Contents

RF & MICROWAVE SCALAR ANALYZERS

6820A SERIES

and

RF & MICROWAVE SYSTEM ANALYZERS

6840A SERIES

Getting Started

Document part no. 46892/922

SCALAR ANALYZER
6820A SERIES
and
MICROWAVE SYSTEM ANALYZER
6840A SERIES

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About this manual

Intended audience

Persons engaged on work relating to the design and manufacture of RF and microwave sub-systems and modules, or the installation and maintenance of these systems. It is assumed that the reader will be familiar with the terms used in RF and microwave measurements.

Structure

The purpose of this manual is to show how 6800A Series instruments can be used for common microwave measurements. It serves to demonstrate many of the features and capabilities of the 6800A in actual measurement situations. By following the example measurement procedures provided in this guide you will soon become familiar with the basic controls and capabilities of the instrument, and will see how quickly and easily accurate measurements can be made.

Chapter 1 provides an overview of front panel operation and then presents a general step-by-step procedure for making microwave measurements on components and transmission lines. With a few exceptions, this procedure is followed throughout the examples in Chapter 2.

Chapter 2 illustrates the 6800A at work making some typical measurements. The examples provided illustrate many of the instrument's features and their ease of implementation. They are grouped into component, spectrum analyzer and transmission line measurements.

When you are familiar with the basic operation of the 6800A, you can then make fullest use of the more detailed information contained in the 6800A Operating Manual, which includes detailed descriptions of all the soft key menus. Remote operation is not covered in this manual; this information can be found in the Remote Operating Manual.

Document conventions

The following conventions are used in this manual:

CAPS	Capitals are used to identify names of controls and panel markings, or system functions where no direct reference to an associated key is intended.
[CAPS]	Capitals in square brackets indicate hard key titles.
[Italics]	Italics in square brackets indicate soft key titles.
[Averaging ●]	A '●' after a soft key title indicates that the key has a toggle action, and that the function is enabled.
[Averaging ○]	A '○' after a soft key title indicates that the key has a toggle action, and that the function is disabled.

The term '6800A' is used in a general sense to refer to any instrument in the 6800A series.

Associated publications

There are two other publications covering specific aspects of the equipment:

- **Operating Manual** (46882/920). Provides local operating information for the instrument.
- **Remote Operating Manual** (46882/921). Provides information for controlling the instrument remotely using either the GPIB or RS-232 interfaces.

CONTENTS

Chapter 1
INTRODUCTION

Controls overview

The front panel of the 6800A has been designed to simplify operation and provide a logical approach to making measurements. It is assumed that you are familiar with the basic concepts of the 6800A user interface; this is covered in detail at the front of Chapter 3 of the 6800A Operating Manual. Note that the 6820A series of instruments are scalar analyzers with integrated synthesized source; a 6840A series instrument additionally has an integral spectrum analyzer. A brief outline of the functions of the front panel hard keys is given below:

DISPLAY group

[DISPLAY]	Enables selection of single or dual channel display, and which measurements within a channel are to be displayed.
[SELECT MEAS]	Cycles around all the displayed measurements, making each active in turn.
[SWITCH CHANNEL]	Switches to the other channel, making it active.

CHANNEL MODE group

[SCALAR]

Configures the 6800A to make scalar measurements. If the channel is not already scalar, pressing this key defines it as a scalar channel containing measurement 1 (with channel specific parameters set to default values).

Configure inputs to measure absolute power or a power ratio, or the **tuned input** mode can be used where the spectrum analyzer receiver is used in place of a detector for frequency selective power measurements.

Use the **conversion measurements** facilities to make measurements on frequency conversion devices. Functions are provided that enable the frequency displayed on the x-axis to be scaled/offset from the source frequency for these measurements. Power conversion devices such as amplifiers can similarly be measured, by displaying a power sweep range that is offset from the source power range.

For systems where a linear phase/frequency response is important, **group delay** measurements can be performed.

Input offsets can be applied, and AC or DC **detection mode** selected.

Correction can be applied to compensate for non-ideal detector characteristics (using detector EEPROM data).

Limit checking can be applied, whereby the measurement is compared against upper and lower complex limit lines, defined by the user.

Apply **averaging** and **smoothing** to reduce trace noise and ripple.

[FAULT LOCATION]

Configures the 6800A to make fault location measurements. If the channel is not already fault location, pressing this key defines it as a fault location channel containing measurement 1 (with channel specific parameters set to default values).

Transmission line parameters can be entered directly, or can be set up automatically from a **transmission line database** record. Functions are provided for searching, copying records to 6800A stores, and storing data for transmission lines not included in the database.

Most of the functions described above for a scalar channel are provided (**input offsets**, **detection mode**, **detector correction**, **averaging** and **limit checking**), but with the following additions:

Windowing - reduces side lobes associated with the main peak on the display.

Masking correction - corrects for amplitude errors.

Zoom mode - allows part of the display range to be magnified.

[SPECTRUM]

Configures the 6800A to make spectrum analyzer measurements (only applies to 6840A series instruments). If the channel is not already spectrum analyzer, pressing this key defines it as a spectrum analyzer channel containing measurement 1 (with channel specific parameters set to default values).

Set up the spectrum analyzer **receiver parameters** (e.g. frequency range, resolution bandwidth, video bandwidth).

Signal tracking can be enabled to prevent the signal going outside the sweep range during narrow-band sweeps.

The **demodulation** facility allows the display of demodulated signals.

Limit checking can be applied and the **x-axis annotation** specified.

SETUP & ANALYSIS group

[SOURCE] Provides control of the synthesized sweep generator.

Scalar channel:

Select **source mode** (CW or sweep), and set up **sweep parameters**. The signal can also be **frequency modulated** in CW mode.

Select the **levelling mode** that is used to control the output power.

Select the **frequency standard** used by the synthesized source.

Provides control of the programmable **voltage output**.

Fault location channel:

The functions provided are similar to those of a scalar channel, except that the source mode is not user-definable, and the source frequency range is set via the [FAULT LOCATION] key

Spectrum analyzer channel:

Enables the source to be set to CW or to be used as a tracking generator, i.e. set to the frequency range of the spectrum analyzer receiver (with optional offset / scaling).

[CAL] Enables system errors to be removed prior to a measurement, and detectors to be zeroed.

[SCALE / FORMAT] Enables the size and placement of the trace on the graticule to be adjusted, and selection of the units in which the measurement is displayed.

[MARKER] Provides access to various marker functions, which allow the measurement to be examined in greater detail (e.g. max/min, peak-peak, search, bandwidth). The marker table can also be turned on/off

[SAVE / RECALL] Enables measurement traces and instrument settings to be saved or recalled, using either internal stores or removable storage. Provides a facility for making measurements relative to a stored trace.

[PRINT] Accesses the hard copy functions of the 6800A. Hard copies of all measurements can be created using a suitable printer. A printer can also be used to print out textual data, such as limit specifications and instrument settings stores.

SYSTEM group

[RUN APPS] Used to select and run application programs, which have previously been installed from removable storage.

[UTILITY] Provides access to instrument setup and service functions:

Enter main screen and measurement titles.
Set user passwords.
Define the step size used by the step up/down keys.
Configure instrument for a particular country.
Install application programs.
Set up instrument for remote (GPIB or RS-232) operation.

Set up the LCD and real time clock.
Instrument store management.
Display/keyboard tests.
Examine power-on test results.
Instrument calibrations.

[LOCAL] Used to return the instrument to local (front panel) operation after being put into remote mode.

[PRESET] Returns the instrument to its default set-up conditions, or to settings defined by the user.

SOURCE ON / OFF Turns the source on and off.

Additional information on the spectrum analyzer

A common requirement in RF and microwave measurements is to examine two or more signals which are close together in frequency, identify low level signals (such as modulation, harmonics and noise) in the presence of high level signals, and accurately measure the frequency and level of signals. In order to do this, it is necessary to understand the basic functioning of a spectrum analyzer and the parameters and settings of a spectrum analyzer which affect the accuracy and repeatability of measurements.

Whereas a scalar analyzer measures the response of a device or sub-system due to an applied stimulus, a spectrum analyzer is generally used to analyze the frequency content of a signal. The signal is represented by displaying the amplitude of its frequency components. The frequency resolution and the part of the spectrum to be analyzed are easily set by the user.

RF and microwave spectrum analyzers operate on the following principle. A ramp generator sweeps a local oscillator, whose output is mixed with the input signal to be measured. The output from the mixer is a fixed intermediate frequency; this passes through switchable band pass IF filters and is then detected. The horizontal axis of the display is driven by the ramp generator and the y axis by the detector output.

Spectrum analyzer controls

The main parameters that need to be set when using a spectrum analyzer are:

- ***Frequency range*** of the spectrum analyzer receiver; this determines the part of the spectrum that is to be analyzed.
- ***Reference level***. This is the response value that corresponds to the top graticule line for dBm, dBμV and Volts formats, and the middle line for % and kHz/MHz formats (when viewing FM demodulated waveforms).
- ***Resolution bandwidth***. This is the bandwidth of the IF filter. Resolution is the ability of the analyzer to discriminate between signals closely separated in frequency. For example, if two tones are analyzed, the analyzer will only be able to discriminate between them if the resolution bandwidth selected is narrower than the tone separation. Filter selection becomes more critical if the tones are at different levels. Narrow resolution bandwidth also results in lower noise on the trace. The resolution bandwidth can be set between 1 kHz and 3 MHz in a 1, 3, 10... sequence.
- ***Video bandwidth***. Signals close to the noise level will be hard to see clearly. To overcome this, a low pass filter (called the video filter) is introduced after the detector. The video bandwidth is the high frequency cutoff point of the filter. The video filter reduces high frequency noise on the detected signal and enables low level signals to be identified that would otherwise be buried in the noise. The video bandwidth can be set between 1 Hz and 100 kHz in a 1, 3, 10... sequence.
- ***Sweep time***. Due to the finite bandwidth of the resolution filters, it takes time for the energy to build up in the filter as the spectrum analyzer sweeps through a signal. If the analyzer is sweeping too fast, the resolution filters will not respond correctly; this results in the signal being reduced in amplitude and appearing to the right of the correct position. The narrower the filter, the slower the sweep speed must be.
- ***Input attenuation***. This is the setting of the internal RF step attenuator, which is needed to prevent high signal levels appearing at the input of the first mixer, resulting in the generation of unwanted intermodulation products.

Coupling of parameters

Under normal circumstances the operator would set the frequency range of the receiver and the reference level. RF attenuation, video bandwidth, resolution bandwidth and sweep time are set automatically by the instrument, but these settings can be uncoupled so that they can be set explicitly by the operator.

Following setting of the frequency span, the instrument maintains the fastest possible sweep time subject to the restriction that Span / Resolution Bandwidth >= 50 at all times. The resolution bandwidth setting will be adjusted, if necessary, to maintain that condition.

Following setting of the reference level, the input attenuator (and also IF and video stages) are set optimally for a signal corresponding to the reference level. The attenuator is set to give optimum dynamic range by maintaining the signal level at the input to the first mixer such that internally generated intermodulation or distortion products do not appear greater than the noise level. (When the input attenuator is controlled manually, however, overloading can occur and distortion products can be produced.

Following setting of the resolution bandwidth or video bandwidth, the optimum setting of sweep time for the current frequency span will be determined automatically.

Other useful features

- ***Auto tune***. Sets up a spectrum analyzer measurement automatically. A wideband measurement is performed, and the receiver tuning and reference level settings are adjusted to place the peak with the highest amplitude at the reference level, and at the centre of the screen. The span is set to 20 MHz. The frequency step size is set equal to the centred signal frequency in order to facilitate stepping between harmonics.
- ***Signal tracking***. When enabled, this function causes the spectrum analyzer centre frequency to be adjusted, at the end of each sweep, in order to place the signal identified by the active marker at the centre of the display. This will prevent the signal going outside the sweep range, and disappearing from the screen, when narrowband sweeps are being used.
- ***Tracking generator***. When enabled, the 6800A source is used as a tracking generator, i.e. it produces a swept signal whose frequency precisely tracks the tuning of the spectrum analyzer receiver. The tracking generator can be used to provide the sweeping signal for measuring the frequency response of both active and passive devices..
- ***Demodulation facilities***. In the demodulation mode the analyzer acts as a fixed tuned receiver and is used for recovering modulating signals or for real time monitoring of a signal. Amplitude demodulated signals can therefore be displayed on the screen against a time axis. The signals can also be heard by using the integral loudspeaker. FM demodulated signals can be analyzed in a similar way by displaying FM deviation against a time axis. The major use for demodulation is to help identify the origin of a spurious transmission.

Switching on

Connect the 6800A to the AC supply using the AC supply lead provided with the instrument. Refer to Chapter 2 of the Operating Manual for full details on connecting to the AC supply.

If the yellow SOFT START LED that is adjacent to the front panel SUPPLY switch is illuminated, this indicates that AC power is being applied to the instrument; if not, operate the rear panel AC supply switch (above the AC input connector). Pressing the SUPPLY switch activates the instrument and the green POWER LED will illuminate. A self-test routine is first of all carried out; if the self-test fails, the test results are logged and a message is displayed. To access the test results, press [UTILITY] *[Service] [Status] [Display Test Results]* which will indicate the reason for the failure.

Once the self tests have been completed, the instrument will be automatically set up to the state it was in when it was last powered down. However, the [PRESET] key can be used to force the instrument into its default state, or to preset the instrument according to the contents of a user-defined settings store (the *[Save Settings as User Default]* soft key in the Save/Recall menu is used to save instrument settings to a user default settings store).

General measurement sequence

Below is a summary of the general measurement procedure that is used in the example measurements presented in Chapter 2. The sequence shown below provides a systematic approach to making microwave measurements. The spectrum analyzer examples do not have a numbered sequence, but the general approach to making measurements is the same as for scalar and fault location measurements.

- Use **[PRESET]** to put the instrument into a known state.
- Use **[DISPLAY]** to define the display configuration.
- Use **[SCALAR]**, **[FAULT LOCATION]** or **[SPECTRUM]** to define the measurements to be made.
- Use **[SOURCE]** to define the stimulus to be applied during the measurement.
- Use **[CAL]** to calibrate out any systematic errors in the measurement path, and to zero detectors.
- Use **[SCALE/FORMAT]** to select the appropriate scale and position for each measurement trace, and to select the units for each measurement response.
- Use **[MARKER]** and other 6800A features to examine the measurement in detail and perform various types of analysis.

Additionally, the following 6800A features can be used once a measurement has been made:

- Use **[PRINT]** to create a permanent record of the measurement results.
- Use **[SAVE/RECALL]** to save the instrument state or measurement traces for future use, and to specify measurements relative to memory (i.e. a stored trace) .

In the example measurements of Chapter 2, the actual keys to be pressed are shown in the left hand column of the page. In the right hand column an explanation of the effect of the keys is given.

Precautions

WARNING **Observe the warnings given in the 'Precautions' section of the Operating Manuals for the 6800A Series.**

Microwave connectors

Care should be taken when using microwave connectors, both on the 6800A and any accessories that are used, such as cables, adapters, attenuators, etc. Complying with the following precautionary notes will ensure longer component life time and less equipment downtime due to connector or component failure. These measures will also help to ensure that the components will operate within specification and give repeatable results.

- The precision connectors fitted to the 6800A, and its accessories may be damaged by mating with a non-precision type. Damage to these and other connectors may occur if the connector interface parameters are not within specification. This should be checked with the appropriate gauging tool. It is strongly recommended that every connector be gauged prior to its first use and regularly thereafter, e.g. every 20 connections.
- The precise geometry of the connectors can be easily degraded by dirt and other contamination adhering to connector interfaces. Alcohol is the recommended cleaning agent, and a clean, damp cotton swab is the recommended applicator. When not in use, keep the connectors covered with the protective caps provided.
- Always use the correct mating techniques. In particular, the two connectors to be mated should be pressed together such that the pin penetrates the collet prior to the nut being tightened. Never rotate one connector body relative to the other because this wears out the mating interfaces, thus reducing connector lifetime.
- Avoid over-torquing connectors during mating, because it may damage the connector centre pin or may cause the connector body to turn in its housing.
- Avoid mechanical shock by dropping or otherwise roughly handling microwave components.

Excessive detector input power

The 6230A/L Series EEPROM scalar detectors that are used with the 6800A utilise zero-biased Schottky diodes. These are of a physically small geometry and consequently can be damaged under high power conditions. **It is strongly recommended that care is taken to avoid exceeding an input power of +20 dBm for 'A' versions and +26 dBm for 'L' versions during normal operation.**

Chapter 2
EXAMPLE MEASUREMENTS

Component measurements

Example 1: Insertion loss measurement of a band-pass filter

In the first example measurement, we will measure the insertion loss response of a 9 GHz band-pass filter. This will be a narrowband measurement so that the passband response can be examined in detail. The measurement system is shown in Fig. 2-1. Note that either a 6823, 6824, 6843 or 6844 is needed in order to cover the required frequency range.

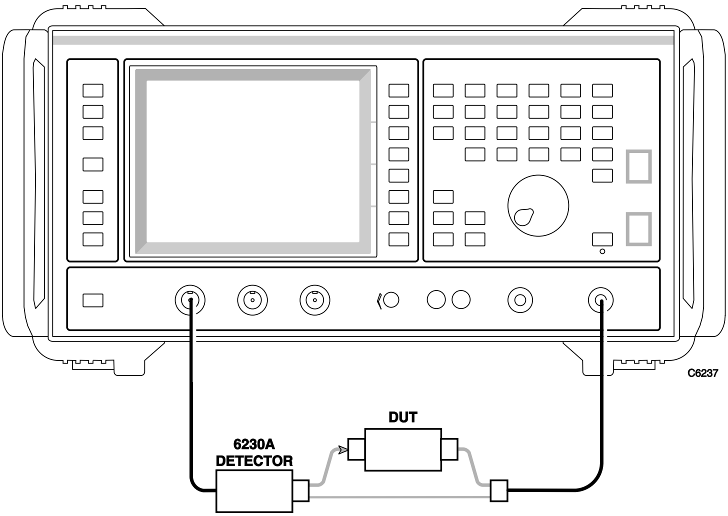


Fig. 2-1 Setup for single channel insertion loss measurement

Although a ratio system involving a reference detector and a power splitter could be used to improve mismatch uncertainty, the source match of the synthesized sweep generator within the 6800A is sufficiently good to make it unnecessary in the majority of measurement situations. (Example 4 provides an example of a ratioed measurement.)

Connect the detector as shown in Fig. 2-1. The 6230A/L series detector contains an EEPROM which holds flatness and linearity correction data for the detector. This is read by the 6800A and used to correct the measurement data, resulting in improved accuracy. Flatness and linearity correction can be turned on or off by using the Input A (B or C) Corr menu; it is enabled by default, i.e. following a PRESET.

Step 1 - Preset the instrument to a known state

[PRESET]
[Full]

Pressing these keys will result in the instrument being preset to its default state, as defined in Appendix A of the Operating Manual. The Scalar menu will be shown along with a single scalar measurement of input A (Fig. 2-2). For 6840A series instruments a spectrum analyzer measurement is displayed.

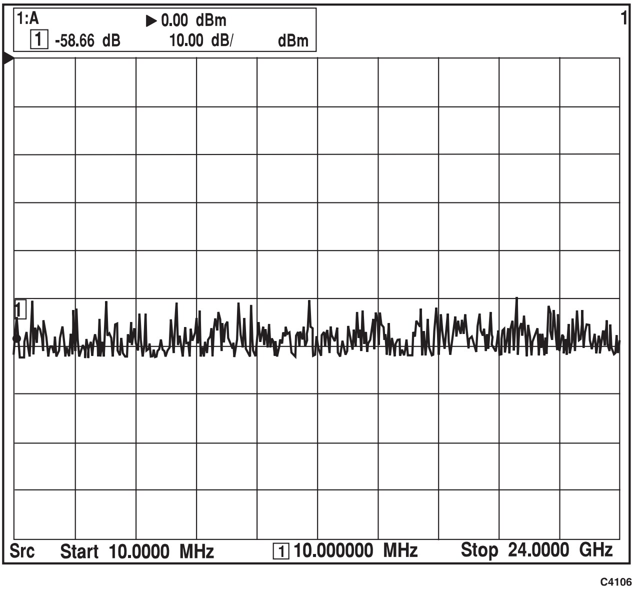


Fig. 2-2 Single channel display

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the insertion loss of the filter. The default state of the instrument is a single channel displaying measurement 1. For a 6820A series instrument this will be a scalar channel. For a 6840A series instrument the channel will be Spectrum Analyzer and it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar. Alternatively, the **[SWITCH CHANNEL]** key can be used so that channel 2 is displayed, which defaults to scalar for all instruments.

Step 3 - Define the measurements

From Fig. 2-1 we see that the insertion loss is measured by a scalar detector connected to input A of the 6800A. No changes need to be made since all scalar measurements default to input A following PRESET.

At this stage, the decision to use either AC or DC detection should be made. When making swept measurements, AC detection mode will tend to give you better low level measurements than DC detection. The reason is that in AC detection mode, the RF output is chopped, and the analyzer constantly compares the RF ON level to the RF OFF level. Because the analyzer is always measuring the RF OFF level, the effects of zero drift are effectively cancelled. In the DC detection mode, an unmodulated RF signal is used and the detector simply converts the incident RF to an equivalent DC output. This mode will have to be used, for example, when measuring amplifiers with automatic gain control that cannot handle AC modulation.

In this example, the AC detection mode will be used, and is set as follows:

[SCALAR] ***[More]*** ***[AC Detection]***	If the ***[AC Detection]*** soft key label is not highlighted, press it to select AC detection mode (the default is DC detection).

It is worth noting that by default, i.e. following the use of the **[PRESET]** key, **detector autozeroing** is disabled. It can be turned on by pressing **[CAL]** ***[Detector Autozeroing]***; this is indicated by the **AZ** indicator in the General Information Area. When it is on, detector zeroing will be performed as a background task in the inter-sweep period. The RF is turned off automatically whilst the zero takes place. This process removes any drift in the zero level of the data acquisition system. If you change the detector connected to a particular input, you should perform a manual detector zero by selecting **[CAL]** ***[Zero Detectors].***

Step 4 - Define the source conditions

Following the pressing of the [PRESET] key in Step 1, all the source parameters have been set to their default values (this is also the case if the channel mode is changed). A complete list of the default conditions may be found in Appendix A of the Operating Manual, but the major ones are shown below:

Start Frequency	Minimum frequency
Stop Frequency	Maximum available
Output Power	0 dBm
Number of Points	401
Sweep Time	Auto
RF	Off
Source Mode	Start & Stop Frequency Sweep
Channel Coupling	On for 6820A series; Off for 6840A series

Since the passband of the filter we wish to measure is centred at 9 GHz, it is necessary to change the start and stop frequency values. The output power level, number of measurement points and sweep time can remain at their default settings.

[SOURCE] ***[Set Start Frequency]***	This results in a dialogue box being displayed which shows the existing value of the parameter and prompts you to enter a new value. Whilst such a dialogue box is displayed the rotary control and step keys may be used to change the value; alternatively the numeric keys may be used to enter a specific value.
[8] [G $_n$]	Once entered, the graticule annotation will reflect the change in start frequency value.
[Set Stop Frequency] **[1] [0] [G $_n$]**	Sets the stop frequency to 10 GHz.
[ENTRY OFF]	The dialogue box is removed by pressing this key.
[SOURCE ON/OFF]	The 6800A source is turned on and off by pressing this key; the LED underneath will illuminate when the source is turned on. Note that it is not necessary to manually turn on the source when a calibration is to be performed, since it is turned on automatically during the calibration process

Step 5 - Calibrate the measurement system

Before making any measurements on the filter the measurement system must be calibrated.

Although the synthesized sweep generator produces a levelled output signal there are still some residual errors resulting in a source power flatness accuracy of ±1 dB. Also, any components such as cables and adapters placed between the signal source and the DUT will have a frequency response. In addition, the scalar detector or autotester being used to make the measurement also has a power variation with frequency. All of these power variations with frequency will affect the accuracy of the measurement and should therefore be removed. Since they are systematic variations their effect can be removed by performing a 'Path Calibration', i.e. by calibrating out the variations in the measurement path.

[CAL] ***[Through Cal]***	Presents a text box informing you that you are about to perform a through path calibration, and indicates the path cal store that is to be used (a different store can be specified by using the ***[Select Path Cal Store]*** soft key). The message also prompts you to make a through connection, i.e. connect the detector on input A to the signal source output of the 6800A (via any cables or adapters that will be used to connect the 6800A source to the DUT).
[Continue]	Turns on the RF power and initiates the path calibration.

Having completed the through path calibration for the measurement path, the path cal data is automatically applied to measurement 1. This is indicated by the presence of **PC** in the trace information box for that measurement. If the path calibration becomes invalid (e.g. due to subsequent changes in measurement parameters), a warning message will be displayed and the path cal indication changes to **PC?**, which is also displayed in a different colour.

Now connect the filter between the connecting cable and the scalar detector.

Step 6 - Select appropriate scaling and format

When the [PRESET] key was pressed in Step 1 the default format for a scalar channel was set to dBm. Since the measurements are now relative to the path calibrations their units are displayed in dB. No change is therefore required to the default format setting.

The default scaling is satisfactory for this measurement, i.e. a reference level of 0 dB located at the top graticule line and a scale factor of 10 dB/div.

Alternatively, suitable scaling could be achieved through the use of the autoscale facility which results in setting the reference level and scaling such that the trace occupies approximately 80% of the graticule height.

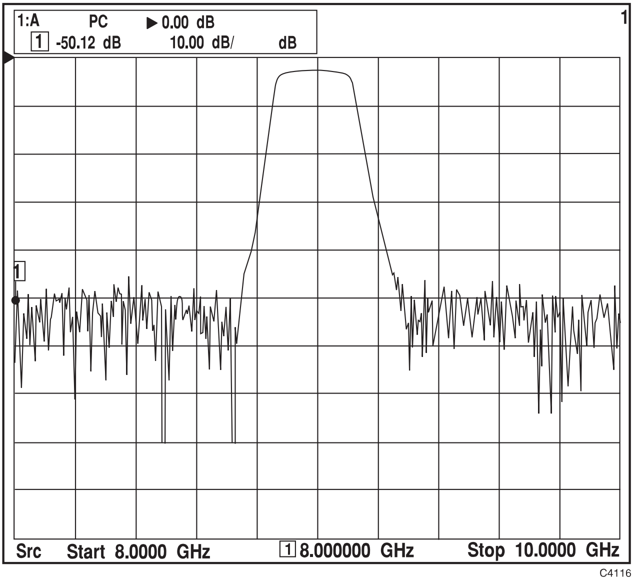


Fig. 2-3 Insertion loss measurement

Step 7 - Use markers and other 6800A features to get detailed information about the measurement

Using markers

It is often necessary to obtain detailed information about a specific feature of a measurement. This can be achieved through the use of markers. By default (i.e. following the use of the **[PRESET]** key) the active marker will be enabled. Use of the rotary control will allow the marker to be moved anywhere across the graticule, and the frequency domain and response values at any measurement point will be displayed.

If it is required to determine the maximum point of the response, for example, carry out the following steps:

[MARKER]	Allows access to a number of functions which provide automatic manipulation of the markers to measure performance features such as -3 dB cutoff points (for bandwidth measurements) and peak-to-peak ripple. These functions are particularly useful for measuring the performance of the band-pass filter used in this example.

[Active Mkr to Maximum] Places the active marker (marker 1 by default) at the maximum point of the response. This is the point of minimum insertion loss in the filter pass band, and the value is displayed in the trace information box. The frequency at which this occurs is displayed below the graticule.

A bandwidth measurement can be carried out in the following way:

[Mkr Functions]
[Bandwidth] Selects the Bandwidth menu.

[Set n dB Value]
[–] **[3] [ENTER/=MKR]** Sets the dB value that is used to determine the bandwidth. In this case, the bandwidth will be determined corresponding to the –3 dB points on the trace. (Since the default value is –3 dB there would be no need to enter this in this example.)

[Bandwidth Search] Initiates the bandwidth search and displays the result in a window overlaying the graticule. The window is removed if there is any change in the measurement or markers, or if the **[ENTRY OFF]** key is pressed. If the bandwidth function is successful, the two highest numbered markers, other than the active one, are placed at the upper and lower -3 dB points. The Q-factor (centre frequency / bandwidth) can optionally be displayed by pressing ***[Display CF/ΔF].***

If the filter is tuneable, the tracking facility can be turned on using the ***[Bandwidth Tracking]*** soft key. The bandwidth function is applied automatically at the end of each sweep, thus continually updating the bandwidth measurement.

Other features of the MARKER menu include:

[MARKER]
[Delta Mkr]
[Delta Mkr ●] Enables the delta marker; this is indicated by **Δ** on the display. Measurements are now made relative to the delta marker position.

[MARKER]
[More]
[Position Active Marker] Used to enter a specific frequency value to which the active marker will be set.

The position and response values of all displayed markers can be displayed on the screen in the form of a table, positioned below the graticule, by pressing **[MARKER]** ***[More] [Mkr Table].*** The marker table can also be printed when a hard copy of the measurement trace is created.

Limit checking

Another way of checking that the device under test (DUT) meets its specification is through the use of limit checking. A limit 'mask' is set which defines the acceptable performance for the DUT against which it will be checked. A pass/fail indication is then displayed on the screen. As an example, consider the passband response of the filter, which we will assume should fall within the limits –1 dB and –2.5 dB relative to the path calibration, over the frequency range 8.9 GHz to 9.1 GHz. To test for this you can use limit checking in the following way:

[SCALAR] ***[Limit Checking]*** ***[Edit Spec]***	The Limit Editor window is displayed containing a blank **Limit Checking Specification** form. This consists of fields for **start** and **stop** domain values, i.e. stimulus, and the corresponding **upper** and **lower** response values.
[Limit Type]	Enables the type of limit checking to be specified, i.e. an upper limit only, a lower limit only or both. It is also used to specify whether the domain values are to be used as absolute values or as offsets relative to the centre value of the measurement.
[Upper and Lower Limits] ***[Absolute Domain Values]*** ***[Return to Limit Editor]***	In this example, both upper and lower limits are set, using absolute domain values.
[Edit Segments] ***[Flat]***	It is possible to set **flat** or **slope** segments but to test the filter passband a **flat** segment is required.
[⇨] **[8] [.] [9] [G n]**	This activates the **start** domain field and sets its value to 8.9 GHz.
[⇨] [–] **[1] [ENTER/=MKR]**	The **upper** response field is activated and the value is set to -1 (dB).
[⇨] [–] **[2] [.] [5] [ENTER/=MKR]**	The **lower** response field is activated and the value is set to -2.5 (dB).
[⇨] **[9] [.] [1] [G n]**	The **stop** domain field is activated and the value is set to 9.1 GHz. Note that upper and lower values for the stop frequency are not required as they are the same as those for the start frequency for a flat segment.
[Return to Limit Editor	Returns to the Limit Editor menu.

[Save As] Before exiting from the Limit Editor menu, the limit specification can be saved for future use. Pressing this soft key leads to the Save Spec As menu, which enables the specification to be saved to a user-specified store.

[Exit]] Exits the limit editor.

[Limit Checking ●] When this key is pressed the indicator in the bottom right corner of the soft key label is illuminated to indicate that limit check is now 'on'. The upper and lower limit lines appear on the graticule along with a window which contains the pass/fail indication as to whether the measurement falls within the limit specification at every measurement point. The result is updated every sweep.

Many different limit specifications can be defined, and any of these can be applied to one or more traces. Before applying a limit checking specification to a measurement, make it the active one (if there is more than one measurement):

[Assign Spec] A sub-menu is presented in which a limit checking specification can be selected from a displayed list. Pressing ***[Select]*** assigns the specification to the currently active trace.

Since limits are checked only at the actual measured data points, it is possible for the device to be out of specification without a limit test failure indication if the point density is insufficient. Either specify a sufficiently high number of measurement points in the Source menu, or reduce the span of the frequency sweep so that the passband occupies more of the display.

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Improving the measurement

Although the above trace displays the required response of the filter, it lacks any detail of the passband ripple due to the vertical scaling being 10 dB/div. This could be improved by setting the reference level to 0 dB and the scale factor to 0.2 dB/div, for example:

[SCALE/FORMAT]	
[Set Ref Level]	
[0] [ENTER/=MKR]	Sets the reference level to 0 dB.
[Set Scale]	
[0] [.] [2] [ENTER/=MKR]	Sets the scale factor to 0.2 dB/div.

In addition, the span of the frequency sweep could be reduced so that only the passband is displayed, giving better horizontal resolution.

The measurement can be further improved by maximising the dynamic range so as to lower the noise floor. The amount of noise on the trace can be reduced by turning on averaging and setting a longer sweep time. The procedure is similar to that described previously, but with some additional settings in the Source and Scalar menus. Since the changes to the source set-up will invalidate the calibration, a new through cal will also be required.

Steps 1 to 3

These are the same as before.

Step 4 - Define the source conditions

[SOURCE] ***[Set Start Frequency]*** **[8] [G $_n$]** ***[Set Stop Frequency]*** **[1] [0] [G $_n$]**	Sets the start and stop frequencies to 8 GHz and10 GHz.
[Set Output Power] **[8] [ENTER/=MKR]**	Sets to the highest levelled output power (8 dBm).
[Sweep Time] ***[User Set Sweep Time]*** ***[Set Sweep Time]*** **[2] [ENTER/=MKR]**	Sets the sweep time to 2 seconds; this has the effect of reducing noise. Longer sweep times may also be necessary to prevent incorrect operation when testing certain devices.
[ENTRY OFF]	Terminates numeric entry.
[Return to Source]	Returns to the Source menu.

Steps 5 and 6

These are the same as before.

Step 7 - Use markers and other 6800A features to get detailed information about the measurement

[SCALAR]
[Averaging]
[Averaging ●]

Turns on averaging; this is indicated by the **A** flag in the trace information box. In this example, the **average number** is left at the default value of 16, but can be changed using the ***[Set Average Number]*** soft key. The minimum amount of averaging should be selected to reduce noise to an acceptable level, in order to maintain a sufficiently fast response.

The trace that results when the dynamic range is maximised in this way is shown in Fig. 2-4.

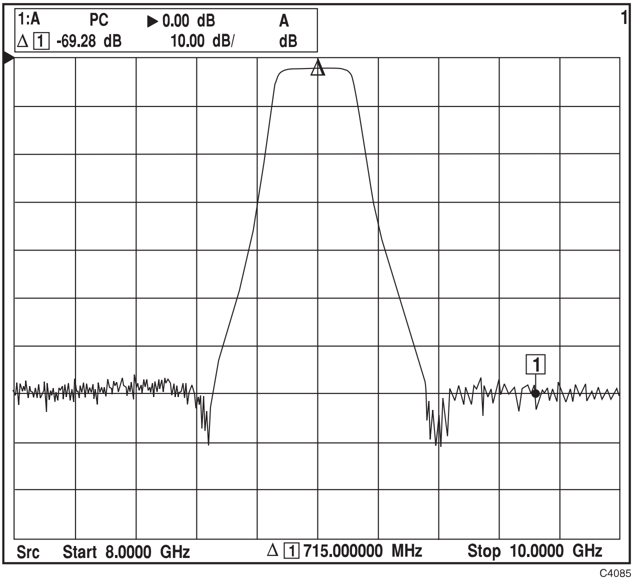


Fig. 2-4 Effect of maximising dynamic range and reducing noise

Example 2: Insertion and return loss measurement using an autotester

In the second example measurement, we will measure both the insertion loss and return loss responses of a 9 GHz band-pass filter. As in Example 1, this will be a narrowband measurement so that the passband responses can be examined in detail. The measurement system is shown below: As in the previous example, either a 6823, 6824, 6843 or 6844 is needed in order to cover the required frequency range.

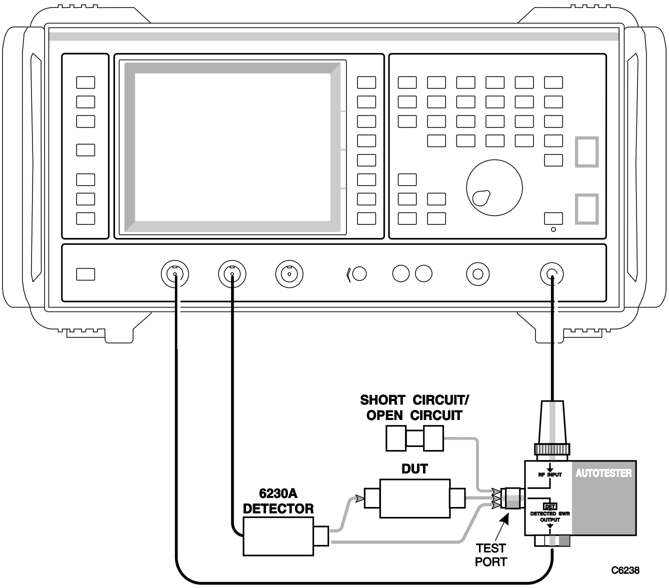


Fig. 2-5 Setup for simultaneous measurement of insertion and return loss

Connect the detector and autotester as shown in Fig. 2-5. The 6230A/L series detector contains an EEPROM which holds flatness and linearity correction data for the detector. This is read by the 6800A and used to correct the measurement data, resulting in improved accuracy. Flatness and linearity correction can be turned on or off by using the Input A (B or C) Corr menu; it is enabled by default, i.e. following a PRESET.

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Scalar menu will be shown along with a single scalar measurement of input A. For 6840A series instruments a spectrum analyzer measurement is displayed.

Step 2 - Define the display configuration

A single channel will be used to display both the insertion loss and return loss of the filter.

The default state of the instrument is a single channel displaying measurement 1. For a 6820A series instrument this will be a scalar channel; for a 6840A series instrument the channel will be spectrum analyzer and it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar (otherwise, pressing the [SCALAR] key in Step 3 will reset the channel to a single measurement). Alternatively, **[SWITCH CHANNEL]** could be used to display channel 2, which defaults to scalar for all instruments.

[DISPLAY] ***[Channel 1 Meas 2 ●]***	Use these keys to turn on measurement 2.

Step 3 - Define the measurements

From Fig. 2-5 we see that insertion loss is measured by the scalar detector connected to input B and return loss is measured by the autotester connected to input A. Since all scalar measurements default to input A (following PRESET) it is necessary to define the insertion loss measurement to be made from input B.

Before any changes can be made to the parameters of a measurement it must be the 'active measurement'. This is indicated by its trace information area being surrounded by a red highlight box. It can be seen that measurement 1 is the currently active measurement as indicated by the presence of the highlight box surrounding the trace information area, and as such it can have its parameters altered.

The first measurement we want to define is the insertion loss measured by the scalar detector connected to input B. We choose to display this as measurement 1. Before this can be done we must make it the 'active measurement'.

[SELECT MEAS]	Selects which of the displayed measurements is the active measurement. As the key is pressed the active measurement highlight box will move between the displayed measurements. Make sure you leave the display with measurement 1 as the active measurement.
[SCALAR] ***[Input Selection]*** ***[B]***	Defines measurement 1 to measure input B, i.e. the insertion loss through the filter. This is indicated by **1:B** appearing in the active measurement trace information box.

As in Example 1, **detector autozeroing** can be enabled by pressing **[CAL]** ***[Detector Autozeroing]***, which means that detector zeroing will be performed as a background task in the inter-sweep period. This process removes any drift in the zero level for both detectors or autotesters connected to the instrument. If you change the detector/autotester connected to a particular input, you should perform a manual detector zero by selecting **[CAL]** ***[Zero Detectors].***

Step 4 - Define the source conditions

[SOURCE] ***[Set Start Frequency]*** **[8] [G n]**	Sets the start frequency to 8 GHz.
[Set Stop Frequency] **[1] [0] [G n]**	Sets the stop frequency to 10 GHz.
[ENTRY OFF]	Terminates numeric entry.

Step 5 - Calibrate the measurement system

Before making any measurements on the filter the measurement system must be calibrated to remove the effects of power variations with frequency of the components that comprise the measurement system.

We do this by performing a through path calibration for the transmitted power path (i.e. insertion loss). In this example we also need to perform a short/open path calibration for the reflected power path (i.e. return loss).

Firstly, for input B the insertion loss path.

[SELECT MEAS]	Use this key to make measurement 1 the active measurement.
[CAL] ***[Through Cal]***	Presents a text box informing you that you are about to perform a through path calibration, and indicates the path cal store that is to be used (a different store can be specified by using the ***[Select Path Cal Store]*** soft key). The message also prompts you to make a through connection, i.e. connect the scalar detector on input B directly to the Test Port of the autotester.
[Continue]	Turns on the RF power and initiates the path calibration.

When calibration is completed for the insertion loss path, the path cal data is automatically applied to measurement 1, and is indicated by the presence of **PC** in the trace information box for that measurement. If the path calibration becomes invalid (e.g. due to subsequent changes in measurement parameters), a warning message will be displayed and the path cal indication changes to **PC?**.

In order to measure return loss, the system must first be calibrated against a known reference. Open circuit or short circuit terminations are chosen as both these devices theoretically reflect 100% of the power incident upon them, and therefore have a return loss of 0 dB. If only an open circuit or short circuit is used, however, there is an uncertainty added to the measurement due to test port impedance mismatch. This uncertainty can be minimized by calibrating the system against both open and short circuits, then calculating the average (done automatically by the 6800A). The short/open path cal for the return loss path is done as follows:

[SELECT MEAS]	Use this key to make measurement 2 the active measurement.

[Short AND Open Cal]	Presents a message stating that the path cal store about to be used for the calibration is store 2, and prompts you to connect a short (i.e. a short circuit) to the Test Port of the autotester. A different path cal store can be specified by using the ***[Select Path Cal Store]*** soft key.
[Continue]	Turns on the RF power and initiates the short circuit calibration. After completing the short circuit cal, a message will be displayed stating that an open (i.e. an open circuit) should be connected to the Test Port of the autotester.
[Continue]	Initiates the open circuit calibration.

Upon completion of the short/open path calibration for the return loss path, the path cal data is automatically applied to measurement 2. This is indicated by **PC** being displayed in the trace information area for that measurement.

Now connect the filter between the autotester Test Port and the scalar detector.

Step 6 - Select appropriate scaling and format

When the [PRESET] key was pressed in Step 1 the default format for a scalar channel was set to dBm. Since the measurements are now relative to the path calibrations their units are displayed in dB. This is satisfactory for the insertion and return loss measurements of this example.

The default settings for scaling will be used, i.e. a reference level of 0 dB and a scale factor of 10 dB/div.

Alternatively, suitable scaling could be achieved through the use of the autoscale facility which results in setting the reference level and scaling such that the trace occupies approximately 80% of the graticule height.

Fig. 2-6 shows the insertion loss / return loss measurement.

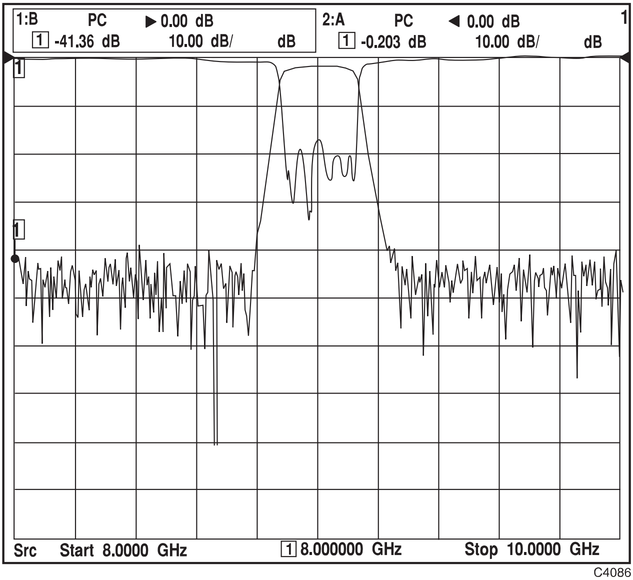


Fig. 2-6 Insertion and return loss measurement

Step 7 - Use markers and other 6800A features to get detailed information about the measurement

Markers and limit checking can be used to obtain detailed information about specific features of the measurement, as outlined in Example 1.

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 3: Dual channel insertion/return loss measurement of a band-pass filter using an autotester

In this example measurement, the passband insertion loss and return loss responses will be displayed on one channel, as in Example 2, but in addition the broadband insertion loss will be displayed on the other channel. Most of the steps are the same as in Example 2, so they will not be described in detail. The measurement system is the same and is repeated below.

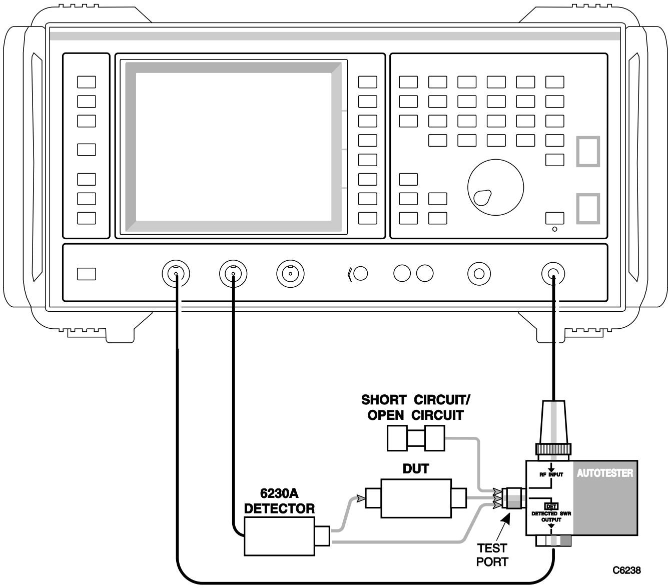


Fig. 2-7 Setup for dual channel insertion and return loss measurement

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Scalar menu will be shown along with a single scalar measurement of input A. For 6840A series instruments a spectrum analyzer measurement is displayed.

Step 2 - Define the display configuration

We choose to display the three measurements as follows:

On channel 1 we will display simultaneous narrowband insertion and return loss measurements and on channel 2 we will display the broadband insertion loss of the filter.

The default state of the instrument is a single channel displaying measurement 1 (Scalar for 6820A series, Spectrum Analyzer for 6840A series).

[DISPLAY] ***[Dual Channel Display ●]***	Use these keys to give a dual channel display.

Use the **[SWITCH CHANNEL]** and **[SCALAR]** keys, if necessary, to set channel 1 mode to Scalar (channel 2 defaults to Scalar when PRESET is used).

[DISPLAY] ***[Channel 1 Meas 2 ●]***	Use these keys to turn on measurement 2 of channel 1.

The display should now be as shown in Fig. 2-8.

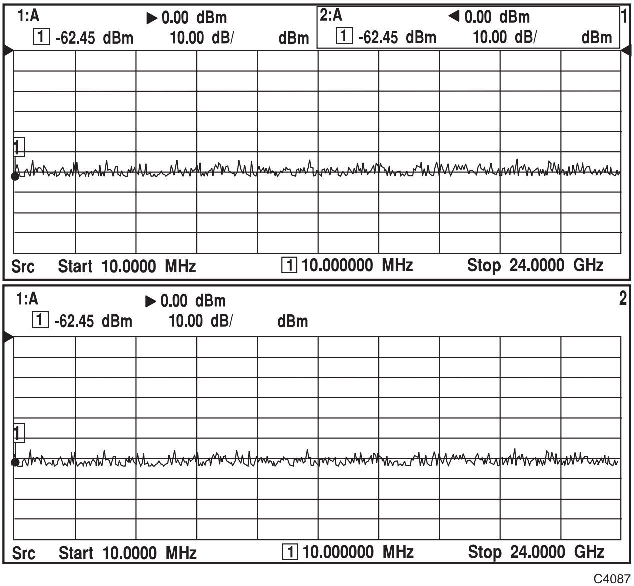


Fig. 2-8 Two channel display

Step 3 - Define the measurements

Return loss is measured by the autotester connected to input A, and will be displayed as measurement 2 of channel 1. Since the default scalar measurement definition is input A, no change is required here. Measurement 1 of channel 1 will be used to display the narrowband insertion loss measured by the scalar detector connected to input B, so the measurement definition is changed as follows:

[SELECT MEAS]	Makes measurement 1 of channel 1 the active measurement.

[SCALAR] ***[Input Selection]*** ***[B]***	Defines measurement 1 of channel 1 to measure input B, i.e. the insertion loss through the filter. This is indicated by **1:B** appearing in the active measurement trace information box.

We now need to define the broadband insertion loss response on measurement 1 of channel 2.

[SWITCH CHANNEL]	Makes measurement 1 of channel 2 the active measurement.
[SCALAR] ***[Input Selection]*** ***[B]***	Defines measurement 1 of channel 2 to measure input B. This is indicated by **1:B** appearing in the active measurement trace information box.

Step 4 - Define the source conditions

The sweep range will be set to 10 MHz - 20 GHz for the broadband insertion loss measurement on channel 2. Ensure channel 2 is the active channel, using **[SWITCH CHANNEL]** if necessary.

[SOURCE] ***[Set Stop Frequency]*** **[2] [0] [G n]**	Sets the stop frequency to 20 GHz.

Since the passband of the filter we wish to measure is centred at 9 GHz, it is necessary to change the start and stop frequency values for channel 1.

In order to have different source conditions for each channel it is necessary that the channels are uncoupled. This is the default condition for 6840Aseries instruments. For 6820A series channel coupling is on by default, but can be turned off using **[DISPLAY]** ***[Channel Coupling]***.

We can now alter the start and stop frequencies for channel 1 to 8 GHz and 10 GHz respectively, provided it is the currently active channel.

[SWITCH CHANNEL]	Use this key to ensure channel 1 is the active channel.
[SOURCE] ***[Set Start Frequency]*** **[8] [G n]**	Sets the start frequency to 8 GHz.
[Set Stop Frequency] **[1] [0] [G n]**	Sets the stop frequency to 10 GHz.
[ENTRY OFF]	Terminates parameter entry.

Step 5 - Calibrate the measurement system

The measurement system must now be calibrated to remove the effects of power variations with frequency within the system. As in Example 2, this is done by performing a through path calibration for the transmitted power path (i.e. insertion loss), and a short/open path calibration for the reflected power path (i.e. return loss).

Firstly, for input B, the passband insertion loss path, with the detector on input B connected directly to the test port of the autotester.

[SELECT MEAS]	Makes measurement 1 of channel 1 the active measurement.
[CAL] ***[Through Cal]*** ***[Continue]***	Turns on the RF power and initiates the through path calibration.

Upon completion of the through path calibration, the path cal data is automatically applied to the measurement, and **PC** is shown in the trace information box for that measurement.

Now perform a short/open path cal on the autotester for the return loss path.

[SELECT MEAS]	Makes measurement 2 of channel 1 the active measurement.
[Short AND Open Cal] ***[Continue]***	Initiates the short circuit calibration.
[Continue]	Initiates the open circuit calibration.

Upon completion of the short/open path calibration for the return loss path, the path cal data is automatically applied to measurement 2 of channel 1, and is stored in the specified path cal store. Again, **PC** is shown in the trace information box for that measurement.

Path calibrations are now being applied to both of the passband measurements on channel 1, but not to the broadband insertion loss measurement on channel 2, measurement 1. Since this measurement is to be made over a greater frequency range, the same path calibration cannot be used as for the passband insertion loss measurement, since the path cal data only applies to the region in between the start and stop frequency values of channel 1. A further path cal must be performed for the broadband insertion loss measurement.

[SELECT MEAS]	Makes measurement 1 of channel 2 the active measurement.
[Through Cal] ***[Continue]***	Performs the path calibration and applies the path cal data to the measurement. As for the other two measurements, **PC** is displayed in the trace information box

Note that a path cal could first be done for the broadband response on channel 2, which could then also be applied to the narrowband insertion loss measurement on channel 1. In this case, however, there would be fewer than 401 calibrated measurement points and the intermediate ones would have to be obtained by linear interpolation. Performing a unique path calibration for the narrowband measurement avoids the use of interpolated data.

Now connect the filter between the autotester Test Port and the scalar detector.

Step 6 - Select appropriate scaling and format

[SCALE/FORMAT] ***[VSWR]***
If required, use these keys to change the format of the return loss measurement to VSWR, after making measurement 2 of channel 1 the active measurement. (This would not be appropriate, however, for the filter measurement of this example.)

[Set Ref Level] **[1] [0] [ENTER/=MKR]**
Sets the reference level to +10 dBm. Repeat for the other two measurements after selecting them using **[SELECT MEAS]**

The default settings for scaling will be used.

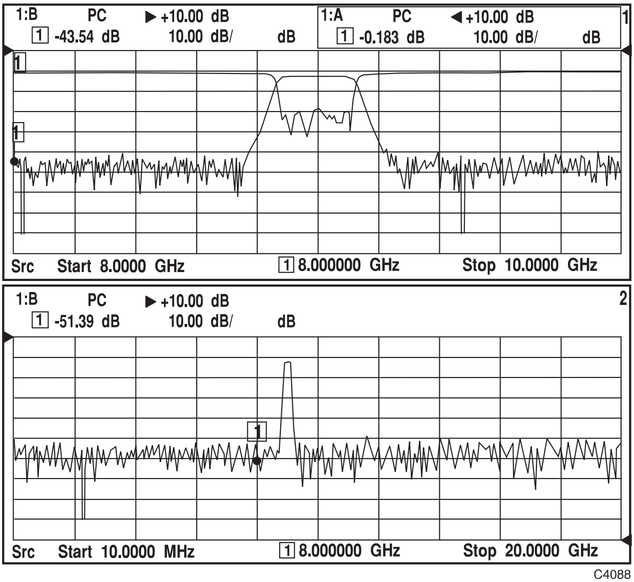


Fig. 2-9 Passband insertion and return loss and broadband insertion loss

Step 7 - Use markers and other 6800A features to get detailed information about the measurement

Markers and limit checking can be used to obtain detailed information about specific features of the measurement, as outlined in Example 1.

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 4: Insertion and return loss measurement using an autotester and a reference channel

It might be assumed that, having performed a path calibration, the traces obtained are a true representation of the response of the device under test (DUT). This assumption may not always be correct, however, since:

There may be changes in the input power to the DUT caused, for example, by drift in the RF source or flexing of the RF cable introducing a changed loss between the source and the DUT.

Errors can be caused by a poor source match, which particularly affects highly reflecting and low loss device measurements. This results in relatively large amounts of signal returning to the 6800A source and being reflected back towards the DUT. This is seen as a ripple superimposed on the measurement.

In this example, insertion and return loss will again be measured for the 9 GHz band-pass filter, but a reference channel will be used to reduce the effects of the above errors. The measurement system is shown in Fig. 2-10. The output of the source is fed to a power splitter in order to provide a separate reference channel to monitor the power near the measurement port, i.e. the actual incident power reaching the DUT. Any variations in the DUT input level are measured by the reference channel, and the 6800A compensates for the variation by ratioing the reference signal with the reflected and transmitted signal measurements. Using this technique, measurement ripples up to 1 dB due to multiple reflections can be reduced to less than 0.2 dB.

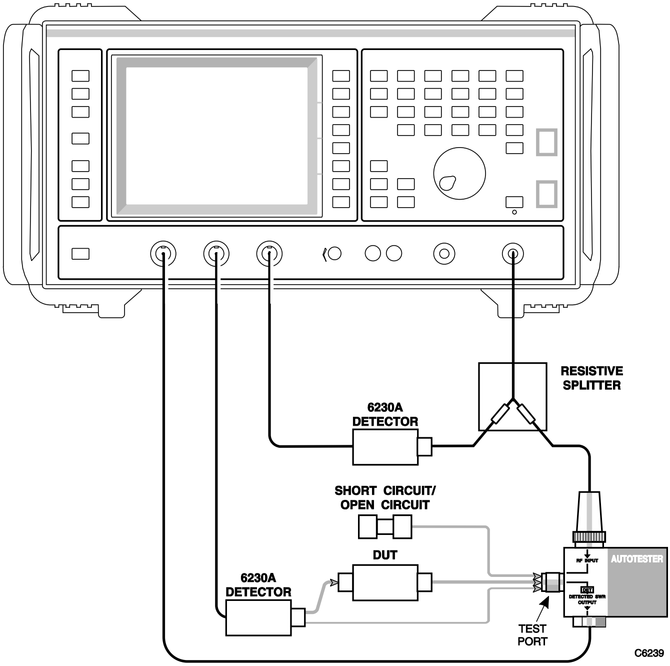


Fig. 2-10 Setup for insertion and return loss measurement using an autotester and a reference channel

Because of the power loss through the resistive splitter, there is a corresponding loss in the maximum displayed dynamic range of the measurement. Alternatively, a high directivity directional coupler could be used instead of a splitter to sample the actual power incident upon the DUT.

A power divider should not be used as these devices have an unacceptably high SWR

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state. The Scalar menu will be shown along with a single scalar measurement of input A. For 6840A series instruments a spectrum analyzer measurement is displayed.

Step 2 - Define the display configuration

A single channel will be used to display both the insertion loss and return loss of the filter.

For a 6840A series instrument, it will be necessary to press the **[SCALAR]** key first, to define the channel type as Scalar. (Otherwise, pressing the [SCALAR] key in Step 3 will reset the channel to a single measurement.). Alternatively, **[SWITCH CHANNEL]** could be used to display channel 2, which defaults to scalar for all instruments.

[DISPLAY] ***[Channel 1 Meas 2 ●]***	Use these keys to turn on measurement 2 of channel 1.

Step 3 - Define the measurements

From Fig. 2-10 it can be seen that insertion loss is measured by the scalar detector connected to input B and return loss is measured by the autotester connected to input A. The detector that measures the reference signal is connected to input C. Since all scalar measurements default to input A (following PRESET) it is necessary to define the insertion and return loss measurements to be made from the appropriate ratios.

The first measurement we want to define is the ratioed insertion loss measured by the detectors connected to inputs B and C. We choose to display this as measurement 1.

[SELECT MEAS]	Makes measurement 1 the active measurement.
[SCALAR] ***[Input Selection]*** ***[B / C]***	Defines measurement 1 to measure the ratio B / C. This is indicated by **1:B/C** appearing in the active measurement trace information box.
[SELECT MEAS]	Make measurement 2 the active measurement.
[A / C]	Defines measurement 2 to measure the ratio A / C. This is indicated by **2:A/C** appearing in the active measurement trace information box.

Step 4 - Define the source conditions

[SOURCE] ***[Set Start Frequency]*** **[8] [G $_n$]**	Sets the start frequency to 8 GHz.
[Set Stop Frequency] **[1] [0] [G $_n$]**	Sets the stop frequency to 10 GHz.
[ENTRY OFF]	Terminates numeric entry.

Step 5 - Calibrate the measurement system

The measurement system must now be calibrated to remove the effects of power variations with frequency within the system. As in previous examples, this is done by performing a through path calibration for the transmitted power path (i.e. insertion loss), and a short/open path calibration for the reflected power path (i.e. return loss).

Firstly, for input B, the insertion loss path, with the detector on input B connected directly to the test port of the autotester.

[SELECT MEAS]	Makes measurement 1 the active measurement.
[CAL] ***[Through Cal]*** ***[Continue]***	Turns on the RF power and initiates the through path calibration.

Upon completion of the through path calibration, the path cal data is automatically applied to the measurement, and **PC** is shown in the trace information box for that measurement.

Now perform a short/open path cal on the autotester for the return loss path.

[SELECT MEAS]	Makes measurement 2 the active measurement.
[Short AND Open Cal] ***[Continue]***	Initiates the short circuit calibration.
[Continue]	Initiates the open circuit calibration.

Upon completion of the short/open path calibration for the return loss path, the path cal data is automatically applied to measurement 2, and **PC** is shown in the trace information box.

Now connect the filter between the autotester Test Port and the scalar detector connected to input B.

Step 6 - Select appropriate scaling and format

[SCALE/FORMAT] ***[VSWR]***	If required, use these keys to change the format of the return loss measurement to VSWR, after making measurement 2 the active measurement. (This would not be appropriate, however, for the filter measurement of this example.)

The default settings for scaling will be used.

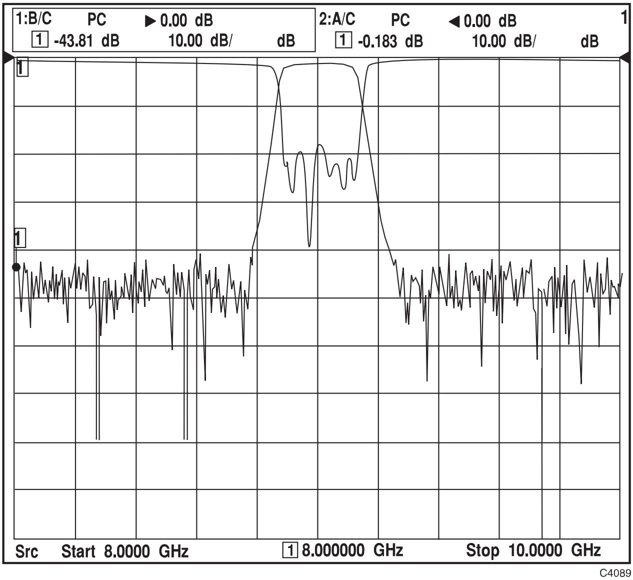


Fig. 2-11 Insertion and return loss measurement using a reference channel

Step 7 - Use markers and other 6800A features to get detailed information about the measurement

Markers and limit checking can be used to obtain detailed information about specific features of the measurement, as outlined in Example 1.

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 5: Amplifier gain compression measurement

It is often necessary to characterise the power handling capacity of an amplifier. A key aspect of this is the output power at which the gain of the amplifier drops to 1 dB below its small signal value; this is known as the *1 dB compression point*. In other words, it is the output power at which the gain characteristic of the amplifier starts to become non-linear. The test system shown in Fig. 2-12 is designed to measure the 1 dB compression point of an amplifier.

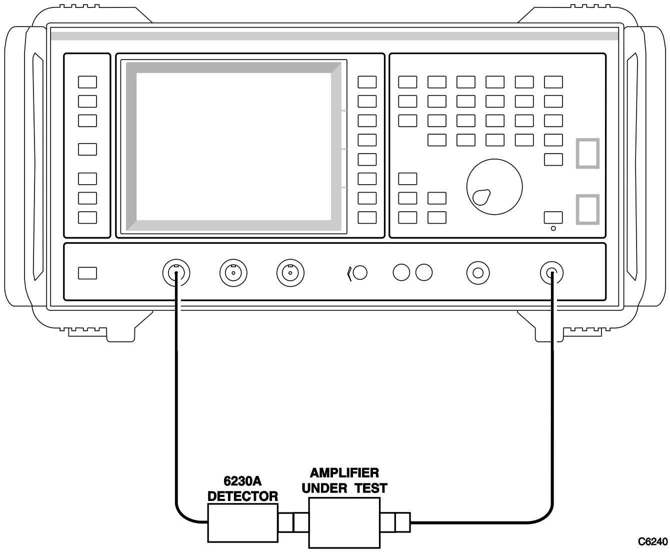


Fig. 2-12 Setup for gain compression measurement

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Scalar menu will be shown along with a single scalar measurement of input A. For 6840A series instruments a spectrum analyzer measurement is displayed.

Step 2 - Define the display configuration

Measurement 1 will be used to display the gain of the amplifier; measurement 2 will be used to display the output power.

The default state of the instrument is a single channel displaying measurement 1. For a 6820A series instrument this will be a scalar channel. For a 6840A series instrument the channel will be spectrum analyzer; pressing **[SWITCH CHANNEL]** displays channel 2 which is scalar.

[DISPLAY] ***[Channel 2 Meas 2 ●]***	Use these keys to turn on measurement 2 of channel 2 (assuming channel 2 is being displayed)..

Step 3 - Define the measurements

The default measurement definition for both measurements is input A. Since this is the power output of the amplifier no change needs to be made to measurement 2. The definition for measurement 1 is also input A, since after calibration the displayed response is input A minus the response during calibration, which represents 0 dB.

Step 4 - Define the source conditions

Following an instrument PRESET the source mode defaults to **Start & Stop Freq Sweep**, but for this measurement setup the source mode required is **Power Sweep**.

[SOURCE] ***[Select Source Mode]*** ***[Power Sweep]***	This selects the power sweep mode of the source. The graticule start and stop annotation will change from frequency to power in dBm; both will be at 0 dBm at this stage. This example assumes a start power of -30 dBm and a stop power of -10 dBm.
[Return to Source]	Returns to the Source menu.
[Set Start Power] [–] **[3 [0] [ENTER/=MKR]** ***[Set Stop Power]*** [–] **[1] [0] [ENTER/=MKR]**	Sets a power sweep of -30 dBm to -10 dBm.
[Set Frequency] **[7] [5] [0] [M µ]**	In this example, it is assumed that the source frequency is set to 750 MHz.
[ENTRY OFF]	Terminates numeric entry.
[Sweep Time] ***[User Set Sweep Time]*** ***[Set Sweep Time]*** **[1] [ENTER/=MKR]**	Sets the sweep time of the source to 1 s. During power sweeps the source step attenuator repeatedly switches in order to cover the required power range. Longer sweep times slow down the switching rate reducing wear on the attenuator switches. (Short sweep times are not necessary for this measurement.)

Note To prevent excessive wear of the attenuator switches during power sweeps the source should be turned off using the [SOURCE ON/OFF] key during the times when RF power is not required.

Step 5 - Calibrate the measurement system

It is now necessary to calibrate the system by measuring the response with the amplifier replaced by a through connection. The system is calibrated from the knowledge that this direct connection is equivalent to a 0 dB gain amplifier. Use [SELECT MEAS] to ensure that measurement 1 is active.

[CAL] ***[Through Cal]*** ***[Continue]***	Turns on the RF power and initiates path calibration for the gain measurement. When completed, the path cal data is automatically applied to the measurement, and **PC** is shown in the trace information box for measurement 1.

Now connect the detector on input A to the amplifier output and the source to the amplifier input (Fig. 2-12). Apply power to the amplifier.

Now that the gain and output power measurements have been obtained, they can be frozen using the **Hold** function in the Display menu, and the source can be turned off. This prevents unnecessary wear of the source step attenuator, as described previously.

Step 6 - Select appropriate scaling and format

The default formats for the measurements are satisfactory, i.e. dB for channel 1 and dBm for channel 2

[SCALE/FORMAT] ***[Autoscaling]*** ***[Autoscale]*** **[SELECT MEAS]** ***[Autoscale]*** ***[Return to Scale/Format]***	Use the autoscale facility to obtain suitable scaling for both measurements.
[Set Scale] **[1] [ENTER/=MKR]**	In this example, autoscaling would result in the scaling for measurement 1 being set to 0.5 dB/div. This can be changed by manually setting it to 1 dB/div (use **[SELECT MEAS]** to first make measurement 1 active).

Step 7 - Use markers and other 6800A features to get detailed information about the measurement

The gain is calculated in the instrument by ratioing the measurement with the calibration readings. When the gain drops by 1 dB, the output power measurement directly gives the -1 dB compression value. Use the marker functions to read off the -1 dB compression point accurately.

[MARKER] ***[Active Mkr to Maximum]***	Places the active marker (marker 1 by default) at the maximum point on the gain response.
[Delta Mkr ***[Delta Mkr ●]*** ***[Return to Marker]***	Turns on the delta marker; this is indicated by Δ on the display. Its position will initially be the same as that of the active marker. In the delta marker mode, the measured response is relative to the response at the delta marker position.

[More] ***[Assign Active Mkr 1-8]*** **[2] [ENTER/=MKR]** ***[Return to Prior Menu]***	Designates marker 2 as the active marker. The position of the active marker remains unchanged.
[Mkr Functions] ***[Search]*** ***[Set Search Value]*** [–] **[1] [ENTER/=MKR]** ***[Search Right]***	The instrument searches right from the current active marker position (i.e. the maximum point on the trace) in order to find the point where the response is 1 dB below the delta marker response.
[Return to Mkr Funcs] ***[Return to Marker]***	Returns to the top level Marker menu.
[Delta Mkr] ***[Delta Mkr O]***	Turns off the delta marker. The active marker now gives the actual response instead of relative to the delta marker.

Marker 2 (the active marker) on measurement 1 measures the 1 dB compressed gain, and is positioned at the source input power which causes that compression. The corresponding output power can be determined from the response of marker 2 on measurement 2 (the marker positions are the same for the two measurements within a channel).

If the small signal (i.e. maximum) gain is required, this can be measured as follows:

[Return to Marker] ***[More]*** ***[Assign Active Mkr 1-8]*** **[1] [ENTER/=MKR]**	Marker 1 on measurement 1 now gives the small signal gain.

Alternative method:

Alternatively, the 1 dB gain compression point mat be found more simply as follows:

[MARKER] ***[Active Mkr to Maximum]***	Places the active marker (marker 1 by default) at the maximum point on the gain response.
[Mkr Functions] ***[1 dB Gain Compression]***	Searches right from the active marker position for the point at which the gain has fallen by 1 dB; the active marker is then placed at that point.

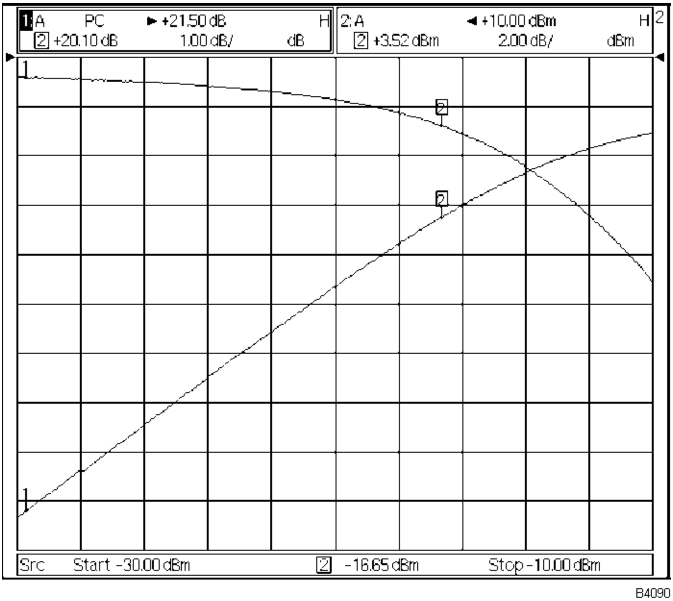


Fig. 2-13 Gain compression measurement

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 6: High dynamic range insertion loss of a band-pass filter (6840A only)

The tuned input mode of the scalar analyzer can be used to allow increased dynamic range measurements of insertion loss / frequency response to be made on filters, duplexers etc. In this mode, the spectrum analyzer receiver is used in place of a scalar detector in order to give frequency selective scalar analyzer measurements.

The swept frequency range of the receiver is defined by the displayed frequency range. Because of the reduced bandwidth over which the measurement is made, there is less broadband thermal noise in the measurement (which is proportional to bandwidth); the reduced noise floor allows the measurement to be made over a greater dynamic range. The spectrum analyzer receiver parameters are determined automatically based on the displayed frequency range.

In this example, a 6840A series instrument will be used to measure the passband response of a 9 GHz band-pass filter. The measurement setup is shown below:

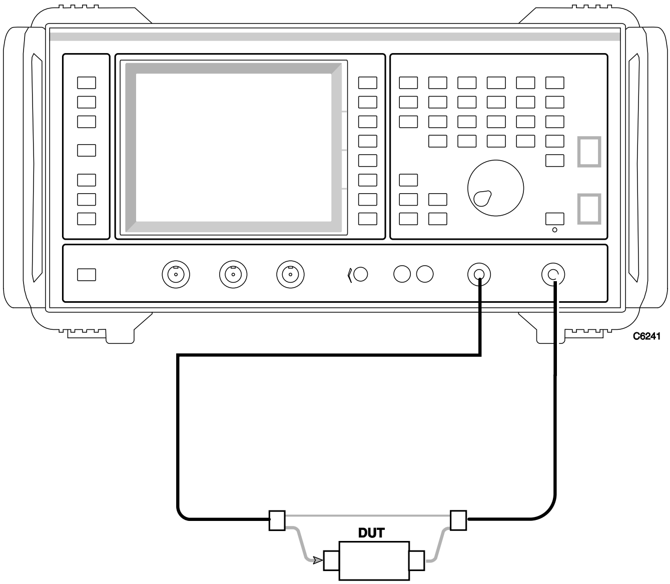


Fig. 2-14 Setup for high dynamic range insertion loss measurement

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the insertion loss of the filter. Since a 6840A series instrument is used, the default channel is Spectrum Analyzer, so it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar. Alternatively, press **[SWITCH CHANNEL]** to display channel 2, which is scalar by default.

[SCALAR] ***[Yes]***	Select Scalar mode and press the *[Yes]* soft key to confirm the change.

Step 3 - Define the measurements

[Input Selection] ***[Tuned Input]*** ***[Tuned Input]***	Selects the tuned input mode of operation. **RX** is displayed in the trace information area to indicate that the spectrum analyzer receiver is being used instead of a scalar detector
[Set Res BW]	Use the [⇩] step key to reduce the resolution bandwidth which increases the displayed dynamic range.

Step 4 - Define the source conditions

[SOURCE] ***[Select Source Mode]*** ***[Cntr & Span Freq Sweep]*** ***[Return to Source]***	Selects the Centre & Span Frequency Sweep mode; this is the most appropriate mode for a symmetrical device such as a band-pass filter.
[Set Cntr Frequency] **[9] [G n]**	Sets the centre frequency for the example filter to 9 GHz.
[Set Span] **[1] [5] [0] [0] [M μ]**	Sets an appropriate span for the filter; for this example a span of 1500 MHz is used.
[Set Output Power] **[0] [ENTER/=MKR]**	Sets the source output power to 0 dBm.
[ENTRY OFF]	Terminates numeric entry.

Step 5 - Calibrate the measurement system

[CAL] ***[Through Cal]***	A message prompts you to make a through connection, i.e. connect the source output to the spectrum analyzer input (via any cables or adapters that will be used to connect the filter).
[Continue]	Turns on the RF power and initiates a through path calibration, and automatically applies the path cal data to the measurement.

Now connect the band-pass filter between the source output and the spectrum analyzer input:

Step 6 - Select appropriate scaling and format

The default format and scaling are satisfactory for this measurement, i.e. dB units, a reference level of 0 dB and a scale factor of 10 dB/div. Note that the reference level has been re-positioned to one graticule line from the top, so that the top of the response curve does not get obscured by the bandwidth result window.

Step 7 - Use markers and other 6800A features to get detailed information about the measurement

[SCALAR] ***[Smoothing]*** ***[Smoothing ●]***	Turns on smoothing; as indicated by the **S** flag in the trace information box. Smoothing reduces the amount of ripple on the trace. In this example, the **smoothing aperture** value is left at the default value of 1%, but can be changed using the ***[Set Aperture]*** soft key. Note that for this type of filter the value should be < 2%; if it is set higher than this the filter slope will be displayed incorrectly.
[MARKER] ***[Active Mkr to Maximum]***	Places the active marker at the minimum insertion loss point in the filter passband.
[Mkr Functions] ***[Bandwidth]*** ***[Bandwidth Search]***	Use the bandwidth marker function to locate the –3 dB points on the filter response. The two highest numbered markers, other than the active one, are placed at the upper and lower positions, and the values of bandwidth and centre frequency are displayed.

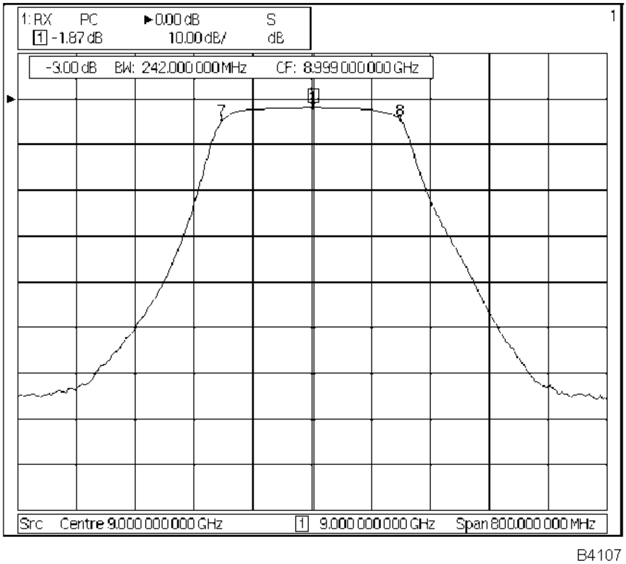


Fig. 2-15 High dynamic range insertion loss measurement

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 7: High dynamic range insertion loss of a filter with ratioed input (6840A only)

This example is similar to the previous one in that the tuned input mode of the scalar analyzer is employed for band-pass filter measurements, but this time a ratioed input is used to improve the source match for the measurement of insertion loss / frequency response.

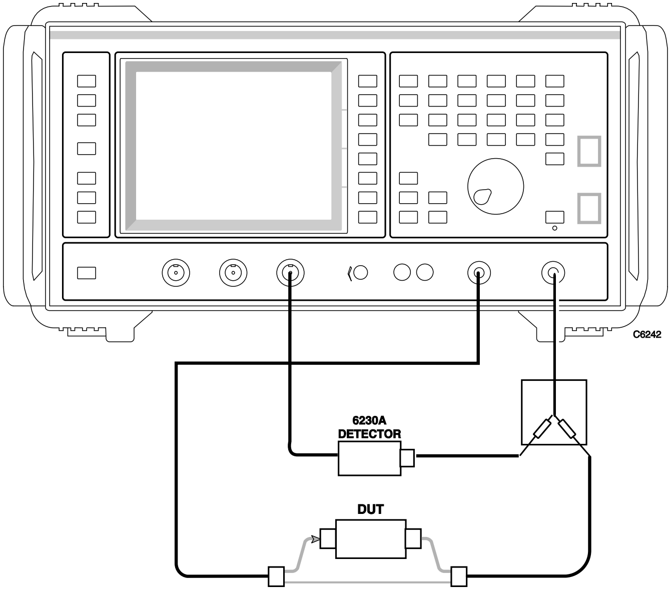


Fig. 2-16 Setup for high dynamic range insertion loss measurement using a ratioed input

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the insertion loss of the filter. Since a 6840A series instrument is used, the default channel is Spectrum Analyzer, so it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar.

[SCALAR] ***[Yes]***	Select Scalar mode and press the *[Yes]* soft key to confirm the change.

Step 3 - Define the measurements

[Input Selection] ***[Tuned Input]*** ***[Tuned Input / C]***	Selects the ratioed, tuned input mode of operation. **RX/C** is displayed in the trace information area.
[Set Res BW]	Use the **[⇩]** step key to adjust the resolution bandwidth to give the highest dynamic range.

Step 4 - Define the source conditions

[SOURCE] ***[Select Source Mode]*** ***[Cntr & Span Freq Sweep]*** ***[Return to Source]***	Selects the Centre & Span Frequency Sweep mode; this is the most appropriate mode for a symmetrical device such as a band-pass filter.
[Set Cntr Frequency] **[9] [G n]**	Sets the centre frequency for the example filter to 9 GHz.
[Set Span] **[1] [5] [0] [0] [M μ]**	Sets an appropriate span for the filter; for this example a span of 1500 MHz is used.
[Set Output Power] **[0] [ENTER/=MKR]**	Sets the source output power to 0 dBm.
[ENTRY OFF]	Terminates numeric entry.

Step 5 - Calibrate the measurement system

[CAL] ***[Through Cal]***	A message prompts you to make a through connection, i.e. connect the power splitter output to the spectrum analyzer input (via any cables or adapters that will be used to connect the filter).
[Continue]	Turns on the RF power and initiates a through path calibration, and automatically applies the path cal data to the measurement.

Now connect the band-pass filter between the power splitter output and the spectrum analyzer input:

Step 6 - Select appropriate scaling and format

The default format and scaling are satisfactory for this measurement, i.e. dB units, a reference level of 0 dB and a scale factor of 10 dB/div.

Step 7 - Use markers and other 6800A features to get detailed information about the measurement

[SCALAR] ***[Smoothing]*** ***[Smoothing ●]***	Turns on smoothing; as indicated by the **S** flag in the trace information box. Smoothing reduces the amount of ripple on the trace. In this example, the **smoothing aperture** value is left at the default value of 1%, but can be changed using the ***[Set Aperture]*** soft key.

[MARKER] ***[Active Mkr to Maximum]***	Places the active marker at the minimum insertion loss point in the filter passband.
[Mkr Functions] ***[Bandwidth]*** ***[Bandwidth Search]***	Use the bandwidth marker function to locate the –3 dB points on the filter response. The two highest numbered markers, other than the active one, are placed at the upper and lower positions, and the values of bandwidth and centre frequency are displayed.
[MARKER] ***[More]*** ***[Mkr Table ●]***	Display the marker table showing the frequency/ amplitude values for the three markers at the minimum insertion loss and –3 dB points.

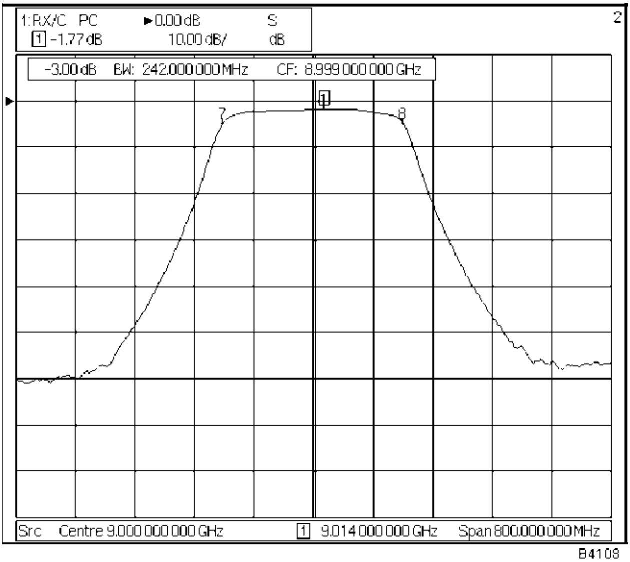


Fig. 2-17 High dynamic range, ratioed insertion loss measurement

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 8: Conversion gain of a down-converter - tuned input method (6840A only)

This example illustrates the use of the offset tuned receiver mode of the scalar analyzer to measure the conversion gain/loss and frequency response of mixers, up-converters and down-converters. Using the tuned input of the spectrum analyzer receiver instead of a broadband scalar detector reduces the noise floor and provides greater dynamic range.

The example uses a 6843 instrument to measure the conversion gain of a down-converter, which has an integral 1.7 GHz local oscillator. The device operates over an input frequency range of 2.2 GHz ±50 MHz and the down-converted output is 500 MHz ±50 MHz with a gain of approximately 20 dB. The down-converted output is passed through an internal bandpass filter to select the appropriate sideband (input frequency - LO frequency). The instrument's source provides the RF input signal for the down-converter under test. The measurement setup is shown below.

Note that in this example, the only advantage in using the tuned input rather than a broadband scalar detector is noise floor reduction through reduction of the resolution bandwidth. This is because the DUT provides its own filtering. However, if this were not the case, the tuned input would result in an improved measurement. A further reason for using the tuned input method is that calibration using a scalar detector at the low source power levels required (-50 dBm) would not work properly.

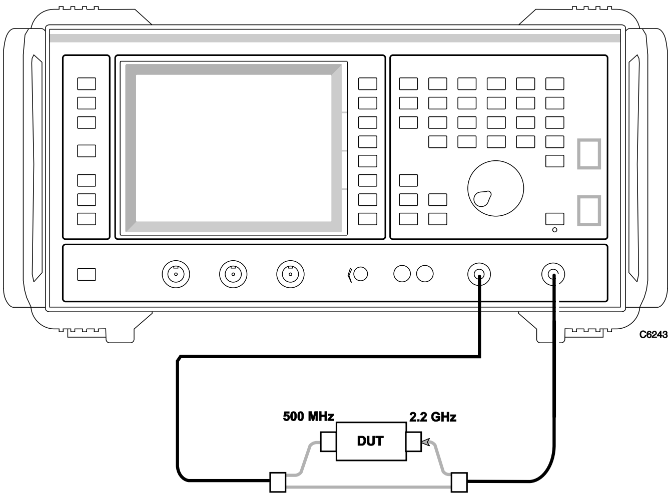


Fig. 2-18 Setup for conversion gain measurement of a down-converter

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the conversion gain of the down-converter. Since a 6840A series instrument is used, the default channel is Spectrum Analyzer, so it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar. Alternatively, press **[SWITCH CHANNEL]** to display channel 2, which is scalar by default.

[SCALAR] ***[Yes]***	Select Scalar mode and press the ***[Yes]*** soft key to confirm the change.

Step 3 - Define the measurements and source conditions

[Input Selection] ***[Tuned Input]*** ***[Tuned Input]***	Selects the tuned input mode of operation. **RX** is displayed in the trace information area to indicate that the spectrum analyzer receiver is being used instead of a scalar detector
[Set Res BW] ***[Return to Input Sel]*** ***[Return to Scalar]***	Pressing the **[⇩]** key reduces the analyzer resolution bandwidth which results in an improved noise floor.
[Conversion Measurements] ***[Conv Meas Set-up]*** ***[Downconverter]***	Display the Conversion Measurement Set-up form and specify that the measurement is to be performed on a down-converter. Specifying the converter type must always be the first step for these types of measurements.
[⇩] **[4] [5] [0] [M μ]** ***[⇩]*** **[5] [5] [0] [M μ]**	Sets the start and stop frequencies for the down-converter output. This sets the frequency range of the spectrum analyzer receiver and this is what is displayed on the x-axis.
[⇩] [⇩] [⇩] **[2] [0] [ENTER/=MKR]**	Activates the Approximate Gain/Loss field; this is used to set the conversion gain to +20 dB. This parameter can only be set when in tuned input mode.
[⇩] ***[Upper]***	Activates the Sideband field; two additional soft keys are displayed, labelled *[Upper]* and *[Lower]*. These are used to select which of the two possible input frequency ranges are used to produce the specified output frequency range; the source is set to sweep over this range.

[⇩]
[2] [.] [1] [5] [G n]

Sets the start frequency of the down-converter input to 2.15 GHz, i.e. the start of the source sweep. The stop frequency is automatically set by the 6843 to 2.25 GHz, so does not need to be entered.

Whenever a value is entered for the input start or stop frequency, the other will be set automatically so that the frequency span is the same as that of the output start and stop frequencies.

Once the input and output frequencies have been specified, the local oscillator frequency is calculated and displayed on the form (1.7 GHz in this example).

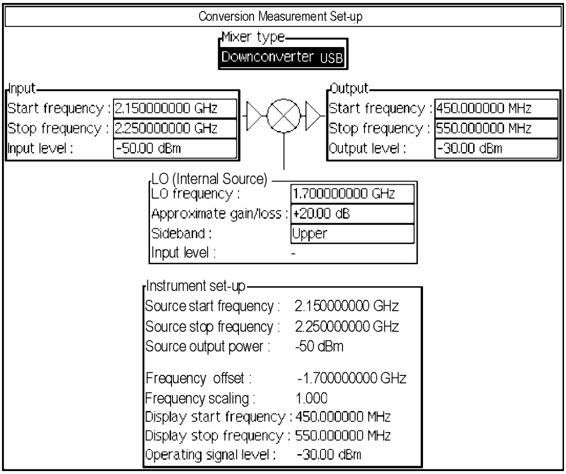
Note that if the LO frequency is known, this could be entered together with the output frequency range and the 6843 will calculate the corresponding input frequency range. In this example, the down-converter's integral LO operates at 1.7 GHz. Setting the LO frequency parameter to this value and entering the output frequency range as above results in the input frequency range being set to 2.15 - 2.25 GHz.

Also note that pressing the ***[Cntr / Span]*** soft key enables the input and output frequency ranges to be specified by entering a centre frequency and span. In this example, the frequency span of the down-converter input would be set automatically once the centre frequency of the input has been entered.

[⇩] [⇩]
[–] **[5] [0] [ENTER/=MKR]**

Activates the Input Level field. This parameter is set to ensure that the source does not overload the down-converter input; in this example the DUT requires an input of about –50 dBm.

The Conversion Measurement Set-up form with the parameters entered is as follows:



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[Return to Conv Meas]] Returns to the Conversion Meas menu. The indicator in the bottom right hand corner of the ***[Apply Scale/Offset]*** soft key will be illuminated to indicate that the frequencies displayed on the x-axis have been scaled and/or offset from the source.

Step 4 - Calibrate the measurement system

[CAL]
[Through Cal]
[Display Freq Range]

A message prompts you to make a through connection, i.e. connect the source output to the spectrum analyzer input (via any cables or adapters that will be used to connect the DUT).

[Continue] Turns on the RF power and initiates a through path cal, and automatically applies the path cal data to the measurement.

Two options are available when performing a through calibration for a measurement on a frequency conversion device.

The first is to perform the calibration with the spectrum analyzer receiver set to the range required for the measurement; the source frequency range is moved to cover the output range that the spectrum analyzer receiver would expect to see if the DUT were present (i.e. the displayed range). This is the default and is the option that is used in this example to remove the insertion loss of the cable placed between the down-converter IF output and the spectrum analyzer input.

If a cable is placed between the 6843 source output and the down-converter input then the alternative method is to leave the source and re-tune the receiver to the source frequency range during calibration; this option is selected using the *[Source Freq Range]* soft key:

[CAL] ***[Through Cal]*** ***[Source Freq Range]***	A message prompts you to make a through connection, i.e. connect the source output to the spectrum analyzer input (via any cables or adapters that will be used to connect the DUT).
[Continue]	Turns on the RF power and initiates a through path cal, and automatically applies the path cal data to the measurement.

If a measurement set up like that of Fig. 2-18 is to be configured using cables at both the input and output of the down-converter under test then a further step must be taken. There are two possible methods which can be used although both require the calibration mode, *[Source Freq Range]*.

Method 1 employs a fixed offset to remove the loss of the IF output cable from the measured value. This is achieved by first measuring the loss at the IF output centre frequency (500 MHz in this case) and then setting this value as an offset by selecting:

[SCALAR] ***[More]*** ***[Input Set-up]*** ***[Input Level Offsets]*** ***[Input A Offset]***	Level offsets are input as a fixed offset value per detector input. The offset value is entered as a negative number to compensate for gain. A positive offset is used for devices with loss, such as a cable (as in this case).

Method 2 employs a trace memory to remove the insertion loss of the IF output cable from the measured gain value. This is achieved by first measuring the insertion loss over the IF output frequency range (500 MHz ±50 MHz in this case) and storing the resulting trace. The stored trace is subtracted from the final measured value of conversion loss after first calibrating the measurement with the *[Source Freq Range]* calibration option. The *[Relative to Memory]* function under [SAVE/RECALL] is used to subtract the stored trace of IF cable loss from the live trace after the down-converter calibration process.

[CAL] ***[Through Cal]*** ***[Source Freq Range]***	Select Through Cal and the Source Freq Range option for the calibration.
[Continue]	Turns on the RF power, initiates a through cal and automatically applies the path cal data to the measurement.
[SAVE/RECALL] ***[Apply Trace Memory]*** ***[Relative to Memory]***	The [SAVE/RECALL] key provides the function ‘Relative to Memory’, which is used to subtract a stored trace from the current live trace. The stored trace file is retrieved by selecting from the displayed list using the ***[⇧]***, ***[⇩]*** soft keys and then pressing ***[Select]***. The trace information box displays **Rx-M** as the measurement definition.

Now connect the down-converter between the source output and the spectrum analyzer input, using the cables used during calibration:

Step 5 - Select appropriate scaling and format

[SCALE/FORMAT] ***[Autoscaling]*** ***[Autoscale]***	Suitable scaling is achieved through the use of the autoscale facility, which results in setting the reference level and vertical scaling such that the trace occupies approximately 80% of the graticule height.

Step 6 - Use markers and other 6800A features to get detailed information about the measurement

Use the markers to determine the peak value and the -3 dB bandwidth of the output filter of the down-converter.

[MARKER] ***[Active Mkr to Maximum]***	Positions the active marker at the maximum point of the response.
[Mkr Functions] ***[Bandwidth]*** ***[Set n dB Value]*** [–] **[3] [ENTER/=MKR]** ***[Bandwidth Search]***	Determines the 3 dB bandwidth of the down-converter's filter response. The two highest numbered markers, other than the active one, are placed at the upper and lower -3 dB points

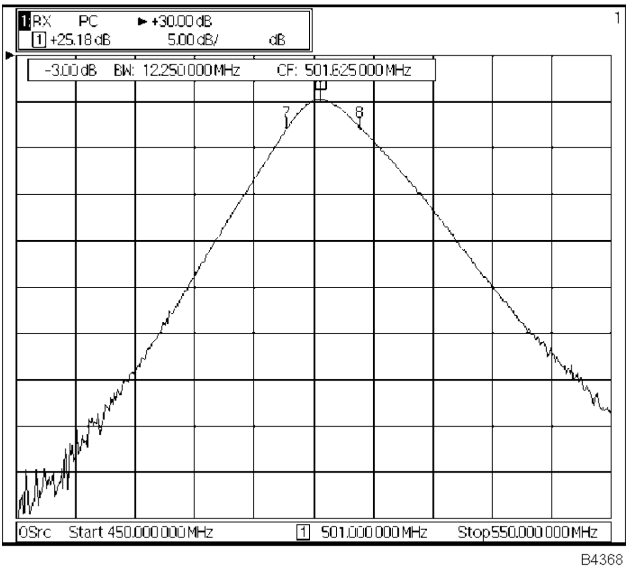


Fig. 2-19 Conversion gain measurement of a down-converter

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 9: Swept measurement of a mixer using an external source

This example illustrates the use of external source control mode of the 6800A series of scalar and microwave system analyzers to measure the conversion gain/loss and frequency response of mixers, up-converters or down-converters.

The example uses a 6840A series instrument to measure the conversion loss of a mixer that requires an external local oscillator signal of +7dBm over the frequency range 2.5 GHz to 5.5 GHz. The mixer operates over an input frequency range of 3 GHz to 6 GHz and the conversion loss of the down-converted output is measured at an IF of 500 MHz. The expected conversion loss is approximately 6 dB. The source in the instrument provides the RF input signal for the mixer under test via an attenuator pad connected directly to the source output. The purpose of the pad is to improve the source output VSWR because the mixer under test requires a good termination on all ports.

The measurement set up is shown below and employs a 6823 scalar analyzer with a 10 MHz to 20 GHz source as the external source for the local oscillator (LO) input. Note that in this example, the tuned input rather than a broadband scalar detector is used to measure the conversion loss to filter out unwanted mixing products.

If the mixer or down-converter were to be fitted with an IF filter, it would then be possible to make the measurement with the 6230A series scalar detector.

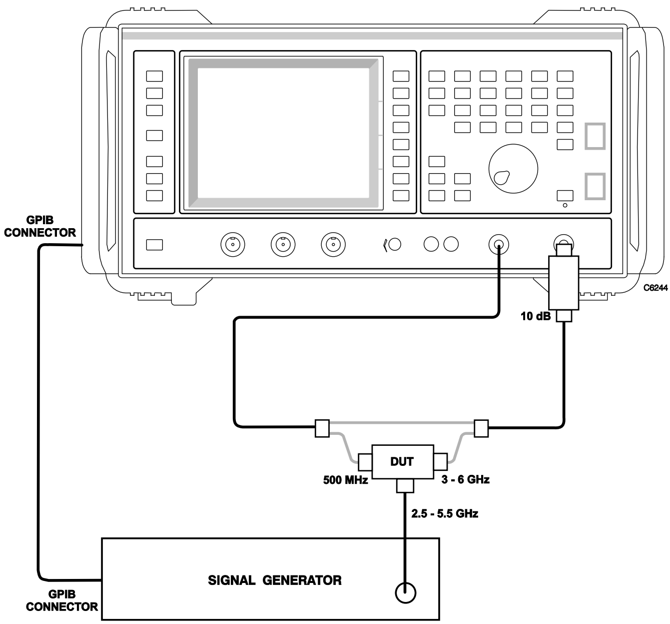


Fig. 2-20 Setup for mixer measurement using an external source

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement.
[UTILITY] ***[Remote Control]*** ***[No External Controller]***	Ensure the 6843 is set to control an external device.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the conversion loss of the mixer. Since a 6840A series instrument is used, the default channel is Spectrum Analyzer, so it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar. Alternatively, press **[SWITCH CHANNEL]** to display channel 2, which is scalar by default.

[SCALAR] ***[Yes]***	Select Scalar mode and press the *[Yes]* soft key to confirm the change.
[DISPLAY] ***[Channel 1 Meas 2 ●]***	Use these keys to turn on measurement 2.

Step 3 - Define the scalar measurement conditions for conversion loss

[SELECT MEAS]	Use this key to make measurement 1 the active measurement.
[SOURCE] ***[Sweep Time]*** ***[User Set Sweep Time]*** ***[Set Sweep Time]*** **[2] [ENTER/=MKR]**	Sets the source sweep time to 2 seconds to improve signal-to-noise ratio.
[SCALAR] ***[Input Selection]*** ***[Tuned Input]*** ***[Tuned Input]***	Selects the tuned input mode of operation for measurement 1. **RX** is displayed in the trace information area to indicate that the spectrum analyzer receiver is being used instead of a scalar detector
[Set Res BW] **[⇩] [⇩]** ***[Return to Input Sel]*** ***[Return to Scalar]***	The resolution bandwidth is manually set to provide an improved signal-to-noise ratio for the gain measurement.

[Conversion Measurements] ***[Conv Meas Set-up]*** ***[Downconverter]*** ***[Upper Sideband]***	Display the Conversion Measurement Set-up form and specify that the measurement is to be performed on a down-converting mixer. Specifying the converter type must always be the first step for these types of measurements. Activates the Sideband field; two additional soft keys are displayed, labelled *[Upper]* and *[Lower]*. These are used to select which of the two possible input frequency ranges are used to produce the specified output frequency range.
[⇩] ***[5][0][0][* [M μ]**	Sets the IF frequency for the down-converter output.
[⇩] **[3] [G n]** ***[⇩]*** **[6] [G n]**	Sets the start and stop frequencies of the mixer input (RF source) to 3 GHz and 6 GHz, and is also displayed on the x-axis.
[⇩] **[-] [1] [0] [ENTER/=MKR]**	Sets the input power on the RF input of the mixer to –10 dBm.
[⇩] [⇩] [⇩] **[1] [0] [ENTER/=MKR]**	Sets the LO drive power to the mixer under test to +10 dBm from the external slave source.
[⇩] **[-] [6] [ENTER/=MKR]** ***[⇩]***	Activates the Approximate Gain/Loss field; this is used to set the approximate conversion loss to -6dB.

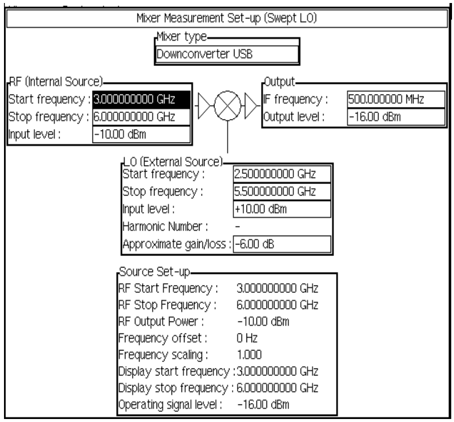
Once the input and output frequencies have been specified, the local oscillator frequencies are calculated and displayed on the form (2.5 GHz to 5.5 GHz in this example).

Note that if the LO frequency is known, this could be entered together with the input frequency range and the 6840A will calculate the corresponding IF frequency.

Now that the mixer parameters have been specified it is necessary to enable the external source driver. This example assumes the external source is a 6823 scalar analyzer with a 10 MHz to 20 GHz source.

[Ext Src Select] ***[Select Source]*** ***[⇩] [6823]*** ***[Return to External Src]***	Selects the external source selection menu and displays a list of source type numbers. Scroll down and select 6823.
[Ext Source Address] ***[Return to Conv Meas]***	Set the GPIB address for the 6823 external source.
[External Source ●]	Use this key to turn on the 6823 external source.

The Mixer Measurement Set-up form with the parameters entered is as follows:



[Return to Conv Meas]]	Returns to the Mixer Meas menu. The indicator in the bottom right hand corner of the *[Apply Scale/Offset]* soft key will be illuminated to indicate that the frequencies displayed on the x-axis have been offset from the source output frequency.

Step 4 - Calibrate the conversion loss measurement

The test set up can now be calibrated to set a 0 dB reference point for the insertion loss measurement.

[CAL] ***[Through Cal]***	A message prompts you to make a through connection, i.e. connect the source output to the spectrum analyzer input (via the attenuator pad, cables and/or adapters that will be used to connect the DUT).
[Source Freq Range]	Selects a calibration at the frequency range of the RF source by setting the tuned input to the source frequency range.
[Continue]	Turns on the RF power and initiates a through calibration, and automatically applies the calibration data to the measurement.

Step 5 - Use markers to get detailed information about the conversion loss measurement

Use the markers to determine the –1 dB bandwidth of the mixer output.

[MARKER] ***[More]*** ***[Position Active Mkr*]** **[4][.][5] [G n]**	Set a frequency value that positions the active marker at the centre point of the response, 4.5 GHz in this example.

[Mkr Functions] ***[Bandwidth]*** ***[Set n dB Value]*** **[-][1] [ENTER/=MKR]** ***[Bandwidth Search]***	Sets the bandwidth search value to –1 dB. Measures the –1 dB bandwidth of the filter and positions markers at the –1 dB points.
[Remove Results Window]	Removes the –1 dB bandwidth results window but leaves the two markers in position.

The markers can also be used to determine the maximum gain of the down-converter or the gain at the centre frequency.

Example 10: Conversion gain of a down-converter - scalar detector method

This example illustrates the measurement of the conversion gain of a down-converter, but this time a scalar detector is used instead of the tuned input. This would obviously be the method used if a 6820A series instrument is used for the measurement, which does not contain a spectrum analyzer.

The DUT is the same as the one in Example 8, and the procedure is similar. However, because of the low input requirements of the down-converter and the use of a broadband scalar detector, several additional steps need to be taken to ensure that noise does not cause problems with the measurement. In particular, the AC detection, averaging and smoothing features of the 6800A are used. The source output power will need to be set to a higher level in this case (e.g. -40 dBm) so that noise does not affect the calibration.

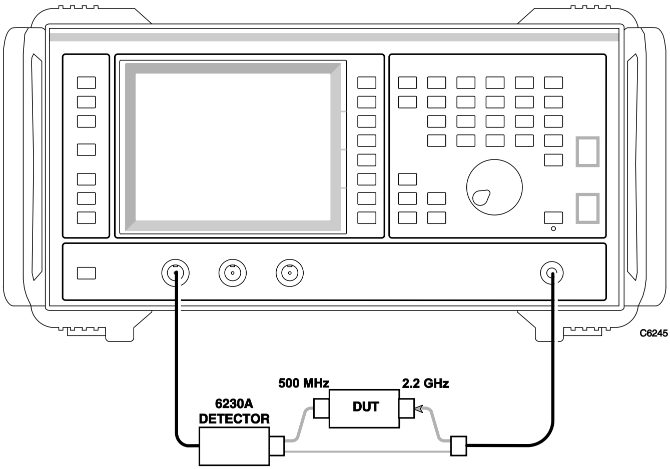


Fig. 2-21 Setup for conversion gain measurement of a down-converter

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Scalar menu will be shown along with a single scalar measurement of input A. For 6840A series instruments a spectrum analyzer measurement is displayed.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the conversion gain of the down-converter. For a 6840A series instrument the default channel is Spectrum Analyzer, so it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar.

Step 3 - Define the measurements and source conditions

[SCALAR] ***[Input Selection]*** ***[A]*** ***[Return to Scalar]*** ***[More]*** ***[AC Detection]*** ***[Return to Prior Menu]***	Defines measurement 1 to measure input A and specifies the AC detection mode. AC detection is used to cancel the effects of zero drift and to reject signals from other sources (such as transmitters) which could interfere with the measurement.
[Conversion Measurements] ***[Mixer Meas Set-up]*** : : ***[Return to Scalar]***	Display the Mixer Measurement Set-up form and enter the appropriate data into the fields. The details are the same as in Example 8, except that the Approximate Gain/Loss cannot be set when not in tuned input mode, and the Input Level field is set to -40 dBm.
[Averaging] ***[Set Average Number]*** **[4] [ENTER/=MKR]** ***[Averaging ●]*** ***[Return to Scalar]***	The amount of noise on the trace can be reduced by turning on averaging; in this example the average number is set to 4. The minimum amount of averaging should be selected to reduce noise to an acceptable level, in order to maintain a sufficiently fast response.
[Smoothing] ***[Smoothing ●]***	Turns on smoothing to reduce the amount of ripple on the trace. In this example, the **smoothing aperture** value is left at the default value of 1%, but can be changed using the ***[Set Aperture]*** soft key.
[SOURCE] ***[Sweep Time]*** ***[User Set Sweep Time]*** ***[Set Sweep Time]*** **[4] [ENTER/=MKR]**	Sets the sweep time to 4 seconds; this has the effect of further reducing noise when averaging is enabled by allowing a longer averaging time.
[ENTRY OFF]	Terminates numeric entry.

The calibration procedure and the subsequent measurement are the same as in Example 8, except for an additional step to restart averaging ([SCALAR] *[Restart Averaging]*). The displayed measurement would be similar to that of Example 8.

Example 11: Filter test using the tracking generator

In this example, the frequency response of a low pass filter is measured using the spectrum analyzer and tracking generator. The tracking generator is the 6800A source which is set up to provide a swept signal whose frequency precisely tracks the tuning of the spectrum analyzer receiver. As for tuned input scalar measurements, this method allows increased dynamic range measurements of frequency response to be made, and is particularly useful with large measurement frequency ranges. The measurement setup is shown below:

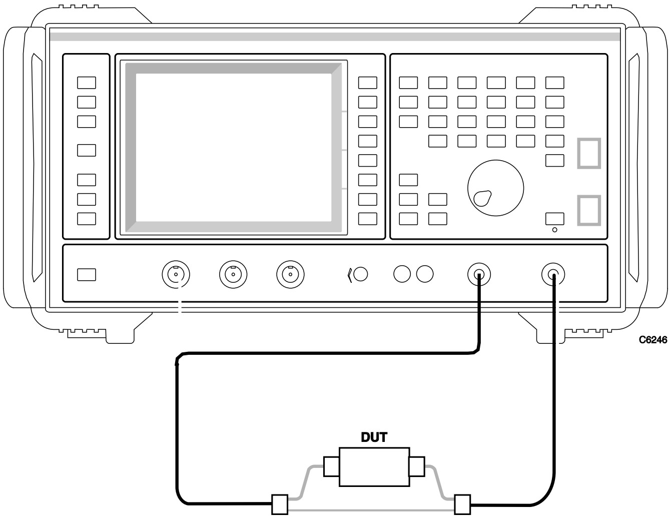


Fig. 2-22 Setup for filter test using the tracking generator

Note that the normal procedure used for scalar measurements does not apply, since this is essentially a spectrum analyzer measurement.

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement (for 6840A series instruments).
[SPECTRUM] ***[Cntr/Span ○]***	Selects spectrum analyzer mode with start/stop frequency entry.
[Set Start Frequency] **[1] [0] [M μ]**	Sets the start frequency to 10 MHz.
[Set Stop Frequency] **[1] [8] [G n]**	Sets the stop frequency to 18 GHz.

[SOURCE]
[Tracking Generator] — Selects the spectrum analyzer tracking generator function.

[Set Output Power]
[0] [ENTER/=MKR] — Sets the power level to 0 dBm.

Connect the SIGNAL SOURCE OUTPUT to the SPECTRUM ANALYZER INPUT using any cables that will be used in the measurement.

[CAL]
[Normalise]
[Continue] — The Normalise function is used in conjunction with the tracking generator output to compensate for frequency response errors incurred by the spectrum analyzer test fixtures and cables. This permits the frequency response of the device under test to be displayed with all external errors removed. The source is turned on automatically when *[Continue]* is pressed.

Having completed normalisation for the measurement path, the normalisation data is automatically applied to the measurement. This is indicated by the presence of **Nrm** in the trace information box.

Now connect the filter between the tracking generator (source output) and the spectrum analyzer input using the cables used during normalisation.

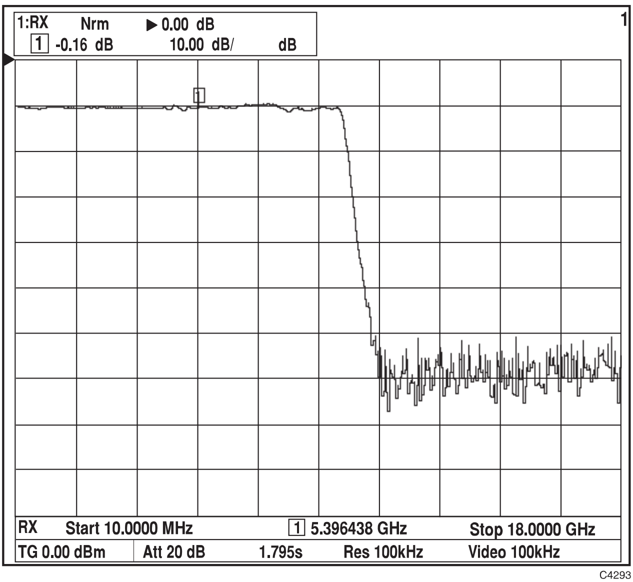


Fig. 2-23 Low-pass filter response

Use the markers to determine the -3 dB response of the filter.

[MARKER] ***[Peak Search]***	Positions the active marker at the point of minimum insertion loss on the pass band response of the filter.
[Delta Mkr] ***[Delta Mkr ●]*** ***[Return to Marker]***	Enables the delta marker and returns to the Marker menu.
[Mkr Functions] ***[Set Search Value]*** [–] **[3] [ENTER/=MKR]**	Enter a value of –3 dB for the marker search.
[Search Right] ***[Return to Marker]***	Locates the point 3 dB below the delta marker setting and returns to the Marker menu.
[Delta Mkr] ***[Delta Mkr ○]***	Turns off the delta marker so that the active marker indicates the frequency at the –3 dB point of the low pass filter.

Example 12: Group delay measurement of a bandpass filter (Option 022 only)

This example illustrates the use of the tuned input mode of the scalar analyzer to measure the group delay and frequency response of a bandpass filter.

The example uses a 6840A series instrument to measure the group delay of a 9 GHz coaxial bandpass filter. The source in the instrument provides the RF input signal for the bandpass filter under test via an attenuator pad connected directly to the source output. The purpose of the pad is to improve the source output VSWR because the measurement of group delay is more sensitive to source and load match than is the case for a frequency response measurement.

The measurement setup is shown below. Note that in this example, the tuned input rather than a broadband scalar detector must be used in order to measure group delay.

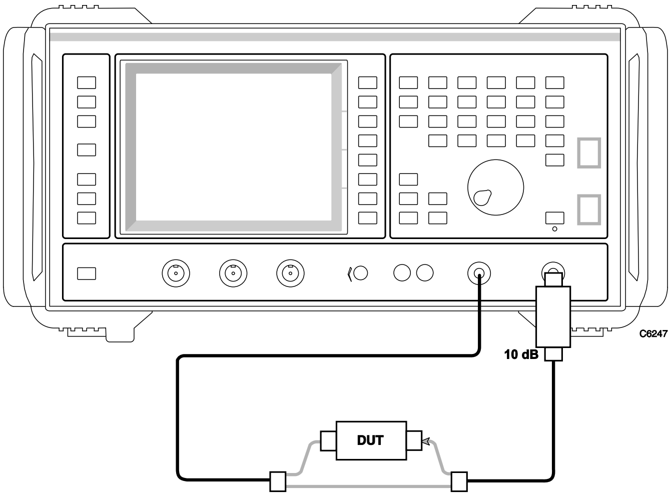


Fig. 2-24 Setup for group delay measurement of a bandpass filter

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the frequency response and measurement 2 of channel 1 will be used to display the group delay of the bandpass filter. Since a 6840A series instrument is used, the default channel is Spectrum Analyzer, so it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar. Alternatively, press **[SWITCH CHANNEL]** to display channel 2, which is scalar by default.

[SCALAR] ***[Yes]***	Select Scalar mode and press the *[Yes]* soft key to confirm the change.
[DISPLAY] ***[Channel 1 Meas 2 ●]***	Use these keys to turn on measurement 2.

Step 3 - Define the measurements

[SELECT MEAS]	Use this key to make measurement 1 the active measurement.
[SCALAR] ***[Input Selection]*** ***[Tuned Input]*** ***[Tuned Input]***	Selects the tuned input mode of operation for measurement 1. **RX** is displayed in the trace information area to indicate that the spectrum analyzer receiver is being used instead of a scalar detector.

Step 4 - Define the source conditions

[SOURCE] ***[Select Source Mode]*** ***[Cntr & Span Freq Sweep]*** ***[Return to Source]***	Selects the Centre & Span Frequency Sweep mode.
[Set Cntr Frequency] **[9] [G n]**	Sets the centre frequency for the filter to 9 GHz.
[Set Span] **[3] [0] [0] [M μ]**	Sets a suitable span to show about 20 dB range from the filter passband.
[Set Output Power] **[5] [ENTER/=MKR]**	Sets the source output power to 5 dBm to give a good signal to noise ratio.
[ENTRY OFF]	Terminates numeric entry.
[SOURCE ON/OFF]	Use this key to turn on the 6800A source.

Step 4 - Select an appropriate scaling for the filter response

[SCALE/FORMAT] ***[Set Scale]*** **[2] [ENTER/=MKR]** ***[Set Ref Level]*** **[0] [ENTER/=MKR]**	In order to make a group delay measurement it is necessary to set up a suitable frequency versus amplitude range. In this example a 2 dB/div range is used giving a screen range of 20 dB. This determines the span bandwidth that can sensibly be set up for the DUT.

It may now be necessary to return to the source menu and re-adjust the span to achieve a suitable display of the bandpass filter. Temporarily inserting the filter may help to set the span to the required value.

Step 5 - Calibrate the frequency response measurement

[CAL] ***[Through Cal]***	A message prompts you to make a through connection, i.e. connect the source output to the spectrum analyzer input (via the attenuator pad, cables and/or adapters that will be used to connect the DUT).
[Continue]	Turns on the RF power and initiates a through calibration, and automatically applies the calibration data to the measurement.

Step 6 - Use markers to get detailed information about the frequency response measurement

Use the markers to determine the -3 dB bandwidth of the filter.

[MARKER] ***[Active Mkr to Maximum]***	Positions the active marker at the maximum point of the response.
[Mkr Functions] ***[Bandwidth]*** ***[Bandwidth Search]***	Measures the -3 dB bandwidth of the filter and positions markers at the -3 dB points.
[Remove Results Window]	Removes the -3 dB bandwidth results window but leaves the two markers in position.

Step 7 - Define the group delay measurement

Measurement 2 of channel 1 will be used to display the group delay of the bandpass filter. Select this with the [SELECT MEAS] key as below then set up group delay from the [SCALAR] menu.

[SELECT MEAS]	Use this key to make measurement 2 the active measurement.
[SCALAR] ***[Group Delay] [Group Delay]***	Defines measurement 2 as a group delay measurement. The tuned input is automatically selected and the Resolution Bandwidth is fixed at 3 MHz. In addition, *coupled aperture* is selected by default - the aperture setting is determined by the frequency span and the range and deviation parameters are coupled to the aperture.

Step 8 - Calibrate the group delay measurement

The group delay measurement must now be calibrated to remove the effects of any delays in the measurement system. Group delay calibration is similar to a frequency response through cal, except that delay times in the measurement system rather than amplitude variations are removed.

[CAL] ***[Through Cal]*** ***[Continue]***	Calibrate the measurement of group delay by linking the source output (after the attenuator pad) and the spectrum analyzer (tuned input) input. Selects the through cal and makes the calibration.

Connect the bandpass filter under test and observe the measurement 1 trace. If necessary adjust the source span to show about 20 dB of the bandpass filter passband response on the screen.

Step 9 - Select an appropriate scaling for group delay

[SCALE/FORMAT] ***[Autoscaling]*** ***[Autoscale]***	Use the autoscale facility to set an appropriate scale factor and reference level for the group delay display.
or	
[Set Scale] **[2] [G $_n$]** ***[Set Ref Level]*** **[7] [G $_n$]**	Alternatively adjust the scale by setting a suitable value such as 2 ns/div and a reference level of +7 ns.

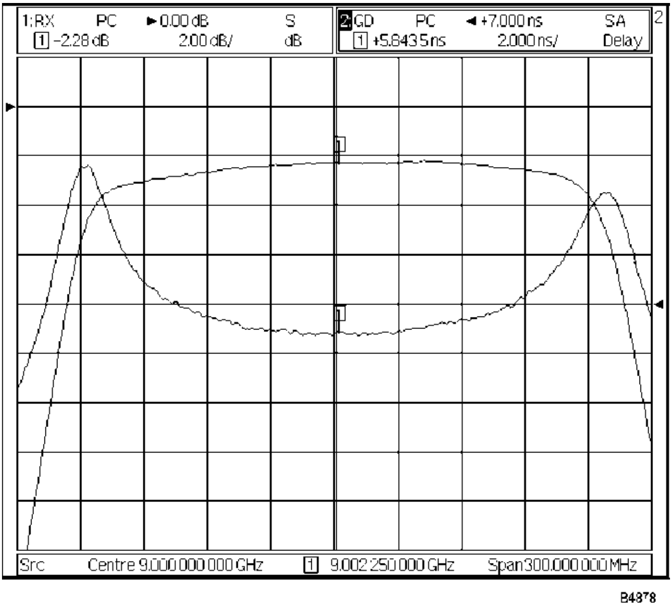


Fig. 2-25 Group delay measurement of a bandpass filter

Step 10 - Use markers to get detailed information about the group delay measurement

Use the marker facility to find the peak-to-peak variation in group delay in a specified bandwidth over the frequency span of the measurement.

[MARKER] ***[Pk - Pk]***	Selects the peak-to-peak function.
[Use Sub-range ●] ***[Set Sub-range Start]*** ***[Set Sub-range Stop]***	Use the rotary control to adjust the sub-range start and stop markers to be coincident with the lower and upper -3 dB markers.
[Set Bandwidth] **[5] [0] [M μ]**	Sets the bandwidth of the frequency window that is used for pk-pk delay measurements to 50 MHz. This window is moved over the frequency sweep (or sub-range, if specified) one measurement point at a time and the pk-pk function is applied to the measurement points covered by the window for each of its positions.
[Pk - Pk Delay ●]	Enables the peak-to-peak delay function, using the specified measurement bandwidth. The active and delta markers are placed at the maximum and minimum values respectively.

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 13: Group delay measurement of a down-converter (Option 022 only)

This example illustrates the use of the offset tuned receiver mode of the scalar analyzer to measure the group delay and frequency response of mixers, up-converters and down-converters.

The example uses a 6840A series instrument to measure the group delay of a down-converter, which has an integral 1.7 GHz local oscillator. The device operates over an input frequency range of 2.2 GHz ±50 MHz and the down-converted output is 500 MHz ± 50 MHz with a gain of approximately 15 dB. The source in the instrument provides the RF input signal for the down-converter under test via an attenuator pad connected directly to the source output. The purpose of the pad is to improve the source output VSWR because the measurement of group delay is more sensitive to source and load match than is the case for the conversion gain measurement.

The measurement setup is shown below. Note that in this example, the tuned input rather than a broadband scalar detector must be used in order to measure group delay.

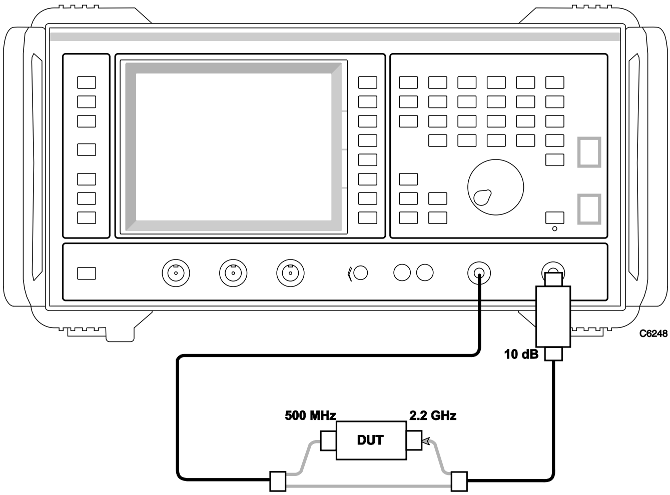


Fig. 2-26 Setup for group delay measurement of a down-converter

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the frequency response and measurement 2 of channel 1 will be used to display the group delay of the down-converter. Since a 6840A series instrument is used, the default channel is Spectrum Analyzer, so it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar. Alternatively, press **[SWITCH CHANNEL]** to display channel 2, which is scalar by default.

[SCALAR] ***[Yes]***	Select Scalar mode and press the *[Yes]* soft key to confirm the change.
[DISPLAY] ***[Channel 1 Meas 2 ●]***	Use these keys to turn on measurement 2.

Step 3 - Define the frequency response measurement and source conditions

[SELECT MEAS]	Use this key to make measurement 1 the active measurement.
[SOURCE] ***[Sweep Time]*** ***[User Set Sweep Time]*** ***[Set Sweep Time]*** **[2] [ENTER/=MKR]**	Sets the source sweep time to 2 seconds to improve signal-to-noise ratio.
[SCALAR] ***[Input Selection]*** ***[Tuned Input]*** ***[Tuned Input]***	Selects the tuned input mode of operation for measurement 1. **RX** is displayed in the trace information area to indicate that the spectrum analyzer receiver is being used instead of a scalar detector
[Set Res BW] **[⇩] [⇩]** ***[Return to Input Sel]*** ***[Return to Scalar]***	The resolution bandwidth is manually set to provide an improved signal-to-noise ratio for the gain measurement.
[Conversion Measurements] ***[Mixer Meas Set-up]*** ***[Downconverter]***	Display the Mixer Measurement Set-up form and specify that the measurement is to be performed on a down-converter. Specifying the converter type must always be the first step for these types of measurements.
[Cntr/Span ●] ***[⇩]*** **[5] [0] [0] [M μ]** ***[⇩]*** **[2] [5] [M μ]**	Selects the centre/span entry mode for the down-converter output. This sets the frequency range of the spectrum analyzer receiver and this is displayed on the x-axis. The span is set to 25 MHz for this example.
[⇩] [⇩] [⇩] **[1] [5] [ENTER/=MKR]**	Activates the Approximate Gain/Loss field; this is used to set the conversion gain to +15 dB.

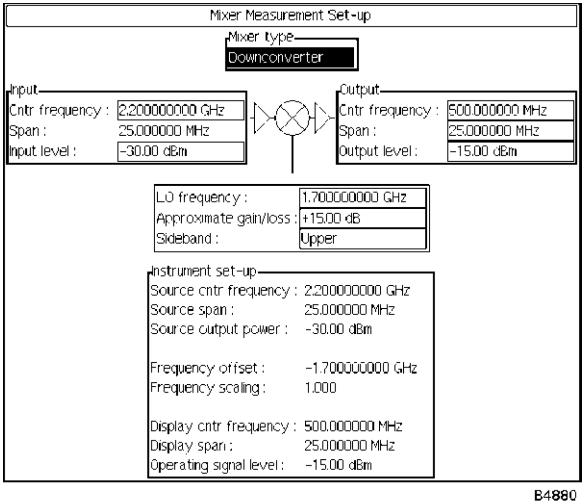
[⇩] ***[Upper]***	Activates the Sideband field; two additional soft keys are displayed, labelled *[Upper]* and *[Lower]*. These are used to select which of the two possible input frequency ranges are used to produce the specified output frequency range; the source is set to sweep over this range.
[⇩] **[2] [.] [2] [G n]**	Sets the centre frequency of the down-converter input to 2.2 GHz, i.e. the centre frequency of the source sweep. The span is automatically set by the instrument to 25 MHz., so does not need to be entered. Similarly, whenever a value is entered for the input start or stop frequency, the other will be set automatically so that the frequency span is the same as that of the output

Once the input and output frequencies have been specified, the local oscillator frequency is calculated and displayed on the form (1.7 GHz in this example).

Note that if the LO frequency is known, this could be entered together with the output frequency range and the 6800A will calculate the corresponding input frequency range.

[⇩] **[–] [3] [0] [ENTER/=MKR]**	Activates the Input Level field. This parameter is set to ensure that the source does not overload the down-converter input. In this example the DUT requires an input of about -40 dBm, so -30 dBm is set to give the required level after the external 10 dB attenuator pad.

The Mixer Measurement Set-up form with the parameters entered is as follows:



[Return to Conv Meas]] Returns to the Conversion Meas menu. The indicator in the bottom right hand corner of the *[Apply Scale/Offset]* soft key will be illuminated to indicate that the frequencies displayed on the x-axis have been scaled and/or offset from the source.

Step 4 - Calibrate the frequency response measurement

The frequency response measurement must be calibrated to remove the effects of amplitude variations with frequency.

[CAL]
[Through Cal]
[Source Freq Range]
A message prompts you to make a through connection, i.e. connect the source output to the spectrum analyzer input (via any cables or adapters that will be used to connect the DUT).

[Continue] Turns on the RF power and initiates a through calibration, and automatically applies the calibration data to the measurement.

Note that two options are available when performing a through calibration for a measurement on a frequency conversion device. The first is to perform the calibration with the spectrum analyzer receiver set to the range required for the measurement; the source frequency range is moved to cover the output range that the spectrum analyzer receiver would expect to see if the DUT were present (i.e. the displayed range).

If a cable is placed between the 6800A source output and the down-converter input then the alternative method is to leave the source and re-tune the receiver to the source frequency range during calibration. This option is selected using the *[Source Freq Range]* soft key and is used in this example (this is the default selection following an instrument preset so would not normally need to be pressed).

Now connect the down-converter between the source output and the spectrum analyzer input.

Step 5 - Select an appropriate scaling for the frequency response

[SCALE/FORMAT] ***[Set Scale]*** **[2] [ENTER/=MKR]** ***[Set Ref Level]*** **[2] [5] [ENTER/=MKR]**	In order to make a group delay measurement it is necessary to set up a suitable frequency versus amplitude range. In this example a 2 dB/div scaling is used giving a screen range of 20 dB. This determines the span bandwidth that can sensibly be set up for the DUT.

Step 6 - Use markers to get detailed information about the frequency response measurement

Use the markers to determine the -3 dB bandwidth of the output filter of the down-converter.

[MARKER] ***[Active Mkr to Maximum]***	Positions the active marker at the maximum point of the response.
[Mkr Functions] ***[Bandwidth]*** ***[Bandwidth Search]***	Determines the 3 dB bandwidth of the down-converter's filter response. The two highest numbered markers, other than the active one, are placed at the upper and lower -3 dB points
[Remove Results Window]	Removes the -3 dB bandwidth results window but leaves the two markers in position.

Step 7 - Define the group delay measurement

Measurement 2 of channel 1 will be used to display the group delay of the down-converter. Select this with the [SELECT MEAS] key as below then set up the group delay measurement from the [SCALAR] menu.

[SELECT MEAS]	Use this key to make measurement 2 the active measurement.
[SCALAR] ***[Group Delay]*** ***[Group Delay]***	Defines measurement 2 as a group delay measurement. The tuned input is automatically selected and the Resolution Bandwidth is fixed at 3 MHz. In addition, *coupled aperture* is selected by default - the aperture setting is determined by the frequency span and the range and deviation parameters are coupled to the aperture.

[Set Aperture]
[3] [M μ]
[Set Range]
[1] [M μ]
[Set FM Deviation]
[1] [M μ]

Alternatively, these parameters can be entered manually.

Step 8 - Calibrate the group delay measurement

The group delay measurement must now be calibrated to remove the effects of any delays in the measurement system. Group delay calibration is similar to a frequency response through cal, except that delay times in the measurement system rather than amplitude variations are removed.

[CAL]
[Through Cal]
[Source Freq Range]
[Continue]

Calibrate the measurement of group delay by connecting the source output (after the attenuator pad) directly to the spectrum analyzer input. The calibration is performed over the frequency range of the source by pressing *[Source Freq Range]*; this is selected by default.

Now connect the down-converter under test and observe the measurement 1 trace. If necessary adjust the source span to show about 20 dB of the down-converter passband response on the screen.

Step 9 - Select an appropriate scaling for the group delay

[SCALE/FORMAT]
[Autoscaling]
[Autoscale]

Use the autoscale facility to set an appropriate scale factor and reference level for the group delay display.

or

[Set Scale]
[5] [G n]
[Set Ref Level]
[4] [0] [G n]

Alternatively adjust the scale by setting a suitable value such as 5 ns/div and a reference level of +40 ns.

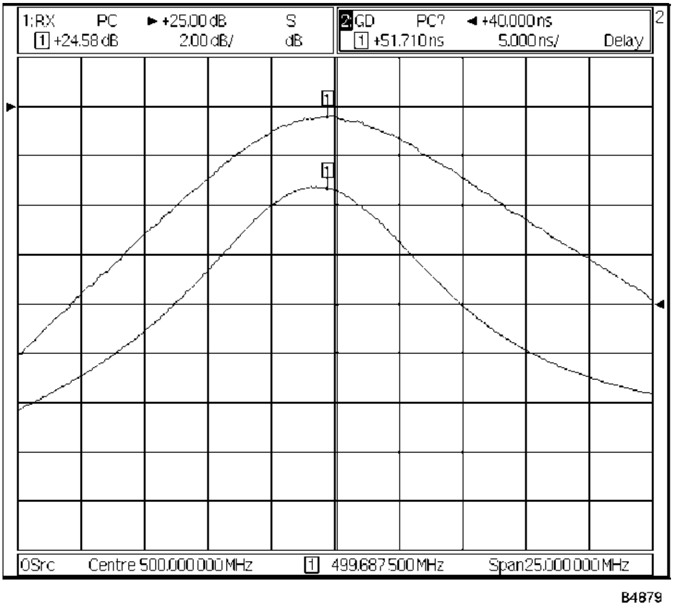


Fig. 2-27 Group delay measurement of a down-converter

Step 10 - Use markers to get detailed information about the group delay measurement

Use the marker facility to find the peak-to-peak variation in group delay in a specified bandwidth over the frequency span of the measurement.

[MARKER] ***[Pk - Pk]***	Selects the peak-to-peak function.
[Use Sub-range ●] ***[Set Sub-range Start]*** ***[Set Sub-range Stop]***	Use the rotary control to adjust the sub-range start and stop markers to be coincident with the lower and upper -3 dB markers.
[Set Bandwidth] **[5] [0] [M μ]**	Sets the bandwidth of the frequency window that is used for pk-pk delay measurements to 50 MHz. This window is moved over the frequency sweep (or sub-range, if specified) one measurement point at a time and the pk-pk function is applied to the measurement points covered by the window for each of its positions.
[Pk - Pk Delay ●]	Enables the peak-to-peak delay function, using the specified measurement bandwidth. The active and delta markers are placed at the maximum and minimum values respectively.

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Source & spectrum analyzer measurements

Example 14: Locating and viewing a CW signal

This example shows how to locate a known CW signal and display it on screen with an appropriate span, resolution bandwidth and reference level.

[PRESET]
[Full]

Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement (for 6840A series instruments).

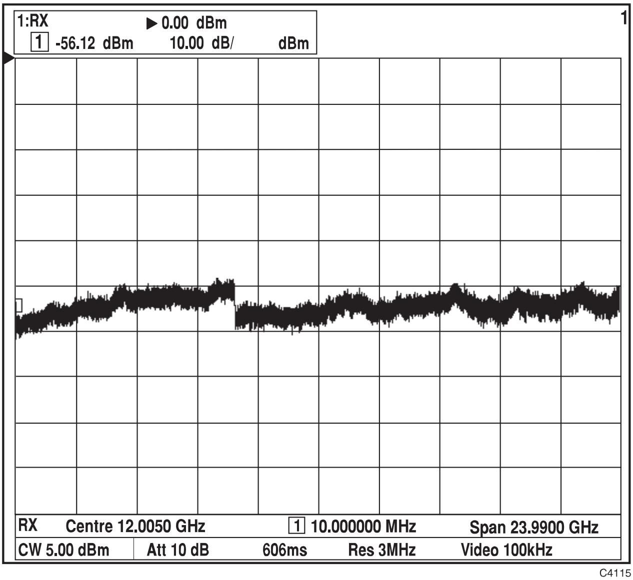


Fig. 2-28 Display following preset

Connect the signal to the spectrum analyzer input via a suitable coaxial cable..

Measurement 1 of channel 1 will be used to display the signal. Since the default state of a 6840A series instrument is a single channel displaying a single spectrum analyzer measurement, no change needs to be made to the display configuration.

[SPECTRUM]
[Cntr/Span ●]

Selects the centre/span frequency sweep mode.

[Set Cntr Frequency]	Enter the CW frequency for the applied signal using the numeric keypad and press the appropriate terminator key.
[Set Span]	Adjust the span by entering a value from the numeric keypad or by using the rotary control or up/down keys ([⇧] and [⇩]) to reduce the span as required.

Alternatively, if the frequency of the signal is not known exactly:

[Auto Tune]	Automatically searches on full span for the largest displayed input signal. The instrument then sets the frequency of this signal as the centre frequency and reduces the span to 20 MHz.

The final span after auto tune may be wider or narrower than required, but can be adjusted using ***[Set Span]***, as described above.

A further alternative is to use the active marker, as follows:

[Cntr/Span ○]	Selects the start/stop frequency sweep mode.
[Set Start Frequency]	Enter a suitable start frequency, e.g. 10 MHz.
[Set Stop Frequency]	Enter a suitable stop frequency for the frequency band of interest.
[MARKER] ***[Peak Search]***	Places the active marker on the peak of the largest signal within the selected span.
[Mkr to Centre Freq]	Sets the active marker (and therefore the selected signal) to the centre frequency of the display.
[Mkr to Ref Level]	Sets the amplitude value of the active marker as the top of screen reference level.
[SPECTRUM] ***[Cntr/Span ●]***	Return to the Spectrum menu and select centre / span frequency sweep.
[Set Span]	Adjust the span to produce the required display.

If the signal of interest is drifting in frequency then the signal tracking function can be selected to keep the signal in the centre of the display (**[SPECTRUM]** ***[Signal Tracking ●]***).

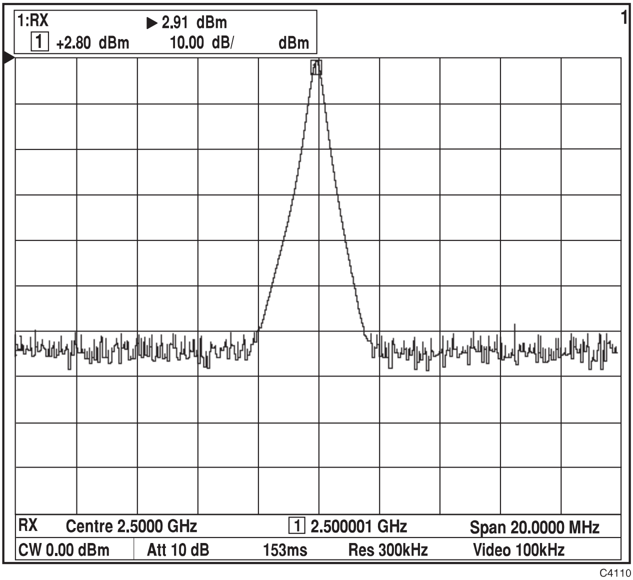


Fig. 2-29 Locating and viewing a CW signal

Example 15: Measuring the SSB phase noise of aCW signal

This example shows how to use the marker features of a 6840A series instrument to measure the SSB phase noise of a signal. Having located the signal as in the previous example, it is first necessary to adjust the spectrum analyzer to display the signal in an appropriate manner for the measurement.

Adjust the spectrum analyzer setup

There are two areas which need further setting up: the spectrum analyzer span and the display resolution and video bandwidths. The appropriate span can be determined by taking the offset required (all phase noise measurements are taken at a specified offset) and allowing a span of 2.5 times the maximum offset. In this example a 100 kHz maximum offset is required so the spectrum analyzer span is set to 250 kHz.

The coupled spectrum analyzer resolution bandwidth and video bandwidth will be set to 3 kHz and 10 kHz respectively when a span of 250 kHz is entered. For this measurement these will be reduced to 1 kHz and 300 Hz in order to provide a smoother signal for the measurement.

The following key presses set these parameters:

[SPECTRUM] ***[Set Span]*** **[2] [5] [0] [k m]**	Select Spectrum mode and sets the span to 250 kHz.
[MARKER] ***[Peak Search]*** ***[Mkr to Centre Freq]***	Ensures the signal to be measured is at the centre of the display after the span is set.
[SPECTRUM] ***[More]*** ***[Set Res BW]*** **[⇩]**	Reduces the coupled resolution bandwidth from 3 kHz to 1 kHz.
[Coupled Functions] ***[Set Video BW]*** **[⇩] [⇩] [⇩]**	Reduces the coupled video bandwidth from 10 kHz to 300 Hz.

Use the marker menu to measure the phase noise

[MARKER] ***[Peak Search]***	Selects the marker menu and first sets the active marker to the peak of the signal.
[Mkr Functions] ***[Noise in 1 Hz BW ●]*** ***[Return to Marker]***	Selects the **noise in 1 Hz** function so that the amplitude marker corrects for the resolution bandwidth.

[Delta Mkr]
[Delta Mkr ●]

Selecting the delta marker allows the amplitude data to be displayed in dB/Hz at the required offset.

The rotary control can now be used to set the required frequency offset as displayed by the active marker. The marker amplitude readout displays the measured phase noise in dB/Hz which is actually in dBc/Hz because the delta marker was set relative to the carrier peak. An example of a set of values obtained is shown in the table below:

Offset	**Phase Noise at 2.5 GHz**	**Phase Noise at 10 GHz**
10.27 kHz	-95 dBc/Hz	-89 dBc/Hz
20.06 kHz	-99 dBc/Hz	-94 dBc/Hz
100.29 kHz	-114 dBc/Hz	-101 dBc/Hz

Example 16: Measurement of low level CW signals

This example measures the frequency and level of a –70 dBm signal at around 500 MHz and places the signal in the centre of the display.

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement (for 6840A series instruments).

Connect the signal to the spectrum analyzer input via a suitable coaxial cable..

[SPECTRUM] ***[Cntr/Span ●]***	Selects the centre/span frequency sweep mode.
[Set Cntr Frequency] **[5] [0] [0] [M µ]**	Sets the centre frequency to the frequency of interest (500 MHz).
[Set Span] **[1] [0] [0] [M µ]**	Sets a suitable initial span, e.g. 100 MHz.
[Set Ref Level] [–] **[3] [0] [ENTER/=MKR]**	Enter a value for the top of screen reference; a value of –30 dBm is suitable if the signal is just above the noise level.
[More] ***[Coupled Functions]***	Enter the Coupled Functions menu.
[Coupled Input Atten ○] ***[Set Input Atten]***	Uncouple the Input Attenuation setting then reduce its value to 0 dBm using the **[⇩]** key.

Ensure the signal is on-screen and then reduce the span by pressing **[⇩]** step key until either the span is 50 kHz or the displayed signal is less than 3 divisions from either screen edge. If too close to the screen boundary then a further keypress will cause the signal to disappear off-screen. The signal can be re-centred using the marker functions:

[MARKER] ***[Peak Search]***	Places the active marker on the peak of the signal.
[Mkr to Centre Freq]	Sets the active marker (and therefore the selected signal) to the centre frequency of the display.
[SPECTRUM] ***[Set Span]***	Re-selects entry of span values.

If necessary, continue using the **[⇩]** key to reduce the span; once a span of 50 kHz has been reached it is then possible to make a further improvement to the signal-to-noise ratio as follows:

[More] ***[Coupled Functions]***	Enter the Coupled Functions menu.
[Coupled Video BW ○] ***[Set Video BW]***	Uncouple the Video Bandwidth setting then reduce its value using the **[⇩]** key. Reducing to too low a value will generate an *Uncal* warning. The sweep time remains coupled, and will increase to retain integrity of the measured data (provided that the Uncal indicator is not present).

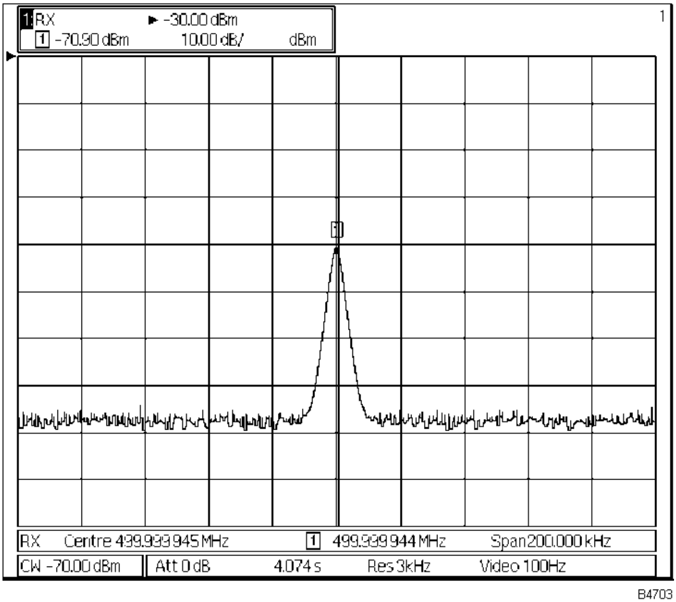


Fig. 2-30 Measurement of a low level CW signal

Example 17: Measurement of a signal and its harmonics

In this example, a 100 MHz signal at approximately 5 dBm is displayed and the harmonic levels up to a frequency of 800 MHz are measured

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement (for 6840A series instruments).

Connect the signal to the spectrum analyzer input

[SPECTRUM] ***[Cntr/Span ○]***	Selects the start/stop frequency sweep mode.
[Set Start Frequency] **[9] [0] [M μ]**	Enter a value which is lower than the fundamental frequency of the signal. Alternatively, select the active marker, adjust the marker frequency with the rotary control so that it is just lower than the signal fundamental frequency, then press [ENTER / =MKR]..
[Set Stop Frequency] **[8] [0] [0] [M μ]**	Enter a value which is eight times the fundamental frequency (800 MHz in this example). Alternatively, the value can be set using the active marker, as above.
[MARKER] ***[Peak Search Functions]*** ***[Peak Search]***	Places the active marker on the peak of the largest signal within the selected span (the fundamental in this case).
[Identify Peaks] ***[Return to Marker]***	Searches the displayed span, identifies eight peaks with the eight markers, then displays a marker table which shows frequency and level values for each marker. Note that the frequency values differ from the expected harmonic frequencies; this is due to the normal errors associated with spectrum analyzers (depends on the total span).
[Mkr Functions] ***[Measure Rel to Carrier ●]***	If this function is enabled, the reading at the current position of the active marker is set to 0 dB (the carrier in this case), and subsequent measurements are made relative to this reading (the measurement units will be in dBc).

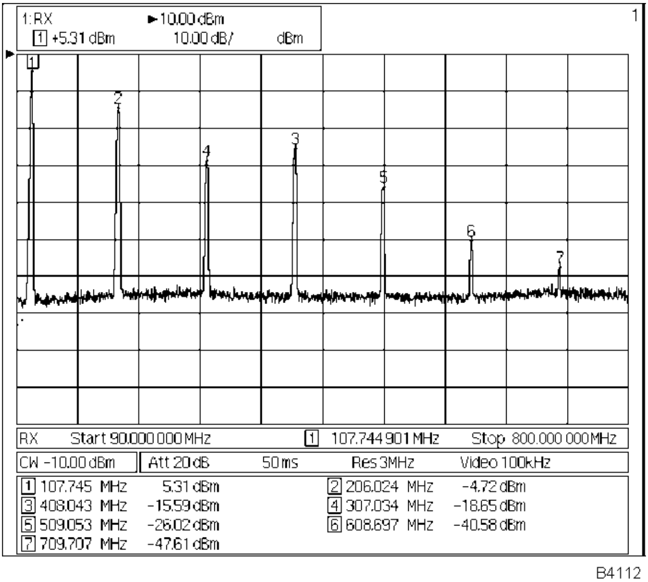


Fig. 2-31 Measurement of a signal and its harmonics

Example 18: Intermodulation measurements

Typically, intermodulation measurements are performed on an amplifier or mixer. In this example, intermodulation distortion products at an amplifier's output are displayed on the screen.

The measurement setup is shown in Fig. 2-32. Set the internal source to 501 MHz.. Set the external source (e.g. Aeroflex 2025) to an appropriate offset for the measurement. For example, setting it to a frequency of 499 MHz gives an offset of 2 MHz. Connect the two source outputs to a combiner, and connect the combiner output to the input of the amplifier under test. Connect the output of the amplifier to the spectrum analyzer input.

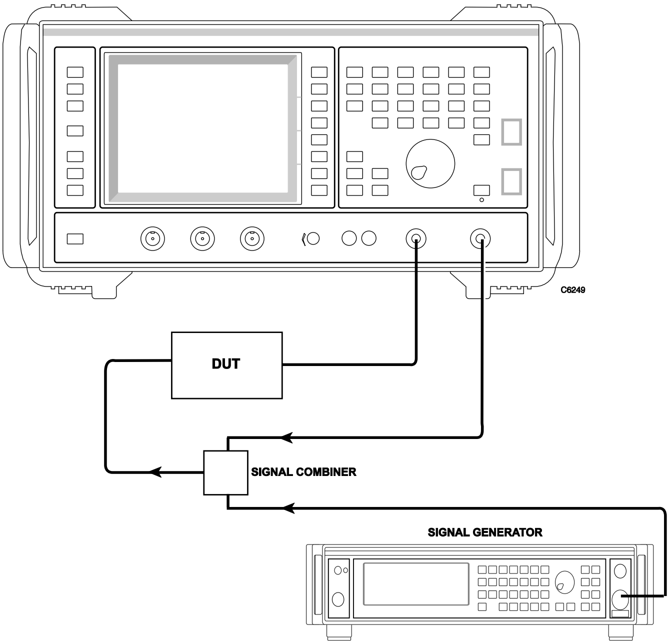


Fig. 2-32 Setup for intermodulation measurements

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement (for 6840A series instruments).

[SPECTRUM] ***[Cntr/Span ●]***	Selects the centre/span frequency sweep mode.
[Set Cntr Frequency] **[5] [0] [0] [M µ]**	Sets the centre frequency to 500 MHz.
[SOURCE] ***[CW]*** ***[Set Frequency]*** **[5] [0] [1] [M µ]**	Sets the internal source to the required frequency of 501 MHz.
[Set Output Power] [–] **[2] [0] [ENTER/=MKR]**	Choose an appropriate power level for the amplifier under test, e.g. –20 dBm.
[SOURCE ON/OFF]	Use this key to turn on the 6800A source

Now set the frequency and output power of the external source to 499 MHz and approximately –20 dBm.

[SPECTRUM] ***[Set Span]*** **[1] [0] [M µ]**	Sets the span such that the two test signals are within the display by setting a span of 1 MHz/div. The intermodulation distortion products of the amplifier output signal will be displayed on the screen (see Fig. 2-33). In this example, the display will show the third order components due to the two test signals, at frequencies of $2f_1 - f_2$ and $2f_2 - f_1$ (i.e. 503 MHz and 497 MHz).

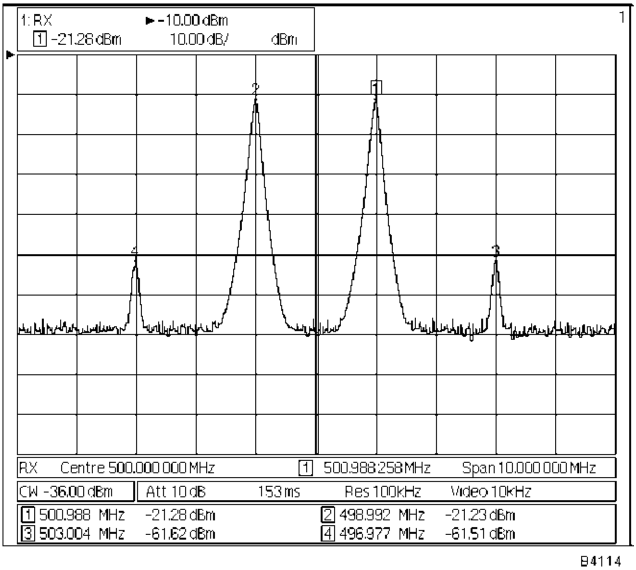


Fig. 2-33 Intermodulation measurements

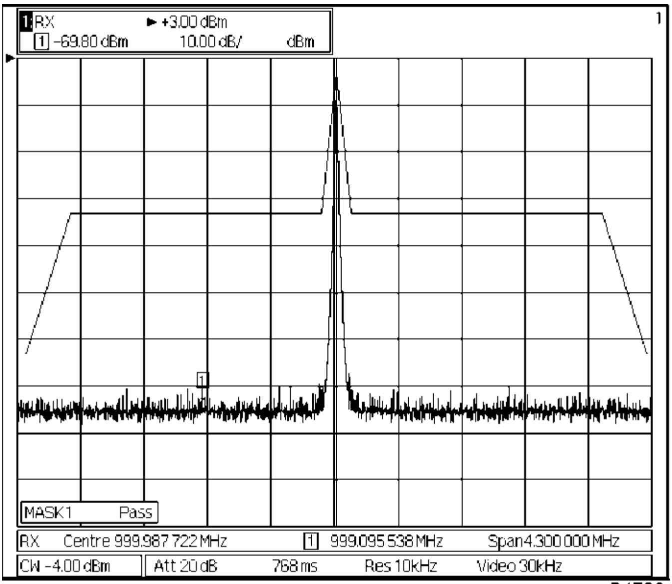
[MARKER] ***[Peak Search]***	Places the active marker on the peak of the largest signal within the selected span, which could be either of the two test signals (499 MHz or 501 MHz).
[Peak Search Functions] ***[Identify Peaks]*** ***[Return to Marker]***	Locates the intermodulation distortion products and identifies them with markers. Unwanted markers can be turned off using **[MARKER]** ***[More] [Set Up Mkrs]***.
[Mkr Functions] ***[Measure Rel to Carrier ●]***	If this function is enabled, the reading at the current position of the active marker is set to 0 dB (the carrier in this case), and subsequent measurements are made relative to this reading (the measurement units will be in dBc).

Example 19: Spectrum analyzer limit masks

Example 1 shows how a limit specification can be created and how limit lines can be applied to the measured trace. That example uses *absolute domain values,* where the frequencies entered are the actual values specified in the limit specification. It is also possible to create a limit specification where the frequency values are entered as *relative domain values.* In this case absolute frequency values are not required and the limit specification can be applied to any chosen centre frequency. This type of limit is particularly useful to define transmitter frequency occupancy masks when measured with a spectrum analyzer. This type of mask is also useful when the exact centre frequency value may not be known or is unimportant but where the occupied bandwidth limit is important.

The following procedure shows how a limit mask can be created and stored in a 6840A series instrument, using the latter method.

The diagram below illustrates the required limit mask as defined by amplitude values along with the relative frequency break points. Note that absolute values of frequency are not required, only the offset from the centre frequency.



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Use the diagram to set up the limit mask required as follows. Note that when the domain values are entered as offsets the resulting limit lines will be reflected symmetrically about the centre frequency, so that it is only necessary to specify the segments above or below the centre frequency. In this example positive offsets are used, representing frequencies above the centre value.

[SPECTRUM] ***[More]*** ***[Limit Checking]*** ***[Edit Spec]***	The Limit Editor window is displayed containing a blank **Limit Checking Specification** form. This consists of fields for **start** and **stop** domain values, i.e. stimulus, and the corresponding **upper** and **lower** response values.
[Limit Type] ***[Upper Limit Only]*** ***[Relative Domain Values]*** ***[Return to Limit Editor]***	Specifies that only an upper limit is to be used, and that the domain values are to be specified as offsets relative to the centre value of the measurement.
[Edit Segments] ***[Slope]***	Specifies that the first segment of the limit mask is to be the **slope** type.
[⇨] **[0] [k m]** ***[⇨]*** **[0] [ENTER/=MKR]** ***[⇨]*** **[1] [0] [0] [k m]** ***[⇨]*** [–] **[3] [0] [ENTER/=MKR]**	Activates the **start** domain field and sets a value of zero for the offset frequency. Then the **upper** response field is activated and a level of 0 dBm is set. Values of 100 kHz and –30 dBm are then set for the end point of the segment.
[⇩] ***[Flat]***	Specifies that the next segment is to be of the **flat** type.
[⇨] [⇨] [⇨] **[1] [.] [8] [M μ]**	Activates the appropriate field and enters 1.8 MHz for the **stop** domain value. It is not necessary to enter values for the start of the line since the instrument assumes that a new segment will start where the previous one ends and sets the values accordingly. There is also no need to specify the response value for the stop frequency since it is the same as that for the start frequency for a flat segment.
[⇩] ***[Slope]***	Specifies that the next segment is to be of the **slope** type.
[⇨] [⇨] [⇨] **[2] [.] [1] [M μ]** ***[⇨]*** [–] **[6] [0] [ENTER/=MKR]**	Enters 2.1 MHz for the stop frequency and a corresponding response value of –60 dBm. Again it is not necessary to enter start values.
[Return to Limit Editor]	Returns to the Limit Editor menu.

[Save As]	Before exiting from the Limit Editor menu, the limit specification can be saved for future use. Pressing this soft key leads to the Save Spec As menu, which enables the specification to be saved to a user-specified store.
[Exit]]	Exits the limit editor.

Applying the limit specification is achieved by first setting the spectrum analyzer to display the signal required with the controls: ***[Set Cntr Frequency]***, ***[Set Span]*** and ***[Set Ref Level]*** and then proceeding as follows:

[SPECTRUM] ***[More]*** ***[Limit Checking]*** ***[Assign Spec]***	A sub-menu is presented in which a limit checking specification can be selected from a displayed list. Pressing ***[Select]*** assigns the specification to the currently active trace.
[Limit Checking ●]	Applies the limit specification to the current trace.

Example 20: External frequency modulation of the source

This example shows how the source can be set up to produce a frequency modulated signal using an external function generator.

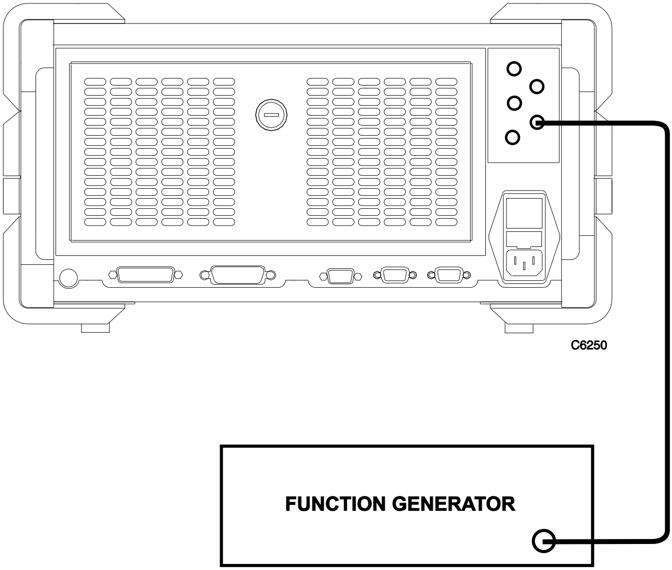


Fig. 2- Set-up for external modulation of the source

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. For 6840A series instruments the Spectrum menu will be shown along with a single spectrum analyzer measurement. A 6820A series unit will display a scalar measurement.

Step 2 - Define the source configuration

It is only possible for the source to be frequency modulated when in CW mode. There are two possible modes of operation of the source for a 6820A series unit: scalar CW mode or source only CW mode. For a 6840A series unit there is in addition a tracking generator CW mode. The scalar modes are shown first so, for a 6840A series unit, press the [**SWITCH CHANNEL**] key.

Step 3 - Define the source conditions

[SOURCE] ***[Select Source Mode]*** ***[CW]*** ***[Return to Source]***	Sets the source to the CW mode of operation.
[Set Frequency] **[1] [.] [2] [G n]**	Sets the carrier frequency to 1.2 GHz.
[Set Output Power] **[0] [ENTER/=MKR]**	Sets the source output power to 0 dBm.
[FM] ***[FM ●]***	Selects the FM set up menu and switches on the FM mode.
[External AC]	Selects external AC modulation (default).
[Set FM Deviation] **[1] [0] [k m]**	Sets a deviation of 10 kHz.

Apply a 1 kHz signal from the external function generator to the MOD' BNC connector on the rear panel of the 6800A. Set the level of the signal to 1 V peak at the connector since this value is required for the optimum deviation accuracy from the source.

If using a 6820A series unit it will not be possible to view the frequency modulated signal produced via the unit itself; an external spectrum analyzer or modulation analyzer will be required.

Source only mode (all instrument types)

This mode is essentially the same as the scalar CW mode described above except that the source is operated with the scalar functions disabled and the display screen is used as a single user interface for the source. When activated in a 6840A series unit the spectrum analyzer function is also disabled and therefore the modulated signal cannot be viewed.

The source only mode is enabled by selecting [**SOURCE**] ***[Enter Source Only Mode]***. All other source functions operate as above.

Spectrum analyzer mode for a 6840A series unit

After PRESET the 6840A series unit will be in spectrum analyzer mode.

[SOURCE] ***[CW]***	Sets the source to the CW mode of operation.
[Set Frequency] **[1] [.] [2] [G n]**	Sets the carrier frequency to 1.2 GHz.
[Set Output Power] **[0] [ENTER/=MKR]**	Sets the source output power to 0 dBm.

[FM] ***[FM ●]***	Selects the FM set up menu and switches on the FM mode.
[External AC]	Selects external AC modulation (default).
[Set FM Deviation] **[1] [0] [k m]**	Sets a deviation of 10 kHz.

It is now possible to view the modulated signal with the 6840A series spectrum analyzer by connecting the source output to the spectrum analyzer input. Select: [**SPECTRUM**] ***[Auto Tune]*** to view the signal carrier, followed by ***[Span]*** [⇩] to reduce the span in order to view the modulation sidebands.

The signal can also be demodulated and either the audio waveform viewed or the recovered audio can be heard via the internal loudspeaker. Selecting [**SPECTRUM**] ***[More] [Demodulation]*** allow access to these functions.

Example 21: Internal frequency modulation of the source (Options 022 & 023)

This example shows how the source can be set up to produce a frequency modulated signal in conjunction via the internal modulation generator, which is available when the unit is fitted with option 022 group delay (6840A series only) or option 023 internal modulation generator (all models).

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement for the 6840A series. A 6820A series unit will display a scalar measurement

Step 2 - Define the source configuration

It is only possible for the source to be frequency modulated when in CW mode. There are two possible modes of operation of the source for a 6820A series unit: scalar CW mode or source only CW mode. For a 6840A series unit there is in addition a tracking generator CW mode. The scalar modes are shown first so, for a 6840A series unit, press the [**SWITCH CHANNEL**] key.

Step 3 - Define the source conditions

[SOURCE] ***[Select Source Mode]*** ***[CW]*** ***[Return to Source]***	Sets the source to the CW mode of operation.
[Set Frequency] **[1] [.] [2] [G n]**	Sets the carrier frequency to 1.2 GHz.
[Set Output Power] **[0] [ENTER/=MKR]**	Sets the source output power to 0 dBm.
[FM] ***[FM ●]***	Selects the FM set up menu and switches on the FM mode.
[Internal]	Selects internal modulation.
[Set FM Deviation] **[1] [0] [k m]**	Sets a deviation of 10 kHz.
[Set Internal Mod Freq] **[1] [k m]**	Sets the frequency of the internal modulation generator to 1 kHz.

If using a 6820A series unit it will not be possible to view the frequency modulated signal produced via the unit itself; an external spectrum analyzer or modulation analyzer will be required.

Source only mode (all unit types)

This mode is essentially the same as the scalar, CW mode described above except that the source is operated with the scalar functions disabled and the display screen is used as a single user interface for the source. When activated in a 6840A series unit the spectrum analyzer function is also disabled and therefore the modulated signal can not be viewed.

The source only mode is enabled by selecting [**SOURCE**] ***[Enter Source Only Mode]***. All other source functions operate as above.

Spectrum analyzer mode for a 6840A series unit

After PRESET the 6840A series unit will be in spectrum analyzer mode.

[SOURCE] ***[CW]***	Sets the source to the CW mode of operation.
[Set Frequency] **[1] [.] [2] [G n]**	Sets the carrier frequency to 1.2 GHz.
[Set Output Power] **[0] [ENTER/=MKR]**	Sets the source output power to 0 dBm.
[FM] ***[FM ●]***	Selects the FM set up menu and switches on the FM mode.
[Internal]	Selects internal modulation.
[Set FM Deviation] **[1] [0] [k m]**	Sets a deviation of 10 kHz.
[Set Internal Mod Freq] **[1] [k m]**	Sets the frequency of the internal modulation generator to 1 kHz.

It is now possible to view the modulated signal with the 6840A series spectrum analyzer by connecting the source output to the spectrum analyzer input. Select: [**SPECTRUM**] ***[Auto Tune]*** to view the signal carrier followed by ***[Span]*** [⇩] to reduce the span in order to view the modulation sidebands.

The signal can also be demodulated and either the audio waveform viewed or the recovered audio can be heard via the internal loudspeaker. Selecting [**SPECTRUM**] ***[More] [Demodulation]*** allow access to these functions.

Transmission line measurements

Example 22: Return loss measurement of a coaxial cable using a fault locator

The 6240 Series Fault Locator, when used with the 6800A, enables both return loss and fault location measurements to be made from a single test port. The display can show the measurements simultaneously on two channels.

This example describes a measurement of the return loss of a coaxial cable using a 6240 Series Fault Locator. Connect the Fault Locator to input A and input B of the 6800A, and the RF input of the Fault Locator to the signal source of the 6800A (Fig. 2-34).

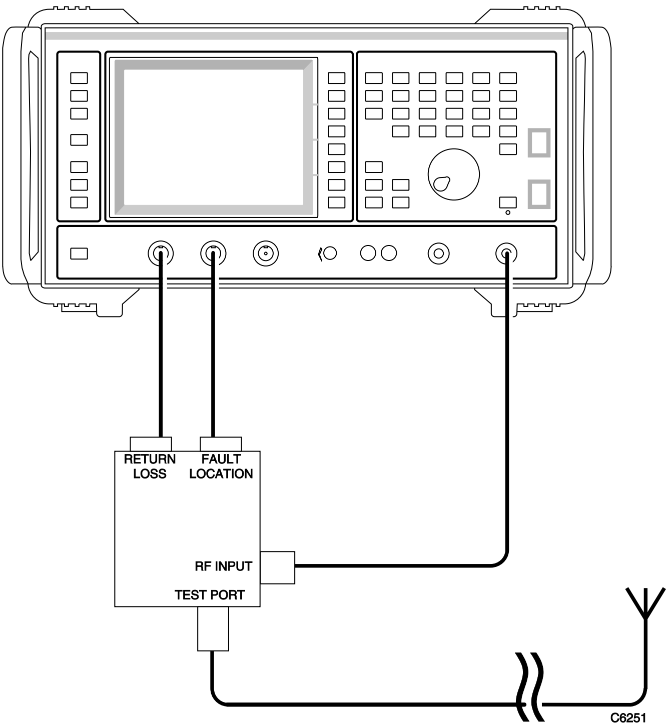


Fig. 2-34 Setup for return loss measurement using a Fault Locator

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Scalar menu will be shown along with a single scalar measurement of input A. For 6840A series instruments a spectrum analyzer measurement is displayed.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the return loss of the cable. For a 6840A series instrument the default channel is Spectrum Analyzer, so it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar. Alternatively, **[SWITCH CHANNEL]** could be used to display channel 2, which defaults to scalar for all instruments.

Step 3 - Define the measurements

[SCALAR] ***[Input Selection]*** ***[A]*** ***[Return to Scalar]***	This is dependent on which input the return loss cable from the fault locator is connected to. In this example input A has been selected.
[More] ***[AC Detection]***	Sets the detection mode to AC.

Step 4 - Define the source conditions

[SOURCE] ***[Set Start Frequency]*** **[1] [.] [7] [5] [G n]**	Sets the start frequency to 1.75 GHz.
[Set Stop Frequency] **[1] [.] [9] [5] [G n]**	Sets the stop frequency to 1.95 GHz.
[ENTRY OFF]	Terminates numeric entry.

Step 5 - Calibrate the measurement system

The calibration sequence is dependent on the type of Fault Locator used. A precision open/short is not supplied with the 6242 since it is not necessary for the frequency range covered by the 6242. For this Fault Locator the Short or Open Cal sequence should be followed:

[CAL] ***[Short OR Open Cal]***	A message is displayed asking for either a short circuit or open circuit to be connected. In this case the test port of the 6242 should be left open circuit.

[Continue]	Turns on the RF power and initiates the short circuit calibration. Upon completion, the path cal data is automatically applied to the measurement.

For all other Fault Locator types the Short and Open Cal sequence should be followed:

[CAL] ***[Short AND Open Cal]***	Presents a message stating that the path cal store about to be used for the calibration is store 1, and prompts for connection of a short circuit (termination) to the Fault Locator test port.
[Continue]	Initiates the short circuit calibration. When completed a message will be displayed stating that an open circuit termination should be connected to the test port.
[Continue]	Initiates the open circuit calibration. Upon completion, the path cal data is automatically applied to the measurement.

Upon completion of the path calibration the path cal data is automatically applied to the measurement, and **PC** is shown in the trace information box.

Now connect the cable under test to the Fault Locator, and terminate with an antenna or a suitable load.

Step 6 - Select appropriate scaling and format

[SCALE/FORMAT] ***[Set Scale]*** **[5] [ENTER/=MKR]**	Sets the scale factor to 5 dB/div.
[VSWR]	If required use these keys to change the format of the return loss measurement to VSWR.

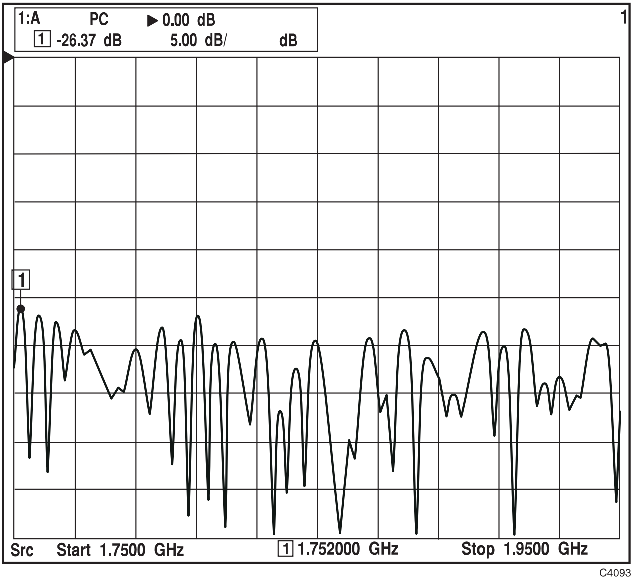


Fig. 2-35 Return loss measurement of coaxial cable

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 23: Return loss measurement of a coaxial cable using a return loss bridge

This example shows how to make a return loss measurement using a separate return loss bridge and detector rather than a Fault Locator. The return loss bridge and detector would normally be used with a 6821 version (1 MHz to 3 GHz), enabling users working in the RF band to make return loss measurements at relatively low cost. However, the bridge/detector arrangement can also be used with other instruments of the 6800A series.

The following procedure describes a return loss measurement on a 30 m length of coaxial cable. The measurement setup is shown below:

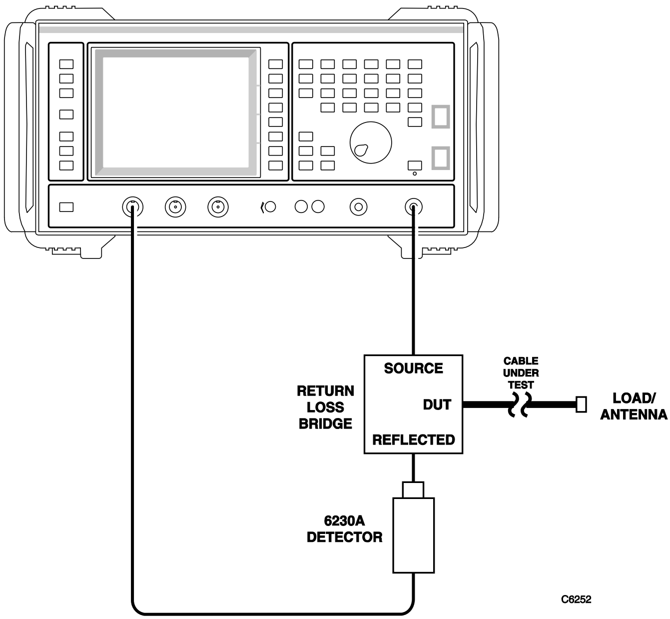


Fig. 2-36 Setup for return loss measurement using a return loss bridge and detector

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Scalar menu will be shown along with a single scalar measurement of input A. For 6840A series instruments a spectrum analyzer measurement is displayed.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the return loss of the transmission line. For a 6840A series instrument the default channel is Spectrum Analyzer, so it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar (or use **[SWITCH CHANNEL]** to display channel 2).

Step 3 - Define the measurements

Since the return loss is measured by a scalar detector connected to input A, no change needs to be made to the measurement definition since all scalar measurements default to input A following PRESET.

[SCALAR] ***[More]*** ***[AC Detection]***	AC detection is used to reject signals from other sources (such as transmitters) which could interfere with the measurement.

Step 4 - Define the source conditions

[SOURCE]	
[Set Start Frequency] **[8] [7] [0] [M μ]**	Sets the start frequency to 870 MHz.
[Set Stop Frequency] **[1] [G n]**	Sets the stop frequency to 1 GHz.
[ENTRY OFF]	Terminates numeric entry.

Step 5 - Calibrate the measurement system

In order to measure return loss, the system must first be calibrated against a known reference. Open circuit or short circuit terminations are chosen as both these devices theoretically reflect 100% of the power incident upon them, and therefore have a return loss of 0 dB.

[CAL] ***[Short OR Open Cal]***	A message is displayed asking for either a short circuit or open circuit to be connected to the test (DUT) port of the bridge. In this example, it is only necessary to leave the DUT port open for the calibration, since this will result in 100% reflection at lower frequencies.
[Continue]	Turns on the RF power and initiates the short circuit calibration.

Upon completion of the calibration, the path cal data is automatically applied to the return loss measurement, and **PC** is shown in the trace information box.

Now connect the cable under test to the DUT port of the bridge, and terminate the cable with either the antenna or a suitable load.

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 24: Fault location measurement of a coaxial cable using a fault locator

The objective of this example measurement is to give you an understanding of the fault location capabilities of the 6800A. It is recommended that the principles and requirements of a fault location measurement should first be understood by referring to Appendix C of the 6800A Operating Manual.

In this example, a fault location measurement will be made on a transmission line consisting of two sections of coaxial cable, with lengths 3 m and 24 m, connected together using an adapter. The measurement will be performed using a 6240 Series Fault Locator, and the measurement setup is shown below:

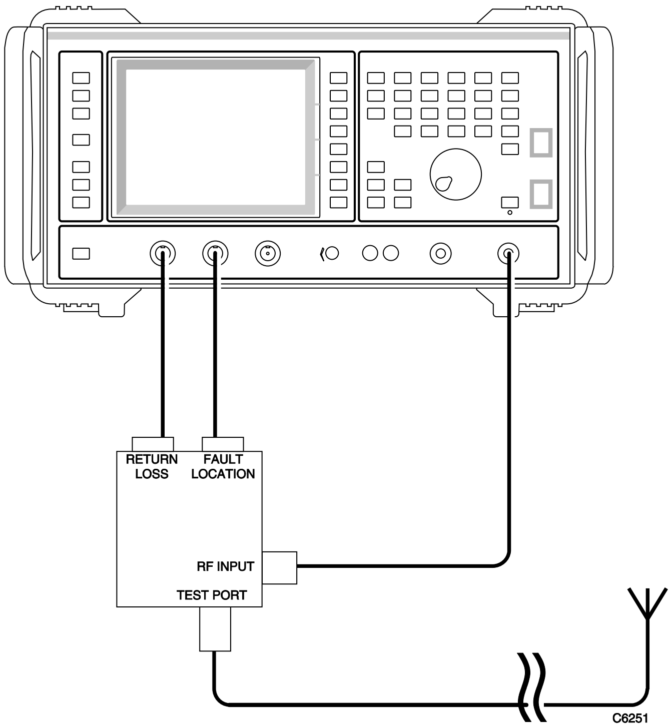


Fig. 2-37 Setup for fault location measurement using a Fault Locator

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Scalar menu will be shown along with a single scalar measurement of input A. For 6840A series instruments a spectrum analyzer measurement is displayed.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the fault location measurement.

[FAULT LOCATION] ***[Yes]***	Select Fault Location mode and press the ***[Yes]*** soft key to confirm the change.

Step 3 - Define the measurements

When a channel is set to fault location mode, and a Fault Locator is used, the 6800A automatically recognises which input the fault location lead is connected to and selects this input automatically (input B in this example). Input B is used by the 6800A in order to create the fault location response.

In a fault location measurement, the frequency span of the sweep and the distance range to be displayed are related by

$$\text{Frequency Span (GHz)} = \frac{\text{Constant} \times V_r \times \text{Number of Points}}{\text{Range (metres)}}$$

and so two methods of parameter entry are provided.

In the 'range entry' mode (the default mode), the range is entered and this determines the frequency span over which the source is swept. The system adjusts the centre frequency to the centre of the span previously set. A different band of frequencies may be chosen by adjusting the centre frequency, but the value of span (and hence range) will always be preserved. In the 'frequency entry' mode, a frequency span can be entered by adjusting the start/stop values. The range will then be calculated from the entered span.

[Configure Measurement]	A form is displayed listing the fault location parameters, which can be selected for editing using the ***[⇧]*** and ***[⇩]*** soft keys.

Select the **Entry Mode** parameter, then press

[Range]	Select ‘range entry’ mode.

Select the **Range** parameter, then press

[3] [0] [ENTER/=MKR]	Enter a range that is about 10 to 20 % greater than the estimated length of the waveguide under test. (The start and stop frequency values are automatically calculated.)

Select the **Centre Frequency** parameter, then press

[2] [G $_n$]	Sets a centre frequency suitable for the cable under test. Higher frequencies may show up faults better provided the frequency chosen is within the operating band of the cable. If an antenna is connected to the end of the transmission line, the centre frequency should be the operating frequency of the antenna. A value of 2 GHz is used in this example.

Select the **Tx Line Medium** parameter, then press

[Coax]	Specify coaxial transmission line.

Select the **Relative Velocity** parameter, then press

[0] [.] [8] [1] [ENTER/=MKR]	In coaxial mode the value entered for relative velocity is important for accurate distance calculation. A value for the cable under test is usually known, and will usually lie between 0.6 and 1. For the coaxial cable used in this example a velocity factor of 0.81 is used.

Select the **Attenuation** parameter, then press

[0] [.] [2] [5] [ENTER/=MKR]	A value of 0.25 dB/m is entered to compensate for the attenuation of the cable. Note that since attenuation varies with frequency, a figure appropriate to the centre frequency of the measurement should be used.

Select the **Display Units** parameter, then press

[Feet] or ***[Metres]***	Sets the display units to feet or metres, as required.

Select the **Number of points** parameter, then press

[4] [0] [0] [ENTER/=MKR]	Set the number of measurement points to 400. In exceptional cases fewer points may be selected to reduce the sweep bandwidth.

Select the **Input Configuration** parameter, then press

[Scalar Inputs]	Select the scalar input for the fault location measurement.
[Return to Fault Loc]	Returns to the Fault Loc menu.

If a transmission line consists of more than one section and the attenuation figures are significantly different, enter the value for the longer section. If the two sections have similar length use an average value for the two sections.

The relative velocity and attenuation parameters could also be entered by using the Transmission Line Database (stored internally). This allows fault location parameters to be set up automatically by specifying the transmission line type.

[Configure Measurement] ***[Tx Dbase In Use ●]***	Enables transmission line parameters to be set from a transmission line database record.
[Select Tx Line from Dbase]	A form is displayed giving data for transmission lines that match the subset selection criteria (specified by using *[Select Subset]*). The ***[⇧]***, ***[⇩]***, ***[Page Up]*** and ***[Page Down]*** soft keys are used to highlight the required transmission line record. On pressing ***[Select]*** the record is loaded for use by the instrument and the appropriate data fields in the entry table are modified accordingly
[Return to Fault Loc]	Returns to the Fault Loc menu.

Step 4 - Define the source conditions

Due to the nature of a fault location measurement, control of the source is not performed in the same way as for a scalar measurement. The output power level and sweep time are specified in the normal way via the [SOURCE] key, but the frequency sweep parameters must be done whilst setting up the measurement configuration, as described in the next step. It is not necessary to turn on the RF power since, for a fault location channel, it is turned on during the fault location calibration.

Step 5 - Calibrate the measurement system

[CAL] ***[Fault Location Cal]***	As for a scalar channel, the measurement system must be calibrated before making any measurements. Connect a matched load to the TEST PORT of the Fault Locator.
[Continue]	A detector zero is automatically performed, followed by calibration of the measurement system. The calibration data is stored, path calibration is applied and you are then returned to the main Cal menu.

Now connect the cable under test to the test port of the Fault Locator, and connect a load (or antenna) to the end of the cable under test. Alternatively, a detector can be used as a termination.

Step 6 - Select appropriate scaling and format

When the [PRESET] key was pressed in Step 1 the default format for a fault location channel was set to dB (i.e. return loss). However, if it is required to express the measurement as VSWR, change the format as follows. (If the performance of the transmission line is good, it is often easier to see faults or discontinuities with a vertical scale of VSWR.)

[SCALE/FORMAT] ***[dB]*** or ***[VSWR]***	Use these keys to change between dB and VSWR format.

It may be necessary to change the scaling to suit the measurement. The default scaling for the two formats is given below:

Format	Ref. Level	Scale Factor
dB	0	10.0 dB/div
VSWR	1.0	0.2 /div

The default reference position for dB format is the top graticule line; for VSWR format the reference position is the bottom graticule line.

For the example measurement, the scale factor is changed as follows:

[Set Scale] **[5] [ENTER/=MKR]**	Sets the scale factor to 5 dB/div.

The resulting display is shown below:

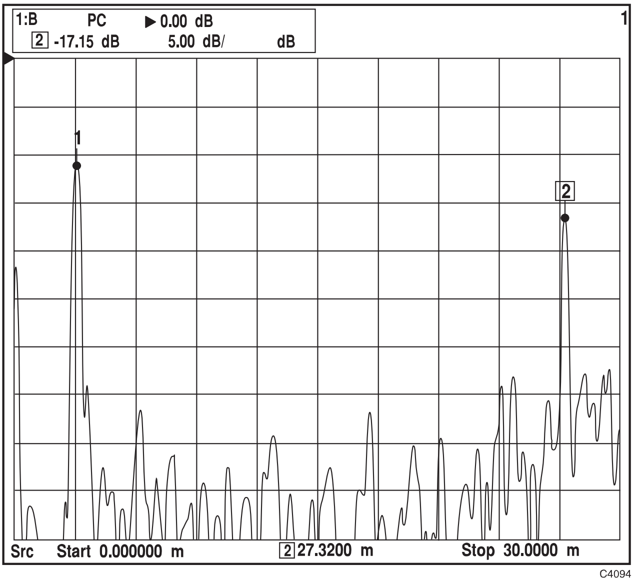


Fig. 2-38 Fault location measurement of a coaxial cable

Alternatively, more suitable scaling could be achieved through the use of the autoscale facility, where the instrument determines the optimum values of scale and reference level, as for a scalar measurement. The fault location channel uses, in addition, an algorithm in which automatic baseline clipping is employed to eliminate noise and emphasise peaks. The reference level is selected such that the positive peaks of the measurement are not clipped by the top graticule line; the scale factor is selected such that 10% of the measurement points are visible above the bottom graticule line, the remaining 90% being clipped.

Step 7 - Use markers and other 6800A features to get detailed information about the measurement

Using markers

More detailed information about the measurement (including the actual length of the cable) can be obtained through the use of markers. Faults on the transmission line (e.g. due to discontinuity or mismatch) result in peaks in the response. The Marker menu provides functions to locate peaks in the trace and places the active marker at those positions; the response values can be read off from the trace information area. To use this feature press the following keys:

[MARKER]

[Next Peak Right] Positions the active marker at the next peak in the trace to the right of its current position.

and

[Next Peak Left] Positions the active marker at the next peak in the trace to the left of its current position.

In the example shown in Fig. 2-38, it can be seen that the return loss measured at the load (indicated by marker 2) is 17 dB. If the cable were not terminated a large reflection (0 dB) would be seen at the open end of the cable.

The peak at marker 1 is due to a discontinuity resulting from a poor connection where the two cable sections are joined together. Marker 1 shows the fault to be located at approximately 3 m, which is the length of the first section of cable. Since this marker is not active, it is represented on the display by a number '1' which is not enclosed in a box.

As for a scalar channel, the position and response values of all displayed markers can be displayed on the screen in the form of a table, positioned below the graticule, by pressing **[MARKER]** ***[More] [Mkr Table]***. The marker table can also be printed when a hard copy of the measurement trace is created.

Limit checking

The limit checking feature of the 6800A can be used to check that the performance of the cable is satisfactory. For example, a flat limit line could be set up to check that the return loss at any point along the cable is better than 20 dB.

[FAULT LOCATION] ***[Limit Checking]*** ***[Edit Spec]***	A blank limit checking specification is displayed. This consists of fields for **start** and **stop** domain values, i.e. stimulus, and the corresponding **upper** and **lower** response values.
[Limit Type] ***[Upper and Lower Limits]*** ***[Absolute Domain Values]*** ***[Return to Limit Editor]***	In this example, both upper and lower limits are set, using absolute domain values.
[Edit Segments] ***[Flat]***	A new, flat line segment is added to the table with zero values in all fields. The start field value is highlighted.
[⇨] **[0] [ENTER/=MKR]**	Sets the **start** domain value to 0 m.
[⇨] [–] **[2] [0] [ENTER/=MKR]** ***[⇨]*** [–] **[2] [0] [0] [ENTER/=MKR]**	Sets the **upper** limit value to -20 dB. Since no **lower** limit is required, the lower limit value is forced out of range by setting it to -200 dB.
[⇨] **[3] [0] [ENTER/=MKR]**	Sets the **stop** domain value to 30 m. Note that upper and lower values for the stop value are not required as they are the same as those for the start value for a flat segment.
[Return to Limit Editor]	Returns to the Limit Editor menu.
[Save As]	Before exiting from the Limit Editor menu, the limit specification can be saved for future use. Pressing this soft key leads to the Save Spec As menu, which enables the specification to be saved to a user-specified store.
[Exit]	Exits the limit editor.
[Limit Checking ●]	Turns on limit checking. The limit line is displayed on the graticule along with a window containing the pass/fail indication.

Masking correction

For some measurements *masking correction* can be used to give more accurate results for amplitude. A large peak in a fault location measurement (due to a discontinuity or mismatch) can cause an error in the apparent magnitude of a fault beyond it, leading to underestimates in the severity of distant faults. This effect is cumulative, but can be compensated for by applying masking correction. Masking correction is enabled using:

[FAULT LOCATION] ***[Masking Correction ●]***	Use this key to toggle masking correction on and off.

Fig. 2-39 shows the trace that results when masking correction is applied. For both this trace and the original one shown in Fig. 2-38, the active marker has been placed at the peak at the end of the cable. It can be seen that this peak measures about 2 dB higher when masking correction is applied.

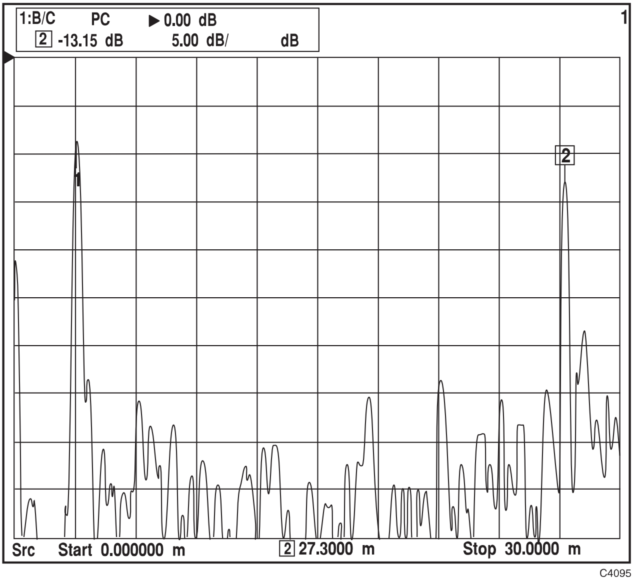


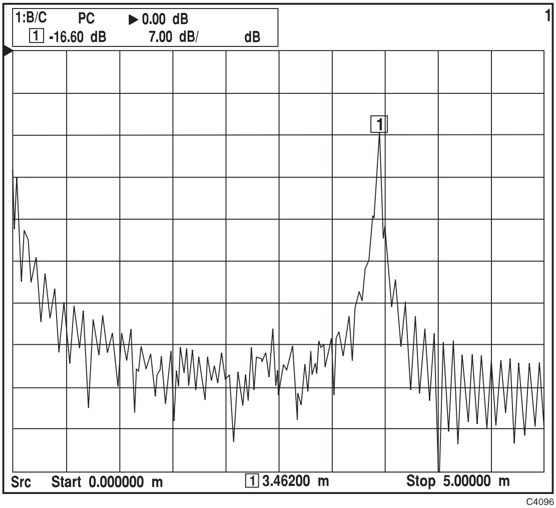
Fig. 2-39 Effect of masking correction

Windowing function

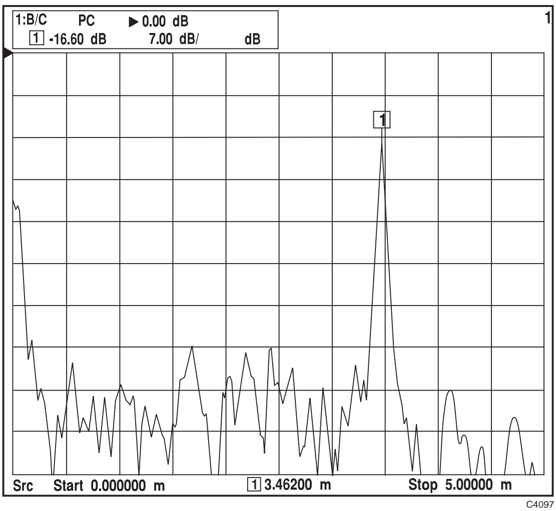
Windowing is a function which is applied to the acquired fault location data. Data windowing reduces the amplitudes of the sidelobes associated with the main peak of the display, but gives reduced distance resolution. Thus variation of the windowing level provides a trade-off between distance resolution and the height of the sidelobes. Three levels of windowing are provided. A low windowing level gives greater distance resolution but higher sidelobes; a high windowing level gives reduced sidelobe height but with some loss of distance resolution. A medium windowing level gives an optimum trade-off between distance resolution and sidelobe height for most applications; this is the default setting.

[FAULT LOCATION] ***[Windowing]*** ***[Windowing Low]*** or ***[Windowing Medium]*** or ***[Windowing High]***	Use these keys to select the windowing level

Fig. 2-40 shows the effect on the display of two levels of data windowing. In order that the effect can be seen more clearly, the measurement was performed on a different section of cable, of length 3.5 m.



LOW



HIGH

Fig. 2-40 Effect of windowing

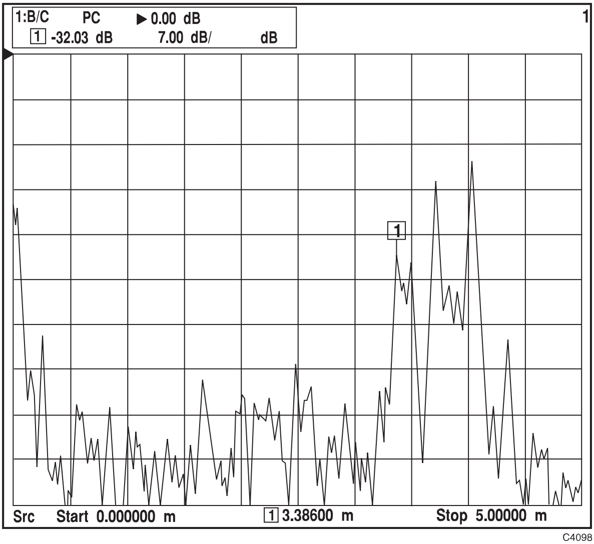
Zoom mode

The 6800A provides a function that allows you to ‘zoom in’ on a part of the transmission line that is of particular interest, for example, connectors or the interface between two sections of transmission line. Following calibration, the horizontal axis will display distance from zero to the range specified in the Config Meas menu. This zoom facility enables you to specify a sub-range of displayed distance values by entering the required start and stop values, or by specifying centre and span values.

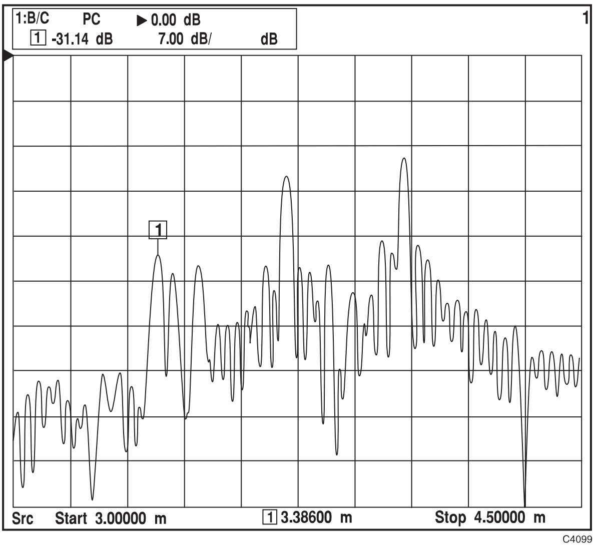
In this example, the interface between two sections of transmission line will be examined. The sections are approximately 3.5 and 0.5 m in length, and the range of the measurement was initially set up to be 0 to 5 m.

[FAULT LOCATION] ***[Zoom Mode]*** ***[Zoom Mode ●]***	Turn on the zoom mode.
[Set Display Start] **[3] [ENTER/=MKR]**	Sets the start distance to 3 m.
[Set Display Stop] **[4] [.] [5] [ENTER/=MKR]**	Sets the stop distance to 4.5 m.

The 6800A now displays the response of the transmission line over the range 3 m to 4.5 m, showing more detail in this region (Fig. 2-41). The peak in the response at which the active marker has been placed corresponds to the connection between the two cables. The next peak represents a fault in the second section and the following peak is the response at the end of this section.



NORMAL DISPLAY



SUB-RANGE DISPLAY

Fig. 2-41 Display of sub-range

The display start and stop values can also be set to the distances corresponding to the position of the active marker. Position the active marker on the trace, press either ***[Set Display Start]*** or ***[Set Display Stop]***, then press the **[ENTER/=MKR]** key on the numeric keypad. Repeat for the other parameter.

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 25: Fault location measurement of a coaxial cable using an RF divider and scalar detector

This example shows how to make a fault location measurement using an RF divider and scalar detector instead of a Fault Locator

The following procedure describes a fault location measurement on a 30 m length of coaxial cable (Andrew LDF2-50), using a 6240 series instrument.

Connect the signal source of the instrument to port 1 of the divider. Connect a 6230A scalar detector to port 2 of the divider and to input B of the 6800A (Fig. 2-42).

Note If a 6240 Series Fault Locator is not detected, the 6800A assumes that the measurement is to be made with an RF divider and a single detector connected to input B.

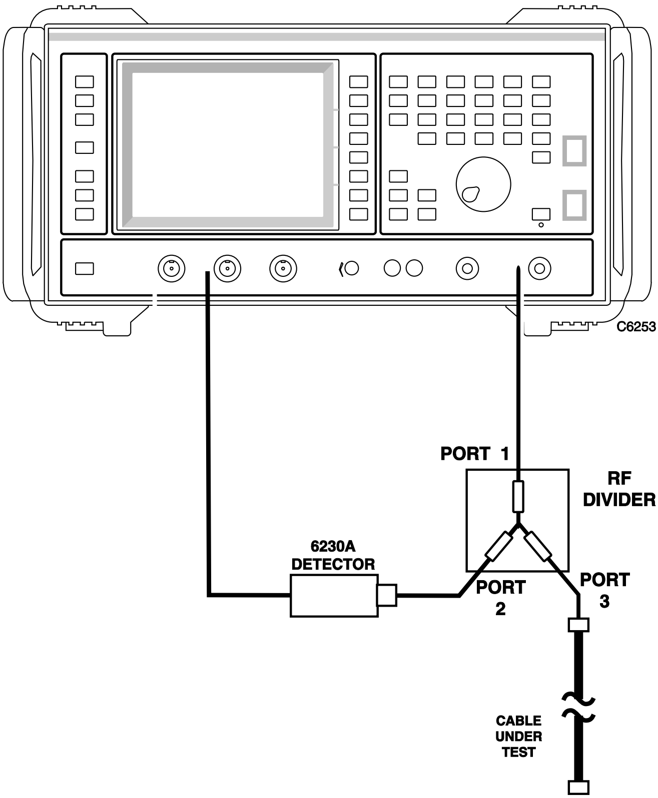


Fig. 2-42 Setup for fault location measurement using an RF divider and scalar detector

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement of input A.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the fault location measurement.

[FAULT LOCATION] ***[Yes]***	Select Fault Location mode and press the *[Yes]* soft key to confirm the change.

Step 3 - Define the measurements

[Configure Measurement]	A form is displayed listing the fault location parameters, which can be selected for editing using the ***[⇧]*** and ***[⇩]*** soft keys.

Select the **Entry Mode** parameter, then press

[Range]	Select ‘range entry’ mode.

Select the **Range** parameter, then press

[Set Range] **[3] [3] [ENTER/=MKR]**	Enter a range which is about 10 to 20% greater than the estimated length of the cable under test.

It should be noted that the range entered determines the swept bandwidth of the source, and vice versa. The shorter the range the greater the bandwidth. If a 6841 is used which has an upper frequency of 3 GHz, the minimum range possible is approximately 10 m when the number of points is set to 401. If a smaller distance range is required, this can be achieved by reducing the number of measurement points.

Select the **Centre Frequency** parameter, then press

[9] [4] [0] [Mμ]	Sets the centre frequency to the system's nominal operating frequency.

Select the **Tx Line Medium** parameter, then press

[Coax]	Specify coaxial transmission line.

Select the **Relative Velocity** parameter, then press

[0] [.] [8] [8] **[ENTER/=MKR]**	A velocity factor of 0.88 is assumed in this example.

Select the **Attenuation** parameter, then press

[0] [.] [1] [1] **[ENTER/=MKR]**	A value of 0.11 dB/m is entered to compensate for the attenuation of the cable at the operating frequency.

Select the **Display Units** parameter, then press

[Feet] or ***[Metres]***	Sets the display units to feet or metres, as required.

Select the **Input Configuration** parameter, then press

[Scalar Inputs]	Selects the tuned input mode of operation. **RX** is displayed in the trace information area to indicate that the spectrum analyzer receiver is being used instead of a scalar detector.

Step 4 - Calibrate the measurement system

[CAL] ***[Fault Location Cal]***	A matched load is connected to port 3 of the divider and calibration of the measurement system is performed.

Now connect the cable under test to port 3 of the divider, and connect either the antenna or a suitable load to the end of the cable.

The remaining steps would be similar to those of Example 24.

Example 26: Fault location measurement of a coaxial cable using an RF divider and tuned input

This example shows how to make a fault location measurement using an RF divider instead of a Fault Locator. The tuned input mode is also used; this allows increased dynamic range of the measurement. The tuned input method has a further advantage when making measurements on transmission lines in microwave systems: it rejects interfering signals from other transmitters, which would degrade the measurement. (The tuned input cannot be used for fault location measurements on waveguides, however.)

The following procedure describes a fault location measurement on a 30 m length of coaxial cable (Andrew LDF2-50), using a 6240 series instrument.

Connect the signal source of the instrument to port 1 of the divider, and connect the spectrum analyzer input to port 2 of the divider (Fig. 2-43).

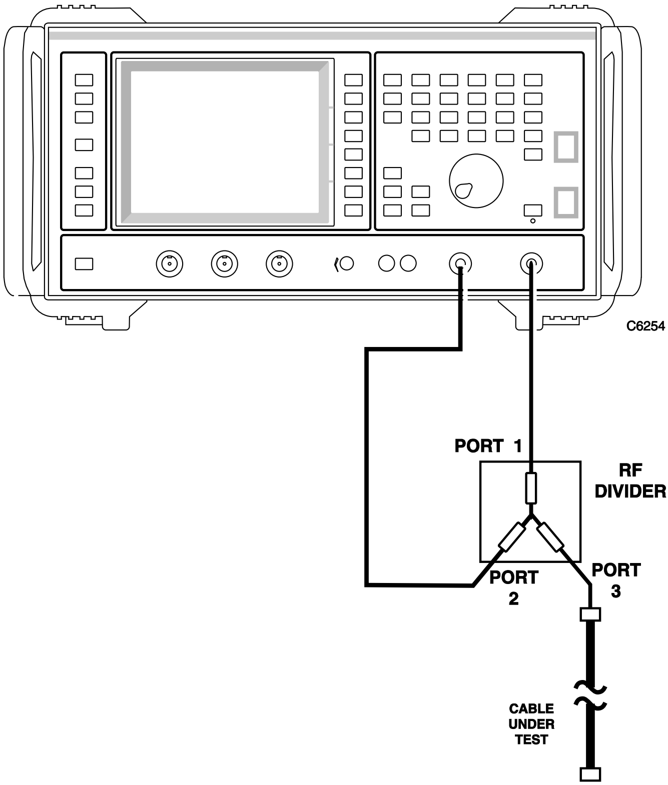


Fig. 2-43 Setup for fault location measurement using an RF divider and tuned input

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Spectrum menu will be shown along with a single spectrum analyzer measurement of input A.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the fault location measurement.

[FAULT LOCATION] ***[Yes]***	Select Fault Location mode and press the *[Yes]* soft key to confirm the change.

Step 3 - Define the measurements

[Configure Measurement]	A form is displayed listing the fault location parameters, which can be selected for editing using the ***[⇧]*** and ***[⇩]*** soft keys.

Select the **Entry Mode** parameter, then press

[Range]	Select ‘range entry’ mode.

Select the **Range** parameter, then press

[Set Range] **[3] [3] [ENTER/=MKR]**	Enter a range which is about 10 to 20% greater than the estimated length of the cable under test.

It should be noted that the range entered determines the swept bandwidth of the source, and vice versa. The shorter the range the greater the bandwidth. If a 6841 is used which has an upper frequency of 3 GHz, the minimum range possible is approximately 10 m when the number of points is set to 401. If a smaller distance range is required, this can be achieved by reducing the number of measurement points.

Select the **Centre Frequency** parameter, then press

[9] [4] [0] [Mµ]	Sets the centre frequency to the system's nominal operating frequency.

Select the **Tx Line Medium** parameter, then press

[Coax]	Specify coaxial transmission line.

Select the **Relative Velocity** parameter, then press

[0] [.] [8] [8] **[ENTER/=MKR]**	A velocity factor of 0.88 is assumed in this example.

Select the **Attenuation** parameter, then press

[0] [.] [1] [1] **[ENTER/=MKR]**	A value of 0.11 dB/m is entered to compensate for the attenuation of the cable at the operating frequency.

Select the **Display Units** parameter, then press

[Feet] or ***[Metres]***	Sets the display units to feet or metres, as required.

Select the **Input Configuration** parameter, then press

[Tuned Input]	Selects the tuned input mode of operation. **RX** is displayed in the trace information area to indicate that the spectrum analyzer receiver is being used instead of a scalar detector.

Step 4 - Calibrate the measurement system

[CAL] ***[Fault Location Cal]***	A matched load is connected to port 3 of the divider and calibration of the measurement system is performed.

Now connect the cable under test to port 3 of the divider, and connect either the antenna or a suitable load to the end of the cable.

The remaining steps would be similar to those of Example 24.

Example 27: Single-ended insertion loss measurement of a transmission line using a fault locator

A conventional insertion loss measurement on a transmission line requires simultaneous access to both ends of the line. This is not practical when the line is long, so the 6800A provides a method whereby insertion loss is derived from a measurement of return loss.

In a single-ended insertion loss measurement, either a short circuit termination or an open circuit termination is connected to the end of the line, so that theoretically 100% of the input power is reflected back to the source. A 6240 series Fault Locator is used as the bridge at the input end of the line to measure the reflected signal. As an alternative to the Fault Locator a dedicated bridge or coupler with a scalar detector can be used. Since this signal is attenuated twice (once in each direction), the measurement of the total attenuation in dB is halved by the 6800A to produce a value for the insertion loss.

This method is not suitable for high loss cables, because the signal is attenuated in both directions by the cable.

The following procedure describes a single-ended insertion loss measurement on a 30 m length of coaxial cable. The procedure is similar to that described in Example 23, except for the calibration step. The measurement setup is shown in Fig. 2-44.

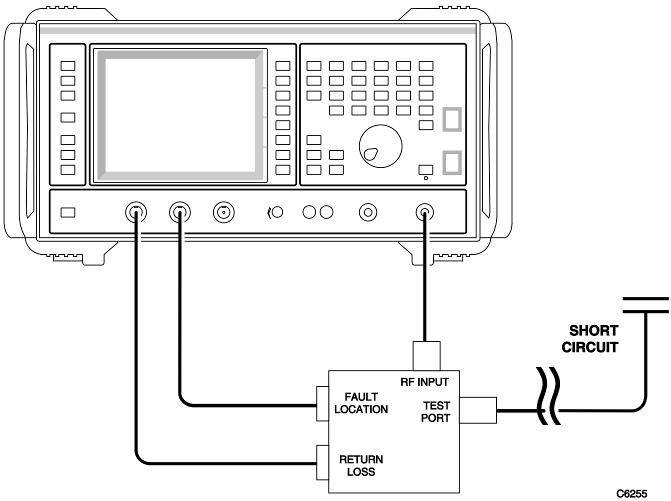


Fig. 2-44 Setup for single-ended insertion loss measurement

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Scalar menu will be shown along with a single scalar measurement of input A. For 6840A series instruments a spectrum analyzer measurement is displayed.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the insertion loss of the cable. For a 6840A series instrument the default channel is Spectrum Analyzer, so it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar.

Step 3 - Define the measurements

Since the return loss is measured by a scalar detector connected to input A, no change needs to be made to the measurement definition since all measurements default to input A following PRESET.

[SCALAR] ***[More]*** ***[AC Detection]***	Sets the detection mode to AC in order to reject signals from other sources (such as transmitters) which could interfere with the measurement

Step 4 - Define the source conditions

[SOURCE] ***[Set Start Frequency]*** **[1] [0][M μ]**	Sets the start frequency to 10 MHz.
[Set Stop Frequency] **[2] [G n]**	Sets the stop frequency to 2 GHz.
[ENTRY OFF]	Terminates numeric entry.

Step 5 - Calibrate the measurement system

[CAL] ***[Single Ended Ins Loss]*** ***[Short OR Open Cal]***	Presents a message that prompts for connection of a short circuit termination to the test port.
[Continue]	Initiates the short circuit calibration. Upon completion, a message will be displayed stating that the transmission line under test should be connected to the test port, and the line terminated with a short circuit.
[Continue]	The trace now shows the insertion loss of the transmission line under test.

Step 7 - Select appropriate scaling and format

The default format of dB is appropriate to this measurement.

[SCALING/FORMAT]
[Set Scale]
[1] [ENTER/=MKR][Sets the scale factor to 1 dB/div..

Step 8 - Use markers and other 6800A features to get detailed information about the measurement

It is likely that there will be a ripple superimposed on the measurement due to mismatch between the test port and the cable under test. This displayed effect of the ripple can be minimised using the smoothing feature of the 6800A. Smoothing is used to filter active trace data by performing a ‘moving average’ on the data over a specified percentage of the sweep span (the smoothing aperture).

[SCALAR]
[Smoothing]
[Set Aperture]
[2] [ENTER/=MKR] Sets the smoothing aperture to 2%.

[Smoothing ●] Turns on smoothing; this is indicated by the **S** flag in the trace information box.

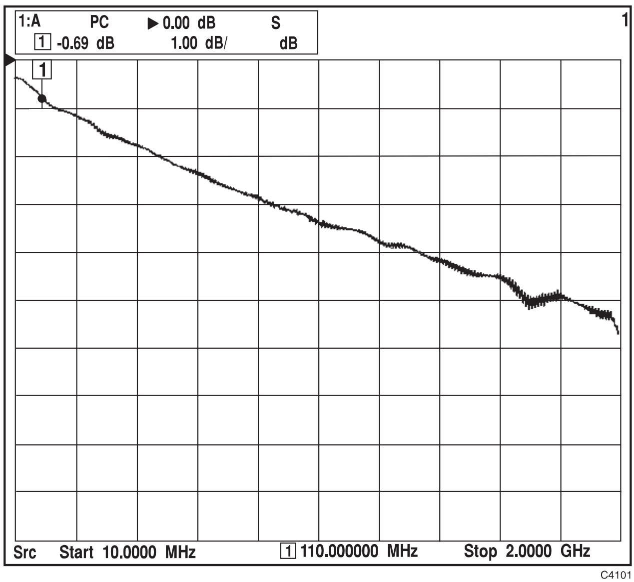


Fig. 2-45 Single-ended insertion loss measurement

Example 28: Return loss measurement of a waveguide using a single waveguide coupler

In this example a return loss measurement will be made on a section of waveguide over the frequency range 8 GHz to 12.4 GHz. The measurement setup is shown in Fig. 2-46.

The principles involved in making measurements on waveguide devices are the same as for coaxial components. However, there are some practical differences in the measurement methods, as described below:

Coaxial-to-waveguide adapters are required to allow the system detectors to be used. The match of the detector will be degraded by the VSWR of the adapter, so these should be of low VSWR to reduce measurement uncertainty.

Waveguide directional couplers are used instead of an autotester or bridge. Couplers should have a directivity of at least 40 dB and a coupling factor of less than 20 dB.

To obtain a reference short circuit for the return loss measurement, a polished flat metal plate is bolted across the output port of the coupler in place of the DUT.

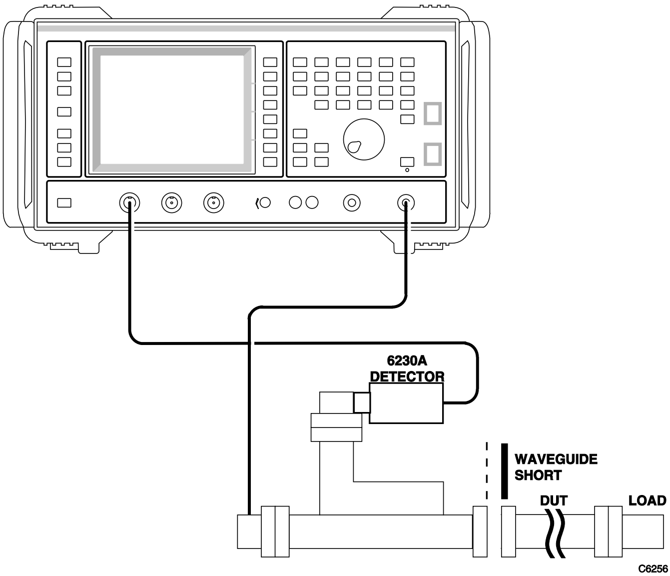


Fig. 2-46 Setup for return loss measurement using a single waveguide coupler

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Scalar menu will be shown along with a single scalar measurement of input A. For 6840A series instruments a spectrum analyzer measurement is displayed.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the return loss of the waveguide. For a 6840A series instrument the default channel is Spectrum Analyzer, so it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar.

Step 3 - Define the measurements

Since the detector is connected to input A of the 6800A it is not necessary to define the input used as it defaults to input A.

[SCALAR] ***[More]*** ***[AC Detection]***	Sets the detection mode to AC in order to reject signals from other sources (such as transmitters) which could interfere with the measurement.

Step 4 - Define the source conditions

[SOURCE]	
[Set Start Frequency] **[8] [G $_n$]**	Sets the start frequency to 8 GHz.
[Set Stop Frequency] **[1] [2] [.] [4] [G $_n$]**	Sets the stop frequency to 12.4 GHz.
[ENTRY OFF]	Terminates numeric entry.

Step 5 - Calibrate the measurement system

[CAL] ***[Short OR Open Cal]***	A message is displayed asking for either a short circuit or open circuit to be connected. In this case a waveguide short is connected to the output port of the coupler.
[Continue]	Initiates the short circuit calibration.

Upon completion of the calibration the path cal data is automatically applied to the measurement, and **PC** is shown in the trace information box for that measurement.

Now connect the waveguide under test to the coupler, and terminate with a suitable load, as shown in Fig. 2-46.

Step 6 - Select appropriate scaling and format

[SCALE/FORMAT] ***[VSWR]***	If required use these keys to change the format of the return loss measurement to VSWR.

To improve the detail of the measurement the scaling can be changed from the default setting of 10 dB/div.

[Set Scale] **[5] [ENTER/=MKR]**	Sets the scale factor to 5 dB/div.

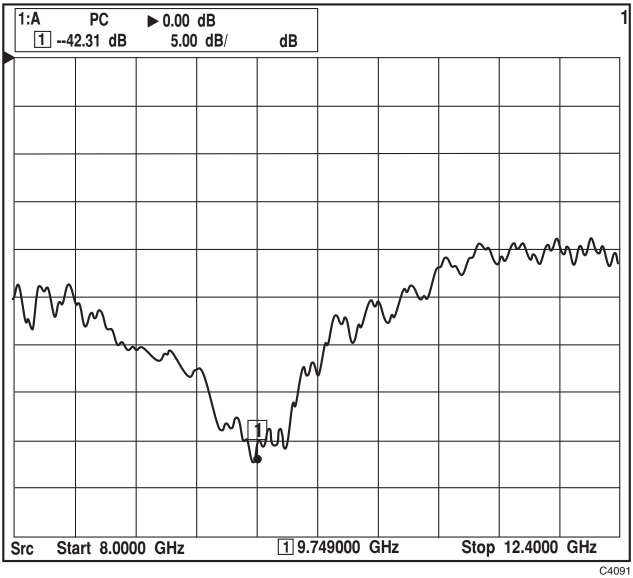


Fig. 2-47 Return loss measurement of a waveguide

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 29: Return loss measurement of a waveguide using a dual waveguide coupler

This example is similar to the previous one, except that an additional coupler is used to provide a reference channel. A reference channel is used to minimise errors due to the following:

There may be changes in the input power to the DUT caused, for example, by drift in the RF source or flexing of the RF cable introducing a changed loss between the source and the DUT.

Errors can be caused by a poor source match, which particularly affects highly reflecting and low loss device measurements. This results in relatively large amounts of signal returning to the 6800A signal source and being re-reflected back towards the DUT. This is seen as a ripple superimposed on the measurement.

The measurement setup is shown in Fig. 2-48. The signal source output is fed to a directional coupler in order to provide a separate reference channel to monitor the power near the measurement port, i.e. the actual incident power reaching the DUT. Any variations in the DUT input level are measured by the reference channel, and the 6800A compensates for the variation by ratioing the reference signal with the reflected and transmitted signal measurements. Using this technique, measurement ripples up to 1 dB due to multiple reflections can be reduced to less than 0.2 dB.

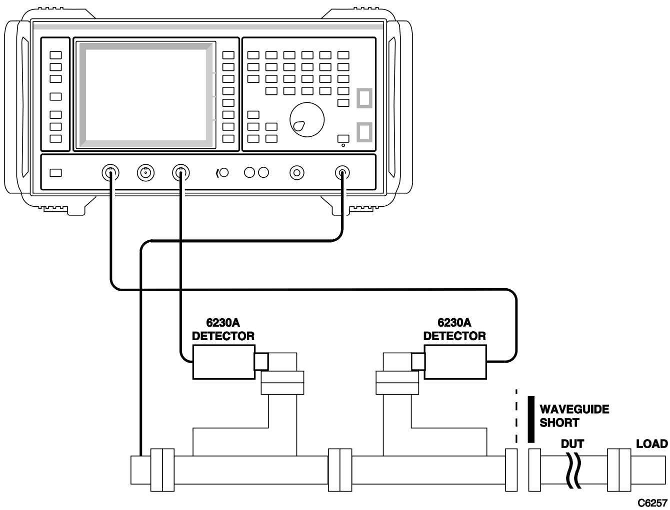


Fig. 2-48 Setup for return loss measurement using a dual waveguide coupler

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Scalar menu will be shown along with a single scalar measurement of input A. For 6840A series instruments a spectrum analyzer measurement is displayed.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the return loss of the waveguide. For a 6840A series instrument the default channel is Spectrum Analyzer, so it will be necessary to press the **[SCALAR]** key to set the channel mode to Scalar.

Step 3 - Define the measurements

From Fig. 2-48 it can be seen that return loss is measured by the detector connected to input A, with the reference signal connected to input C.

[SCALAR] ***[More]*** ***[AC Detection]*** ***[Return to Prior Menu]***	Sets the detection mode to AC in order to reject signals from other sources (such as transmitters) which could interfere with the measurement.
[Input Selection] ***[A/C]***	Defines measurement 1 of channel 1 to measure the ratio A/C. This is indicated by **1:A/C** appearing in the trace information box.

Step 4 - Define the source conditions

[SOURCE]	
[Set Start Frequency] **[8] [G$_n$]**	Sets the start frequency to 8 GHz.
[Set Stop Frequency] **[1] [2] [.] [4] [G$_n$]**	Sets the stop frequency to 12.4 GHz.
[ENTRY OFF]	Terminates numeric entry.

Step 5 - Calibrate the measurement system

[CAL] ***[Short OR Open Cal]***	A message is displayed asking for either a short circuit or open circuit to be connected. In this case a waveguide short is connected to the output port of the coupler.
[Continue]	Initiates the short circuit calibration.

Upon completion of the calibration the path cal data is automatically applied to the measurement, and **PC** is shown in the trace information box.

Now connect the waveguide under test to the coupler, and terminate with a suitable load, as shown in Fig. 2-48.

Step 6 - Select appropriate scaling and format

[SCALE/FORMAT] ***[VSWR]***	If required use these keys to change the format of the return loss measurement to VSWR.

To improve the detail of the measurement the scaling can be changed from the default setting of 10 dB/div.

[Set Scale] **[5] [ENTER/=MKR]**	Sets the scale factor to 5 dB/div.

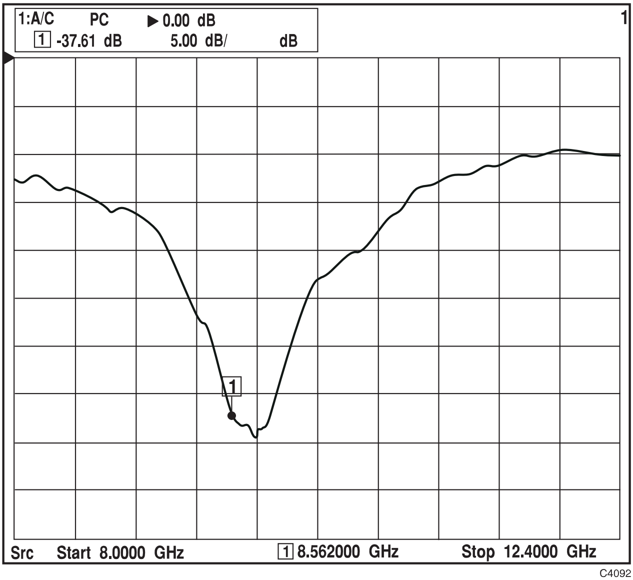


Fig. 2-49 Return loss measurement of a waveguide

By comparing the trace with that of the previous example using a single coupler, it can be seen that the measurement ripple has been significantly reduced.

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Example 30: Fault location measurement of a waveguide using a fault locator

In this example the transmission line under test is a waveguide comprising four sections, of total length approximately 10 m. It is normally terminated with an antenna whose operating frequency is 10 GHz.

The procedure is essentially the same as in Example 24. The measurement setup is shown below. It will be necessary to make connections to the waveguide via suitable coaxial-to-waveguide adapters (which should be of low VSWR).

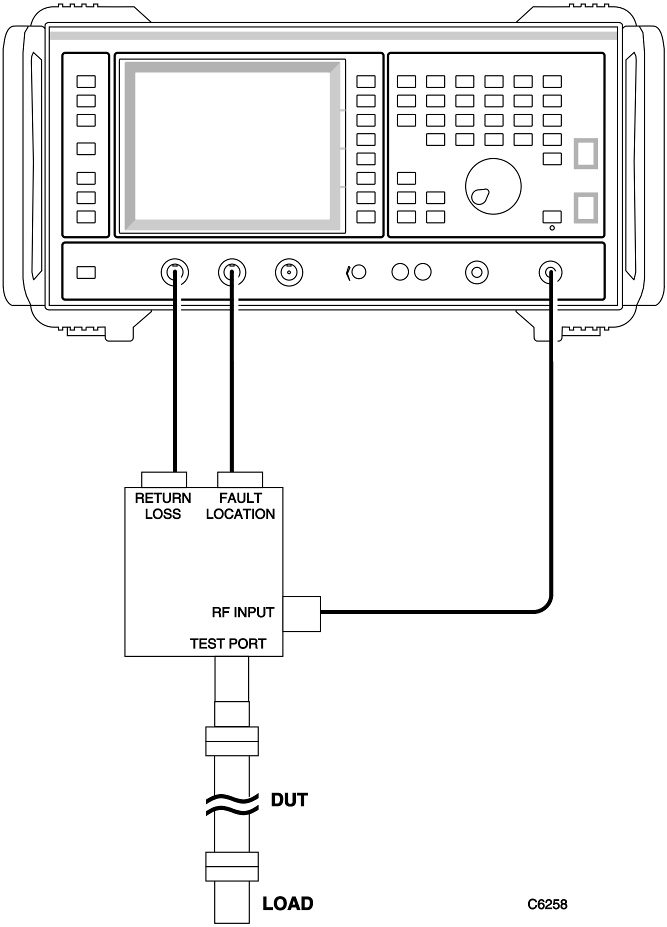


Fig. 2-50 Setup for fault location measurement using a Fault Locator

Step 1 - Preset the instrument to a known state

[PRESET] ***[Full]***	Sets the instrument to its default state, as defined in Appendix A of the Operating Manual. The Scalar menu will be shown along with a single scalar measurement of input A. For 6840A series instruments a spectrum analyzer measurement is displayed.

Step 2 - Define the display configuration

Measurement 1 of channel 1 will be used to display the fault location measurement.

[FAULT LOCATION] ***[Yes]***	Select Fault Location mode and press the *[Yes]* soft key to confirm the change.

Step 3 - Define the measurements

[Configure Measurement]	A form is displayed listing the fault location parameters, which can be selected for editing using the ***[⇧]*** and ***[⇩]*** soft keys.

Select the **Entry Mode** parameter, then press

[Range]	Select 'range entry' mode.

Select the **Range** parameter, then press

[1] [2] [ENTER/=MKR]	Enter a range that is about 10 to 20 % greater than the estimated length of the waveguide under test. (The start and stop frequency values are automatically calculated.)

Select the **Centre Frequency** parameter, then press

[1] [0] [G $_n$]	Sets a centre frequency suitable for the waveguide under test. A value of 10 GHz is used in this example.

Select the **Tx Line Medium** parameter, then press

[Waveguide]	Specify waveguide transmission line.

Select the **Cutoff Frequency** parameter, then press

[6] [.] [5] [5] [7] [G $_n$]	This specifies the frequency below which propagation ceases in the waveguide. This parameter is required in order that the 6800A can generate the non-linear frequency sweep that is required for waveguide measurements (to eliminate the effects of dispersion).

Select the **Attenuation** parameter, then press

[0] [.] [1] [8] [7] **[ENTER/=MKR]**	A value of 0.187 dB/m is entered to compensate for the attenuation of the waveguide.

Select the **Display Units** parameter, then press

[Feet] or ***[Metres]***	Sets the display units to feet or metres, as required.

Select the **Input Configuration** parameter, then press

[Scalar Inputs]	Select a scalar input for the fault location measurement.

If a transmission line consists of more than one section and the attenuation figures are significantly different, enter the value for the longer section. If the two sections have similar length use an average value for the two sections.

The cutoff frequency and attenuation parameters could also be entered by using the Transmission Line Database (stored internally). This allows fault location parameters to be set up automatically by specifying the transmission line type (this can be done independently for each channel). The measurement configuration procedure would then be as shown below:

Using the Transmission Line Database

[Configure Measurement]	A form is again displayed listing the fault location parameters, but this time the fields for Cutoff Frequency, Attenuation and Tx Line Medium are set by the database.
[Tx Dbase In Use]	Used to select the database record for the waveguide type.
[Select TX Line from Dbase]	The ***[⇧]***, ***[⇩], [Page Up] and [Page Down]*** soft keys are used to highlight the required database record. Pressing the ***[Select Subset]*** soft key allows a subset of the database to be listed according to user-defined search criteria.
[View]	Displays the record data.
[Select]	The record from the database is loaded for use by the measurement, and the Config Meas menu is re-displayed.

The other parameters are entered as before.

Step 4 - Define the source conditions

The output power level and sweep time can be changed from the default values, if necessary, by using the [SOURCE] key.

Step 5 - Calibrate the measurement system

[CAL] ***[Fault Location Cal]***	The measurement system must be calibrated before making any measurements. Connect a matched load to the TEST PORT of the Fault Locator.

[Continue]	A detector zero is automatically performed, followed by calibration of the measurement system. The calibration data is stored, path calibration is applied and you are then returned to the main Cal menu.

Now connect the waveguide under test to the test port of the Fault Locator, and connect a load to the end of the waveguide.

Step 6 - Select appropriate scaling and format

[SCALE/FORMAT] ***[dB] or [VSWR]***	Use these keys to change between dB and VSWR format.
[Set Scale] **[7] [ENTER/=MKR]**	Sets the scale factor to 7 dB/div.

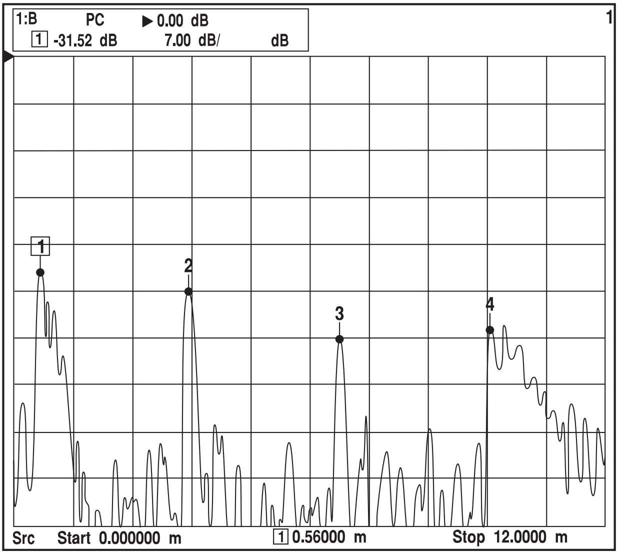


Fig. 2-51 Fault location measurement of a waveguide

Step 7 - Use markers and other 6800A features to get detailed information about the measurement

The facilities provided by the 6800A to aid examination of the fault location measurement have been covered in Example 24.

It can be seen from the above figure that there are four main peaks on the trace, on which markers have been placed. Marker 1 indicates the connection between the fault locator and the waveguide. Markers 2 and 3 each indicate a connection between two sections of waveguide, and marker 4 represents the antenna connection.

A hard copy record of the measurement results can be created, and the instrument settings / measurement traces stored for later use, by following the procedures described in 'Miscellaneous features of the 6800A'.

Chapter 3
MISCELLANEOUS FEATURES OF THE 6800A

Creating hard copy

Once a measurement has been made and a plot has been produced on the screen, it may be necessary to create a hard copy of the measurement. Note that a hard copy can also be created at a later time by storing the measurement data with **[SAVE/RECALL]** and using the hard copy feature on the recalled measurement.

Use of the **[PRINT]** key provides access to menus which allow choice of the hard copy device, the 6800A interface to which it is connected, and which elements of the displayed measurement are to be printed.

Using a printer

To create a print of the measurement connect the printer to a USB port or the PARALLEL connector, as appropriate.

[PRINT] ***[Select Printer]***	Specify the printer that is to be used.

Prints can be customised by choosing which graphical attributes are to be printed (for example graticule or marker information). The current print options can be saved for future use either to an internal store or to a file on removable storage.

[Return to Select Printer] ***[Return to Print]*** ***[Print Options]***	A list is displayed showing the elements of the screen display that can be printed. These can be highlighted using the arrow soft keys and turned on or off using the ***[On/Off]*** soft key. The ***[Save Options]*** soft key is used to save the current print options, either to an internal store or to a file on removable storage; these can be recalled later using ***[Recall Options]***.
[Return to Print] ***[Print]***	Starts the printing operation. This will be done as a background task.

Installing printers

The 6800A supports many different USB and parallel printers, which need to be installed before they can be used. Refer to the 6800A Operating Manual for the installation procedure.

Printing to a file

As an alternative to printing directly to a printer, it is also possible to generate a formatted file, in *.PRN format, to enable printing via a PC. Before using the print-to-file facility it is necessary to select the printer type as described above in ‘Using a printer’.

The operation of this facility is similar to normal printing and the following sequence is used:

[PRINT] ***[Print]***	Selects the hard copy output and initiates the print.
[Print to File] ***[OK]]***	Selects the print-to-file option.

At this point the Print to File sub-menu is displayed. The print file can either be stored in internal memory or on removable storage so that the file can be readily transported to a PC.

USB Memory ●] ***[New File Name]*** ***[Done]***	Enables the print file to be stored on removable storage, using a file name specified by the user.
[OK]	Initiates storing of the print file onto the removable storage. The file will appear as: *filename.prn* on the removable storage.

Saving instrument settings and measurement traces

Having configured the source conditions, the measurement format and scaling for a particular DUT, it may be desirable to save them in an internal 6800A store for future use (or to a file on removable storage). This removes the need to perform the set-up sequence from the start each time a similar device is measured.

[SAVE/RECALL] ***[View Inst Settings]*** ***[Current Settings]***	Before saving the current instrument settings it may be preferable to examine the current major instrument settings values.
[Save to Store]	Saves the current instrument settings either to an internal store or to a file on removable storage

If the same device were to be measured in the future the instrument settings required are simply recalled:

[SAVE/RECALL] ***[Recall Settings]***	Recalls instrument settings by selecting from a displayed list of internal settings stores, or selecting a settings store file on removable storage.

To save the currently active measurement trace to an internal store or as a file on removable storage press:

[SAVE/RECALL] ***[Save Trace]***	Activates the Save Trace function.
[New Store Name]	Enter a new store name and press ***[Done]*** to terminate. Alternatively, the required storage location can be selected from the displayed list (press ***[USB Memory]*** to access the removable storage)

[Set Store Information]	Enables descriptive text about the store to be entered, and allows password protection to be set up for the store.

Some of the instrument settings are also saved with the measurement. These are required in order that the instrument can re-create the channel and measurement setup necessary to display the trace as it appeared at the time when it was stored.

If a stored measurement needs to be displayed (e.g. for comparison with the current measurement), it can be recalled using:

[SAVE/RECALL] ***[Recall Trace]***	Recalls a measurement trace stored either in an internal store or as a file on removable storage. The removable storage is accessed by pressing ***[USB Memory].***

It should be noted that when a trace memory is recalled, the instrument settings that were saved with it may affect the other measurement that is displayed. The option is given of using either the saved settings or the current settings.

Using removable storage

Typical uses for removable storage are described below. The procedures are similar for other types of data, e.g. instrument settings, limit specifications, transmission line database records.

Saving traces to removable storage

Once a measurement has been made and a trace produced on the screen, it can be saved as an MS-DOS file on removable storage. If required, a number of traces relating to a particular project can be saved under a specific directory.

[SAVE/RECALL] ***[Save Trace]*** ***[USB Memory ●]***	When the removable storage function is selected, the list of measurement trace stores shown will be those found in the current directory of the removable storage currently inserted in the USB port. Any directories within the current directory will also be shown. The ***[⇧]*** and ***[⇩]*** soft keys are used to select the required store; the **[ENTER/=MKR]** key is used to change directory. Pressing the ***[Save]*** soft key saves the trace data as an MS-DOS file in the specified store. Either an existing store can be overwritten or a new store can be created using the ***[New Store Name]*** soft key.

Note that access to removable storage is global to the instrument, and the state is preserved across visits to all menus that can access the USB port.

Entering of file names will be easier and quicker if an external keyboard is used; this is connected to the keyboard interface at the rear of the instrument.

Copying traces between the 6800A and removable storage

Measurement traces (and other data) can be copied between removable storage and internal 6800A stores. This data is held as MS-DOS files.

[UTILITY] ***[Store Management]*** ***[Trace Memory]***	This activates a sub-menu which enables internal directories and trace memory stores to be selected using the ***[⇧]*** and ***[⇩]*** soft keys. The ***[USB Memory]*** soft key is used to switch between internal and removable storage stores. A directory is entered by highlighting it then pressing ***[Change Directory]***. When a store is highlighted this soft key becomes ***[Delete]***, which is used to remove the store.
	To copy a store, it is selected as described above; if the store is on removable storage the destination will be internal store and vice versa. Pressing the ***[Copy]*** soft key performs the copy operation.
	Other types of store can be copied/deleted in the same way.

Using the screen dump facility

The 6800A can create a screen dump of the display in the form of a standard bitmap file.

[PRINT] ***[Screen Dump]***	This activates a sub-menu and dialogue box which enables a filename to be entered and the destination to be specified (removable storage or internal storage). A "**.**bmp" extension will be automatically added to the filename.
[OK]	Exits the screen dump menu and prompts the user to set up the screen as required and press the [PRINT] key to perform the screen dump.

Once the required display is set up, pressing the [PRINT] key writes the data to the specified file, and normal menu operation is resumed.

Installing and running applications

The 6800A has the capability to install applications from removable storage into internal non-volatile storage, so that there is no need to carry the applications with the instrument.

[UTILITY] ***[Applications]*** ***[Install Application]***	A list of the applications on the removable storage is displayed. The ***[⇧]*** and ***[⇩]*** soft keys are used to select the required application; pressing ***[Install]*** copies the selected application into the instrument's store.

Once installed, the application is run using the **[RUN APPS]** key:

[RUN APPS]	The available applications stored within the instrument are listed. The ***[⇧]*** and ***[⇩]*** soft keys are used to select the application to be run, pressing the ***[Run]*** soft key executes the selected application.

Installed applications can be designated as Auto Run, which means that it will be automatically executed when the instrument powers up. This can be done by pressing

[UTILITY] ***[Applications]*** ***[Mark as Auto Run]***	Pressing ***[Select]*** designates the selected application as the one to be run on power up. To restore the application to non Auto Run, press ***[Clear Auto Run]***.

The Auto Run feature can be toggled on and off using **[UTILITY]** ***[Applications]*** ***[Auto Run]***. When the instrument powers up and auto run was previously enabled, the application that has been designated as auto run will be automatically executed.

Entering a new password

Some instrument functions need to be enabled by entering a Level 1 or Level 2 password. A new password can be specified using the following sequence:

[UTILITY]
[Security]
[Set Passwords]

A primary 6-digit password must be entered in order to continue any further. Each instrument leaves the factory with the primary password held in the screen title associated with the instrument settings store called 'password'. This can be viewed using

[SAVE/RECALL]***[Recall Settings]***

and selecting the appropriate settings store.

(If this store is overwritten at any time before the primary password has been noted, contact the nearest Aeroflex Service Centre.)

A sub-menu will then appear enabling the level 1 and level 2 passwords to be set by pressing the ***[Set Level 1 Password]*** and ***[Set Level 2 Password]*** soft keys respectively and then entering a new password.

The level 1 password is a 4-digit number in the range 1000 to 9999, and the factory set default is 9999. The level 2 password is a 6-digit number in the range 100000 to 999999, and the factory set default is 999999.

Source only mode

A *source only mode* is available in which the data acquisition system is turned off and the 6800A acts solely as a source. When in this mode, the various source settings are displayed, and all front panel keys, with the exception of the numeric keypad, units terminator keys and the [PRESET] key, will be locked out.

The source only mode is enabled by pressing the ***[Enter Source Only Mode]*** soft key in the Source menu,

Normal operation is restored by pressing the ***[Exit Source Only Mode]*** soft key on the Source menu or using the **[PRESET]** key.

Customising the instrument for international operation

The 6800A allows various instrument settings to be specified according to the country in which the instrument is to be used. These country specific settings are:

Language	Date format	Decimal point
Keyboard layout	Time format	Spreadsheet separator

[UTILITY]
[International]

Displays the current settings and provides a menu for changing them. The ***[⇧]*** and ***[⇩]*** soft keys are used to select a parameter for changing. A list of the available values for the parameter appears below the parameters section. The ***[Change]*** soft key moves the highlight into the selection list so that a new value for the parameter can be selected, by pressing ***[Select]***. The ***[Go to Param Selection]*** soft key moves the highlight back into the parameters section..

Note that the above parameters can be quickly set to default combinations by setting the **Country** parameter to the desired country.

Settings for additional countries may be available on removable storage, and can be installed by pressing

[UTILITY]
[International]
[Install New Locale]

The ***[⇧]*** and ***[⇩]*** soft keys are used to select the required country, if there are more than one. Pressing ***[Add]*** installs the settings into the instrument.

Using an external keyboard

The 6800A has a text entry function which can be used, for example, to enter screen/measurement titles or removable storage file/directory names. The 6800A allows these text entry operations to be performed more easily using an external keyboard connected to the rear panel KEYBOARD connector. The keys are mapped to the 6800A keys as follows:

6800A key	Keyboard	6800A key	Keyboard
Soft keys 1 to 8	F1 to F8	[PRESET]	<Alt> PR
[SPECTRUM]	<Alt> SP	[SOURCE ON/OFF]	<Alt> RF
[SCALAR]	<Alt> SC	[G n]	<Ctrl> G
[FAULT LOCATION]	<Alt> FL	[M μ]	<Ctrl> M
[RUN APPLICATION]	<Alt> RA	[k m]	<Ctrl> K
[SELECT MEAS]	<Alt> SE	[ENTER / =MKR]	<ENTER>
[SWITCH CHANNEL]	<Alt> SW	[BACK SPACE]	<BACKSPACE>
[DISPLAY]	<Alt> DI	[ENTRY OFF]	<ESC>
[SCALE / FORMAT]	<Alt> SF	Increment (↑)	Up arrow key
[MARKER]	<Alt> MR	Decrement (↓)	Down arrow key
[SOURCE]	<Alt> SO	[0] to [9]	0 to 9
[CAL]	<Alt> CA	[–]	-
[COPY]	<Alt> CO	[.]	.
[SAVE / RECALL]	<Alt> SR	Rotary control	Left / right arrow keys
[UTILITY]	<Alt> UT		

Setting up the LCD display

Facilities are provided to set the backlight brightness and colour palette for the LCD. The backlight brightness can be selected from four settings (plus Off). These functions are available from the Display menu, accessed via the [UTILITY] key:

[UTILITY]
[Service]
[Set-up]
[Display]

The ***[Minimum Brightness***], ***[Low Brightness], [High Brightness]*** and ***[Maximum Brightness]*** soft keys are used to set the brightness level of the backlight.

Pressing the ***[Colour Palettes]*** soft key (colour displays) leads to a sub-menu from which a colour palette can be selected.

Setting the real time clock

A real time clock is provided which can be used to date/time stamp hard copy output or removable storage files. If necessary, the real time clock can be set as follows:

[UTILITY] ***[Service]*** ***[Set-up]*** ***[Set Date & Time]***	Enters the Date & Time menu and the current date and time are displayed. Pressing ***[Enter Date]*** allows the date to be changed. When a terminator key is pressed to enter a value the next field will be selected. Pressing ***[Enter Time]*** allows the time to be similarly changed. When the ***[Store Date & Time]*** soft key is pressed the new numbers are checked. If the checks pass then the instrument's real-time clock and calendar will be updated with the entered values.

Setting the real time clock

A real time clock is provided which can be used to date/time stamp hard copy output or removable storage files. If necessary, the real time clock can be set as follows:

[UTILITY] ***[Service]*** ***[Set-up]*** ***[Set Date & Time]***	Enters the Date & Time menu and the current date and time are displayed. Pressing ***[Enter Date]*** allows the date to be changed. When a terminator key is pressed to enter a value the next field will be selected. Pressing ***[Enter Time]*** allows the time to be similarly changed. When the ***[Store Date & Time]*** soft key is pressed the new numbers are checked. If the checks pass then the instrument's real-time clock and calendar will be updated with the entered values.

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Downloaded Software	any software downloaded from an Aeroflex web site
Embedded Software	Licensed Software that forms part of the Designated Equipment supplied by Aeroflex and without which the Equipment cannot function
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