DC level change from graticule zero.
5. **Calibration**
   - **a.** If a calibration adjustment is provided, adjust the UUT's response to be appropriate to the settings on the 9100 screen, as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
   - **b.** If no adjustment is provided on the UUT 'Scope, record its response at the calibration point as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
6. **9100** — Set Output **OFF**.

14.5.6.4 UUT Oscilloscope — DC-Coupled Amplitude Calibration using the 9100 as an Adjustable Source

The following procedure assumes that the 9100 instrument is in Manual Mode. It is also assumed that the user will be familiar with the methods of editing screen values. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.*

9100 and UUT Oscilloscope Setup

1. **Connections** — Connect the 9100 to the UUT Oscilloscope as in *para 14.5.6.2*, and ensure that both instruments are powered ON and warmed up.
2. **UUT 'Scope** — Select the required function for amplitude calibration.
3. **9100** — Ensure that the 9100 is in DC Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the [ ] soft key on the right of the screen.

Sequence of Operations

Refer to the table or list of UUT Oscilloscope DC-Coupled amplitude calibration points in the *UUT Oscilloscope Manufacturer's Calibration Guide.*

Follow the correct sequence of calibration stages as directed by the guide, and carry out the following operations ***(1)*** to ***(6)*** at each stage.

1. **9100** — Set the 9100 Output to the required DC voltage and load impedance for the UUT 'Scope amplitude cal point:
2. **UUT 'Scope**
   - **a**. Select the correct channel for the cal point.
   - **b**. Select 'DC-Coupled', if required.
   - **c**. Select the correct range for the cal point.
   - **d**. With reference zero input, set the Y controls to put the trace onto graticule zero. Remove the zero reference.
3. **9100** — Set Output **ON**.
4. **UUT 'Scope**
   - **a**. Adjust the sweep speed and trigger level for a stable display.
   - **b**. Observe and note the DC level change from graticule zero.
5. **Calibration**
   - **a**. Use the 9100 Deviation control to slew the 9100 Output voltage until the UUT's response is appropriate to the 9100 settings, as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
   - **b**. Record the 9100 screen output voltage as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
6. **9100** — Set Output **OFF**.

14.6 Sine Function

14.6.1 Introduction

This sub-section is a guide to the use of the 9100 for generating a sine wave for flatness and bandwidth calibration of oscilloscopes. The following topics are covered:

In this sub-section, we deal with the full range of 'Sine' facilities. For those who require more detailed instructions for manipulating the front panel controls, the DC Voltage function was used as an example for the general familiarization tutorials in *Section 3*.

14.6.2 Auxiliary and Oscilloscope Functions Selection

(Manual Mode selected)

14.6.2.1 'Aux' Key

The Oscilloscope function is an 'Auxiliary' function. The Auxiliary menu screen is viewed by pressing the 'Aux' key at the right of the 'CALIBRATION SYSTEM' panel. Then pressing any one of the right-side screen keys will select a particular aspect of oscilloscope calibration.

14.6.2.2 Default Settings

At power-on the system defaults into DC Voltage function. Each time the **'Aux'** key is pressed, the system shows the 'Auxiliary Functions' menu *(Sub-section 14.3).*

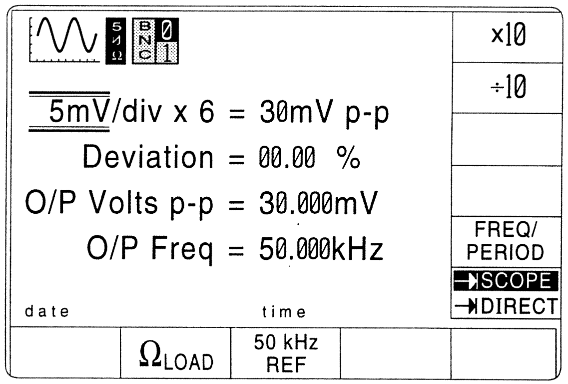
14.6.3 Sine Function

The Sine function is included primarily for flatness and bandwidth calibration of UUT oscilloscopes. For this purpose:
Options 250 and 600: the frequency is variable between 10Hz and 250MHz at output voltages between 10.656mV p-p and 5.56V p-p, into a 50Ω load;
Option 600 only: in addition, the frequency is variable between 250MHz and 600MHz at output voltages between 10.656mV p-p and 3.336V p-p, into a 50Ω load.

Both options also provide outputs into a 1MΩ load, the frequency being variable between 10Hz and 49.999kHz at output voltages from 4.44mV p-p to 133.44V p-p. The Volt-Hertz profiles for the Sine function are shown in *Fig. 14.6.5.1.*

The key will select the Sine function.

Whenever the menu screen is opened, except on recovery from a standby period, it will appear with the following default settings:



14.6.4 Screen Keys

14.6.4.1 Bottom Screen Keys

Ω_{LOAD} Toggles the indicated output load matching indicator (top left of the screen) between 1MΩ and 50Ω, adjusting the internal circuitry as required.

The parameters for each expected load selection are given in *paras 14.6.3.*

50kHz REF Sets the marked 'O/P Freq' value to 50kHz.

14.6.4.2 Right Side Screen Keys

A. Digit Edit Facility Keys operate on the value marked by the cursor.

X10 Multiplies the marked value by ten.

÷10 Divides the marked value by ten.

± Inverts the polarity of the marked value (cursor on Deviation value) .

ZERO Sets the marked Deviation value to zero.

FREQ/ PERIOD Where the presentation shows the signal *frequency* (default), pressing the FREQ/PERIOD 'toggle' screen key will switch to show the signal *period.* A second press reverts to show frequency.

→SCOPE (highlighted) →DIRECT With the toggle SCOPE highlighted, the tab (→) key can be used to move the cursor between 'V/div'; the multiplier (in this case '6'); the Deviation percentage value and the Frequency value. Note that these are the only variables on the default display.

→SCOPE →DIRECT (highlighted) With the toggle DIRECT highlighted, the cursor transfers to the 'O/P Volts p-p' value, and can be moved to the Frequency value.

14.6.4.2 Continued Overleaf

14.6.4 Screen Keys *(Contd.)*

14.6.4.2 Right Side Screen Keys *(Contd.)*

B. Direct Edit Facility

With →SCOPE highlighted, Direct Edit is available only when the cursor is with the 'Deviation' value or 'O/P Freq'/'O/P Period' value.

With →DIRECT highlighted, Direct Edit is available only for the 'O/P Volts p-p' value or 'O/P Freq'/'O/P Period' value.

Right side screen keys operate on the value in the edit box, and acting in place of the ↵ key, exit from Direct Edit back to Digit Edit; then set the value as evaluated in the box:

i. Deviation Value (→SCOPE highlighted)

% Evaluates the number in the box in **Deviation Percentage**.

The selected Deviation Percentage value is set into a resolution of four significant digits with two decimal places.

ii. 'O/P Volts p-p' Value (→DIRECT highlighted)

mV Evaluates the number in the box in **millivolts**.
V Evaluates the number in the box in **Volts**.

The 'O/P Volts p-p' value is set into a resolution of five significant digits.

iii. 'O/P Freq' Value (→SCOPE or →DIRECT highlighted)

Hz Evaluates the number in the box in **hertz**.
kHz Evaluates the number in the box in **kilohertz**.
MHz Evaluates the number in the box in **megahertz**.

iv. 'O/P Period' Value (→SCOPE or →DIRECT highlighted)

ns Evaluates the number in the box in **nanoseconds**.
µs Evaluates the number in the box in **microseconds**.
ms Evaluates the number in the box in **milliseconds**.

Help Available!

User's Handbook Volume 1, Section 3: Editing Tutorials.

14.6.5 Value Editing

14.6.5.1 Elements Contributing to the Output Voltage Value

At maximum and minimum output voltages, the screen settings of the contributors' values (scaling factor, multiplier and deviation) are limited by the output voltage itself. For example:

	Options 250 and 600						Option 600 Only	
Contributor	LF (Ω_{LOAD} = 1MΩ)		LF (Ω_{LOAD} = 50Ω)		HF (Ω_{LOAD} = 50Ω)		HF (Ω_{LOAD} = 50Ω)	
	Minimum Value	Maximum Value	Minimum Value	Maximum Value	Minimum Value	Maximum Value	Minimum Value	Maximum Value
Frequency	10Hz	49.999kHz	10Hz	49.999kHz	50kHz	250MHz	250MHz	600MHz
Scaling Factor	1mV/div	20V/div	1mV/div	1V/div	2mV/div	1V/div	2mV/div	1V/div
Multiplier	5	6	5	5	6	5	6	5
Deviation	-11.20%	+11.20%	-11.20%	+11.20%	-11.20%	+11.20%	-11.20%	+11.20%
Output Voltage	4.4400mVp-p	133.44Vp-p	4.4400mVp-p	5.5600Vp-p	10.656mVp-p	5.5600Vp-p	10.656mVp-p	5.5600Vp-p*

* = < 5.5600V is available, but specified only to 3.360V.

Between the output voltage limits, the contributors can be adjusted as follows:

a. Scaling Factor in Volts/division (adjustable sequence: 1,2,5; default 5mV);
b. Scaling Multiplier (adjustable through integers 1 to 10; default 6);
c. Percentage Deviation (a maximum range of ±11.20% about the value of (a) x (b), at a resolution of four significant digits, with two decimal places; default zero);
d. Output Voltage (adjustable by manipulation of (a) x (b) x (c) with **→SCOPE** highlighted, and in its own right with **→DIRECT** highlighted; default 30.000mV).

When the Output Voltage value is being adjusted directly, the values of the other three variables (a), (b), and (c) are also changed automatically to provide the required Output Voltage value. These changes are shown on the screen as they occur.

14.6.5 Value Editing *(Contd.)*

14.6.5.2 Output Voltage Editing

The editing processes follow the same general rules as for editing voltages described in the *User's Handbook, Volume 1, Section 3.*

Tab ⇥ Key and Cursors (→SCOPE highlighted)
Repeatedly pressing this key moves the cursor from the default Scaling Factor to the Multiplier, then to the Deviation and back to the Scaling Factor. The type of cursor at each position indicates the type of adjustment possible to that value.

Scaling Factor (→SCOPE highlighted)
The type of cursor (lines) used for the scaling factor signifies that the value can be adjusted only as a whole value using the ⌃ and ⌄ keys. The ‹ and › keys are inactive.

From the default '5mV/div', the value can be raised using the ⌃ key by increments through 10mV/div, 20mV/div, 50mV/div and so on up to 20V/div, providing that the other contributors will not take the output voltage value above 133.44V p-p. Similarly, the ⌄ key will reduce the scaling factor down to 1mV/div, unless the output voltage would fall below 4.4400mV p-p.

Multiplier (→SCOPE highlighted)
Again the ‹ and › keys are inactive.

From the default 'x 4', the value can be changed using the ⌃ and ⌄ keys, by single integer increments to values between 1 and 10, providing that the other contributors do not take the output voltage value out of its limits. The product of the scaling factor and multiplier are shown on the right side of the '=' sign.

Deviation (→SCOPE highlighted)
The triangular type of cursor indicates that all the cursor keys can be used as in other functions.

From the default 00.00%, the deviation percentage can be changed to any value within its resolution between -11.20% and +11.20%, providing that the other contributors do not take the output voltage value out of its limits. The result of combining the scaling factor, multiplier and deviation are shown as the value of 'O/P Volts p-p'.

Output Voltage (→DIRECT highlighted)
The triangular type of cursor indicates that all the cursor keys can be used.

Sine LF: For frequencies from 10Hz to 49.999kHz; from the default 30.000mV, the output voltage can be changed to any resolved value between 4.4400mV and 133.44V.

Sine HF (Both Options): For frequencies of 50kHz to 250MHz, the output voltage can be changed to any value within its resolution between 10.656mV and 5.5600V.

Sine HF (Option 600 only): For frequencies of 250MHz to 600MHz, the output voltage can be changed to any value within its resolution between 10.656mV and 3.3360V.

The software ensures that the contributors' values remain within their limits. The contributors' values are altered on the screen for each change in output voltage.

Output Frequency (→SCOPE or →DIRECT highlighted)
The triangular type of cursor indicates that all the cursor keys can be used.

From the default 50kHz, the output frequency can be changed to any resolvable value between 10Hz and 250MHz (Option 250), or between 10Hz and 600MHz (Option 600).

Sine LF: Between 10Hz and 49.999kHz, the full output voltage range is available.

Sine HF (Both Options): Between 50kHz and 250MHz, the output voltage range is limited to between 10.656mV and 5.5600V.

Sine HF (Option 600 only): Between 250MHz to 600MHz, the output voltage range is limited to between 10.656mV and 5.5600V, but specified only up to 3.3360V.

14.6.5.3 Volt-Hertz Profiles

Fig. 14.6.5.1 illustrates the limits of LF and HF Voltage and Frequency values:

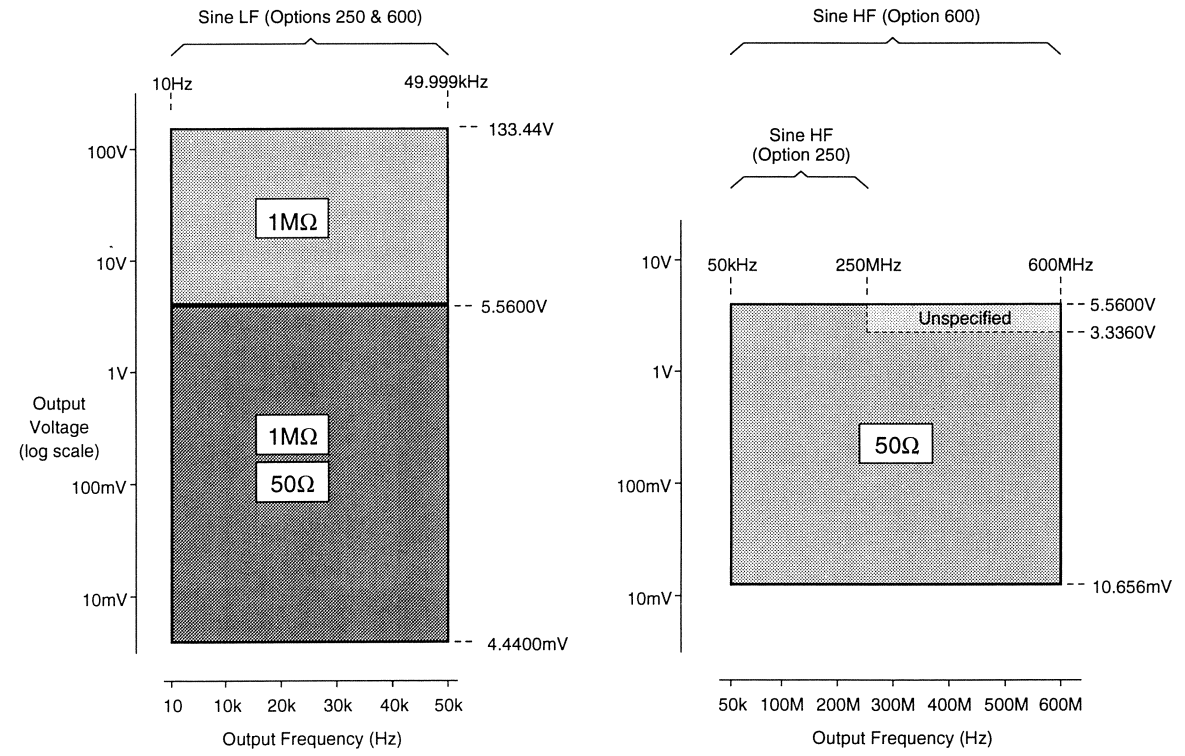


Fig. 14.6.5.1 Sine Function — LF & HF Volt-Hz Profiles into 50Ω and 1MΩ Loads

14.6.6 Using the 9100 Sine Function to Calibrate the Flatness/Bandwidth of a UUT Oscilloscope

14.6.6.1 Introduction

Two types of procedures for amplitude calibration are given:

a. Using the 9100 as a fixed source, where the oscilloscope can be adjusted;

b. Using the 9100 as an adjustable source, reading oscilloscope deviations via the 9100 screen.

14.6.6.2 Interconnections

Caution The BNC trigger and signal cables are clearly identified. Do ***not*** cross-connect these cables between 9100 and UUT oscilloscope — this can damage the trigger input circuitry of certain oscilloscopes.

a. Use the supplied BNC cable marked 'TRIGGER' with ***black*** sleeves (Fluke part no. 630441) to connect the 9100 TRIG OUT socket (angled end) to the UUT Trigger In socket (straight end).

b. Use the supplied BNC cable marked 'SIGNAL' with ***red*** sleeves (Fluke part no. 630442) to connect the 9100 SIG OUT socket (angled end) to the input of the UUT Signal Channel to be calibrated (straight end).

14.6.6.3 UUT Oscilloscope — Flatness Calibration at Specified Frequencies using the 9100 as a Fixed Source

The following procedure assumes that the 9100 instrument is in Manual Mode. It is also assumed that the user will be familiar with the methods of editing screen values. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.*

9100 and UUT Oscilloscope Setup

1. **Connections** Connect the 9100 to the UUT Oscilloscope as in *para 14.6.6.2*, and ensure that both instruments are powered ON and warmed up.
2. **UUT 'Scope** Select the required function for flatness calibration.
3. **9100** Ensure that the 9100 is in Sine Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the soft key at the top right of the screen.

Sequence of Operations at 1kHz

Refer to the table or list of UUT Oscilloscope flatness calibration points in the *UUT Oscilloscope Manufacturer's Calibration Guide.*

Follow the correct sequence of calibration stages as directed by the guide, and carry out the following operations *(1)* to *(6)* at each stage.

1. **9100** Set the 9100 Sine Output to the required load impedance, frequency and p-p voltage for the UUT 'Scope flatness cal point:
2. **UUT 'Scope**
   - **a.** Select the correct channel for the cal point.
   - **b.** Select the correct range for the cal point.
3. **9100** Set Output **ON**.
4. **UUT 'Scope**
   - **a.** Adjust the sweep speed and trigger level for a stable display.
   - **b.** Observe and note the sinewave amplitude response.
5. **Calibration**
   - **a.** If a calibration adjustment is provided, adjust the UUT's response to be appropriate to the settings on the 9100 screen, as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
   - **b.** If no adjustment is provided on the UUT 'Scope, record its response at the calibration point as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
6. **9100** Set Output **OFF**.

14.6.6 Continues overleaf →

14.6.6 Using the 9100 Sine Function to Calibrate the Flatness/Bandwidth of a UUT Oscilloscope *(Contd.)*

14.6.6.4 UUT Oscilloscope — Flatness Calibration at Specified Frequencies using the 9100 as an Adjustable Source

The following procedure assumes that the 9100 instrument is in Manual Mode. It is also assumed that the user will be familiar with the methods of editing screen values. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.*

9100 and UUT Oscilloscope Setup

1. **Connections** — Connect the 9100 to the UUT Oscilloscope as in *para 14.6.6.2*, and ensure that both instruments are powered ON and warmed up.
2. **UUT 'Scope** — Select the required function for flatness calibration.
3. **9100** — Ensure that the 9100 is in Sine Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the  soft key at the top right of the screen.

Sequence of Operations

Refer to the table or list of UUT Oscilloscope flatness calibration points in the *UUT Oscilloscope Manufacturer's Calibration Guide.*

Follow the correct sequence of calibration stages as directed by the guide, and carry out the following operations *(1)* to *(6)* at each stage.

1. **9100** — Set the 9100 Sine Output to the required load impedance, frequency and p-p voltage for the UUT 'Scope flatness cal point:
2. **UUT 'Scope** —
   a. Select the correct channel for the cal point.
   b. Select the correct range for the cal point.
3. **9100** — Set Output **ON**.
4. **UUT 'Scope** —
   a. Adjust the sweep speed and trigger level for a stable display.
   b. Observe and note the sinewave amplitude response.
5. **Calibration** —
   a. Use the 9100 Deviation control to slew the 9100 Output voltage until the UUT's response is appropriate to the 9100 settings, as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
   b. Record the 9100 screen output voltage and frequency as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
6. **9100** — Set Output **OFF**.

14.7 Edge Function

14.7.1 Introduction

This sub-section is a guide to the use of the 9100 for generating a defined low or high amplitude edge to examine oscilloscope pulse response. The following topics are covered:

In this sub-section, we deal with the full range of 'Edge' facilities. For those who require more detailed instructions for manipulating the front panel controls, the DC Voltage function was used as an example for the general familiarization tutorials in *Section 3*.

14.7.2 Auxiliary and Oscilloscope Functions Selection

(Manual Mode selected)

14.7.2.1 'Aux' Key

The Oscilloscope function is an 'Auxiliary' function. The Auxiliary menu screen is viewed by pressing the 'Aux' key at the right of the 'CALIBRATION SYSTEM' panel. Then pressing any one of the right-side screen keys will select a particular aspect of oscilloscope calibration.

14.7.2.2 Default Settings

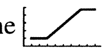
At power-on the system defaults into DC Voltage function. Each time the **'Aux'** key is pressed, the system shows the 'Auxiliary Functions' menu *(Sub-section 14.3)*.

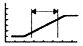
14.7.3 Edge Function

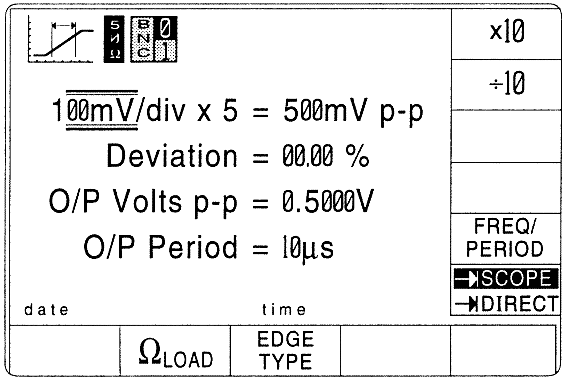
The Edge function is included primarily for the calibration of pulse response in UUT oscilloscopes. For this purpose two edges with different rise/fall times are provided:

'Low Edge' in which the (10% to 90%) rise/fall time is ≤1ns, the period is variable between 10ms and 10ns at output voltages between 88.800mV p-p and 1.112V p-p, into a 50Ω load (full output specification is not obtained below 888mV). The edge polarity is selectable rise (positive-going) or fall (negative-going); in both cases ending at 0V nominal.

'High Edge' in which the (10% to 90%) rise/fall time is ≤100ns, the period is variable between 10ms and 10μs at output voltages between 1.112V p-p and 55.6V p-p, into a 1MΩ load. Only edges of positive-going polarity are available, ending at 0V nominal.

The  key will select the Edge function.

Whenever the  menu screen is opened, except on recovery from a standby period, it will appear with the following default settings:



14.7.4 Screen Keys

14.7.4.1 Bottom Screen Keys

Ω_{LOAD} Toggles the indicated output load matching indicator (top left of the screen) between 1MΩ (High Edge) and 50Ω (Low Edge), adjusting the internal circuitry as required.

The 1MΩ option can be selected for output voltages between 88.800mV p-p and 55.6V p-p for periods between 10ms and 10μs.
Note: Full specification is not available below 888.00mV.
High edge duration ≤ 100ns (10% to 90% of amplitude).

Warning: When output is on with 1MΩ selected, imposing a 50Ω load on the output will result in incorrect outputs or an output trip. If this occurs, correct the load and turn the output back on.

The 50Ω option can be selected for output voltages between 88.800mV p-p and 1.112V p-p for periods between 10ms and 10ns (default 1μs).
Low edge duration ≤ 1ns (10% to 90% of amplitude).

EDGE TYPE Toggles from a 'rising' (positive-going) edge to a 'falling' (negative-going) edge and vice-versa. The selected edge type is illustrated at the top left of the screen (default is 'rising').
Both edge types have the same durations *(see above)*.
'Falling' edge is ***not*** available for the Ω_{LOAD} selection of 1MΩ.

14.7.4.2 Right Side Screen Keys

A. Digit Edit Facility Keys operate on the value marked by the cursor.

X10 Multiplies the marked value by ten.

÷10 Divides the marked value by ten.

± Inverts the polarity of the marked value (cursor on Deviation value).

ZERO Sets the marked Deviation value to zero.

FREQ/PERIOD Where the presentation shows the signal *period* in the default display, pressing the FREQ/PERIOD 'toggle' screen key will switch to show the signal *frequency*, with the appropriate calculated numerical frequency value for the previously-displayed period.

→SCOPE →DIRECT With the toggle **→SCOPE** highlighted, the tab (→) key can be used to move the cursor between 'V/div'; the multiplier (in this case '5'); the Deviation percentage value; and the Period/Frequency value. Note that these are the only variables on the default display.

→SCOPE **→DIRECT** With the toggle **→DIRECT** highlighted, the cursor transfers to the 'O/P Volts p-p' value, and can be moved to the Period/Frequency value using the (→) key.

14.7.4.2 Continued Overleaf

14.7.4 Screen Keys *(Contd.)*

14.7.4.2 Right Side Screen Keys *(Contd.)*

B. Direct Edit Facility

With →SCOPE highlighted, Direct Edit is available only when the cursor is with the 'Deviation' value.

With →DIRECT highlighted, Direct Edit is available only for the 'O/P Volts p-p' value.

Right side screen keys operate on the value in the edit box, and acting in place of the ↵ key, exit from Direct Edit back to Digit Edit; then set the value as evaluated in the box:

i. Deviation Value (→SCOPE highlighted)

% Evaluates the number in the box in **Deviation Percentage**.

The selected Deviation Percentage value is set into a resolution of four significant digits with two decimal places.

ii. 'O/P Volts p-p' Value (→DIRECT highlighted)

mV Evaluates the number in the box in **millivolts**.

V Evaluates the number in the box in **Volts**.

The 'O/P Volts p-p' value is set into a resolution of five significant digits.

Help Available!

User's Handbook Volume 1, Section 3: Editing Tutorials.

14.7.5 Value Editing

14.7.5.1 Elements Contributing to the Output Voltage Value

At maximum and minimum output voltages, the screen settings of the contributors' values (scaling factor, multiplier and deviation) are limited by the output voltage itself. For example:

Contributor	High Edge (Ω_{LOAD} = 1MΩ)		Low Edge (Ω_{LOAD} = 50Ω)	
	Minimum Value	Maximum Value	Minimum Value	Maximum Value
Period (Freq)	10μs (100kHz)	10ms (100Hz)	0.1μs (10MHz)	10ms (100Hz)
Scaling Factor	20mV/div	10V/div	20mV/div	0.2V/div
Multiplier	4	5	4	5
Deviation	+11.20%	+11.20%	+11.00%	+11.20%
Output Voltage	88.800mVp-p*	55.600Vp-p	88.800mVp-p	1.1120Vp-p

* Full specification does not apply below 888.00mV

Amplitude in this function is not traceable.

Between the output voltage limits, the contributors can be adjusted as follows:

a. Scaling Factor in Volts/division (adjustable sequence: 1,2,5; default 100mV);

b. Scaling Multiplier (adjustable through integers 1 to 10; default 5);

c. Percentage Deviation (a maximum range of ±11.20% about the value of (a) x (b), at a resolution of four significant digits, with two decimal places; default zero);

d. Output Voltage (adjustable by manipulation of (a), (b) and (c) with ➔SCOPE highlighted, and in its own right with ➔DIRECT highlighted; default 0.5000V).

When the Output Voltage value is being adjusted directly, the values of the other three variables (a), (b), and (c) are also changed automatically to provide the required Output Voltage value. These changes are shown on the screen as they occur.

14.7.5.2 Overleaf

14.7.5 Value Editing *(Contd.)*

14.7.5.2 Output Voltage Editing

The editing processes follow the same general rules as for editing voltages described in the *User's Handbook, Volume 1, Section 3*. Amplitude in this function is not traceable.

Tab (⇥) Key and Cursors (⇥SCOPE highlighted)
Repeatedly pressing this key moves the cursor from the default Scaling Factor to the Multiplier, the Deviation, then the Period/Frequency and back to the Scaling Factor. The type of cursor at each position indicates the type of adjustment possible to that value.

Scaling Factor (⇥SCOPE highlighted)
The type of cursor (lines) used for the scaling factor signifies that the value can be adjusted only as a whole value using the (∧) and (∨) keys. The (<) and (>) keys are inactive.

High Edge (1MΩ Load): From default scaling factor 100mV/div, the value can be raised using the (∧) key by increments through 200mV/div, 500mV/div, 1V/div and so on up to 20V/div, providing that the other contributors will not take the output voltage value above its limit. Similarly, the (∨) key will reduce the scaling factor down to 20mV/div, unless the output voltage would fall below its limit.

Low Edge (50Ω Load): From the default '100mV/div', the scaling factor can be raised using the (∧) key by increments through 200mV/div to 500mV/div. Similarly, the (∨) key will reduce the scaling factor down to 20mV/div, unless the output voltage would fall below its limit.

Multiplier (⇥SCOPE highlighted)
Again the (<) and (>) keys are inactive.

From the default 'x 5', the value can be changed using the (∧) and (∨) keys, by single integer increments to values between 1 and 10 (High Edge) or between 1 and 5 (Low Edge), providing that the other contributors do not take the output voltage value out of its limits. The product of the scaling factor and multiplier are shown on the right side of the '=' sign.

Deviation (⇥SCOPE highlighted)
The triangular type of cursor indicates that all the cursor keys can be used as in other functions.

From the default 00.00%, the deviation percentage can be changed to any value within its resolution between -11.20% and +11.20%, providing that the other contributors do not take the output voltage value out of its limits. The result of combining the scaling factor, multiplier and deviation are shown as the value of 'O/P Volts p-p'.

Output Voltage (→DIRECT highlighted)

The triangular type of cursor indicates that all the cursor keys can be used.

High Edge: For periods from 10ms to 10µs; from the default 0.5000V, the output voltage can be changed to any value within its resolution from 88.800mVp-p (full specification does not apply below 888.00mV) to 55.600Vp-p.

Low Edge: For periods from 10ms to 10ns, the output voltage can be changed to any value within its resolution between 88.800mVp-p and 1.1120Vp-p.

The software ensures that the contributors' values remain within their limits. The contributors' values are altered on the screen for each change in output voltage.

14.7.5.3 Output Period/Frequency Editing (→SCOPE or →DIRECT highlighted)

The type of cursor (lines) used for the period or frequency signifies that the value can be adjusted only as a whole value using the ⌃ and ⌄ keys.

The < and > keys are inactive.

Low Edge (50Ω and 1MΩ Loads): From the default 10µs, the period can be raised using the ⌃ key by increments through 20µs, 50µs and so on up to 10ms. Similarly, the ⌄ key will reduce the scaling factor down to 0.1µs. Equivalent frequencies are accessible in the same 1, 2, 5 sequence.

High Edge (1MΩ Load): Periods below 10µs are not available. From the default 10µs, the value can be raised using the ⌃ key by increments through 20µs, 50µs and so on up to 10ms. Equivalent frequencies are accessible in the same 1, 2, 5 sequence.

14.6.6 Using the 9100 Sine Function to Calibrate the Flatness/Bandwidth of a UUT Oscilloscope

14.6.6.1 Introduction

Two types of procedures for amplitude calibration are given:

a. Using the 9100 as a fixed source, where the oscilloscope can be adjusted;

b. Using the 9100 as an adjustable source, reading oscilloscope deviations via the 9100 screen.

14.6.6.2 Interconnections

Caution The BNC trigger and signal cables are clearly identified. Do ***not*** cross-connect these cables between 9100 and UUT oscilloscope — this can damage the trigger input circuitry of certain oscilloscopes.

a. Use the supplied BNC cable marked 'TRIGGER' with ***black*** sleeves (Fluke part no. 630441) to connect the 9100 TRIG OUT socket (angled end) to the UUT Trigger In socket (straight end).

b. Use the supplied BNC cable marked 'SIGNAL' with ***red*** sleeves (Fluke part no. 630442) to connect the 9100 SIG OUT socket (angled end) to the input of the UUT Signal Channel to be calibrated (straight end).

14.7.6.3 UUT Oscilloscope — Pulse Response Calibration using the 9100 as a Fixed Source

The following procedure assumes that the 9100 instrument is in Manual Mode. It is also assumed that the user will be familiar with the methods of editing screen values. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.*

9100 and UUT Oscilloscope Setup

1. **Connections** — Connect the 9100 to the UUT Oscilloscope as in *para 14.7.6.2*, and ensure that both instruments are powered ON and warmed up.
2. **UUT 'Scope** — Select the required function for pulse response calibration.
3. **9100** — Ensure that the 9100 is in Edge Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the soft key at the top right of the screen.

Sequence of Operations at 1kHz

Refer to the table or list of UUT Oscilloscope pulse response calibration points in the *UUT Oscilloscope Manufacturer's Calibration Guide.*

Follow the correct sequence of calibration stages as directed by the guide, and carry out the following operations *(1)* to *(6)* at each stage.

1. **9100** — Set the 9100 Edge Output to the load impedance, period and p-p voltage required for the UUT 'Scope pulse response cal point:
2. **UUT 'Scope**
   - **a.** Select the correct channel for the cal point.
   - **b.** Select the correct range for the cal point.
3. **9100** — Set Output **ON**.
4. **UUT 'Scope**
   - **a.** Adjust the sweep speed and trigger level for a stable display.
   - **b.** Observe and note the resulting (10% to 90%) combined pulse rise/fall time.
   - **c.** Calculate the UUT 'Scope Pulse rise/fall response:

     Using Low Edge; rise/fall time = $\sqrt{(\text{Observed Rise Time}^2 - 1)}$ ns

     Using High Edge; rise/fall time = $\sqrt{(\text{Observed Rise Time}^2 - 10^4)}$ ns
5. **Calibration**
   - **a.** If a calibration adjustment is provided, adjust the UUT's response to be appropriate to the settings on the 9100 screen, as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
   - **b.** If no adjustment is provided on the UUT 'Scope, record its response at the calibration point as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
6. **9100** — Set Output **OFF**.

14.8 Markers Function

14.8.1 Introduction

This sub-section is a guide to the use of the 9100 for generating timing markers for use for time base calibration of oscilloscopes. The following topics are covered:

In this sub-section, we deal with the full range of 'Markers' facilities. For those who require more detailed instructions for manipulating the front panel controls, the DC Voltage function was used as an example for the general familiarization tutorials in *Section 3*.

14.8.2 Auxiliary and Oscilloscope Functions Selection

(Manual Mode selected)

14.8.2.1 'Aux' Key

The Oscilloscope function is an 'Auxiliary' function. The Auxiliary menu screen is viewed by pressing the 'Aux' key at the right of the 'CALIBRATION SYSTEM' panel. Then pressing any one of the right-side screen keys will select a particular aspect of oscilloscope calibration.

14.8.2.2 Default Settings

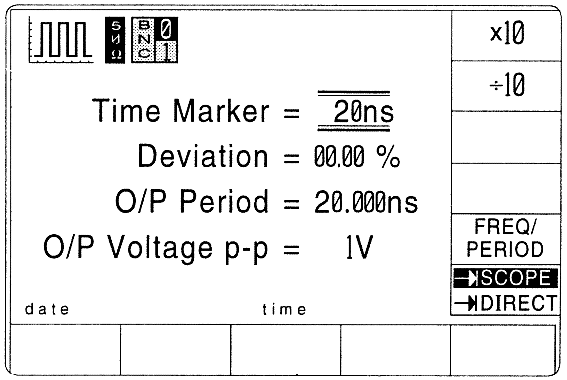
At power-on the system defaults into DC Voltage function. Each time the **'Aux'** key is pressed, the system shows the 'Auxiliary Functions' menu *(Sub-section 14.3).*

14.8.3 Markers Function

The Marker function is included to generate square-wave timing markers (sine wave markers above 112.5MHz) for use in calibrating oscilloscope time bases. The period is variable from 4ns to 5.5s (2ns to 5.5s for Option 600) using the Time Marker interval and Deviation controls.

The  key will select the Markers function.

Whenever the  menu screen is opened, except on recovery from a standby period, it will appear with the following default settings:



Note: In **Markers** function, the **Deviation** operates on the **Time Marker** interval, to modify the **O/P Period**, and ***not*** to modify the O/P Voltage, as in the other functions of the oscilloscope calibration feature.

14.8.4 Screen Keys

14.8.4.1 Bottom Screen Keys

The keys beneath the screen are not used in Markers function.

14.8.4.2 Right Side Screen Keys

A. Digit Edit Facility Keys operate on the value marked by the cursor.

X10	Multiplies the marked value by ten.
÷10	Divides the marked value by ten.
±	Inverts the polarity of the marked value (cursor on Deviation value) .
ZERO	Sets the marked Deviation value to zero.
FREQ/ PERIOD	Where the presentation shows the O/P *period* in the default display, pressing the FREQ/PERIOD 'toggle' screen key will switch to show the O/P *frequency*, with the appropriate calculated numerical frequency value for the previously-displayed period. This control does not affect the Time Marker interval.
⇥SCOPE ⇥DIRECT	With the toggle ⇥SCOPE highlighted, the tab ⇥ key can be used to move the cursor between 'Time Marker' and the Deviation percentage value.
⇥SCOPE ⇥DIRECT	With the toggle ⇥DIRECT highlighted, the cursor transfers to the 'O/P Frequency/Period' value, and can be moved to the O/P Voltage p-p value using the ⇥ key.

14.8.4.2 Continued Overleaf

14.8.4 Screen Keys *(Contd.)*

14.8.4.2 Right Side Screen Keys *(Contd.)*

B. Direct Edit Facility

With ➔SCOPE highlighted, Direct Edit is available only when the cursor is with the 'Deviation' value.

With ➔DIRECT highlighted, Direct Edit is available only for the 'O/P Frequency/Period' value.

Right side screen keys operate on the value in the edit box, and acting in place of the ↵ key, exit from Direct Edit back to Digit Edit; then set the value as evaluated in the box:

i. Deviation Value (➔SCOPE highlighted)

% Evaluates the number in the box in **Deviation Percentage**.

The selected Deviation Percentage value is set into a resolution of four significant digits with two decimal places.

ii. 'O/P Period' Value. (➔DIRECT highlighted)

ns	Evaluates the number in the box in **nanoseconds**.
µs	Evaluates the number in the box in **microseconds**.
ms	Evaluates the number in the box in **milliseconds**.
s	Evaluates the number in the box in **seconds**.

iii. 'O/P Freq' Value. (➔DIRECT highlighted)

Hz	Evaluates the number in the box in **hertz**.
kHz	Evaluates the number in the box in **kilohertz**.
MHz	Evaluates the number in the box in **megahertz**.

Help Available!

User's Handbook Volume 1, Section 3: Editing Tutorials.

14.8.5 Value Editing

14.8.5.1 Elements Contributing to the Output Value

At maximum and minimum output periods/frequencies, the screen settings of the contributors' values (Time Marker and Deviation) are limited by the output period/ frequency itself. For example:

Contributor	Time			Frequency		
	Minimum Output Value		Maximum Output Value	Minimum Output Value	Maximum Output Value	
	Option 250	Option 600	Both Options	Both Options	Option 250	Option 600
Time Marker Interval	5ns	5ns	5s	5s	5ns	5ns
Time Deviation	-20%	-20%	+10%	+10%	-20%	-20%
Output Period/Frequency	4.0000ns	1.6666ns	5.5000s	0.1818Hz	250.00MHz	600.00MHz

Time

Between the output period/frequency limits, the contributors can be adjusted as follows:

a. Time Marker interval in seconds (→|SCOPE highlighted, adjustable sequence: 1,2,5; default 20ns);

b. Percentage Deviation (→|SCOPE highlighted, a maximum range of ±45.00% about the value of (a) at a resolution of four significant digits, with two decimal places; default zero).

c. Output Period/Frequency (→|DIRECT highlighted, adjustable itself or by manipulation of (a) and (b); default 20.000ns).

When the Output Period/frequency value is being adjusted directly, the values of the two contributors are also changed automatically to provide the required Output Voltage value. These changes are shown on the screen as they occur.

Voltage

Between limits, the output voltage can be adjusted as follows:

d. Output Voltage (→|DIRECT highlighted, adjustable sequence: 1,2,5; default 1V).

14.8.5.2 Overleaf →

14.8.5 Value Editing *(Contd.)*

14.8.5.2 Output Frequency/Period Editing

The editing processes follow the same general rules as for editing voltages described in the *User's Handbook, Volume 1, Section 3.*

Tab ⇥ Key and Cursors (→SCOPE highlighted)
Repeatedly pressing this key moves the cursor between the default Time Marker interval and the Deviation. The type of cursor at each position indicates the type of adjustment possible to that value.

Time Marker Interval (→SCOPE highlighted)
The type of cursor (lines) used for the time marker interval signifies that the value can be adjusted only as a whole value using the ⌃ and ⌄ keys. The ‹ and › keys are inactive.

From the default '20ns', the value can be raised using the ⌃ key by increments through 50ns, 100ns, 200ns and so on up to 5s, providing that the deviation value will not take the output period value above 5.5s. Similarly, the ⌄ key will reduce the time marker interval down to:

a. 5ns (Option 250), unless the output period would fall below 4ns; or
b. 2ns (Option 600), unless the output period would fall below 1.6666ns.

Deviation (→SCOPE highlighted)
The triangular type of cursor indicates that all the cursor keys can be used.

From the default 00.00%, the deviation percentage can be changed to any value within its resolution between -45% and +45%, providing that the other contributors do not take the output period value out of its limits. The result of combining the time marker interval and deviation are shown as the value of 'O/P Period'.

Output Period/Frequency (→DIRECT highlighted)
The triangular type of cursor indicates that all the cursor keys can be used.

From the default 20.000ns, the output period can be changed to any value within its resolution between 4ns and 5.5s (between 1.6666ns and 5.5s for Option 600).

The software ensures that the contributors' values remain within their limits. The contributors' values alter on the screen for each change in output frequency or period.

14.8.5.3 Output Voltage Editing (→DIRECT highlighted)

The type of cursor (lines) used for the O/P Voltage signifies that the value can be adjusted only as a whole value using the ⌃ and ⌄ keys. The ‹ and › keys are inactive.

For the full range of Periods/Frequencies; from the default 1V, the output voltage can be changed to 0.5V, 0.2V or 0.1V.

14.8.6 Trigger Timing Relationship

The positive edge of the trigger output, from the 9100 rear panel 'Trig' BNC socket, leads the positive edge of a marker by, 25ns (typically), depending on the period of the markers. This is illustrated in Fig 14.8.6.1:

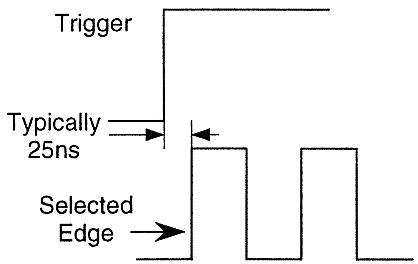


Fig. 14.8.6.1 Marker Function — Trigger Timing Relationship

14.8.7 Using the 9100 Markers Function to Calibrate the Time Base of a UUT Oscilloscope

14.8.7.1 Introduction

Two types of procedures for amplitude calibration are given:

a. Using the 9100 as a fixed source, where the oscilloscope can be adjusted;
b. Using the 9100 as an adjustable source, reading oscilloscope deviations via the 9100 screen.

14.8.7.2 Interconnections

Caution The BNC trigger and signal cables are clearly identified. Do ***not*** cross-connect these cables between 9100 and UUT oscilloscope — this can damage the trigger input circuitry of certain oscilloscopes.

a. Use the supplied BNC cable marked 'TRIGGER' with ***black*** sleeves (Fluke part no. 630441) to connect the 9100 TRIG OUT socket (angled end) to the UUT Trigger In socket (straight end).

b. Use the supplied BNC cable marked 'SIGNAL' with ***red*** sleeves (Fluke part no. 630442) to connect the 9100 SIG OUT socket (angled end) to the input of the UUT Signal Channel to be calibrated (straight end).

14.8.7.3 UUT Oscilloscope — Time Base Calibration using the 9100 as a Fixed Source

The following procedure assumes that the 9100 instrument is in Manual Mode. It is also assumed that the user will be familiar with the methods of editing screen values. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.*

9100 and UUT Oscilloscope Setup

1. **Connections** — Connect the 9100 to the UUT Oscilloscope as in *para 14.8.7.2*, and ensure that both instruments are powered ON and warmed up.
2. **UUT 'Scope** — Select the required function for time base calibration.
3. **9100** — Ensure that the 9100 is in Markers Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the ⎍⎍ soft key on the right of the screen.

Sequence of Operations at 1kHz

Refer to the table or list of UUT Oscilloscope time base calibration points in the *UUT Oscilloscope Manufacturer's Calibration Guide.*

Follow the correct sequence of calibration stages as directed by the guide, and carry out the following operations *(1)* to *(6)* at each stage.

1. **9100** — Set the 9100 Markers Output to the required frequency and p-p voltage for the UUT 'Scope time base cal point.
2. **UUT 'Scope**
   - **a.** Select the correct channel for the cal point.
   - **b.** Select the correct range for the cal point.
3. **9100** — Set Output **ON**.
4. **UUT 'Scope**
   - **a.** Adjust the sweep speed and trigger level for a stable display.
   - **b.** Observe and note the accuracy of marker alignment, indicating any misadjustment in the UUT's time base speed or linearity.
5. **Calibration**
   - **a.** If calibration adjustments for time base speed and linearity provided, adjust the UUT's time base to be appropriate to the settings on the 9100 screen, as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
   - **b.** If no adjustment is provided on the UUT 'Scope, record the timebase condition at the calibration point as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
6. **9100** — Set Output **OFF**.

14.8.7.4 UUT Oscilloscope — Time Base Calibration using the 9100 as an Adjustable Source

The following procedure assumes that the 9100 instrument is in Manual Mode. It is also assumed that the user will be familiar with the methods of editing screen values. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.*

9100 and UUT Oscilloscope Setup

1. **Connections** Connect the 9100 to the UUT Oscilloscope as in *para 14.8.7.2*, and ensure that both instruments are powered ON and warmed up.
2. **UUT 'Scope** Select the required function for time base calibration.
3. **9100** Ensure that the 9100 is in Markers Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the soft key on the right of the screen.

Sequence of Operations

Refer to the table or list of UUT Oscilloscope time base calibration points in the *UUT Oscilloscope Manufacturer's Calibration Guide.*

Follow the correct sequence of calibration stages as directed by the guide, and carry out the following operations *(1)* to *(6)* at each stage.

1. **9100** Set the 9100 Markers Output to the required frequency and p-p voltage for the UUT 'Scope time base cal point.
2. **UUT 'Scope**
   - **a.** Select the correct channel for the cal point.
   - **b.** Select the correct range for the cal point.
3. **9100** Set Output **ON**.
4. **UUT 'Scope**
   - **a.** Adjust the sweep speed and trigger level for a stable display.
   - **b.** Observe and note the accuracy of marker alignment, indicating any misadjustment in the UUT's time base speed or linearity.
5. **Calibration**
   - **a.** Use the 9100 Deviation control to slew the 9100 Output frequency until the UUT's response is appropriate to the 9100 settings, as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
   - **b.** Record the 9100 screen output voltage and frequency as detailed in the *UUT Oscilloscope Manufacturer's Calibration Guide.*
6. **9100** Set Output **OFF**.

Section 15 Using the Options 250 and 600 — Procedure Mode

15.1 About Section 15

Descriptions in *Section 5* of the *9100 User's Handbook Volume 1* provide a general guide through the phases of using a procedure card in the 9100, to calibrate a manually-operated measuring instrument. These includes safety features, use of the tracker ball, printing and saving results; Procedure Mode selection, and access to its operation. Finally *Section 5* gives a brief introduction to specific elements of procedure.

The treatment of *Section 5* in *Volume 1* will be sufficient to introduce new users to the operation of procedure cards. There is therefore no need for further description.

For a guide to using front panel controls in Manual Mode for Option 250 or 600, please turn to *Section 14*.

Section 16: 9100 Options 250 and 600 System Application via the IEEE-488 Interface

16.1 About Section 16

In *Volume 2 of the 9100 User's Handbook, Section 6* describes the environment in which the Model 9100 will operate in remote applications, using the SCPI (Standard Commands for Programmable Instruments) language, within the IEEE-488.1 remote interface. Section 6 shows how the 9100 adopts the IEEE-488.2 message-exchange model and reporting structure, and defines the SCPI commands and syntax used to control the standard functions of the 9100.

In this *Volume 3 of the 9100 User's Handbook*, this *Section 16* merely provides the additional codes necessary to control the extra functions incorporated into the Oscilloscope Calibration Feature of the 9100: Options 250 and 600, with some repetition of introductory material from Volume 2, Section 6; in order to avoid excessive cross-referring.

16.2 9100 Options 250 and 600 — SCPI Language - Commands and Syntax

The command subsystems are placed in alphabetical order.

16.2.1 Introduction

This Sub-Section lists and describes the set of SCPI remote commands needed to operate Options 250 and 600 of the 9100.

To provide familiar formatting for users who have previously used the SCPI reference documentation, the command descriptions are dealt with in a similar manner. In particular, each sub-system's documentation starts with a short description, followed by a table showing the complete set of commands in the sub-system; finally the effects of individual keywords and parameters are described. Some extra identification of style and syntax is detailed in *paras 16.2.1.1 and 16.2.1.2* to clarify shorthand meanings.

16.2.1.1 SCPI Syntax and Styles

Where possible the syntax and styles used in this section follow those defined by the SCPI consortium. The commands on the following pages are broken into three columns; the KEYWORD, the PARAMETER FORM, and any NOTES.

The KEYWORD column provides the name of the command. The actual command consists of one or more keywords since SCPI commands are based on a hierarchical structure, also known as the tree system.

Square brackets ([ ]) are used to enclose a **keyword** that is optional when programming the command; that is, the 9100 will process the command to have the same effect whether the optional node is omitted by the programmer or not.

Letter case in tables is used to differentiate between the accepted shortform (upper case) and the long form (upper and lower case).

The PARAMETER FORM column indicates the number and order of parameter in a command and their legal value. Parameter types are distinguished by enclosing the type in angle brackets (< >). If **parameter** form is enclosed by square brackets ([ ]) these are then optional (care must be taken to ensure that optional parameters are consistent with the intention of the associated keywords). The vertical bar (|) can be read as "or" and is used to separate alternative parameter options.

16.2.1.2 Legend

<DNPD> = Decimal Numeric Program Data, used to identify numerical information needed to set controls to required values. The numbers should be in '*Nrf*' form as described in the IEEE 488.2 Standard Specification.

<CPD> = Character Program Data. This normally represents alternative groups of unique 'literate' parameter names, available for the same keyword. In the notation the set of alternatives will follow the <CPD> in the Parameter Form column of the Sub-System table, enclosed in a pair of braces. For example, in the OUTPut sub-system, the compound command header (keyword): `OUTPut:COMPensation` is followed by the parameter form `<CPD>{ON|OFF|0|1}`. The `<CPD>` gives the denomination of 'Character' program data, and `{ON|OFF|0|1}` gives the actual characters to be used to command each unique parameter.

<SPD> = String Program Data. This is a string of variable literate characters which will be recognized by the internal 9100 software. They are used for such inputs as passwords, serial numbers and date/time.

? = Indicate query commands with no associated command form, and no attached parameters.
(for example: `CALibration:TRIGger?`).

(?) = All commands which may include parameters in the command form, but also have an additional query form without parameters.
(for example: `OUTPut:COMPensation(?) <CPD>{HIGHi|LOWi}`)
The response from this query will be one of the parameters listed in association with the command.

16.2.2 CALibration Subsystem

This subsystem is used to calibrate the functions and hardware ranges of the 9100. This will correct for any system errors due to drift or ageing effects.

Before any calibration can take place, two security levels must be set. First, there is a switch on the 9100 itself that must be set to CAL ENABLE. Having done this, the calibration password command must be sent.

Once entered into Calibration mode, the commands present in the table at *16.2.2.1* are enabled. This is the same as that in the *User's Handbook Volume 2, paras 6.6.2.1*, with the addition of the new Options 250 and 600 HF VCO linearity command LTARget.

16.2.2.1 CALibration Subsystem Table

Keyword	Parameter Form	Notes
`CALibration`		
`:SECure`		
`:PASSword`	`<SPD>`	
`:EXIT`	`[<SPD>,<CPD>{PRD7|PRD14|PRD30|PRD60}]`	
`:TARGet`	`<DNPD>,<DNPD>[,<DNPD>]`	
`:TRIGger?`		`[query only]`
`:SPECial?`		`[query only]`
`:CJUNction?`	`<DNPD>`	
`:LTARget`	**`<DNPD>,<DNPD>,<DNPD>`**	**`Options 250 and 600 only`**

16.2.2.2 CAL:LTAR <DNPD>,<DNPD>,<DNPD>

Purpose

For the Option 250 or 600 HF VCO linearity calibration operation, the required calibration point (factor) must be targetted. This command permits the user to define three parameters associated with the calibration point in the current operation:

- The first <DNPD> is an integer from 1 to 6, allocated to the calibration point at which calibration is intended. This will be one of those listed on the (manual) Calibration mode screen, in 'Target State', for Option 250 or 600 HF VCO linearity calibration.
- The second <DNPD> is a value which will determine the required *hardware range (amplitude)* of the 9100 for that point.
- The third <DNPD> is a value which will determine the required *hardware range (frequency)* of the 9100 for that point.

Once a target has been set, the 9100 adjustment is restricted to values within the selected hardware voltage span and frequency band. In order to release this restriction, one of the following commands must be sent: `TRIG?`, `EXIT` or a new `TARG` or `LTAR` command. Any error which occurs will also release the restriction.

16.2.3 OUTPut Subsystem

This subsystem is not affected by the addition of Option 250 or 600.

16.2.4 SOURce Subsystem

This subsystem is used to select the sources of 9100 output .

The standard list of SOURce commands is given in *9100 User's Handbook Volume 2, paras 6.6.4.1.*
The additional Options 250 and 600 SOURce commands are shown in the table at *16.2.4.1.*

16.2.4.1 SOURce Subsystem Table

Keyword	Parameter Form	Notes
[SOURce]		
:SPERiod[:CW|FIX](?)	<DNPD>	
:SCOPe		
[:SHAPe](?)	<CPD>{DC|SINusoid|SQUare|EDGE|MARKer}	
UUT_Z(?)	<DNPD>	
TRANsition(?)	<CPD>{RISing|FALLing}	

16.2.4.2 **[SOUR]:SPER[:CW|FIX](?) <DNPD>**

Purpose
This command is used to set the period parameter in association with either 'Edge' or 'Marker' function. It is similar to the FREQuency command, but can be used **only** in conjunction with the SCOPe command, within constraints imposed by the UUT_Z <DNPD> command.

For Example:

An 'Edge' function output period can be programmed by:

SCOP EDGE;:VOLT <DNPD>;:**SPER <DNPD>**;:SCOP:UUT_Z 1E6;TRAN RIS

A 'Marker' function output period can be programmed by:

SCOP MARK;:VOLT 1.000;**:SPER <DNPD>**

<DNPD>
The 'decimal numeric program data' is a number which sets the required output period of the selected operation, expressed in units of seconds. It will automatically choose the 'best' hardware range for the defined frequency of output.

For details of local operation and parameter limitations, refer to *Section 14*, *Sub-Sections 14.7* (Edge) *and 14.8* (Markers).

Response to Query Version
The instrument will return the present output period value for the selected operation, dependent upon the EDGE or MARK parameter implicit, or included, in the most-recent SCOP command, and the most-recent VOLT command. The returned number will be in standard scientific format (for example: 50µs would be returned as 50E-6).

For Example:

If in Edge or Markers Function, the period is returned by the query: **:SPER?**

16.2.4.3 `[SOUR]:SCOP[:SHAP](?)` `<CPD>{DC|SIN|SQU|EDGE|MARK}`

Purpose
Selects the Option 250/600 Oscilloscope Calibration Feature, and the output waveshape (function) within Option 250 or 600.

<CPD>
The 'character program data' determines the waveshape of the output signal. It can be chosen from five alternatives:

DC Determines that subsequent selection of VOLT will choose DC hardware for the output voltage. Voltage levels will be set subsequently using the VOLT <DNPD> command, within constraints imposed by the UUT_Z <DNPD> command.

Examples:

To select a DC source of -2.78V (the largest value available into a load of 50Ω):

```
SCOP DC;:VOLT -2.78;:SCOP:UUT_Z 50
```

To select a DC source of +10.5V (only available into a load of 1MΩ):

```
SCOP DC;:VOLT +10.5;:SCOP:UUT_Z 1E6
```

To select a DC source of +110.5V (above the default voltage safety threshold) with output already on:

```
SCOP DC;:VOLT +110.5;:SCOP:UUT_Z 1E6;:OUTP ON
```

SINusoid Subsequent selection of VOLT will choose AC hardware for the output voltage. Voltage p-p values will be set using the VOLT <DNPD> command, and frequency values using the FREQ <DNPD> command; both within constraints imposed by the UUT_Z <DNPD> command.

Examples:

To select a sinusoidal voltage source of 5.56V p-p (the largest value available into a load of 50Ω) at 100MHz:

```
SCOP SIN;:VOLT 5.56;:FREQ 1E7;:SCOP:UUT_Z 50
```

To select a sinusoidal voltage source of 20.3V p-p (only available into a load of 1MΩ) at 40kHz:

```
SCOP SIN;:VOLT 20.3;:FREQ 40E3;:SCOP:UUT_Z 1E6
```

SQUare Selects a square wave output, and determines that the frequency will be 1kHz with a mark/period ratio of 0.5. Subsequent selection of VOLT will choose AC hardware for the output voltage. Voltage p-p values will be set using the VOLT <DNPD> command, within constraints imposed by both the UUT_Z <DNPD> command and the programmed frequency.

Examples:

To select a square voltage source of 3.336V p-p (the largest value available into a load of 50Ω) at 1kHz:

```
SCOP SQU;:VOLT 3.336;:SCOP:UUT_Z 50
```

To select a square voltage source of 131.5V p-p (only available into a load of 1MΩ) at 1kHz:

```
SCOP SQU;:VOLT 131.5;:SCOP:UUT_Z 1E6
```

16.2.4.3 [SOUR]:SCOP[:SHAP](?) <CPD>{DC|SIN|SQU|EDGE|MARK} *(Contd.)*

EDGE Selects a pulsed voltage whose edge *durations* are determined by the UUT_Z <DNPD> command, and *directions* by the TRANsition <CPD> command, also determining that the mark/period ratio will be 0.5. Subsequent selection of VOLT will choose AC hardware for the output voltage. Voltage p-p values will be set using the VOLT <DNPD> command, and either Frequency or Period values using the FREQ <DNPD> or SPER <DNPD> command; both within constraints imposed by the UUT_Z <DNPD> command.

Examples:

To select a falling edge source of 1.112V p-p (the largest value available into a load of 50Ω) at 100MHz:

```
SCOP EDGE;:VOLT 1.112;:FREQ 10E6;:SCOP:UUT_Z 50;TRAN FALL
```

To select a rising edge source of 66.72V p-p (only available into a load of 1MΩ) at a period of 10μs:

```
SCOP EDGE;:VOLT 55.6;:SPER 10E-6;:SCOP:UUT_Z 1E6;TRAN RIS
```

MARKer Up to 112.5MHz, selects a pulsed voltage and determines that the mark/period ratio will be 0.5. Between 112.5MHz and 250MHz (600MHz for Option 600), selects a sinusoidal voltage. Subsequent selection of VOLT will choose AC hardware for the output voltage. Voltage p-p values will be set by the VOLT <DNPD> command, and frequencies by the FREQ <DNPD> command. Because this function is designed to operate only into 50Ω loads, the UUT_Z command is not required.

Examples:

To select a 10ns marker source of 1.00V p-p:

```
SCOP MARK;:VOLT 1.00;:FREQ 100E6
```

or, using the alternative period definition:

```
SCOP MARK;:VOLT 1.00;:SPER 10E-9
```

For details of local operation and parameter limitations, refer to *Section 14*, *Sub-Sections 14.4* (Square Function), *14.5* (DC Function), *14.6* (Sine Function), *14.7* (Edge Function) *or 4.18* (Markers Function).

Response to Query Version

The 9100 will return the appropriate <CPD> from the selection {DC|SIN|SQU|EDGE|MARK} which represents the present source 'shape'.

16.2.4.4 `[SOUR]:SCOP:UUT_Z(?)` `<DNPD>`

Purpose
This command selects the 50Ω or 1MΩ scope impedance level.

`<DNPD>`
The 'decimal numeric program data' is one of two numbers, expressed in units of Ohms. Numbers ≤55 will be rounded to '50' and those >55 will be rounded to '1E6'

For details of local operation and parameter limitations, refer to *Section 14*, *Sub-Sections 14.4* (Square Function), *14.5* (DC Function), *14.6* (Sine Function), *14.7* (Edge Function) *or 4.18* (Markers Function).

Response to Query Version
The instrument will return the present setting: '50' or '1E6'.

16.2.4.5 `[SOUR]:SCOP:TRAN(?)` `<CPD>{RISing|FALLing}`

Purpose
This command applies only to the Edge function. It selects the direction of the edge which follows the trigger.

`<CPD>`
'RIS' sets a positive-going edge, 'FALL' sets a negative-going edge.

For details of local operation and parameter limitations, refer to *Section 14*, *Sub-Section 14.7* (Edge Function).

Response to Query Version
The instrument will return the present edge setting: 'RIS' or 'FALL'.

SECTION 17 Options 250 and 600 SPECIFICATIONS

17.1 General

17.1.1 Line Power Supply

Source: Takes power internally from the 9100 Instrument

Consumption: Adds 50VA to the Model 9100 consumption.

Power Fuses: This option does not alter the fusing requirements of the 9100.

17.1.2 Mechanical (Option 250 or 600 Module)

Dimensions: The module is fitted internally within the 9100, and does not affect the overall dimensions.

Weight: Adds 1.1lbs (0.5kg) to the weight of the Model 9100.

17.1.3 SAFETY:

Refer to 9100 User's Handbook Volume 2, Section 7, page 7-1

17.1.4 Environmental Conditions

Temperature, Warm-up Time, Maximum Relative Humidity (non-condensing), Altitude, Shock, Vibration, Enclosure and EMC:
Refer to 9100 User's Handbook Volume 2, Section 7, page 7-1

17.1.5 The Meaning of 'Accuracy' when used in the Function Accuracy Tables

Accuracy includes long-term stability, temperature coefficient, linearity, load and line regulation and the traceability of factory and National calibration standards. In general, nothing further needs to be added to determine the Test Uncertainty Ratio over the instrument under test.

During manufacture and at Fluke Service Centers, the precision 50Ω co-axial signal lead (part no. 630442) is used as connection during Options 250 and 600 calibration and verification of Sine function.

Replacement cables or terminators can be purchased (part nos. given below) without the need to recalibrate.

Other suppliers' 50Ω precision cables and precision terminators can be used when the Sine function is being used to calibrate oscilloscopes, ***providing that they were also used during the most-recent Option 250 or 600 calibration of Sine function***.

17.1.6 Peak Terminal Voltages and Currents

	Peak Volts to Ground	Peak Current
SIG BNC Socket	140V	60mA
TRIG BNC Socket	3V	60mA

CAUTION:
Damage will result by applying a voltage >3Vpk from an external source across the inner and outer conductors.
Internal trips may operate when the live SIG OUT inner and outer conductors are shorted together.

17.2 Products Provided with the Option 250 or 600 to the Model 9100

630441	BNC-BNC 50Ω Co-axial Trigger lead.
630442	Precision BNC-BNC 50Ω Co-axial Signal lead.
630444	2 x BNC-BNC 50Ω Co-axial Trigger leads for use with T Adaptor.
630445	BNC 50Ω T Adaptor.
630446	BNC 50Ω Through Terminator.
630447	Precision BNC 50Ω HF Through Terminator.

17.3 Square Function Specifications

17.3.1 Square Function Accuracy

Load Impedance	Voltage/Div Scaling Factor (pk-to-pk)	Scaling Factor Sequence	Multiplier Range Integers	Voltage Deviation % Setting	Output Voltage Range (pk-to-pk)	Voltage Accuracy 1Year % of Output Tcal ±5°C [2]	Output Frequency	Frequency Accuracy (ppm of output) Basic	Option 100
50Ω	1mV/div to 2V/div	1, 2, 5	1 to 10	±11.20	4.4400mV to 3.3360V	±0.25%	1kHz	25	0.25
1MΩ	1mV/div to 20V/div	1, 2, 5	1 to 10	±11.20	4.4400mV to 133.44V	±0.25%	1kHz	25	0.25

Other Square Function Specifications

Symmetry:	50%
Polarity:	Positive from ground
Rise/Fall time:	5μs
Aberration:	<1% in first 30μs

17.4 DC Function Specifications

17.4.1 DC Function Accuracy

Load Impedance	Voltage/Div Scaling Factor	Scaling Factor Sequence	Multiplier Range Integers	Voltage Deviation % Setting	Output DC Voltage Range	Voltage Accuracy 1Year % of Output + Floor Tcal ±5°C [2]
50Ω	+1mV/div to +2V/div	1, 2, 5	1 to 10	±11.20	+4.4400mV to +2.7800V	±0.2% + 40μV
50Ω	-1mV/div to -2V/div	1, 2, 5	1 to 10	±11.20	-4.4400mV to -2.7800V	±0.2% + 40μV
1MΩ	+1mV/div to +20V/div	1, 2, 5	1 to 10	±11.20	+4.4400mV to +133.44V	±0.2% + 40μV
1MΩ	-1mV/div to -20V/div	1, 2, 5	1 to 10	±11.20	-4.4400mV to -133.44V	±0.2% + 40μV

NOTES: [2] Tcal = temperature at calibration. Factory calibration temperature = 23°C

17.5 Sine Function Specifications [1]

17.5.1 Sine Function Voltage Accuracy

Load Impedance	Output Frequency	Voltage/Div Scaling Factor (pk-to-pk)	Scaling Factor Sequence	Multiplier Range Integers	Voltage Deviation % Setting	Output Voltage Range (pk-to-pk)	1Year Tcal ±5°C [2] (% of Output)			
							Voltage Accuracy 10Hz to 49.999kHz ‡	Flatness 50.001kHz to 100.00MHz Relative to 50kHz	Flatness 100.01 MHz to 250.00MHz Relative to 50kHz	Flatness 250.01 MHz to 600.00MHz Relative to 50kHz
1MΩ	10Hz to 49.999kHz	1mV/div to 20V/div	1, 2, 5	1 to 10	±11.20	4.4400mV to 133.44V	±0.25	---	---	---
50Ω	10Hz to 49.999kHz	1mV/div to 2V/div	1, 2, 5	1 to 10	±11.20	4.4400mV to 5.5600V	±0.25	---	---	---
50Ω	50kHz to 250MHz	1mV/div to 2V/div	1, 2, 5	1 to 10	±11.20	10.656mV to 5.5600V	±1.5	±1.5 †	±3 † §	---
50Ω	250MHz to 600MHz	1mV/div to 2V/div	1, 2, 5	1 to 10	±11.20	10.656mV to 3.3360V*	---	---	---	±5 † §

† = Relative to Standards.
‡ = Includes the uncertainty of the precision in-line terminator (part no. 630447) when used.
§ = Into load VSWR 1.2 to 1.4 add 1% of output, into VSWR 1.4 to 1.6 add 2% of output.
* = < 5.5600V is available, but unspecified.

17.5.2 Sine Function Frequency Accuracy

All Frequencies:	
Basic	25ppm
With Option 100	0.25ppm

Other Sine Function Specifications

Purity:	**2nd Harmonic**	< -35dBc [3]
	3rd Harmonic	< -40dBc
	Spurious Signals	< -40dBc

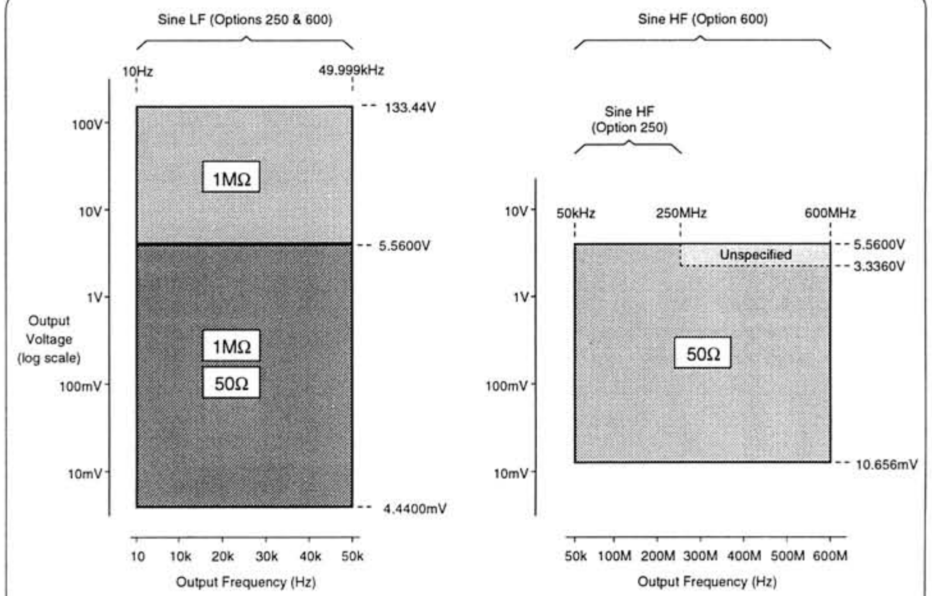


Fig. 17.4.1 Sine Function — LF & HF Volt-Hz Profiles

NOTES: [1] Specifications are valid only when the output signal is connected via the precision signal cable (Fluke part no. 630442) into a VSWR <1.6, and subject to the peak current limits stated on page 7-1.

[2] Tcal = temperature at calibration. Factory calibration temperature = 23°C

[3] <-35dBc typical, -28dBc worst case

17.6 Edge Function Specifications [1]

17.6.1 Edge Function Accuracy

Load Impedance	Voltage/Div Scaling Factor (pk-to-pk)	Scaling Factor Sequence	Multiplier Range Integers	Voltage Deviation % Setting	Output Voltage Range (pk-to-pk)	Voltage Accuracy ‡ 1Year % of Output Tcal ±5°C [2]	Output Period (Fixed Values in 1, 2, 5 sequence)	Rise/Fall Time Between 10% & 90% Selectable Rise	Fall
Low Edge: 50Ω	20mV/div to 500mV/div	1, 2, 5	1 to 10	±11.20	88.800mV to 1.1120V	±3%	100ns to 10ms	≤ 1ns	≤ 1ns
High Edge: 1MΩ	20mV/div to 20V/div ♣	1, 2, 5	1 to 10	±11.20	888.00mV to 55.600V ♣	±3%	10μs to 10ms	≤ 100ns	---

♣ = Output Voltage extends from 888.00mV down to 88.800mV (unspecified).
‡ = Includes the uncertainty of the precision in-line terminator (part no. 630447) when used.

17.6.2 Edge Function Period Accuracy

Basic	25ppm
With Option 100	0.25ppm

Other Edge Function Specifications

Symmetry:	50%
Polarity:	'Rise' selected: from a negative potential to ground. 'Fall' selected: from a positive potential to ground.
Low Edge Aberration:	in first 10ns: ±2% of signal pk-pk ampliude, or 10mV, whichever is the greater.
High Edge Aberration:	in first 500ns: ±2% of signal pk-pk ampliude, or 50mV, whichever is the greater.
Low Edge Pulse-top Flatness:	after first 10ns: ±0.5%
High Edge Pulse-top Flatness:	after first 500ns: ±1%

NOTES: [1] Specifications are valid only when the output signal is connected via the precision signal cable (Fluke part no. 630442) or similar cable of similar length.
[2] Tcal = temperature at calibration. Factory calibration temperature = 23°C

17.7 Markers Function Specifications

17.7.1 Markers Function Accuracy

Bandwidth Option	Load Impedance Factor	Time/Div Scaling Sequence	Scaling Factor % Setting	Time Deviation Range ♦	Output Time/Div Basic	Period Accuracy (ppm of Output Period) Option 100	(pk-pk)	Output Voltage Values
250	50Ω	4ns/div to 5s/div	1, 2, 5	±45	4.0000ns to 5.5000s	25	0.25	0.1V, 0.2V, 0.5V, 1V
600	50Ω	2ns/div to 5s/div	1, 2, 5	±45	2.0000ns to 5.5000s	25	0.25	0.1V, 0.2V, 0.5V, 1V

♦ = Max. and Min. values place upper and lower limits on Multiplier Range and Time Deviation.

Other Markers Function Specifications

Waveshape:	Period ≤ 8.8888ns:	Sine
	Period ≥ 8.8889ns:	Square

NOTES: [2] Tcal = temperature at calibration. Factory calibration temperature = 23°C

17.8 Trigger Out Specifications

17.8.1 Rising Edge — 1V into 50Ω

Function	**Trigger Repetition Rate** (Signal Freq = f_{out}) *or* **Trigger Period** Signal Period = (τ_{out})		Trig Out Lead ♠ Typical Delay
	Option 250	**Option 600**	
MARKERS			
4.0000ns to 89.293ns	$(\tau_{out}) \times 32$	---	
2.0000ns to 89.293ns	---	$(\tau_{out}) \times 64$	
89.294ns to 5.5000s	(τ_{out})	(τ_{out})	25ns
LOW EDGE			
100.00ns to 10.000ms	τ_{out}	τ_{out}	25ns
HIGH EDGE			
10.000µs to 10.000ms	τ_{out}	τ_{out}	300ns
SINE			
10.000Hz to 11.199MHz	f_{out}	f_{out}	
11.200MHz to 250.00MHz	$f_{out} / 32$	---	
11.200MHz to 600.00MHz	---	$f_{out} / 64$	
SQUARE (1kHz)	f_{out}	f_{out}	
DC	64Hz Nominal	64Hz Nominal	

♠ = Valid only when the TRIG OUT is connected via the special trigger cable (Fluke part no. 630441).

Section 18 Model 9100 Options 250 and 600 — Oscilloscope Calibration Feature — Routine Maintenance and Test

18.1 About Section 18

The *9100 User's Handbook Volume 2, Section 8,* gives first-level procedures for maintaining a Model 9100, performing the Selftest operations and dealing with their results. This includes recommending maintenance intervals, methods and parts, and detailing the routine maintenance procedures. This Section 18 can add little to this information in respect of Options 250 and 600, except to provide the additional error codes which may be generated as a result of selftests.

18.2 9100 Options 250 and 600 Routine Maintenance and Repair.

No items are required, additional to those described in the *9100 User's Handbook Volume 2, Section 8.*

18.3 Model 9100 Options 250 and 600 Test and Selftest

Although both 'Fast' and 'Full' Selftests now include checks of Option 250 or 600, no further descriptions of operator actions are required, additional to those described in the *9100 User's Handbook Volume 2, Section 8.*

Selftest results may generate error codes related to Options 250 and 600, and these are attached at *Appendix A* to this section.

Error Reporting Subsystem - Additional Codes for Options 250 and 600

Note to users: *For the sake of completeness, this appendix collects together the additional error codes which might be generated either on the instrument front panel, or via the IEEE 488 system bus, as a result of fitting Option 250 or 600.*

18.A.1 Error Detection

All errors which cannot be recovered without the user's knowledge, result in some system action to inform the user via a message, and where possible restore the system to an operational condition. Errors are classified by the method with which they are handled. Recoverable errors report the error and then continue. System errors which cannot be recovered cause the system to reset via the Power-on state to a 'System Trip' error report state, from which a 'resume' may clear the error, but generally such messages are caused by hardware or software faults, which require user action.

18.A.2 Error Messages

18.A.2.1 System Trip Errors

For all system trip errors, the error condition is reported only via the front panel. The error will pull the processor reset line to restart the system as at power-on. The screen will display a message indicating that there has been a system trip error and thus the processor has been reset. Having removed any external errors, a user may continue by use of the 'resume' key, or from power on, and initiate repair if the fault persists.

The following additional Option 250/600 error number will be displayed together with its fault description:

```
9513 - UNEXPECTED High Edge overload
```

ALWAYS: record the total message content for possible use by the Service Center.

18.A.2.2 Recoverable Errors

18.A.2.2.1 Type of Errors

These consist of **Command** Errors, **Execution** Errors, **Query** Errors and **Device-Dependent** Errors. Command, Query and Execution Errors are generated due to incorrect remote programming. Device-Dependent Errors can be generated by manual as well as remote operation. Each of the reportable errors is identified by a code number.

18.A.2.2.2 Error Reporting

In response to a bus or a keyboard error, there are certain categories of error reporting. Primarily, the error will be reported to the original source of the error, but in some cases will be reported to both local and remote operators. Locally, the error will be displayed on the front-panel screen; remotely, it will set the relevant ESR bit, and add the error to the Error Queue.

Note about the ERROR Queue (accessible via the IEEE-488 Interface)
The Error Queue is a sequential memory stack. Each reportable error has been given a listed number and explanatory message, which are entered into the error queue as the error occurs. The queue is read destructively as a First-In/First-Out stack, using the query command SYSTem ERRor? to obtain a code number and message.

Repeated use of the query SYSTem ERRor? will read successive Device-Dependent, Command and Execution errors until the queue is empty, when the 'Empty' message (`0, "No error"`) will be returned.

It would be good practice to repeatedly read the Error Queue until the 'Empty' message is returned.

The common command *CLS clears the queue.

18.A.2.2.3 Additional Option 250/600 Command Errors (CME)

(Remote operation only)

None added.

18.A.2.2.4 Additional Option 250/600 Execution Errors (EXE)

(Remote operation only)

None added

18.A.2.2.5 Additional Option 250/600 Query Errors (QYE)

(Remote operation only)

None added

ALWAYS: record the total message content for possible use by the Service Center.

18.A.2.2.6 Device-Dependent Errors (DDE)

A Device-Dependent Error is generated if the device detects an internal operating fault (eg. during self-test). The DDE bit (3) is set *true* in the Standard-defined Event Status Byte, and the error code number is appended to the Error queue. The error description appears on the display, remaining visible until the next key-press or remote command.

Errors are reported by the mechanisms described in the *9100 User's Handbook, Volume 1, Section 6, Sub-section 6.5*, which deals with status reporting.

18.A.2.2.7 Additional Option 250/600 Device-Dependent Errors, Reported only Locally on the Front Panel Screen

The list of added errors for local operations, which are not reported to the remote operator, is given below. Note that the error *number* will not be presented on the screen

```
-7020,"New string contains illegal characters or values"

-9055,"Only a restricted setting allowed"
-9056,"No frequency change allowed"
-9057,"Time marker period too big"
-9058,"Time marker period too small"
-9059,"Invalid no. of divisions"
-9060,"Invalid V/div value"
-9061,"Illegal V/div, no. of div's combination"
-9062,"-ve edge unavailable with 1MΩ load"
-9063,"Frequency too big for 1MΩ load"
-9064,"Amplitude too big for 50Ω load"
-9065,"Frequency too big for present amplitude"
-9066,"Entered number exceeds limits"
-9067,"Search procedure - NO test point"
-9068,"Search procedure - Function ID Expected"
```

18.A.2.2.8 Additional Option 250/600 Device-Dependent Errors, Reported only Remotely via the IEEE-488 Interface

None added

18.A.2.2.9 Additional Option 250/600 Device-Dependent Errors, Reported both Locally and Remotely

Errors are reported both on the front panel screen and via the IEEE-488 interface. Note that the locally-presented error message will not include the error *number*.

General

```
1012,"Overload of high edge"
```

Calibration: None added

Characterization: None added

DAC Compensation: None added

Configuration: None added

ALWAYS: record the total message content for possible use by the Service Center.

Section 19 Verifying the Model 9100 Options 250 and 600 Specifications

19.1 About Section 19

Section 19 introduces the verification of Model 9100 Options 250 and 600 performance, including the issue of traceability and a verification procedure.

19.2 Need for Verification

19.2.1 Factory Calibration and Traceability

Factory calibration of the Model 9100, with Option 250 or 600 installed, ensures full traceability up to and including National Standards. Its traceable accuracy figures are quoted in the specifications given in *Section 17*, and all relate to a 1-year calibration interval These figures include all calibration uncertainties, including those of National Standards, and therefore constitute absolute accuracies.

19.2.2 Verification on Receipt from the Factory

Each 9100 is despatched from Fluke with a Certificate of Calibration, which gives detailed results of its pre-shipment performance. However, organizations may wish to confim that all instruments perform within published specifications, on receipt from their manufacturers.

Such verification is only possible, however, if the user's organization possesses suitable standards equipment, of the necessary traceable accuracy. Without these standards, users may rely on an external support organization for verification, probably also using these organizations to recalibrate the unit at appropriate intervals.

19.2.3 Verification after User-Calibration

Calibration against standards, as detailed in *Section 20* of this handbook, covers only the possible adjustments used to place corrections in its calibration memory. Pre-calibration and post-calibration performance at each adjustment point can be assessed as part of the adjustment procedure. However, to cover all the required points, the procedure in this section should be used to verify pre- and post-calibration performance.

19.3 Equipment Requirements

As stated earlier, the standards required to verify that Option 250 or 600 is within its published specifications must possess the necessary traceable accuracy. The ISO10012-1 guidance generally accepts a minimum test uncertainty ratio (the ratio between the absolute accuracy of the standard used to verify the Option at a verification point, and the accuracy of the Option at that point) of 3:1, which must apply at all points being used to verify the Option's accuracy.

Also note that the standards must operate within the optimum output conditions of the Option, as defined in the accuracy tables given in *Section 17* of this handbook — i.e. the measurement equipment should be able to operate within the relevant Option 250 or 600 limits so that no additional accuracy figures have to be taken into account.

The specific equipment requirements for verifying individual functions are listed in the sub-sections detailing their verification procedures.

19.4 Interconnections

The form of interconnection required to ensure optimum conditions for verification measurements will depend on the individual function being verified, and on the measuring equipment connected to the 9100's terminals. Suitable connections are described in the sub-sections detailing the functions' verification procedures.

19.5 Verification Points

The accuracy specifications detailed in *Section 17* of this handbook cover the full range of output values which can be generated by Options 250 and 600, and their accuracies can therefore be verified against the specification at any number of points in these output ranges.

This section recommends a set of verification points for the full procedure, but as the choice of points will largely depend on the traceable accuracy of the standards used, and on oscilloscope's ultimate use, it is beyond the scope of this handbook to define a precise set of verification points for all cases. However, when selecting verification points the following guidelines should be followed:-

1. Where the Option's specification is broken up into several different output amplitude and/or frequency bands, verification points should be close to the top and bottom of each band.
2. For Option 250 or 600 functions which can be adjusted, the default or recommended 'calibration targets' detailed in *Section 20* can be used as suitable verification points.

19.6 Calculating Absolute Specification Limits

For each chosen verification point it will be necessary to calculate absolute measurement limits which can be used to judge whether or not the Option is performing within its specification. As mentioned earlier, the accuracy specifications detailed in *Section 17* of this handbook are absolute accuracies which incorporate all the uncertainties involved in calibrating Option 250 or 600 up to and including those of National Standards.

If verification results are to be at all meaningful, the measuring equipment which is used to verify the Option's accuracy must have separate traceability to the same National Standards, and the uncertainties involved in this traceability must be taken into account when determining the absolute verification limits required at the chosen verification points.

To ensure that worst-case conditions are taken into account, these verification limits should be calculated as described in the *9100 User's Handbook, Volume 2, Section 9, sub-section 9.6.*

19.7 Verification Procedure

Suitability

The procedures given in this section to verify the Model 9100 Options 250 and 600 specifications are suitable for verification both after receipt from the factory, or when associated with user-calibration.

Verification Points

The procedures cover the points which can be adjusted during the calibration process, and those which cannot. The procedures given in *Section 20* for calibration of Options 250 and 600 deal only with those points for which adjustment is possible. For this reason, it is necessary to carry out both adjustment and verification for a complete calibration.

Traceability

Where, to conform to quality standards, the 9100 Option 250 or 600 is required to be traceable to higher standards; then all equipment used to verify the Option 250 or 600 specification must also be traceable to those standards.

19.8 Options 250 and 600 Verification by Functions

Sub-section 19.8 is a guide to the process of verifying the Model 9100 Option 250 or 600 functions from the front panel. The following topics are covered:

The list of topics above are placed in the order in which the Option 250/600 functions should be verified. Although it is not essential to verify all the functions at any one time, functions higher in the list should be verified before those lower in the list.

19.8.1 Verifying the Edge Function

19.8.1.1 Summary

Equipment requirements are given at *para 19.8.1.2* and test interconnections at *para 19.8.1.3*.

The Edge Function is verified by carrying out measurements of risetime, aberration and amplitude; in the sequences given at *paras 19.8.1.4* and *19.8.1.5*, at the verification points shown in *Tables 19.8.1.4* and *19.8.1.5*, respectively.

19.8.1.2 Equipment Requirements

- Precision oscilloscope with bandwidth ≥1GHz for Risetime and Aberration measurements.
  Examples: Tektronix Model TDS820 (Low Edge),
  Tektronix Model TDS310 (High Edge).
- Long-scale DMM for Amplitude measurements.
  Example: Fluke Model 1281
- Precision 50Ω BNC co-axial 'Signal' cable.
  Example: Fluke part no. 630442 (supplied).
- Precision 50Ω BNC through terminator, for signal connection from Option 250/600 SIG OUT in 50Ω output mode to the input of the DMM; if required for Amplitude measurements.
  Example: Fluke part no. 630447 (supplied).
- BNC-4mm Terminal Adapter for signal connection from Option 250/600 SIG OUT to the input of the DMM for Amplitude measurements.
  Example: ITT Pomona Adapter 1269.
- 50Ω BNC co-axial cable for trigger inputs to the precision oscilloscope.
  Example: Fluke part no. 630441 (supplied).
- 50Ω BNC through terminator, where required, for trigger connection from Option 250/600 50Ω output, to any oscilloscope with high impedance trigger input; for Risetime and Aberration measurements.
  Example: Fluke part no. 630447 (supplied).

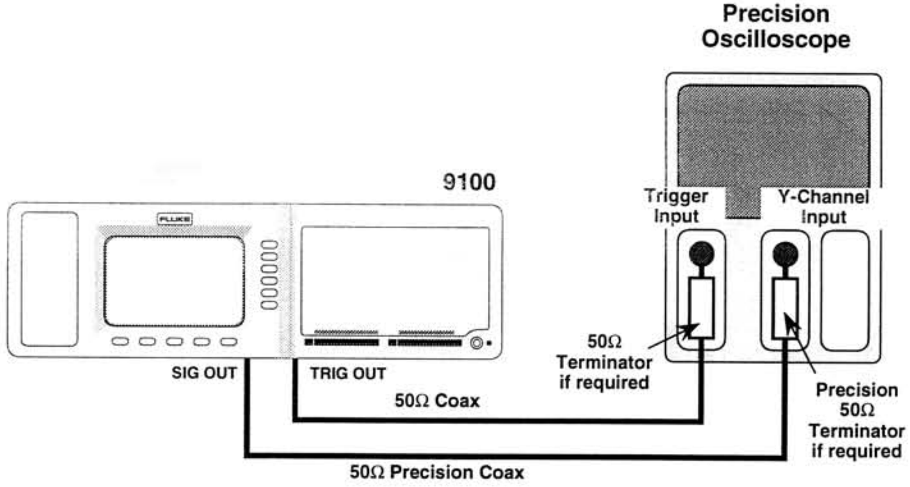
Caution Do ***not*** cross-connect the SIG OUT and TRIG OUT cables between 9100 and precision oscilloscope — this can damage the trigger input circuitry of certain oscilloscopes.

19.8.1 Verifying the Edge Function *(Contd.)*

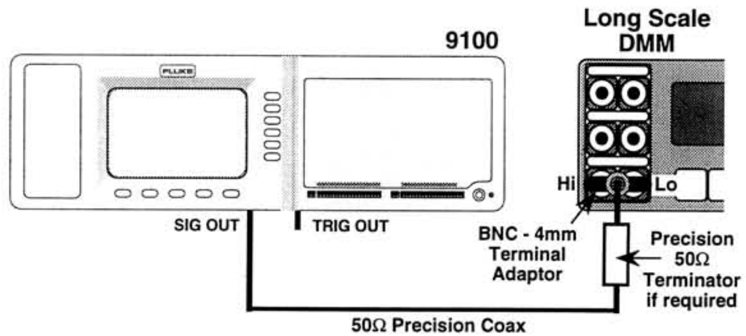
19.8.1.3 Interconnections

Use the following connections for the Measurements shown:

a. Risetime and Aberration Measurements



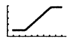
b. Amplitude Measurements



19.8.1.4 Verifying Edge Function Risetime and Aberration

The following procedure assumes that the 9100 instrument is in Manual Mode. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1*. Familiarity with the methods of editing screen values is also assumed *(also Section 3)*. Options 250 and 600 operation is described in this *Volume 3, Section 14*.

9100 and Precision Oscilloscope Setup

1. **Connections** Connect the 9100 to the oscilloscope as in *para 19.8.1.3(a)*, and ensure that both instruments are powered ON and warmed up.
2. **Oscilloscope** Select the required function to measure edge response.
3. **9100** Ensure that the 9100 is in Edge Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the  soft key at the right of the screen.

Sequence of Operations.

Refer to *Table 19.8.1.4*. Follow the correct sequence of verification points as shown on the table, and carry out the following operations *(1)* to *(7)* at each verification point.

1. **9100** Set the 9100 Ω_{LOAD}, **EDGE TYPE**, **O/P Volts p-p** and **O/P Period** as required for the verification point:
2. **Oscilloscope**
   - **a.** Select the correct channel.
   - **b.** Select the correct sweep speed, trigger level, trigger edge and channel sensitivity to measure at the verification point.
3. **9100** Set Output **ON**.
4. **Oscilloscope**
   - **a.** Adjust the sweep speed and trigger level for a stable display.
   - **b.** Check the waveform for correct polarity ('Rise' selected: from a negative potential to ground; 'Fall' selected: from a positive potential to ground).
5. **Rise Time**
   - **a.** Measure the (10% to 90%) combined pulse rise/fall time.
   - **b.** Calculate the Edge function rise/fall time:

     $$\text{Edge Function Rise/fall time} = \sqrt{(\text{Observed Rise Time}^2 - \text{Scope Pulse Response Time}^2)}\ \text{ns}$$

   - **c.** Record the Measured Edge function rise/fall time on the *copy of the Table*.
   - **d.** Calculate the User's Measurement Uncertainty and Upper Validity Tolerance Limit, and enter in the appropriate columns of the *copy of the Table*.
   - **e.** Check that the Measured Value is at or less than the Upper Validity Tolerance Limit.
6. **Aberration**
   - **a.** Measure the Aberration Voltage and record on the *copy of the Table.*
   - **b.** Calculate the User's Measurement Uncertainty and Upper Validity Tolerance Limit, and enter in the appropriate columns of the *copy of the Table*.
   - **c.** Check that the Measured Value is at or less than the Upper Validity Tolerance Limit.
7. **9100** Set Output **OFF**.

19.8.1 Verifying the Edge Function *(Contd.)*

Table 19.8.1.4 — Edge Function Verification — Risetime and Aberration

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Ver. Pt.	Edge Type/ Load	Period	Output Voltage (p-p)	Test Type	Upper Tolerance Limit (Hr)	User's Measurement Uncertainty (Um)	Upper Validity Tolerance Limit	Measured Value
1a	High ↑ 1MΩ	10µs	50.00V	Risetime (10% - 90%)	<100ns			ns
1b				Aberration in first 500ns	<1V p-p			V p-p
2a	High ↑ 1MΩ	10µs	5.000V	Risetime (10% - 90%)	<100ns			ns
2b				Aberration in first 500ns	<0.1V p-p			V p-p
3a	Low ↑ 50Ω	100ns	1.000V	Risetime (10% - 90%)	<1ns			ns
3b				Aberration in first 10ns	<20mV p-p			mV p-p
4a	Low ↓ 50Ω	100ns	1.000V	Risetime (10% - 90%)	<1ns			ns
4b				Aberration in first 10ns	<20mV p-p			mV p-p
5a	Low ↑ 50Ω	100ns	0.100V	Risetime (10% - 90%)	<1ns			ns
5b				Aberration in first 10ns	<10mV p-p			mV p-p
6a	Low ↓ 50Ω	100ns	0.100V	Risetime (10% - 90%)	<1ns			ns
6b				Aberration in first 10ns	<10mV p-p			mV p-p

19.8.1.5 Verifying Edge Function Amplitude

The following procedure assumes that the 9100 instrument is in Manual Mode. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.* Familiarity with the methods of editing screen values is also assumed *(also Section 3).* Options 250 and 600 operation is described in this *Volume 3, Section 14.*

9100 and DMM Setup

1. **Connections** Connect the 9100 to the DMM as in *para 19.8.1.3(b)*, and ensure that both instruments are powered ON and warmed up.
2. **DMM** Select ACV to measure RMS at 1kHz (AC Coupled).
3. **9100** Ensure that the 9100 is in Edge Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the soft key at the right of the screen.

Sequence of Operations.

Refer to *Table 19.8.1.5.* Follow the correct sequence of verification points as shown on the table, and carry out the following operations *(1)* to *(5)* at each verification point.

1. **9100** Set the 9100 Ω_{LOAD}, **EDGE TYPE**, **O/P Volts p-p** and **O/P Period** as required for the verification point:
2. **DMM**
   a. Select the correct RMS range for the verification point pk-pk Output Voltage
   (RMS = 0.5 x 0.9968 x pk-pk).
3. **9100** Set Output **ON**.
4. **Amplitude**
   a. Measure the RMS output value.
   b. Calculate the Pk-Pk value of 9100 output voltage:
   Pk-Pk = 2 x 1.0032 x RMS value
   c. Record the measured Pk-Pk value on the *copy of the Table.*
   d. Calculate the User's Measurement Uncertainty and Validity Tolerance Limits, and enter in the appropriate columns of the *copy of the Table.*
   e. Check that the Measured Value is at or between the Validity Tolerance Limits.
5. **9100** Set Output **OFF**.

19.8.1 Verifying the Edge Function *(Contd.)*

Table 19.8.1.5 — Edge Function Verification — Amplitude

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Test Grp.	Edge Type/ Load	Test Type	Period	Output Voltage (p-p)	Absolute Tolerance Limits (Voltage p-p) Lower (Lr)	Absolute Tolerance Limits (Voltage p-p) Higher (Hr)	User's Measurement Uncertainty (Um)	Validity Tolerance Limits Lower	Validity Tolerance Limits Higher	Measured Value
7a	High ↑ 1MΩ	Amplitude	1ms	50.000V	48.500V	51.500V				
7b				5.000V	4.850V	5.150V				
7c				2.000V	1.940V	2.060V				
7d				0.100V	0.097V	0.103V				
7e				10.000V	9.700V	10.300V				
7f				1.000V	0.970V	1.030V				
8a	Low ↑ 50Ω	Amplitude	1ms	1.000V	0.970V	1.030V				
8b				0.370V	0.3589V	0.3811V				
8c				0.300V	0.291V	0.309V				
8d				0.100V	0.097V	0.103V				
9a	Low ↓ 50Ω	Amplitude	1ms	1.000V	0.970V	1.030V				
9b				0.370V	0.3589V	0.3811V				
9c				0.300V	0.291V	0.309V				
9d				0.100V	0.097V	0.103V				

19.8.2 Verifying the DC Function

19.8.2.1 Summary

Equipment requirements are given at *para 19.8.2.2* and test interconnections at *para 19.8.2.3.*

The DC Function is verified by carrying out measurements of amplitude in the sequence given at *para 19.8.2.4*, at the verification points shown in *Table 19.8.2.4.*

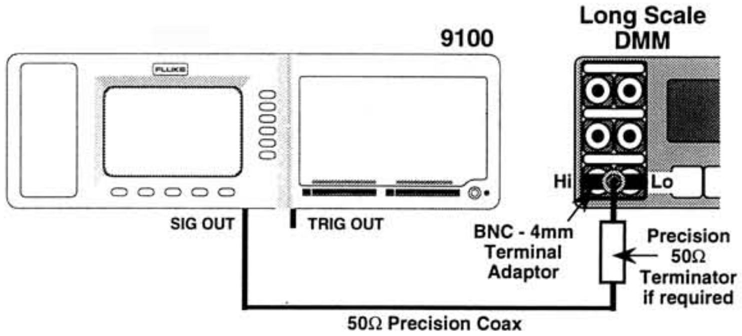
19.8.2.2 Equipment Requirements

- Long-scale DMM for magnitude measurements.
  Example: Fluke model 1281.
- Precision 50Ω BNC co-axial 'Signal' cable, used during the most-recent calibration.
  Example: Fluke part no. 630442 (supplied).
- Precision 50Ω BNC through terminator used during the most-recent calibration, for signal connection from Option 250/600 SIG OUT in 50Ω output mode to the input of the DMM; if required for Amplitude measurements.
  Example: Fluke part no. 630447 (supplied).
- BNC-4mm Terminal Adapter for signal connection from Option 250/600 SIG OUT to the input of the DMM for Amplitude measurements.
  Example: ITT Pomona Adapter 1269.

19.8.2.3 Interconnections

Use the following connections for the Measurements shown:

Magnitude Measurements



19.8.2 Verifying the DC Function *(Contd.)*

19.8.2.4 Verifying DC Function Magnitude

The following procedure assumes that the 9100 instrument is in Manual Mode. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.*. Familiarity with the methods of editing screen values is also assumed *(also Section 3)*. Option 250/600 operation is described in this *Volume 3, Section 14.*

9100 and DMM Setup

1. **Connections** Connect the 9100 to the DMM as in *para 19.8.2.3*, and ensure that both instruments are powered ON and warmed up.
2. **DMM** Select DCV.
3. **9100** Ensure that the 9100 is in DC Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the soft key at the right of the screen.

Sequence of Operations.

Refer to *Table 19.8.2.4.* Follow the correct sequence of verification points as shown on the table, and carry out the following operations *(1)* to *(5)* at each verification point.

1. **9100** Set the 9100 Ω_{LOAD} and **O/P Volts p-p** as required for the verification point:
2. **DMM** **a**. Select the correct DCV range for the verification point Output Voltage.
3. **9100** Set Output **ON**.
4. **Amplitude** **a**. Measure the DCV output value.
   c. Record the measured DCV value on the *copy of the Table*.
   d. Calculate the User's Measurement Uncertainty and Validity Tolerance Limits, and enter in the appropriate columns of the *copy of the Table*.
   e. Check that the Measured Value is at or between the Validity Tolerance Limits.
5. **9100** Set Output **OFF**.

Table 19.8.2.4 — DC Function Verification — Magnitude

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Ver. Pt.	Load	Test Type	Output Voltage	Absolute Tolerance Limits (DCV) Lower (Hr)	Higher (Lr)	User's Measurement Uncertainty (Um)	Validity Tolerance Limits Lower	Higher	Measured Value
1a	1MΩ	Positive Magnitude	100.00V	99.800V	100.20V				
1b			19.000V	18.962	19.038V				
1c			3.750V	3.7425V	3.7575V				
1d			1.800V	1.7964V	1.8036V				
1e			0.500V	0.4990V	0.5010V				
1f			0.100V	0.0998V	0.1002V				
1g			0.010V	9.940mV	10.060mV				
2a	1MΩ	Negative Magnitude	-100.00V	-100.20V	-99.800V				
2b			-19.000V	-19.038V	-18.962				
2c			-3.750V	-3.7575V	-3.7425V				
2d			-1.800V	-1.8036V	-1.7964V				
2e			-0.500V	-0.5010V	-0.4990V				
2f			-0.100V	-0.1002V	-0.0998V				
2g			-0.010V	-10.060mV	-9.940mV				

Verification Points 3 & 4 overleaf →

19.8.2 Verifying the DC Function *(Contd.)*

Table 19.8.2.4 — DC Function Verification — Magnitude (Contd.)

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Ver. Pt.	Load	Test Type	Output Voltage	Absolute Tolerance Limits (DCV) Lower (Hr)	Higher (Lr)	User's Measurement Uncertainty (Um)	Validity Tolerance Limits Lower	Higher	Measured Value
3a	50Ω	Positive Magnitude	1.800V	1.7964V	1.8036V				
3b			0.500V	0.4990V	0.5010V				
3c			0.100V	0.0998V	0.1002V				
3d			0.010V	9.940mV	10.060mV				
4a	50Ω	Negative Magnitude	-1.800V	-1.8036V	-1.7964V				
4b			-0.500V	-0.5010V	-0.4990V				
4c			-0.100V	-0.1002V	-0.0998V				
4d			-0.010V	-10.060mV	-9.940mV				

19.8.3 Verifying the Square Function

19.8.3.1 Summary

Equipment requirements are given at *para 19.8.3.2* and test interconnections at *para 19.8.3.3.*

The Square Function is verified by carrying out measurements of amplitude; in the sequences given at *para 19.8.3.4*, at the verification points shown in *Table 19.8.3.4.*

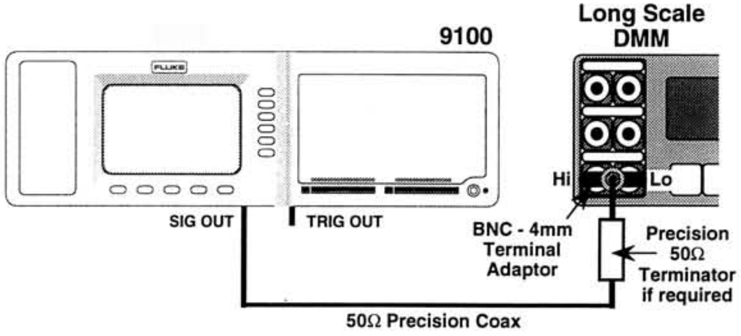
19.8.3.2 Equipment Requirements

- Long-scale DMM for magnitude measurements.
  Example: Fluke model 1281.
- Precision 50Ω BNC co-axial 'Signal' cable, used during the most-recent calibration.
  Example: Fluke part no. 630442 (supplied).
- Precision 50Ω BNC through terminator used during the most-recent calibration, for signal connection from Option 250/600 SIG OUT in 50Ω output mode to the input of the DMM; if required for Amplitude measurements.
  Example: Fluke part no. 630447 (supplied).
- BNC-4mm Terminal Adapter for signal connection from Option 250/600 SIG OUT to the input of the DMM for Amplitude measurements.
  Example: ITT Pomona Adapter 1269.

19.8.3.3 Interconnections

Use the following connections for the Measurements shown:

Magnitude Measurements

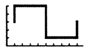


19.8.3 Verifying the Square Function *(Contd.)*

19.8.3.4 Verifying Square Function Amplitude

The following procedure assumes that the 9100 instrument is in Manual Mode. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.* Familiarity with the methods of editing screen values is also assumed *(also Section 3).* Option 250/600 operation is described in this *Volume 3, Section 14.*

9100 and DMM Setup

1. **Connections** Connect the 9100 to the DMM as in *para 19.8.3.3*, and ensure that both instruments are powered ON and warmed up.
2. **DMM** Select ACV to measure RMS at 1kHz (AC Coupled).
3. **9100** Ensure that the 9100 is in Square Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the  soft key at the top right of the screen.

Sequence of Operations.

Refer to *Table 19.8.3.4*. Follow the correct sequence of verification points as shown on the table, and carry out the following operations *(1)* to *(5)* at each verification point.

1. **9100** Set the 9100 Ω_{LOAD}, **O/P Volts p-p** and **O/P Period** as required for the verification point:
2. **DMM** **a**. Select the correct RMS range for the verification point pk-pk Output Voltage
   (RMS = 0.5 x 0.9968 x pk-pk).
3. **9100** Set Output **ON**.
4. **Amplitude** **a**. Measure the RMS output value.
   b. Calculate the Pk-Pk value of 9100 output voltage:
   Pk-Pk = 2 x 1.0032 x RMS value
   c. Record the measured Pk-Pk value on the *copy of the Table.*
   d. Calculate the User's Measurement Uncertainty and Validity Tolerance Limits, and enter in the appropriate columns of the *copy of the Table.*
   e. Check that the Measured Value is at or between the Validity Tolerance Limits.
5. **9100** Set Output **OFF**.

Table 19.8.3.4 — Square Function Verification — Amplitude

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Test Grp.	Load	Test Type	Output Voltage p-p	Absolute Tolerance Limits (p-p Voltage) Lower (Hr)	Higher (Lr)	User's Measurement Uncertainty (Um)	Validity Tolerance Limits (p-p Voltage) Lower	Higher	Measured Value (p-p Voltage)
1	1MΩ	Amplitude	120.00V	119.70V	120.30V				
			50.000V	49.875	50.125V				
			40.000V	39.900V	40.100V				
			5.0000V	4.9875V	5.0125V				
			4.2000V	4.1895V	4.2105V				
			3.6000V	3.5910	3.6090V				
			3.0000V	2.9925V	3.0075V				
			1.2000V	1.1970V	1.2030V				
			0.9000V	897.75mV	902.25mV				
			0.1650V	164.59mV	165.41mV				
			0.1300V	129.68mV	130.32mV				
			0.0250V	24.938mV	25.062mV				
			0.0200V	19.950mV	20.050mV				
			0.0100V	9.9750mV	10.025mV				

Table 19.8.3.4 continues overleaf →

19.8.3 Verifying the Square Function *(Contd.)*

Table 19.8.3.4 — Square Function Verification — Amplitude (Contd.)

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Test Grp.	Load	Test Type	Output Voltage p-p	Absolute Tolerance Limits (p-p Voltage) Lower (Hr)	Higher (Lr)	User's Measurement Uncertainty (Um)	Validity Tolerance Limits (p-p Voltage) Lower	Higher	Measured Value (p-p Voltage)
1	50Ω	Amplitude	3.0000V	2.9925V	3.0075V				
			1.2000V	1.1970V	1.2030V				
			0.9000V	897.75mV	902.25mV				
			0.1650V	164.59mV	165.41mV				
			0.1300V	129.68mV	130.32mV				
			0.0250V	24.938mV	25.062mV				
			0.0200V	19.950mV	20.050mV				
			0.0100V	9.9750mV	10.025mV				

19.8.4 Verifying the Markers Function

19.8.4.1 Summary

The Markers Function is verified by carrying out measurements in the following sequence:

Test Grp.	Load	Voltage p-p	Period	Specification Basic	Specification with Opt. 100
1	50Ω	1.0000V	100.000ns 1.00000μs 10.0000μs 100.000μs	±0.0025ns ±0.000025μs ±0.00025μs ±0.0025μs	
2	50Ω	1.0000V	100.000ns		±0.25ppm

19.8.4.2 Equipment Requirements

- (If Option 100 *not* fitted): Digital counter for 25ppm clock accuracy measurements.
  Example: Tektronix Model CDC250.
- (If Option 100 fitted): Digital counter for 25ppm and 0.25 ppm clock accuracy measurements.
  Example: Hewlett Packard Model HP53181A with Option 012.
- Precision 50Ω BNC co-axial 'Signal' cable.
  Example: Fluke part no. 630442 (supplied).
- Precision 50Ω BNC through terminator, for connection from Option 250/600 SIG OUT (50Ω output) to the signal input of a high input impedance digital counter if required.
  Example: Fluke part no. 630447 (supplied).

Caution Do ***not*** cross-connect the SIG OUT and TRIG OUT cables between 9100 and precision oscilloscope — this can damage the trigger input circuitry of certain oscilloscopes.

19.8.4.3 Interconnections

Use the following connections for the Measurements shown:

Period/Frequency Measurements (including Option 100)

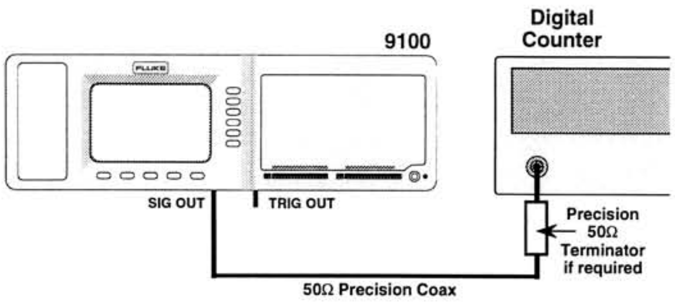


Table 19.8.4.4 — Markers Function Verification at 1V — Period

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Test Grp.	Load	Test Type	Output Period	Absolute Tolerance Limits (Period) Lower (Hr)	Absolute Tolerance Limits (Period) Higher (Lr)	User's Measurement Uncertainty (Um)	Validity Tolerance Limits (Period) Lower	Validity Tolerance Limits (Period) Higher	Measured Value (Period)
1	50Ω	Period *(Not Option 100)*	100.00ns	99.9975ns	100.0025ns				
			1.0000µs	0.999975µs	1.000025µs				
			10.000µs	9.99975µs	10.00025µs				
			100.00µs	99.9975µs	100.0025µs				
2	50Ω	Period *(Option 100)*	100.00ns	99.999975ns	100.000025ns				

19.8.4.4 Verifying Markers Function Period

The following procedure assumes that the 9100 instrument is in Manual Mode. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1*. Familiarity with the methods of editing screen values is also assumed *(also Section 3)*. Option 250/600 operation is described in this *Volume 3, Section 14*.

9100 and Counter Setup

1. **Connections** — Connect the 9100 to the counter as in *para 19.8.4.3*, and ensure that both instruments are powered ON and warmed up. (If Option 100 is fitted, use the long-resolution counter.)
2. **Counter** — Select the required function to measure period.
3. **9100** — Ensure that the 9100 is in Markers Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the  soft key at the right of the screen.

Sequence of Operations.

Refer to *Table 19.8.4.4*. Follow the correct sequence of verification points as shown on the table (omitting Test Group 2 if Option 100 is not fitted), and carry out the following operations *(1)* to *(5)* at each verification point.

1. **9100** — Set the 9100 **O/P Volts p-p** and **O/P Period** as required for the verification point:
2. **Counter** — Select the correct display time, trigger source and level to measure at the verification point.
3. **9100** — Set Output **ON**.
4. **Counter**
   - **a.** Adjust the trigger level for a stable display.
   - **b.** Record the measured period on the *copy of the Table*.
   - **c.** Calculate the User's Measurement Uncertainty and Validity Tolerance Limits, and enter in the appropriate columns of the *copy of the Table*.
   - **d.** Check that the Measured Value is at or between the Validity Tolerance Limits.
5. **9100** — Set Output **OFF**.

Table 19.8.4.4 overleaf →

19.8.5 Verifying the Sine Function

19.8.5.1 Summary

Equipment requirements are given at *para 19.8.5.2* and test interconnections at *para 19.8.5.3*.

The Sine Function is verified by carrying out measurements of amplitude at frequencies between 40Hz and 49.9Hz; in the sequences given at *para 19.8.5.4*, at the verification points shown in *Table 19.8.5.4*; and between 50kHz and 600MHz; in the sequences given at *para 19.8.5.5*, at the verification points shown in *Table 19.8.5.5*.

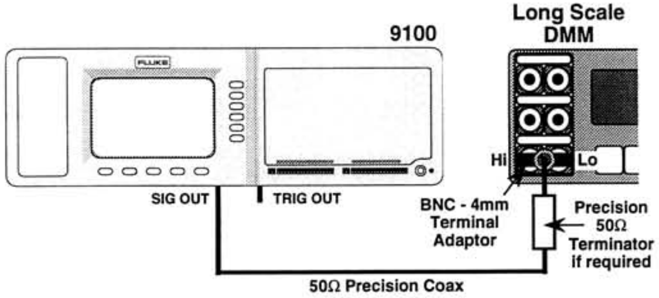
19.8.5.2 Equipment Requirements

- Long-scale DMM for Amplitude measurements from 40Hz to 50kHz.
  Example: Fluke Model 1281.
- RF Power Meter for Power measurements of 100MHz and 600MHz and from 20mVp-p to 2.5Vp-p into 50Ω.
  Examples: Hewlett Packard HP437B with HP8482A head, or Marconi Instruments Model 6960B with Model 6912 head.
- Precision 50Ω BNC co-axial 'Signal' cable, used during the most-recent calibration.
  Example: Fluke part no. 630442 (supplied).
- Precision 50Ω BNC through terminator used during the most-recent calibration, for signal connection from Option 250/600 SIG OUT in 50Ω output mode to the input of the DMM; if required for Amplitude measurements.
  Example: Fluke part no. 630447 (supplied).
- BNC-4mm Terminal Adapter for signal connection from Option 250/600 SIG OUT cable to the input of the DMM for Amplitude measurements.
  Example: ITT Pomona Adapter 1269.
- Precision-N to BNC Adapter for signal connection from Option 250/600 SIG OUT cable to the input of the RF Power Meter head for Amplitude measurements.
  Example: Huber & Suhner Adapter type no. 31BNC-N-50-51.

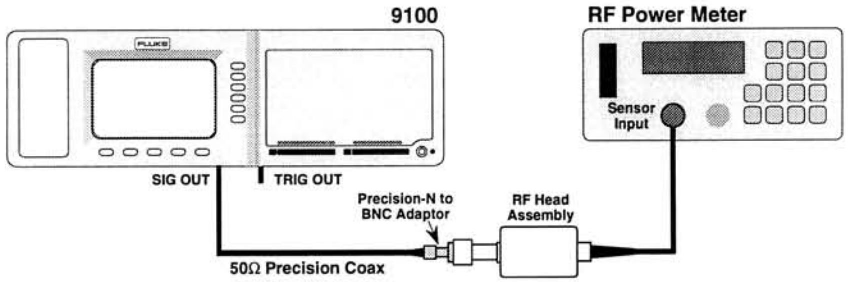
19.8.5.3 Interconnections

Use the following connections for the Measurements shown:

a. Amplitude Measurements: 40Hz to 49.9kHz



b. Relative Flatness Measurements: 100MHz and 600MHz



19.8.5 Verifying the Sine Function *(Contd.)*

19.8.5.4 Verifying Sine Function Amplitude — 40Hz to 49.9Hz

The following procedure assumes that the 9100 instrument is in Manual Mode. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.* Familiarity with the methods of editing screen values is also assumed *(also Section 3)*. Option 250/600 operation is described in this *Volume 3, Section 14.*

9100 and DMM Setup

1. **Connections** Connect the 9100 to the DMM as in *para 19.8.5.3(a)*, and ensure that both instruments are powered ON and warmed up.
2. **DMM** Select ACV to measure RMS at 1kHz (AC Coupled).
3. **9100** Ensure that the 9100 is in Sine Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the  soft key at the right of the screen.

Sequence of Operations.

Refer to *Tables 19.8.5.4* on the following pages. Follow the correct sequence of verification points as shown on the table, and carry out the following operations *(1)* to *(5)* at each verification point.

1. **9100** Set the 9100 Ω_{LOAD}, **O/P Volts p-p** and **O/P Freq** as required for the verification point:
2. **DMM** **a**. Select the correct RMS range for the verification point pk-pk Output Voltage (RMS = 0.3536 x pk-pk).
3. **9100** Set Output **ON**.
4. **Amplitude** **a**. Measure the RMS output value.
   b. Calculate the Pk-Pk value of 9100 output voltage:
   Pk-Pk = 2.8284 x RMS value
   c. Record the measured Pk-Pk value on the *copy of the Table.*
   d. Calculate the User's Measurement Uncertainty and Validity Tolerance Limits, and enter in the appropriate columns of the *copy of the Table.*
   e. Check that the Measured Value is at or between the Validity Tolerance Limits.
5. **9100** Set Output **OFF**.

Table 19.8.5.4 — Sine Function Verification Amplitude — 40Hz to 49.999kHz

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Test Grp.	Load	Test Type	Output Voltage (p-p)	Absolute Tolerance Limits (Voltage p-p) Lower (Lr)	Absolute Tolerance Limits (Voltage p-p) Higher (Hr)	User's Measurement Uncertainty (Um)	Validity Tolerance Limits Lower	Validity Tolerance Limits Higher	Measured Value
1a	1MΩ	Amplitude at 1kHz	110.00V	109.725V	110.275V				
1b			50.000	49.875V	50.125V				
1c			7.5000	7.4813V	7.5187V				
1d			4.0000	3.9900V	4.0100V				
1e			1.0000V	0.9975V	1.0025V				
1f			0.1900V	189.53mV	190.47mV				
1g			0.0190V	18.953mV	19.047mV				
2a	1MΩ	Amplitude at 40Hz	110.00V	109.725V	110.275V				
2b			50.000	49.875V	50.125V				
2c			7.5000	7.4813V	7.5187V				
2d			4.0000	3.9900V	4.0100V				
2e			1.0000V	0.9975V	1.0025V				
2f			0.1900V	189.53mV	190.47mV				
2g			0.0190V	18.953mV	19.047mV				

19.8.5 Verifying the Sine Function *(Contd.)*

Table 19.8.5.4 — Sine Function Verification Amplitude — 40Hz to 49.999kHz

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Test Grp.	Load	Test Type	Output Voltage (p-p)	Absolute Tolerance Limits (Voltage p-p) Lower (Lr)	Higher (Hr)	User's Measurement Uncertainty (Um)	Validity Tolerance Limits Lower	Higher	Measured Value
3a	1MΩ	Amplitude at 49.999kHz	110.00V	109.725V	110.275V				
3b			50.000	49.875V	50.125V				
3c			7.5000	7.4813V	7.5187V				
3d			4.0000	3.9900V	4.0100V				
3e			1.0000V	0.9975V	1.0025V				
3f			0.1900V	189.53mV	190.47mV				
3g			0.0190V	18.953mV	19.047mV				

Test Grp.	Load	Test Type	Output Voltage (p-p)	Absolute Tolerance Limits (Voltage p-p) Lower (Lr)	Higher (Hr)	User's Measurement Uncertainty (Um)	Validity Tolerance Limits Lower	Higher	Measured Value
4a	50Ω	Amplitude at 1kHz	4.0000	3.9900V	4.0100V				
4b			1.0000V	0.9975V	1.0025V				
4c			0.1900V	189.53mV	190.47mV				
4d			0.0190V	18.953mV	19.047mV				
5a	50Ω	Amplitude at 49.999kHz	4.0000	3.9900V	4.0100V				
5b			1.0000V	0.9975V	1.0025V				
5c			0.1900V	189.53mV	190.47mV				
5d			0.0190V	18.953mV	19.047mV				
6a	50Ω	Amplitude at 40Hz	4.0000	3.9900V	4.0100V				
6b			1.0000V	0.9975V	1.0025V				
6c			0.1900V	189.53mV	190.47mV				
6d			0.0190V	18.953mV	19.047mV				

19.8.5 Verifying the Sine Function *(Contd.)*

Table 19.8.5.4 — Sine Function Verification Amplitude — 40Hz to 49.999kHz

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Test Grp.	Load	Test Type	Output Voltage (p-p)	Absolute Tolerance Limits (Voltage p-p) Lower (Lr)	Higher (Hr)	User's Measurement Uncertainty (Um)	Validity Tolerance Limits Lower	Higher	Measured Value
7a	50Ω	Amplitude at 49.999kHz	2.5000V	2.4938V	2.5062V				
7b			0.9000V	0.8978V	0.9022V				
7c			0.3150V	314.22mV	315.78mV				
7d			0.1000V	99.750mV	100.250mV				
7e			0.0325V	32.419mV	32.581mV				
7f			0.0200V	19.950mV	20.050mV				

19.8.5.5 Verifying Sine Function Flatness — 50kHz to 600MHz

The following procedure assumes that the 9100 instrument is in Manual Mode. In the case of difficulty, re-read the *User's Handbook, Volume 1, Section 3; sub-section 3.3.1.* Familiarity with the methods of editing screen values is also assumed *(also Section 3).* Option 250/600 operation is described in this *Volume 3, Section 14.*

9100 and DMM Setup

1. **Connections** Connect the 9100 to the RF Power Meter as in *para 19.8.5.3(b)*, and ensure that both instruments are powered ON and warmed up.
2. **Power Meter** Set to measure power in units of watts, *not* dBm.
3. **9100** Ensure that the 9100 is in Sine Function with Output OFF. If in any other function, press the '**Aux**' key on the right of the front panel, then the  soft key at the right of the screen.

Sequence of Operations.

Refer to *Tables 19.8.5.5* on the following pages.
Follow the correct sequence of verification points as shown on the table, and carry out the following operations *(1)* to *(6)* at the verification points on each table.

1. **9100**
   a. At the verification point frequencies, the 9100 Ω_{LOAD} automatically defaults to 50Ω.
   b. Set **O/P Volts p-p** and **O/P Freq** as required for the verification point:
2. **Power Meter** The example power meter auto-ranges to accommodate the input power.
3. **9100** Set Output **ON**.
4. **'Ref'**
   a. Measure the 9100 output power at 50kHz.
   b. Calculate the Pk-Pk value of 9100 output voltage into 50Ω:
   $$\text{Pk-Pk Voltage} = 20\sqrt{(\text{power into } 50\Omega)}$$
   c. Record the result in the '**Measured p-p Voltage at 50kHz**' column on the *copy of the Table.*
5. **Flatness**
   a. At each other '**Output Freq.**' point in the table, measure the 9100 output power.
   b. Calculate the Pk-Pk value of 9100 output voltage into 50Ω:
   $$\text{Pk-Pk Voltage} = 20\sqrt{(\text{power into } 50\Omega)}$$
   c. Record the result in the the '**Measured p-p Voltage for Flatness Check**' column on the *copy of the Table.*
   N.B. In operation (**d**), the Flatness Validity Tolerance for the relative flatness measurement is the combination of the Power Meter and Sensor accuracy, their calibration uncertainties and the 9100 Sine function accuracy. For worst-case summation, add the uncertainties directly.
   For further assistance, refer to *sub-section 19.8.5.6.*
   d. Insert the User's Measurement Uncertainty (Um) and calculate the Flatness Validity Tolerance Limits. Enter the limits in the appropriate columns of the *copy of the Table.*
   e. Check that the Measured p-p Voltage is at or between the Flatness Validity Tolerance Limits.
6. **9100** Set Output **OFF**.

19.8.5 Verifying the Sine Function *(Contd.)*

Table 19.8.5.5 — Sine Function Verification — Flatness — 50kHz to 600MHz

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Test Grp.	Load	Test Type	Output Freq.	Measured p-p Voltage at 50kHz	Specification Relative to 50kHz (% of Output)	User's Total Measurement Uncertainty (Um)	Flatness Validity Tolerance Limits		Measured p-p Voltage for Flatness Check
							Lower	Higher	
Ref	50Ω	2.500V Flatness	50kHz						
8a			10MHz		±1.5				
8b			12MHz		±1.5				
8c			100MHz		±1.5				
8d			250MHz		±3.0				
8e			329.99MHz *		±5.0				
8f			330MHz *		±5.0				
8g			400MHz *		±5.0				
8h			470MHz *		±5.0				
8j			530MHz *		±5.0				
8k			600MHz *		±5.0				
8l			1MHz		±1.5				
8m			30MHz		±1.5				

* = Option 600 only

Test Grp.	Load	Test Type	Output Freq.	Measured p-p Voltage at 50kHz	Specification Relative to 50kHz (% of Output)	User's Total Measurement Uncertainty (Um)	Flatness Validity Tolerance Limits		Measured p-p Voltage for Flatness Check
							Lower	Higher	
Ref	50Ω	3.500V Flatness	50kHz						
9a			10MHz		±1.5				
9b			12MHz		±1.5				
9c			100MHz		±1.5				
9d			250MHz		±3.0				
9e			329.99MHz *		±5.0				
9f			330MHz *		±5.0				
9g			400MHz *		±5.0				
9h			470MHz *		±5.0				
9j			530MHz *		±5.0				
9k			600MHz *		±5.0				
9l			1MHz		±1.5				
9m			30MHz		±1.5				

* = Option 600 only

19.8.5 Verifying the Sine Function *(Contd.)*

Table 19.8.5.5 — Sine Function Verification — Flatness — 50kHz to 600MHz (Contd.)

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Test Grp.	Load	Test Type	Output Freq.	Measured p-p Voltage at 50kHz	Specification Relative to 50kHz (% of Output)	User's Total Measurement Uncertainty (Um)	Flatness Validity Tolerance Limits		Measured p-p Voltage for Flatness Check
							Lower	Higher	
Ref	50Ω	900mV Flatness	50kHz						
10a			10MHz		±1.5				
10b			12MHz		±1.5				
10c			100MHz		±1.5				
10d			250MHz		±3.0				
10e			329.99MHz *		±5.0				
10f			330MHz *		±5.0				
10g			400MHz *		±5.0				
10h			470MHz *		±5.0				
10j			530MHz *		±5.0				
10k			600MHz *		±5.0				
10l			1MHz		±1.5				
10m			30MHz		±1.5				

* = Option 600 only

Test Grp.	Load	Test Type	Output Freq.	Measured p-p Voltage at 50kHz	Specification Relative to 50kHz (% of Output)	User's Total Measurement Uncertainty (Um)	Flatness Validity Tolerance Limits		Measured p-p Voltage for Flatness Check
							Lower	Higher	
Ref	50Ω	315mV Flatness	50kHz						
11a			10MHz		±1.5				
11b			12MHz		±1.5				
11c			100MHz		±1.5				
11d			250MHz		±3.0				
11e			329.99MHz *		±5.0				
11f			330MHz *		±5.0				
11g			400MHz *		±5.0				
11h			470MHz *		±5.0				
11j			530MHz *		±5.0				
11k			600MHz *		±5.0				
11l			1MHz		±1.5				
11m			30MHz		±1.5				

* = Option 600 only

19.8.5 Verifying the Sine Function *(Contd.)*

Table 19.8.5.5 — Sine Function Verification — Flatness — 50kHz to 600MHz (Contd.)

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Test Grp.	Load	Test Type	Output Freq.	Measured p-p Voltage at 50kHz	Specification Relative to 50kHz (% of Output)	User's Total Measurement Uncertainty (Um)	Flatness Validity Tolerance Limits		Measured p-p Voltage for Flatness Check
							Lower	Higher	
Ref	50Ω	100mV Flatness	50kHz						
12a			10MHz		±1.5				
12b			12MHz		±1.5				
12c			100MHz		±1.5				
12d			250MHz		±3.0				
12e			329.99MHz *		±5.0				
12f			330MHz *		±5.0				
12g			400MHz *		±5.0				
12h			470MHz *		±5.0				
12j			530MHz *		±5.0				
12k			600MHz *		±5.0				
12l			1MHz		±1.5				
12m			30MHz		±1.5				

* = Option 600 only

Test Grp.	Load	Test Type	Output Freq.	Measured p-p Voltage at 50kHz	Specification Relative to 50kHz (% of Output)	User's Total Measurement Uncertainty (Um)	Flatness Validity Tolerance Limits		Measured p-p Voltage for Flatness Check
							Lower	Higher	
Ref	50Ω	32.5mV Flatness	50kHz						
13a			10MHz		±1.5				
13b			12MHz		±1.5				
13c			100MHz		±1.5				
13d			250MHz		±3.0				
13e			329.99MHz *		±5.0				
13f			330MHz *		±5.0				
13g			400MHz *		±5.0				
13h			470MHz *		±5.0				
13j			530MHz *		±5.0				
13k			600MHz *		±5.0				
13l			1MHz		±1.5				
13m			30MHz		±1.5				

* = Option 600 only

19.8.5 Verifying the Sine Function *(Contd.)*

Table 19.8.5.5 — Sine Function Verification — Flatness — 50kHz to 600MHz (Contd.)

Please copy the following table.
Enter the calculation results and measurements in the appropriate columns on the copy:

Test Grp.	Load	Test Type	Output Freq.	Measured p-p Voltage at 50kHz	Specification Relative to 50kHz (% of Output)	User's Total Measurement Uncertainty (Um)	Flatness Validity Tolerance Limits		Measured p-p Voltage for Flatness Check
							Lower	Higher	
Ref	50Ω	21mV Flatness	50kHz						
14a			10MHz		±1.5				
14b			12MHz		±1.5				
14c			100MHz		±1.5				
14d			250MHz		±3.0				
14e			329.99MHz *		±5.0				
14f			330MHz *		±5.0				
14g			400MHz *		±5.0				
14h			470MHz *		±5.0				
14j			530MHz *		±5.0				
14k			600MHz *		±5.0				
14l			1MHz		±1.5				
14m			30MHz		±1.5				

* = Option 600 only

19.8.5.6 Verifying Sine Function Flatness — 50kHz to 600MHz — Setting Validity Tolerances

a. **Introduction**

The first part of the verification procedure in sub-section 18.8.5.4 deals with verification of amplitude at frequencies below 50kHz, with input impedances of 50Ω and 1MΩ. A DMM in ACV function is used here as the calibration standard. Unfortunately, the frequency response of DMMs falls off at frequencies which must be used to verify HF flatness above 1MHz, and so a commonly-used technique employs an RF Power Meter. Flatness is normally expressed as a voltage relative to that at a reference frequency of 50kHz, and in our procedure the sub-table on page 19-28 is used to register the values at this reference frequency, as measured on the DMM. This can be used as an extra check to show the differences between the errors of the DMM and Power Meter, and the differences in impedance and standing wave ratio of their 50Ω terminations; if required.

For the flatness verification, each output voltage is measured as a power into 50Ω in an RF Power Meter, and converting power to pk-to-pk voltage using a formula given in the procedure. This voltage is compared against that obtained on the power meter at 50kHz, by checking that it is within validity tolerance limits about the 50kHz value.

To calculate the validity tolerance limits at each verification point, we must take into account the specified RF Power Meter accuracy, the sensor calibration correction and uncertainty, and the specified 9100 Option 250/600 accuracy. In this case, as we are quoting a worst-case summation tolerance, the validity tolerance must be the sum of the Power Meter tolerances plus the specification of the Sine function as a percentage of the value obtained at 50kHz.

b. **Calculation of Validity Tolerances — an Example**

This example uses figures derived from the specifications for the Marconi Instruments Model 6960B power meter.
On *page 19-30*, the 2.5V **Ref** test point on table 19.8 5.5 is at 50kHz, and the test point **8a** is at 10MHz.
If we are applying the sensor calibration correction to each measurement, we do not need to include it in the Validity Tolerance.

From the Power Meter Specification, let us say that its instrumentation accuracy is:	0.5%.
From the sensor calibration record at 50kHz, let us say that its uncertainty is:	0.9%.
Add the 50kHz sensor uncertainty to the Power Meter accuracy:	0.5% + 0.9% = ±1.4%
From the sensor calibration record at 10MHz, let us say that its uncertainty is:	0.6%.
Add the 10MHz sensor uncertainty to the Power Meter accuracy:	0.5% + 0.6% = ±1.1%
Add the total 10MHz uncertainty to the total 50kHz uncertainty:	1.4% + 1.1% = ±2.5%
But this is a power uncertainty, and the pk-pk voltage uncertainty will be half:	±1.25%
To this we must add the 9100 Option 250/600 pk-pk voltage flatness specification,	
At 10MHz, the Option 250/600 specification relative to 50kHz is **±1.5%** (pk-pk voltage):	(1.5% + 1.25%) = **±2.75%**

c. **A Measurement Example**

On *page 19-30*, the 2.5V **Ref** test point on table 19.8.5.5 is at 50kHz, and the test point **8a** is at 10MHz.
Let us say that the 50kHz 'Ref' test point power reading, as corrected by the sensor cal correction, was **15.71mW**.
Convert this to pk-pk voltage across 50Ω: Vpk-pk = 20√(Power into 50Ω) = 20√0.01571 = 2.50679V

To this value we must set the Validity Tolerance Limits:

Lower Limit = 2.50679 - (2.75% x 2.50679) = 2.50679 - 0.06894 = **2.43785**.
Higher Limit = 2.50679 + (2.75% x 2.50679) = 2.50679 + 0.06894 = **2.57573**.

These are the Validity Tolerance Limits to be placed on the pk-pk voltage flatness measurement at 10MHz, after conversion from the power reading. If the voltage is outside these limits, the 9100 has failed to verify.

Section 20 Calibrating the Model 9100 Options 250 and 600

20.1 About Section 20

This section deals with the calibration of the functions embodied in the Model 9100 oscilloscope calibration feature (Option 250 or 600).

It is assumed that users will be familiar with the general principles of calibrating the standard 9100 functions. In case of difficulty, refer to the *9100 User's Handbook, Volume 2, Section 10*, which contains the general details of entry into and exit from Calibration mode, Special Calibration and Standard Calibration for the standard instrument, basic sequences, front-panel calibration of the standard functions, and an introduction to remote calibration.

The information in this Section 20 is confined to lists of calibration points, equipment requirements, interconnections and suggested procedures for Edge, DC, Square, Markers and Sine functions of Options 250 and 600.

N.B. These procedures are written for those users who possess the necessary traceable standards and skills to perform the calibration operations on a calibrator of the 9100's complexity. Otherwise it is recommended that the 9100 Options 250 and 600 be calibrated and verified either by return to a Fluke Service Center, or where possible, by an on-site process using the Model 4950 Multifunction Transfer Standard.

20.2 Front Panel Calibration by Functions

20.2.1 Introduction

Sub-section 20.2 is a guide to the process of calibrating the Model 9100's Option 250 and 600 functions from the front panel. The following topics are covered:

20.2.2 Summary of Calibration Process

20.2.2.1 General Procedure

The *9100 User's Handbook, Volume 1, Section 10, Subsections 10.2 and 10.3* introduced the general calibration process for the Model 9100. They also outlined the methods used to select functions, hardware configurations and target calibration points, and how to calibrate the 9100 at these target points.

The entire process is outlined again in the *9100 User's Handbook, Volume 1, Section 10, Subsection 10.4.2.1* as a sequence of simple steps.

Note: Sine Function Calibration Points

At some calibration points the 9100 Option 250/600 provides extra display resolution. This is due to the non-decade switching required to track the oscilloscope 1, 2, 5 sequence, and to avoid rounding errors.

20.2.2.2 Sequencing Options 250 and 600 Calibrations

The table below indicates the recommended order in which the Option 250/600 functions should be calibrated:

Sequence	Function	Reference
1	Edge Function	*Section 20.2.3*
2	DC Function	*Section 20.2.4*
3	Square Function	*Section 20.2.5*
-	Markers Function	*No Calibration Required*
4	Sine Function (10Hz to 49.999kHz)	*Section 20.2.6*
5	Sine Function (50kHz to 600MHz Linearity)	*Section 20.2.7*
6	Sine Function (50kHz to 600MHz Flatness)	*Section 20.2.8*

Table 20.2.2.1: Recommended Sequence of Option 250/600 Calibrations

Note: Resolution at Calibration Points

At some calibration points the 9100 Option 250/600 provides extra display resolution. This is due to the non-decade switching required to track the oscilloscope 1, 2, 5 sequence, and to avoid rounding errors.

20.2.3 Edge Function Calibration

20.2.3.1 Introduction

This sub-section is a guide to calibrating the Option 250/600 Edge Function using its front panel controls. The following topics are covered:

20.2.3.2 Calibration Equipment Requirements
20.2.3.3 Interconnections
20.2.3.4 Calibration Setup
20.2.3.5 Calibration Procedure

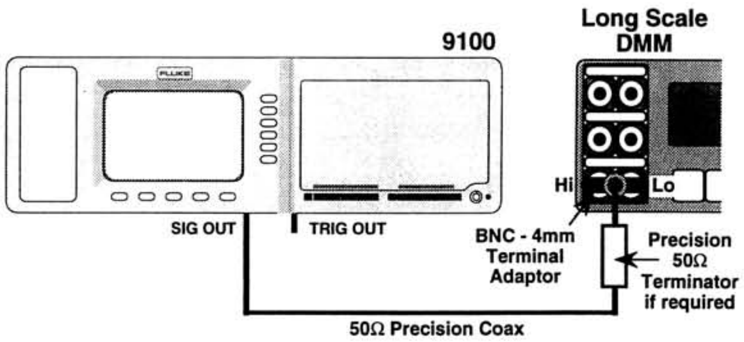
20.2.3.2 Calibration Equipment Requirements

- Long-scale DMM for Amplitude measurements.
  Example: Fluke Model 1281.
- Precision 50Ω BNC co-axial 'Signal' cable.
  Example: Fluke part no. 630442 (supplied).
- Precision 50Ω BNC through terminator, for signal connection from Option 250/600 SIG OUT in 50Ω output mode to the input of the DMM; if required for Amplitude measurements.
  Example: Fluke part no. 630447 (supplied).
- BNC-4mm Terminal Adapter for signal connection from Option 250/600 SIG OUT to the input of the DMM for Amplitude measurements.
  Example: ITT Pomona Adapter 1269.

20.2.3.3 Interconnections

Use the following connections for the Measurements shown:

Amplitude Measurements



20.2.3.4 Calibration Setup

1. Connections Ensure that the 9100 is connected to the Standards DMM as shown in *Para 20.2.3.3*, and that both instruments are powered on and warmed up.

2. 9100 Ensure that the 9100 is in STANDARD CAL mode and then select the Option 250/600 Edge function by pressing the '**Aux**' key on the right of the front panel, followed by the soft key on the right of the screen

Table 20.2.3.1: Edge Function Hardware Configurations and Calibration Points at 1kHz

Load	Edge Type	Output span covered by hardware configuration	Suitable output to select hardware configuration	Calibration Targets			Factor Number
				Default	Minimum	Maximum	
1MΩ	↑	088.80mV to 4.4440V	100mV 2V	100.00mV 2.0000V	090.00mV 1.8000V	110.00mV 2.2000V	1 2
1MΩ	↑	4.4441V to 55.600V	5V 50V	5.0000V 50.000V	4.2500V 45.000V	5.7500V 55.000V	1 2
50Ω	↑	088.80mV to 336.00mV	100mV 300mV	100.00mV 300.00mV	090.00mV 270.00mV	110.00mV 330.00mV	1 2
50Ω	↑	0.3361V to 1.1120V	370mV 1V	370.00mV 1.0000V	340.00mV 0.9000V	400.00mV 1.1000V	1 2
50Ω	↓	088.80mV to 336.00mV	100mV 300mV	100.00mV 300.00mV	090.00mV 270.00mV	110.00mV 330.00mV	1 2
50Ω	↓	0.3361V to 1.1120V	370mV 1V	370.00mV 100.00V	340.00mV 0.9000V	400.00mV 1.1000V	1 2

20.2.3.5 Calibration Procedure

1. Select the required hardware configuration by setting the 9100 Option 250/600 output to a suitable value that uses the hardware configuration.
2. Ensure that the DMM is AC-coupled.
   Set the DMM to the correct RMS range for the calibration point pk-pk Output Voltage (RMS = 0.5 x pk-pk).
3. Press the 9100's **TARGET** screen key to display the hardware configuration's target selection screen.
4. Use (a) or (b):
   a. To use the target calibration points used during the *previous calibration* (indicated by the displayed SAVED CALIBRATION TARGETS), press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
   b. To use the *default* target calibration points defined for this hardware configuration, press the **DEFLT** screen key and then press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
5. To change the amplitude of the target calibration point, press the **TAB** ⊕ key to position the cursor on the target value amplitude. Now use any of the 9100's normal editing modes to change this value. (Note that the new value must lie within the minimum and maximum limits specified in the tables opposite)
6. Press the **TRANSFR** screen key to transfer the target calibration point value to the 9100's output control display.
7. Calculate the RMS value of 9100 output voltage: RMS = 0.5 x Pk-Pk value
8. Press the **ON** key to turn the 9100 output on.
9. Press the **TAB** ⊕ key to return the cursor to the 9100 output amplitude display, and increment or decrement this value using the cursor controls and/or spinwheel, until the reading on the DMM connected to the 9100 front-panel terminals is the RMS equivalent of the displayed target Pk-Pk value. (Note: make sure to allow for any settling time required by the external measuring instrument.)
9. When you are satisfied with the measurement, press the **CALIB** key to generate and implement the correction factor required by the 9100, to ensure that its displayed output value and actual output value coincide. The screen will revert to the **CAL** mode of the normal function screen, and the measured value should now be equal to the RMS equivalent of displayed output value.
11. Press the **OFF** key to turn the 9100 output off.
12. Repeat steps (2) to (11) for each of the target values displayed in the target selection screen.
13. Repeat steps (1) to (12) for each of the hardware configurations detailed in the tables opposite (also see note below).

Note: If other Option 250/600 functions are being calibrated in addition to Edge function, refer to *Table 20.2.2.1 on page 20.2-2* for information on sequencing calibrations.

20.2.4 DC Function Calibration

20.2.4.1 Introduction

This sub-section is a guide to calibrating the Option 250/600 DC Function using its front panel controls. The following topics are covered:

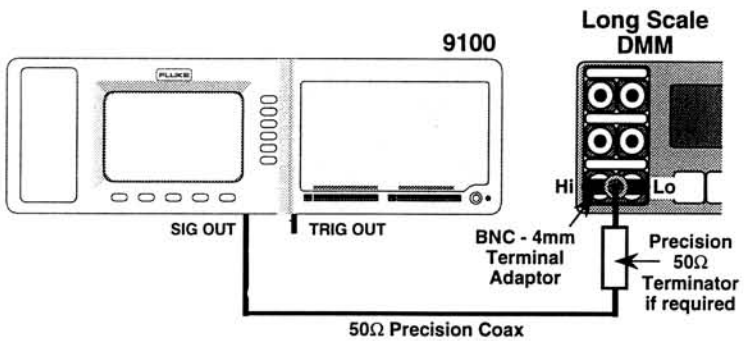
20.2.4.2 Calibration Equipment Requirements

- Long-scale DMM for magnitude measurements.
  Example: Fluke Model 1281.
- Precision 50Ω BNC co-axial 'Signal' cable.
  Example: Fluke part no. 630442 (supplied).
- Precision 50Ω BNC through terminator, for signal connection from Option 250/600 SIG OUT in 50Ω output mode to the input of the DMM; if required for Amplitude measurements.
  Example: Fluke part no. 630447 (supplied).
- BNC-4mm Terminal Adapter for signal connection from Option 250/600 SIG OUT to the input of the DMM for Amplitude measurements.
  Example: ITT Pomona Adapter 1269.

20.2.4.3 Interconnections

Use the following connections for the Measurements shown:

Magnitude Measurements



10.2.4.4 Calibration Setup

1. **Connections** Ensure that the 9100 is connected to the Standards DMM as shown in *Para 20.2.4.3*, and that both instruments are powered on and warmed up.

2. **9100** Ensure that the 9100 is in STANDARD CAL mode and then select the Option 250/600 DC function by pressing the '**Aux**' key on the right of the front panel, followed by the [ ] soft key on the right of the screen

Table 20.2.4.1: DC Function Hardware Configurations and Calibration Points

Load	Output span covered by hardware configuration	Suitable output to select hardware configuration	Calibration Targets			Factor Number
			Default	Minimum	Maximum	
1MΩ	±04.440mV to ±14.700mV	10mV	-10.000mV +10.000mV	-11.500mV +08.500mV	-08.500mV +11.500mV	1 2
1MΩ	±14.701mV to ±147.00mV	100mV	-100.00mV +100.00mV	-115.00mV +085.00mV	-085.00mV +115.00mV	1 2
1MΩ	±147.01mV to ±745.00mV	500mV	-500.00mV +500.00mV	-575.00mV +425.00mV	-425.00mV +575.00mV	1 2
1MΩ	±0.7451V to ±2.7200V	1.8V	-1.8000V +1.8000V	-2.1000V +1.5000V	-1.5000V +2.1000V	1 2
1MΩ	±2.7201V to ±4.4440V	3.75V	-3.7500mV +3.7500mV	-4.3000V +3.2000V	-3.2000V +4.3000V	1 2
1MΩ	±4.4441V to ±32.000V	19V	-19.000V +19.000V	-22.000V +16.000V	-16.000V +22.000V	1 2
1MΩ	±32.001V to ±133.44V	100V	-100.00V +100.00V	-115.00V +085.00V	-085.00V +115.00V	1 2
50Ω	±04.440mV to ±14.700mV	10mV	-10.000mV +10.000mV	-11.500mV +08.500mV	-08.500mV ±11.500mV	1 2
50Ω	±14.701mV to ±147.00mV	100mV	-100.00mV +100.00mV	-115.00mV +085.00mV	-085.00mV +115.00mV	1 2
50Ω	±147.01mV to ±745.00mV	500mV	-500.00mV +500.00mV	-575.00mV +425.00mV	-425.00mV +575.00mV	1 2
50Ω	±0.7451V to ±2.7800V	1.8V	-1.8000V +1.8000V	-2.1000V +1.5000V	-1.5000V +2.1000V	1 2

10.2.4.5 Calibration Procedure

1. Select the required hardware configuration by setting the 9100 Option 250/600 output to a suitable value that uses the hardware configuration.
2. Set the DMM to the appropriate measurement function and range.
3. Press the 9100's **TARGET** screen key to display the hardware configuration's target selection screen.
4. Use (a) or (b):
   a. To use the target calibration points used during the *previous calibration* (indicated by the displayed SAVED CALIBRATION TARGETS), press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
   b. To use the *default* target calibration points defined for this hardware configuration, press the **DEFLT** screen key and then press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
5. To change the amplitude of the target calibration point, press the **TAB** ⊖ key to position the cursor on the target value amplitude. Now use any of the 9100's normal editing modes to change this value. (Note that the new value must lie within the minimum and maximum limits specified in the tables opposite)
6. Press the **TRANSFR** screen key to transfer the target calibration point value to the 9100's output control display.
7. Press the **ON** key to turn the 9100 output on.
8. Press the **TAB** ⊖ key to return the cursor to the 9100 output amplitude display, and increment or decrement this value using the cursor controls and/or spinwheel until the reading on the DMM connected to the 9100 front-panel terminals is the same as the displayed target value. (Note: make sure to allow for any settling time required by the external measuring instrument.)
9. When you are satisfied with the measurement, press the **CALIB** key to generate and implement the correction factor required by the 9100, to ensure that its displayed output value and actual output value coincide. The screen will revert to the **CAL** mode of the normal function screen, and the measured value should now be equal to the displayed output value.
10. Press the **OFF** key to turn the 9100 output off.
11. Repeat steps (2) to (10) for each of the target values displayed in the target selection screen.
12. Repeat steps (1) to (11) for each of the hardware configurations detailed in the tables opposite (also see note below).

Note: If other Option 250/600 functions are being calibrated in addition to DC function, refer to *Table 20.2.2.1 on page 20.2-2* for information on sequencing calibrations.

20.2.5 Square Function Calibration

20.2.5.1 Introduction

This sub-section is a guide to calibrating the Option 250/600 Square Function using its front panel controls. The following topics are covered:

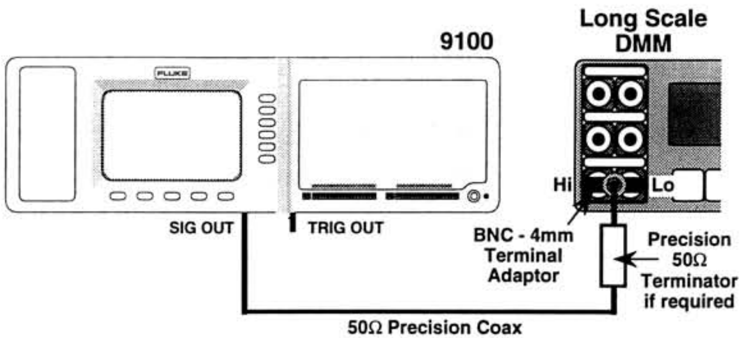
20.2.5.2 Calibration Equipment Requirements

- Long-scale DMM for Amplitude measurements.
  Example: Fluke Model 1281.
- Precision 50Ω BNC co-axial 'Signal' cable.
  Example: Fluke part no. 630442 (supplied).
- Precision 50Ω BNC through terminator, for signal connection from Option 250/600 SIG OUT in 50Ω output mode to the input of the DMM; if required for Amplitude measurements.
  Example: Fluke part no. 630447 (supplied).
- BNC-4mm Terminal Adaptor for signal connection from Option 250/600 SIG OUT to the input of the DMM for Amplitude measurements.
  Example: ITT Pomona Adapter 1269.

20.2.5.3 Interconnections

Use the following connections for the Measurements shown:

Amplitude Measurements



20.2.5.4 Calibration Setup

1. **Connections** Ensure that the 9100 is connected to the Standards DMM as shown in *Para 20.2.5.3*, and that both instruments are powered on and warmed up.

2. **9100** Ensure that the 9100 is in STANDARD CAL mode and then select the Option 250/600 Square function by pressing the '**Aux**' key on the right of the front panel, followed by the ⊓⊔ soft key on the right of the screen .

Table 20.2.5.1: Square Function Hardware Configurations and Calibration Points at 1kHz

Load	Output span covered by hardware configuration	Suitable output to select hardware configuration	Calibration Targets			Factor Number
			Default	Minimum	Maximum	
1MΩ	04.440mV to 22.220mV	10mV 20mV	10.000mV 20.000mV	08.500mV 17.000mV	11.500mV 23.000mV	1 2
1MΩ	22.221mV to 147.00mV	25mV 130mV	25.000mV 130.00mV	21.000mV 110.00mV	29.000mV 150.00mV	1 2
1MΩ	147.01mV to 1.0890V	165mV 0.9V	165.00mV 0.9000V	140.00mV 0.7650V	190.00mV 1.0350V	1 2
1MΩ	1.0891V to 3.3360V	1.2V 3V	1.2000V 3.0000V	1.0000V 2.5500V	1.4000V 3.4500V	1 2
1MΩ	3.3361V to 4.4440V	3.6V 4.2V	3.6000V 4.2000V	3.2000V 4.0000V	3.9000V 4.6000V	1 2
1MΩ	4.4441V to 44.440V	5V 40V	5.0000V 40.000V	4.2500V 34.000V	5.7500V 46.000V	1 2
1MΩ	44.441V to 133.44V	50V 120V	50.000V 120.00V	42.500V 100.00V	57.500V 133.44V	1 2
50Ω	04.440mV to 22.220mV	10mV 20mV	10.000mV 20.000mV	08.500mV 17.000mV	11.500mV 23.000mV	1 2
50Ω	22.221mV to 147.00mV	25mV 130mV	25.000mV 130.00mV	21.000mV 110.00mV	29.000mV 150.00mV	1 2
50Ω	147.01mV to 1.0890V	165mV 0.9V	165.00mV 0.9000V	140.00mV 0.7650V	190.00mV 1.0350V	1 2
50Ω	1.0891V to 3.3360V	1.2V 3V	1.2000V 3.0000V	1.0000V 2.5500V	1.4000V 3.4500V	1 2

20.2.5.5 Calibration Procedure

1. Select the required hardware configuration by setting the 9100 Option 250/600 output to a suitable value that uses the hardware configuration.
2. Ensure that the DMM is AC-coupled.
Set the DMM to the correct RMS range for the calibration point pk-pk Output Voltage (RMS = 0.5 x 0.9968 x pk-pk).
3. Press the 9100's **TARGET** screen key to display the hardware configuration's target selection screen.
4. Use (a) or (b):
   a. To use the target calibration points used during the *previous calibration* (indicated by the displayed SAVED CALIBRATION TARGETS), press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
   b. To use the *default* target calibration points defined for this hardware configuration, press the **DEFLT** screen key and then press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
5. To change the amplitude of the target calibration point, press the **TAB** ⊖ key to position the cursor on the target value amplitude. Now use any of the 9100's normal editing modes to change this value. (Note that the new value must lie within the minimum and maximum limits specified in the tables opposite)
6. Press the **TRANSFR** screen key to transfer the target calibration point value to the 9100's output control display.
7. Calculate the RMS value of 9100 output voltage: RMS = 0.5 x 0.9968 x Pk-Pk value
8. Press the **ON** key to turn the 9100 output on.
9. Press the **TAB** ⊖ key to return the cursor to the 9100 output amplitude display, and increment or decrement this value using the cursor controls and/or spinwheel, until the reading on the DMM connected to the 9100 front-panel terminals is the RMS equivalent of the displayed target Pk-Pk value. (Note: make sure to allow for any settling time required by the external measuring instrument.)
9. When you are satisfied with the measurement, press the **CALIB** key to generate and implement the correction factor required by the 9100, to ensure that its displayed output value and actual output value coincide. The screen will revert to the **CAL** mode of the normal function screen, and the measured value should now be equal to the RMS equivalent of displayed output value.
11. Press the **OFF** key to turn the 9100 output off.
12. Repeat steps (2) to (11) for each of the target values displayed in the target selection screen.
13. Repeat steps (1) to (12) for each of the hardware configurations detailed in the tables opposite (also see note below).

Note: If other Option 250/600 functions are being calibrated in addition to Square function, refer to *Table 20.2.2.1 on page 20.2-2* for information on sequencing calibrations.

20.2.6 Sine Function LF Calibration

20.2.6.1 Introduction

This sub-section is a guide to calibrating the Option 250/600 Sine Function using its front panel controls. The following topics are covered:

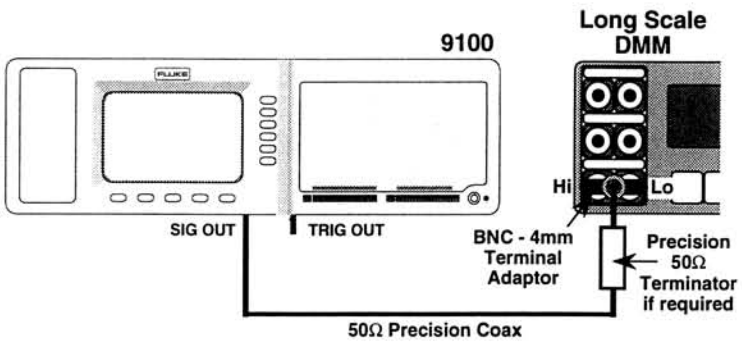
20.2.6.2 Calibration Equipment Requirements

- Long-scale DMM for Amplitude measurements.
  Example: Fluke Model 1281.
- Precision 50Ω BNC co-axial 'Signal' cable.
  Example: Fluke part no. 630442 (supplied).
- Precision 50Ω BNC through terminator, for signal connection from Option 250/600 SIG OUT in 50Ω output mode to the input of the DMM; if required for Amplitude measurements.
  Example: Fluke part no. 630447 (supplied).
- BNC-4mm Terminal Adaptor for signal connection from Option 250/600 SIG OUT to the input of the DMM for Amplitude measurements.
  Example: ITT Pomona Adapter 1269.

20.2.6.3 Interconnections

Use the following connections for the Measurements shown:

Flatness Measurements



20.2.6.4 Calibration Setup

1. **Connections** Ensure that the 9100 is connected to the Standards DMM as shown in *Para 20.2.6.3*, and that both instruments are powered on and warmed up.

2. **9100** Ensure that the 9100 is in STANDARD CAL mode and then select the Option 250/600 Sine function by pressing the '**Aux**' key on the right of the front panel, followed by the soft key on the right of the screen.

Table 20.2.6.1: Sine Function Hardware Configurations and Calibration Points Into 1MΩ Load

Load	Output span covered by hardware configuration	Frequency	Suitable output to select hardware configuration	Calibration Targets			Factor Number
				Default	Minimum	Maximum	
1MΩ	04.440mV to 44.440mV	1.0000kHz	19mV	19.000mV	16.000mV	22.000mV	1
		30.000kHz	19mV	19.000mV	16.000mV	22.000mV	2
		49.000kHz	19mV	19.000mV	16.000mV	22.000mV	3
1MΩ	44.441mV to 444.40mV	1.0000kHz	190mV	190.00mV	160.00mV	220.00mV	1
		30.000kHz	190mV	190.00mV	160.00mV	220.00mV	2
		49.000kHz	190mV	190.00mV	160.00mV	220.00mV	3
1MΩ	444.41mV to 2.2220V	1.0000kHz	1V	1.0000V	0.8500V	1.1500V	1
		30.000kHz	1V	1.0000V	0.8500V	1.1500V	2
		49.000kHz	1V	1.0000V	0.8500V	1.1500V	3
1MΩ	2.2221V to 5.4440V	1.0000kHz	4V	4.0000V	3.4000V	4.6000V	1
		30.000kHz	4V	4.0000V	3.4000V	4.6000V	2
		49.000kHz	4V	4.0000V	3.4000V	4.6000V	3
1MΩ	5.4441V to 8.8880V	1.0000kHz	7.5V	7.5000V	06.400V	08.600V	1
		30.000kHz	7.5V	7.5000V	06.400V	08.600V	2
		49.000kHz	7.5V	7.5000V	06.400V	08.600V	3
1MΩ	8.8881V to 8.8880V	1.0000kHz	50V	50.000V	42.500V	57.500V	1
		30.000kHz	50V	50.000V	42.500V	57.500V	2
		49.000kHz	50V	50.000V	42.500V	57.500V	3
1MΩ	88.881V to 133.44V	1.0000kHz	110V	110.00V	090.00V	130.00V	1
		30.000kHz	110V	110.00V	090.00V	130.00V	2
		49.000kHz	110V	110.00V	090.00V	130.00V	3

Table 20.2.6.2: Sine Function Hardware Configurations and Calibration Points into 50Ω Load

Load	Output span covered by hardware configuration	Frequency	Suitable output to select hardware configuration	Calibration Targets			Factor Number
				Default	Minimum	Maximum	
50Ω	04.440mV to 44.440mV	1.0000kHz 30.000kHz 49.000kHz	19mV 19mV 19mV	19.000mV 19.000mV 19.000mV	16.000mV 16.000mV 16.000mV	22.000mV 22.000mV 22.000mV	1 2 3
50Ω	44.441mV to 444.40mV	1.0000kHz 30.000kHz 49.000kHz	190mV 190mV 190mV	190.00mV 190.00mV 190.00mV	160.00mV 160.00mV 160.00mV	220.00mV 220.00mV 220.00mV	1 2 3
50Ω	444.41mV to 2.2220V	1.0000kHz 30.000kHz 49.000kHz	1V 1V 1V	1.0000V 1.0000V 1.0000V	0.8500V 0.8500V 0.8500V	1.1500V 1.1500V 1.1500V	1 2 3
50Ω	2.2221V to 5.5600V	1.0000kHz 30.000kHz 49.000kHz	4V 4V 4V	4.0000V 4.0000V 4.0000V	3.4000V 3.4000V 3.4000V	4.6000V 4.6000V 4.6000V	1 2 3

Procedure Overleaf →

20.2.6.5 Calibration Procedure *(Using calibration-point tables 20.2.6.1 and 20.2.6.2)*

1. Select the required hardware configuration by setting the 9100 Option 250/600 output to a suitable value that uses the hardware configuration.

2. Set the DMM to the correct RMS range for the calibration point pk-pk Output Voltage (RMS = 0.3536 x pk-pk).

3. Press the 9100's **TARGET** screen key to display the hardware configuration's target selection screen.

4. Use (a) or (b):

a. To use the target calibration points used during the *previous calibration* (indicated by the displayed SAVED CALIBRATION TARGETS), press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.

b. To use the *default* target calibration points defined for this hardware configuration, press the **DEFLT** screen key and then press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.

5. To change the amplitude of the target calibration point, press the **TAB** ⊕ key to position the cursor on the target value amplitude. Now use any of the 9100's normal editing modes to change this value. (Note that the new value must lie within the minimum and maximum limits specified in the tables opposite)

6. Press the **TRANSFR** screen key to transfer the target calibration point value to the 9100's output control display.

7. Calculate the RMS value of 9100 output voltage: RMS = 0.3536 x Pk-Pk value

8. Press the **ON** key to turn the 9100 output on.

9. Press the **TAB** ⊕ key to return the cursor to the 9100 output amplitude display, and increment or decrement this value using the cursor controls and/or spinwheel, until the reading on the DMM connected to the 9100 front-panel terminals is the RMS equivalent of the displayed target Pk-Pk value. (Note: make sure to allow for any settling time required by the external measuring instrument.)

9. When you are satisfied with the measurement, press the **CALIB** key to generate and implement the correction factor required by the 9100, to ensure that its displayed output value and actual output value coincide. The screen will revert to the **CAL** mode of the normal function screen, and the measured value should now be equal to the RMS equivalent of displayed output value.

11. Press the **OFF** key to turn the 9100 output off.

12. Repeat steps (2) to (11) for each of the target values displayed in the target selection screen.

13. Repeat steps (1) to (12) for each of the hardware configurations detailed in the tables opposite (also see note below).

Note: If other Option 250/600 functions are being calibrated in addition to Square function, refer to *Table 20.2.2.1 on page 20.2-2* for information on sequencing calibrations.

20.2.7 Sine Function HF Linearity Calibration

20.2.7.1 Introduction

This calibration is required only after replacement of the levelling 100pF components. It is unlikely that a user will possess the required equipment. The following topics are covered:

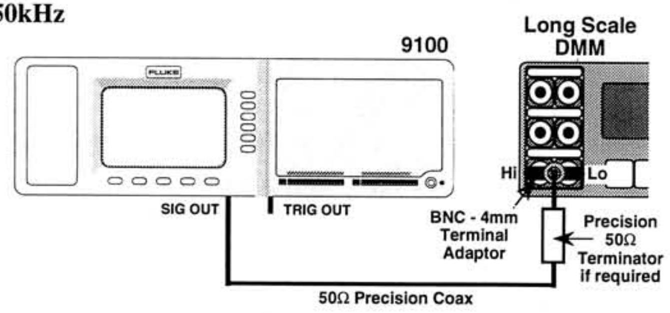
20.2.7.2 Calibration Equipment Requirements

- Long-scale DMM for Amplitude measurements at 50kHz.
  Example: Fluke Model 1281.
- RF Power Meter for Power measurements from 10MHz to 600MHz and from 0.9V p-p to 5Vp-p into 50Ω.
  Examples: Hewlett Packard HP437B with HP8482A head, or Marconi Instruments Model 6960B with Model 6912 head.
- Precision 50Ω BNC co-axial 'Signal' cable.
  Example: Fluke part no. 630442 (supplied).
- Precision 50Ω BNC through terminator, for signal connection from Option 250/600 SIG OUT in 50Ω output mode to the input of the DMM; if required for Amplitude measurements.
  Example: Fluke part no. 630447 (supplied).
- BNC-4mm Terminal Adaptor for signal connection from Option 250/600 SIG OUT cable to the input of the DMM for Amplitude measurements.
  Example: ITT Pomona Adapter 1269.
- Precision-N to BNC Adaptor for signal connection from Option 250/600 SIG OUT cable to the input of the RF Power Meter head for Amplitude measurements.
  Example: Huber & Suhner Adapter type no. 31BNC-N-50-51.

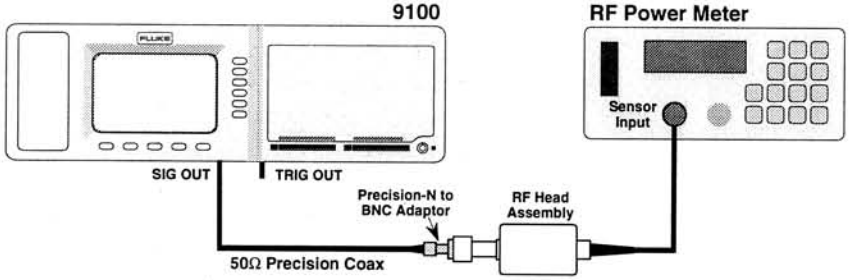
20.2.7.3 Interconnections

Use the following connections for the Measurements shown:

a. Linearity Measurements: 50kHz



b. Linearity Measurements: 10MHz to 600MHz



20.2.7.4 50kHz Linearity Calibration Setup

1. **Connections** Ensure that the 9100 is connected to the Standards DMM as shown in *Para 20.2.7.3a*, and that both instruments are powered on and warmed up.

2. **9100** Ensure that the 9100 is in Calibration Mode. Select the SCOPE LINEAR CAL mode.

Table 20.2.7.1: Sine Function Hardware Configurations and Linearity Calibration Points at 50kHz

Load	Frequency	Output span covered by hardware configuration	Suitable output to select hardware configuration	Calibration Targets			Factor Number
				Default	Minimum	Maximum	
50Ω	50.000kHz	10.656mV to 5.5600V	0.9V	0.9000V	0.6000V	1.0000V	1
			1.25V	1.2500V	1.0500V	1.5000V	2
			1.75V	1.7500V	1.5500V	2.1000V	3
			2.5V	2.5000V	2.1500V	2.8000V	4
			3.5V	3.5500V	2.8500V	3.9500V	5
			5V	5.0000V	4.0000V	6.0000V	6

20.2.7.5 **Calibration Procedure** *(Using calibration-point table 20.2.7.1)*

1. Select the required hardware configuration by setting the 9100 Option 250/600 output to a suitable value that uses the hardware configuration.
2. Ensure that the DMM is AC-coupled.
   Set the DMM to the correct RMS range for the calibration point pk-pk Output Voltage (RMS = 0.3536 x pk-pk).
3. Press the 9100's **TARGET** screen key to display the hardware configuration's target selection screen.
4. Use (a) or (b):
   a. To use the target calibration points used during the *previous calibration* (indicated by the displayed SAVED CALIBRATION TARGETS), press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
   b. To use the *default* target calibration points defined for this hardware configuration, press the **DEFLT** screen key and then press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
5. To change the amplitude of the target calibration point, press the **TAB** ⊕ key to position the cursor on the target value amplitude. Now use any of the 9100's normal editing modes to change this value. (Note that the new value must lie within the minimum and maximum limits specified in the table opposite)
6. Press the **TRANSFR** screen key to transfer the target calibration point value to the 9100's output control display.
7. Calculate the RMS value of 9100 output voltage: RMS = 0.3536 x Pk-Pk value
8. Press the **ON** key to turn the 9100 output on.
9. Press the **TAB** ⊕ key to return the cursor to the 9100 output amplitude display, and increment or decrement this value using the cursor controls and/or spinwheel, until the reading on the DMM connected to the 9100 front-panel terminals is the RMS equivalent of the displayed target Pk-Pk value. (Note: make sure to allow for any settling time required by the external measuring instrument.)
9. When you are satisfied with the measurement, press the **CALIB** key to generate and implement the correction factor required by the 9100, to ensure that its displayed output value and actual output value coincide. The screen will revert to the **CAL** mode of the normal function screen, and the measured value should now be equal to the RMS equivalent of displayed output value.
11. Press the **OFF** key to turn the 9100 output off.
12. Repeat steps (2) to (11) for each of the target values displayed in the target selection screen.
13. Repeat steps (1) to (12) for each of the hardware configurations detailed in *Table 20.2.7.1* (also see note below).

Note: If other Option 250/600 functions are being calibrated in addition to Square function, refer to *Table 20.2.2.1 on page 20.2-2* for information on sequencing calibrations.

20.2.7.6 10MHz - 600MHz Linearity Calibration Setup

1. **Connections** Ensure that the 9100 is connected to the Standards DMM as shown in *Para 20.2.7.3b*, and that both instruments are powered on and warmed up.

2. **9100** Ensure that the 9100 is in Calibration Mode with SCOPE LINEAR CAL mode selected.

Table 20.2.7.2: Sine Function Hardware Configurations and Linearity Calibration Points at 10MHz - 600MHz

Load	Frequency	Output span covered by hardware configuration	Suitable output to select hardware configuration	Calibration Targets			Factor Number
				Default	Minimum	Maximum	
50Ω	10MHz	10.656mV to 5.5600V	0.9V	0.9000V	0.6000V	1.0000V	1
			1.25V	1.2500V	1.0500V	1.5000V	2
			1.75V	1.7500V	1.5500V	2.1000V	3
			2.5V	2.5000V	2.1500V	2.8000V	4
			3.5V	3.5500V	2.8500V	3.9500V	5
			5V	5.0000V	4.0000V	6.0000V	6
50Ω	12MHz	10.656mV to 5.5600V	0.9V	0.9000V	0.6000V	1.0000V	1
			1.25V	1.2500V	1.0500V	1.5000V	2
			1.75V	1.7500V	1.5500V	2.1000V	3
			2.5V	2.5000V	2.1500V	2.8000V	4
			3.5V	3.5500V	2.8500V	3.9500V	5
			5V	5.0000V	4.0000V	6.0000V	6
50Ω	100MHz	10.656mV to 5.5600V	0.9V	0.9000V	0.6000V	1.0000V	1
			1.25V	1.2500V	1.0500V	1.5000V	2
			1.75V	1.7500V	1.5500V	2.1000V	3
			2.5V	2.5000V	2.1500V	2.8000V	4
			3.5V	3.5500V	2.8500V	3.9500V	5
			5V	5.0000V	4.0000V	6.0000V	6
50Ω	250MHz	10.656mV to 5.5600V	0.9V	0.9000V	0.6000V	1.0000V	1
			1.25V	1.2500V	1.0500V	1.5000V	2
			1.75V	1.7500V	1.5500V	2.1000V	3
			2.5V	2.5000V	2.1500V	2.8000V	4
			3.5V	3.5500V	2.8500V	3.9500V	5
			5V	5.0000V	4.0000V	6.0000V	6
50Ω	600MHz	10.656mV to 3.3360V	0.9V	0.9000V	0.6000V	1.0000V	1
			1.25V	1.2500V	1.0500V	1.5000V	2
			1.75V	1.7500V	1.5500V	2.1000V	3
			2.5V	2.5000V	2.1500V	2.8000V	4
			3.5V	3.5500V	2.8500V	3.9500V	5

20.2.7.7 Calibration Procedure *(Using calibration-point table 20.2.7.2)*

1. Select the required hardware configuration by setting the 9100 Option 250/600 output to a suitable value that uses the hardware configuration.
2. Set the RF Power Meter to measure power in units of watts, *not* dBm..
3. Press the 9100's **TARGET** screen key to display the hardware configuration's target selection screen.
4. Use (a) or (b):
   a. To use the target calibration points used during the *previous calibration* (indicated by the displayed SAVED CALIBRATION TARGETS), press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
   b. To use the *default* target calibration points defined for this hardware configuration, press the **DEFLT** screen key and then press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
5. To change the amplitude of the target calibration point, press the **TAB** ⊖ key to position the cursor on the target value amplitude. Now use any of the 9100's normal editing modes to change this value. (Note that the new value must lie within the minimum and maximum limits specified in the table opposite)
6. Press the **TRANSFR** screen key to transfer the target calibration point value to the 9100's output control display.
7. Calculate the Power Equivalent of the 9100 output voltage into 50Ω: Power into 50Ω = $(\text{Pk-Pk Voltage}/20)^2$
8. Press the **ON** key to turn the 9100 output on.
9. Press the **TAB** ⊖ key to return the cursor to the 9100 output amplitude display, and increment or decrement this value using the cursor controls and/or spinwheel, until the reading on the RF Power Meter connected to the 9100 front-panel terminals is the Power Equivalent of the displayed target Pk-Pk value. (Note: make sure to allow for any settling time required by the external measuring instrument.)
9. When you are satisfied with the measurement, press the **CALIB** key to generate and implement the correction factor required by the 9100, to ensure that its displayed output value and actual output value coincide. The screen will revert to the **CAL** mode of the normal function screen, and the measured value should now be equal to the Power Equivalent of displayed output value.
11. Press the **OFF** key to turn the 9100 output off.
12. Repeat steps (2) to (11) for each of the target values displayed in the target selection screen.
13. Repeat steps (1) to (12) for each of the hardware configurations detailed in *Table 20.2.7.2* (also see note below).

Note: If other Option 250/600 functions are being calibrated in addition to Square function, refer to *Table 20.2.2.1 on page 20.2-2* for information on sequencing calibrations.

20.2.8 Sine Function HF Flatness Calibration

20.2.8.1 Introduction

These procedures complete the calibration of the Sine function. The following topics are covered:

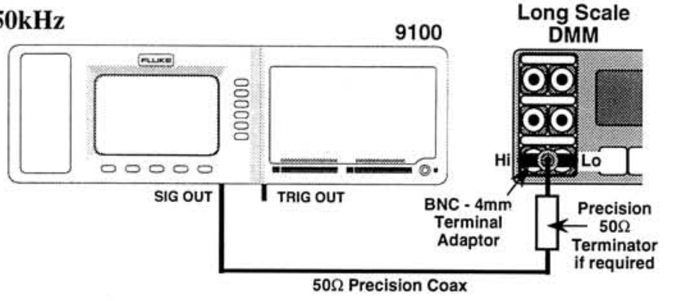
20.2.8.2 Calibration Equipment Requirements

- Long-scale DMM for Amplitude measurements at 50kHz.
  Example: Fluke Model 1281.
- RF Power Meter for Power measurements from 10MHz to 600MHz and from 21mVp-p to 2.5Vp-p into 50Ω.
  Examples: Hewlett Packard HP437B with HP8482A head, or Marconi Instruments Model 6960B with Model 6912 head.
- Precision 50Ω BNC co-axial 'Signal' cable.
  Example: Fluke part no. 630442 (supplied).
- Precision 50Ω BNC through terminator, for signal connection from Option 250/600 SIG OUT in 50Ω output mode to the input of the DMM; if required for Amplitude measurements.
  Example: Fluke part no. 630447 (supplied).
- BNC-4mm Terminal Adaptor for signal connection from Option 250/600 SIG OUT cable to the input of the DMM for Amplitude measurements.
  Example: ITT Pomona Adapter 1269.
- Precision-N to BNC Adaptor for signal connection from Option 250/600 SIG OUT cable to the input of the RF Power Meter head for Amplitude measurements.
  Example: Huber & Suhner Adapter type no. 31BNC-N-50-51.

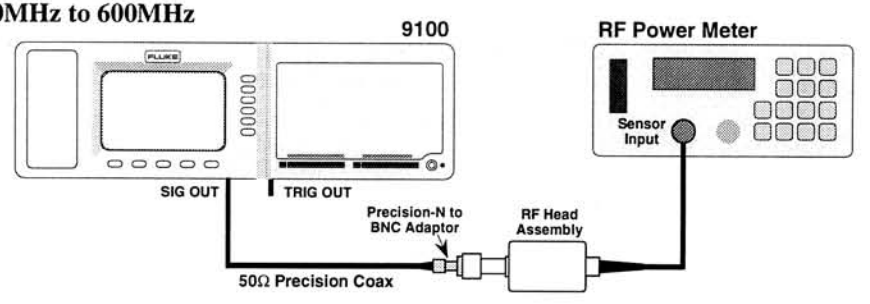
20.2.8.3 Interconnections

Use the following connections for the Measurements shown:

a. Reference Measurements: 50kHz



b. Flatness Measurements: 10MHz to 600MHz



20.2.8.4 50kHz Reference Calibration Setup

1. Connections Ensure that the 9100 is connected to the Standards DMM as shown in *Para 20.2.8.3a*, and that both instruments are powered on and warmed up.

2. 9100 Ensure that the 9100 is in STANDARD CAL mode and then select the Option 250/600 Sine function by pressing the '**Aux**' key on the right of the front panel, followed by the soft key on the right of the screen.

Table 20.2.8.1: Sine Function Hardware Configurations and Reference Calibration Points at 50kHz

Load	Output span covered by hardware configuration	Frequency	Suitable output to select hardware configuration	Calibration Targets			Factor Number
				Default	Minimum	Maximum	
50Ω	10.656mV to 5.5600V	50kHz	2.5V	2.5000V	1.7500V	3.2500V	1
			3.5V	3.5500V	2.8500V	3.9500V	1
			0.9V	0.9000V	0.6000V	1.2000V	1
			315mV	315.00mV	250.00mV	380.00mV	1
			100mV	100.00mV	80.000mV	120.00mV	1
			32.5mV	32.500mV	26.500mV	39.000mV	1
			21mV	21.000mV	16.500mV	25.000mV	1

Note that because there are 11 target frequencies for each target value in Sine function flatness calibration, these are selectable in two groups on the selection screen. This screen therefore differs slightly from that shown in Volume 2, Sect. 9, with two toggle screen keys (for Factors 1-6 and 7-11); but operation is self-explanatory.

20.2.8.5 Calibration Procedure *(Using calibration-point table 20.2.8.1)*

1. Select the required hardware configuration by setting the 9100 Option 250/600 output to a suitable value that uses the hardware configuration.
2. Ensure that the DMM is AC-coupled.
   Set the DMM to the correct RMS range for the calibration point pk-pk Output Voltage (RMS = 0.3536 x pk-pk).
3. Press the 9100's **TARGET** screen key to display the hardware configuration's target selection screen.
4. Use (a) or (b):
   a. To use the target calibration points used during the *previous calibration* (indicated by the displayed SAVED CALIBRATION TARGETS), press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
   b. To use the *default* target calibration points defined for this hardware configuration, press the **DEFLT** screen key and then press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
5. To change the amplitude of the target calibration point, press the **TAB** ⊖ key to position the cursor on the target value amplitude. Now use any of the 9100's normal editing modes to change this value. (Note that the new value must lie within the minimum and maximum limits specified in the table opposite)
6. Press the **TRANSFR** screen key to transfer the target calibration point value to the 9100's output control display.
7. Calculate the RMS value of 9100 output voltage: RMS = 0.3536 x Pk-Pk value
8. Press the **ON** key to turn the 9100 output on.
9. Press the **TAB** ⊖ key to return the cursor to the 9100 output amplitude display, and increment or decrement this value using the cursor controls and/or spinwheel, until the reading on the DMM connected to the 9100 front-panel terminals is the RMS equivalent of the displayed target Pk-Pk value. (Note: make sure to allow for any settling time required by the external measuring instrument.)
9. When you are satisfied with the measurement, press the **CALIB** key to generate and implement the correction factor required by the 9100, to ensure that its displayed output value and actual output value coincide. The screen will revert to the **CAL** mode of the normal function screen, and the measured value should now be equal to the RMS equivalent of displayed output value.
11. Press the **OFF** key to turn the 9100 output off.
12. Repeat steps (2) to (11) for each of the target values displayed in the target selection screen.
13. Repeat steps (1) to (12) for each of the hardware configurations detailed in *Table 20.2.8.1* (also see note below).

Note: If other Option 250/600 functions are being calibrated in addition to Square function, refer to *Table 20.2.2.1 on page 20.2-2* for information on sequencing calibrations.

20.2.8.6 10MHz - 600MHz Flatness Calibration Setup

1. **Connections** Ensure that the 9100 is connected to the Standards DMM as shown in *Para 20.2.8.3b*, and that both instruments are powered on and warmed up.

2. **9100** Ensure that the 9100 is in STANDARD CAL mode and Option 250/600 Sine function. Note that because there are 11 target frequencies for each target value in Sine function flatness calibration, these are selectable in two groups on the selection screen. This screen therefore differs slightly from that shown in Volume 2, Sect. 9, with two toggle screen keys (for Factors 1-6 and 7-11); but operation is self-explanatory.

Table 20.2.8.2: Sine Function Hardware Configurations and Flatness Calibration Points at 10MHz - 600MHz

Load	Output span covered by hardware configuration	Suitable output to select hardware configuration	Frequency	Calibration Targets			Factor Number
				Default	Minimum	Maximum	
50Ω	10.656mV to 5.5600V	2.5V	10.000MHz	2.5000V	1.7500V	3.2500V	2
			12.000MHz	2.5000V	1.7500V	3.2500V	3
			100.00MHz	2.5000V	1.7500V	3.2500V	4
			250.00MHz	2.5000V	1.7500V	3.2500V	5
			329.99MHz	2.5000V	1.7500V	3.2500V	6
			330.00MHz	2.5000V	1.7500V	3.2500V	7
			400.00MHz	2.5000V	1.7500V	3.2500V	8
			470.00MHz	2.5000V	1.7500V	3.2500V	9
			530.00MHz	2.5000V	1.7500V	3.2500V	10
			600.00MHz	2.5000V	1.7500V	3.2500V	11
50Ω	10.656mV to 5.5600V	3.5V	10.000MHz	3.5500V	2.8500V	3.9500V	2
			12.000MHz	3.5500V	2.8500V	3.9500V	3
			100.00MHz	3.5500V	2.8500V	3.9500V	4
			250.00MHz	3.5500V	2.8500V	3.9500V	5
			329.99MHz	3.5500V	2.8500V	3.9500V	6
			330.00MHz	3.5500V	2.8500V	3.9500V	7
			400.00MHz	3.5500V	2.8500V	3.9500V	8
			470.00MHz	3.5500V	2.8500V	3.9500V	9
			530.00MHz	3.5500V	2.8500V	3.9500V	10
			600.00MHz	3.5500V	2.8500V	3.9500V	11
50Ω	10.656mV to 5.5600V	0.9V	10.000MHz	0.9000V	0.6000V	1.2000V	2
			12.000MHz	0.9000V	0.6000V	1.2000V	3
			100.00MHz	0.9000V	0.6000V	1.2000V	4
			250.00MHz	0.9000V	0.6000V	1.2000V	5
			329.99MHz	0.9000V	0.6000V	1.2000V	6
			330.00MHz	0.9000V	0.6000V	1.2000V	7
			400.00MHz	0.9000V	0.6000V	1.2000V	8
			470.00MHz	0.9000V	0.6000V	1.2000V	9
			530.00MHz	0.9000V	0.6000V	1.2000V	10
			600.00MHz	0.9000V	0.6000V	1.2000V	11

Table 20.2.8.2: Sine Function Hardware Configurations and Flatness Calibration Points at 10MHz - 600MHz *(Contd.)*

Load	Output span covered by hardware configuration	Suitable output to select hardware configuration	Frequency	Calibration Targets			Factor Number
				Default	Minimum	Maximum	
50Ω	10.656mV to 5.5600V	315mV	10.000MHz	315.00mV	250.00mV	380.00mV	2
			12.000MHz	315.00mV	250.00mV	380.00mV	3
			100.00MHz	315.00mV	250.00mV	380.00mV	4
			250.00MHz	315.00mV	250.00mV	380.00mV	5
			329.99MHz	315.00mV	250.00mV	380.00mV	6
			330.00MHz	315.00mV	250.00mV	380.00mV	7
			400.00MHz	315.00mV	250.00mV	380.00mV	8
			470.00MHz	315.00mV	250.00mV	380.00mV	9
			530.00MHz	315.00mV	250.00mV	380.00mV	10
			600.00MHz	315.00mV	250.00mV	380.00mV	11
50Ω	10.656mV to 5.5600V	100mV	10.000MHz	100.00mV	80.000mV	120.00mV	2
			12.000MHz	100.00mV	80.000mV	120.00mV	3
			100.00MHz	100.00mV	80.000mV	120.00mV	4
			250.00MHz	100.00mV	80.000mV	120.00mV	5
			329.99MHz	100.00mV	80.000mV	120.00mV	6
			330.00MHz	100.00mV	80.000mV	120.00mV	7
			400.00MHz	100.00mV	80.000mV	120.00mV	8
			470.00MHz	100.00mV	80.000mV	120.00mV	9
			530.00MHz	100.00mV	80.000mV	120.00mV	10
			600.00MHz	100.00mV	80.000mV	120.00mV	11
50Ω	10.656mV to 5.5600V	32.5mV	10.000MHz	32.500mV	26.500mV	39.000mV	2
			12.000MHz	32.500mV	26.500mV	39.000mV	3
			100.00MHz	32.500mV	26.500mV	39.000mV	4
			250.00MHz	32.500mV	26.500mV	39.000mV	5
			329.99MHz	32.500mV	26.500mV	39.000mV	6
			330.00MHz	32.500mV	26.500mV	39.000mV	7
			400.00MHz	32.500mV	26.500mV	39.000mV	8
			470.00MHz	32.500mV	26.500mV	39.000mV	9
			530.00MHz	32.500mV	26.500mV	39.000mV	10
			600.00MHz	32.500mV	26.500mV	39.000mV	11
50Ω	10.656mV to 5.5600V	21mV	10.000MHz	21.000mV	16.500mV	25.000mV	2
			12.000MHz	21.000mV	16.500mV	25.000mV	3
			100.00MHz	21.000mV	16.500mV	25.000mV	4
			250.00MHz	21.000mV	16.500mV	25.000mV	5
			329.99MHz	21.000mV	16.500mV	25.000mV	6
			330.00MHz	21.000mV	16.500mV	25.000mV	7
			400.00MHz	21.000mV	16.500mV	25.000mV	8
			470.00MHz	21.000mV	16.500mV	25.000mV	9
			530.00MHz	21.000mV	16.500mV	25.000mV	10
			600.00MHz	21.000mV	16.500mV	25.000mV	11

20.2.8.7 Calibration Procedure *(Using calibration-point table 20.2.8.2)*

1. Select the required hardware configuration by setting the 9100 Option 250/600 output to a suitable value that uses the hardware configuration.
2. Set the RF Power Meter to measure power in units of watts, *not* dBm..
3. Press the 9100's **TARGET** screen key to display the hardware configuration's target selection screen.
4. Use (a) or (b):
   a. To use the target calibration points used during the *previous calibration* (indicated by the displayed SAVED CALIBRATION TARGETS), press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
   b. To use the *default* target calibration points defined for this hardware configuration, press the **DEFLT** screen key and then press the **Factor** screen key corresponding to the required target value, to display a 'calibrate' screen for the target value.
5. To change the amplitude of the target calibration point, press the **TAB** ⊖ key to position the cursor on the target value amplitude. Now use any of the 9100's normal editing modes to change this value. (Note that the new value must lie within the minimum and maximum limits specified in the table opposite)
6. Press the **TRANSFR** screen key to transfer the target calibration point value to the 9100's output control display.
7. Calculate the Power Equivalent of the 9100 output voltage into 50Ω: Power into 50Ω = (Pk-Pk Voltage/20)^2
8. Press the **ON** key to turn the 9100 output on.
9. Press the **TAB** ⊖ key to return the cursor to the 9100 output amplitude display, and increment or decrement this value using the cursor controls and/or spinwheel, until the reading on the RF Power Meter connected to the 9100 front-panel terminals is the Power Equivalent of the displayed target Pk-Pk value. (Note: make sure to allow for any settling time required by the external measuring instrument.)

9. When you are satisfied with the measurement, press the **CALIB** key to generate and implement the correction factor required by the 9100, to ensure that its displayed output value and actual output value coincide. The screen will revert to the **CAL** mode of the normal function screen, and the measured value should now be equal to the Power Equivalent of displayed output value.

11. Press the **OFF** key to turn the 9100 output off.
12. Repeat steps (2) to (11) for each of the target values displayed in the target selection screen.
13. Repeat steps (1) to (12) for each of the hardware configurations detailed in the *Tables 20.2.8.2* (also see note below).

Note: If other Option 250/600 functions are being calibrated in addition to Square function, refer to *Table 20.2.2.1 on page 20.2-2* for information on sequencing calibrations.