Newtons4th Ltd

SLM3505

USER MANUAL

“Do not be hasty when making measurements.”

The SLM3505 is a precision instrument that provides you with the tools to make a wide variety of measurements accurately, reliably, and efficiently - but good metrology practice must be observed. Take time to read this manual and familiarise yourself with the features of the instrument in order to use it most effectively.

DANGER OF ELECTRIC SHOCK

Only qualified personnel should install this equipment, after reading and understanding this user manual. If in doubt, consult your supplier.

RISQUE D'ELECTROCUTION

L'installation de cet équipement ne doit être confiée qu'à un personnel qualifié ayant lu et compris le présent manuel d'utilisation. Dans le doute, s'adresser au fournisseur.

GEFAHR VON ELEKTRISCHEM SCHOCK

Nur entsprechend ausgebildetes Personal ist berechtigt, diese Ausrüstung nach dem Lesen und Verständnis dieses Anwendungshandbuches zu installieren. Falls Sie Zweifel haben sollten, wenden Sie sich bitte an Ihren Lieferanten.

RISCHIO DI SCARICHE ELETTRICHE

Solo personale qualificato può installare questo strumento, dopo la lettura e la comprensione di questo manuale. Se esistono dubbiconsultate il vostro rivenditore.

PELIGRO DE DESCARGA ELÉCTRICA

Solo personal cualificado debe instalar este instrumento, después de la lectura y comprensión de este manual de usuario. En caso de duda, consultar con su suministrador.

IMPORTANT SAFETY INSTRUCTIONS

This equipment is designed to comply with BSEN 61010-1 (2001) (Safety requirements for electrical equipment for measurement, control, and laboratory use) – observe the following precautions:

- Ensure that the supply voltage agrees with the rating of the instrument printed on the back panel ***before*** connecting the mains cord to the supply.
- This appliance ***must*** be earthed. Ensure that the instrument is powered from a properly grounded supply.
- The inputs are rated at 1kV rms or dc cat II; 600V rms or dc cat III. **Do not exceed the rated input**.
- Keep the ventilation holes on the underneath and rear free from obstruction.
- Do not operate or store under conditions where condensation may occur or where conducting debris may enter the case.
- There are no user serviceable parts inside the instrument – do not attempt to open the instrument, refer service to the manufacturer or his appointed agent.

Newtons4th reserves the right to make changes to this document or the product it describes at any time, without notice, and without a commitment to update the contents of this particular document.

Note: Newtons4th Ltd. shall not be liable for any consequential damages, losses, costs or expenses arising from the use or misuse of this product however caused.

DECLARATION OF CONFORMITY

CE

Manufacturer: **Newtons4th Ltd.**

Address: **30 Loughborough Rd.**

Mountsorrel

Loughborough

LE12 7AT

UK

We declare that the product:

Description: **Selective Level Meter**

Model: **SLM3505**

Conforms to the requirements of Council Directives:

89/336/EEC relating to electromagnetic compatibility:

EN 61326:1997 Class A

73/23/EEC relating to safety of laboratory equipment:

EN 61010-1

April 2006

Eur Ing Allan Winsor BSc CEng MIEE

(Director Newtons4th Ltd.)

WARRANTY

This product is guaranteed to be free from defects in materials and workmanship for a period of 36 months from the date of purchase.

In the unlikely event of any problem within this guarantee period, first contact Newtons4th Ltd. or your local representative, to give a description of the problem. Please have as much relevant information to hand as possible – particularly the serial number and release numbers (press SYSTEM then LEFT arrow key).

If the problem cannot be resolved directly then you will be given an RMA number and asked to return the unit. The unit will be repaired or replaced at the sole discretion of Newtons4th Ltd.

This guarantee is limited to the cost of the instrument itself and does not extend to any consequential damage or losses whatsoever including, but not limited to, any loss of earnings arising from a failure of the product or software.

In the event of any problem with the instrument outside of the guarantee period, Newtons4th Ltd. offers a full repair and re-calibration service – contact your local representative. It is recommended that the instrument be re-calibrated annually.

Table of Contents

1 INTRODUCTION

1.1 Manual Layout and Content

The layout of this manual is in a manner that introduces the SLM3505 to the user and helps with the familiarization and understanding of the functionality, application, features, menues and performance of the instrument.
While it is possible to use the manual to review specific functions, it is recommended that you read the complete manual before using the instrument for the first time.

The information in this manual is believed to be accurate and complete but Newtons4th Ltd cannot accept any liability whatsoever, for any consequential damage or losses arising from errors, inaccuracies or omissions.

Release revision 2.65

16th January 2012

1.2 Instrument Functions

The SLM3505 Selective Level Meter was designed to provide a single instrument solution for multiple applications in the communication industry and specifically the Power System Communication environment. Features include:

- Frequency Selective Level Voltmeter
- Signal Generator
- VSWR Meter
- Impedance Analyzer
- Frequency Response Analyzer
- LCR Meter-Inductance, Capacitance, Resistance Measurement
- Oscilloscope

1.3 Instrument Features

The instrument is housed in a rugged aluminum case and is provided with various accessories together with an optional carry case as standard.
The instrument has a state of the art 5.7” (150mm) Color Display to maximize visibility in all conditions, including full sunlight. Its overall size is (12”x 9”x 1.75”) (310mm x 225mm x 45mm) and relatively light weight (5lbs) (2.3Kg) The SLM3505 operates off internal rechargeable batteries, an AC/DC power source or an external 12V vehicle battery.

Further Features Include:

- Up to 1000 analyzer setups, readings and sweep results can be stored
- On board real time clock
- Full colour display
- 6 digit freq, 5 digit volts and 4 digit dBm resolution
- Operational temperature range -5 to +50°C
- 1GB internal flash storage and ports. Many of the instrument test functions will provide the user with valuable information. Therefore 1 Gigabyte of memory, an external USB port and an RJ45 input connection for laptop connectivity provides a versatile solution for storage and communication.

1.4 Application Overview

This section provides a short overview of where the instrument applications are more commonly used. Some uses are explained in more detail and provide an incite into the flexibility of the instrument.

- Power Line Carrier Alignment & Maintenance
- Line Trap Testing
- Line Tuner Testing
- PLC Transmitter & Receiver Test & Set-up
- Audio Tone Protection Relay Channel Test & Setting

Transmitter/Receiver Testing

The instrument has a wide frequency range (5Hz to 5MHz) and is ideal for checking transmitters and receivers on Power Line Carriers, Audio Tone or Analog Baseband Microwave systems. The SLM3505 scans the required frequency range then centre's automatically on the largest or two largest signal peaks, easily detecting the carrier frequencies. It is also ideal for work on audio tone and microwave systems.

Line Trap testing

The instrument can plot an impedance verses frequency graph directly on the display. Therefore the user can view a pictorial representation of the resonant frequency and make adjustments while viewing the changes in a real time environment.

Line Tuner Testing

The instrument provides the solution for adjusting a Line Tuner's Series inductor and Impedance Matching transformer, for minimum reflected power.
This is achieved with a directional coupler or using an innovative impedance measurement technique.

2 SAFETY

READ THIS GUIDE AND SAFETY INFORMATION BEFORE USING THE INSTRUMENT.

- Only use the instrument under the conditions and purpose for which it is intended.
- Ensure that the AC supply Voltage and the power pack supplied are at the same ratings. AC operation is intended for indoor use only.
- This instrument is NOT "field" repairable (with the exception of battery replacement). Return the unit to Newtons4th Ltd for repair or replacement.
- Use only batteries recommended within this guide. Refer to battery information under the "Getting Started", section of this manual. NOTE: Proper anti-static procedures should be used when opening the instrument to change the batteries, such as a grounding strap.
- The instrument is NOT waterproof or airtight. Return to the factory for evaluation if exposed to abnormal environmental conditions.
- Do not operate or store under conditions where condensation may occur or where conducting debris may enter the case.
- Keep the ventilation holes on the top and bottom ends of the instrument clear.
- **NOTE:** Operators should follow all standard and specific company safety procedures when using this product and accessories. Special precautions must be adhered to when working with or around antennas, power lines, radio frequency sources, etc. FAILURE TO COMPLY WITH SAFETY RULES MAY RESULT IN INJURY OR DEATH.
- When using this instrument, access to other products or system parts may be needed. Read and follow the safety instructions of all utilized components.

3 GETTING STARTED

3.1 Unpacking the Instrument

The instrument was dispatched in a custom designed shipping container. Upon receipt of the equipment, inspect all packaging for visual damage. If any damage is indentified, report immediately to Newtons4th Ltd so the carrier may be notified. If the packaging damage is noticeable while the delivery person is present, obtain a written statement from the carrier.

3.2 Power Sources and Communications

The instrument can be powered by multiple sources; directly from the AC/DC Adapter, from the internal battery source (Lithium polymer batteries) or directly through the DC input, (9-18V @ 3A source required). The instrument is shipped with a 6 meter power adapter lead that permits use through a vehicle DC source outlet socket.

AC/DC Adapter – The AC/DC adapter can accept a wide AC input range (100 to 240Vac). Adapter plugs are available to accommodate the various country standards.

Battery Power – The instrument is shipped with a battery source consisting of (3) lithium polymer rechargeable batteries. They are secured into the battery compartments with tie-wraps.

DC Input – The instrument is supplied with a 6 meter vehicle power adaptor lead. The vehicle DC source outlet socket can then be used to power and charge the instrument. The DC input will operate with a 9-18V dc source at 3A; however the equipment warranty does not cover any damage caused by any other source than the ones provided with this instrument.

Charging the batteries – The instrument has a sophisticated battery monitoring and charging system, providing the user with a battery status indication. When running on battery power, the monitor goes from green to orange to red, indicating the state of the batteries. The instrument will beep and a prompt on the screen appears when power levels are at a stage when data or set-up information should be stored. When receiving the instrument it is recommended that the batteries are first charged and fully discharged two or three times to help extend battery life. Finally fully charge the batteries before using the instrument

The system provides the following indications while the batteries are charging:

- When charging - blue with >>>>.
- When finished charging, but power connected- blank.
- If batteries get too hot, charging is suspended - red with XXXX

Changing the batteries - Only qualified personnel, trained and knowledgeable in electronic instrument repair and safety, having read this guide should attempt to change the batteries.

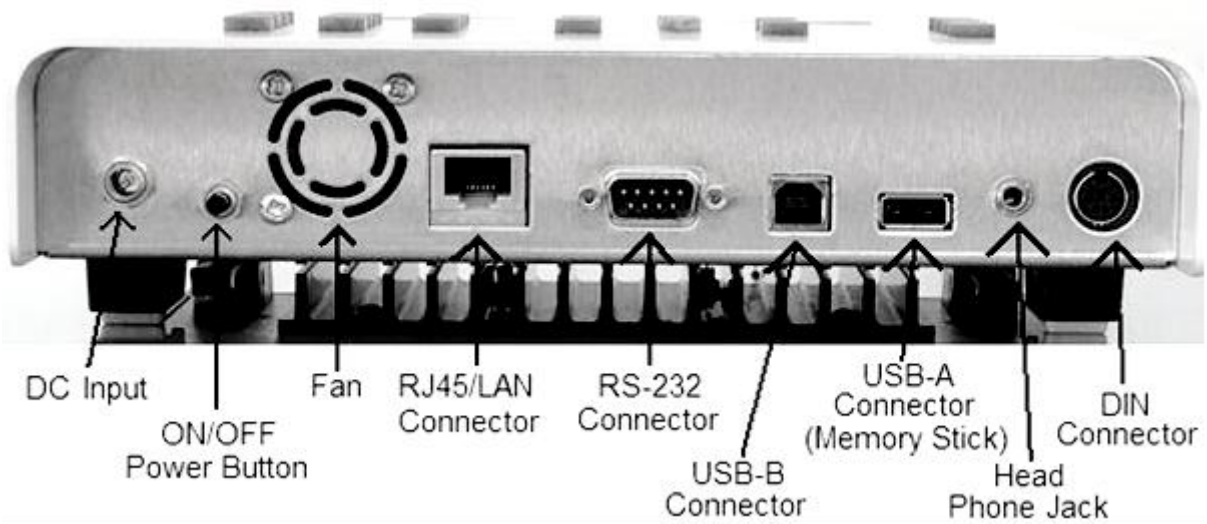
Disconnect the instrument from all external power sources. Remove the four (4) hex bolts from the sides of the instrument housing (2 on each side). NOTE: Proper anti-static precautions should be used when opening the instrument, such as a grounding strap.

Note the position and location of all ribbon cables. Disconnect ribbon cables as necessary to securely rest the instrument cover face down. Cut the tie-wraps holding the batteries in and remove all of the old batteries. NOTE: All three batteries should be replaced at the same time. Make sure disposal of the used batteries is in accordance with the local country regulations. Make sure the batteries are first charged and fully discharged two or three times to help extend battery life. Then finally fully charge the new batteries before using the instrument.

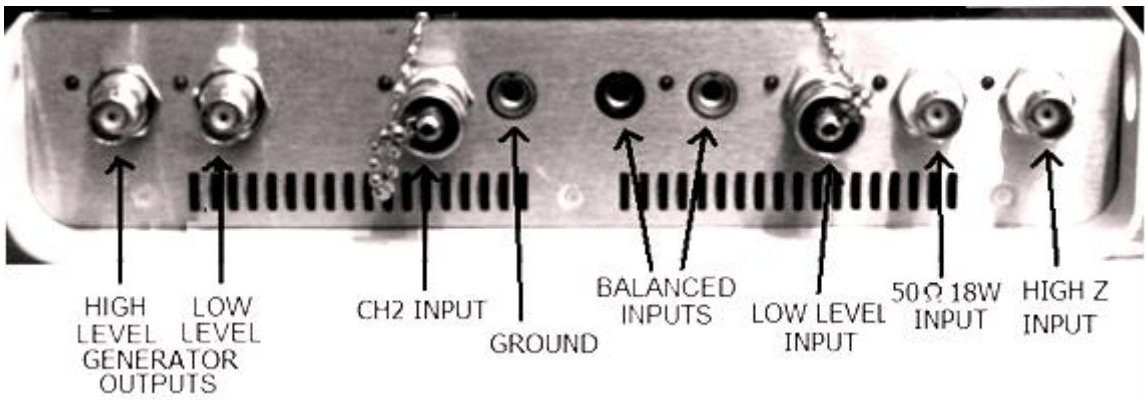
Communications – The instrument has communication interface ports supporting USB, RS232 and LAN options.

3.3 Instrument Controls and Connections

Communication and Power Panel



Input/Output Panel



4 INSTRUMENT OVERVIEW

The SLM3505 is a menu driven instrument. All functions are controlled from the keypad and the menu screens. The keypad has 23 keys that control its operation. Figure 4-1 is a picture of the keypad.
The function of each key is displayed above or below the key with the primary function below the key. The number/function above each key is only active under certain options. An example is the numeric keys which are for entering a specific frequency or voltage. Full detailed descriptions for the keys are provided later in this manual.

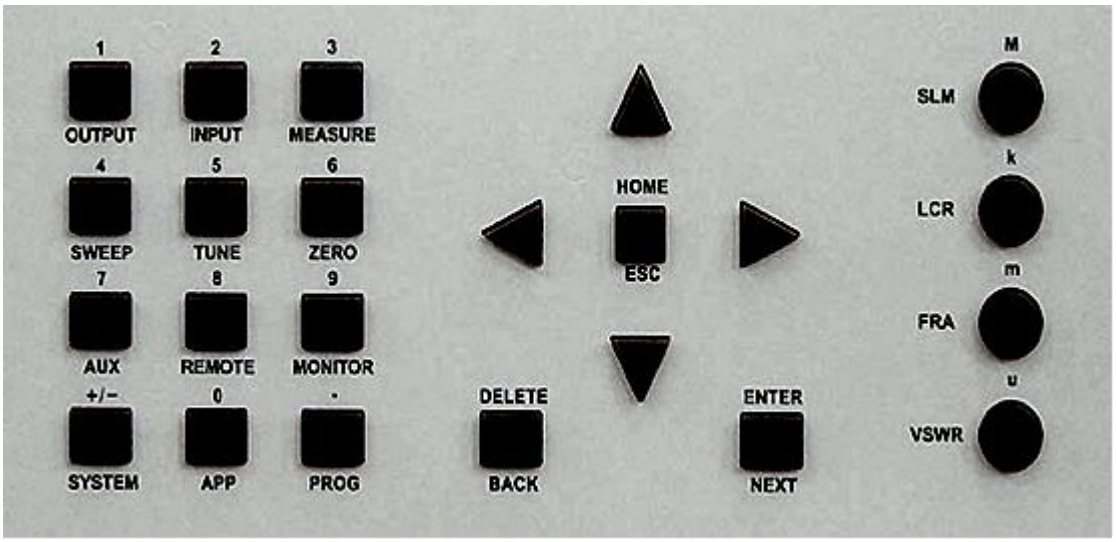


Figure 4.1 Keypad

The four round keys on the right labeled: **SLM**, **LCR**, **FRA** and **VSWR** allow direct access to the main operating modes of the instrument.

SLM – Selective Level Meter – Selects the *Selective Level Meter* Mode.

LCR – Impedance Analyzer - Selects the *Impedance Analyzer* Mode.

FRA – Frequency Response Analyzer - Selects the *Frequency Response Analyzer* Mode.

VSWR – Standing Wave Ratio – Selects the *voltage Standing Wave Ratio* Mode.

The four main Mode keys '**SLM', 'LCR', 'FRA'** and **'VSWR'** have a second function. The letter above each key is a numeric multiplier **'M'** for mega, **'K'** for kilo, **'m'** for milli and **'µ'** micro. When entering large or small numbers these multipliers may be used to save key strokes.

By pressing the relevant Mode button twice allows the menu screens to appear. Accessing the menu functions using the "keypad Operation" is described in section 4.1. Pressing the HOME/ESC button reverts back to the main function screen.

4.1 Keypad Operation

The relevant menu screen can be selected from the 12 primary function alphanumeric keys, such as "INPUT" or "OUTPUT" etc. On the menu screen, the left column lists the functions and the right column lists the options available for that function. The four arrow keys are then used to navigate around the menu, use the 'UP/DOWN' arrow keys to place a ***highlight*** box over the desired option and then press the 'RIGHT' arrow key to select and show any further options available. Use the 'UP/DOWN' arrow keys again to place a ***highlight*** box over the relevant option and then press the "ENTER" key.

Where the column selection has a numeric value, such as voltage or frequency, the 'LEFT/RIGHT' arrow keys are used together with the (secondary function) number and letter keys to adjust the value. When the new value has been set press the "ENTER" key.

Press the HOME/ESC key at any time to abort the present activity and revert to the previous menu or ultimately the main function screen.

The 12 keys on the left side all have three functions. The function below the key is the primary function. The function above the key is the secondary function. A third function, not shown, is an alphanumeric keypad as below:

OUTPUT	. ( ) # 1	**INPUT**	A B C 2
MEASURE	D E F 3	**SWEEP**	G H I 4
TUNE	J K L 5	**ZERO**	M N O 6
AUX	P Q R 7	**REMOTE**	T U V 8
MONITOR	W X Y Z 9	**SYSTEM**	Space
APP	+ - * / 0		
PROG	Upper/Lower case selection		
Up Arrow	Increments all letters and characters		
Down Arrow	Decrements all letters and characters		

4.2 Getting started with Initial signal capture

Introduction

This may be the first time the instrument has been operated and therefore the user may not be familiar with the initial set up. Always allow 30 minutes warm up time before use to ensure accurate measurements. The primary function of the SLM3505 is for checking signal lines and is designed to measure the level of individual frequencies from 5 Hz to 5 MHz. Therefore this section provides guidance in order to capture signals which are initially known or unknown in frequency or amplitude. A more detailed function of the main menu options is explained later in this manual.

Signal Connection

The signal line should initially be connected to the ±300v input, as it may not be known what amplitude of signal is expected. This will safeguard the instrument until the exact amplitudes are known.

Known frequency Setup

This procedure can be used if the frequency of interest is already known.

1. Select SLM mode by pressing the "SLM" button
2. Press the input key and from the menu set the input to "high z", Scale factor to +1.0000 and CH1 input ranging to "full autorange".
3. Press the measure key and from the menu set the centre frequency to "single fixed" and enter the known frequency, set the bandwidth to "3.1KHz" and press the Esc key. (The instrument will look around the entered frequency and display the amplitude in Volts and dBm).

   Note: if the source frequency is unstable selecting AFC from the centre frequency options is recommended.

Unknown frequency Setup

This is a little different as there could be a number of frequencies on the line and a decision will be required as to which frequency is to be selected for measurement. Therefore an initial sweep across a frequency band is initialized to show what frequencies are present. This is done as follows:

1. Select SLM mode by pressing the "SLM" button
2. Press the input key and from the menu set the input to "high z", Scale factor to +1.0000 and CH1 input ranging to "full autorange".
3. Press the measure key and from the menu set the centre frequency to "single fixed" and bandwidth to "3.1KHz", enter and press the Esc key.
4. Press the sweep key and in the sweep menu set display to "Graph".
5. In the same menu enter the "sweep start" to (10KHz) and "sweep end" to (500KHz). (In brackets is the suggested frequency band to be swept, although this can be changed if required).
6. In the same menu set the sweep steps to (40) (In brackets are the suggested steps, although this can be increased if it is thought all frequencies are not being seen).
7. In the same menu highlight "start" and press enter. (The display will change to graphical display sweeping across the band showing the frequency peak(s) and amplitude).
8. When looking at the graphical display use the L/R arrow keys to toggle the frequency cursor across the screen, as it aligns with a frequency peak the actual frequency will be shown at the bottom of the display and the amplitude on the Left side.

Once the frequency is known it can be selected as in the known frequency setup and can be analyzed in more detail.

5 OUTPUT KEY – The Output key controls the *Signal Generator*. Figure 5.1 displays the menu functions and options available.

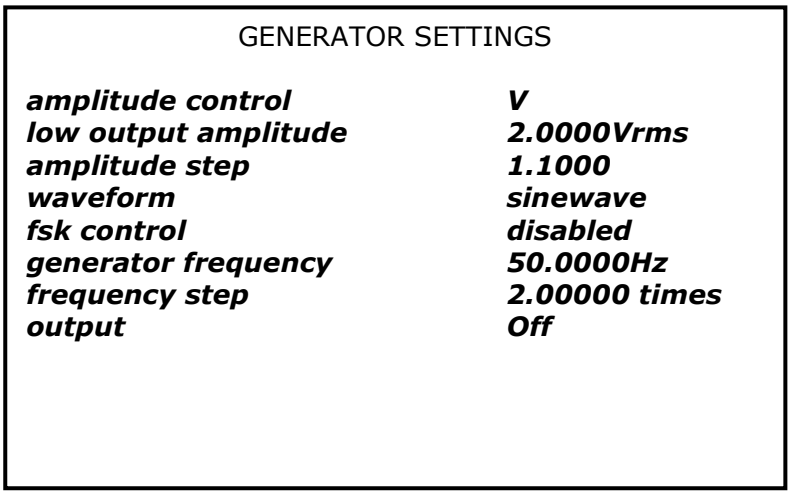


Figure 5.1

The signal generator is a Direct Digital Synthesis (DDS) single or sweep frequency generator. It generates Sine, Square and Triangular waveforms over a frequency range from 5Hz to 5MHz, together with a white noise option. The signal generator's high level output is 2W into a 50 ohm load, 10v rms (10KHz to 5MHz). The low level output is 5V rms into high impedance load, (5Hz to 5MHz). It may be used independently of the other instruments that are connected to the instrument or in conjunction with them. The output negative is connected to the case.

5.1 Genrator Menu Functions

"Amplitude Control" – Has three options: *"V, dBm* or *dBu"* and controls how 'amplitude' and 'amplitude step' is displayed on the screen. Amplitude is displayed either in Volts, dBm or dBu and is adjusted using the *"low output amplitude", "high output amplitude"* or *"amplitude step"* menu function. Amplitude step is set in either volts or db times the step value. The amplitude step can be set as small as one millivolt or 0.001 dBm. The values can be changed by following the "Keypad Operation" instructions in section 4.1. (Once the step has been set, using the up/dn arrow keys with the main display will increase/decrease the amplitude by the step factor).

Waveform – Has four options: *"sinewave, triangle, squarewave* and *white noise".* The use and selection of the different waveforms is dependent on user need. The sinewave is used for power line carrier testing.

FSK Control - FSK (Frequency Shift Keying) has two options *"disabled* and *enabled"* and can be used to check the loss of guard timers in Transfer Trip equipment. Enabling this option adds *"Frequency 0", "frequency 1" and "guard time"* to the left menu functions. This allows a "0" frequency and a "1" frequency to be entered together with a guard time so the delay between the frequencies can be checked. The "0" "1" Frequency and guard time can be entered in the options menu by following the "Keypad Operation" instructions in section 4.1.

Note: The "guard time" function is not operational at this time. A firmware upgrade will enable this function.

Generator Frequency - This function determines the generator output frequency. The "**Frequency Step**" function determines the multiple amount the frequency changes when required to step up or step down. The "**Step type**" can be either set for linear or logarithmic depending on user preference. Settings for these options can be entered by following the "Keypad Operation" instructions in section 4.1. (Once the step has been set, using the L/R arrow keys with the main display will increase/decrease the generator by the step factor).

***Note:** If the generator is off, when using the L/R arrows the frequency changes on the main display, if the generator is on the frequency changes in the generator window only.

Output – This controls the relevant output connection and has three options: *"off, low* and *high".* When the high level output is selected the impedance is fixed at 50Ω (75Ω optional). However, selecting the "*low"* output adds another function to the left menu, "**Output Impedance**" This function allows the right menu options of 50Ω, 75Ω or 600Ω output impedance to be selected.

6 INPUT KEY – This controls the signal input connections, the menu has three functions, *"input"," scale factor" and "CH1 input ranging".* These options are in all modes however an additional *CH2 input ranging* function is available in "*FRA"* mode. Figure 6.1 displays this screen.

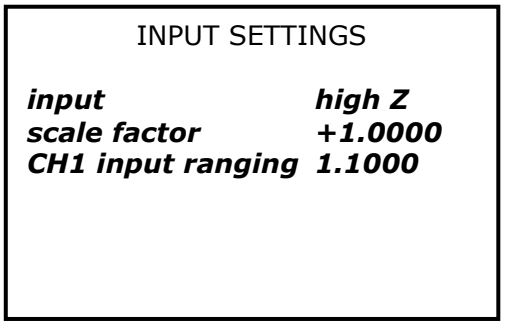


Figure 6.1

6.1 Input Menu Functions

Input – Has four options from the right menu, *"high Z", "50Ω 18W" (75Ω optional), "low level" and "balanced"*.

The "high Z" input is the default, max ±300v Pk, 1MΩ impedance whilst the "50Ω 18W*"* input is max 30v rms.

The "low level*"* input, max ±10v Pk which, when selected adds "*impedance*" to the left menu functions. This allows options of *"high impedance"* (1MΩ), *"50Ω", "75Ω",* and *"600Ω",* to be entered.

The "balanced" input, which has three 4mm connectors (positive, negative and ground), is a differential type, max ±10v Pk and a selectable impedance the same as the low level input.

The "Channel 2" input is max ±10v Pk fixed at 1MΩ impedance.

WARNING:

The low voltage inputs, (BALANCED INPUTS, Low Level 50Ω 18W and CH2) are rated at ±10V pk maximum voltage. Applying a higher voltage will damage the input(s) requiring factory repair. Use the low voltage input(s) only after confirming the input signal will not exceed the maximum rating.

Meter Inputs – Refer to section 3.4 (Instrument controls and Connections), which shows the input connector orientation. Each input has a red LED, the LED that is "ON" will be next to the active input. The high Z, low level and balanced inputs are differential inputs they effectively put no load on the signal being measured. The 50Ω 18W input can be used to accept transmitters etc as this input provides termination. The 'high Z' input should be used when measuring RF carrier signals or signals that require minimal loading. All inputs are isolated from ground.

High Z - This is the high impedance input. Use it for carrier readings when possible or low current signals. This will prevent possible damage to the lower voltage inputs as it affectively puts no load on the source.

50 Ω 18W - This is a "terminated" input and puts a 50 Ω load on the source. Only use this input if signal is less than 18 watts (30V RMS).

Low level and Balanced - These inputs have the option to be used in either differential (high Z) or terminated mode. Terminations are 50Ω, 75Ω or 600Ω and selectable from the low level or balanced "input" options menu and then the "*impedance"* options menu.

Scale Factor - This option is used to compensate for an attenuator or a scope probe. If using a X10 probe, putting '10' in as the scale factor gives the correct value for voltage. The settings can be changed by following the "Keypad Operation" instructions in section 4.1.

CH1 input ranging – Has three options '*full autorange'*, '*range up only' and "manual"*. Use full autorange for normal signals allowing the instrument to select the optimum range for the signal level. Range up is useful for rapidly fluctuating signals as the shunt will stay on the range suitable for the highest signal level. Manual will add "CH1 input range" to the menu where the user can define which range is used. This is also applicable to Channel 2 when used in FRA mode.

The Low Level manual ranges selectable are:
1mV, 3mV, 10mV, 30mV, 100mV, 300mV, 1V, 3V, 10V

The High z Level manual ranges selectable are:
30mV, 100mV, 300mV, 1V, 3V, 10V, 30V, 100V, 300V

7 MEASURE KEY– This is a multifunction key and is used to set the measurement options for the different modes of operation. The screen in Figure 7.1 appears when in "*SLM*" mode and "*MEASURE*" is selected. However the functions will change depending on the mode selected as described below.

MEASUREMENT SETTINGS

Mode	***selective level meter***
centre frequency	***generator frequency***
bandwidth	***100Hz***
reference impedance	***50Ω***
zero reference	***+0.000dBm***
threshold	***-50.00 dBm***
peak level	***off***
bargraph display	***off***
filter	***normal***

Figure 7.1

Mode – Can select five different instruments: "*selective level meter"* **(SLM)**, "*impedance meter"* **(LCR)**, "*frequency response meter"* **(FRA)** and "*voltage standing wave ratio"* **(VSWR)** meter. These modes may also be selected by the four round keys on the right-side of the keypad. However, the only way to select the "***oscilloscop****e"* is from the mode option menu.

7.1 (SLM) Mode measurment menu functions

This mode has eight functions:*"centre frequency", "bandwidth", "reference impedance", "zero reference", "threshold", "peak level", "bargraph display" and "filter".* They are selected for optimum measurement settings depending on user need. Note the menu functions will alter when some options are selected.

Center Frequency - Has six options: *"generator frequency", "AFC" (Automatic Frequency Capture), "single fixed" "dual fixed" and "input frequency"*. These options control how the input(s) determine the frequency displayed on the screen.

The *"generator frequency"* is the frequency the instrument is generating.

When *"AFC"* is selected this adds a second "centre frequency", "AFC Gain", "frequency step" and "step type" to the function menu. This allows the frequency to be automatically centered and the level to be measured or moved up or down by the step frequency in a linear or logarithmic amount. The AFC gain can be increased if there is trouble locking onto the frequency. However, the higher the gain the stability will suffer slightly as a result.

When "*single fixed"* is selected this adds a second "centre frequency", "frequency step" and "step type" to the function menu. This allows the original input centre frequency level to be measured or moved up or down by the step frequency in a linear or logarithmic amount. The frequency settings can be changed by following the "Keypad Operation" instructions in section 4.1.

When "*dual fixed"* is selected this removes the second "centre frequency", "frequency step" and "step type" function and replaces them with "centre frequency 1" and" centre frequency 2". This allows the levels at the two set frequencies to be measured. The two option frequencies can be changed by following the "Keypad Operation" instructions in section 4.1.

The "*input frequency"* is the frequency of the input signal and is usually used when a clean spot frequency is known.

bandwidth – Has nine options:"*wide", "3.1KHz", "1.95KHz", "600Hz", "400Hz", "360Hz", "100Hz", "25Hz", "3Hz" and "1Hz"*. This sets the frequency window around the centre frequency. The 'wide' setting lets the meter see all frequencies across the range (5Hz to 5MHz) and the amplitude displayed is the addition of all the frequencies seen. Note the bandwidth is always displayed on the bottom of the screen even when not selected. The 100Hz bandwidth is normally used with RF carrier frequencies. The 25Hz bandwidth is normally used with audio tones or when frequencies are closely spaced where the 100Hz filter would not work.

Reference impedance – Has six impedance options in this sub menu, these are *"50Ω, 75Ω, 120Ω 135Ω, 150Ω and 600Ω".* These options set the internal reference impedance that the selective level meter uses for dBm calculations.

Zero Reference – This allows the zero dB reference level to be set so that the entered level then becomes the 0dB reference.

Threshold – Sets the minimum voltage the instrument will read. The default setting is -50dB. The setting can be changed by following the "Keypad Operation" instructions in section 4.1.

Peak level – Has two options "on" or "off", this function shows the highest level reached but will be overwritten if a higher level is detected.

Bargraph display – Has two options "on" or "off", this function inserts a horizontal level bargraph at the bottom of the display to provide a visual representation of signal amplitude. This option adds "bargraph minimum" and "bargraph maximum" to the left function menu where the minimum and maximum bargraph scale can be set for user preference.

Filter - Has three options: *"normal", "slow" and "none".* This sets how many samples the instrument takes before updating the display and effectively smoothes the readings. If none is selected then the readings are unfiltered and more prone to noise.

NOTE: While in the SLM measure menu and pressing the "Zero" button, it is possible to set the display 0dB reference level. This allows the present level to be set as the 0dB reference or, the level can be entered manually. This is done by highlighting and entering the preferred option. To clear the entry and return to the original level, highlight "clear 0dB reference" and then press enter.

7.2 (LCR) Mode measurement menu functions

This mode has three functions, *"measurement", "speed"* and *"filter".* They are adjusted for optimum measurement settings depending on requirements, allowing the user to measure the characteristics of different electrical circuits.

Measurement – Has three options: *"impedance magnitude", "parallel circuit"* and *"series circuit".* The 'impedance magnitude' option is normally used for measuring the peak impedance of line traps or parallel L/C circuits at their resonant frequency and captures the highest magnitude measured. The 'parallel circuit' and "series circuit" option measures the amount of inductance or capacitance seen by the instrument in that circuit. Measuring inductance requires keeping the frequency below the self resonance of the circuit.

Speed – Has five options: *"very slow", "slow", "medium", "fast"* and *very fast".* Selection is chosen for optimum measurement update and is a tradeoff between display stability and update time. Setting the option to '*fast*' whilst carrying out a sweep decreases the sweep time, whilst 'slow' increases sweep time.

Filter - Has three options: *"normal", "slow" and "none".* This sets how many samples the instrument takes before updating the display and effectively smoothes the readings. If none is selected then the readings are unfiltered and more prone to noise.

7.3 (VSWR) Mode measurement menu functions

This mode has four functions: *"method", "reference impedance", "speed"* and *"filter"*. These selections set the type of coupling, speeds and filter sampling required.

Method – Allows the selection of two options: *"impedance"* and *"directional coupler".* The impedance method allows computation of a transmission line VSWR from analyzing the measured line impedance without needing a direct coupler. Selecting direct coupler adds "*scale factor*", "*centre frequency"* and "*bandwidth"* to the function menu where appropriate options can be entered. Using a direct coupler allows the actual forward and reflected voltages to be measured on CH1 and CH2. A direct coupler is available as an optional extra.

Reference impedance – Allows the selection of six impedance options: *"50Ω, 75Ω, 120Ω, 135Ω, 150Ω* and *600Ω"* and is necessary when using the impedance method to make dB calculations.

Speed – Has five options: *"very slow", "slow", "medium", "fast"* and *very fast".* Selection is chosen for optimum measurement update and is a tradeoff between display stability and update time. Setting the option to '*fast*' whilst carrying out a sweep decreases the sweep time, whilst 'Slow' increases sweep time.

Filter - Has three options: *"normal", "slow" and "none".* This sets how many samples the instrument takes before updating the display and effectively smoothes the readings. If none is selected then the readings are unfiltered and more prone to noise.

7.4 (FRA) Mode measurement menu functions

This mode has four functions: *"speed", "filter", "graph"* and *"computation"*. These selections choose the type of update speeds, filtering, frequency response, graphic display and input channel computaion settings required.

Speed – Has five options: *"very slow, slow, medium, fast* and *very fast".* Selection is chosen for optimum measurement update and is a tradeoff between display stability and update time. Setting the option to '*fast*' whilst carrying out a sweep decreases the sweep time, whilst 'Slow' increases sweep time.

Filter - Filter has three options: *"normal", "slow" and "none".* This sets how many samples the instrument takes before updating the display and effectively smoothes the readings. If none is selected then the readings are unfiltered and more prone to noise.

Graph - Graph has two options: *"gain* and *phase".* This sets how the frequency response is displayed, the two options work in conjunction with the computation option. Selecting '*gain*' plots the gain or loss of the signal levels between the two channels. '*Phase*' plots the phase angle difference between the two channels.

Computation - Computation has two options: *"ch2/ch1* and *ch1/ch2".* The chosen option determines how the graph displays the results of the frequency response sweep.

7.5 Oscilloscope Mode.

The oscilloscope is can be either single or dual trace and has a sample rate of 5Msamples/s and a time base sweep of 5µs/div to 5s/div, this provides the user with a convenient tool for displaying and analyzing input waveforms. (Sample display is shown in Fig 7.3)

This section provides the basic information necessary to use the instrument. Use the '*HI ∞*' input as channel 1 (1MΩ ±300v pk) and '*CH2*' input (±10v pk 1MΩ) as channel 2. Refer to section 3.4 "Instrument controls and connections" for connector orientation.

Make sure the setting for channel 1 is '*high Z*' (channel 2 is fixed at 1MΩ) and confirm the CH1 setting before using the oscilloscope. During operation using the UP/DOWN arrow keys will increase or decrease the trigger level whist the LEFT/RIGHT arrow keys will increase or decrease the trace sweep time.

The oscilloscope has six functions available: '*timebase*', '*trigger level'*, '*trigger mode'*, '*trigger polarity'*, '*pretrigger*' and '*traces*'. These are shown below in Fig 7.2 oscilloscope setting screen.

Caution: Only use the '*HI ∞*' input and '*CH2*' input, being aware that '*CH2*' input is only rated at ±10v pk. However, the '*HI ∞*' input can be used up to ±300v pk.

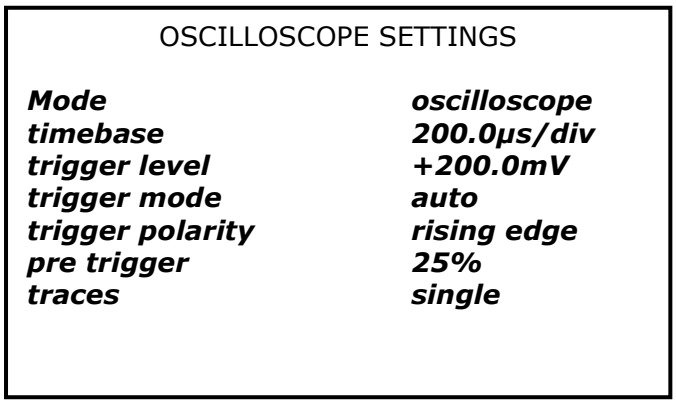


Figure 7.2

Timebase - Sets the sweep rate of the oscilloscope, the setting can be adjusted by following the "Keypad Operation" instructions in section 4.1.

Trigger level – Sets the minimum voltage required to start a sweep and can be adjusted by following the "Keypad Operation" instructions in section 4.1.

Trigger mode – Has three options: '*auto*', '*normal*' and '*single shot'*.

'Auto' puts the oscilloscope in the *auto run* mode where the trace is synchronized to the trigger event. However, in this mode it draws a trace even if no trigger event is seen.

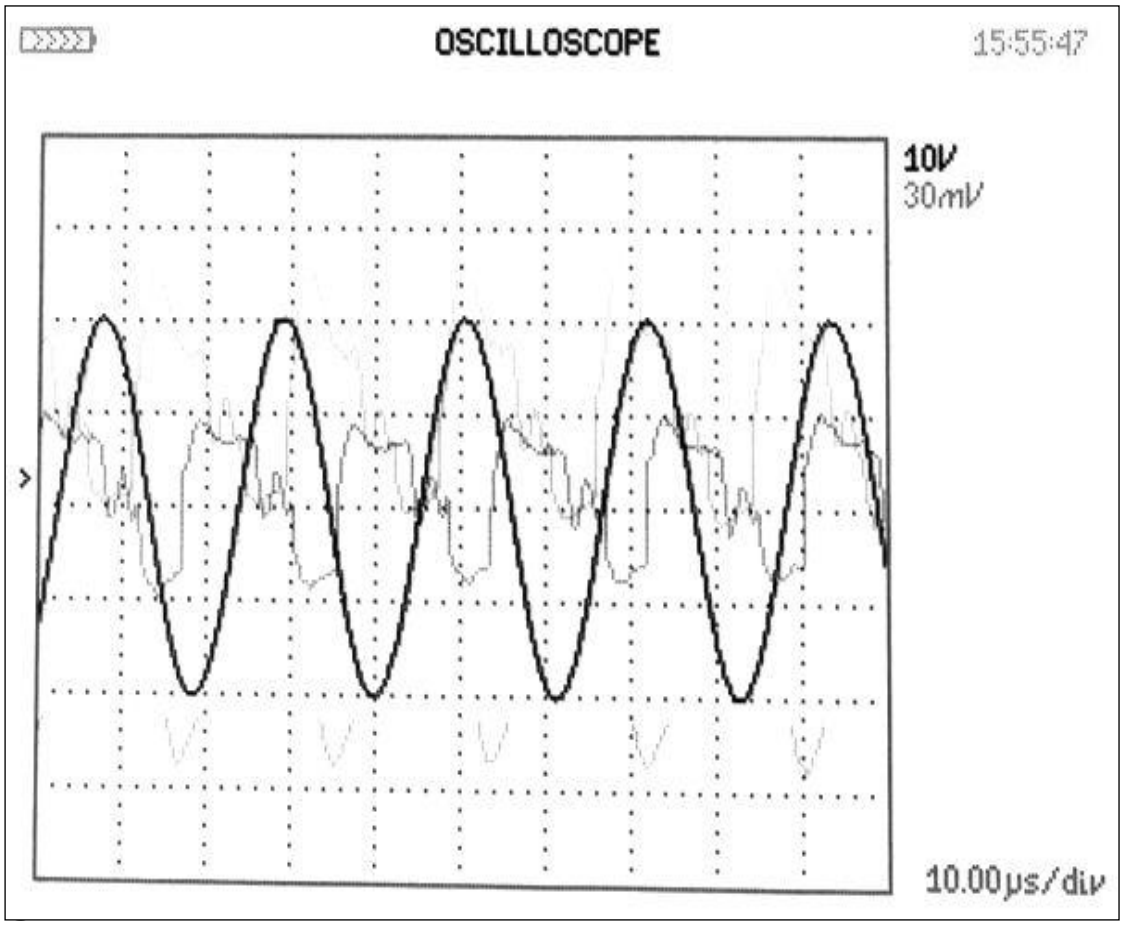
'Normal': Sets the trace to respond to each trigger event. If there are no trigger events the display is not updated until a trigger event occurs.

'Single shot': Sets the trace to respond only to the first trigger event captured. By pressing the "Home/Esc" key re-arms the trigger circuit for the next event capture.

Trigger Polarity - Has two options: '*rising edge'* and '*falling edge'*. Selecting 'rising edge' sets the oscilloscope to start the sweep when the trigger voltage goes positive. Selecting 'falling edge', sets the oscilloscope to start the sweep when the trigger voltage goes negative.

Pre-trigger – Has four options: '*none*', '*25%', '50%*' and '*75%*'. This determines the amount of pre-trigger, or waveform display delay based on the mark/space ratio time of the waveform. 'None' has no pre-triggering and therefore the waveform starts at the beginning of the trace. '25%' has a pre-trigger time of a quarter of the mark/space ratio time, so the triggering edge of the waveform is displayed after the trace starts by 25% of the mark/space ratio time. This is also applicable for 50% and 75% depending on the pre-trigger time required.

Traces – Traces has three options: '*single*', *"dual" and "ch2 current".* This selects either single or dual trace input voltage operation. However in ch2 this will show the current waveform developed across the generator shunt.



Dual Trace Display

8 SWEEP KEY– Sweep works in all modes. It allows the instrument to sweep across a frequency band from the start frequency to the end frequency in up to 2000 steps. In VSWR mode, the sweep function only works with the impedance method. The sweep setting menu screen is shown below in Fig 8.1 displaying the 10 general functions. However, additional functions will appear when selecting some options from the right menu list.

*Note: Make sure the generator is on before starting a sweep.

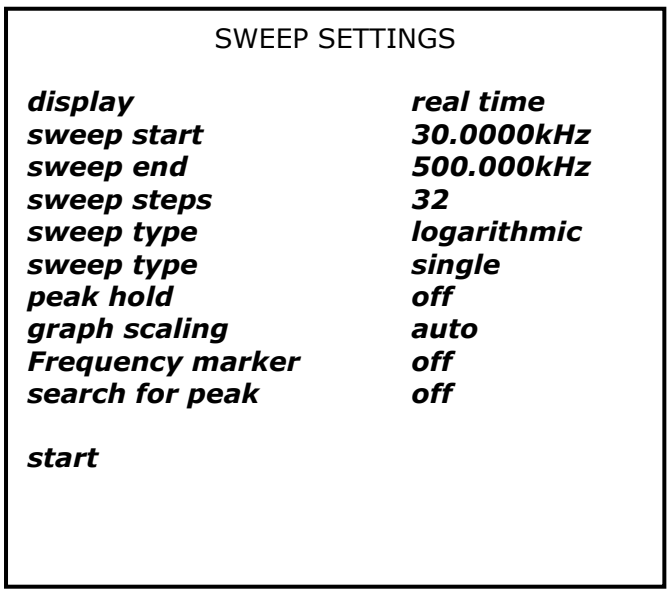


Figure 8.1

8.1 Sweep Menu Functions

Display – Has three options: "*real time"*, "*table"* and "*graph"*. Sweeping a band of frequencies stores each step into a table. After the sweep is completed this information may then be displayed as either a table or a graph depending on the option selected. Selecting "real time" returns the display back to normal operation.

This information may be saved via the 'PROG' key either internally, on a memory stick, or directly to a PC. Refer to section 16 for saving information.

Sweep Start, Sweep End and Sweep Steps – The "*sweep start*" and "*sweep end*" sets the two frequencies over which the band will cover.

The "***sweep steps***" sets the amount of steps taken to cover the frequency band, at each step a reading is taken and is set depending on the accuracy and resolution required. This can be a maximum of 2000, however the more steps entered the more memory is required. The frequencies and steps can be entered by following the "Keypad Operation" instructions in section 4.1.

Linear Example of sweeping from 100 kHz to 200 kHz in 1 kHz steps:
Start by subtracting 100 kHz from 200 kHz. This gives the difference of 100 kHz. Set the number of steps for 100 plus one or 101. Since the sweep starts at 100 kHz and goes to 200 kHz, there are 101 – 1 kHz steps. Thus each step is 1 kHz apart.

Sweep Type – Is displayed twice on the function menu as there are two different options for each function. These options are '*linear/ logarithmic*' and '*single/continuous*', these are set depending on the type of sweep required.

The 'continuous' option repeats the sweep until the 'HOME/ESC' key is pressed which stops the sweep.

Peak Hold – Has two options "*on*" and "*off*". However, it is only operational when the "continuous sweep" option is selected. As the sweeps continue this allows the present sweep readings to be compared against the previous readings which then determines the highest level reached.

Graph Scaling – Has two options, *"auto"* and *"manual",* in most cases auto scaling will work and adjusts the graph scale automatically to suite the measurement levels.

When a more specific graph scale is needed then the "**manual**" option may be selected. This adds two functions to the left menu, *"graph maximum"* and *"graph minimum"*, here both levels can be specifically set by following the "Keypad Operation" instructions in section 4.1.

Frequency Marker–Has three options *"off", "single" and "dual".* If "single" is selected this adds "marker 1" function to the left menu and If "dual" is selected this also adds "marker 2" function to the left menu, allowing the setting of a specific frequency to be entered. While in the sweep mode it draws a vertical line on the graph at that frequency allowing the user to determine the measurement at that desired frequency. The frequency is set by following the "Keypad Operation" instructions in section 4.1.

Search for Peak–Has two options *"on"* and *"off". However, in LCR mode it has three options, "Off", "Single", and "Dual"*. If "on" is selected, this draws a vertical line at the frequency of peak measurement, or the option of one or two frequency peaks in LCR mode. The screen in Figure 8.2 shows a sweep across a frequency band of 150KHz to 250KHz. It shows the peak impedance of 43.971kΩ at 200KHz with the marker set at 209KHz.

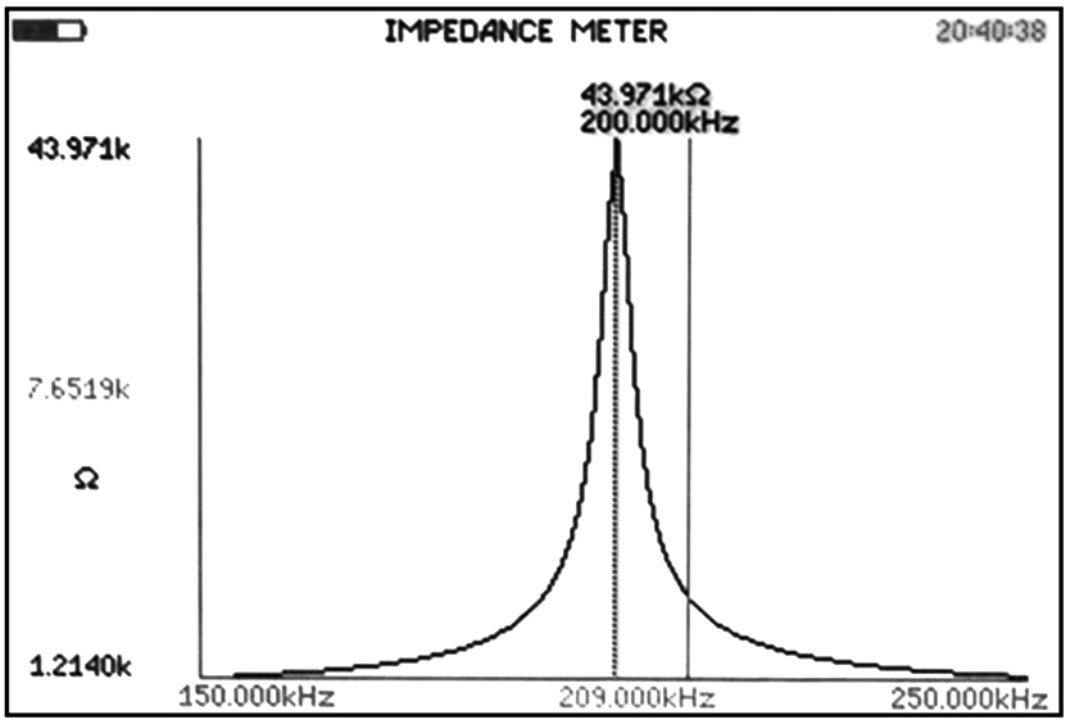


Figure 8.2

Start – The ‘start’ function starts the sweep mode.

9 **TUNE KEY –** Has five functions: "*centre frequency"*, "step type", "*frequency step"*, "*auto tune type"* and "*start auto tune"*. This selects the tuning method for the selective level meter (SLM) and effectively tunes the instrument for a particular frequency to look for. This is used with sweep mode (graph display) where the instrument is looking across a known frequency band for the expected signal.

9.1 Tune Menu Functions

Centre Frequency – Sets the frequency for which the instrument input is looking for and is not the generator frequency. This may be from line transmitter etc. This frequency is set by following the "Keypad Operation" instructions in section 4.1.

Step type – Sets the type of frequency step preferred either linear or logarithmic.

Frequency Step – Sets the frequency step that is increased or decreased when the LEFT/RIGHT arrows are pressed. This frequency is set by following the "Keypad Operation" instructions in section 4.1.

Auto Tune Type – This has two functions, "*three stage auto tune"* and *"single stage retune"* and is normally used with a (real time display). Three stage auto tune, is used when the frequency is not known and effectively looks across the sweep frequency range for the largest signal. It then homes in on this signal and shows the frequency obtained. "**Single stage retune"** will allow fine tuning around the found frequency.

Start Auto Tune – This starts the auto tune function, the real time display flashes "autotune" in the top left corner whilst the tuning is taking place. When finished the found frequency is displayed.

10 ZERO KEY – Displays information dependant on the mode being used, (SLM/FRA) sets or clears the 0db level reference. (LCR) sets or clears lead/cable compensation. (VSWR) allows the storage of impedance measurements.

10.1 Zero Key Displays

(LCR) mode provides zero compensation information and is used to remove the capacitive element of test leads from the measured impedance. Select *"compensate"* then Enter, to start zero compensation or, *"clear compensation"* then Enter to clear any previous compensation. The display in Figure 10.1 appears when the zero key is pressed. "DUT" means 'Device under Test', be sure to clear compensation before doing further testing.

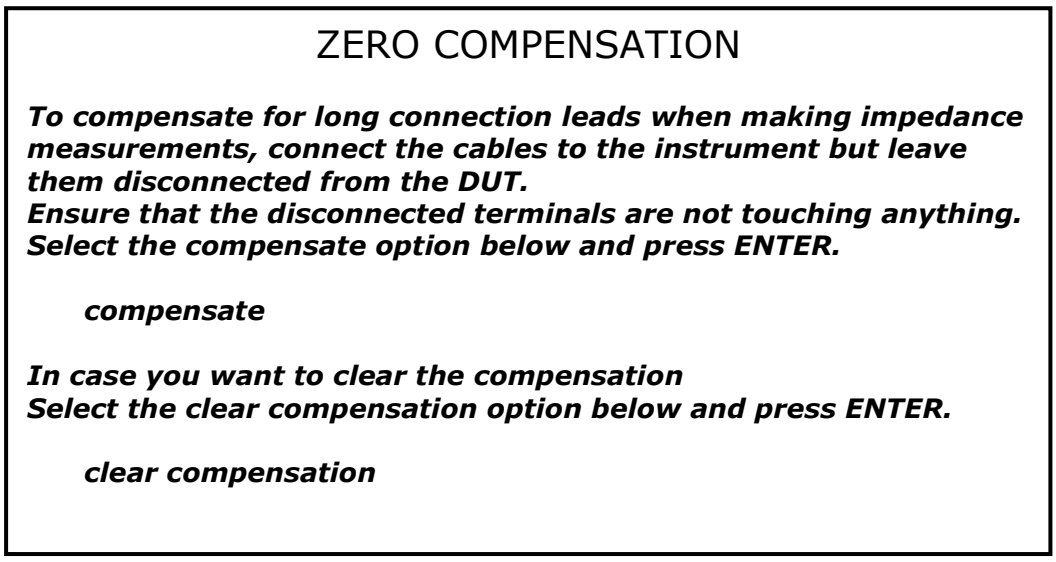


Figure 10.1

(FRA) mode provides 0dB reference and dB calculation information. It is useful when looking for changes in gain under specific conditions such as where an attenuator -3dB cut off point occurs in relation to the 0dB reference. Select *"set present measurement at 0dB reference"* then Enter, to start 0dB reference or, *"clear 0dB reference"* then Enter to clear the setting. The screen in Figure 10.2 appears when the zero key is pressed.

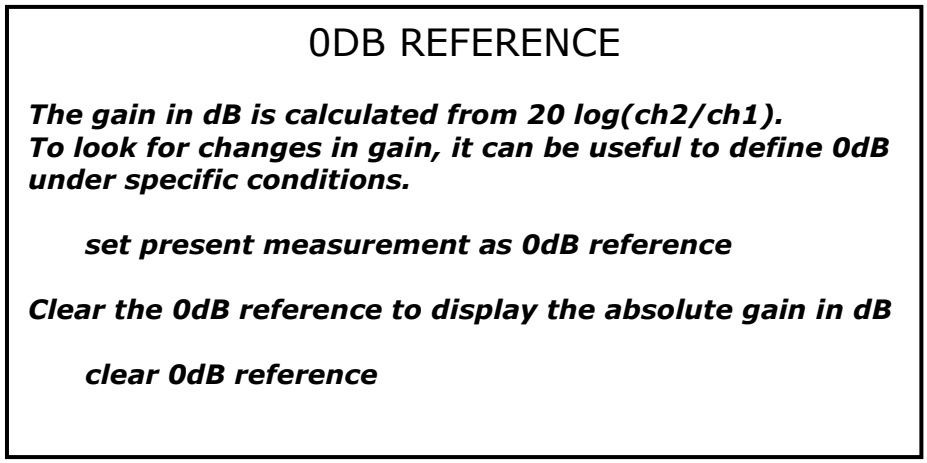


Figure 10.2

(VSWR) mode provides VSWR impedance measurement and storage information. When a measurement is taken using the generator it is then stored. The forward and reflected power from a transmission line can then be calculated and using the previously stored value. Select *"store impedance"* then Enter, to store the measurement or, *"measure impedance"* then Enter to return to real time LCR mode. The screen in Figure 10.3 appears when the zero key is pressed.

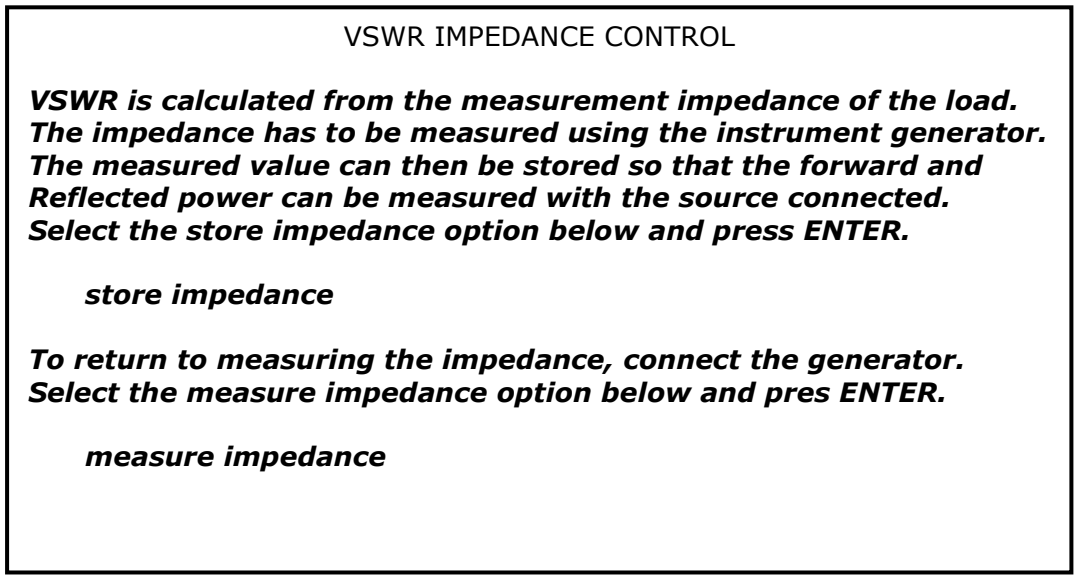


Figure 10.3

11 AUX KEY - This is for the Auxiliary Port Settings and is for future applications, it is not functional at this time. The screen in Figure 11.1 appears when the key is pressed

AUXILIARY PORT SETTINGS

This is reserved to control accessories connected to the AUX port.
There are no accessories currently available.
Pres ESC to return to the measurements.

Figure 11.1

12 REMOTE KEY – This function is used to set the communication interface with the instrument. The key has three functions: "*resolution"*, "*interface"* and "baud rate" which only appears in the function menu when the "RS232" option is selected. An I.P. address appears in the function menu when the "LAN" port is selected. USB is self connecting and only requires the user to tell the program in the computer which COM port the USB is connected to.

12.1 Remote Key Functions

Resolution – Has two options: “normal” and “high” this alters the number of digits being displayed.

Interface - Has three options: “RS232”, “USB” and “LAN” depending on the interface the user requires to connect the instrument with.

Baud Rate – Only appears when RS232 interface is selected and has four settings: 38400, 19200, 9600 and 1200 depending on the data rate of the system the instrument is interfacing with.

USB Option – The USB option activates the Type B connector at the bottom of the meter.

LAN Option – This option activates the LAN connector at the bottom of the meter and adds an “IP” address function to the menu. The address can be entered using the arrow keys.

13 MONITOR KEY – This function is for future applications and is not functional at this time. The screen in Figure 4.12 appears when this function is selected.

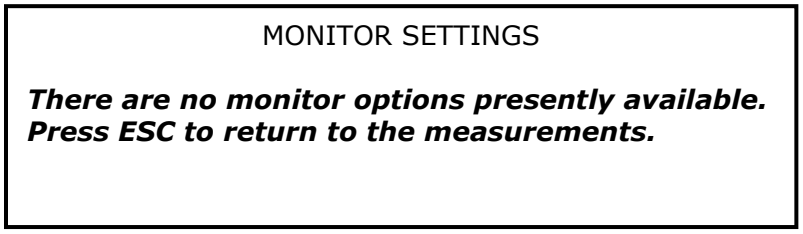


Figure 13.1

14 SYSTEM KEY – Has Nine functions: "initial settings", "*set clock", "set date", "display", "brightness", "enlarge results", "phase convention", "keyboard beep"* and *"step message"*. These functions allow the user to configure the instrument for individual requirements and also set correct time and date for storage file records. When this function is selected, pressing the RIGHT ARROW key shows the user settings and the LEFT ARROW shows the system data, both sets of information are explained later in this section.

14.1 System Key Functions

Language – These menu options depend on the (Country) firmware loaded, ie Italy will provided a choice of Italian or English etc.

Initial settings – This setting has three options which sets the instrument initial settings at switch on. These are either the settings stored in memory program 1, as per the factory default or the settings which were last used.

Set Clock – This option sets the time. Use the UP/DOWN arrow keys to highlight hours, minutes or seconds, and the LEFT/RIGHT arrow keys to change the time.

Set Date – This option sets the date. Use the UP/DOWN arrow keys to highlight the month, day or year, and the LEFT/RIGHT arrow keys to change the date.

Display – Has three options: *"colour"*, *"white on black"* and *"black on white"*. The white on black option is easier to see in natural daylight due to the shielding in the glass of the display. Glare does occur in direct sunlight.

Brightness – The instrument display has two options, *"low"* and *"high"*. The default setting is 'low' to conserve battery power. This option works best in the 'colour' or 'white on black' mode and makes the display easier to see in natural daylight.

Enlarge Results – Has two options *"on"* or *"off"* and changes the size of the text/numbers on the display. Each instrument mode is different. The SLM mode changes the volts and dBm. The impedance mode changes the impedance. The VSWR mode changes percent reflected power. The FRA mode changes the gain.

Phase Convention – This is available in both "LCR" and "FRA" mode and displays the phase angle between the input current and voltage. This phase angle has three options: *"-180° to +180°", "0° to -360°"* or *"0° to +360°"* depending on user preference.

Keyboard Beep – An audible 'beep' is available and sounds every time a key is pressed. This option can be *"enabled",* or *"disabled"* if the sound is not required.

Step Message – Has two options *"enabled"* or *"disabled".* A single line message appears on the display in real time mode when stepping the frequency or amplitude up or down using the arrow keys. It shows the new value selected. The 'step message' may be disabled if desired.

User Settings – This function is accessed by pressing the system key followed by the 'right arrow' key, this will then display the screen in figure 14.1. This allows the "user" to enter three separate lines of information which is saved in a data file when "*save*" is selected and ENTER pressed.

User Data, Example.

(Default 1st "Newtons4th Ltd", can be overwritten).

Figure 14.2 is an example, which in this case shows the station name, line number and technician name. The third 'user data' line (ie technician name), is the data displayed on the *'PROGRAM STORE/RECALL'* display screen, See section 16.

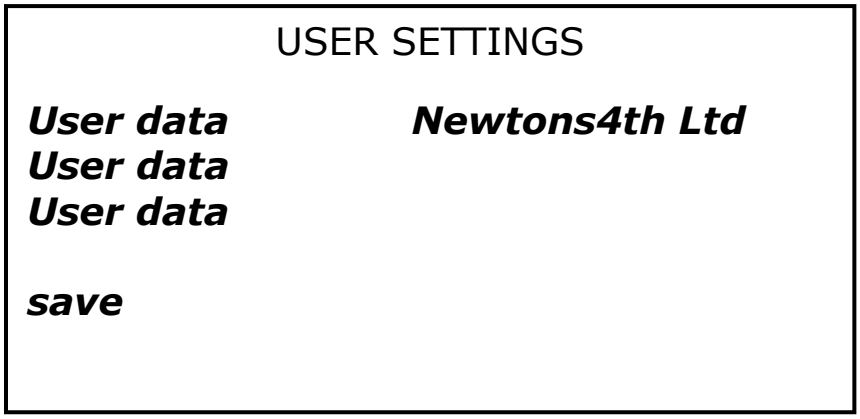


Figure 14.1 (Main Settings)

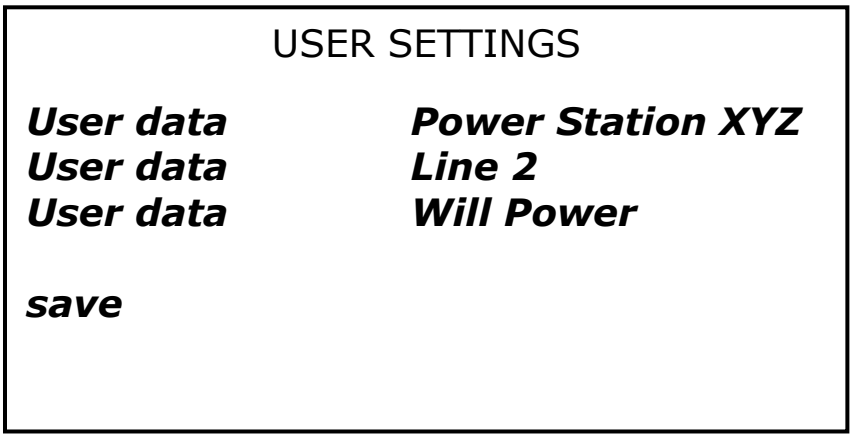


Figure 14.2 (example data)

Data Screen – The instrument Data screen is accessed by pressing the "System Key" followed by the **'**left' arrow key. This displays the following system information: "*serial number", "impedance", "manufacturing code", "main release", "DSP release", "FPGA release", "boot release"* and *"last calibration"*.

From this data the user can see the instrument traceability information, firmware release levels, calibration date etc and determine if any updates are necessary or if the instrument is due calibration.

15 APP KEY – This function allows the main default setup of the application option selected. Figure 15.1 shows what appears when the "Inductance" option is selected.

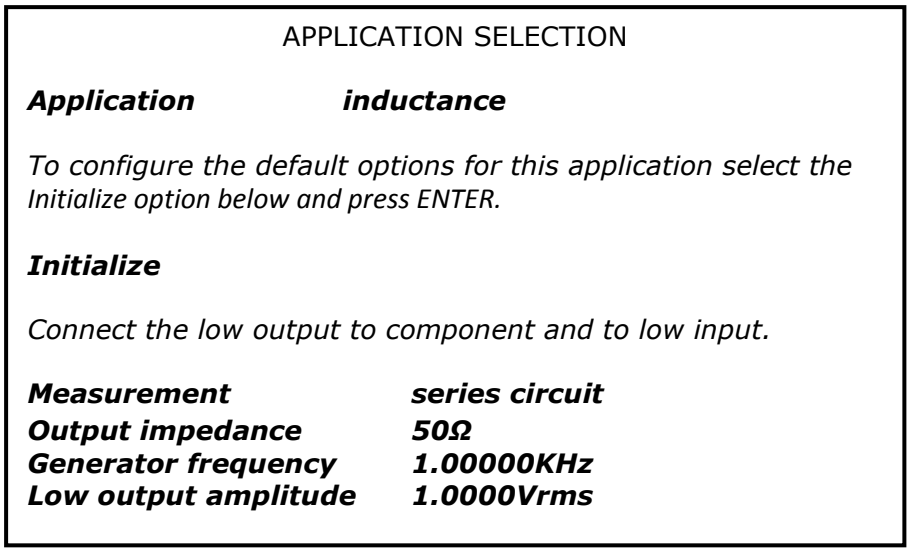


Figure 15.1

15.1 App Key Functions & menus

Application – Has a selection of normal, oscilloscope, capacitance, inductance and resistance available. When the option is selected and "Initialize" is entered this allows the main default options menu of that application to appear. Once selections have been made, press the "Home" key and the appropriate display will appear.

Oscilloscope Menu – Setup options are as follows and explanations for each setting can be found under the main mode or measurement key description.

Input (high z, 50Ω 18W, low level, balanced)
Impedance (high impedance, 50Ω, 75Ω, 600Ω)
Timebase (enter time/div)
Trigger level (enter voltage level)
Trigger mode (auto, normal, single shot)
Trigger polarity (rising edge, falling edge)
Pretrigger (none, 25%, 50%, 75%)
Traces (single, dual, ch2 current)
Cursors (on, off)

Capacitance, Inductance & Resistance Menu – Setup options are as follows and explanations for each setting can be found under the main mode or measurement key description.

Measurement (parallel circuit, series circuit)
Output impedance (50Ω, 75Ω, 600Ω)
Generator frequency (enter frequency Hz)
Low output amplitude (enter voltage level rms)

16 PROG KEY – Allows the user to internally or externally store and recall instrument setups and readings. It has the following functions: *"memory", "file type", "action", "location", "name"* and *"execute"*.

The memory information in red at the bottom of the screen displays, *"memory status", available files"* and *"free space".* This applies to the internal or external memory whichever is selected. They inform the user of the memory status, how many files are available in memory and how much memory space is still available.

All file directory information can be displayed by pressing the "Prog" key and then the "SLM" button. This will allow all the information to be displayed as a table and show what the internal file directory contains. (By pressing the "SLM" button again exits the directory).

Note: This information is also available to be read over the instrument communication link.

16.1 Prog Key Functions

Memory – Memory has two options: **'***internal'* and *'USB memory stick'*. The instrument has one gigabyte of internal memory. Note: "USB Memory stick" appears in blue if no device has been detected.

File type – Data has two options: *'program'* and *'results'*. Program allows the user to store a program setup that may be used to provide a specific set of tests. Results allow the user to store the results with their configuration from a specific reading or sweep.

Action – Action has three options: *"recall", "store"* and *"delete"*. While previously selecting "program" or "results" from the "data" function, the user must decide whether to recall, store or delete the data. When storing, up to 999 setups/readings can be saved and each must have a unique number. Memory location '0' is the 'factory default' setting. The 'delete' option allows the user to delete any setup or reading.

Location & Name – These functions are used together. Location must have a number but name is optional and can remain as "*empty*". Using the LEFT/RIGHT arrow keys allows the location to be incremented or decremented. (0 = factory default). See **menus and controls** section and figure 4.1 for entering alpha numeric characters.

Execute – Execute is used to control the 'action' option. After selecting an action (store, recall or delete), the '*execute*' option is selected and the 'enter' key pressed.

If the memory location selected already has results or a setup stored, then the option: *'select here and press ENTER to overwrite',* appears warning the user the location "number" already has data stored in it.

16.2 Example Sweep Results Store/Recall Process

- This example shows the steps necessary to store and recall a set of sweep results. It assumes you have already carried out a sweep and either displayed a table of results or a graph from that sweep. Figure 16.1 displays the "Program Store/Recall" screen.

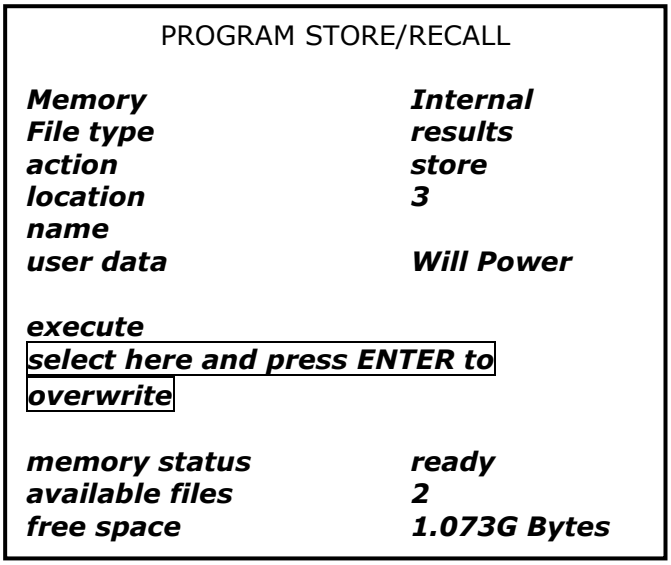


Figure 16.1

16.2 Storing Results

Press the "Prog" key

- Displays the "Program Store/Recall" screen.

Memory:

- Select "internal".

File type:

- Select "results".

Location:

- Using the Left/Right arrow keys increase or decrease the number until an "empty" location is found.

Name:

- Using the alpha numeric keys outlined in section 4.1 enter the appropriate name.

Action:

- Select "Store" then Enter. This adds "user data" to the function menu, using the alpha numeric keys outlined in section 4.1 enter the appropriate information. (This will appear as the 3rd line of user data on the systems user settings screen).

Execute:

- Select "execute" then Enter, data is now stored

16.3 Recalling Results

Press the "Prog" key

- Displays the "Program Store/Recall" screen.

Memory:

- Select "internal".

File type:

- Select "results".

Location:

- Using the Left/Right arrow keys increase or decrease until the number required is found.

Name:

- The correct name should be displayed.

Action:

- Select "recall" then Enter.

Execute:

- Select "execute" then Enter, which should now display the results. In sweep mode selecting either "graph" or "table" will have the results displayed in the desired manner.

16.4 Deleting Results

Press the "Prog" key

- Displays the "Program Store/Recall" screen.

Memory:

- Select "internal".

File type:

- Select "results".

Location:

- Using the Left/Right arrow keys increase or decrease until the number required is found.

Name:

- The correct name should be displayed.

Action:

- Select "delete" then Enter.

Execute:

- Select "execute" then Enter, this should now display the name "empty" for that location number.

16.4 Memory Status

(Displayed In Red) – "Memory status" monitors one of two items. It lets the user know how much memory is available either internally or on the USB memory stick.

The 'available files' function lets the user know how many data files are stored either internally or on the USB memory stick.

Storing data to the memory stick creates two files. One file extension is '.pcs' and is used by the software interface provided by Newtons4th Ltd. The other file is a comma delimited text file with the ".txt' extension. Full information is provided in the appendix on this file format.

17 SELECTIVE LEVEL METER (SLM) MODE

The instrument is used when checking signal lines and is designed to measure the level of individual frequencies from 5 Hz to 5 MHz. The input signal is normally connected to the high "Z" input or if terminated, the 50Ω input. Figure 17.1 shows an example of the SLM mode display.

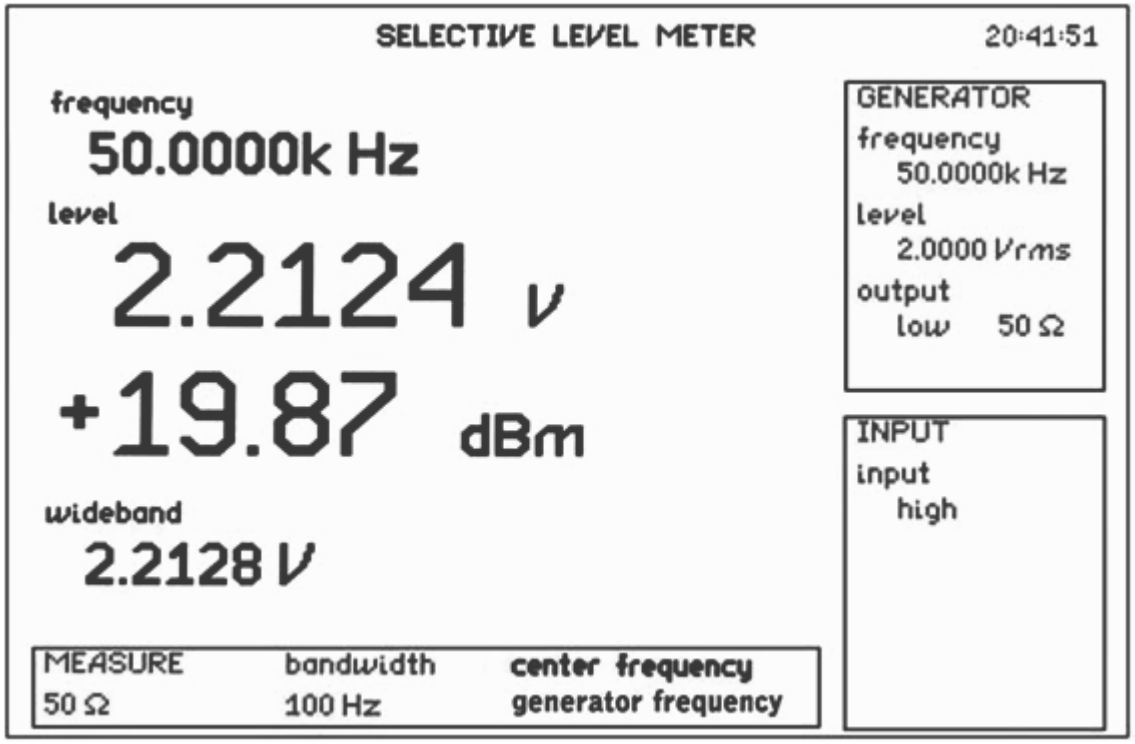


Figure 17.1 – Selective Level Meter Display

17.1 (SLM) Screen Display Areas

The main area shows "frequency", "level" and "wideband" measurements as follows:

"**Frequency":** is the centre frequency(s) the instrument has been set to measure. This is either the generator frequency, input frequency, single or dual frequencies.

"**Level"** is the rms voltage and dBm signal level seen over the measurement frequency "bandwidth", referenced to the "centre frequency".

"**Wideband"** is the rms voltage signal level across the entire frequency range (5Hz to 5MHz) of the instrument. This is useful for determining if there are any other signals present or noise.

The other areas are:

'**GENERATOR**' area: Displays the generator frequency, the output level and if the output is set to 'low', 'high' or "off".

Note: The output level of the generator when connected to one of the inputs may differ to the measurement reading on the SLM display. This is apparent when the load isn't equal to the generator impedance setting.

'**INPUT**' area: Displays the input channel selected. When the INPUT displays anything but 'high' it is in the 'terminate' mode. The inputs available are, high Z, 50Ω 18 W, low level and balanced.

'**MEASURE**' area: Displays its impedance reference, the frequency bandwidth and the centre frequency control settings. Although the input impedance may be set to high, the dBm reading must be referenced to an impedance value, normally 50Ω for carrier applications. However, some utilities still use 600Ω.

17.2 Example (SLM) Carrier Frequency Test

The general instrument setup for carrier testing is for the input signal to be set and connected to the high "Z" input. The reference measurement impedance set to 50Ω and measurement frequency bandwidth at 100Hz.

17.3 Example (SLM) Audio Tone Test

The general instrument setup for audio tones is for the input signal to be set and connected to the balanced input. The reference measurement impedance set to 600Ω and measurement frequency bandwidth at 25Hz.

17.4 Example (SLM to SLM) Passive Sweep Check

This test checks the condition of a transmission line by assessing signal levels swept over a wide frequency band. Normally the SLM is looking for a spot frequency signal and shows the level in volts and dBm. However, this does not provide information about possible abnormalities residing on the line. There are two ways of doing this, the first method needs a clean signal and is faster, whilst the second is more tolerant to signal condition, but slower. The tests use two SLM units the first unit is the transmitter, connected to one end of a transmission line and the second, the receiver is connected to the other end.

Method (1)

The transmitting unit is set to a slow sweep across the desired frequency band, which allows the receiving unit time to track the frequency steps. The signal is received at the high "Z" input and both SLM's are set up using the mandatory selections listed below, other menu options not specified can be left in the initial default condition.

Transmitter SLM set up:

Mode:	FRA
Output menu:	Set generator amplitude (As applicable)
	Set Waveform to "Sinewave"
	Set generator to on "Low"
Measure menu:	Set Speed to "Slow"
Sweep menu:	Set Start/Stop frequencies (eg 1KHz – 100KHz)
	Set the number of steps
	Set sweep to Log
	Set sweep to "Continuous"
	Start sweep

Receiver SLM set up:

Mode:	SLM
Input menu:	Set to "High Z"
Measure menu:	Set bandwidth to 100Hz
	Set Centre frequency to "Input Frequency"
Sweep menu:	Set sweep to "Graph"
	Set Start/Stop frequencies (As Tx unit)
	Set the number of steps (As Tx unit)
	Set sweep to Log
	Set sweep to "Continuous"
	Set Peak Hold to "on"
	Set Graph Scaling to "Manual" (See Note 1)
	Start sweep

Note 1: "Graph Scaling", start with ±20dB, this should provide a realistic starting range until an actual level is determined from the detected signal.

Note 2: The transmitter SLM sweep can be started at any time. However, after starting the receiver sweep, synchronization may take a little time to acquire until the correct frequency is found.

Note 3: By pressing the Home/Esc button the SLM will then be in its last sweep. However, if the receiver (only) button is pressed it will continue to track the transmitter frequency until the transmitter sweep is stopped, or the receiver is turned off.

If an ideal transmission line is tested it should be similar to the display in Fig 17.2.

For demonstration purposes a "CR" was inserted in the transmission line to induce attenuation between 1KHz and 100KHz, the attenuated plot is displayed in Fig 17.3.

With a 2vpk output @ 1khz = 1.4v rms
With a 2vpk output @ 100kHz = 0.39v rms

Therefore gain = 20 x log(Vout/Vin) = **-11dB**

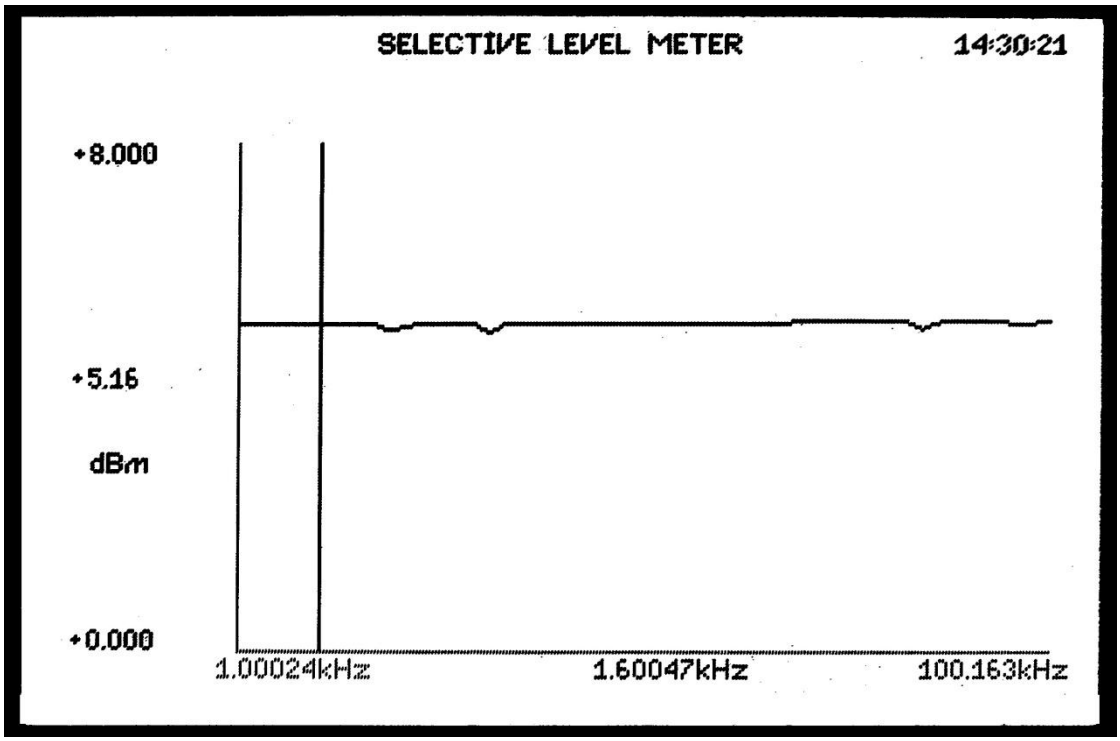


Figure 17.2 – Ideal Transmission Line

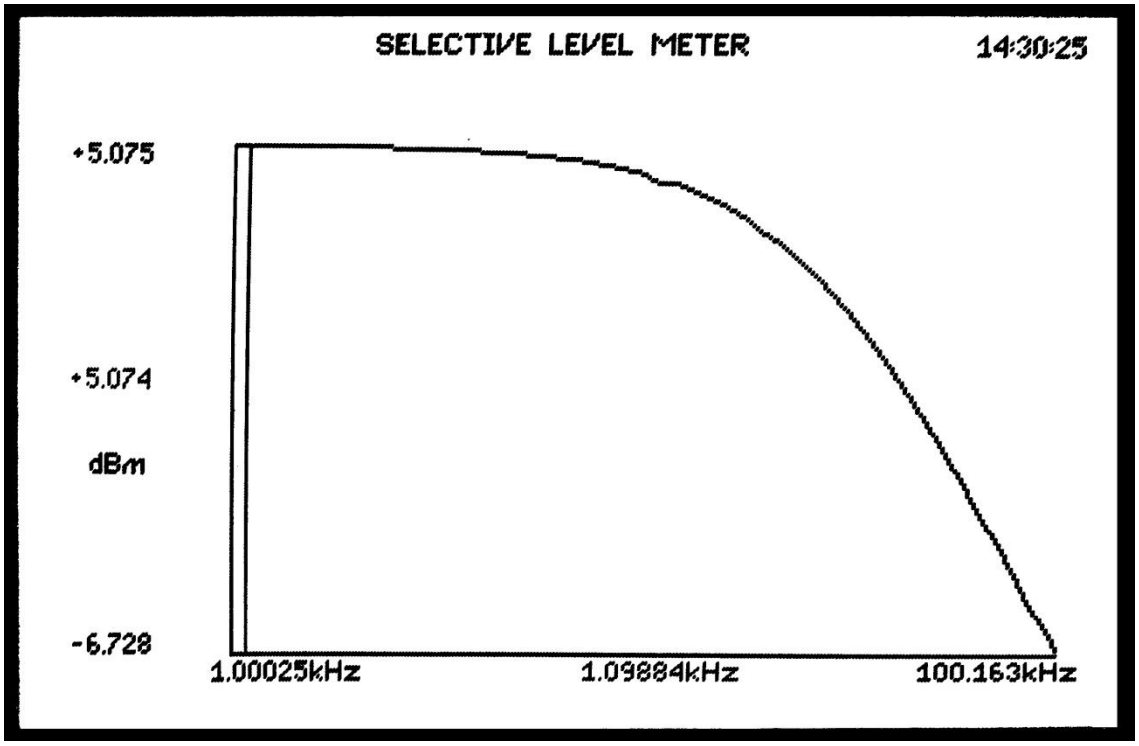


Figure 17.3 – Attenuated Transmission Line

Method (2)

The generating unit is set up the same as method 1. However the receiving unit measure menu centre frequency is set to "Single frequency". Therefore as and when the two sweep frequencies coincide the receiving unit will plot the amplitude this method takes longer for the whole plot to finish but is more tolerant of signal condition.

18 IMPEDANCE METER (LCR) MODE

The meter is used to measure the impedance of different circuits and can range from 100mΩ to 100kΩ. Typically used in power line carrier applications, this could be a line trap or parallel L/C in a line tuner etc. Figure 18.1 shows an example of the LCR mode display.

The signal generator must be turned on to read impedance. Note: when LCR mode is selected it automatically turns the signal generator on.

For impedance measurements, normally the low output of the signal generator is fed into the 'high Z' input and the circuit under test. Through the internal shunt the instrument measures the current drawn from the signal generator while the input measures the voltage across the circuit being tested. When sweeping across a band the instrument can detect up to two impedance peaks and markers can be set for both.

From the fundamental components of voltage, (a + jb), and those of the current, (c + jd), the complex impedance is given by:

$$\mathbf{z} = \mathbf{v} / \mathbf{i}$$

$$= (a + jb) / (c + jd)$$

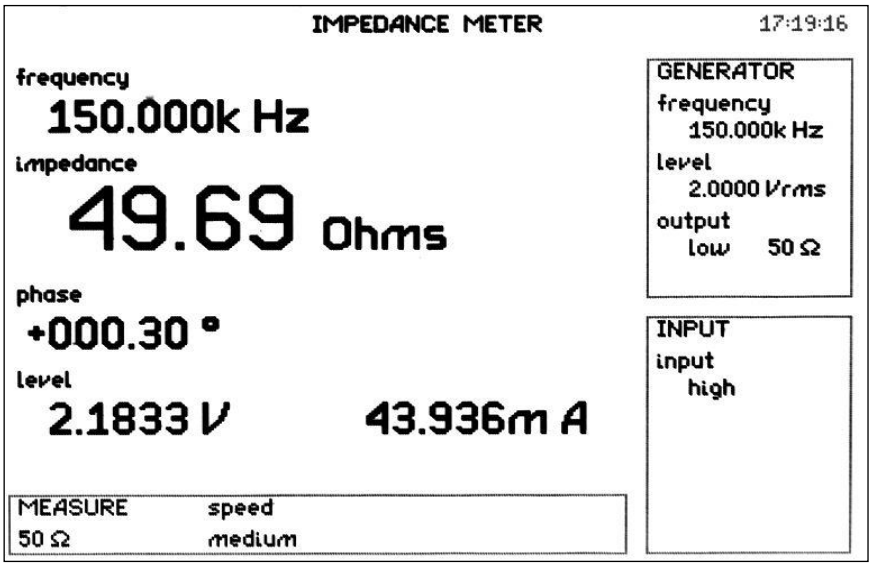


Figure 18.1 – Impedance Meter Display

18.1 (LCR) Screen Display Areas

The main area shows "frequency", "impedance", "phase" and "level" measurements as follows:

"**Frequency":** is the frequency the generator is currently running at.

"**Impedance"** is the value (Ω) measured as a ratio of the voltage and phase angles.

"**Phase"** is the phase angle in degrees between the voltage and current phases.

"**Level"** is the rms voltage and current levels measured.

The other areas are:

'**GENERATOR**' area: Displays the generator frequency, the output level and if the output is set to 'low', 'high' or "off".

'**INPUT**' area: Displays the input channel selected. When the INPUT displays anything but 'high' it is in the 'terminate' mode. The inputs available are, high Z, 50Ω 18 W, low level and balanced.

'**MEASURE**' area: Displays the measurement impedance reference and the speed of measurement update.

Note: When measuring impedance, keep the lead between the generator output and the meter input as short as possible. This limits the amount of error caused by the capacitance of the coaxial lead. The higher the frequency the more error is introduced into the reading.

18.2 Example (LCR) Line Trap Test – The impedance of a line trap is checked by applying a signal at the resonant frequency and adjusting the line trap for maximum impedance. After adjustment, the trap may be swept to confirm the resulting waveform conforms to the manufacturer's specifications.

The drawing in Figure 18.2 shows the connections necessary to test a line trap using the 'high Z' input. However, any of the inputs can be used, and setting the 'low level' output to an amplitude of 2.0V, is sufficient for testing line traps.

Note: When the trap is connected to the line, care must be taken to ensure that high induced voltage from the line is not applied to the input of the instrument. Make sure a portable ground is applied between the line trap and the line getaway.

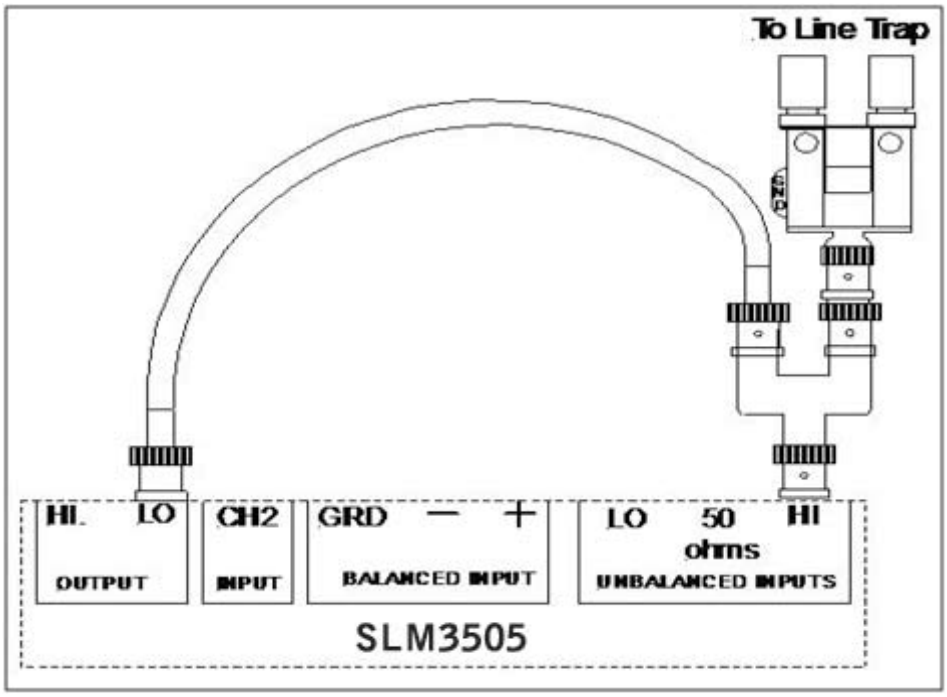


Figure 18.2 - Line Trap Test Connections

18.3 Example (LCR) Line Trap Sweep Test

Figure 18.3 shows the display where a line trap has been tuned to 200 kHz centre frequency.

Figure 18.4 displays the 'sweep setting' screen setup to sweep from 160 kHz to 250 kHz in 91 steps giving a step size of 1 kHz.

Figure 18.5 displays the graphical sweep of the line trap between 160kHz and 250kHz. It also shows the peak impedance (45.206KΩ) and the impedance at the marker frequency of (6.5014KΩ).

Figure 18.6 displays a portion of the table generated during a sweep of the line trap.

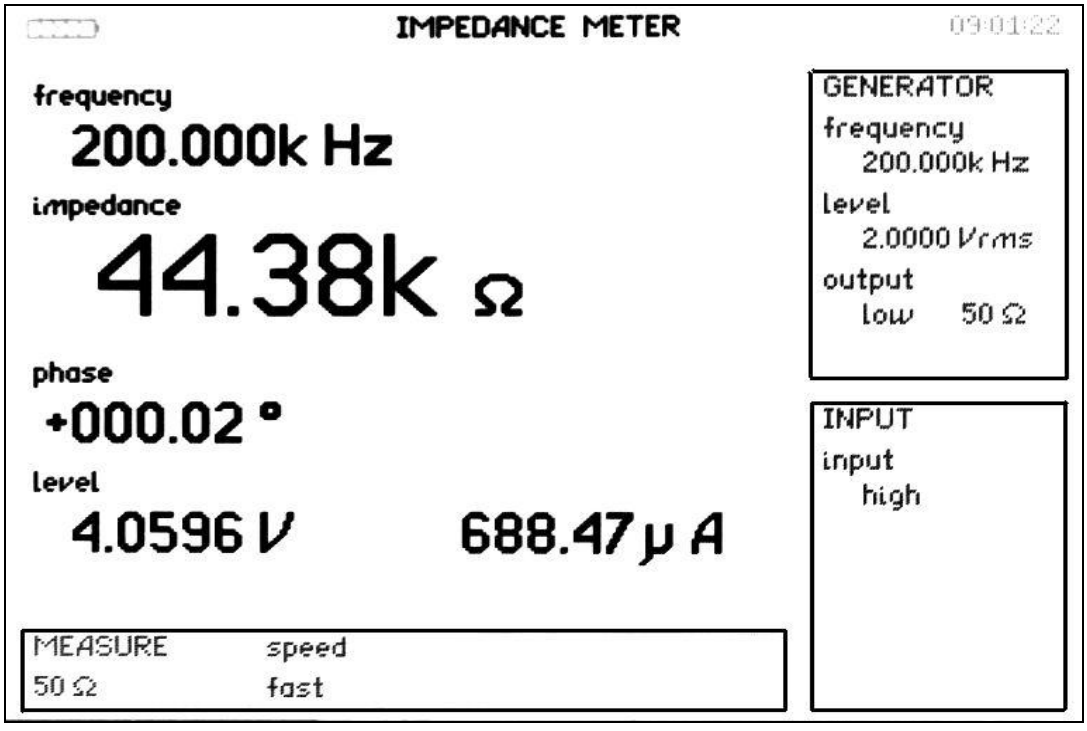


Figure 18.3 – Line Trap Impedance

SWEEP SETTINGS	
display	***real time***
sweep start	***160.000kHz***
sweep end	***250.000kHz***
sweep steps	***91***
sweep type	***linear***
sweep type	***single***
peak hold	***off***
graph scaling	***auto***
Frequency marker	***single***
Marker 1	***211.00kHz***
search for peak	***on***
start	

Figure 18.4 – Impedance Sweep Settings

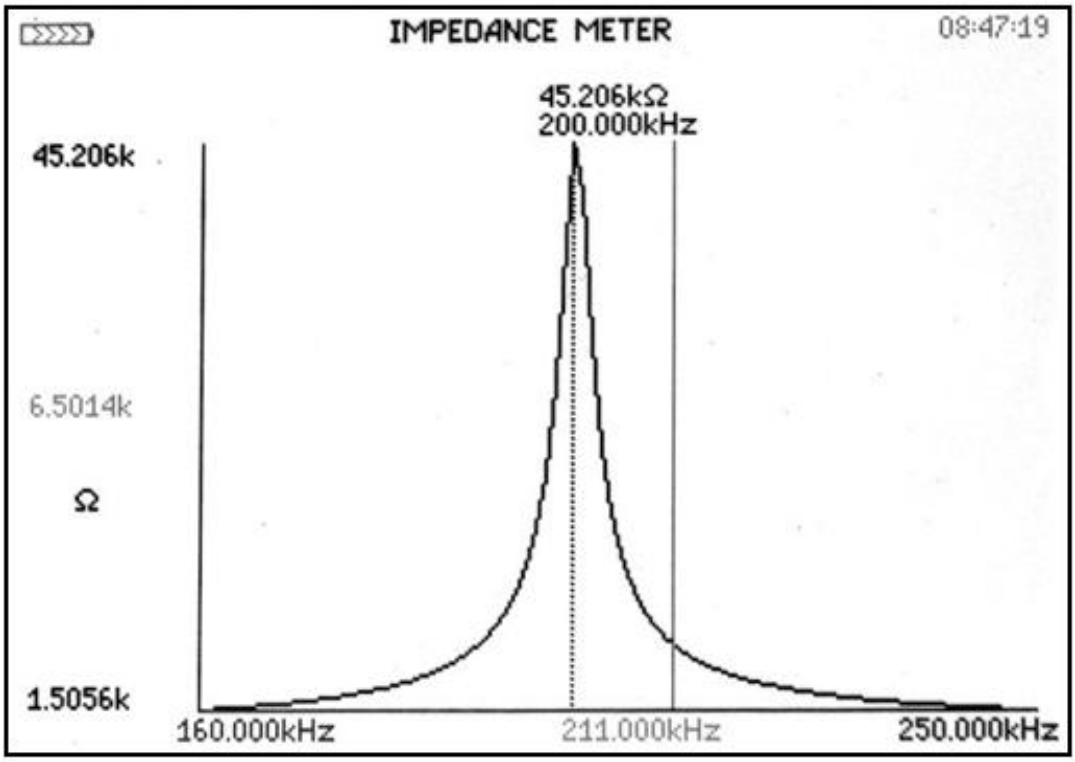
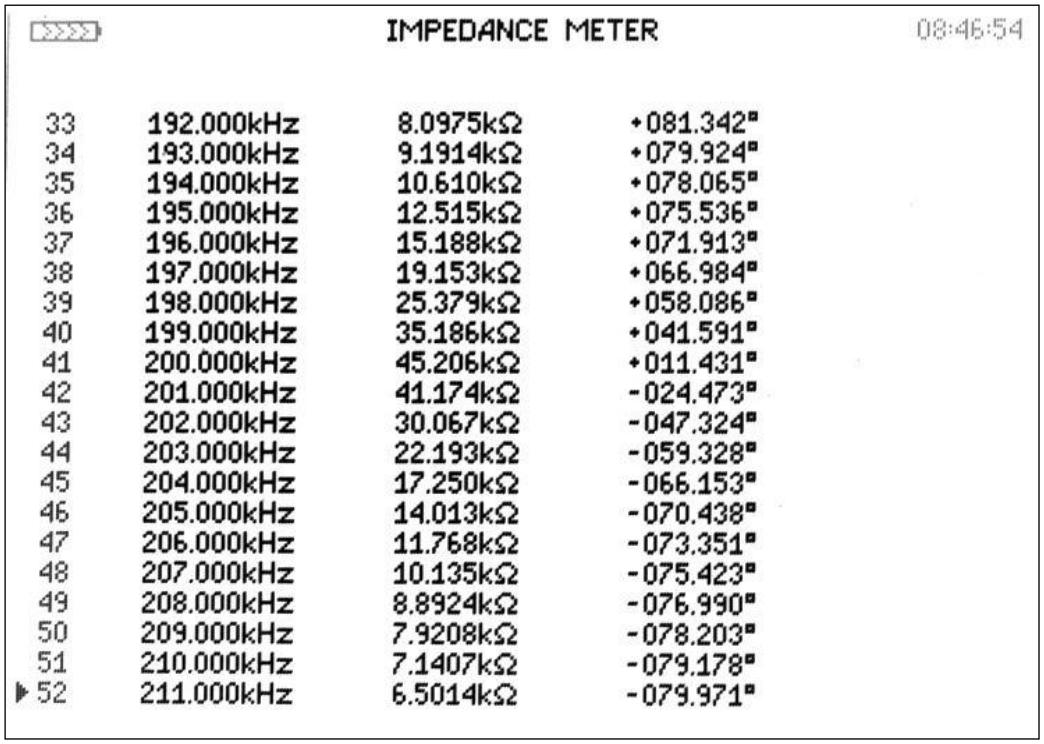


Figure 18.5 – Impedance Sweep Graph



Impedance Sweep Table

18.4 Example basic impedance (Capacitance) test setup

Figure 18.7 shows the setup for basic capacitance measurement.

<u>Measurement process setup</u>

(1) Press the "IMP" key to select impedance mode.

(2) Select the "output" menu and set the frequency to "1KHz" the low output is automatically selected in this mode. (Other options leave as default settings).

(3) Select the "input" menu and set the input to "low level". (Other options leave as default settings).

(4) Select the measure menu and set the measurement to "parallel circuit" (Other options leave as default settings).

(5) Connect the instrument and DUT capacitor as per Fig 18.7 below then revert to the main display where it will show the measured capacitance.

NOTE: The instrument here is shown upside down

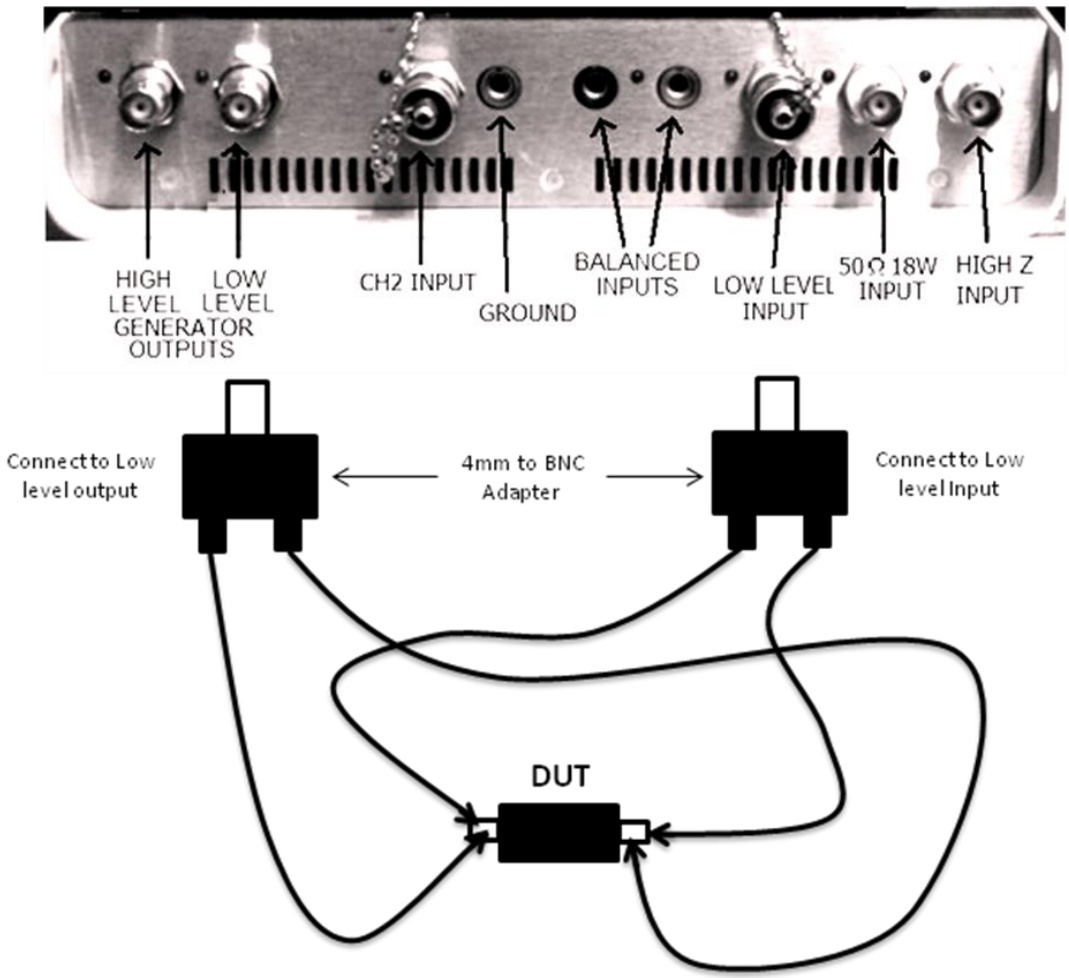


Fig 18.7

19 VOLTAGE STANDING WAVE RATIO (VSWR) MODE

The VSWR Meter is generally used to measure the standing wave ratio of a communications transmission line and associated circuitry. It is derived from the max standing wave value against the min standing wave value, therefore a ratio, but commonly expressed as a percentage. Figure 19.1 shows the VSWR mode display.

The instrument uses two different methods to make these measurements. The first method uses impedance the second uses an external directional coupler, (Option available from Newtons 4th Ltd).

The impedance method uses the signal generator as the current source and an input, (normally the "high z), to measure the voltage developed across the load. From these two values the impedance and VSWR is calculated.

The directional coupler method uses a separate piece of equipment a "Directional Coupler", plugged into the balanced inputs. The coupler is connected between the transmitter and its load and provides directly measured values of forward and reflected power from which the VSWR is calculated.

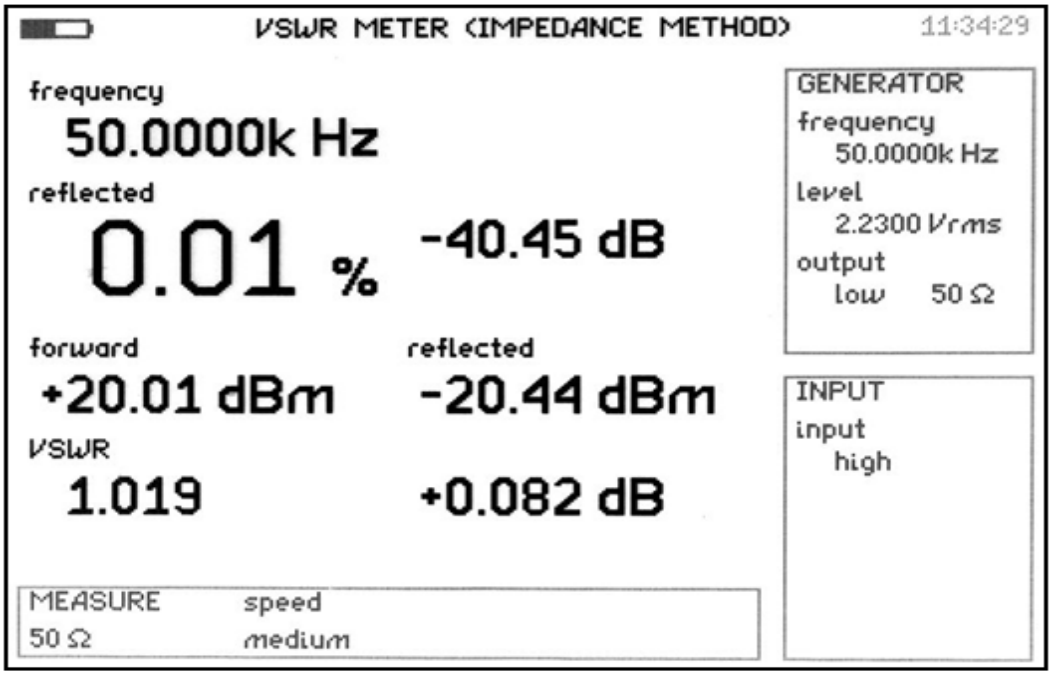


Figure 19.1 – VSWR Mode

19.1 (VSWR) Screen Display Areas

The main area shows "frequency", "reflected %", "reflected dB, "forward dBm", "reflected dBm", "vswr" and clarified as follows.

"**Frequency":** is the frequency the generator is currently running at.

"**Forward dBm & Reflected dBm"** Shows the calculated amount of forward and reflected power seen in the communication line.

"**Reflected dB"** Is the difference between the (forward dBm and reflected dBm).

"**Reflected %"** Is the result of (reflected dB/reflected dBm x 100). This is the reflected power displayed as a percentage.

"VSWR" Is shown as the calculated ratio and also expressed as a power in dB.

"Return Loss" Is shown and is expressed in dB.

The other areas are:

'**GENERATOR**' area: Displays the generator frequency, the output level and if the output is set to 'low', 'high' or "off".

'**INPUT**' area: Displays the input channel selected. When the INPUT displays anything but 'high' it is in the 'terminate' mode. The inputs available are, high Z, 50Ω 18 W, low level and balanced.

Note: when "directional coupler" is selected the input is automatically set to "balanced input"

'**MEASURE**' area: Displays the measurement impedance reference and the speed of measurement update.

19.2 Example (VSWR) Impedance Method Test

In order to take VSWR readings using the impedance method, connect the low output of the signal generator and the communication cable to the 'high Z' input.

Note: Only the 'low' output of the generator may be used to take VSWR readings in the impedance method.

Figure 19.1 shows the display screen and figure 19.2 the connections.

Ideally for a line terminated in its own characteristic impedance there is no reflection, any other impedance will result in a reflection. The calculated reflection will be ratio of the output impedance and the load impedance.

The reflection coefficient:

$$\Gamma v = \frac{ZL - Zo}{ZL + Zo}$$

The VSWR:

$$\text{VSWR} = \frac{ZL}{Zo}$$

WARNING: In this mode make sure any transmitter connected to the communication line is turned <u>OFF</u> before connecting the instrument to the cable.

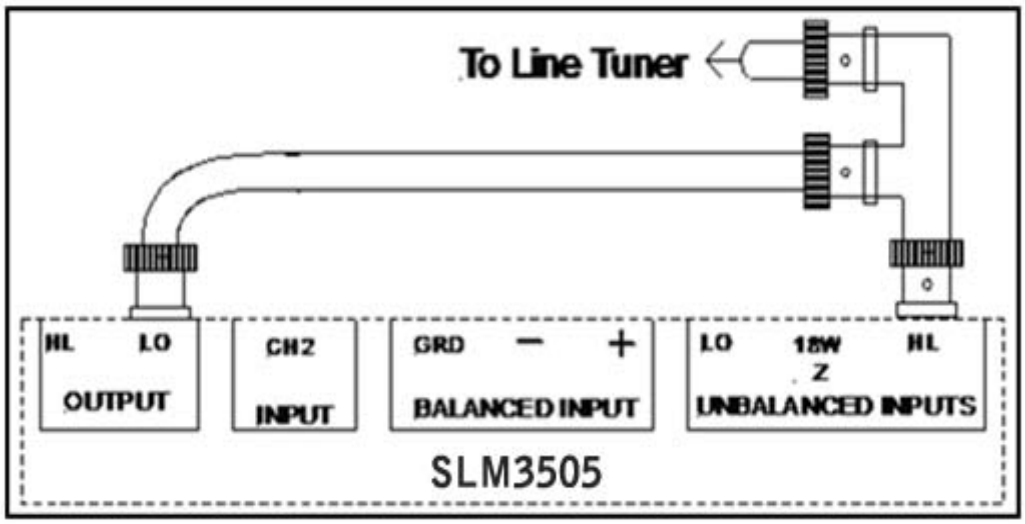


Figure 19.2 – Impedance Method Connection

19.3 Example (VSWR) Direct Coupler Method Test

The 'directional coupler' method is used to take VSWR readings using the local transmitter as the signal source.

The directional coupler input and output is connected in the communication cable between the transmitter output and the transmitter load (ie in figure 19.4 a Line Tuner).

Figure 19.3 shows the 'directional coupler' display screen and Figure 19.4 shows the directional coupler connections.

The coupler is used to measure the reflection coefficient "Γ" which in turn is used to calculate the VSWR.

The reflection coefficient:

$$\Gamma = \frac{Vrev}{Vfwd}$$

The VSWR:

$$\text{VSWR} = \frac{Vfwd+Vrev}{Vfwd-Vrev} = \frac{1+\frac{Vrev}{Vfwd}}{1-\frac{Vrev}{Vfwd}} = \frac{1+\Gamma v}{1-\Gamma v}$$

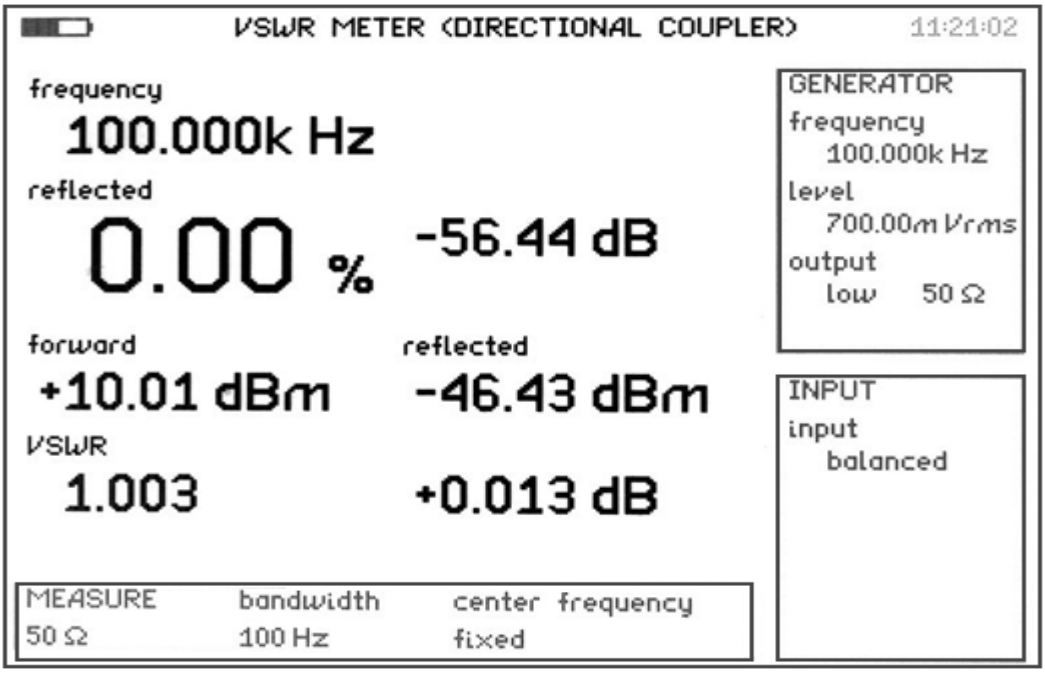


Figure 19.3 – Directional Coupler Method

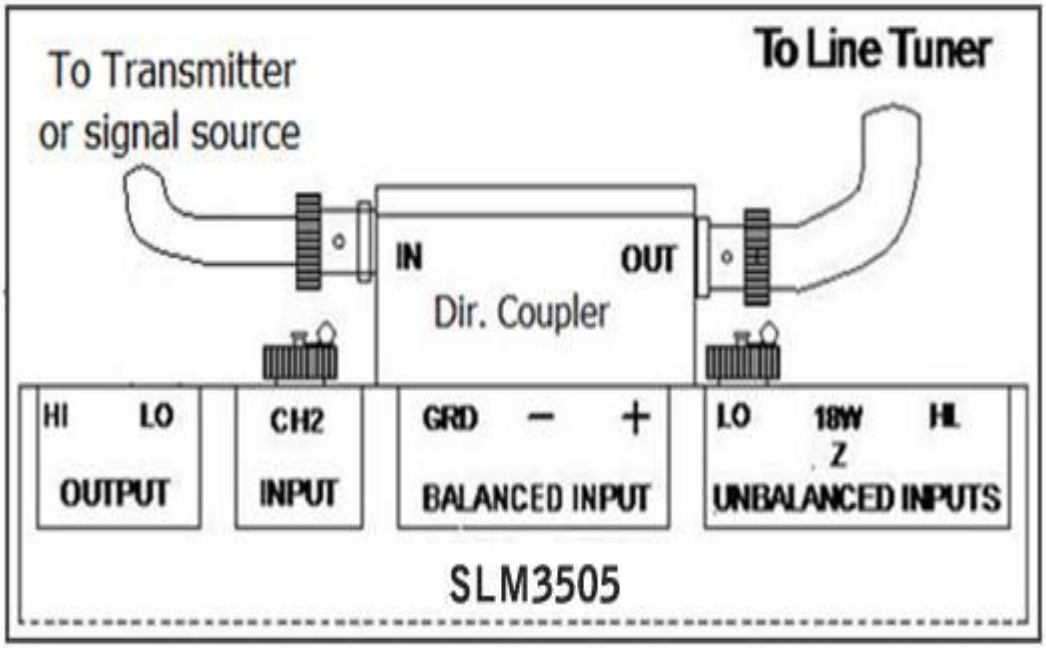


Figure 19.4 - Directional Coupler Connections

19.4 Example (VSWR) Sweep Test

The sweep function can be enabled in the 'VSWR impedance' mode. The load or (line tuner) may be swept to determine the frequency it is tuned to and the bandwidth. This information can be used to confirm that the VSWR figures comply with the system specification over the swept frequency band.

Note: The sweep function only works in the 'impedance' mode.

20 FREQUENCY RESPONSE ANALYSER (FRA) MODE

The Frequency Response Analyzer (FRA) has a frequency range of 5Hz to 5MHz and is used to measure the dynamic response of a system or piece of equipment.
A sine wave is applied to the system under test and the resulting output response is measured.

Figure 20.1 shows the Frequency Response Analyzer display screen.

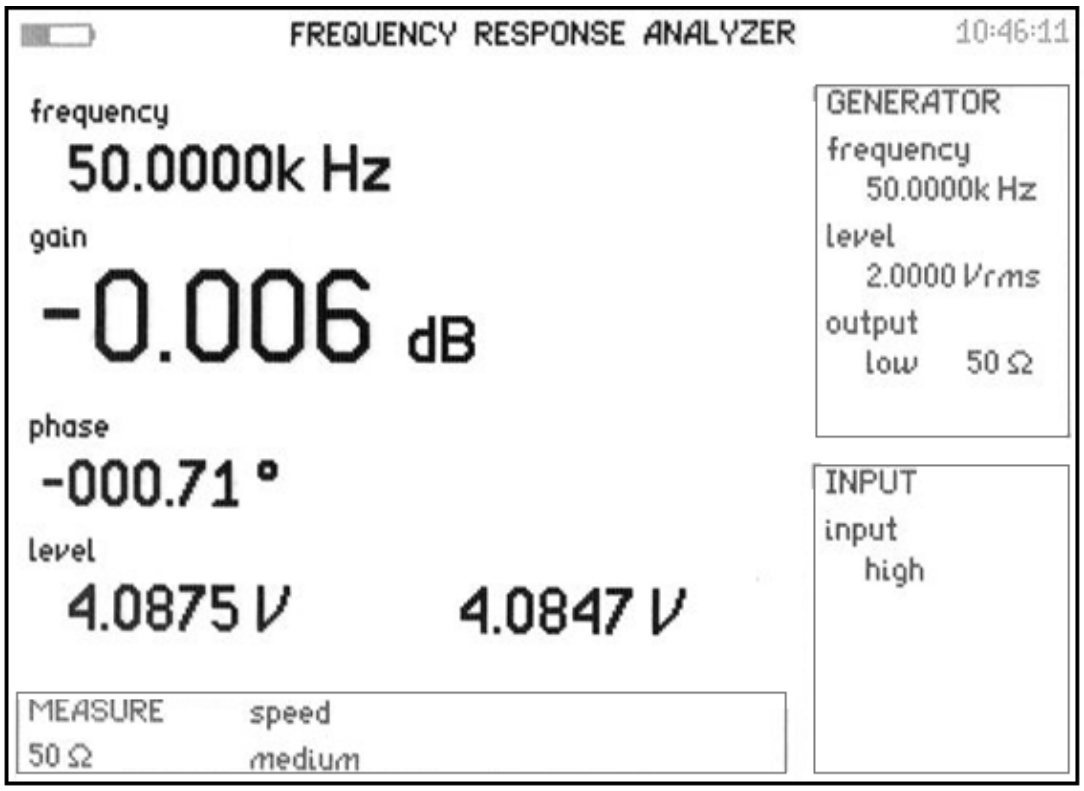


Figure 20.1 – Frequency Response Analyzer

20.1 (FRA) Screen Display Areas

The main area shows "frequency", "gain", "phase" and "delay" measurements as follows:

"**Frequency":** This is the frequency the generator has been set to.

"**Gain":** Shows the measured amplification/attenuation between the input and output.

"**Phase":** This is the relationship seen between the input and output phases.

"**Delay":** This determines the time between the input and output phases and considers this measurement to be the delay time.

"**Level":** The "bottom left" level displays the input rms voltage being fed into the system under test.

Note: The output level of the generator when connected to one of the inputs may differ to the measurement reading on the FRA display. This is apparent when the load isn't equal to the generator impedance setting.

"**Level":** The "bottom right" level displays the output rms voltage from the system under test.

The other areas are:

'**GENERATOR**' area: Displays the generator frequency, the output level and if the output is set to 'low', 'high' or "off".

'**INPUT**' area: Displays the input channel selected. When the INPUT displays anything but 'high' it is in the 'terminate' mode. The inputs available are, high Z, 50Ω 18 W, low level and balanced.

'**MEASURE**' area: Displays the measurement impedance reference and the speed of measurement update.

20.2 Example (FRA) Test

To apply a frequency response/phase gain test to a piece of equipment the normally "low" generator output is connected to the "High z" input of the instrument and to the input of the system under test.

The system under test output is then applied to the instrument "CH2". Measurements are then displayed showing the gain, phase etc seen between the two waveforms.

Caution: Do not use the '*balanced input*' in FRA applications. Only use the '*HI ∞*' input and '*CH2*' input, being aware that '*CH2*' input is only rated at ±10v pk. However the 'HI ∞' input can be used up to ±300v pk.

(FRA) Sweep

A sweep can be set up to measure a dynamic frequency or phase/gain system response over a chosen frequency bandwidth.

This is instigated using the sweep function and can be displayed as a table or graph to show the system characteristics over the frequency band.

The DFT technique can measure phase as well as magnitude and is inherently good at rejecting noise. By computing the gain and phase at a number of points over a frequency range gives results that show a graph on the display.

The DFT analysis yields two components – in-phase and quadrature, or 'a' and 'b' values – from which the magnitude and phase can be derived. The fundamental in-phase and quadrature values of a periodic waveform, v(∅), are given by:

$$a_1 = 1/2\pi \int_0^{2\pi} V(\emptyset).\cos(\emptyset)\, d\emptyset$$

$$b_1 = 1/2\pi \int_0^{2\pi} V(\emptyset).\sin(\emptyset)\, d\emptyset$$

For a sampled signal, the formulae become:

$$a_1 = 1/n \sum_{i=0}^{i=n-1} v[i].\cos(2\pi ci/n)$$

$$b_1 = 1/n \sum_{i=0}^{i=n-1} v[i].\sin(2\pi ci/n)$$

Where n is the number of samples for an integral number of complete cycles of the input waveform, and c is the number of cycles.

Having computed the real and quadrature components, the magnitude and phase of each channel can be derived:

$mag = \sqrt{(a_1^2 + b_1^2)}$

$\theta = \tan^{-1}(b_1/a_1)$

The relative gain and phase of the circuitry under test at that particular frequency is derived from the real and quadrature components by vector division:

vector gain = (a + jb) {ch2} / (a + jb) {ch1}

gain = magnitude (vector gain)

phase = $\tan^{-1}$(b/a (vector gain))

The gain is usually quoted in dB:

$dB = 20 \log_{10}(gain)$

21.1 Bit Error Rate

The Bit Error Rate (BER) functionality of the SLM3505 allows diagnosis of signal problems in the field. Bit Error Rate is the ratio between the number of bit errors transmitted and the number of bits received.

BER = Number of Error Bits / Number of Bits Transmitted

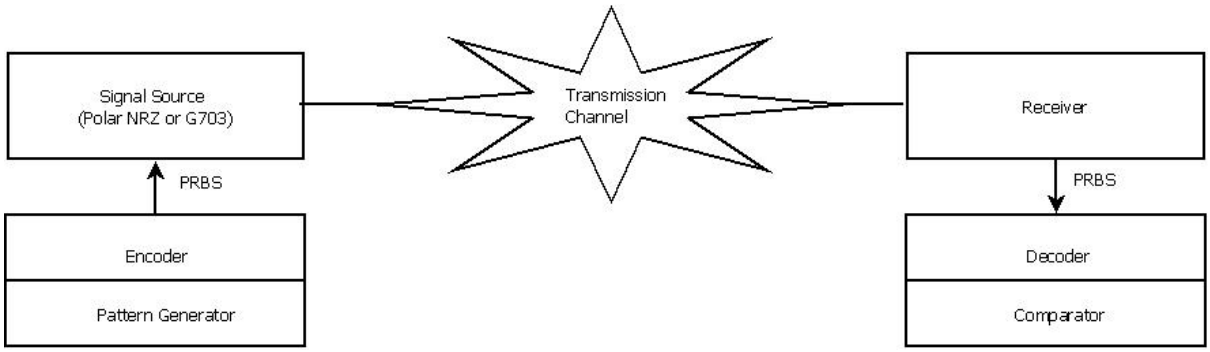
The Bit Error Rate test involves sending a Pseudo-Random Binary Sequence (PRBS), a sequence of binary 1's of 0's which exhibits certain randomness and autocorrelation properties. The PRBS bit sequence is used in testing transmission lines equipment because of their randomness properties.

When BER mode is enabled, the system expects to receive the same pattern that it's transmitting. The total number of bits transmitted, error bits and the BER (%) is displayed on the screen.

The Bit Error Rate tester consists of two Modules:

a) PRBS Generator

b) PRBS Receiver



21.2 Theory of Operation

The Bit Error Rate test involves sending a Pseudo-Random Binary Sequence (PRBS). A Pseudo-Random binary sequence is a periodic, deterministic signal with properties similar to white noise. A PRBS is like a long recurring decimal number – it looks random if you look at a short piece of the sequence, but it actually repeats itself every m bits (see section 1.3).

The PRBS signal is generated using a shift register and an XOR gate.

The Bit Error Rate Module consists of 2 modules:

a) **PRBS generator:** The PRBS bit-patterns are generated in a linear feedback shift register. The user has the ability to select the required bit pattern sequence (see section 1.3) for different bit patterns. Each bit pattern sequence will have a PRBS shift register length (X) which will be described in section 1.3.

b) **PRBS Receiver:** The receiver has signaling output for synchronization state, synchronization loss and bit errors.

   The receiver is synchronized when 2*X (X=PRBS shift register length) error free bits are received. The receiver will begin counting the number of bytes received when the receiver is synchronized and will continue counting even when the receiver loses sync.

   The receiver loses synchronization when the error rate over the last 128 bits exceeds 20%. To detect this level, the bit errors during the last 128 received bits are memorized. If there are more than 25 errors within these 128 bits, the receiver loses sync.

   The number of error bit is incremented when a bit error in the received bit sequence is detected.

21.3 PRBS Test Patterns

The Pseudo-Random test patterns generated by the SLM3505 conform to the ITU-T standards O.150, O.151, O.152 and O.153. The tabel below describes the test patterns supported by the SLM3505.

PRBS Type	PRBS Shift Reg Length (X)	No OF Bits (m)	Standard	Suggested Data Rate (Kbps)
2^9 – 1	9	512	ITU-T O.150/O.153	Upto 14.4
2^11 - 1	11	2047	ITU-T O.150/O.152 /O.153	64, n*64 (n=1..31)
2^15-1	15	32767	ITU-T O.150/O.151	1544, 2048, 6312, 8448, 32064, 44736
2^20-1	20	1048575	ITU-T O.150/O.151	1544, 6312, 32064, 44736

Table 1: PRBS Patterns

21.4 BER Send Mode

2 Modes, namely, "Fixed" and "Continuous". Fixed mode involves sending a fixed number of bits. This mode is not currently implemented. Only continuous mode is enabled.

21.5 BER Transmit Mode

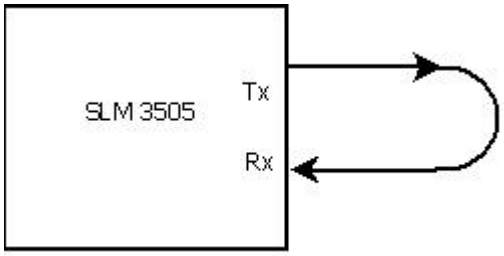
The BER module currently supports 2 types of line codes, namely, "normal" and "G703" mode.

G703 Mode (64kb/s codirectional interface): In this mode, the 64kb/s period is divided into four unit intervals. A binary 1 is coded as a block of "1100" and a binary 0 is coded as a block of "1010". The binary signal is converted into a 3-level signal by alternating the polarity of consecutive blocks. The alternation in polarity of blocks is violated every 8^{th} bit. The current release represents a binary 1 with a +/- 1V and a 0 with 0V. The nominal bit rate is 256 Kb/s with a test load impedance of 120 ohms.

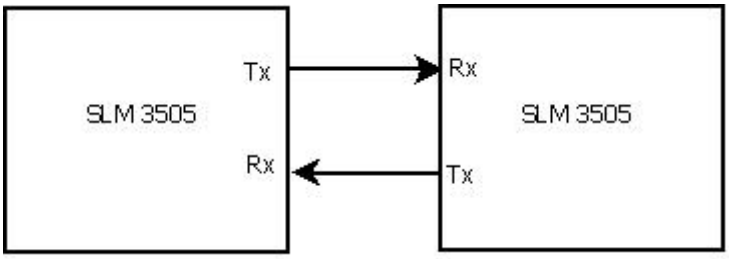
21.6 BER Test Mode

The BER module has 4 test modes namely "Transmit and Receive", "Transmit", "Receive" and "Loopback Mode".

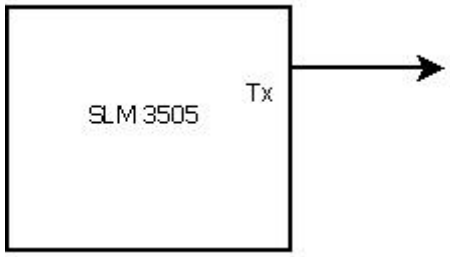
In transmit and receive mode, the PRBS generator and the receiver is enabled.



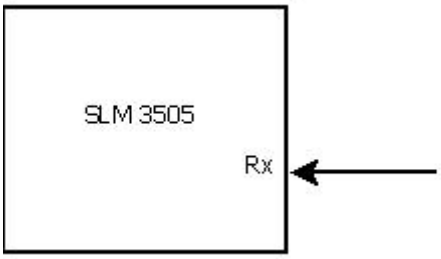
However, in this mode, 2 SLMs will be able to communicate with each other as shown below.



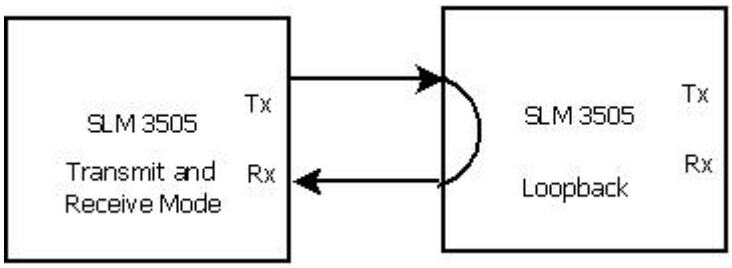
In transmit mode, the PRBS generator is enabled and the receiver is disabled.



In receive mode, the PRBS generator is disabled and the receiver is enabled.

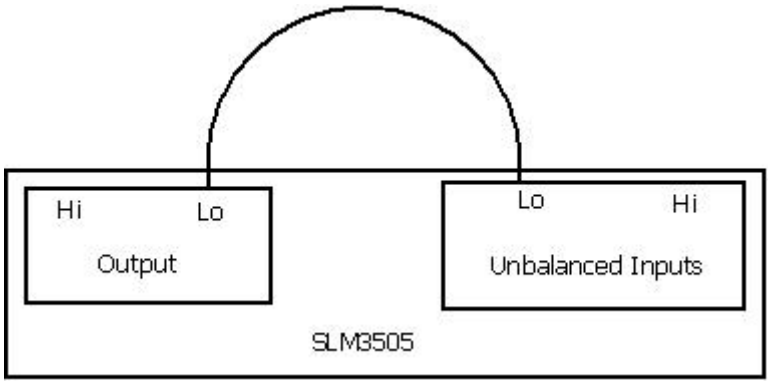


Loopback Mode (**currently disabled**)



21.7 BER Test Setup

The drawing in the figure below shows the connections necessary to perform the BER test using the 'low'.



21.8 Measure Menu

The measure menu shows "Mode", "Pattern", "BER Send Mode", "BERT Mode", "BER Transmit Mode", "Output", "Input" and "Amplitude Control" as follows:

"**Mode":** current mode, i.e., Bit Error Rate Mode

"**Pattern":** Has 4 options, namely, "2^9-bits", "2^11-bits","2^15-bits" and "2^20-bits"

"**BER Send Mode":** Has 2 options, "fixed" and "continuous" **Note:** Fixed Mode not currently implemented

"**BERT Mode":** Has 4 options, "Transmit and Receive Mode", "Transmit Mode", "Receive Mode" and "Loopback Mode" **Note:** Loopback Mode not currently implemented

"BER Transmit Mode": Has 2 options, "Normal Mode" and "G703 Mode"

"Output Mode": controls the relevant output connection and has 3 options, namely, "off", "low" and "high". **Note:** High Output Mode not currently implemented

21.9 (BER) Screen Display Area

The main area shows "Total Bits Transmitted", "No of Error Bits", "Total Bits Received", "BER (%)", "BER (Last 128 bits)" and "Synchronized / No Sync" as follows:

"**Total Bits Transmitted":** is the total number of bits transmitted by the SLM3505

"**No. Of Error Bits":** Shows the number of bit errors detected

"**Total Bits Received":** Shows the total number of bit received

"**BER %":** Shows the bit errors that were detected versus the total number of test bits received since the test started

"BER (Last 128 Bits)": The screen shows "less than 0.2" if the error rate exceeds 20% in the last 128 bits. If there are more than 25 errors within the last 128 bits, then the BER shows less than 0.2.

If the error rate is less than 20% in the last 128 bits, the screen will "show greater than 0.2"

"Synchronized / No Sync": The screen shows "No Sync" if the error rate exceeds 20% in the last 128 bits. If there are more than 25 errors within the last 128 bits, then the BER shows less than 0.2.

If the error rate is less than 20% in the last 128 bits, the screen will "Synchronized".

The "Synchronized / No Sync" indicator is large and easy for inspectors to read.

21.10 (BER) Keypad Operation

Press the HOME/ESC key at any time to abort the present activity and restart the BER test

22 Technical Specification

SELECTIVE LEVEL METER				
Frequency Range	5HZ to 5MHz			
Frequency Accuracy	±0.03% over all temperature range			
Magnitude Accuracy	<1KHz: 0.05% mg + 0.05% rdg + 50uV <10KHz: 0.05%mg + 0.05% rdg + 0.01%/KHz + 50uV <5MHz: 0.05%mg + 0.25% rdg + 0.001%KHz + 50uV			
Inputs (Unbalanced) Type & Connection	Differentially isolated & Isolated BNC			
Pass Bandwidth Frequency Range Settings	1Hz, 3Hz, 25Hz, 100Hz, 1.95K, 3.1K, (Wide)			
Frequency Setting	All frequencies to 6 digit resolution			
Frequency Acquisition	Single and 3 stage frequency acquisition			
Level Meter Accuracy	±0.01dB			
Frequency Synchronization	Auto Sync between meter and generator			
Selectivity	**Narrow**	25Hz	**Wide**	3.1KHz
Pass bandwidth (@a ≤ 0.5dB)	±4Hz		±480Hz	
Pass bandwidth (@a = 3dB)	= 12Hz		= 1.5KHz	
Stop Band Attenuation (@a ≥ 30dB)	±240Hz			
Stop Band Attenuation (@a ≥ 60dB)	±6KHz			
High Voltage Input				
Max Input	±300v Peak			
Input Impedance	1MΩ ±5% // 30pf			
50Ω Input				
Max Input	18W (30v rms)			
Input Impedance	50Ω ±1% // 30pf			
Low Level Input				
Max Input	±10v Peak			
Input Impedance	50Ω ±1% // 30pf 75Ω ±1% // 30pf 600Ω ±1% // 30pf 1MΩ ±5% // 30pf			
Input (Balanced)				
Max Input	±10v Peak			
Input Impedance	50Ω ±1% // 30pf 75Ω ±1% // 30pf 600Ω ±1% // 30pf 1MΩ ±5% // 30pf			
Input Type	Differential			
Input Connection	3 x 4mm Connectors – Positive, Negative & Gnd			
Second Input				
Channel 2 (CH2)	±10v Peak 1MΩ ±5% // 30pf			

SIGNAL GENERATOR	
Generator Type	Direct Digital Synthesis (DDS), Single Frequency or sweep
Generator Waveforms	Sinewave, Square, Triangle, White Noise
Frequency Accuracy	±5ppm over all temperature range (6 digit resolution)
Magnitude Accuracy	±1% ±1%/MHz (4 digit resolution)
High Level Output	
Frequency range	10KHz to 5MHz
Output Level	2W into 50Ω (10v rms)
Output Impedance	50Ω ±2% 75Ω ±2% (Option)
Low Level Output	
Frequency range	5Hz to 5MHz
Output Level	5Vrms into high impedance
Output Impedance	50Ω ± 2% max +24dBm 75Ω ± 2% max +22dBm 600Ω ± 2% max +15dBm
Frequency shift delay timer	0 to 1s (1ms steps)
IMPEDANCE ANALYZER	
Impedance Range	100mΩ to 100KΩ
Accuracy	<10KHz: 1%rdg <1MHz: 1%rdg + 0.005%/KHz + 50uV <5MHz: 5%rdg + 0.002%/KHz + 50uV
Frequency Range	5Hz to 5MHz
Features	LCR Measurements (Inductance, Capacitance, Resistance, Tan delta QF). Lead compensation (Zero lead function). Impedance versus frequency curve.
OSCILLOSCOPE	
Sample Rate	5 Msamples/S
Timebase	5µs/div to 5s/div
Trigger	Auto, Normal, or Single shot
Pretrigger	None, 25%, 50%, 75%
Input Ranges	As Selective level Meter
Second Input (CH2)	±10v Peak 1MΩ ±5% // 30pf

VSWR METER	
Accuracy	1% of reading from 5Hz up to 1MHz 5% of reading above 1MHz to 5MHz for power measurements (forward & reflected) at VSWR=3
Features	Forward Power Reflected Power % Reflected Power Frequency under test visible on one screen
FREQUENCY RESPONSE ANALYSER	
Frequency Range	5Hz to 5MHz
Gain Accuracy dB	0.02dB < 1KHz 0.05dB < 10KHz 0.1dB + 0.001dB/KHz
Phase Accuracy°	0.02° < 10KHz 0.02° + 0.003°/KHz
GENERAL SPECIFICATIONS	
Sweep Steps	Up to 2000 steps in all sweep functions
Set-up and Data Storage	Up to 1000 analyzer setups, readings and sweep results can be stored.
Interface	USB, RS232, LAN
Real Time Clock	Time and date stamp for data stores
Data Storage	Internal 1Gb flash, external USB pen port
Display and Resolution	¼ VGA Colour, 6 digit frequency, 5 digit voltage, 4 digit dBm
Power Source	9 – 18v @ 3A AC adapter or 12v dc from vehicle or external batteries
Battery Type and capacity	3 x Lithium polymer (up to approx 2 hours)
Temperature Range	-5°C to +50°C

23. Appendix A – Text File Format

Saving test results generates two files. The file name is represented by the number location chosen (1-999) from the 'PROGRAM STORE/RECALL' menu. For example, if the file location chosen is: 11, the files generated would be PCA_R011.pcs and PCA_R011.txt.Each file has the same name but different extensions. The first file with the .pcs extension name is the file that the instrument uses to display the test results when that file is recalled.

The second file is a comma delimited text file (CSV) and may be viewed using any text editing/viewing program. The text file has two parts, the header section and the data/results section. The header includes the status of the instrument at the time the test results were taken. This information includes all three USER data inputs from the 'USER SETTINGS' menu, the file name, time and date stamp, serial number, last calibration date and other pertinent information.

The data may be imported into Excel or other programs that can access comma delimited files. Section 21.1 is the header information from a sample impedance sweep file. The information in the header is explained in the '**Header Format'** following the example file.

Note: The header information varies based on the setup of the instrument.

24.1 Example Text File

NEWTONS4TH LTD
Instrument,type,SLM3505
,serial number,1216
,firmware version,2.13
,calibration,10_DEC_2008_1029_SBC
User ID
,user name 1,PowerComm Solutions
,user name 2,
,user name 3,John Doe
Record,file name,PCA_R011.TXT
,name,Test
,datestamp (mmddyyyy),05262009
,timestamp,1132
measurement settings,mode,impedance meter
,measurement,impedance magnitude
,speed,medium
,filter,normal
generator settings,amplitude control,V
,low output amplitude, 2.0000E+00,Vrms
,amplitude step, 1.1000E+00
,fsk control,disabled
,generator frequency, 5.0000E+04,Hz
,frequency step, 1.0000E+02,Hz
,waveform,sinewave
,output,low
,output impedance,50 Ohms
input settings,input,high Z
,scale factor, 1.0000E+00
,CH1 input ranging,full autorange
sweep settings,display,graph
,sweep start, 3.0000E+04,Hz
,sweep end, 5.0000E+05,Hz
,sweep steps,32
,sweep type,linear
,sweep type,single
,graph scaling,auto
,marker,off
,search for peak,off

24.2 Text File Header Format Explanation

1. The first line 'NEWTONS4TH LTD' is the name of the company that manufactures the instrument and is embedded in the firmware.

2. Lines two to five are the serial number of the instrument, manufacturing code, firmware release versions and date of last calibration. This information is accessed by pressing the 'SYSTEM' key and the 'LEFT ARROW' key.

3. Lines six to nine are the 'user data' area. This information is accessed by pressing the 'SYSTEM' key and the 'RIGHT ARROW' key.

4. Lines ten to thirteen are from the 'PROGRAM STORE/RECALL' menu. These lines provide the number (000 to 999) of the file (location), the name of the file and the date and time stamp that was provided at the time the data was saved in the instrument.

5. Lines 14 to 17 are from the 'MEASUREMENT SETTINGS' menu. These lines provide the mode the instrument was in when the data was acquired, how the measurement was taken and the speed and filter settings.

6. Lines 18 to 26 are the 'GENERATOR SETTINGS'. These lines provide the settings of the generator at the time the data was acquired.

7. Lines 27 to 29 are the 'INPUT SETTINGS'. These lines provide the input settings at the time the data was acquired.

8. Lines 30 to 38 are the ''SWEEP SETTINGS'. These lines provide the input settings at the time the data was acquired.

24.3 Text File Example Sweep Data

The data portion of the file starts at 'Results, sweep data'. This example is an impedance sweep. There are five columns of data: Frequency (Hz), Impedance (Ohms), Phase (degrees), Resistance (Ohms) and Reactance (Ohms).

The two columns Frequency and Impedance may be used in Excel to plot a frequency versus impedance graph. All information is given in scientific notation.

In this example the frequency starts at 150 kHz and goes to 210 kHz. The impedance starts at 252 ohms and goes to a peak impedance of 6700 ohms and then down to 235 ohms. Note: the the headers and columns do not line up.

```
Results,sweep data
Frequency(Hz),Impedance(Ohm),Phase(deg),Resistance(Ohm),Reactance (Ohm)
 1.5000E+05, 2.5299E+02, 8.9272E+01, 1.9924E+04, 2.5301E+02
 1.5122E+05, 2.6595E+02, 8.9195E+01, 1.8921E+04, 2.6597E+02
 1.5245E+05, 2.8018E+02, 8.9104E+01, 1.7916E+04, 2.8021E+02
 1.5367E+05, 2.9589E+02, 8.8996E+01, 1.6897E+04, 2.9594E+02
 1.5490E+05, 3.1331E+02, 8.8875E+01, 1.5960E+04, 3.1337E+02
 1.5612E+05, 3.3274E+02, 8.8739E+01, 1.5113E+04, 3.3282E+02
 1.5735E+05, 3.5461E+02, 8.8583E+01, 1.4334E+04, 3.5471E+02
 1.5857E+05, 3.7929E+02, 8.8400E+01, 1.3579E+04, 3.7944E+02
 1.5980E+05, 4.0746E+02, 8.8190E+01, 1.2898E+04, 4.0767E+02
 1.6102E+05, 4.4011E+02, 8.7904E+01, 1.2031E+04, 4.4040E+02
 1.6225E+05, 4.7794E+02, 8.7612E+01, 1.1468E+04, 4.7835E+02
 1.6347E+05, 5.2246E+02, 8.7259E+01, 1.0924E+04, 5.2306E+02
 1.6469E+05, 5.7575E+02, 8.6835E+01, 1.0430E+04, 5.7663E+02
 1.6592E+05, 6.4062E+02, 8.6313E+01, 9.9621E+03, 6.4195E+02
 1.6714E+05, 7.2129E+02, 8.5656E+01, 9.5223E+03, 7.2337E+02
 1.6837E+05, 8.2443E+02, 8.4810E+01, 9.1143E+03, 8.2782E+02
 1.6959E+05, 9.6025E+02, 8.3673E+01, 8.7134E+03, 9.6614E+02
 1.7082E+05, 1.1480E+03, 8.2109E+01, 8.3617E+03, 1.1589E+03
 1.7204E+05, 1.4224E+03, 7.9769E+01, 8.0082E+03, 1.4454E+03
 1.7327E+05, 1.8611E+03, 7.5908E+01, 7.6439E+03, 1.9189E+03
 1.7449E+05, 2.6516E+03, 6.8864E+01, 7.3535E+03, 2.8428E+03
 1.7571E+05, 4.3198E+03, 5.2361E+01, 7.0735E+03, 5.4552E+03
 1.7694E+05, 6.7700E+03, 6.1537E+00, 6.8092E+03, 6.3152E+04
 1.7816E+05, 4.6626E+03,-4.4704E+01, 6.5601E+03,-6.6282E+03
 1.7939E+05, 2.8250E+03,-6.3450E+01, 6.3203E+03,-3.1581E+03
 1.8061E+05, 1.9707E+03,-7.1084E+01, 6.0789E+03,-2.0832E+03
 1.8184E+05, 1.5017E+03,-7.5157E+01, 5.8618E+03,-1.5535E+03
 1.8306E+05, 1.2105E+03,-7.7630E+01, 5.6503E+03,-1.2393E+03
 1.8429E+05, 1.0138E+03,-7.9289E+01, 5.4552E+03,-1.0318E+03
 1.8551E+05, 8.7227E+02,-8.0463E+01, 5.2643E+03,-8.8450E+02
 1.8674E+05, 7.6550E+02,-8.1345E+01, 5.0871E+03,-7.7432E+02
 1.8796E+05, 6.8228E+02,-8.2022E+01, 4.9162E+03,-6.8895E+02
```

1.8918E+05, 6.1556E+02,-8.2563E+01, 4.7553E+03,-6.2078E+02
1.9041E+05, 5.6086E+02,-8.3000E+01, 4.6022E+03,-5.6507E+02
1.9163E+05, 5.1521E+02,-8.3355E+01, 4.4521E+03,-5.1870E+02
1.9286E+05, 4.7641E+02,-8.3605E+01, 4.2773E+03,-4.7939E+02
1.9408E+05, 4.4332E+02,-8.3859E+01, 4.1438E+03,-4.4587E+02
1.9531E+05, 4.1459E+02,-8.4073E+01, 4.0149E+03,-4.1682E+02
1.9653E+05, 3.8945E+02,-8.4259E+01, 3.8935E+03,-3.9142E+02
1.9776E+05, 3.6727E+02,-8.4421E+01, 3.7777E+03,-3.6902E+02
1.9898E+05, 3.4753E+02,-8.4561E+01, 3.6662E+03,-3.4910E+02
2.0020E+05, 3.2988E+02,-8.4684E+01, 3.5609E+03,-3.3131E+02
2.0143E+05, 3.1396E+02,-8.4787E+01, 3.4556E+03,-3.1526E+02
2.0265E+05, 2.9957E+02,-8.4880E+01, 3.3566E+03,-3.0077E+02
2.0388E+05, 2.8649E+02,-8.4962E+01, 3.2622E+03,-2.8760E+02
2.0510E+05, 2.7451E+02,-8.5035E+01, 3.1716E+03,-2.7555E+02
2.0633E+05, 2.6356E+02,-8.5098E+01, 3.0842E+03,-2.6452E+02
2.0755E+05, 2.5345E+02,-8.5156E+01, 3.0014E+03,-2.5436E+02
2.0878E+05, 2.4412E+02,-8.5210E+01, 2.9231E+03,-2.4497E+02
2.1000E+05, 2.3547E+02,-8.5255E+01, 2.8464E+03,-2.3628E+02

25. Appendix B – Contact Details

Please direct all queries or comments regarding the KinetiQ instrument or manual to:

Newtons4th Ltd.

30 Loughborough Rd.

Mountsorrel

LOUGHBOROUGH

LE12 7AT

United Kingdom

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E-mail address: sales@newtons4th.com

office@newtons4th.com

web site: www.newtons4th.com

At Newtons4th Ltd. we have a policy of continuous product improvement and are always keen to hear comments, whether favourable or unfavourable, from users of our products.

An example comment form can be found at the end of this manual – if you have any comments or observations on the product please fill a copy of this form with as much detail as possible then fax or post it to us.

Alternatively send an e-mail with your comments.

SLM3505 comments		
serial number:	main release: dsp release: fpga release: boot release: (press SYS then LEFT)	date:
your contact details:		
comments:		
detailed description of application or circumstances:		
Please post or fax to Newtons4th Ltd.		