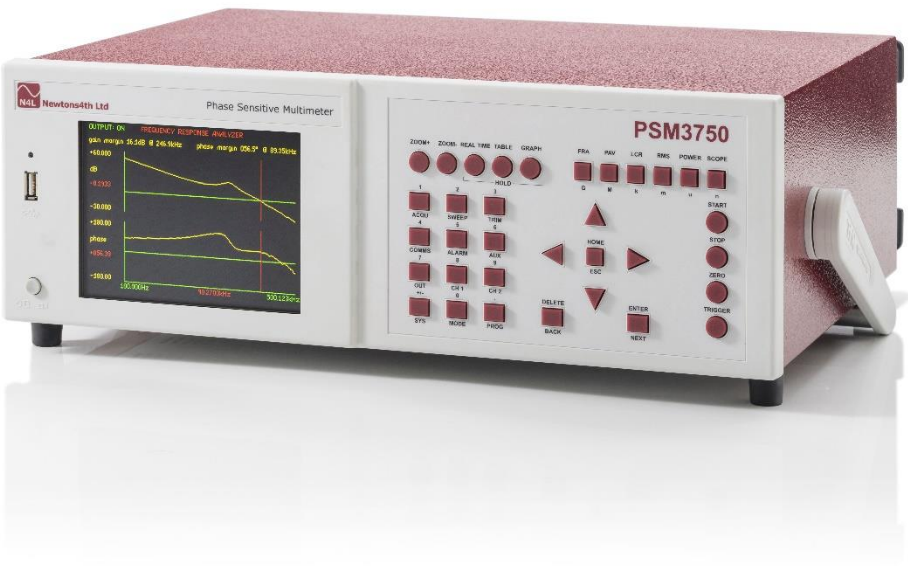
N4L Newtons4th Ltd

PSM 3750

Frequency Response Analyzer

User manual



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Safety

Important safety Information

This manual contains important information that must be followed to ensure the safety of all operatives and both this instrument and any accessories attached.

General Safety Information

Use the product only as detailed in this manual. Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. Carefully read all instructions. Retain these instructions for future reference.

For correct and safe operation of this instrument, it is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The product is designed to be used by trained personnel only it is designed to comply with BSEN 61010-1 (Safety requirements for electrical equipment for measurement, control, and laboratory use)

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.

The inputs and outputs must not be connected to common mode signals greater than 500V peak.

The inputs must not be connected to signals greater than 500V peak.

Input Connections:

It is critical that the 4mm inputs and BNC inputs on each PSM input channel are not connected to any external circuit at the same time.

You MUST only use EITHER the 4mm OR the BNC connection – NOT both, this applies to both Voltage and Current inputs.

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.

The cover(s) should not be removed to attempt repair, maintenance, or adjustment, as this instrument contains no user serviceable parts. All repairs, maintenance or adjustment should only be caried out by Newtons4th Ltd or our official distributor.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

When incorporating this equipment into a system, the safety of that system is the responsibility of the assembler of the system.

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.

To avoid fire or personal injury
Use the correct mains lead. Use only the mains lead supplied with this product and certified for the country of use.

Ground the instrument. This instrument is grounded through the grounding conductor of the mains lead. To avoid electric shock, the grounding conductor **must** be connected to earth ground. Before making connections to the input or output terminals of the instrument, ensure that the instrument is properly grounded.

Power disconnect. Do not position the instrument so that it is difficult to disconnect the mains lead; it must always remain accessible to the user to allow for quick disconnection if needed in an emergency.

Connect and disconnect properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source. Use only insulated voltage probes, test leads, and accessories supplied with the product, or indicated by Newtons4th Ltd. to be suitable for the product.

Observe all terminal ratings. To avoid fire or shock hazard, observe all rating and markings on the instrument. Consult the specifications in this user manual for further ratings information before making connections to the product. Do not exceed the Measurement Category (CAT) rating and voltage or current rating of the lowest rated individual component of a product, probe, or accessory. Use caution

when using 1:1 test leads because the probe tip voltage is directly transmitted to the instrument.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Do not operate with suspected failures. If you suspect that there is damage to this instrument, have it inspected by Newtons4th Ltd or our official distributor. Do not use the instrument if it is damaged or operates incorrectly. If in doubt about safety of the instrument, turn it off and disconnect the mains lead. Clearly mark the instrument to prevent its further operation. Before use, inspect voltage probes, test leads, and accessories for mechanical damage and replace when damaged. Do not use probes or test leads if they are damaged.

Use proper fuse. Use only the fuse type and rating specified for this product.

Do not operate in wet/damp conditions. Be aware that condensation may occur if a unit is moved from a cold to a warm environment.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry. Remove the input signals before you clean the product, only use a dry cloth for cleaning. Do not use chemicals or cleaning products on this instrument.

Provide proper ventilation. Refer to the section on rack mounting in this manual's installation instructions for details on installing the instrument so it has proper ventilation. Slots and openings are provided for ventilation and should never be covered or otherwise obstructed. Do not push objects into any of the openings.

Provide a safe working environment. Always place the instrument in a location convenient for viewing the display and indicators. Use care when lifting and carrying the product. This product is provided with handles for lifting and carrying.

Terms in the manual

These terms may appear in this manual:

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

CAUTION. Caution statements identify conditions or practices that could result in damage to this product or other property.

INFORMATION. Information statements identify instructions or commands that may save time or provide extra functionality

Terms on the product

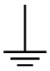
These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

Symbols on the product

 When these symbols are marked on the product, be sure to consult the manual to find out the nature of the potential hazards and any actions which must be taken to avoid them.

The following symbol(s) may appear on the instrument.

 Instrument GND

Conventions used to signify control keys, screen menu options and remote control commands are differentiated as shown below.

control keys	*ACQU*	denoted by *italicised font*
menu options	***bandwidth***	denoted by ***bold italicised font***
script commands	****CLS***	denoted by ***grey, bold italicised font***

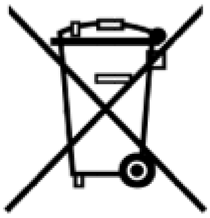
Environmental compliance

This section provides information about the environmental impact of the product.

Product end-of-life handling
Observe the following guidelines when recycling an instrument or component:

Equipment recycling. Production of this equipment required the extraction and use of natural resources.

The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. To avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.



This symbol indicates that this product complies with the applicable European Union requirements according to
Directives 2012/19/EU and 2006/66/EC on waste electrical and electronic equipment (WEEE) and batteries. For information about recycling options, check

Declaration of Conformity

UK
CA CE

Manufacturer: Newtons4th Ltd.
Address: 1 Bede Island Road
Leicester
LE2 7EA

We declare that the product:

Description: Phase Sensitive Multimeter
Model: PSM3750

Conforms to the EEC Directives:

2014/30/EU relating to electromagnetic compatibility:
EN 61326-1:2013

2014/35/EU relating to Low Voltage Directive:
EN 61010-2-030:2010:

July 2021

Jigar Patel
(Senior Engineer Newtons4th Ltd.)

Preface

This manual covers the Newtons4th Ltd Frequency Response Analyzer PSM3750

Key Features

Wide frequency range 10µHz to 50MHz

0.01dB Gain accuracy at < 1kHz

0.025˚ Phase accuracy at < 1kHz

CMRR 140db @ 240Vrms – 50Hz, 120db @ 100Vrms – 1kHz

Frequency, Phase and Tan δ to 6 digits

2 or 3 input channels dependent on model - Isolated Inputs (500Vpk)

Isolated AC+DC coupled signal generator 0V to ±15V output channel sine or square wave with optional DC offset

Free Microsoft Windows Software for databasing, graphs, real time data display, Nyquist and Bode plots, Excel compatible output options

Remote control via USB RS232, LAN or GPIB

Impedance Analysis Interface available

Pre-programmed application modes for -:

Frequency Response Analysis

True RMS Voltmeter

Power Meter

LCR Meter

Harmonic Analyzer

Vector Voltmeter

Oscilloscope

Compatible with many Keysight and 3rd party accessories and adaptors [1]

Microsoft, (Excel, Windows, & Word) are trademarks of the Microsoft group of companies

[1] N4L IAI(Impedance analysis interface) and 22mm adaptor required

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).

If the problem cannot be resolved directly then you will need to request an RMA number from the support section of our website. https://resources.newtons4th.com/ and 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 PSM3750 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.

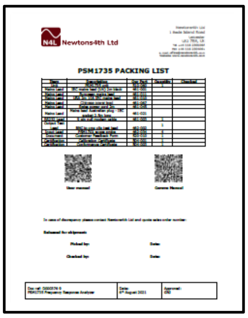
In the event of any problem with the instrument outside of the guarantee period, Newtons4th Ltd. offers a full repair and re-calibration service. It is recommended that PSM3750 is re-calibrated annually.

Please contact your local Distributor or the N4L office for further details of N4L's instrument repair and re-calibration service.

Installing your PSM3750

Checking the shipped contents

Carefully unpack your PSM3750 check the packing list that came with your instrument to verify that you have received all standard accessories and ordered items.


Newtons4th Ltd

PSM1735 PACKING LIST

If any items are missing or damaged, please contact either Newtons 4th Head Office or your local Distributor.

Visit http://www.newtons4th.com to find contact details of your nearest distributor.

It is highly advised to retain all the original protective packaging for re-use when you require to return the instrument for calibration or repair purposes to avoid transit damage.

Operational Requirements
The PSM3750 is designed to be used within the required operating environment, power, and signal input voltage ranges to provide the most accurate measurements and safe instrument operation.

Environmental and Power Requirements

Characteristic	Description
Storage Temperature	0 ° C to +50 ° C
Operational Temperature	-10 ° C to +60 ° C
Operating Humidity	5% to 95% relative humidity (% RH), Noncondensing.
Altitude	2,000 metres
Power source	voltage 90 V - 264 VAC rms, single phase 30VA

Input/Output

Characteristic	Description
Input	Differential
Connectors	Isolated 500Vpk BNC
Maximum Input	500V pk from earth
IP Protection of Inputs and Outputs	IP30 – CEI EN 60529
Output	
Connectors	Single Grounded BNC
Output Voltage (open circuit)	0V to ±10Vpk

Fitment of the PSM3750 Carry/Tilt handle

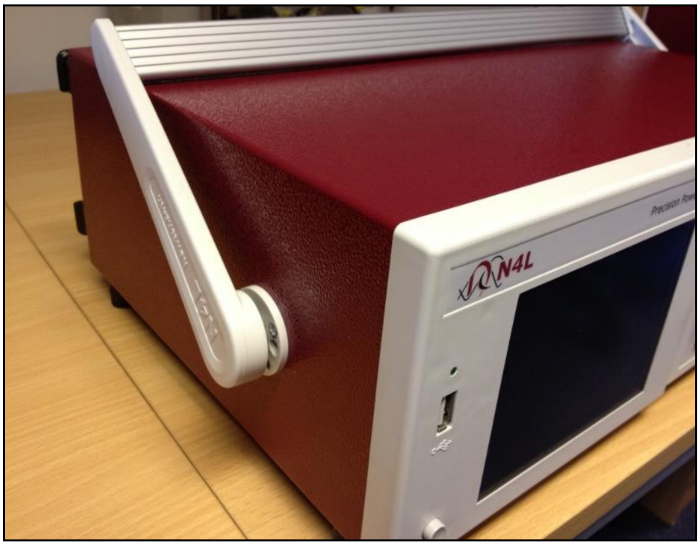
The PSM3750 Phase Sensitive Multimeter is supplied with a Carry / Tilt Handle that is located within the accessory pack.

The handle allows a user to position the instrument upwards at one of two angles for easier viewing when the instrument is positioned below the line of sight.

The design also allows storage under the unit without obstruction of the rubber feet so that instruments can be stacked and is easily removed to allow the connection of rack mounting brackets without the need to remove instrument covers.

Correct installation of the handle is important to ensure the correct operation and long life the handle.

The following pictures illustrate correct and incorrect handle fitment:



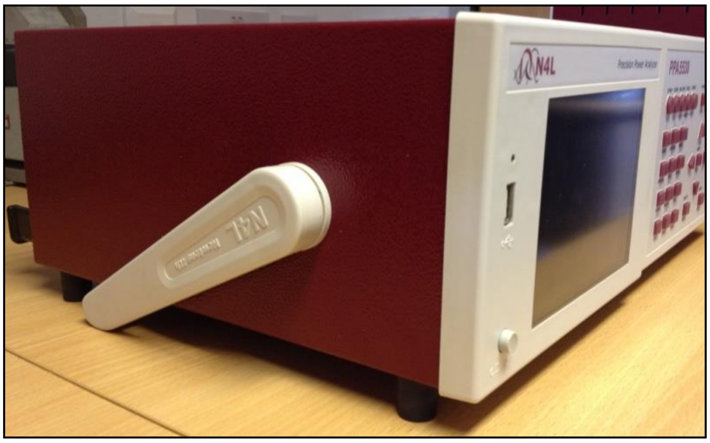
Pic 1

Pic 2

Correct fitting is from the top of the unit as shown in pictures 1 & 2 above.

A correctly fitted handle will have the 'N4L Newtons4th' wording in the correct reading plane when the handle is to the front of the instrument (Pic. 3)

Also, a correctly fitted handle will allow storage under the unit (Pic. 4)



Pic 3

Pic 4

Fitting the handle from the bottom of the unit as shown here is wrong, (Pic. 5)

Incorrect fitting can be seen because the handle does not fit correctly under the unit and handle sides do not fit flush with the registration washer (Pic. 6)

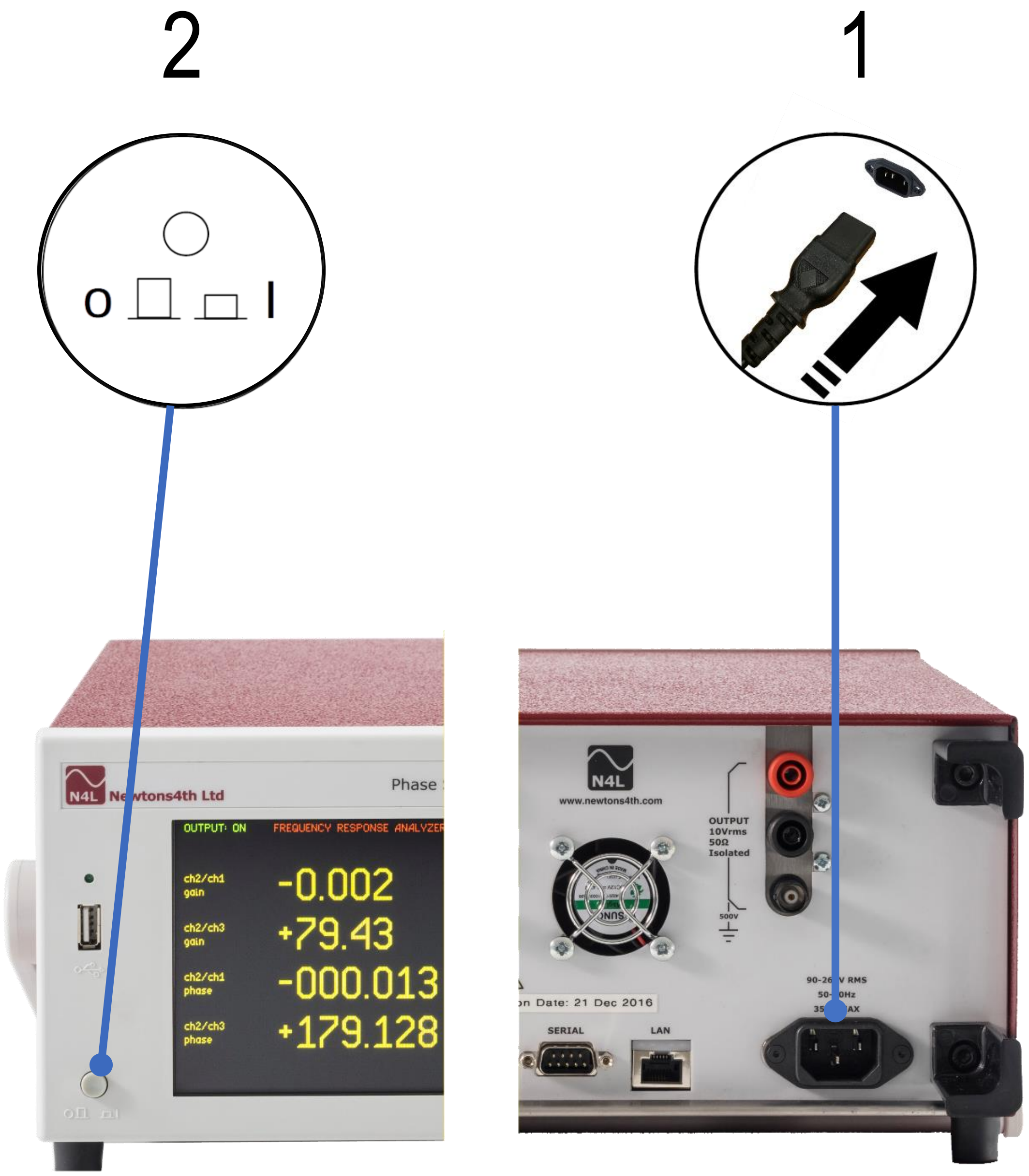
Pic 5

Pic 6

Powering On your PSM3750

Step 1 Attach the supplied IEC power lead to the mains recepticle on the rear of the instrument

Step 2 Turn the instrument on using the On/Off switch on the front lower LH corner



The PSM3750 is supplied ready to use – it comes complete with an appropriate power lead and either 2 or 3 sets of test leads (dependent upon model). It is supplied fully calibrated and does not require anything to be done by the user before it can be put into service.

[See Checking your PSM3750](#)

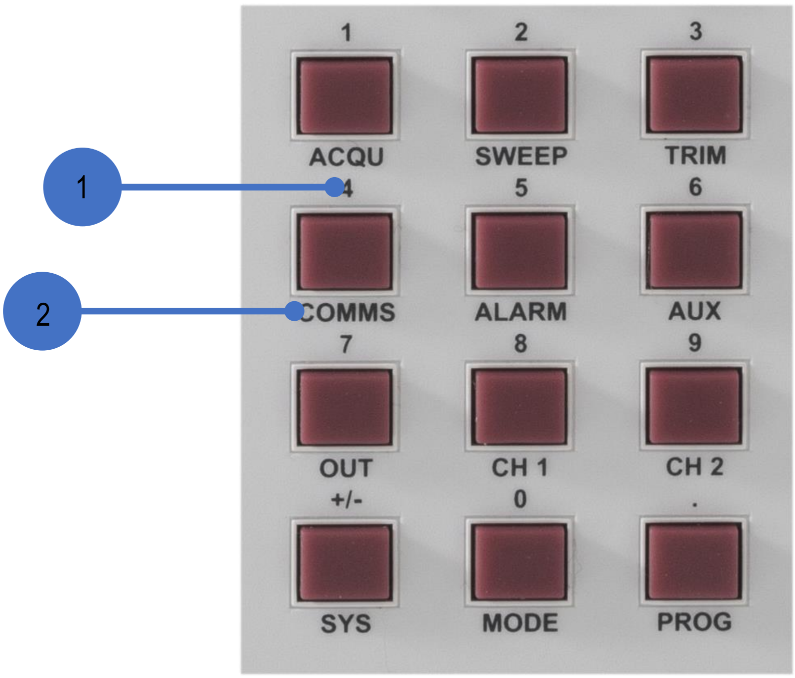
Instrument Layout

Front panel Controls

The front panel has buttons for controlling the instrument, the colour LCD screen, a front USB connector and ON/OFF switch.

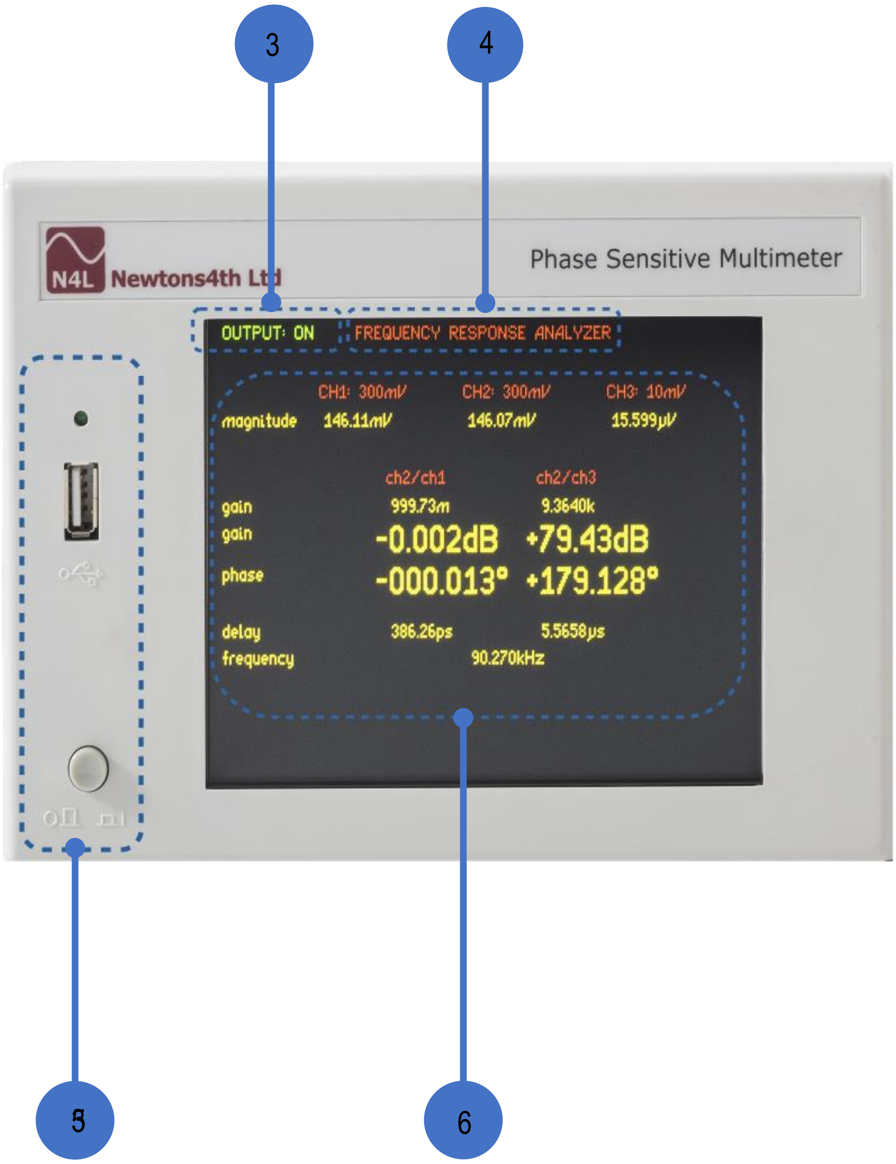
The display and controls are arranged into logical groupings, each item/group of controls is explained below.

Numeric keypad



1. Primary numeric function, the key will display “4” or “G” when entering numerals and text in a menu option.
2. Secondary function, the key will open the COMMS menu screen

Screen area



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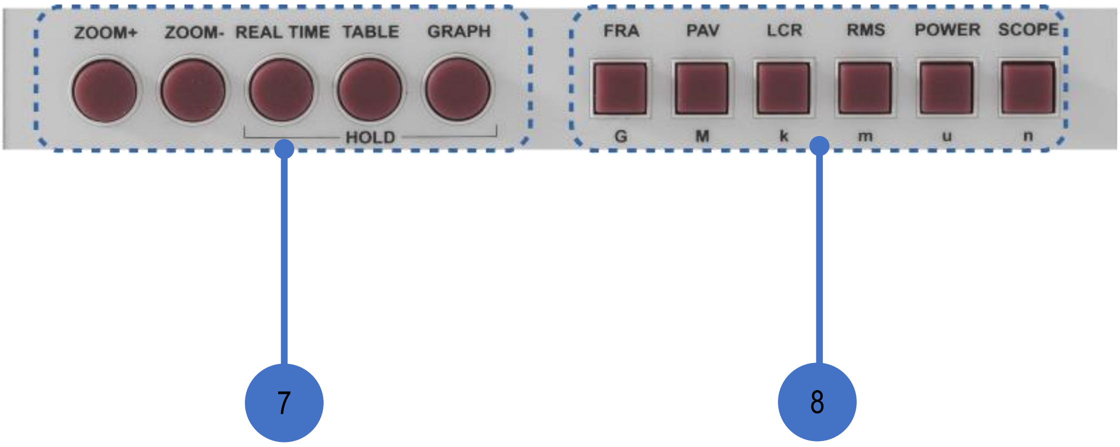
3. Output monitor, in all except the Scope screen this area shows the signal generator status.
4. Pre-programmed MODE selected; this displays the instrument function selected.

5. USB & Power switch. The USB port is used for storing or recalling results, programs, and screen shots to a USB drive. The main push button power switch is below the USB port.
6. Main results display, the contents of this area are context sensitive to the type of instrument MODE selected.

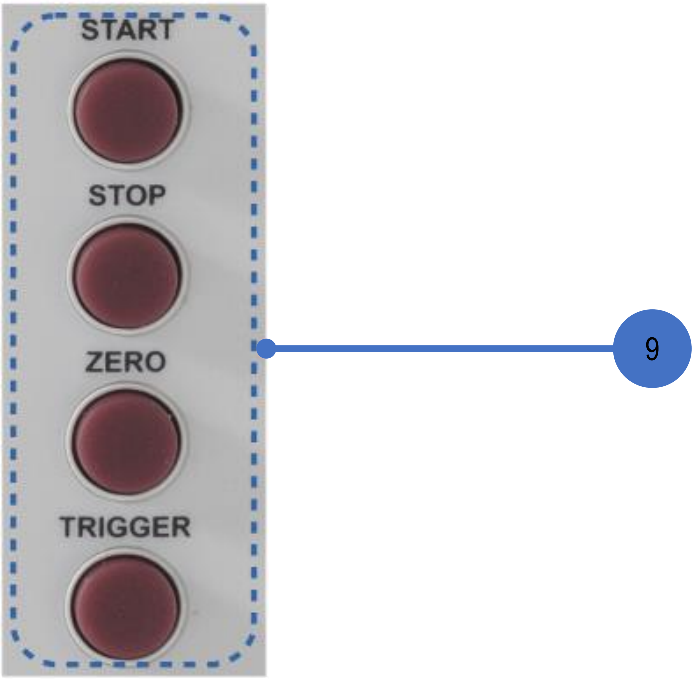
Top row display & application control keys



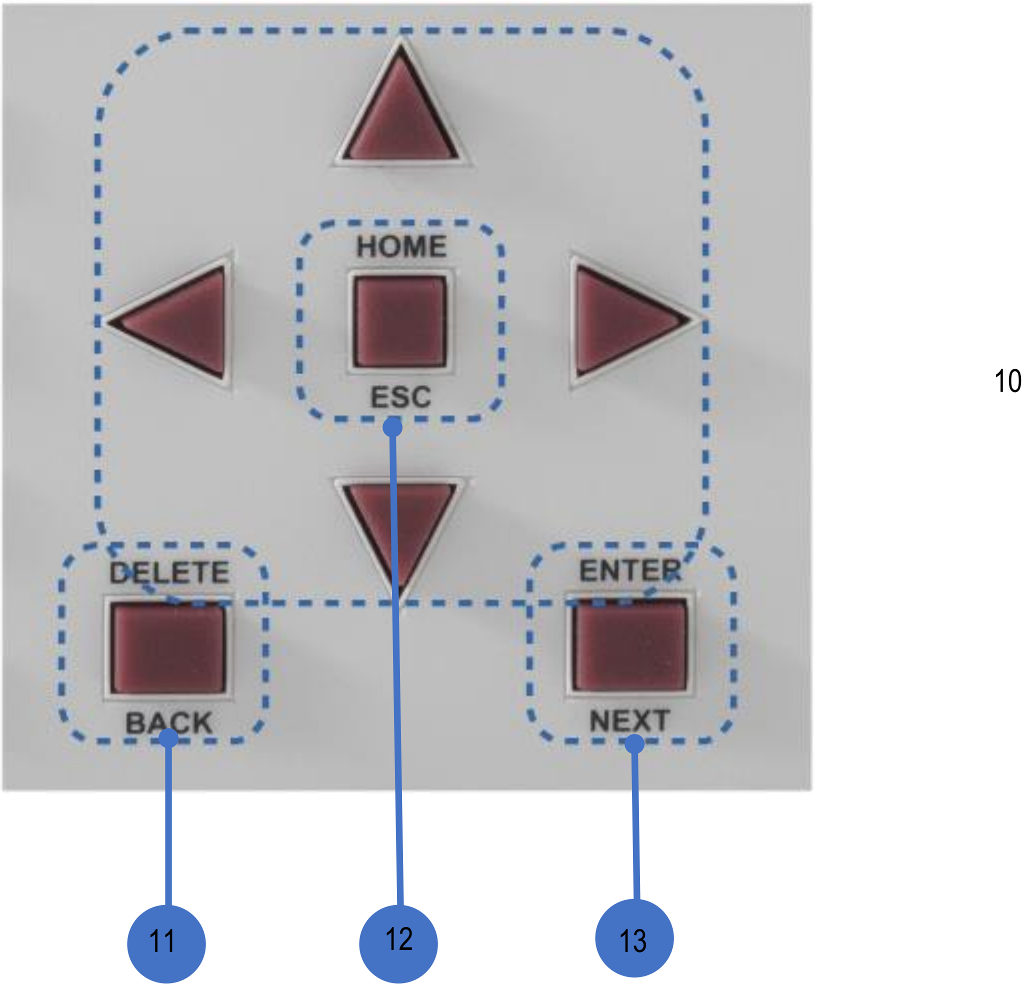
7. Display control keys, this group of keys allows the user to select and highlight up to four parameters, return the screen to real time measurements, switch between tabular and graphical displays, & hold/release the real time readings.

8. Application mode direct access keys, the FRA, PAV, LCR, RMS, POWER, & SCOPE keys allow direct one key access to the appropriate application menus for setting up the instrument.

Control and navigation keys



9. Action keys, this group of keys are used to start and stop sweeps, apply compensation, and releases instrument from HOLD.



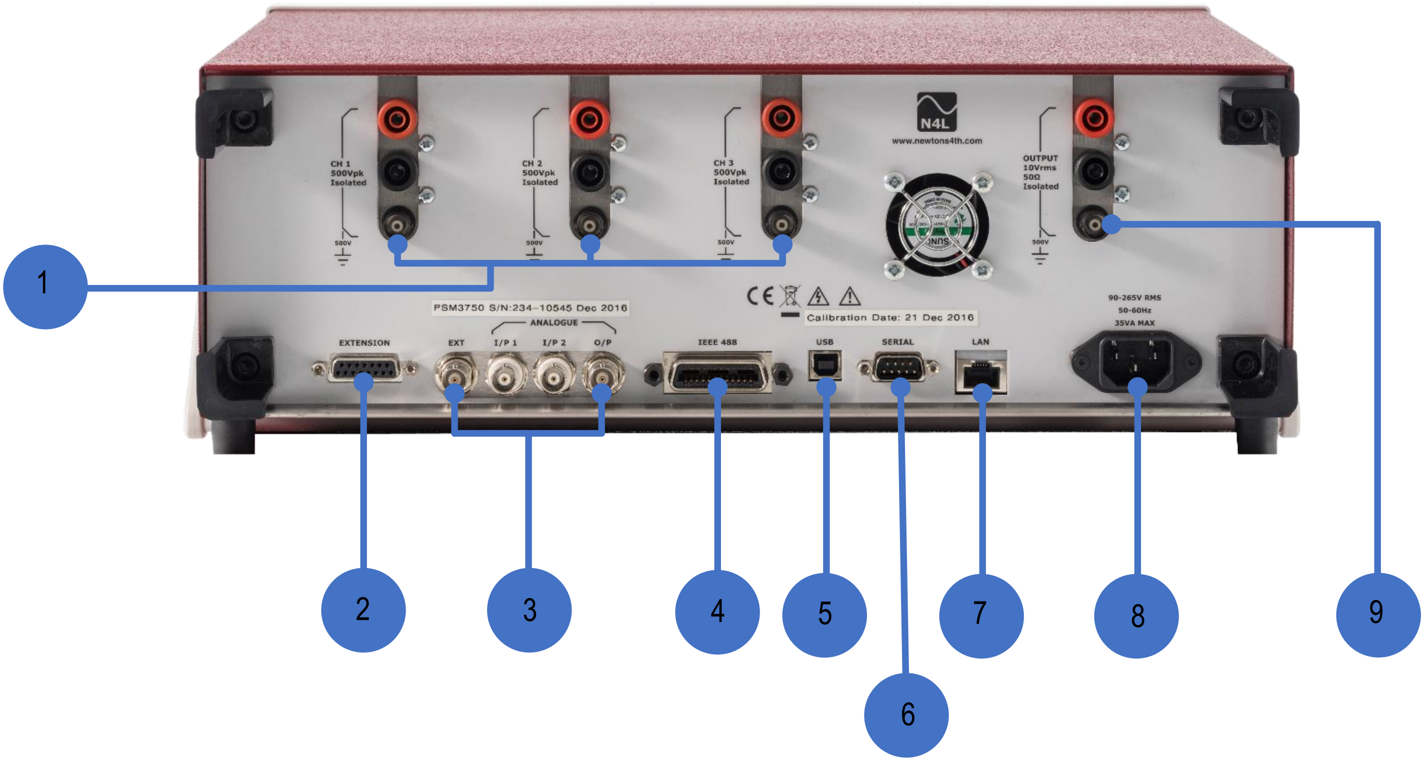
10. Menu navigation keys, the four directional arrow keys are multi-purpose, their main function is to navigate the menu options and drop down choices, in scope and graph mode they are used to control cursors and time-base / measurement per division respectively.

11. Back/Delete key, this dual use key is used to edit alphanumeric entries and also to navigate between certain screens.

12. Home/ESC key, this dual use key will enable the user to return to the selected application start screen once has been adjusted and entered, or will escape from any screen view and return to the selected application home screen

13. Enter/Next key, this dual use key is used to confirm an entry or selection and to navigate between certain screens

Rear panel connectors



1. Input connections 2 or 3 channel dependent on model. Internal connections are via 4mm safety plugs, external connection via safety BNC connector.

2. IAI2 connection port via 15 way D-Sub connector.
3. Auxiliary connections via BNC connections.
4. IEEE488 (GPIB) port.
5. Female USB 2.0 Type B socket for communication.
6. RS232 communication port, 9 pin D-Sub.
7. LAN/Ethernet port.
8. IEC 60320 C13 mains inlet socket
9. Output connections, internal connections are via 4mm safety plugs, external connection via safety BNC connector.

Checking your PSM3750

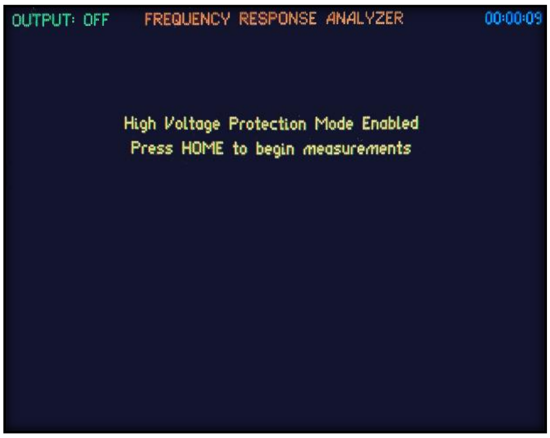
Switch on the PSM3750. The display should illuminate with the model's name and firmware version for a few seconds while it performs some initial tests. Note that the switch on message can be personalised – see User Data

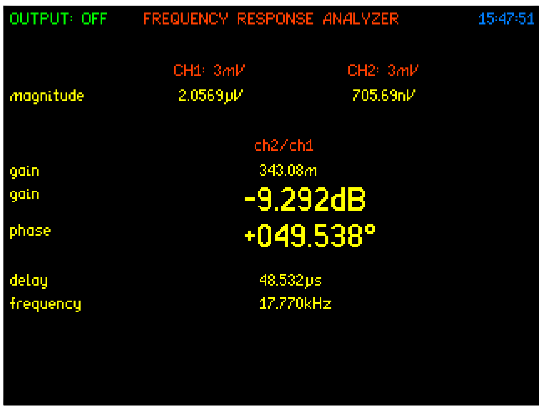
After the tests, the instrument will display a message letting the user know that the high voltage protection mode is enabled.

The High Voltage Protection feature disables autozero if any of the channels shows a measurement of 100 volts or above.

The user will need to press the *HOME* key to begin measurements.

The user can disable the protection message and begin measurements at powerup by setting the "Begin measurements on PowerUp" in the ***SYSTEMS OPTIONS*** menu to ON. This, however, will not disable the high voltage protection mode.





It is recommended that a warmup period of 30 minutes is given to the instrument before commencing any tests to ensure accurate readings.

Since the PSM3750 generator is switched off by default, the display may read some random values due to noise pick up as shown.

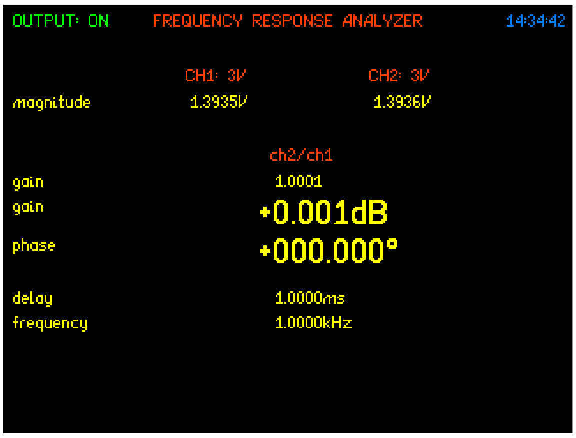
The default screen for the FRA function, (shown above) will be displayed after initialisation.

Connect the output leads to the 4mm sockets on the rear of the PSM3750 and connect the Input probes to the BNC connectors on each of the Input Channels. Connect the Black output lead with the black clips on the input probe lead, and the Red output lead with the actual input probe. Note this is easiest to do by connecting across a resistor.

Press the *OUT* key to invoke the output menu, using the ▼ key, select the output on/off control then the ► key and select "***ON***".

Exit the menu by pressing the *ENTER* key or the *HOME* key twice

The display should now indicate a magnitude value of about 1.4V on all channels, each of which should indicate the 3V range having been selected. Check that the gain reads 0.000dB ±0.010dB, and that the phase reads 0.000° ±0.010° .



N.B. Recently supplied instruments do not feature the High Voltage protection feature described above due to a product design enhancement that renders it unnecessary.

INFORMATION. In the event of any problem with this procedure, please contact customer services at Newtons4th Ltd. or your local authorised representative: contact addresses and telephone numbers are given in the appendix at the back of this manual.

Menus-how to use and navigate them

Main menus There are twelve main menu options available, these are labelled under each of the twelve numeric keys and are accessed by a single keypress.

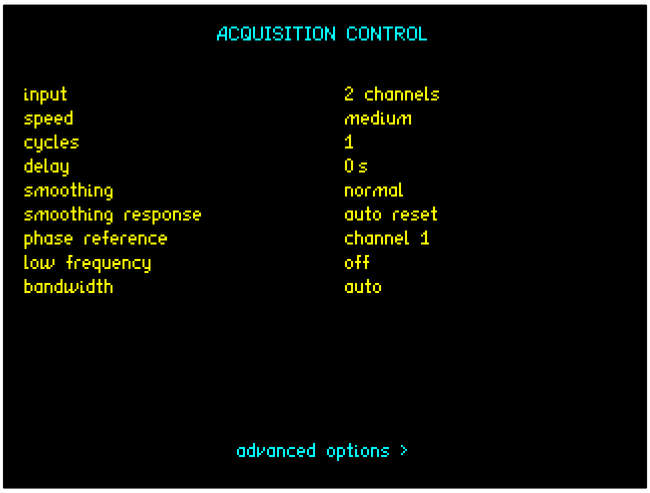
The PSM3750 can be configured for a wide range of application disciplines. Keys 1-9 on the alphanumeric keyboard, +/- and decimal point are used to access the menus to set up the PSM3750 to best suit the intended application.

ACQC	Press key 1
Acquisition Control: Used for configuring inputs appropriate to source and nature of signals being analysed	
SWEEP	Press key 2
All AC measurements using the PSM3750 generator can be swept across a frequency range	
TRIM	Press key 3
The trim function is a powerful and versatile feature that allows closed loop control of the generator amplitude	
COMMS	Press key 4
Used to set the data resolution and change the communication interface protocol to which the instrument responds to future commands via Comms interface	
ALARM	Press key 5
Used to select the alarm types and options	
AUX	Press key 6
Used to select any optional accessories	
OUT	Press key 7
The PSM3750 has a wide bandwidth, grounded, generator output that can be used as a signal generator to produce various waveforms	
CH1	Press key 8
Channel 1 input control	
CH2	Press key 9
Channel 2 input control	
SYS	Press key ±
Used to set general system wide controls	
MODE	Press key 0
Used to select pre-programmed instrument functions	
PROG	Press key **.**
Recall/Store/Delete of non-volatile programs	

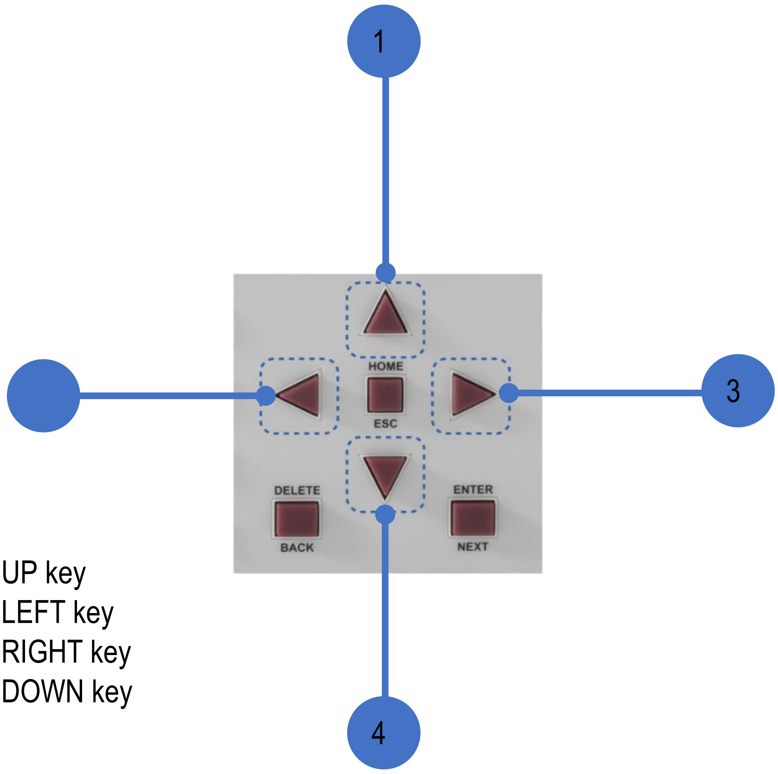
Selection from a list

This data type is used where there are only predefined options available such as the output may be 'on' or 'off', or the bandwidth may be low, wide, or auto.

Upon entry to anyone of the twelve main menus, no options are highlighted (ACQU menu screen shown)

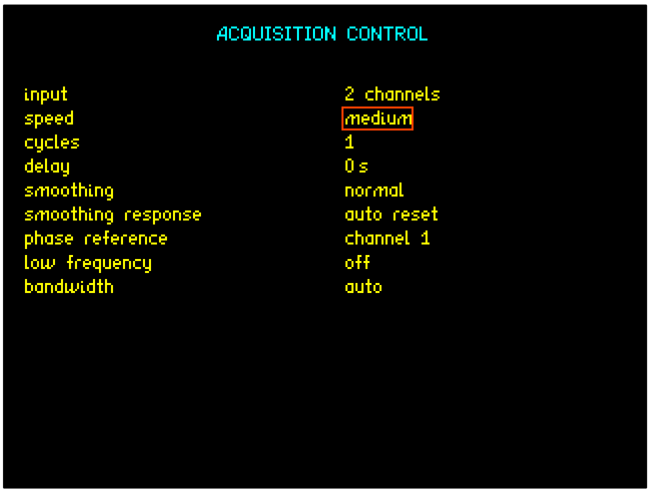


If the ▼ key is then pressed the first option will be highlighted by a flashing box



1 ▲UP key
2 ◄LEFT key
3 ►RIGHT key
4 ▼DOWN key

4 way navigation keys for the menus and data entry



Press the ▼ a second time then the flashing cursor will highlight the second parameter, speed. The ► key steps forward through the list and the ◄ key steps backwards through the list. The number keys 0-9 depending on the number of options available step directly to that point in the list, this provides a quick way to jump through long lists. There is no need to press the ENTER key with this data type.

For example, if the speed selection list comprises the options:

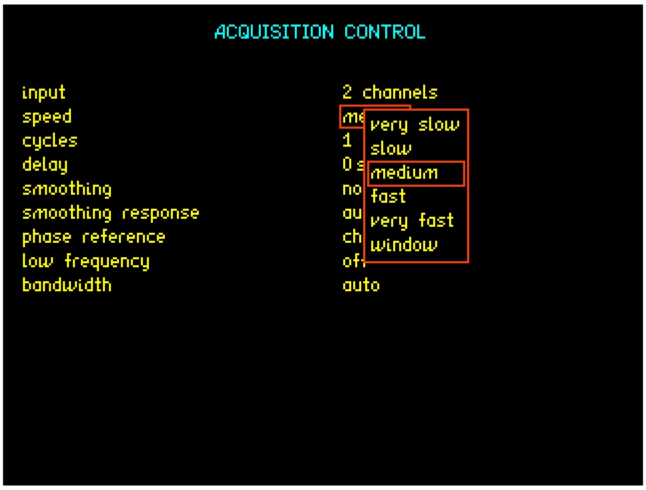
very slow	(item 0)
slow	(item 1)
medium	(item 2)
fast	(item 3)
very fast	(item 4)
window	(item 5)

and the presently selected option is ***medium***, there are 3 ways to select ***window***:

press ► twice

press ◄ three times

or press number *5* key



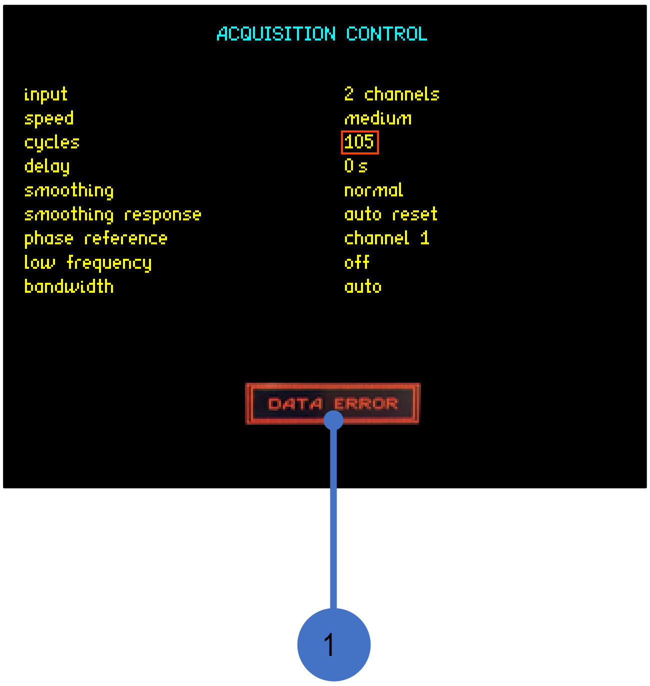
Direct numeric entry

Parameters such as frequency and offset are entered as numeric characters; frequency is an example of an unsigned parameter; offset is an example of a signed parameter.

Numbers are entered using the number keys, decimal point key, or +/- key (if signed value is permitted), & if required, the SI unit prefix multiplier keys (G, M, k, m, µ, & n)

When the numeric character string has been entered, pressing the *ENTER* key sets the parameter to the new value. Until the *ENTER* key is pressed, pressing the *HOME* key aborts the data entry and restores the original number.

If the numeric data value is entered that is outside the valid limits for that parameter, then a warning beep is heard, and a message is displayed on the screen showing ***DATA ERROR*** (see item 1 below) and the parameter is re-set as close to the requested value as possible. For example, the maximum number of cycles; if a value over 100 is entered, a warning beep and message will be given, and the value set to the maximum of 100.

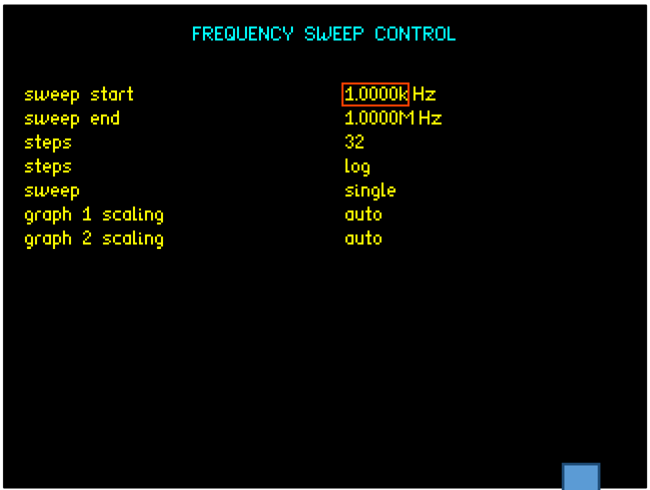


When any menu is first displayed the numeric parameters will have no cursor “▯” visible.

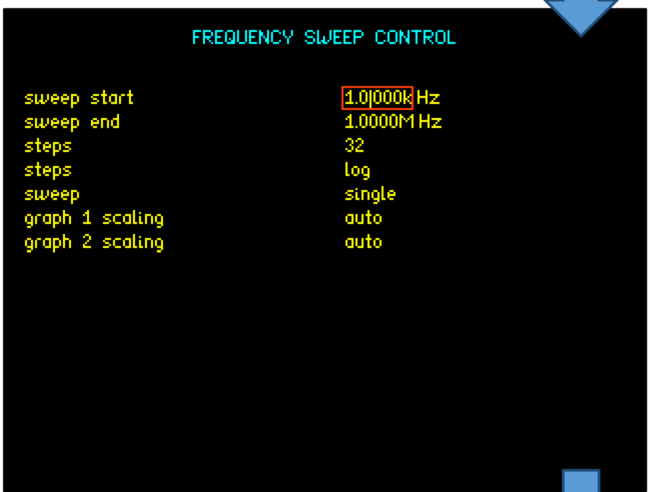
There are two types of numeric variables, those showing an integer value and those showing a decimal value.

To edit an integer numeric value such as ***cycles*** in the above screen shot, use the ▼key to highlight the numeric value, in this case you would need to press the ▼key three times to highlight the ***cycles*** numeric value. Once highlighted a new number will overwrite the existing value if any numeric key(s) are pressed.

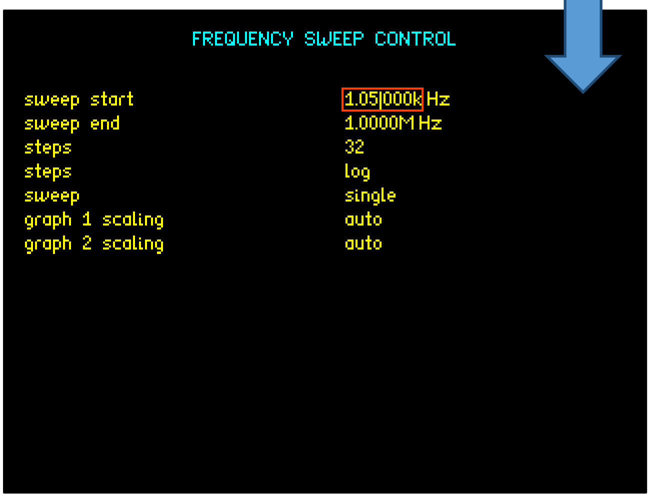
To edit a decimal numeric value such as ***sweep start*** in the *SWEEP* menu



If you wanted to edit the value to be 1.05Hz for example.
Press ▼ x1 to display the cursor | as shown in the second screen shot



Press ► x2 to move the cursor 2 places to the right



Press 5 x1 to insert a 5 to the left of the cursor | Press *ENTER* and now the value is saved for that parameter.

If you want to correct a mistake, then pressing *DELETE* will delete the character to the left of the current cursor position.

If you need to change a value after pressing *ENTER,* then use the ▼ key to position the cursor against the correct parameter and use the ▶ key to move the cursor to the right of the character you want to delete.

REMEMBER the numeric keys and the *DETETE* key always affect the character to the left of the cursor |

INFORMATION. Data values are always shown in engineering notation to at least 5 digits (1.0000-999.99 and a multiplier).

Text Entry

There are occasions where it is useful to enter a text string; for example, a non-volatile program may have some text as a title.

Text is entered by selecting one of 6 starting characters using the main function keys on the top right hand side of the keyboard (item 8 in the diagram), then stepping forwards or backwards through the alphabet with the ▲and ▼ keys.

The starting letters are A (*FRA*), E (*PAV*), I (*LCR*), O (*RMS*), U (*POWER*), or space (*SCOPE*). You can continue from any one of the starting letters backwards and forwards using the ▲and ▼ keys step forward and backwards using the ASCII character definitions – other printable characters such as # or ! can be obtained by stepping on from the space. The available character set is given in the Appendix.

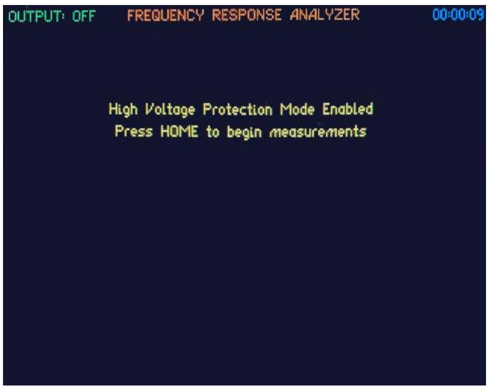
Numbers can also be inserted using the number keys.

When entering alphabetic characters, the *ZOOM+* and *ZOOM-* keys select upper and lower case respectively for the character to the left of the cursor and the next characters to be entered.

The editing keys, ►◄, *DELETE* and *ENTER* operate in the same way as for numeric entry.

User Data

When the PSM3750 is first powered on, for approx. 4 seconds a splash screen is shown, by default, the instrument model, firmware version and Newtons4th Ltd. will be displayed. This splash screen can be edited and personalised to your company details.

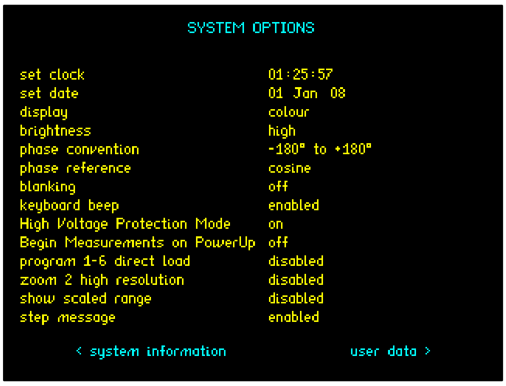


The splash screen then changes to a High Voltage Protection warning screen.

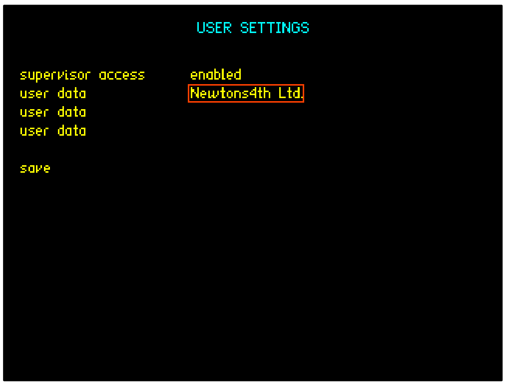
After pressing *HOME* the instrument then displays the default Frequency Response Analyzer screen

Editing the User Data

To do so, press the *SYS* key followed by the ▶ which will then display the following screens: -

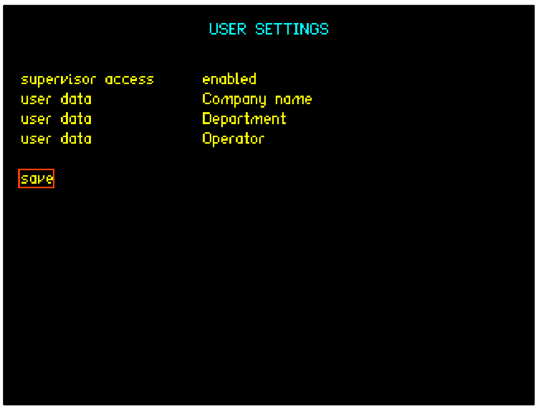


then



There are 3 lines of ***user data*** that can be edited to suit the user, (see section preceding section, Text Entry)

A sample of edited ***user data*** is shown here

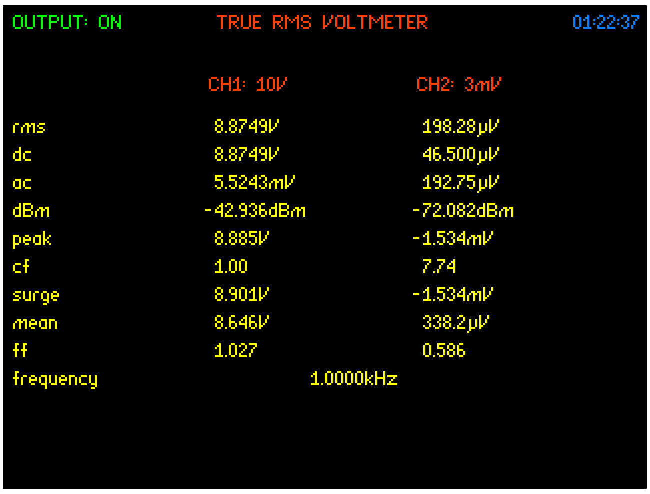


As can be seen in this screen, the 3 lines of user data have been set to “Company name”, “Department”, and “Operator”, however these can be edited by the user to read appropriately to your usage, i.e. “operator could be “Asset No.”or similar.

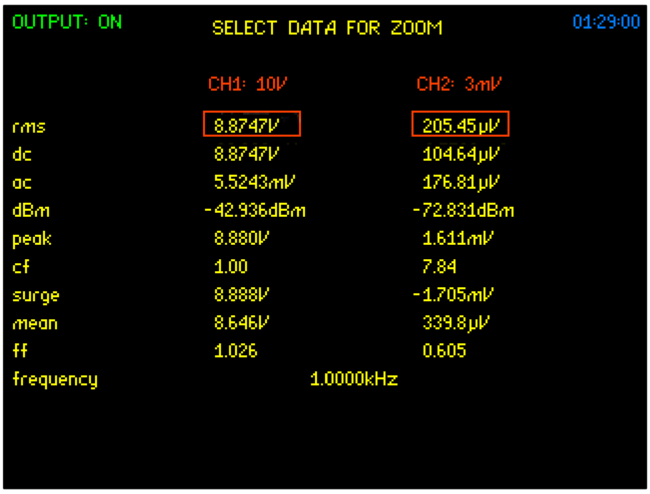
Special Functions

Display Zoom

The PSM3750 normally displays multiple results on the screen in a small font size. The zoom function enables the PSM3750 to display a mixture of up to 4 user selected parameters in a larger font size along with the remainder in the standard size, alternatively the four selected parameters only can be shown by themselves in an extra-large font size.

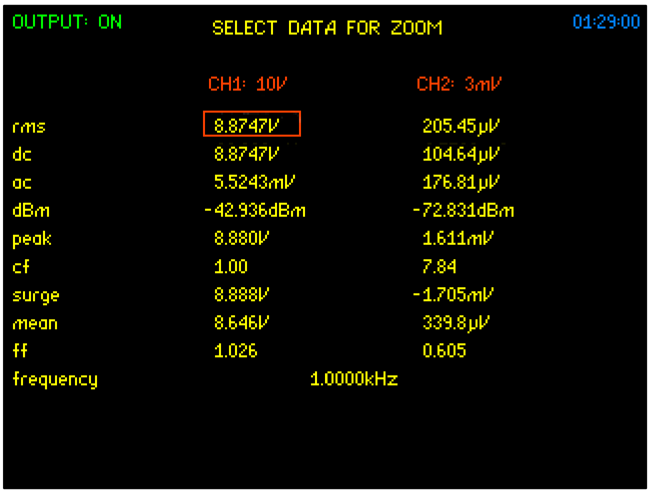


To set which parameters are to be displayed in the larger font size, first return to a no zoom condition by pressing *ZOOM-* twice, if necessary, as each press of *ZOOM-* will reduce the font zoom.

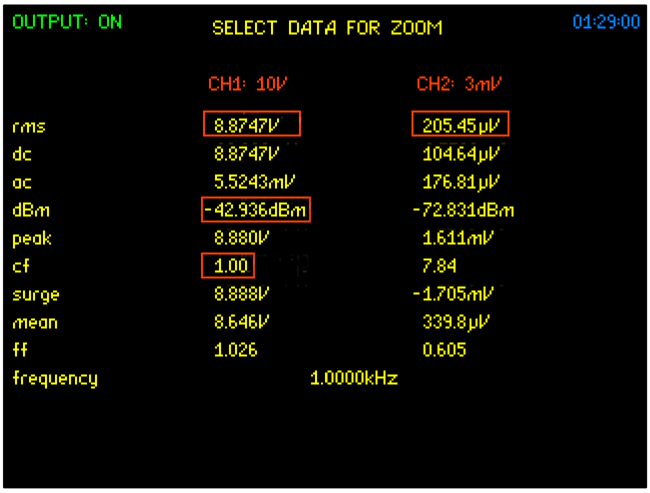


Press the *ZOOM+* key to view the presently selected data (solid red non flashing highlight box), and press *DELETE* to clear the whole selection.

In the example shown here, if the *DELETE* key is pressed all the selected parameters will be deleted for the zoom functions.

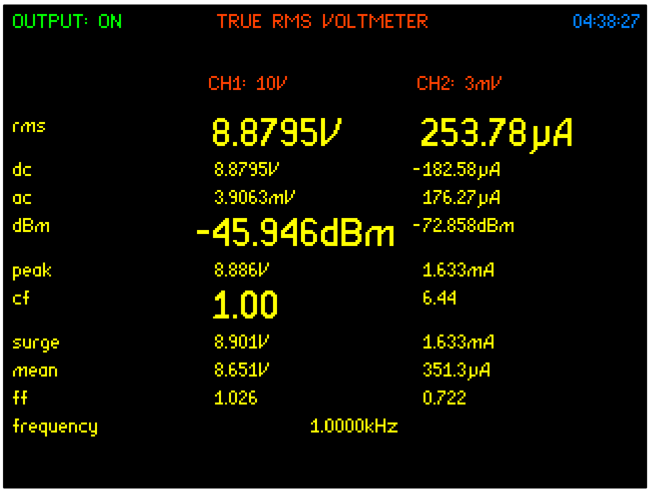


Press the *ZOOM+* key and the topmost left parameter will be left highlighted with a flashing highlight box, but it has not been selected for zoom until the *ENTER* key is pressed and the highlight box stops flashing.

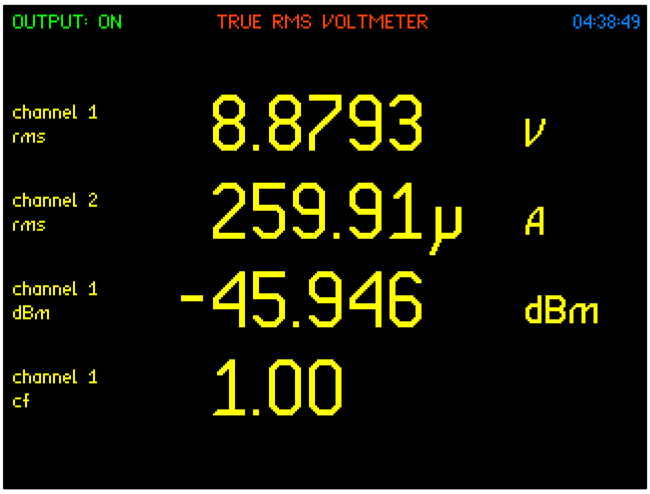


Each parameter that you want to select for zoom display can be selected by using the ▼,▲,►,► &◄ keys. The ▲& ▼ keys allow the selection of the parameters and will if continuously pressed cycle from the top to the bottom and back to the top again. Similarly, the ►& ◄ keys will swap from the CH1 parameters to CH2 parameters and back again.

When the required parameter is highlighted pressing the *ENTER* key will select that parameter for zooming and the highlight box becomes constant rather than flashing, the PSM3750 supports 1-4 parameters in both zoom modes, it is not necessary to have to select four parameters. Each solid highlight signifies that the particular parameter will be zoomed when the *ZOOM+* key is pressed. If a fifth parameter is selected, the first parameter will be deselected.



Having selected the chosen parameters for zooming, pressing the *ZOOM+* key will display the first level of zoom.



The next press of the *ZOOM+* key will increase the zooming effect and only show the selected parameters on the screen as shown in this screen shot.

Alarm Function

The PSM3750 has two independent alarms that can be read remotely or can generate an audible sound. Each of the alarms can be triggered by comparison to one or two thresholds:

- sound the alarm if the value exceeds a threshold
- sound the alarm if the value is below a threshold
- sound the alarm if the value is outside a threshold window
- sound the alarm if the value is inside a threshold window

Additionally, one of the alarms (alarm 1) can be used to generate a sound which varies linearly between two user defined thresholds.

The value to which each alarm is applied can be any of the measurement parameters selected for zoom (see Display Zoom)

The *ALARM* menu screen shown below

alarm 1 data - is the first alarm, this can be linked to any of the measured parameters that have been defined by the zoom function, designated zoom 1 → zoom 4

To program an alarm, first select the functions for the zoom; up to four measurements can be selected for the display, the alarm can be applied to any of them; then press *ALARM* to invoke the ***alarm options*** menu

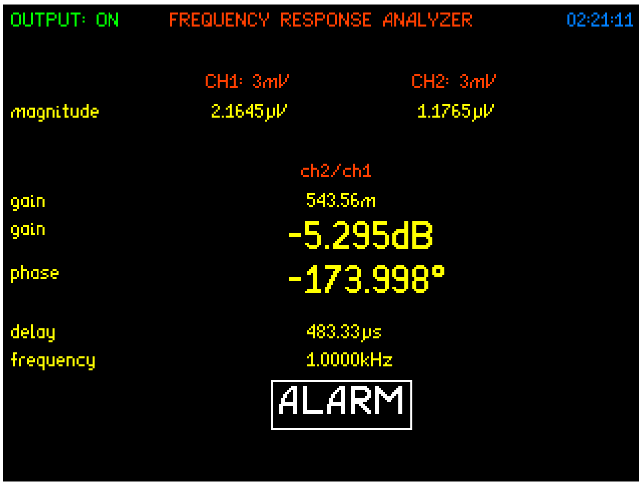
Select which of the zoom functions is to be used, then select the type of alarm from the five choices displayed in the drop down list

The **alarm type** sets up the way the thresholds are treated, enabling the user to set the upper and lower thresholds, both when set to one of the windows or to the linear option. Depending on the selection either one or two thresholds will be displayed for setting to the desired value.

i.e., if ***alarm if high*** is chosen then the high threshold is displayed, conversely for ***alarm if low*** is chosen then the low threshold is displayed. If a ***linear, inside window*** or ***outside window*** option is chosen, then both the high and low thresholds will be displayed.

In this case ***outside window*** has been selected which then displays additional fields to be edited that are appropriate for the choice made. With both this and ***inside window*** the high and low threshold limits are displayed and editable rather than just the high or low threshold when ***alarm if high*** or ***alarm if low*** are chosen.

If ***alarm latch*** is set to ***ON*** the alarm will continue to sound even if the value being monitored returns to a value outside the set threshold(s).



If ***alarm sounder*** is ***enabled***, when triggered the alarm causes both an audible bleep and displays a message at the bottom of the screen.

To clear the alarm, press *HOME*.

The ***linear alarm*** option allows tests to be carried out even if it is not possible to see the display. Pressing *ZERO* in the alarm menu sets the upper and lower threshold to 4/3 and
and 1/3 of the measured value respectively. The repetition rate of the sounder then varies linearly as the value changes between these thresholds.

alarm 2 data, behaves and is set up in the same way as ***alarm 1*** with the following exception that the linear alarm is only available on ***alarm 1***.
In both cases the alarm sound can be disabled, and the alarm can be latched so that it stays on even if the monitored parameter is now outside the set alarm conditions. If using a latched alarm which is continuing to sound, press the *HOME* key to clear the alarm.

Data Hold

When in real time display mode, the data on the display can be held at any time by pressing the *REAL TIME* key. When *HOLD* is activated the word, ***HOLD*** flashes in the top right hand corner of the display.

Press the *REAL TIME* key again or the *HOME* key or *START* key to release ***HOLD***; in this case, *HOME* and *START* keys do not have their normal functions. Changing mode also releases the hold function.

When *HOLD* has been activated, the DSP continues to sample, compute, and filter the results but the data is ignored by the CPU. When *HOLD* is released, the display is updated with the next available value from the DSP.

Program store and recall

There are 999 non-volatile program locations where the settings for the entire instrument can be saved for future recall later. An associated name of up to 24 characters can be entered by the user to aid identification, (see Text Entry)

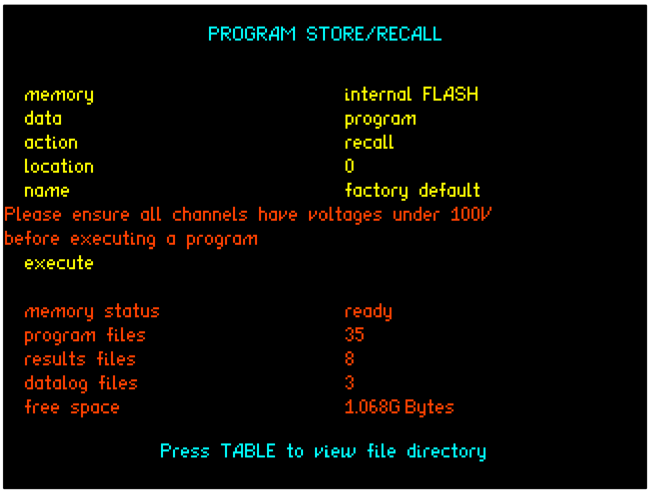
Program number 1 (if not empty) is loaded when the instrument is powered on so that the PSM3750 can be set to a user defined state whenever it is switched on. This is particularly useful to set system options such as phase convention, GPIB address etc. If no settings have been stored in program 1 then the factory default settings are loaded (program number 0).

Program numbers 1-6 may be recalled with a single press of the Application Direct Access keys, (see item 7) if the direct load option is selected in the system menu (see system options).

The instrument can be restored to the factory default settings at any time by recalling program number 0.

The program menu is accessed using the *PROG* key. The program location can be selected either by stepping through the program locations in turn using the ►&◄ keys to see the name or by entering the program number directly.

The default condition when in the Program Store/Recall menu is as shown below.



To store a configuration in any of the locations 2-100, press the ▼ key twice to highlight ***action***, then press the ► key once to select ***store***.

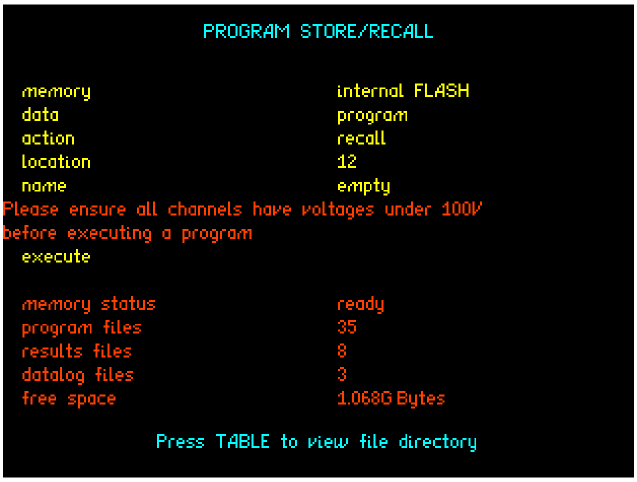
Now using the ▼ key highlight the program number and either step through the numbers with the ►&◄keys or directly enter the number from the numeric keys, then press *HOME*.

Using the ▼ key, highlight ***execute***, and press *ENTER*.

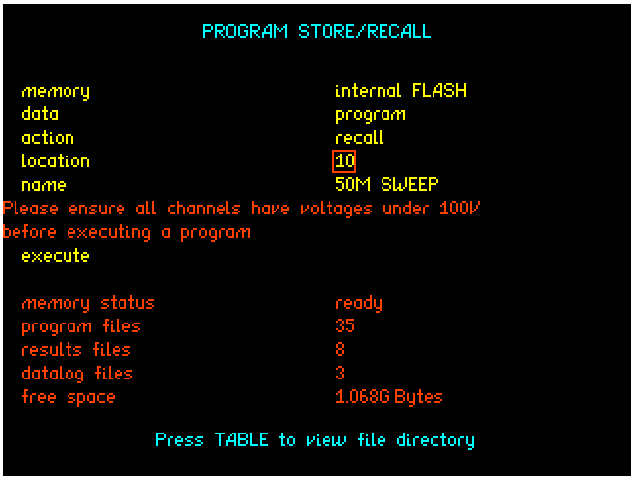
When storing a configuration in a program, there will be a slight pause (of about 1 second) if the program has previously been written or deleted. The process will be very quick if the location has not been used.

Scrolling through the numerical memory locations using the ► & ◄ keys it will be observed that against the field called ***name*** there can be 3 options., either ***empty w***hich means that there is nothing stored in that location , or a name such as ***BATT470*** which shows that the location has

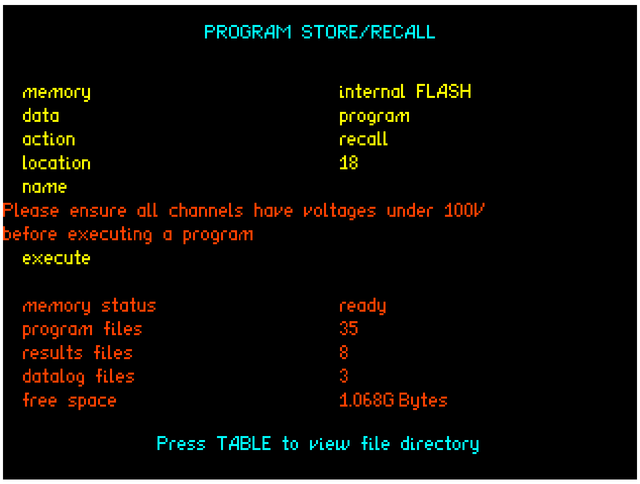
a program stored at that location number which has been named BATT470, lastly it can be completely blank, this does not mean the memory slot is empty, but rather settings were stored without saving their name to identify them. This is poor practice and should be avoided if possible as it is bad housekeeping practice.



In this screenshot location 12 is shown as empty and can be used to store program settings.



In this case location 10 has a program stored called 50M SWEEP, this location can be used for storage but it will be overwritten by the new saved program.



In this last instance, location 18 is not showing either the word empty or a program name. This infers that there is a program stored in this location but it was saved without a name. As previously it can be overwritten with a new program.

CAUTION. Of the 3 cases shown above the memory slot in the first one is empty, however in the second and third cases they both have something stored in them and to use these slots will overwrite the contents already there without any warning.

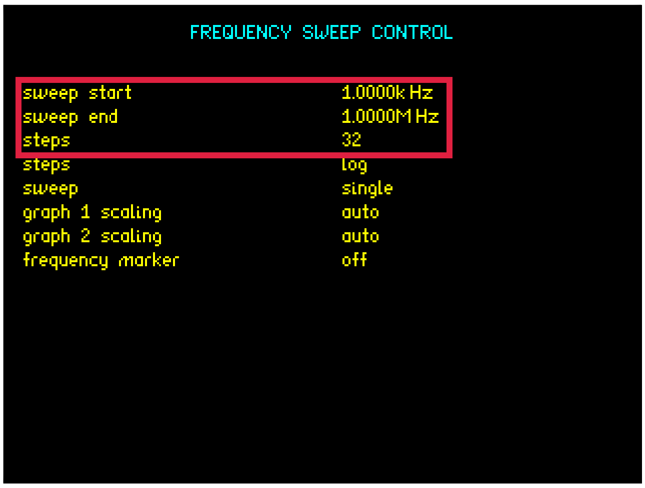
Sweep results store and recall

There are 999 non-volatile program locations where the settings for the entire instrument can be saved for future recall later. Each of the 999 locations can store either real-time results, frequency sweeps or instrument settings "programs". Each location can store the sweep results for up to 50 points, if the sweep to be stored has more than 50 points then multiple locations memory allocation will be used. An associated name of up to 24 characters can be entered by the user to aid identification, (see Text Entry)

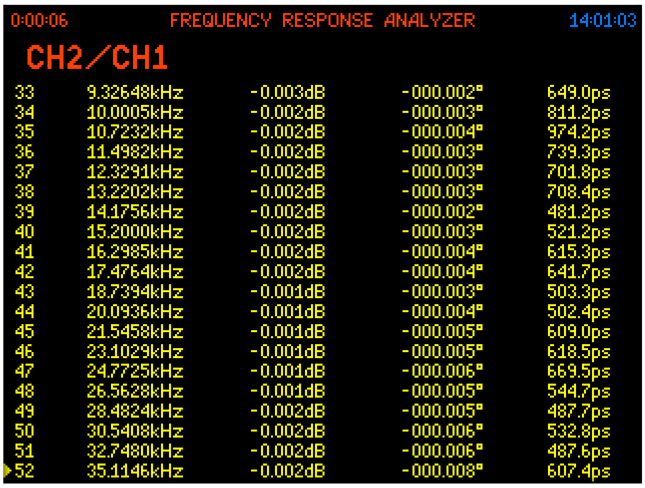
Each stored sweep also saves the instrument configuration along with the sweep results (same as program store/recall), so that the instrument is restored to the same settings when the sweep is recalled. The sweep data may be restored manually or via communications for download to a PC. To manually access the sweep data store, press *PROG* and select memory type sweep.

Saving Sweep details to USB Memory Stick

The following section explains the procedure for storing a Frequency Sweep onto USB memory stick.



Setup Sweep Parameters (SWEEP MENU)



Press START to commence Sweep

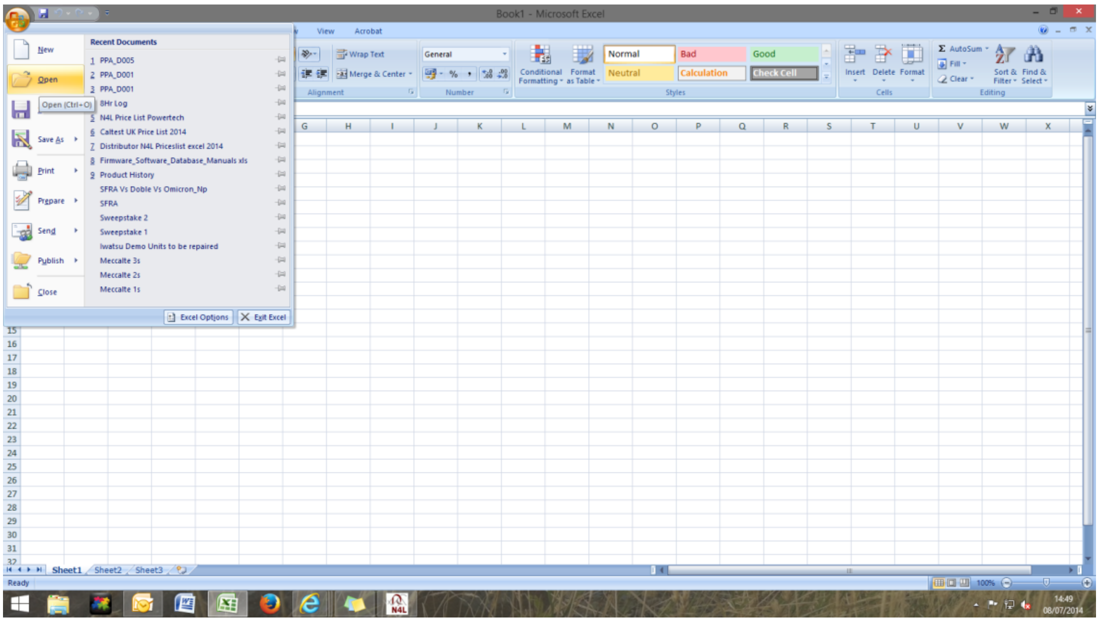
Insert Memory Stick into front USB memory port

Setup Memory Location (PROG MENU)

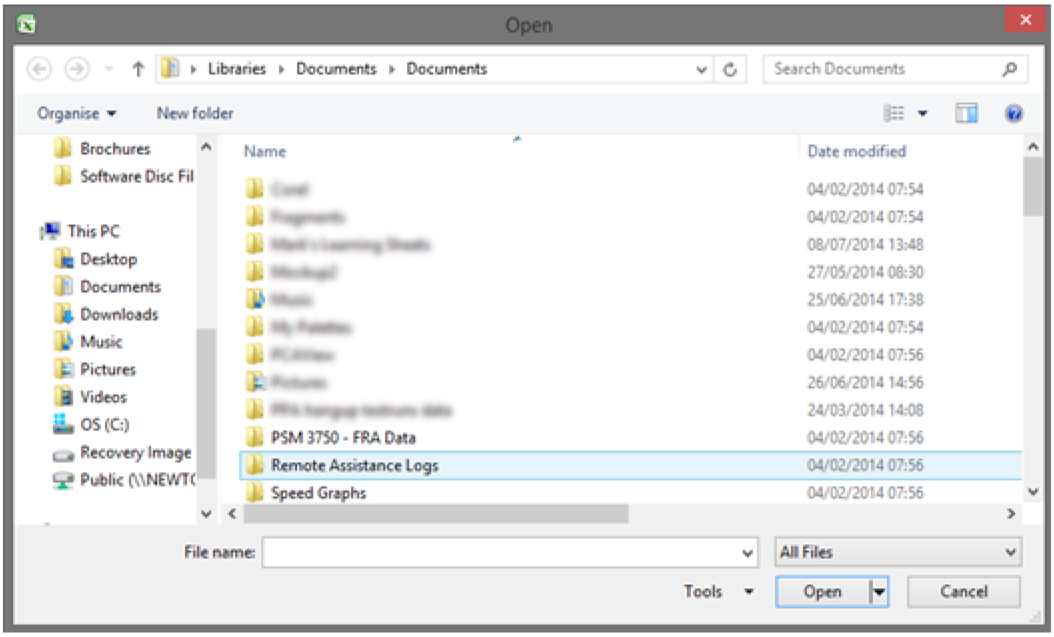
choose ***USB memory stick***
Set data to be stored as ***results***
Set action for the data to ***store***
Select a ***location*** for the data to be stored (999 available)
Select a suitable ***name*** for your tests for ease of identification
Select ***execute*** and press *Enter* to transfer data to memory stick

A message will appear on screen "writing to USB please wait", data will be transferred onto the memory stick. Locate the stored file on memory stick, the file format will have a .txt extension as shown below

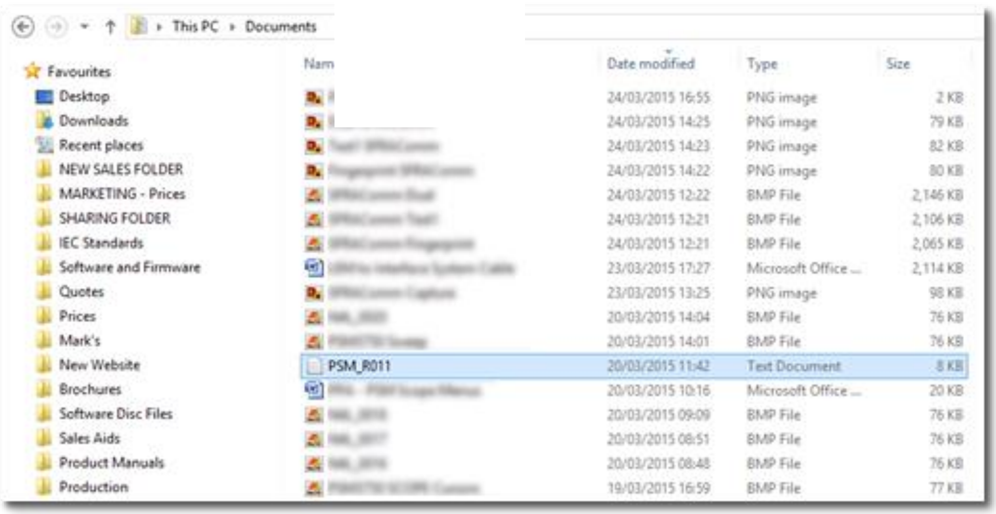
To convert .txt file into an Excel spreadsheet, save .txt file to a folder within your PC, then open up excel file as shown



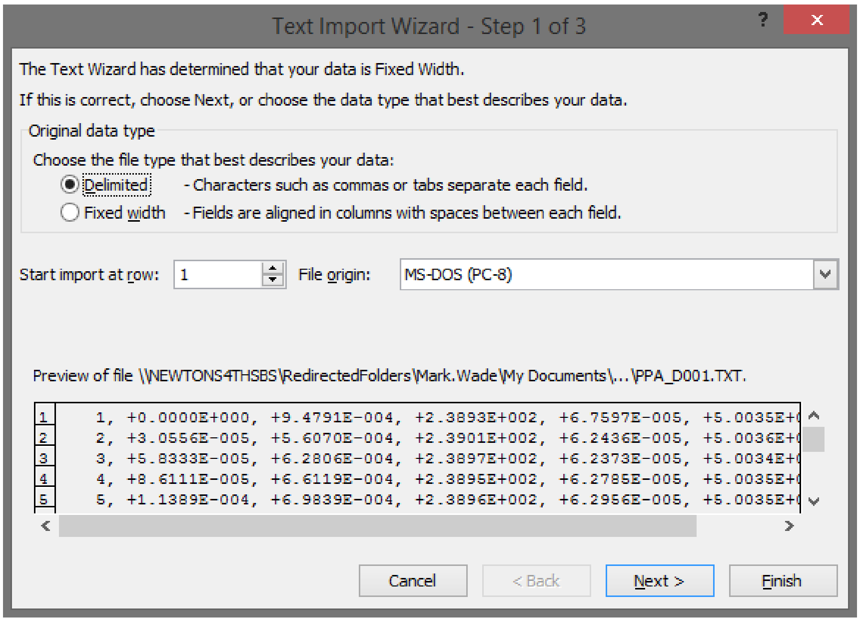
INFORMATION. Dependent on which version of Windows ™ and Excel ™ being used, the actual screens and message windows may differ slightly in appearance. However, the instructions herewith will still function



Click on “OPEN” new spreadsheet, the File location box will appear as above, click on and open the dropdown menu box cel Files” and change to “All Files”

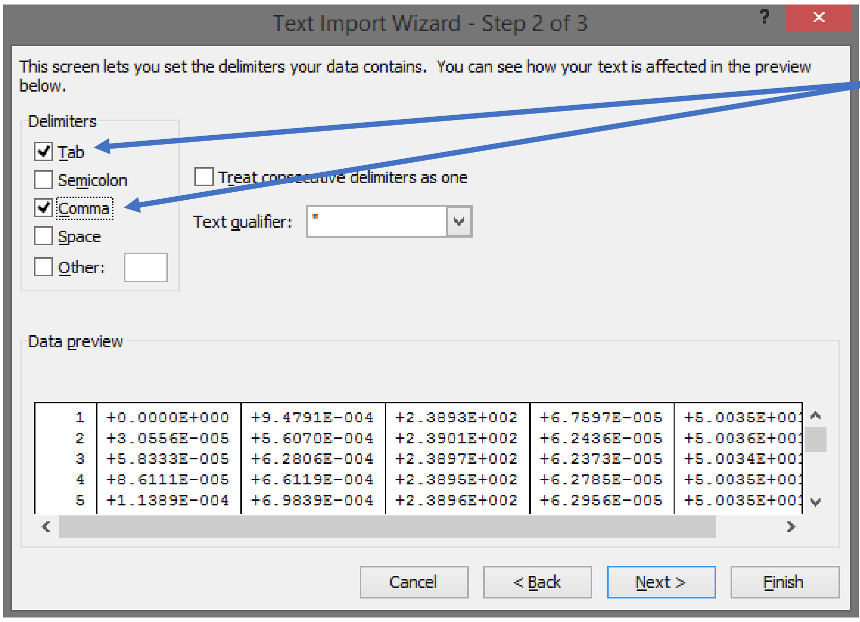


Locate saved .txt file from folders, then double click to open



After opening your file, a further screen will appear as shown left, now change file type from “Fixed width” to Delimited”, once selected click on “Next”

Delimiters screen will appear as shown within the screenshot below



Make sure that the “Tab” and “Comma” delimiters are ticked as shown above then click on “Next”

A new screen will appear then click on “Finish”. Data will be exported into an Excel spreadsheet as shown on the following page.

	A	B	C	D	E	F
1	1	0.00E+00	9.48E-04	2.39E+02	6.76E-05	5.00E+01
2	2	3.06E-05	5.61E-04	2.39E+02	6.24E-05	5.00E+01
3	3	5.83E-05	6.28E-04	2.39E+02	6.24E-05	5.00E+01
4	4	8.61E-05	6.61E-04	2.39E+02	6.28E-05	5.00E+01
5	5	1.14E-04	6.98E-04	2.39E+02	6.30E-05	5.00E+01
6	6	1.42E-04	8.28E-04	2.39E+02	6.38E-05	5.00E+01
7	7	1.69E-04	3.71E-04	2.39E+02	6.56E-05	5.00E+01
8	8	1.97E-04	4.57E-04	2.39E+02	6.74E-05	5.00E+01
9	9	2.25E-04	4.82E-04	2.39E+02	6.83E-05	5.00E+01
10	10	2.53E-04	5.96E-04	2.39E+02	6.85E-05	5.00E+01
11	11	2.81E-04	1.60E-03	2.39E+02	7.30E-05	5.00E+01
12	12	3.08E-04	1.32E-03	2.39E+02	7.19E-05	5.00E+01
13	13	3.36E-04	1.16E-03	2.39E+02	7.27E-05	5.00E+01
14	14	3.64E-04	1.12E-03	2.39E+02	7.28E-05	5.00E+01
15	15	3.91E-04	1.12E-03	2.39E+02	7.24E-05	5.00E+01

Open Excel™ spreadsheet with exported results data.

Setting up the instrument for measurements

For most applications of the PSM3750 it is not unusual to find there is a lot of noise around the specific frequency being measured,[2] it is important that the frequency to be measured can be discriminated from the noise and unwanted signals. This discrimination or measurement selectivity, which is part of the fundamental analog design, high CMRR and use of "real time" DFT analysis allows the PSM3750 to provide exceptional wideband frequency response measurements even when the signal of interest is immersed in noise. The consequence of this is that the user does not have to carefully select criteria to obtain steady reliable measurements.

In most applications, the signal of interest is generated by the PSM3750 itself, utilising the built in isolated output signal generator for sine, square, triangle, sawtooth or true white noise waveforms. The output is fully isolated from earth to 600Vpk CAT II.

When using this normal mode of operation, the PSM3750 will automatically analyse the measurement signal with a DFT algorithm running at the same frequency as the injected signal. This process eliminates the problem of signal frequency detection.

Where an external signal source is used for signal injection, the PSM3750 will detect the injected frequency with a greater level of selectivity as the measurement speed is slowed down. The user need only select the measurement speed to achieve the optimum balance of speed and measurement stability.

While it is not required for the user to define the selectivity, nominal values used by the PSM units are defined in the following table:

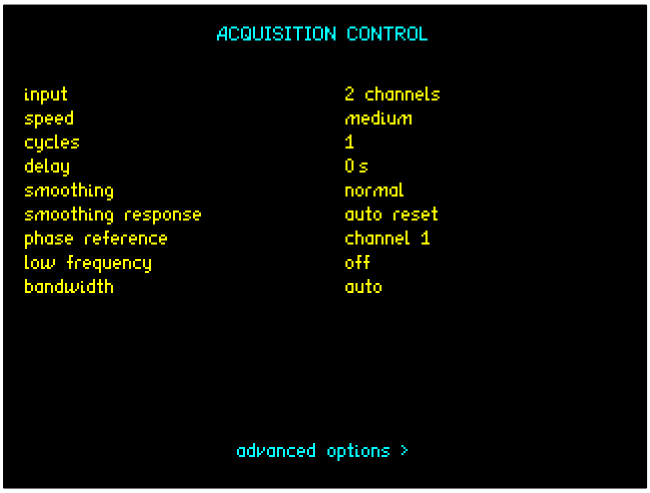
speed	update rate	normal time constant	slow time constant	Measurement Selectivity
Very fast	1/80s	0.05s	0.2s	80Hz
Fast	1/20s	0.2s	0.8s	24Hz
Medium	1/3s	1.5s	6s	3Hz
Slow	2.5s	12s	48s	0.4Hz
Very slow	10s	48s	192s	0.1Hz

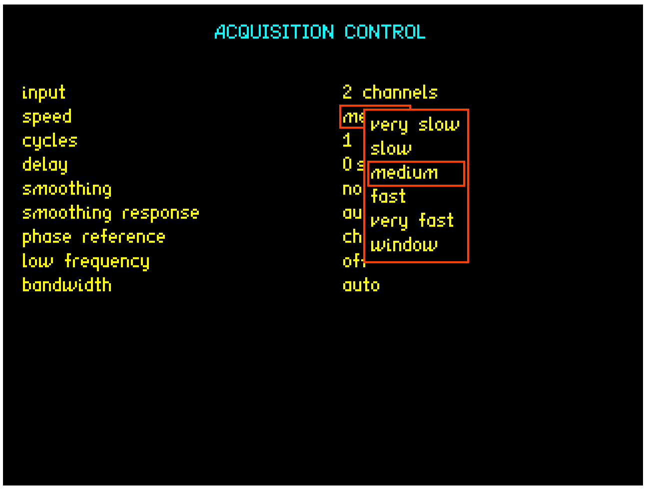
[2] Sometimes referred to as "The Injected Frequency"

Acquisition options [ACQU key]

Acquisition Control: Used for configuring inputs appropriate to source and nature of signals being analyzed.

Input PSM3750 comes in either a 2 or 3 channel version. The 3 channel version can be set to display just 2 channels if the third channel is not in use.



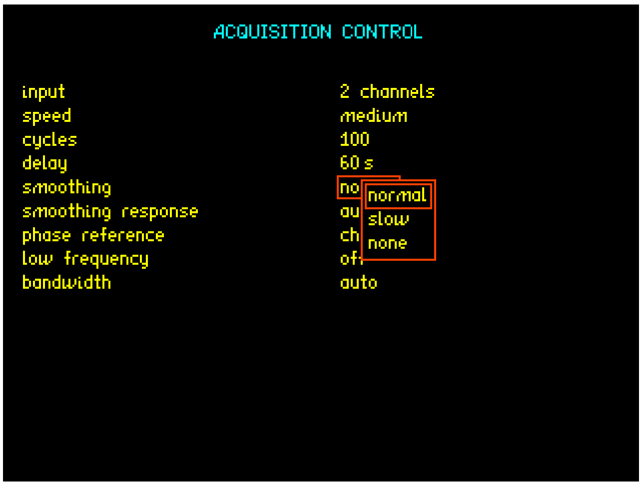


Speed In normal acquisition mode the window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform.
The results from each window are passed through a smoothing filter. There are 5 pre-set speed options that adjust the nominal size of the window, and therefore the update rate and time constant of the filter. Greater stability is achieved at a slower speed at the expense of a slower update rate.

There is also an option to set a specific size of the window to a value other than the 5 pre-set options. In order to synchronise to an integral number of cycles the window size is either reduced by up to 25% or increased as required.

Cycles Manually input number of measurements to be made
at each frequency measurement point in a sweep, the average is then taken. This value is valid between 1 and 100

Delay This sets a time period between each sample within a sweep, this is valid between 0 to 60s.



Smoothing This applies a filter that will gather the data and average it out over a sliding window time scale. This is very useful when gathering data which could be affected by noise. Each speed option has its own time constant for filtering and data updates. Smoothing does not affect a single sweep as each point is a single measurement. If Sweep is set to continuous then the smoothing is applied to each new sweep result.

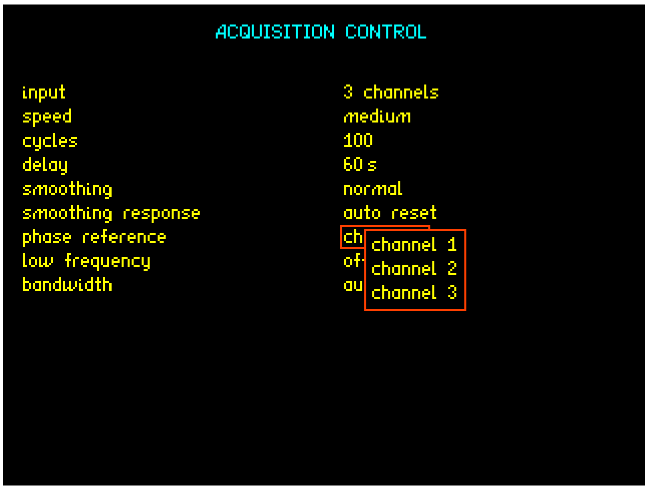
With ***Normal*** smoothing applied the following update windows will apply to the relevant speed selected.

Speed selected	V Fast	Fast	Medium	Slow	V Slow
Update	0.1s	0.4s	1.5s	12s	48s

Slow smoothing will multiply the above values shown in the table by a factor of 4x

None If this option is selected, no smoothing is applied to the computed results, the update rate will be dictated by the ***speed*** only.

Smoothing Response The smoothing response is by default set to ***auto reset*** where the filtering described in ***smoothing*** is reset in response to a significant change in data. This speeds up the response of the instrument to changing conditions. Alternatively, ***auto reset*** can be disabled by choosing ***fixed time***, so that the filtering has a fixed time constant, which would have an exponential change to a step change.

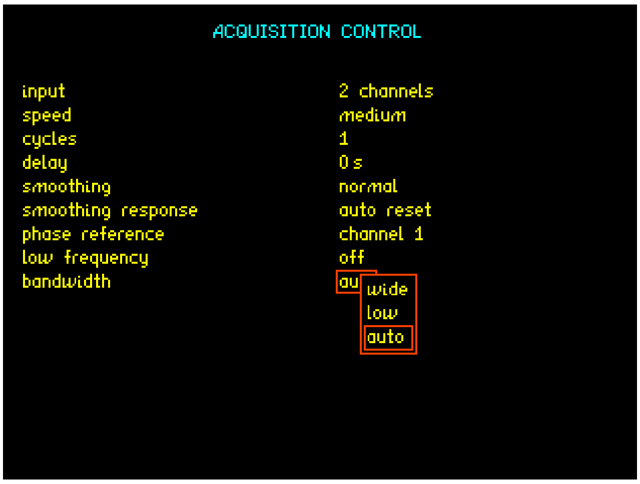


Phase reference In the case where there is very little signal on CH1, the reference for the phase can be set to another channel to give a more accurate measurement. This does not change the phase results it only helps to reduce the uncertainty due to noise.

The screen shot shows a 3 channel PSM3750, if it is only set to 2 channel or it's a 2 channel instrument then the channel 3 option will not be available.

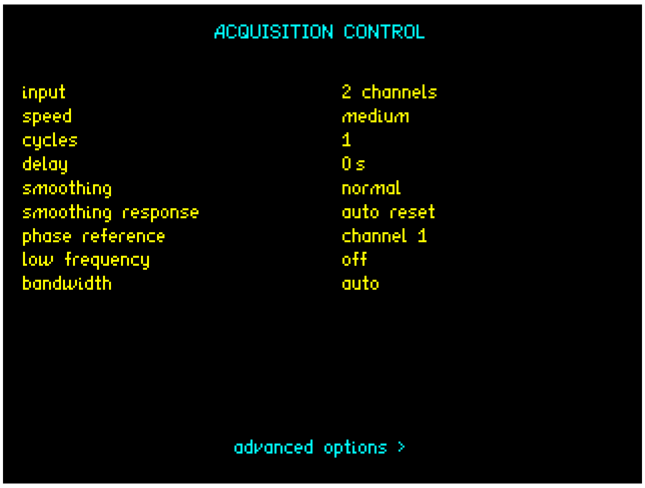
Low frequency

When the generator is not used and so the measurement is synchronised to the input frequency measured on CH1, there is a low frequency option that extends the frequency measurement down to 10µHz. This low frequency option also applies a digital filter which can be useful when measuring in low frequency, noisy environments, this option can be set to on or off.



Bandwidth This is usually set to ***auto*** but can be forced to ***wide*** or ***low*** when not in auto mode, heterodyning is disabled.

Low sets a bandwidth of 100kHz, and Wide sets the bandwidth to 5mHz.



advanced options At the bottom of the default acquisition control screen advanced options is displayed in blue. Pressing the ►key will open a secondary menu screen.

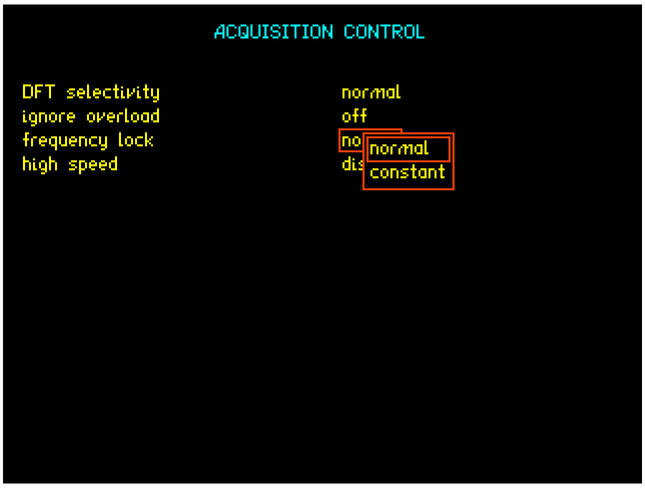
DFT selectivity Analysis of the fundamental component of a signal uses a DFT (Discrete Fourier Transform) algorithm. The selectivity of the DFT analysis is a compromise between noise rejection of frequencies close to the frequency of the fundamental component and the required stability of the frequency component.

Normal is the default setting for DFT selectivity, while selecting ***narrow*** increases the selectivity of the DFT analysis (reducing the effective bandwidth at each component) which has the effect of improving the noise rejection. It does however require that the frequency of the fundamental component is more stable

Ignore overload, in a noisy application any spikes present on the signal may push the instrument onto a higher range than is necessary for the signal being measured. If the nature of the spurious spikes are such that they do not contribute to the measurement and can safely be ignored, then the range can be manually set to the appropriate range for the signal to be measured and the instrument can be told to ignore any overload and not auto-range.

This option is a simple ON/OFF choice.

INFORMATION. If using this mode, it is wise to check the signal on the oscilloscope to be sure that the signal being measured is not genuinely over range.



Frequency lock In a very noisy application, where the frequency of the signal is known but the instrument is unable to measure the frequency even with low frequency mode filters applied, it is possible to manually enter the frequency to be used for analysis.
Normal Utilises N4L unique signal processing techniques for fundamental frequency synchronisation including hysteresis to increase frequency noise immunity.

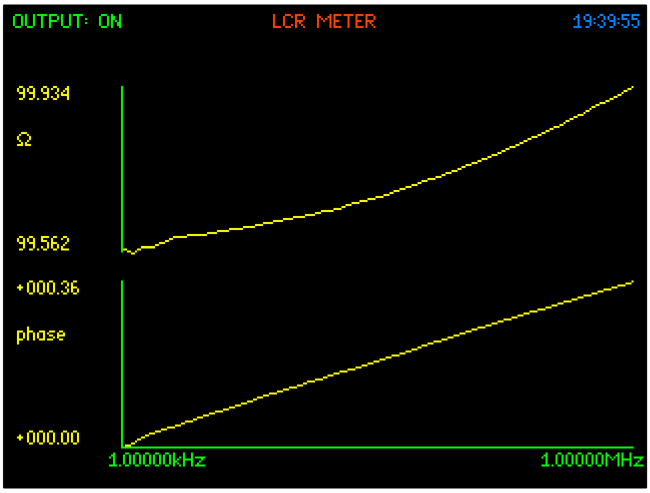
Constant This selection will allow the user to overwrite the present measured frequency with the known frequency. This entered frequency is then used for all the analysis and the frequency of the input signal is not measured.

High speed This mode can be selected for data log speeds less than 100ms, this option is a simple enable/disable choice.

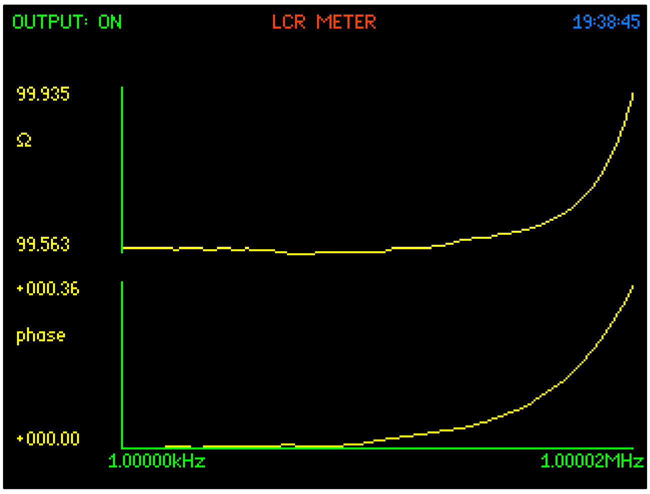
Setting and running a frequency sweep [SWEEP key]

All AC measurements using the PSM3750 generator can be swept across a frequency range. The start frequency stop frequency and number of steps up to a limit of 2000 can be specified. The measurements are subjected to the same speed constraints set in the *ACQU* menu, but the filtering does not apply on each measurement point. If ***sweep*** is set to ***repeat***, then the filtering is applied to each successive sweep.

The signal amplitude and frequency settings used are those set in the generator *OUTPUT* menu. The frequency steps may be set to be logarithmically or linearly spaced. Logarithmic spacing usually gives the clearest display of frequency dependent parameters but linear spacing can be useful in some applications.



In both graphs the same component was swept over the same frequency and number of ***steps***, however in this top graph the sweep ***steps*** are set to ***linear***.



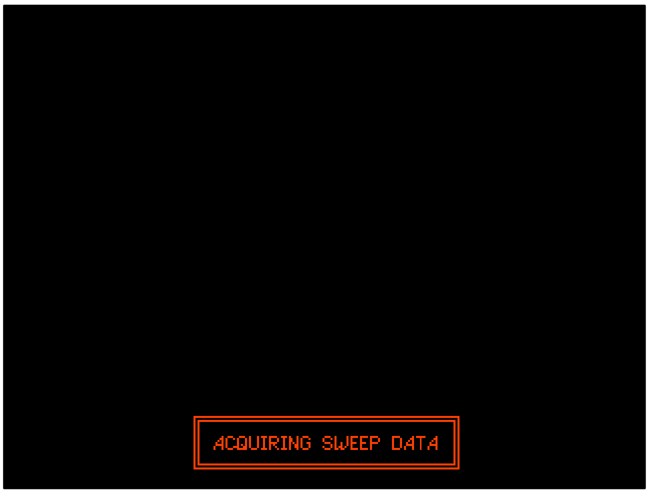
In this graph the component and frequency range are the same as those shown above but the frequency ***steps*** are set to ***log***

The graph normally sets the y axis automatically to the extremes of the measurements (or in FRA mode to 20dB/decade of frequency) but the axis can be fixed if required. The graph of the second parameter (usually phase) can also be independently manually set in a similar manner.

Each frequency point is an entirely new measurement and autoranging is restarted (if enabled). For the fastest possible sweeps, select manual ranging. As each frequency point is a new

measurement, filtering has no effect on a single sweep, but fixed time filtering can be applied independently on each frequency point if repeat sweep in selected.

For maximum sweep speed, particularly when using a large number of points, there is a "fast sweep" mode which disables all non-essential functions, including the display, during the sweep. In this mode, the display is blank except for a flashing message "***ACQUIRING SWEEP DATA***" until the full sweep has been completed when normal display functions are restored. This mode is automatically selected when a user defined window of less than 100ms has been set in the *ACQU* menu options.

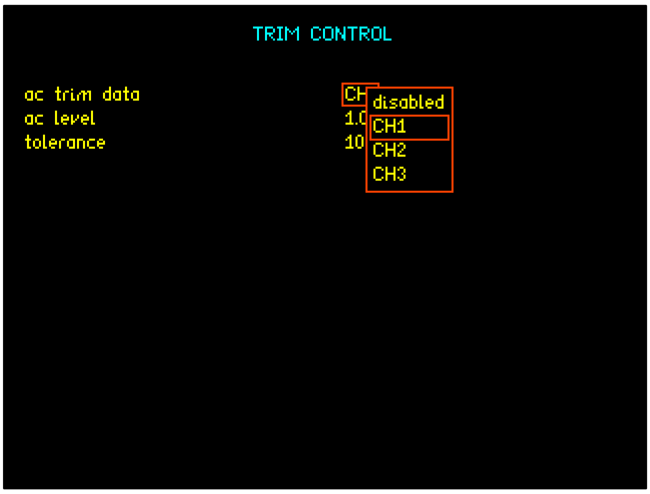


Trim Control [TRIM key]

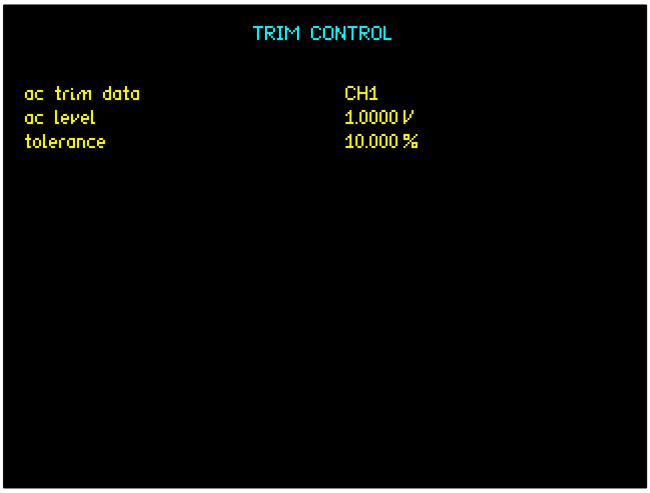
The trim function on the PSM3750 is a powerful and versatile feature that allows closed loop control of the generator amplitude. It allows a specific measurement to be programmed for either CH1, CH2 or CH3 (if fitted) and the generator output will be adjusted to maintain the measured voltage or current. This allows the excitation level to be controlled over changing conditions such as a frequency sweep.

By default, when the TRIM menu screen is first entered ac trim data is set to disabled as shown in the first screen shot.

When disabled is highlighted by use of the ▼key, the first press of the ► key changes the menu to list the Channels



A second press of the ► key changes the menu to a dropdown list of the available Channels.



Note that Channel 1 ac level is shown as volts, each channel can also be shown as amps, this is determined by the input value set in the channel ranging menu. If the input on the channel menu is set to direct or external attenuator then the trim will show ac level as volts, if the channel input is set to shunt, the corresponding ac level will be shown as amps.

At each measurement point, the measured level is checked against the specified level and tolerance; if an adjustment is needed the data is discarded and a new measurement made at the new output level. The user is alerted to the adjustment by an audible beep.

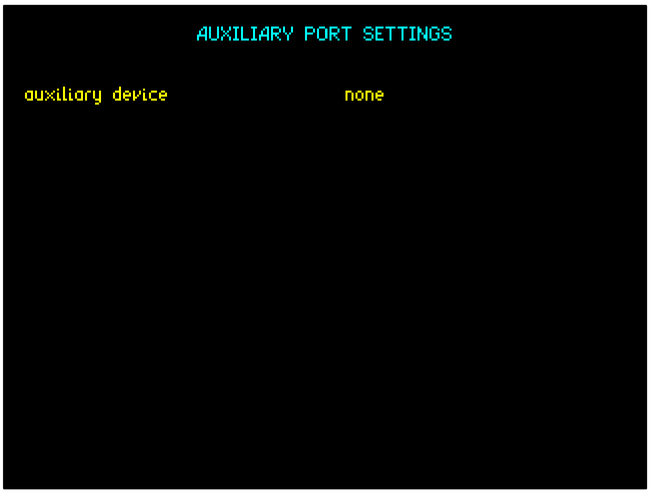
Particularly important in control loop analysis, where it is sometimes referred to as amplitude compression, it prevents the control loop being overdriven as the frequency changes. It is also useful in a more general case where test levels are specified.

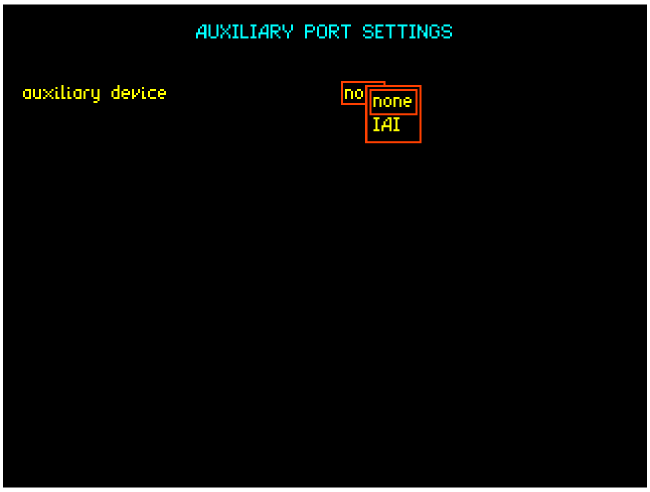
Note that when dBm mode level control is selected, via the ***amplitude control*** in the *Output* menu (see output menu) the trim level is entered as dBm, but the tolerance remains a linear percentage of the actual voltage, not the logarithmic dBm measure.

Auxiliary Port Settings [AUX key]

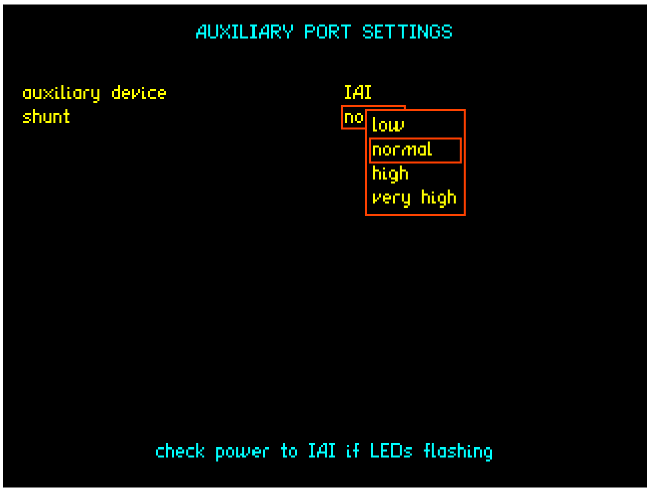
The PSM3750 can be configured to be connected and used for specific analysis applications with the Impedance Analysis Interface. This converts the PSM3750 into a high performance LCR meter with true 4 wire kelvin connections that are taken directly to the component under test without the need for external shunts. Buffering, amplification, and selectable shunts provide LCR measurements over a wide frequency and impedance range.

To select the IAI, press the ▼key and the ***auxiliary device*** which will be set to ***none*** by default will then show a flashing outline. To select the IAI, use the ►or ◄ keys to swap between ***none*** and ***IAI*** as shown in the screenshots below.





When IAI is highlighted, press Enter and Home to select he choice.



Use the ▼ key until the shunt choice is highlighted and then press the ▶ key, this will then allow the chosen shunt in the IAI to be selected.

Low = 5 Ω

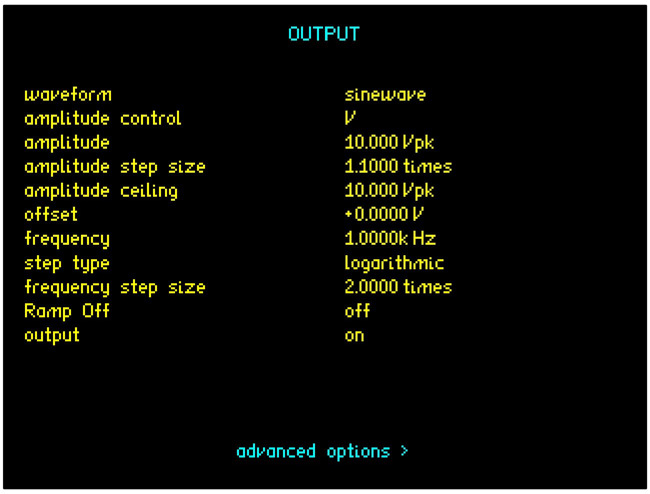
Normal = 50 Ω

High = 5 Ω k

V High = 500k Ω

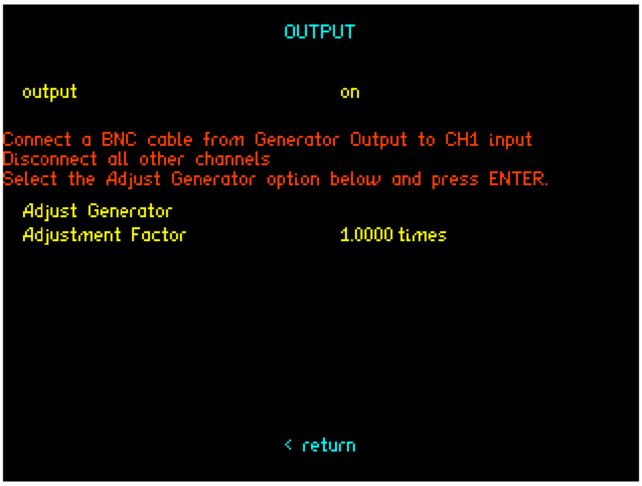
INFORMATION. If the four yellow LED's are flashing check the power cord and main on/off switch on the IAI, as shown below.

Signal Generator Control [OUT key]



PSM3750 has a wide bandwidth, isolated, generator output that can be used as a signal generator to produce various waveforms The output for the signal generator is digitally synthesised. A 150Ms/s, DAC with output filtering, provides a nice sinusoid waveform, even at 35MHz, while preserving very accurate frequency control.

Amplitude, amplitude step size, amplitude ceiling, offset, frequency, & frequency step size are all adjusted as described in the Direct Numeric Entry section. The ► & ◄ keys adjust the frequency of the generator by a fixed increment stored via the ***frequency step size*** parameter; the ▲ & ▼ keys adjust the amplitude (except for the harmonic analyser and power analyser where ▲ & ▼ step the selected harmonic) by a fixed increment stored via the ***amplitude step size*** parameter. Both these adjustments are carried out in the main FRA display screen, (see FRA key)



Advanced options accessed by the ►key gives the menu shown on the left. Generator Adjust: The voltage output generator uses a combination of linear gain and dB gain in hardware, the output range is separated into three voltage bands. Each band of voltages has different settings for the linear and dB gain. When using the generator adjust option, the adjustment is only valid for the band in which the adjustment was performed.

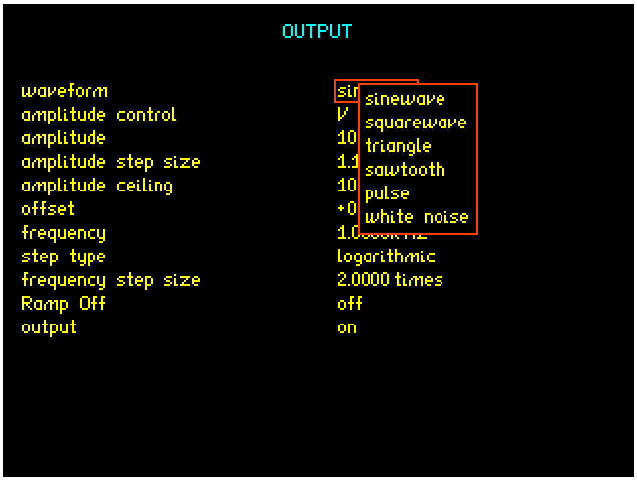
These bands are detailed below;
a) 2.5 to 14.1V
b) 0.5 to 2.5V
c) < 0.5V

The output amplitude is controlled in 2 stages – a fine control with 10 bit resolution, and coarse control with 5 steps. This gives 10mV resolution at high output levels and 1mV resolution at low output levels.

The maximum output available from the generator is a function of frequency:

max frequency	output level into 50Ω	
MHz	peak V	rms V
1	7.5	5
5	5	3.5
10	3	2
15	2	1.4
20	1.5	1
25	1.2	0.8
30	1	0.7
35	0.75	0.5
40	0.6	0.5
50	0.4	0.25

An offset may be added to any output to bias the signal or to null out any DC present with a resolution of +/-10mV.



Waveform This parameter enables the selection of waveform shape for the generator output.

Amplitude control allows the choice between setting amplitude as a peak output voltage or in dBm with reference to 600Ω load.

Amplitude step size the value entered will increase / decrease in relation to pressing the ▲ & ▼ keys, the new value will be displayed within the real-time display (except for the Harmonic and Power Analyzer where the up and down arrow step the selected harmonic).

Amplitude ceiling the maximum value allowed to the output of the generator, this is used when you are using the "trim" function and do not want the output of the generator to go above a certain value, for example if the PSM output is being used to control a DC+AC load bank and you do not want the load bank to go above or below a certain resistance

Offset manually enter any offset to bias the signal or to null out any DC present

Frequency set the frequency of the generator. This can be adjusted by a fixed increment set within the “Frequency step size” via the left and right arrows when in the “Real Time” screens.

Step type This sets the frequency step between linear volts or logarithmic dBm.

Frequency step size the value by which the frequency will increase / decrease in relation to pressing the ▲ & ▼ keys in the “Real Time” screens.

Ramp off This allows the choice between instantaneous switch off of the generator signal, or a controlled ramp down over a period of time.

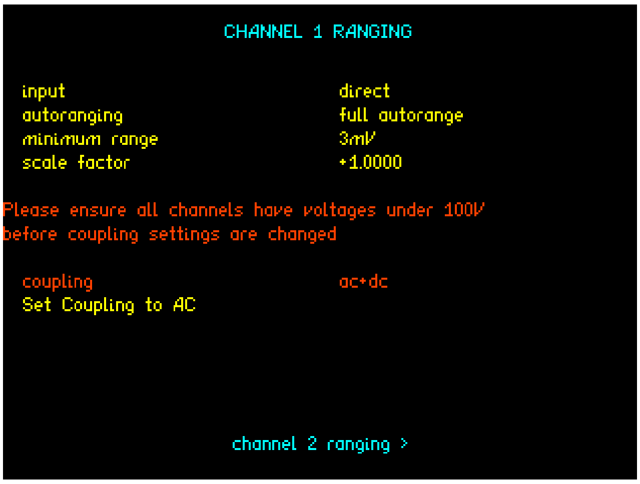
Output May be set to be ***off***, ***on***, or ***DC only***.

Generator Specifications	
Accuracy Magnitude without Trim	Frequency ±0.05% Amplitude ±10% < 25MHz ± 20mV
Magnitude with Trim	(±1% < 1MHz, 5% < 10MHz, 10% < 50MHz) ± 20mV
Output Impedance	50Ω ±2%
Output Voltage	±15V peak (Open Circuit) *
Offset	10V peak maximum
Waveforms	sine, square, triangle, sawtooth, pulse and white noise
Frequency	10µHz to 50MHz
Output Control	10mV to 2mV steps
Type	direct digital synthesis
Update Rate	210MHz
DAC Resolution	14 bit

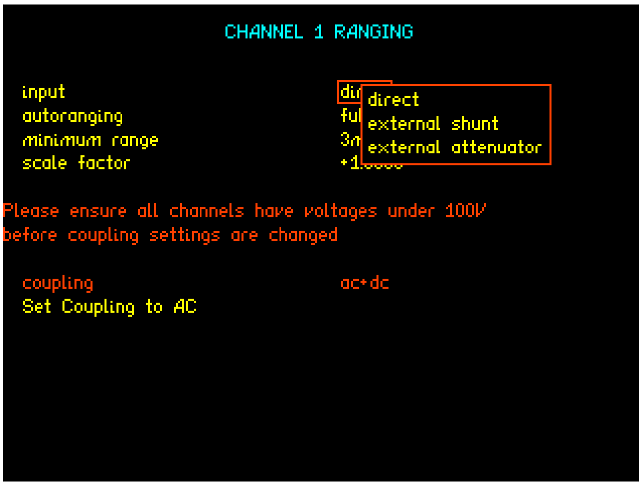
*The absolute amplitude of the generator signal is unimportant in FRA mode, it is only the relative magnitude between two measured inputs that are required, and the absolute amplitude is largely irrelevant in LCR mode, as it is only the relative magnitude/phase angle of two inputs that are required. In the few applications in which generator accuracy becomes important, then the ability to use the TRIM function (See page 54) provides that ability.

Channel 1 & 2 Ranging [CH1 & CH2 keys]

The two or three input channels are fully isolated from each other and earth. The channels are controlled independently but sampled synchronously.



Each input channel may be selected to be:
direct select if input signal is connected directly into the PSM3750 internal shunt connectors
external shunt select if Channel input signal is via an external shunt
external attenuator select if Channel input signal is via an external attenuator

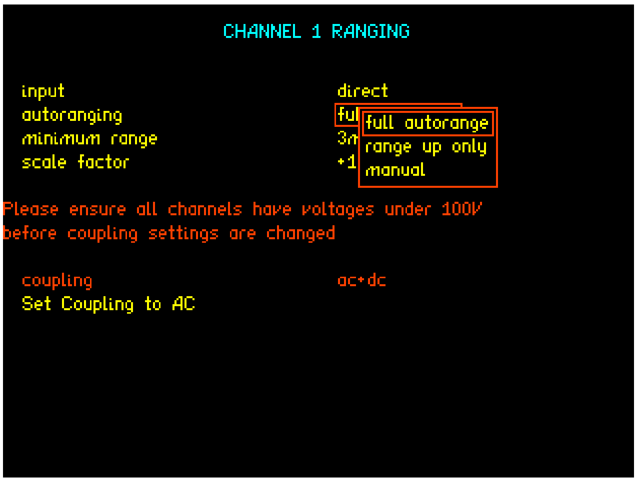


If the external shunt option is selected, the data is scaled by the shunt value (entered under the relevant channel menu using the ***scale factor option***) and the units are displayed in Amps. Any resistor can be used as a shunt, or precision low inductance current shunts are available as accessories, see the Appendix. Current transformers can be used if fitted with an appropriate burden resistor.

INFORMATION.

Note that when in the external shunt mode, input polarity is reversed compared to that of the voltage input: i.e., the - input becomes non-inverting and the + input becomes inverting. This is so that the parasitic capacitance to ground is minimized.

Note that some modes selected by either by use of the Application mode direct access keys or via the options chosen in the MODE menu force the input channels to be voltage or current automatically, e.g., the power meter mode defaults to channel 1 as voltage and channel 2 as current. This automatic selection can be overridden if required by changing the options in the *CH1* & *CH2* menu screens.

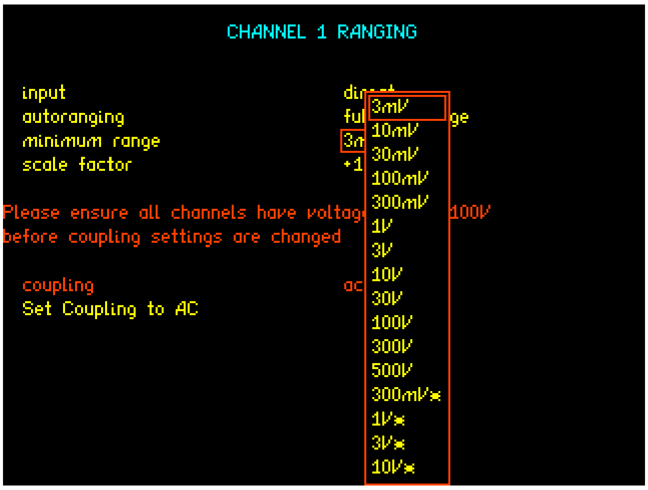


Full autorange this is the default setting. Full autoranging will be selected and implemented within the instrument on bootup unless a custom program has been saved in location 1.

When setting values in an input channel menu, the *ZERO* key provides a quick way to lock and unlock the range. When no flashing box is visible in the input channel menu and auto ranging is selected, pressing the ZERO key selects the range that the instrument is currently using and sets the auto ranging to manual, thus locking the range, and preventing further auto ranging. Pressing the *ZERO* key again returns to full auto ranging from the bottom range.

Range up only selecting this option will allow the test being carried out to find the highest range via peak detection and hold on this range. Once this value has been found another test can be carried out by pressing the “Trigger” button which will restart from the minimum value parameter. Essential for low frequency measurements.

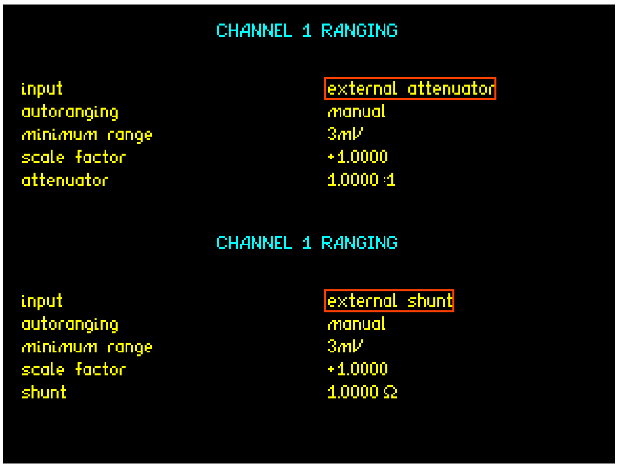
Manual selecting this option will allow the user to set up the range from the configured measurements available. Essential for low frequency measurements.



Minimum range by default this is set at 3mV, but this can be changed, in autoranging mode this will limit the bottom of the autoranging function and if set to manual then this will designate the manual range.

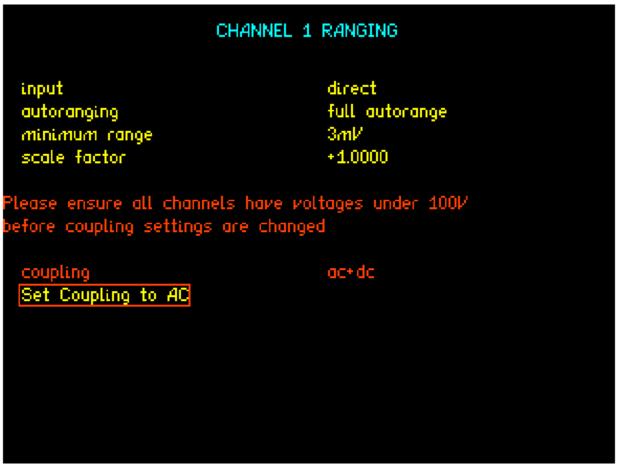
The * next to the last four values in the list designates that a different attenuator (300:1 rather than 10:1) is being used.

Scale factor a scaling factor can be entered for each channel for use with attenuators such as x10 oscilloscope probes. A nominal value can be entered, or the attenuation factor of the probe can be measured, and the precise value entered. The measured voltage will be displayed after multiplication by the scale factor. The scale factor can be set automatically by pressing TRIG when in an input channel menu. For example, with a x10 oscilloscope probe on channel 1 input, a x1 probe on channel 2 input and both probes connected to the same voltage; press CH1 to invoke the input menu for channel 1 then press TRIG and the scale factor for channel 1 is computed so that channel 1 reads the same as channel 2. Note that when using external divider probes to increase the maximum input voltage it is important to use active probes if accurately measuring DC. This because the DC input impedance is different from the AC input impedance. When using passive probes, the DC would read about 10% high.



Attenuator / Shunt When the ***input*** is set to ***external attenuator*** or ***external shunt***, an additional parameter field is displayed enabling the attenuator ratio or shunt value to be entered directly. Do not set both these parameters as well as the scale factor at the same time. The composite screen shot shows both options.

CAUTION. Failure to ensure that all channels have voltages under 100V connected before changing coupling mode, will result in damage to the instrument.



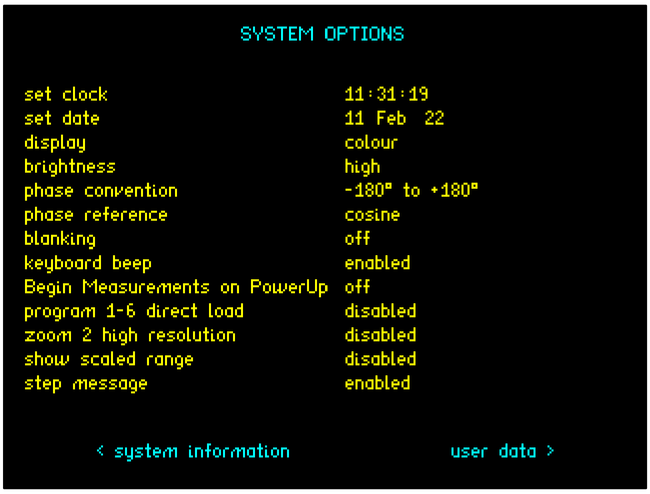
Coupling to change the coupling between AC only and AC+DC press the ▼key until

"Set coupling to…" is highlighted as shown above, then press *Enter* to select the new coupling, the display will then revert to the real time screen in the currently selected mode.

System Options [SYS key]

The systems menu enables the user to set instrument wide defaults, entered by pressing the *SYS* key

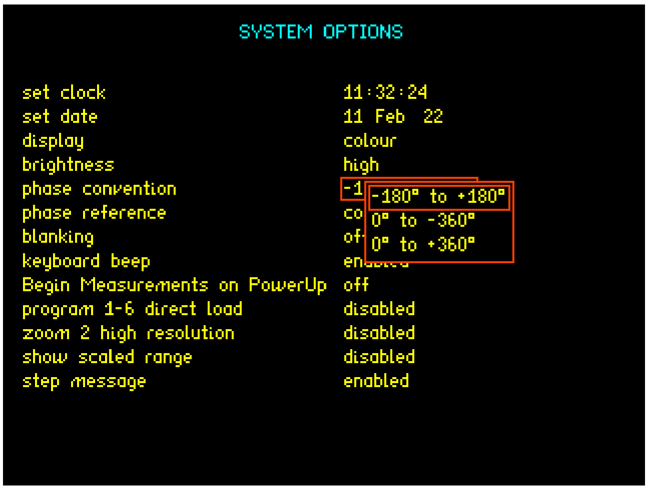
Main default screen



Set clock & ***set date*** these are retained by the on-board back up battery. To edit them follow the Text Entry section.

Display there are three options available, colour, white on black or black on white

Brightness this can be set to high or low



Phase Convention

Measurements of phase can be expressed in one of three conventional formats:

-180° to +180° (commonly used in circuit analysis)

0° to -360° (commonly used in power applications)

0° to +360°

Phase Reference Phase Reference can be set to ***Sine*** or ***Cosine***, only changes the phase of a harmonic, you will see this within Harmonic Mode only.

The measurement made is the same, it is only the way that it is expressed that changes when choosing a different option.

INFORMATION The measurement made is the same, it is only the way that it is expressed that changes when choosing a different option.

blanking blanking only activates for LCR mode when compensation changes the measured value by a factor of 8 or more, the display will blank to zero

keyboard beep each key press is normally accompanied by an audible 'beep' as well as the tactile 'click'. The 'beep' can be disabled for quiet environments if the tactile feel of the key is sufficient feedback.

Begin measurements on Power Up if this parameter is set to on the high voltage message described is disabled and the instrument boots straight into Real Time Measurement mode.

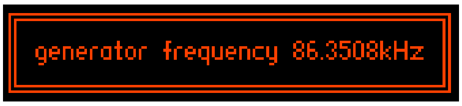
program 1-6 direct load, this parameter is disabled by default and when disabled the 6 main function keys labelled *FRA, PAV, LCR, RMS, POWER, SCOPE,* change the operating mode that the instrument is configured to.

However, if this parameter is set to ***enabled*** the function of these 6 keys changes and they are used to load configurations stored in memory locations 1-6 as a "one-touch" way of configuring the instrument for specific applications. This is a more direct way of accessing stored configurations rather than through the *PROG* menu and stepping through the list of memory locations. This is particularly useful in a production environment where an operator has a small number of specific tests to perform.

Zoom 2 high resolution the measurement parameter selected for Zoom2 can be set to display to one extra digits resolution than normal.

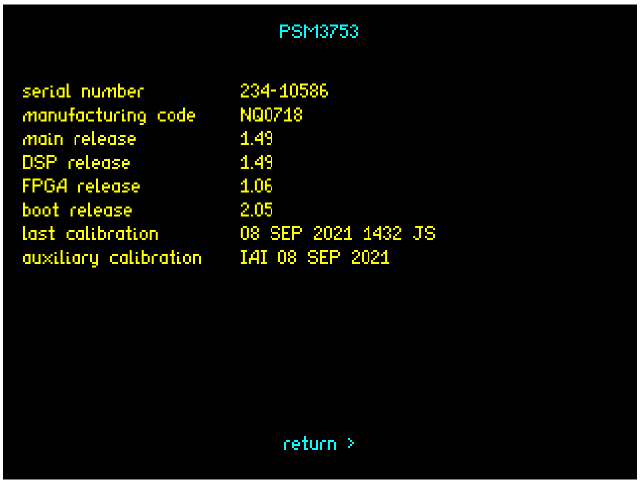
Show scaled range when the scale factor in the CH1 or CH2 menu is set to any value other than unity because of the use of an attenuator or shunt on one or both channels input(s), although the displayed measurement would be the correct value, the range would still reflect the actual input range set if manually set or detected by auto ranging. By enabling this option, the range will display a value commensurate with the measurement being displayed

Step message when enabled each time the ► & ◄ keys are used to adjust the frequency in each of the measurement modes a message is displayed at the bottom of the screen for ≈3 seconds

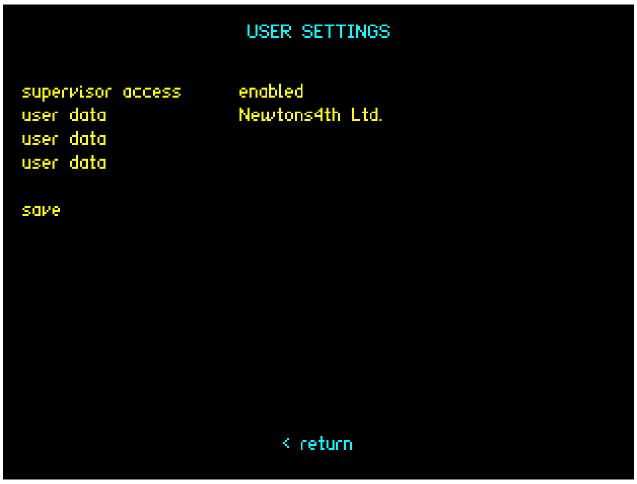


User data > the user data sub menu is accessed by pressing the ► key.

< system information the system information sub menu is accessed by pressing the ◄ key. Once displayed this screen is not editable but gives the user sight of the serial number of the instrument along with the firmware version running and last calibration dates



Pressing the ► key from the ***system options*** screen or the ◄ key twice from the ***user data*** screen will display the ***system information*** screen.

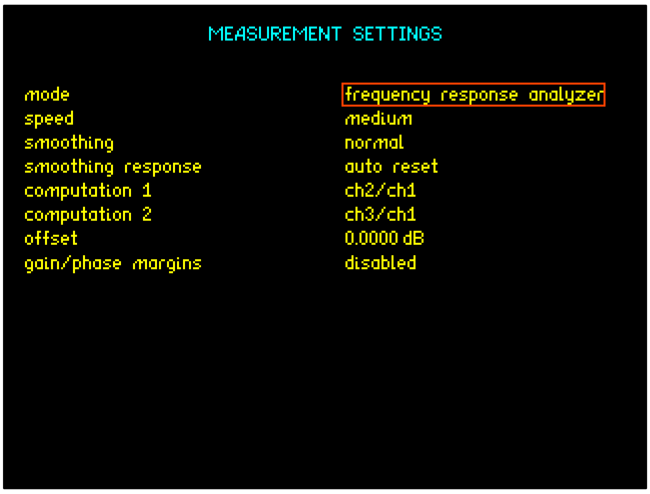


By pressing the ► key twice from the ***system information*** screen the ***user data*** screen will be displayed and the user data

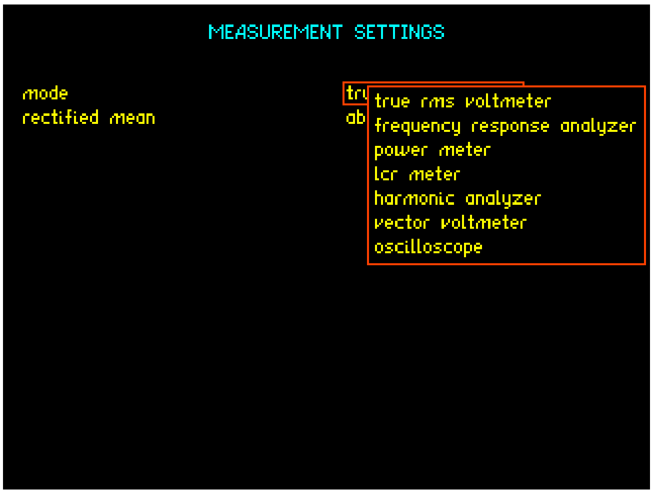
Measurement Settings [MODE key]

The zero (0) key is used to display the *MODE* menu that enables the user to select from the pre-programmed application settings.

To select the operating mode option as shown below, press the ▼key and the option will then show a flashing outline. To select the other application modes, use the ▶and ◀ keys to cycle through the applications as shown in the second screenshot below. If you continue to press the ▼key the option will return to the first option as shown below.



This menu screen provides access to the different application modes that are pre-programmed into the instrument. It is the equivalent to using the Application mode direct access keys.



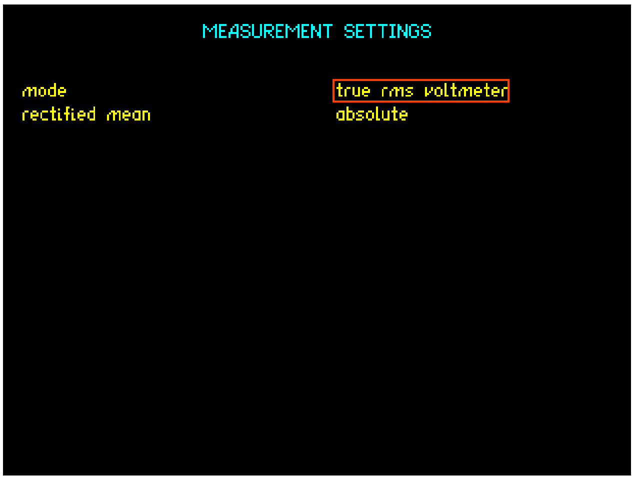
rms voltmeter
↓
frequency response analyser
↓
power meter
↓
LCR meter
↓
harmonic analyser
↓
Vector voltmeter
↓
oscilloscope

Each mode will offer one or more extra parameters pertinent to the application chosen. (See the application section for further details of each mode)

The *MODE* menu or the Application mode direct access keys allow the PSM3750 to be set up with the corresponding parameters and settings for the type of measurement analysis to be undertaken.

This section covers each of the six analysis applications and the oscilloscope mode.

RMS Voltmeter [RMS key]



The RMS voltmeter measures the total rms of the signal present at the input terminals to the bandwidth of the instrument (>1MHz). Care must be taken when measuring low signal levels to minimise noise pick on the input leads.

The RMS voltmeter measures the elementary values:
rms,DC, peak, surge, mean & derives the values: AC, dBm, crest factor and form factor.
The rms value of a periodic waveform, v(ϕ), is given by:

$$rms = \sqrt{\left[1/2\pi \int_{0}^{2\pi} v^2(\phi)\, d\phi \right]}$$

For a sampled signal, the formula becomes:

$$rms = \sqrt{\left[1/n \sum_{i=0}^{i=n-1} v^2[i] \right]}$$

where n is the number of samples for an integral number of complete cycles of the input waveform.

These are fundamental definitions that are valid for all waveshapes. For a pure sinewave, the formulae equate to peak/√2, but this cannot be applied to other waveshapes. The PSM3750 computes the true rms value from the fundamental definition for sampled data.

The DC present is given by:

$$DC = 1/2\pi \int_{0}^{2\pi} v(\phi)\, d\phi$$

For a sampled signal, the formula becomes:

$$DC = 1/n \sum_{i=0}^{i=n-1} v[i]$$

where n is the number of samples for an integral number of complete cycles of the input waveform.

Having computed the true rms and the DC component, the ac component can be derived from:

$$rms^2 = AC^2 + DC^2 \quad => \quad AC^2 = rms^2 - DC^2$$

The AC component is also expressed in dB referred to 1mW into 600Ω (dBm):

$$dBm = 20 \log (V_{AC}/Vref) \qquad \text{where } Vref = \sqrt{(1mW \times 600\Omega)}$$

$$\text{or} \quad 20 \log (I_{AC}/Iref) \qquad \text{where } Iref = \sqrt{(1mW / 600\Omega)}$$

The peak measurement is simply the value with the largest magnitude. Positive and negative peaks are independently filtered then the result with the largest magnitude is taken as the peak value.

To measure surge conditions, the maximum instantaneous peak value (unfiltered) is also recorded. It is important that the PSM3750 does not auto range while measuring surge – either set the ***autoranging*** to ***manual*** or repeat the test with ***autoranging*** set to ***autorange up***. To reset the maximum, press *START*.

Crest factor is derived from the peak and rms:

$$cf = peak / rms$$

The rectified mean measurement is given by:

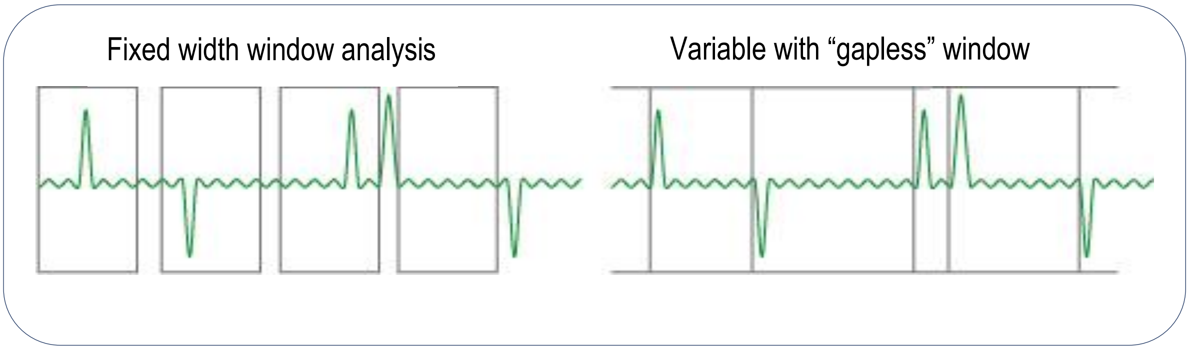
$$mean = 1/2\pi \int_{0}^{2\pi} |v(\phi)| \, d\phi$$

For a sampled signal, the formula becomes:

$$mean = 1/n \sum_{i=0}^{i=n-1} |v[i]|$$

The mean is then normalised to give the same value as rms for a pure sinewave:
Normalised mean = mean x $\pi/2\sqrt{2}$
Form factor is derived from the normalised mean and rms:
ff = mean / rms

The measurements are computed over rectangular windows with no gaps. The processing power of the DSP allows the measurements to be made in real time without missing any samples. In this way, the measured rms is a true value even if the signal is fluctuating. The only occasion when data is missed is when an autozero measurement is requested.



The ZOOM function can be used to select any combination of up to four parameters from the display.
Note that the wideband nature of true rms measurements prevents the use of heterodyning so the frequency range of the measurement is limited to 5MHz. To minimise noise, there is a 100kHz filter applied by default. To obtain the full bandwidth press *ACQU* key, highlight ***bandwidth*** and select ***wide***.

DVM Specification

DVM	
channels	Channels 2 or 3 fully isolated
display	5 digits
measurement	true rms, AC, DC, dBm, peak, cf, surge
coupling	AC or AC+DC
frequency	DC to 5MHz(heterodyning not available)
	20Hz to 5MHz (AC +DC only coupling)
max input	±500V peak
input ranges	*300mV, *1V, *3V, *10V, *= High Voltage Attenuator. 500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
accuracy (AC)	0.075% range + 0.075% reading + 0.1mV <1kHz
	above + 0.003%/kHz < 5MHz
accuracy (DC)	0.1% range + 0.1% reading + 0.5mV
CMRR (typical)	160dB @ 230V 50Hz
	140dB @ 100V 1kHz
	70dB @ 10V 1MHz
time constant	0.2s, 1.5s or 12s

Conditions:

23ºC +/- 5ºC ambient temperature

instrument allowed to warm up for ≥30 minutes

sinewave

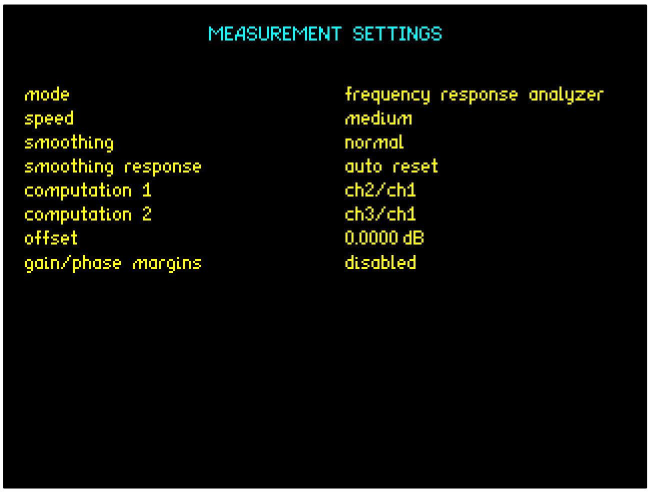
slow speed, normal filtering

AC+DC coupling

autoranging or manual ranging ≥ 1/3 range

Frequency Response Analyser [FRA key]

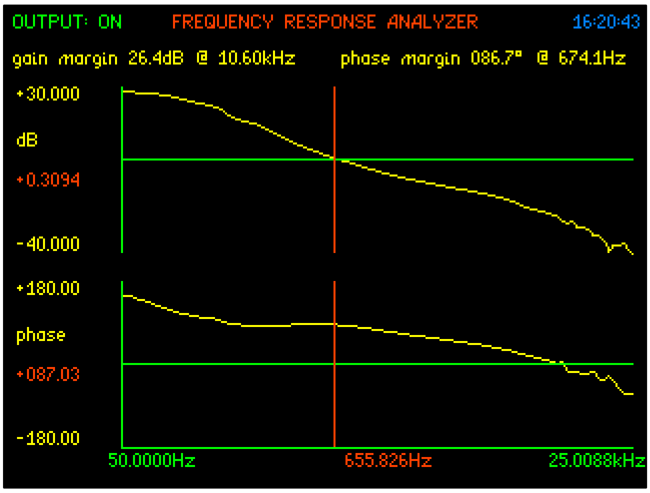
The frequency response of a system can be measured by applying a test signal, for example: an impulse from the built in signal generator to the system and measuring its response using channel 1 and 2. The PSM3750 applies a constant-amplitude sinusoid through the bandwidth of interest and measures the output level and phase shift relative to the input.



The PSM3750 measures the gain and phase of channel 2 relative to channel 1 using a discrete Fourier transform (DFT) algorithm at the fundamental frequency.

The DFT technique can measure phase as well as magnitude and is inherently good at rejecting noise – it is much more reliable than measuring the rms at one point relative to another point.

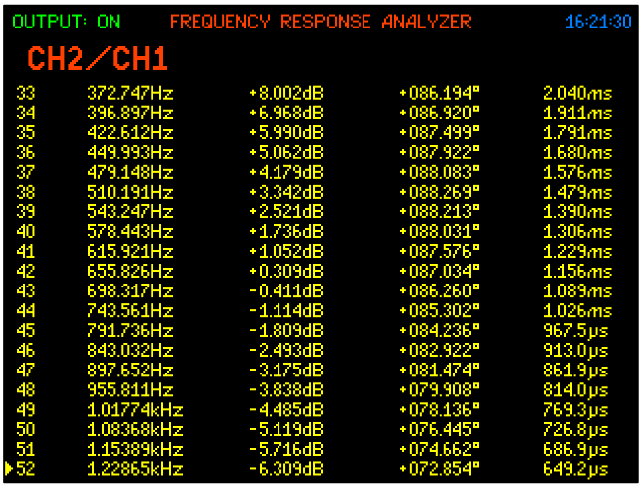
The circuit can be characterised by computing the gain and phase at several points over a swept frequency range. This gives results that show the transfer function of the circuit as a graph on the display.



To display the gain and phase margin results as seen at the top of this screenshot. ***Gain/phase margins*** needs to be changed to enabled in the main Frequency Response Analyser measurement settings menu (shown above) prior to the sweep being initiated.

To switch between the graph and tabular representation of the results, press the *TABLE* & *GRAPH* keys.

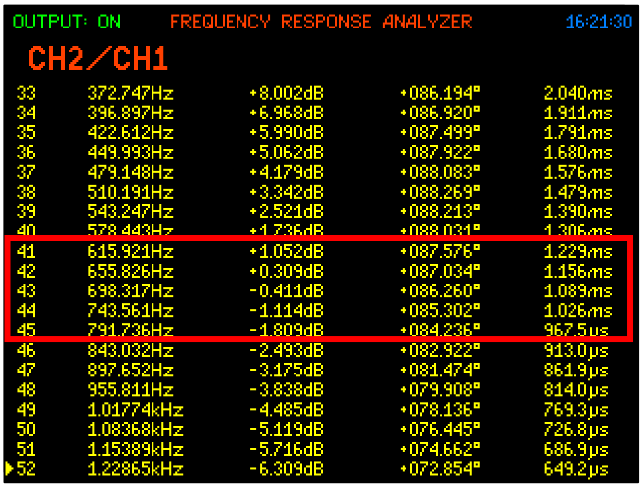
The same data will then be displayed in tabular form as shown below in the following screen shots.


OUTPUT: ON FREQUENCY RESPONSE ANALYZER 16:21:30

CH2/CH1

33	372.747Hz	+8.002dB	+086.194°	2.040ms
34	396.897Hz	+6.968dB	+086.920°	1.911ms
35	422.612Hz	+5.990dB	+087.499°	1.791ms
36	449.993Hz	+5.062dB	+087.922°	1.680ms
37	479.148Hz	+4.179dB	+088.083°	1.576ms
38	510.191Hz	+3.342dB	+088.269°	1.479ms
39	543.247Hz	+2.521dB	+088.213°	1.390ms
40	578.443Hz	+1.736dB	+088.031°	1.306ms
41	615.921Hz	+1.052dB	+087.576°	1.229ms
42	655.826Hz	+0.309dB	+087.034°	1.156ms
43	698.317Hz	-0.411dB	+086.260°	1.089ms
44	743.561Hz	-1.114dB	+085.302°	1.026ms
45	791.736Hz	-1.809dB	+084.236°	967.5μs
46	843.032Hz	-2.493dB	+082.922°	913.0μs
47	897.652Hz	-3.175dB	+081.474°	861.9μs
48	955.811Hz	-3.838dB	+079.908°	814.0μs
49	1.01774kHz	-4.485dB	+078.136°	769.3μs
50	1.08368kHz	-5.119dB	+076.445°	726.8μs
51	1.15389kHz	-5.716dB	+074.662°	686.9μs
▸52	1.22865kHz	-6.309dB	+072.854°	649.2μs

In this example the sweep was of 100 points between 50 Hz and 25kHz. In the Table format the screen can only display 20 data points at a time, use the ▲ & ▼ keys to move up and down through the results. When the ▶ which in this instance is on the bottom of the screen, further presses of the ▼ key will display data point 53 onwards etc.


OUTPUT: ON FREQUENCY RESPONSE ANALYZER 16:21:30

CH2/CH1

33	372.747Hz	+8.002dB	+086.194°	2.040ms
34	396.897Hz	+6.968dB	+086.920°	1.911ms
35	422.612Hz	+5.990dB	+087.499°	1.791ms
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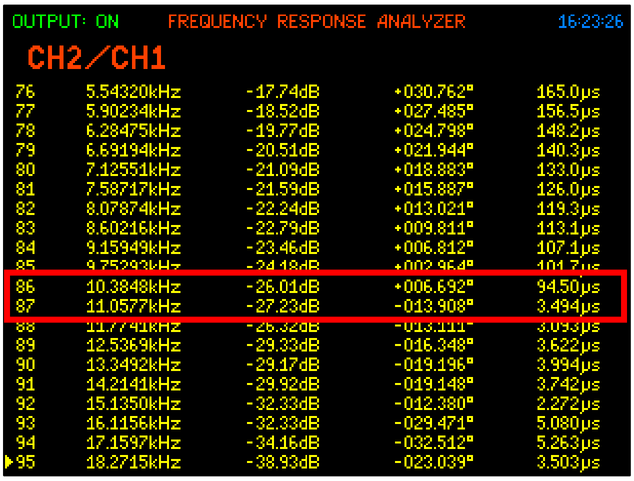
51	1.15389kHz	-5.716dB	+074.662°	686.9μs
▸52	1.22865kHz	-6.309dB	+072.854°	649.2μs

The phase margin for this example is 86.7˚ @ 674.1Hz.

However, this frequency is not one of the equidistance frequency steps calculated by the PSM3750 when the sweep was set up and initiated.

The red section which highlights data points 41 → 45 shows that 3dB point occurred between 655.826Hz and 698.317Hz the result displayed is interpolated to provide the 0 dB point.


OUTPUT: ON FREQUENCY RESPONSE ANALYZER 16:23:26

CH2/CH1

76	5.54320kHz	-17.74dB	+030.762°	165.0μs
77	5.90234kHz	-18.52dB	+027.485°	156.5μs
78	6.28475kHz	-19.77dB	+024.798°	148.2μs
79	6.69194kHz	-20.51dB	+021.944°	140.3μs
80	7.12551kHz	-21.09dB	+018.883°	133.0μs
81	7.58717kHz	-21.59dB	+015.887°	126.0μs
82	8.07874kHz	-22.24dB	+013.021°	119.3μs
83	8.60216kHz	-22.79dB	+009.811°	113.1μs
84	9.15949kHz	-23.46dB	+006.812°	107.1μs
85	9.75293kHz	-24.18dB	+002.964°	101.7μs
86	10.3848kHz	-26.01dB	+006.692°	94.50μs
87	11.0577kHz	-27.23dB	-013.908°	3.494μs
88	11.7741kHz	-28.32dB	-013.111°	3.093μs
89	12.5369kHz	-29.33dB	-016.348°	3.622μs
90	13.3492kHz	-29.17dB	-019.196°	3.994μs
91	14.2141kHz	-29.92dB	-019.148°	3.742μs
92	15.1350kHz	-32.33dB	-012.380°	2.272μs
93	16.1156kHz	-32.33dB	-029.471°	5.080μs
94	17.1597kHz	-34.16dB	-032.512°	5.263μs
▸95	18.2715kHz	-38.93dB	-023.039°	3.503μs

The same interpolation method is used to give the gain margin of 26.4dB @10.60kHz. Data points 86 and 87 are either side of the gain margin frequency of 10.6kHz and dB value for these two points also straddle the interpolated result.

The DFT analysis yields two components – in-phase and quadrature, or 'a' and 'b' values – from which the magnitude and phase can be derived.

Considering the components at the fundamental frequency:

The fundamental in-phase and quadrature values of a periodic waveform, $v(\phi)$, are given by:

$$a_1 = 1/\pi \int_0^{2\pi} v(\phi).\cos(\phi)\, d\phi \qquad \& \qquad b_1 = 1/\pi \int_0^{2\pi} v(\phi).\sin(\phi)\, d\phi$$

For a sampled signal, the formulae become:

$$a_1 = 1/n \sum_{i=0}^{i=n-1} v[i].\cos(2\pi ci/n) \qquad \& \qquad b_1 = 1/n \sum_{i=0}^{i=n-1} v[i].\sin(2\pi ci/n)$$

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:

$$\text{mag} = \sqrt{(a_1^2 + b_1^2)} \qquad \& \qquad \theta = \tan^{-1}(b_1/a_1)$$

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)

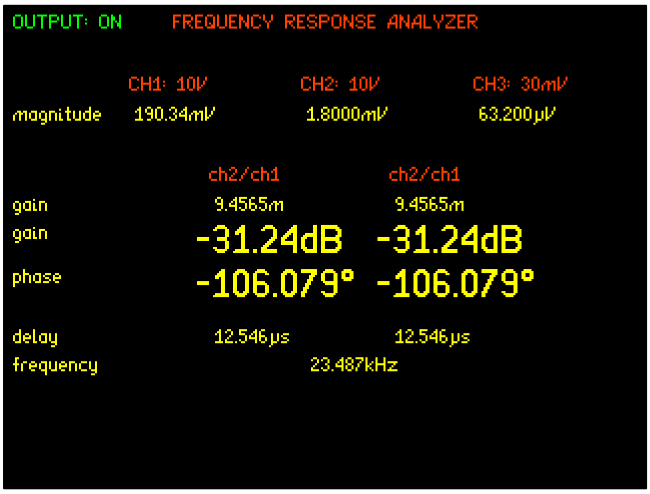
To look at differences in gain from a nominal value, an offset gain can be applied either manually or by pressing *ZERO.*

offset gain = measured dB – offset dB

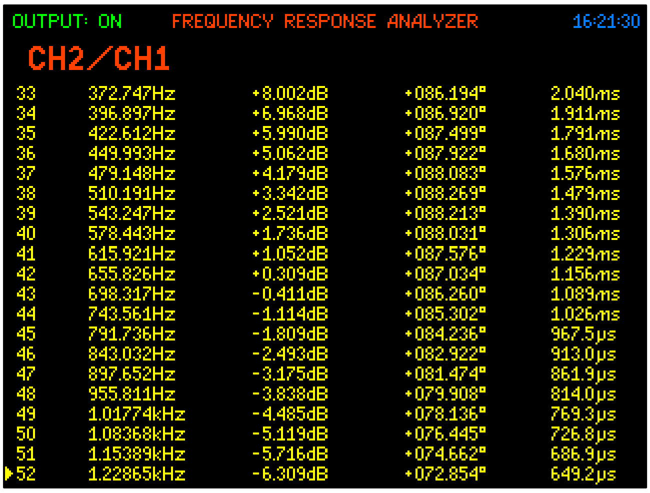
INFORMATION In the above equations for gain, the fundamental values are used.

The filtering is applied to the real and quadrature components individually, rather than the derived magnitude and phase values. This gives superior results as any noise contribution to the components would have random phase and therefore would be reduced by filtering.

The PSM3750 can operate either in real time mode at a single frequency where the gain and phase are filtered and updated on the display continually, or it can sweep a range of frequencies and present the results as a table or graphs of gain and phase.



Real time FRA display

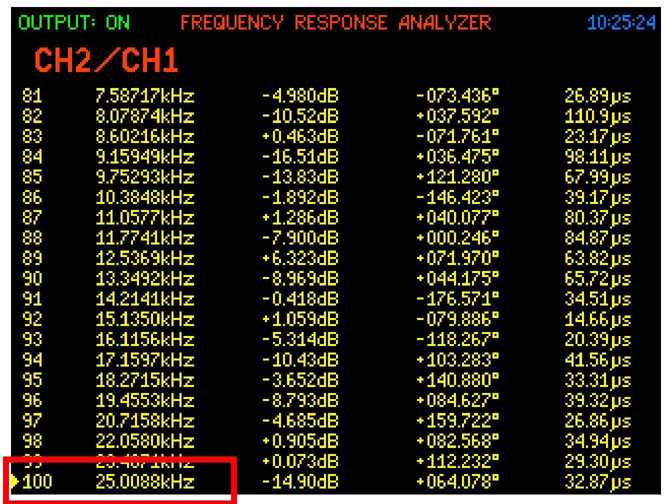


33	372.747Hz	+8.002dB	+086.194°	2.040ms
34	396.897Hz	+6.968dB	+086.920°	1.911ms
35	422.612Hz	+5.990dB	+087.499°	1.791ms
36	449.993Hz	+5.062dB	+087.922°	1.680ms
37	479.148Hz	+4.179dB	+088.083°	1.576ms
38	510.191Hz	+3.342dB	+088.269°	1.479ms
39	543.247Hz	+2.521dB	+088.213°	1.390ms
40	578.443Hz	+1.736dB	+088.031°	1.306ms
41	615.921Hz	+1.052dB	+087.576°	1.229ms
42	655.826Hz	+0.309dB	+087.034°	1.156ms
43	698.317Hz	-0.411dB	+086.260°	1.089ms
44	743.561Hz	-1.114dB	+085.302°	1.026ms
45	791.736Hz	-1.809dB	+084.236°	967.5µs
46	843.032Hz	-2.493dB	+082.922°	913.0µs
47	897.652Hz	-3.175dB	+081.474°	861.9µs
48	955.811Hz	-3.838dB	+079.908°	814.0µs
49	1.01774kHz	-4.485dB	+078.136°	769.3µs
50	1.08368kHz	-5.119dB	+076.445°	726.8µs
51	1.15389kHz	-5.716dB	+074.662°	686.9µs
52	1.22865kHz	-6.309dB	+072.854°	649.2µs

The frequency points to be measured are specified with three parameters:

number of steps, start frequency, & end frequency.

The results are shown in a tabulated format with five columns, step number, frequency, gain, phase, and delay.



81	7.58717kHz	-4.980dB	-073.436°	26.89µs
82	8.07874kHz	-10.52dB	+037.592°	110.9µs
83	8.60216kHz	+0.463dB	-071.761°	23.17µs
84	9.15949kHz	-16.51dB	+036.475°	98.11µs
85	9.75293kHz	-13.83dB	+121.280°	67.99µs
86	10.3848kHz	-1.892dB	-146.423°	39.17µs
87	11.0577kHz	+1.286dB	+040.077°	80.37µs
88	11.7741kHz	-7.900dB	+000.246°	84.87µs
89	12.5369kHz	+6.323dB	+071.970°	63.82µs
90	13.3492kHz	-8.969dB	+044.175°	65.72µs
91	14.2141kHz	-0.418dB	-176.571°	34.51µs
92	15.1350kHz	+1.059dB	-079.886°	14.66µs
93	16.1156kHz	-5.314dB	-118.267°	20.39µs
94	17.1597kHz	-10.43dB	+103.283°	41.56µs
95	18.2715kHz	-3.652dB	+140.880°	33.31µs
96	19.4553kHz	-8.793dB	+084.627°	39.32µs
97	20.7158kHz	-4.685dB	+159.722°	26.86µs
98	22.0580kHz	+0.905dB	+082.568°	34.94µs
99	[illegible]	+0.073dB	+112.232°	29.30µs
100	25.0088kHz	-14.90dB	+064.078°	32.87µs

The PSM3750 computes a multiplying factor that it applies to the start frequency for the specified number of steps. Note that due to compound multiplication it is unlikely that the end frequency will be exactly the end frequency specified. As shown in this example the sweep was set from 50Hz to 25kHz with 100 steps, however the end frequency was calculated just over the 25kHz that was set at 25.0088kHz.

The frequency sweep is initiated by the *START* key, and when completed the data can be viewed as a table or graphs. The *TABLE* and *GRAPH* keys switch between the two display formats, repeated presses of the *GRAPH* key step through the different graph displays gain v frequency, phase v frequency and gain & phase v frequency.

Following a sweep on a control loop, the gain and phase margins can be computed and displayed on the graph. The gain and phase margins are displayed at the top of the graph display screen if the ***gain/phase margins*** parameter is set to ***enable***

The window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. In real time mode the results from each window are passed through a digital filter equivalent to a first order RC low pass filter; in sweep mode, each result comprises a single window without any filtering unless repeat sweep is selected.

The top of the vertical axis for the graph is normally set to be the highest measured value during the sweep. The bottom of the vertical axis is normally either set to the lowest measured value or

the result of the highest value less 20dB/decade of frequency. The vertical axis can be fixed to a manual scale using the menus.

The *ZOOM* function can be used to select up to four parameters from the display when in real time mode. It has no function following a sweep. Pressing *TRIG* restarts the real time measurement at the selected frequency.

Although it is most usual to use the PSM3750 generator when performing gain/phase analysis, there may be circumstances where this is impractical, for example measuring across a transformer under load. In this case, turn off the PSM3750 generator (*OUT* menu) and the frequency reference for the analysis is measured from channel 1. Provided that the signal is clean enough for an accurate frequency measurement (and for DFT analysis the frequency does need to be accurately known), then the gain and phase can be measured reliably.

INFORMATION.

When using an external frequency reference there can be no sweep function.

Frequency response analyser specification

Frequency response (gain/phase) analyser		
frequency	10µHz to 50MHz (own generator) 20mHz to 1MHz (external source)	
max input	±500V peak	
input ranges	*300mV, *1V, *3V, *10V, *= High Voltage Attenuator. 500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV	
ranging	full auto, up only, or manual	
input impedance	1M Ohm // 30pF (exc. leads)	
Magnitude accuracy (auto) (wide)	0.075% range + 0.075% reading + 50µV as above + 0.0003%/kHz as above + 0.003%/kHz	<10kHz < 50MHz < 5MHz
gain accuracy (auto) (wide)	0.01dB 0.01 dB + 0.0001 dB/kHz 0.31 dB + 0.00004 dB/kHz 0.01 dB + 0.001 dB/kHz	<10kHz < 5MHz < 50MHz < 5MHz
phase accuracy (auto) (wide)	0.025° 0.05° + 0.00025°/kHz 0.025° + 0.002°/kHz	< 10kHz < 50MHz < 5MHz
CMRR (typical)	160dB @ 230V 50Hz 140dB @ 100V 1kHz 70dB @ 10V 1MHz	
sweep step rate	1/20s, 1/3s or 2.5s (approx.)	

Conditions:

23ºC +/- 5ºC ambient temperature

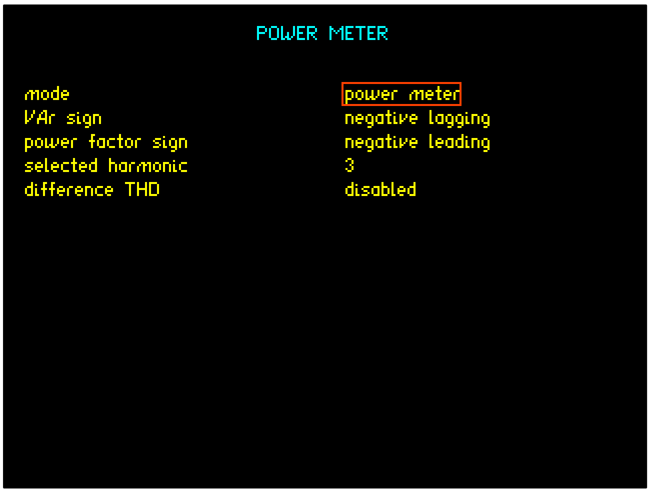
instrument allowed to warm up for ≥30 minutes

AC+DC coupling

auto ranging or manual ranging ≥ 1/3 range
signals > 10mV

Power Meter [POWER key]

The power meter measures the total power and fundamental power of the signal present at the input terminals to the bandwidth of the instrument (>1MHz). Above 5MHz, only the fundamentals are measured.



One of the inputs must be configured as an external shunt input. The external shunt may be a simple resistor or dedicated high frequency precision shunts are available as accessories, see appendix A. Current transformers and clamps may be used if fitted with a suitable burden resistor.

The power meter will operate either from its own generator or, more normally, will use the frequency measured on channel 1 (usually voltage).

The VAr and power factor sign convention can be switched between negative lagging (default) to negative leading.

The selected harmonic can be set to a maximum of 100th

Difference THD can be set to disabled or enabled.

The power meter measures the elementary values:

Watts, Volts rms, & Amps rms

Volts & Amps fundamental (in-phase and quadrature)

Volts $_{DC}$ & Amps $_{AC}$

Volts & Amps harmonic (in-phase and quadrature)

Frequency

and derives the following values:

Volts & Amps fundamental magnitude

VA (true and fundamental)

power factor (true and fundamental)

fundamental Watts

harmonic Watts

phase shift

When the integrator function is activated, the following values are available:

Elapsed time (in hours, minutes, and seconds)

Watt-hours (true and fundamental)

VA hours (true and fundamental)

average power factor (true and fundamental)

Ampere hours (true and fundamental)

The power dissipated in a load subjected to a periodic voltage, v(ϕ), with a current flowing a(ϕ), is given by:

$$w = 1/2\pi \int_{0}^{2\pi} v(\phi).a(\phi)\, d\phi$$

For a sampled signal, the formula becomes: $$w = 1/n \sum_{i=0}^{i=n-1} v[i].a[i]$$

where n is the number of samples for an integral number of complete cycles of the input waveform.

These are elementary definitions that are valid for all waveshapes. The PSM3750 computes the true watts value from the elementary definition for sampled data. Formulae for the components at the fundamental frequency are given in the section on frequency response analysis; formulae for the harmonic components are given in the section on harmonic analysis.

The formulae for the derived results are:

VA	$= V_{rms} \times A_{rms}$
power factor	= Watts/VA
fundamental Watts	$= V_{real} \times A_{real} + V_{quad} \times A_{quad}$
harmonic Watts	$= VH_{real} \times AH_{real} + VH_{quad} \times AH_{quad}$
fundamental VA	$= V_{fund} \times A_{fund}$
fund power factor	$= W_{fund} / VA_{fund}$

INFORMATION.

In power meter mode, the ▲ & ▼keys do not adjust the amplitude but step the harmonic number.

The measurements are computed over rectangular windows with no gaps. The processing power of the DSP allows the measurements to be made in real time without missing any samples. In this way, the measured power is a true value even if the signal is fluctuating. The only occasion when data is missed is when an autozero measurement is requested.

The high linearity of the PSM3750 allows real-time measurements be made on waveforms with periodic bursts such as low standby power PSUs. Use ***range up only*** in the *CH1* & *CH2* menus to find the range.

The PSM3750 blanks the results when either of the measured rms signals are low compared to the full scale range. This function can be disabled via the low blanking option if desired in the SYSTEM OPTIONS menu.

The ZOOM function can be used to select any combination of up to four parameters from the display.

The integrator is started, or reset, by pressing the *START* key. The Watt hour integration and the Ampere hour integration can be selected to be ***signed*** or ***magnitude***. To integrate the total power in terms of heating effect, choose magnitude. If signed integration is selected, then the rms current is given the sign of the power before integration. The Ampere hours and Watt hours then reflect the power taken by the load, less any power generated by the load, such as during regenerative braking in battery systems.

Power meter specification

Power meter	
current input	external shunt or Voltage CT
display	5 digits
measurement	W, VA, PF, V, A, Total, Fundamental, Integrated & Power Harmonics
coupling	AC+DC, AC(<10VDC), AC(<500VDC)
frequency	DC & 10mHz → 5MHz
	5MHz to 50MHz (fundamentals only)
	AC 20Hz to 50MHz (AC only coupling)
max input	±500V peak
input ranges	300mv* 1v* 3v* 10v* *=High Voltage Attenuator: 500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
accuracy (AC)	0.1% range + 0.1% reading + external shunt tolerance
accuracy (DC)	0.2% range + 0.2% reading
CMRR (typical)	160dB @ 230V 50Hz
	140dB @ 100V 1kHz
	70dB @ 10V 1MHz
time constant	0.2s, 1.5s or 12s

Conditions:

23ºC +/- 5ºC ambient temperature

instrument allowed to warm up for ≥30 minutes

sinewave, power factor > 0.7

slow speed, normal filtering

AC+DC coupling

autoranging or manual ranging ≥ 1/3 range

Tolerance of current shunt to be added

LCR Meter [LCR key]

Impedance Analysis – an overview

Real Components are never ideal resistors, capacitors or inductors because of unwanted parasitic effects arising from their construction.

It is useful to model a real component as an appropriate combination of ideal resistance, capacitance, and inductance. For example, a real inductor at a frequency below its resonant frequency may be modelled as a pure inductor with a series resistor; a real resistor may be modelled as a pure resistor with a series inductance or by a pure resistor with a parallel capacitance; a capacitor is most commonly modelled as a pure capacitor with a series resistance.

The parameters of real components vary with the conditions of frequency and voltage/current under which they are used.

In many cases, components are used under conditions where the parasitic effects of the component become critical and must be measured reliably over a wide range of operating conditions.

The impedance is analysed by measurement of the complex impedance, Z under controlled conditions of frequency and voltage or current:

$Z = V / I$ Where V is the voltage across the component & I is the current through the component.

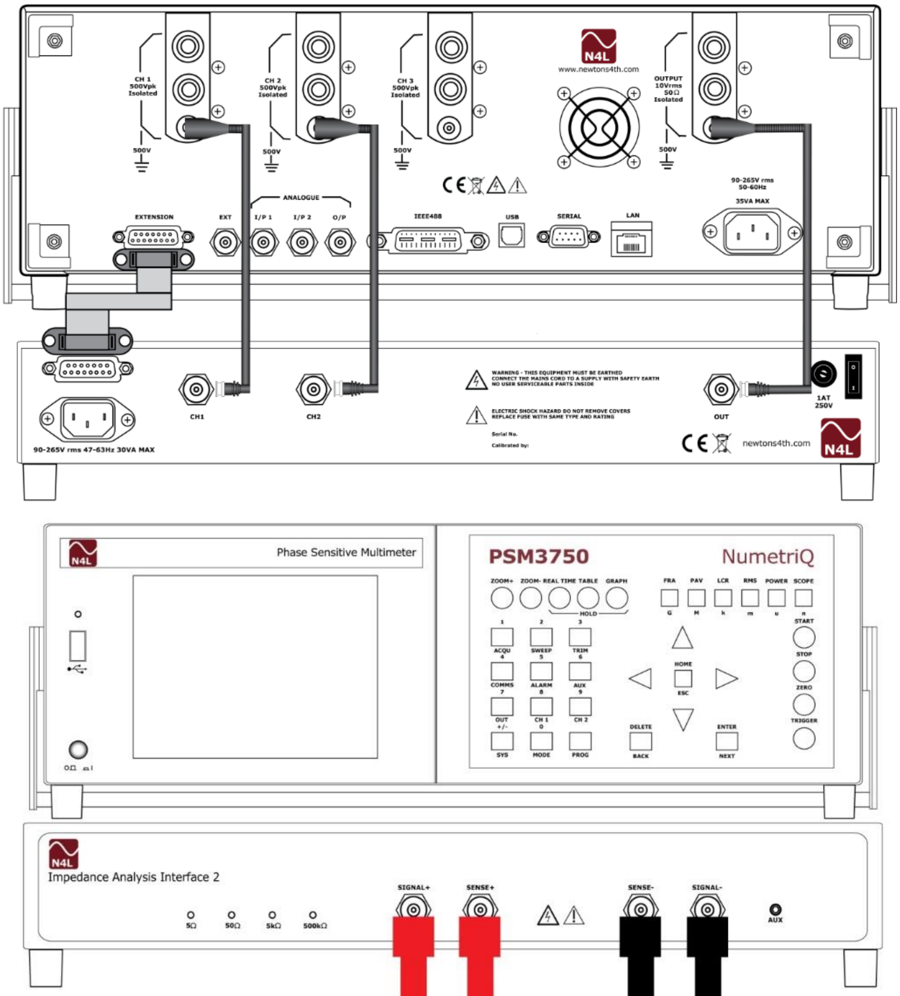
Z, V and I are complex values which may be represented as magnitude and phase or by in-phase and Quadrature components. The LCR measurement is performed by the PSM3750 using a discrete Fourier transform (DFT) at the frequency of operation. This gives the complex impedance directly in the form of an in-phase component and a Quadrature component.

It is important to characterise the component of interest over all the frequencies that are relevant for a given application. For this reason, the IAI2 (see Appendix) can be used in conjunction with the PSM3750 to sweep across a frequency range.

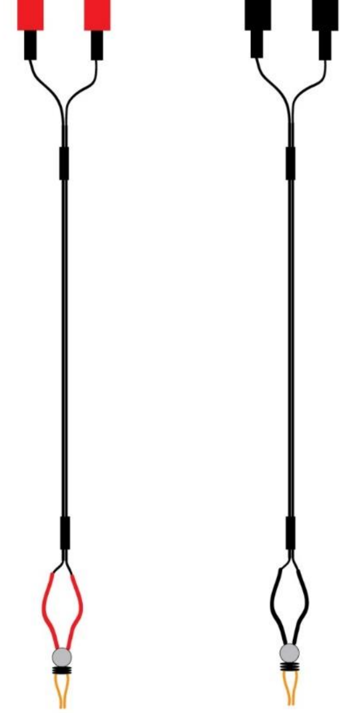
The IAI2 is a separate unit that sits beneath the PSM3750. This also provides a choice of four shunts (low, normal, high & very high) in addition it provides greater bandwidth and a wider impedance measuring range. The IAI2 can be used with either 4 wire Kelvin clip connections or the Kelvin fixture which is the preferred fixture when the test frequency exceeds 5MHz, as it exhibits low parasitics and offers a reliable and repeatable method of connection to the components being tested.

Site the IAI2 under the PSM3750; connect the 3 short BNC leads from the BNC connectors on the rear of the IAI2 (OUT, CH1, and CH2) to the corresponding isolated BNC connectors on the PSM3750 above it. Connect the ribbon cable from the extension port on the rear of the IAI2 to the extension port on the rear of the PSM3750 as shown in the diagram below.

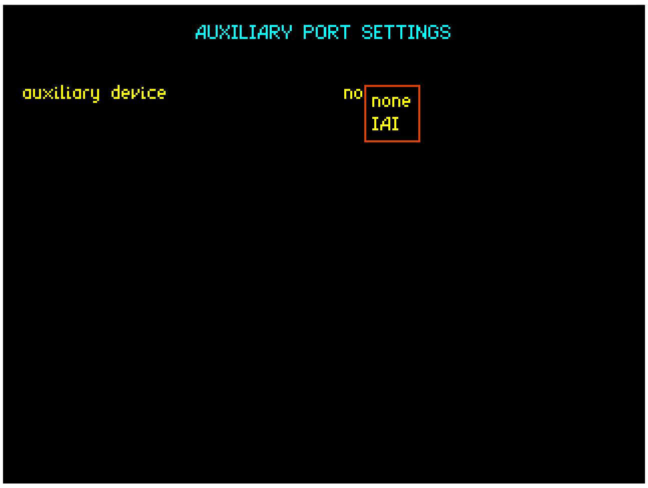
CAUTION. Ensure both the PSM3750 and IAI2 are switched off before making connection to each other.



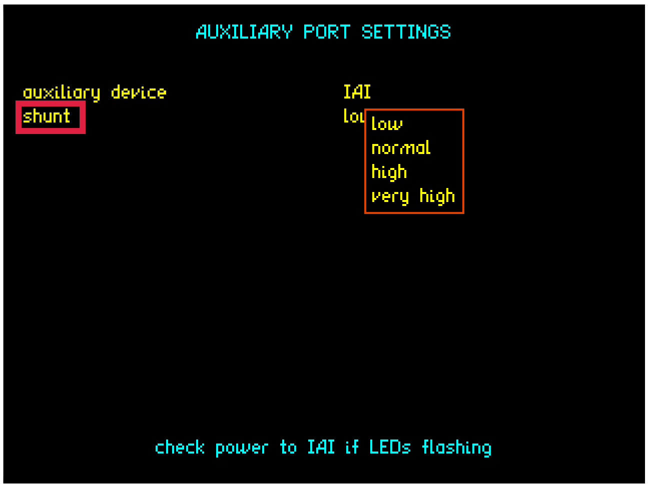
Connect the Red Kelvin Lead to the Signal + & Sense + BNC connectors on the front of the IAI2. The Black Kelvin leads should be connected to the Sense - & Signal - BNC connectors.



Switch on the IAI2 and the PSM3750. All 4 LEDs on the front of the IAI2 should illuminate. The display on the front of the PSM3750 should illuminate with the model name and the firmware version for a few seconds whilst it performs some initial tests. It will then default into the RMS Voltmeter display unless a program has been stored within PROG 1.

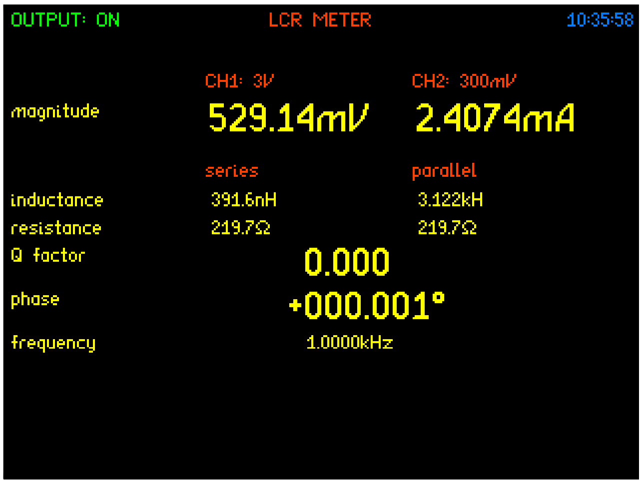


To use the IAI2, after fitting to the PSM3750 press the *AUX* key and change the ***auxiliary device*** to ***IAI***.



Once the IAI has been selected, a second parameter will appear, displaying the IAI2's choice of four shunts (***low, normal, high,*** & ***very high***), Use the ▼ key until ***normal*** is highlighted and press *Enter*. Check that only the LED labelled 50Ω is now illuminated on the IAI2.

If the PSM3750 displays the message shown, then check that the extension port cable is fitted securely at both connectors. If this message does not appear but all 4 LEDs remain illuminated and flashing check that the IAI2 is correctly connected to the mains supply at the rear and that the fuse is intact.



To test that the IAI2 is responding, connect across the Kelvin leads an appropriate test component, for example a 220Ω resistor and switch on the PSM's generator from the *OUT* menu. Press the *LCR* key and make sure that the test component is measured correctly as shown in the adjacent screen shot.

Using the IAI2

In LCR meter mode, channel 1 measures the voltage across the component under test, and channel 2 measures the current through it. To measure the current, channel 2 must be connected across an appropriate external shunt. This is provided by the use of the IAI2.

The device under test (DUT) is measured by the IAI2 in a configuration where the component is ground referenced. This allows the IAI2 to be used to measure the impedance of devices even when one terminal is connected to earth.

The IAI2 has 4 selectable shunts to sense the current through the DUT

SHUNT	VALUE
LOW	5Ω
NORMAL	50Ω
HIGH	5kΩ
VERY HIGH	500kΩ

When the IAI is selected on the instrument via the *AUX* menu as described earlier, the resistance value is automatically entered as the external shunt for channel 2. The shunt may be selected manually or the PSM3750 can be configured to select it automatically.

INFORMATION. For high precision measurement under some conditions, it may be necessary to compensate for parasitic within the test connections explained in compensation

The different shunts built into the IAI2 allow the test conditions to be modified to optimise the measurement accuracy. In general, a higher value shunt increases the magnitude of the current signal at the A/D and decreases the magnitude of the voltage signal across the component; conversely a lower value shunt decreases the magnitude of the current signal at the A/D and increases the magnitude of the voltage signal.

Optimum accuracy is when the voltage and current signals are approximately equal (the impedance of the shunt is approximately the same as the impedance of the DUT), but good results can be obtained with impedances within a factor of 100 of the shunt value.

It is necessary to take great care in order to achieve the best accuracy of measurement. The leads of the component must be scrupulously clean and for repeatability the component must be connected in exactly the same position. Slight variations in connection can result in significantly different measured values, especially at high frequencies.

In general, the "very high" shunt should only be used for high impedance measurements (>1MΩ) at low frequencies (<1kHz).

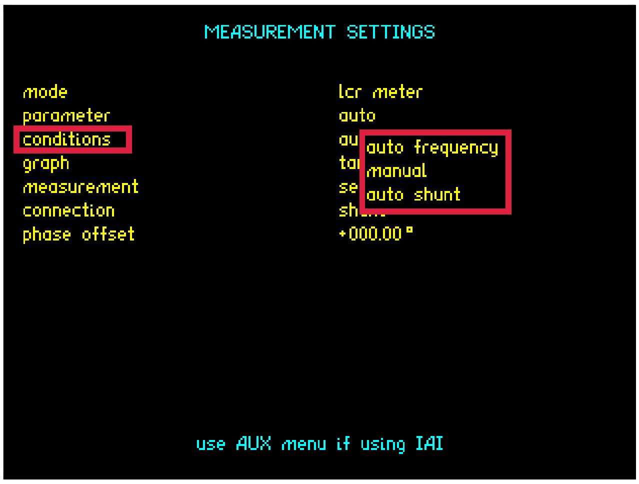
The "low" shunt is used with higher current testing of low impedances as it includes a current boosting amplifier that can deliver up to 0.5Arms.

⚠ **WARNING.** High Voltages can be generated when the current flowing through an inductive component is interrupted. So, remember to turn the output OFF before disconnecting an inductive or unknown component.

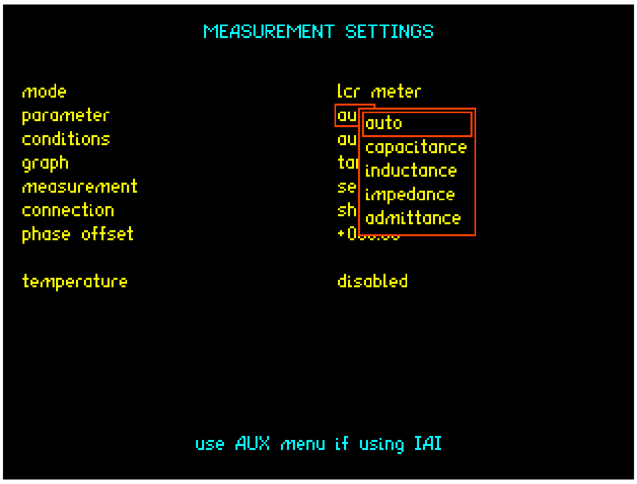
The "normal" and "high" shunts are general purpose and between them cover a wide impedance range.

SHUNT	IMPEDANCE RANGE	FREQUENCY RANGE
LOW	<50Ω	<10MHz
NORMAL	50mΩ to 50kΩ	all
HIGH	5Ω to 5MΩ	all
VERY HIGH	>1MΩ	<1kHz

The table above is only a guide, and each "shunt" can be used beyond the limits quoted.

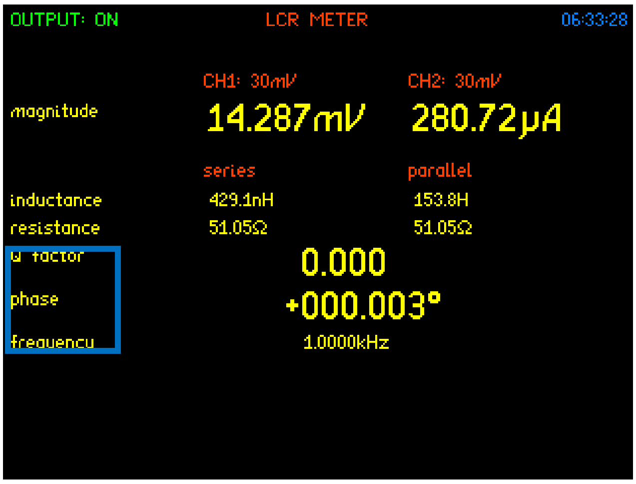


Automatic shunt selection can be configured within the LCR mode (shown below) on the PSM3750; selecting ***auto shunt*** found in the ***conditions*** parameter, will select the appropriate shunt applicable to the test conditions and the measured impedance.

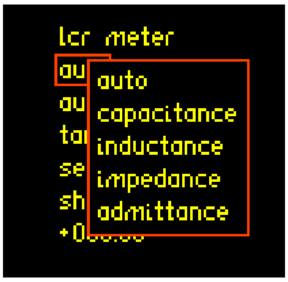


Parameter setting If the ***parameter*** option within the LCR menu is set to "***auto***" the PSM3750 will display capacitance or inductance according to the phase of the measurement.

Alternatively, any individual parameter may be set from the drop down menu displayed within the screenshot.

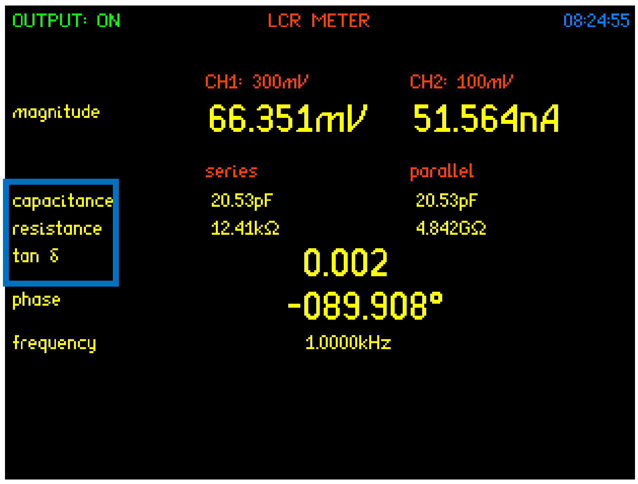


By using a resistor, inductor, & capacitor we can demonstrate the various display configurations



Depending on which parameter value is chosen, the measurements shown in the screen shot above, highlighted by a blue box around them will change appropriately to suit the chosen option, or in the case of auto to suit the type of DUT detected due to the value of the phase measurement. In this case it was set to ***auto*** and the DUT was a resistor. Referring back to the model of an ideal component mentioned at the start of this section, an ideal resistor can be modelled with a resistor and series inductor. In this example as the impedance of the inductive component of this sample dominates the measured phase switches the display to inductance and Q factor.

If the resistor is exchanged for a capacitor with no other changes made to the settings, this screen while still on ***auto*** will change to that shown below.

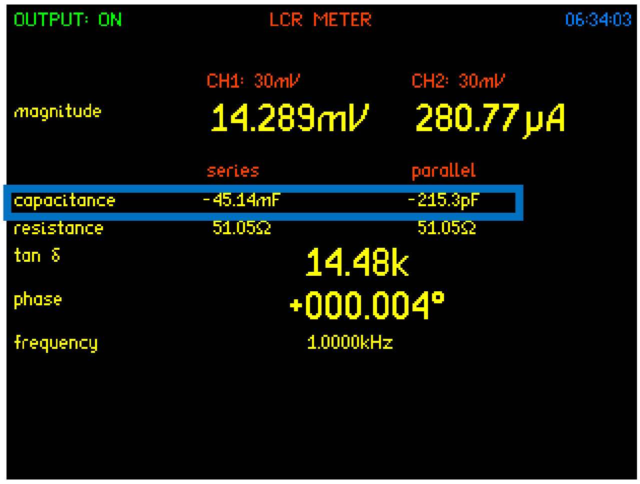


The ***inductance*** measurement is now ***capacitance*** and ***Q factor*** is now ***tanδ***

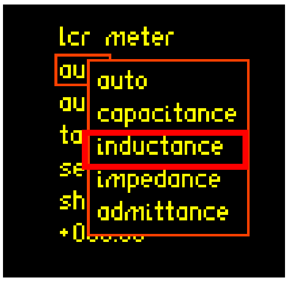
Instead of choosing ***auto*** the user is able to select the type of DUT, the PSM3750 will treat the DUT as that particular type of component. In the case of the DUT being capacitive and the ***parameter*** set to ***capacitance***, the results screen as would be expected appear as shown in the above screenshot.

It follows that if the DUT is an inductive component and inductance is chosen rather than auto that the results would show ***inductance, resistance*** and ***Q factor*** as it would for a predominantly inductive DUT when set to ***auto.***

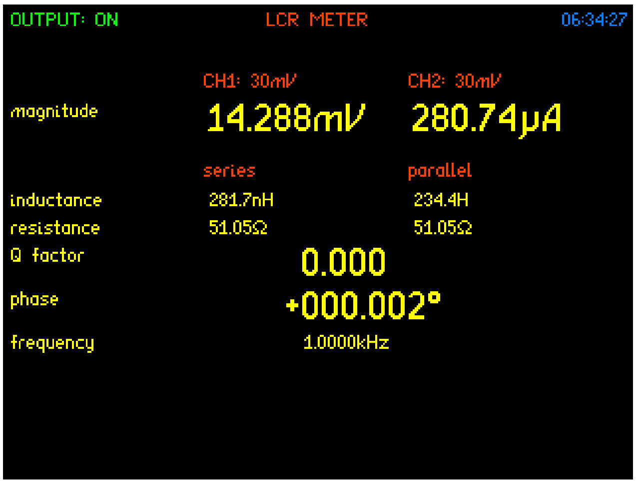
However, if ***capacitance*** was set and an unknown component was measured that was significantly inductive , then this would be signified on the display by the negative result against the capacitance value, as shown below, highlighted by the blue box.



Now when it is expected to be analysing an inductive DUT, and inductance has been selected.

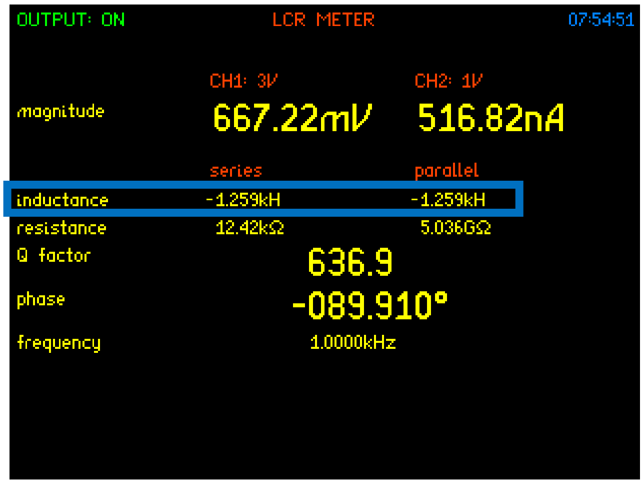


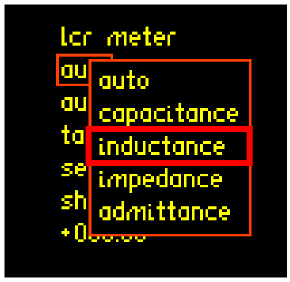
PSM screen showing a negative capacitance result when the ***parameter*** is set to ***capacitance*** and the DUT is primarily inductive.

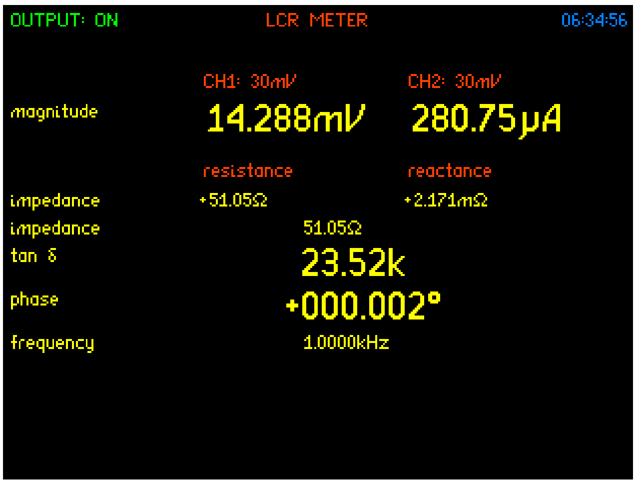


The PSM screen can be seen showing results with the ***parameter*** is set to ***inductance*** and the DUT is primarily inductive.

As with the example on the previous page showing a negative value to signify an inductive result when the PSM is set to capacitance, the converse applies, if set to inductive and the DUT is mainly capacitive, the results will show a negative inductance value.







With the parameter set to impedance, the resistance always shows as a positive value, the reactance likewise is positive for resistive and inductive DUT’s and negative for capacitive DUT’s

The final option that can be chosen is Admittance, which is defined as the reciprocal of Impedance.

$$Y = \frac{1}{Z}$$

Where Z= Impedance measured in Ω, and Y= Admitance measured in Siemens

While Resistance is a measure of the oposition to a steady state current and Impedance takes into account both the Resistance and the Reactance, Admittance takes into account not only the ease with which a steady current can flow, but also the effects of the material's susceptance.

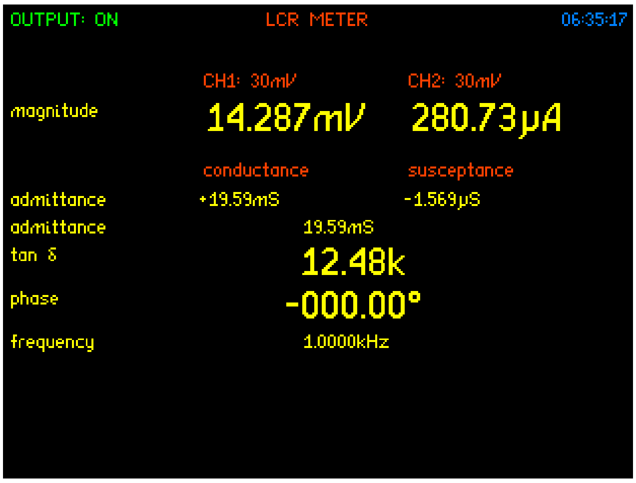
Where $Z = R + jX$

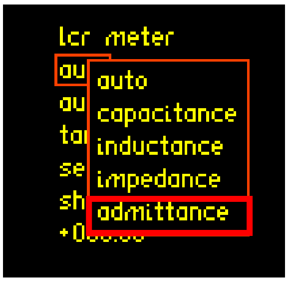
And $Y = G + jB$

Where Y is the Admittance in Siemens

G is the Conductance in Siemens

B is the Suseptance in Siemens

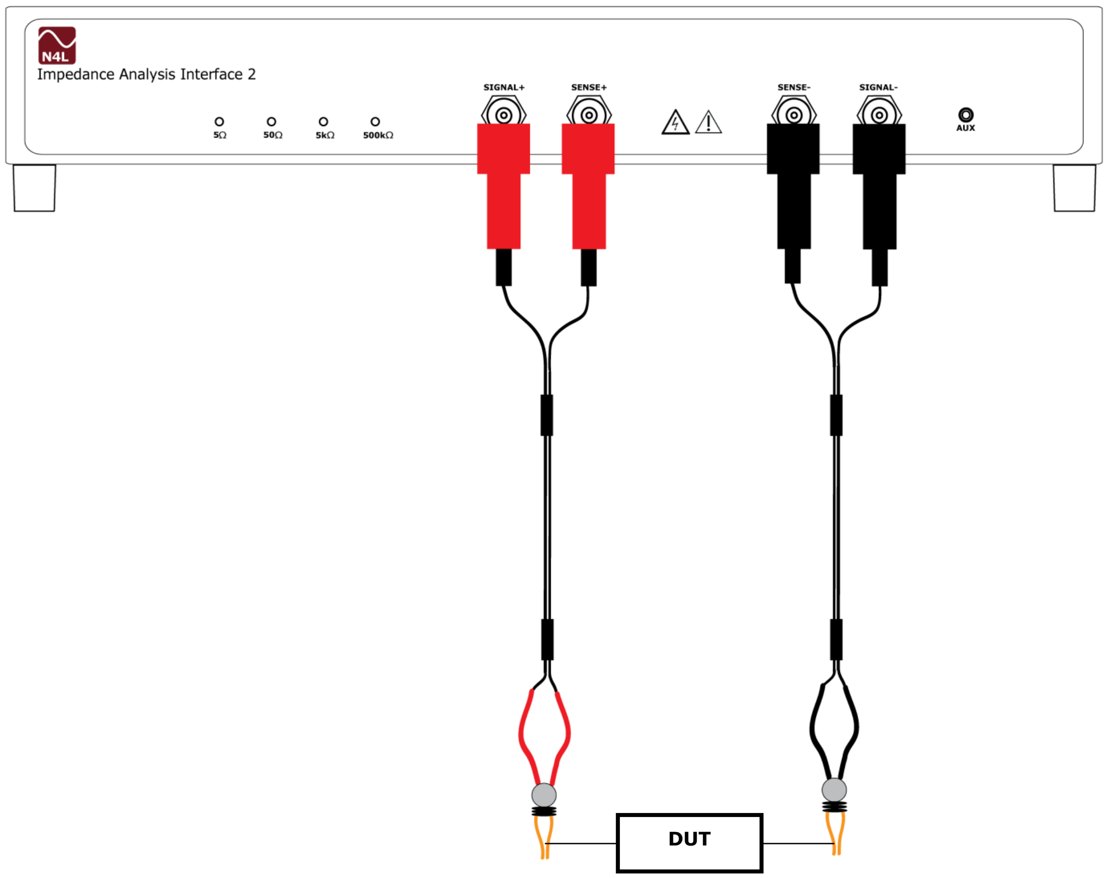




Connecting to the DUT

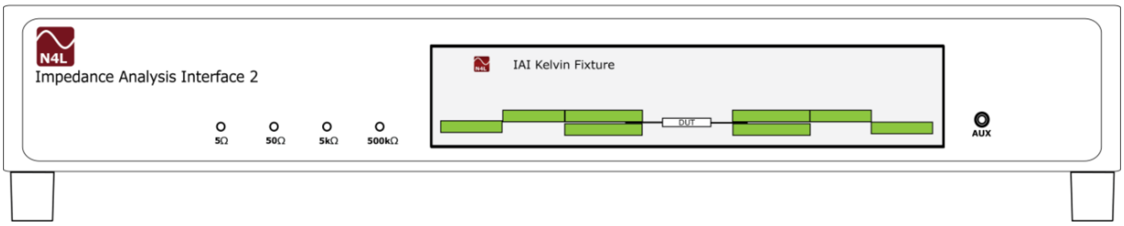
The IAI2 comes supplied with a pair of Kelvin Leads for low frequency use (<5MHz) which make simple connections to a discrete component

The Kelvin Leads can be clipped onto the body of the DUT, as close as possible to the component



For testing components over all frequencies, there is a dedicated test fixture available from N4L as an accessory. This can clip directly onto the front of the IAI2 by means of 4 BNC to BNC couplers supplied with the fixture to minimise effects due to cabling.

Connection is made to the component by four gold plated contact areas' in a four wire Kelvin arrangement; SIGNAL+ and SIGNAL- appear on the lower contacts, whilst SENSE+ and SENSE- are picked up from the upper pair of contacts.

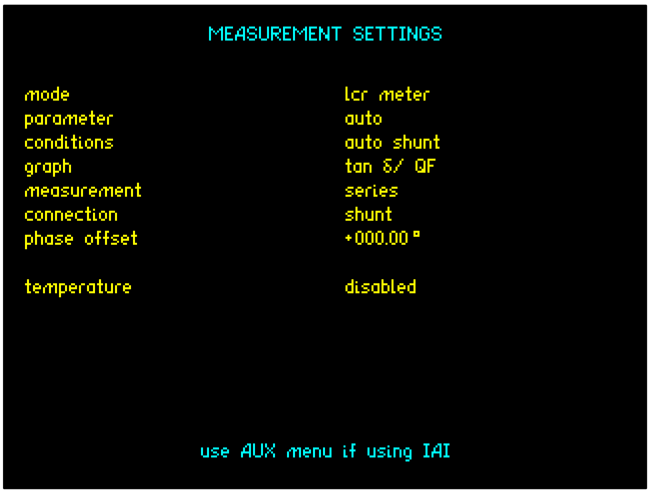


The lower pair of contacts are secured to the connectors attached to the IAI2 and do not move; the upper pair of contacts can be lifted by light finger pressure.

To insert a component, push up the upper contact plate so that the legs of the component can be inserted. If necessary, push up the upper contact plate on one side first and then the other side to allow the component to be pushed home. For high frequency work it is essential for the component to be inserted as far as possible.

The HF fixture can be connected to the IAI2 via short BNC leads instead of the BNC couplers.

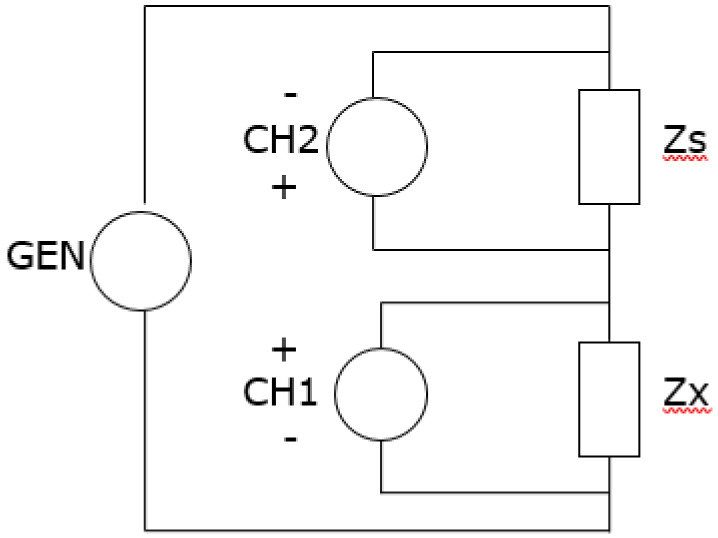
In LCR meter mode, channel 1 measures the voltage across the component under test, and channel 2 measures the current through it. To measure the current, channel 2 must be connected across an appropriate external shunt.



The default settings shown on entry to the settings menu are shown in the screenshot

Measurements can be made without the IAI2 by simply connecting a series shunt (set the ***auxiliary device*** option in the AUX menu to ***none***). The shunt chosen must be appropriate for the voltage, the current and the frequency of operation.

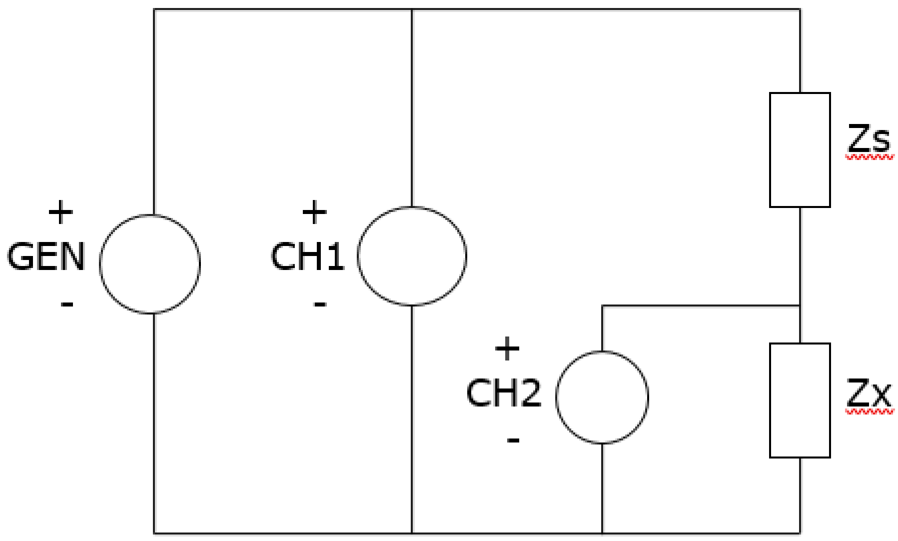
There are three manual ***connection*** options, ***shunt***, ***divider Zx low***, ***divider Zx high***.



For ***shunt*** connection, shown above, the current is measured directly across the shunt using CH2 while the voltage across the Zx is measured by CH1. Notice that the positive inputs to both CH1 and CH2 are connected to the midpoint to minimise common mode loading effects.

Then : Zx = Zs x CH1 / CH2

For ***divider Zx low*** connection, shown below, the total voltage is measured by CH1 and the voltage arising from the potential divider effect of Zs and Zx is measured by CH2. Notice that all the negative terminals are connected together.



Then: Zx = Zs / ((CH1 / CH2) – 1)

The connections for ***divider Zx high*** are the same as above but with Zx in the high arm of the potential divider and the shunt in the low arm.

Then: Zx = Zs x ((CH1 / CH2) – 1)

The PSM3750 measures the real and imaginary components at the fundamental frequency using DFT analysis as described in the section on gain/phase analysis. The frequency may be taken from its own generator or from the circuitry under test.

From the fundamental components of voltage, (a + jb), and those of the current, (c + jd), the PSM3750 computes the complex impedance given by:

$$\mathbf{z} = v / \mathbf{I} = (a + jb) / (c + jd)$$

The components of the complex impedance are filtered independently to minimise the effects of noise, which would have random phase and therefore will be filtered out.

The magnitude of the voltage and current are also computed. From the complex impedance the following parameters can be derived:

AC resistance, inductance, capacitance, impedance, phase, tanδ (= real/imaginary) &

Q factor (= imaginary/real)

Values are displayed for both series and parallel configurations.

Optionally, by selecting the ***parameter*** to be admittance in the LCR measurement settings menu the values can be expressed as admittance, conductance, and susceptance instead of impedance, resistance, and reactance.

If the ***parameter*** option in LCR menu is set to ***auto***, the PSM3750 will display capacitance or inductance according to the phase of the measurement. Alternatively, the display can be forced to capacitance, inductance, impedance, admittance.

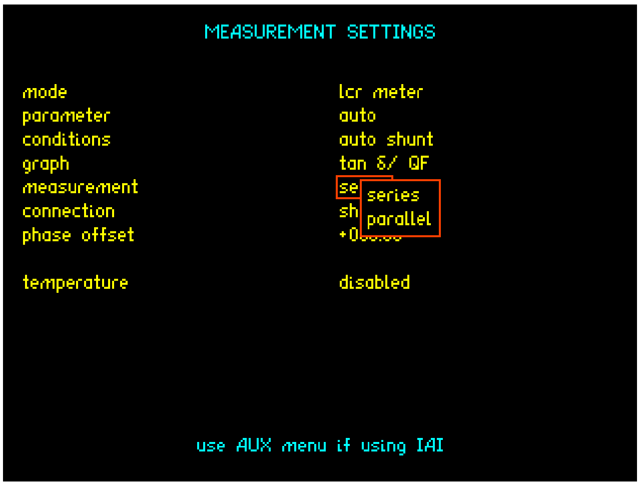
Capacitance is displayed with tanδ, inductance is displayed with Q factor, and impedance is displayed in its resistive + reactive form and as magnitude. The phase of the impedance is displayed with all options.

The operating conditions for the component under test may be selected manually or the PSM3750 will automatically try to find appropriate conditions.

INFORMATION.

In most applications leave the option for ***conditions*** set to ***auto***.

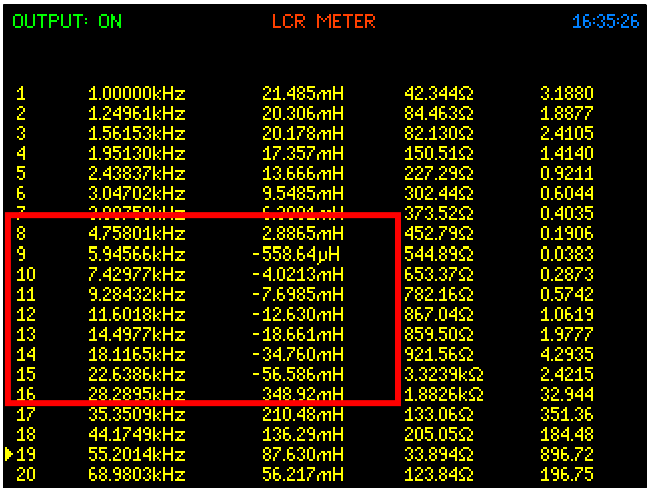
When measuring large electrolytic capacitors, it may be necessary to add an appropriate bias voltage to polarise the electrodes. In this case it may be necessary to select ***AC coupling*** in the *CH1* menu in order to reliably measure the small AC voltage present.



The PSM3750 can operate either in real time mode at a single frequency where the measurements are filtered and updated on the display; or it can sweep a range of frequencies and present the results as a table or graphs. Before performing a sweep, either ***series*** or ***parallel*** must be selected for the ***measurement*** parameter shown in the screenshot above.

The frequency points to be measured are specified by three parameters, these are set in the sweep menu accessed by pressing the *SWEEP* key, where the number of steps, start frequency, & end frequency are set.

The PSM3750 computes a multiplying factor that it applies to the start frequency for the specified number of steps. Note that due to compound multiplication it is unlikely that the end frequency will be exactly that programmed. The frequency sweep is initiated by the *START* key, and when completed the data can be viewed as a table or graphs.



		OUTPUT: ON LCR METER 16:35:26		
1	1.00000kHz	21.485mH	42.344Ω	3.1880
2	1.24961kHz	20.306mH	84.463Ω	1.8877
3	1.56153kHz	20.178mH	82.130Ω	2.4105
4	1.95130kHz	17.357mH	150.51Ω	1.4140
5	2.43837kHz	13.666mH	227.29Ω	0.9211
6	3.04702kHz	9.5485mH	302.44Ω	0.6044
7	[illegible]	[illegible]	373.52Ω	0.4035
8	4.75801kHz	2.8865mH	452.79Ω	0.1906
9	5.94566kHz	-558.64µH	544.89Ω	0.0383
10	7.42977kHz	-4.0213mH	653.37Ω	0.2873
11	9.28432kHz	-7.6985mH	782.16Ω	0.5742
12	11.6018kHz	-12.630mH	867.04Ω	1.0619
13	14.4977kHz	-18.661mH	859.50Ω	1.9777
14	18.1165kHz	-34.760mH	921.56Ω	4.2935
15	22.6386kHz	-56.586mH	3.3239kΩ	2.4215
16	28.2895kHz	348.92mH	1.8826kΩ	32.944
17	35.3509kHz	210.48mH	133.06Ω	351.36
18	44.1749kHz	136.29mH	205.05Ω	184.48
▸19	55.2014kHz	87.630mH	33.894Ω	896.72
20	68.9803kHz	56.217mH	123.84Ω	196.75

The columns of the tabulated results are from left to right:

Step No, Frequency, Inductance or Capacitance, Resistance, and Tanδ

Pressing the *GRAPH* key will switch these results to a plotted graph.

As can be seen in the red highlighted section of the results, the values switch from positive to negative and back again, this is a mathematical way to show that the measurement is flipping between capacitance and inductance

The window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. In real time mode the results from each window are passed through a digital filter equivalent to a first order RC low pass filter; in sweep mode each result comprises a single window without any filtering unless repeat sweep is selected.

Very good results can be obtained in a reasonable time using the medium speed setting (e.g., 50 points x ~1/3s ≅ 17s); for the very best results, use the slow setting (50 points x ~2.5s ≅ 125s or 2 minutes, 5 seconds).

The ZOOM function can be used to select up to four parameters from the display.

⚠ **INFORMATION.**

ZOOM is only relevant when in real time mode. It has no function following a sweep.

Although it is most usual to use the PSM3750 generator when performing LCR measurements, there may be circumstances where this is impractical, for example measuring the inductance of a transformer primary winding under load. In this case, turn off the PSM3750 generator (*OUT* menu) and the frequency reference for the analysis is measured from channel 1. Provided that the signal is clean enough for an accurate frequency measurement (and for DFT analysis the frequency does need to be accurately known), then the measurements can be made reliably.

⚠ **INFORMATION.**

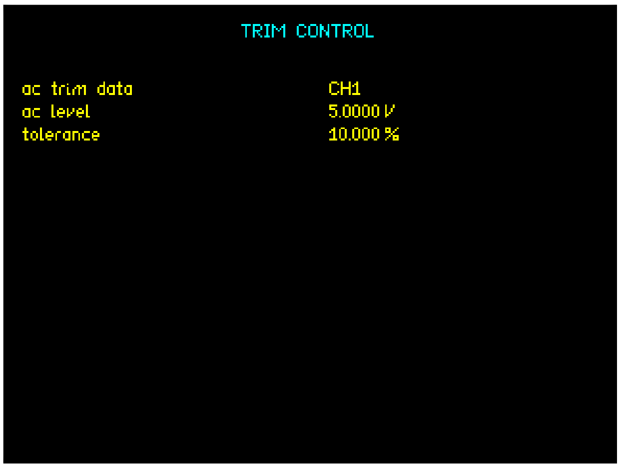
When using an external frequency reference there can be no sweep function.

Selecting Test Conditions:

The Frequency and Voltage of the generator are selected on the PSM3750 Instrument. The actual Voltage across the DUT depends upon the Impedance of the component at the test frequency and the impedance of the selected shunt.

The PSM3750 instrument clearly displays the measured Voltage across the DUT and the measured Current through it.

To fix the test voltage at a specified level, enable ac trim on CH1 using the "TRIM" menu on the PSM3750 and set the desired rms level for Vdut. The instrument will then adjust the generator output level until the measured voltage across the component is as specified.



The optimum test conditions to use depend on the component or DUT and the application as many components change their characteristics with frequency and test voltage. The PSM3750 instrument can automatically select test conditions, or they can be entered manually.

DC offsets can also be added to the test voltage where required, for example testing electrolytic capacitors which need a bias voltage. In this case, it may be best to set the PSM3750 to AC coupling which will increase the measured accuracy in cases where the AC signal is small relative to the DC level.

Compensation:
Any cables or fixtures used to interface the DUT to the IAI2 will introduce measurement errors because of the stray impedances. At low frequencies the stray effects can usually be ignored except when measuring at the extremes of the impedance range or when exceptionally high accuracy is needed. At higher frequencies it is almost always necessary to compensate for stray effects unless using the HF component fixture connected to the front of the IAI2.

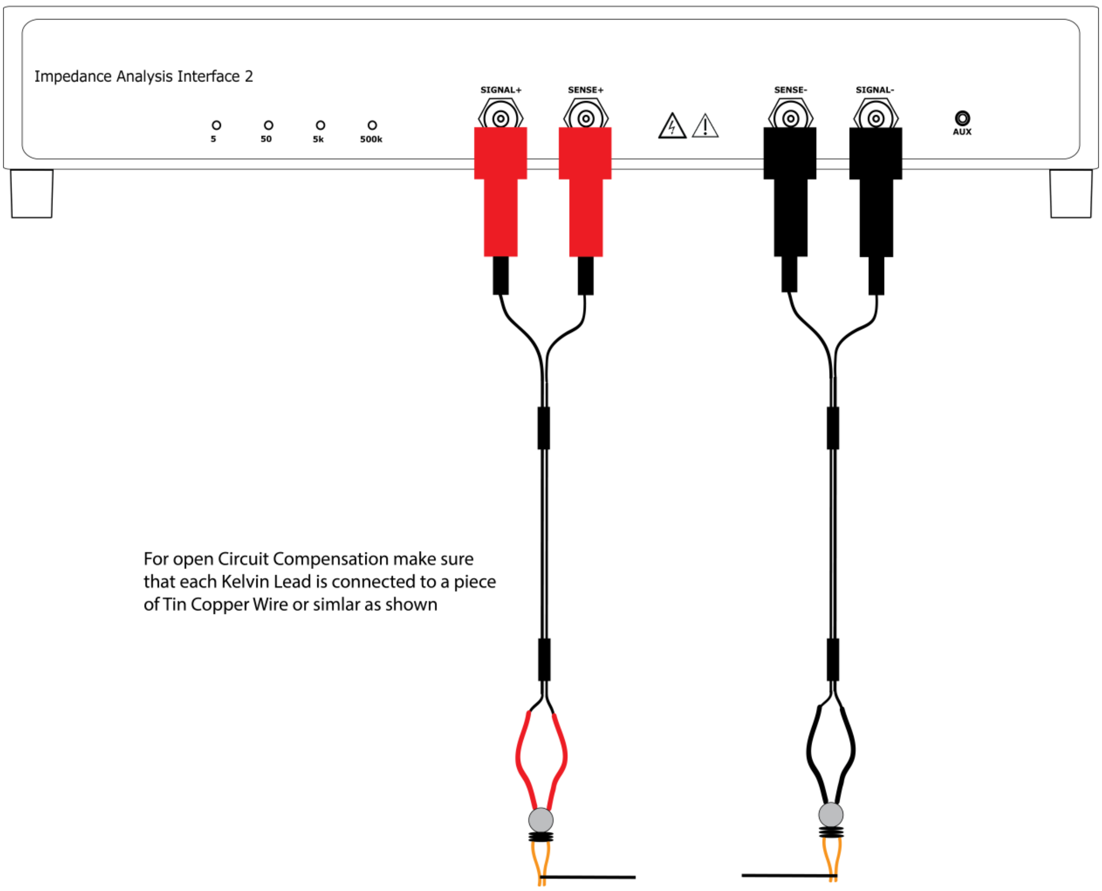
There are 2 forms of compensation:

Short Circuit – For measuring Low Impedances

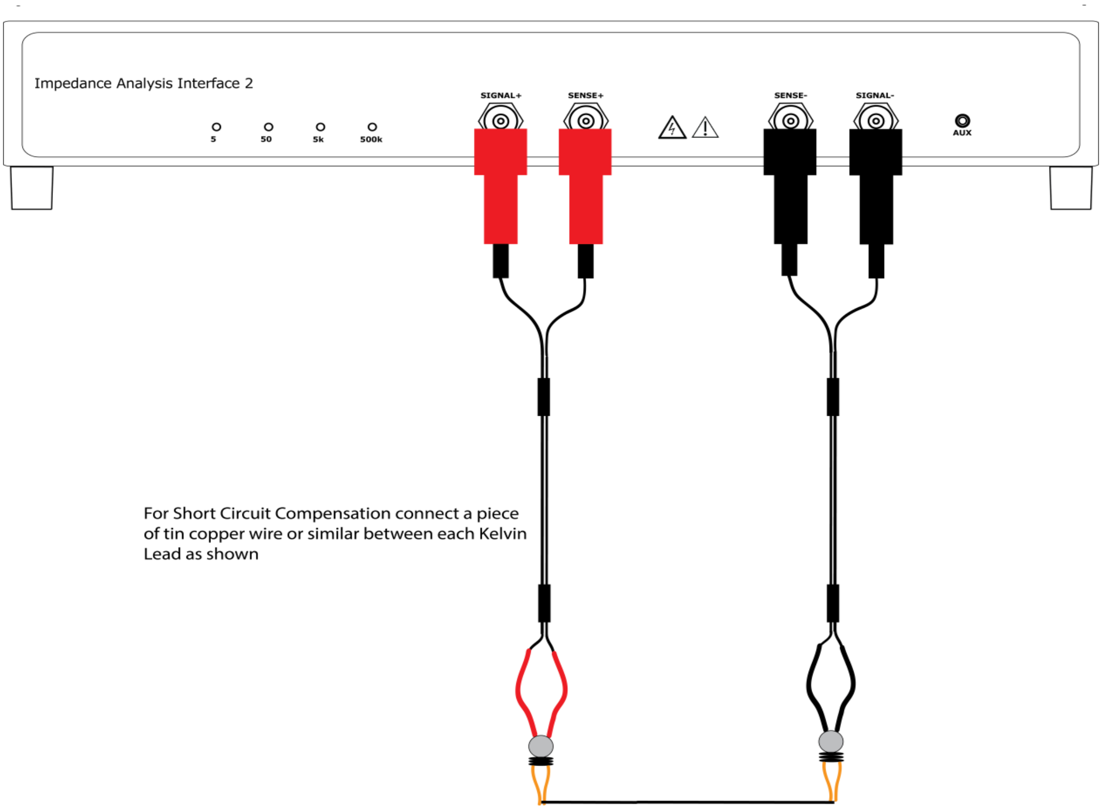
Open Circuit – For measuring High Impedances

It is only necessary to perform one of the two forms of compensation, but both can be performed. For best results, if more than one test is to be performed, they should be performed in the sequence given above.

Compensation Connections
OPEN CIRCUIT CONNECTION

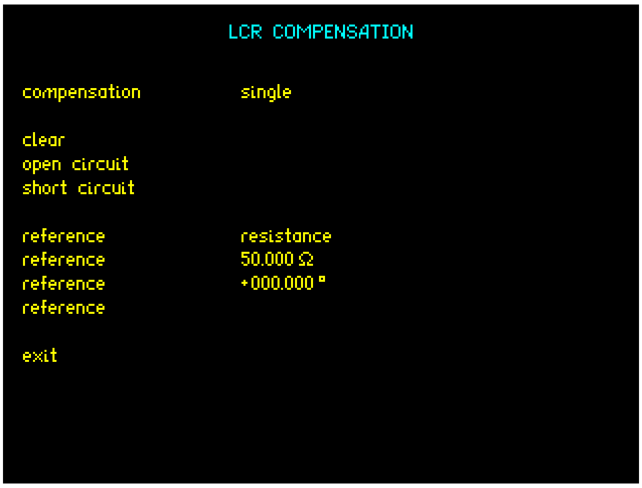


Short Circuit Compensation



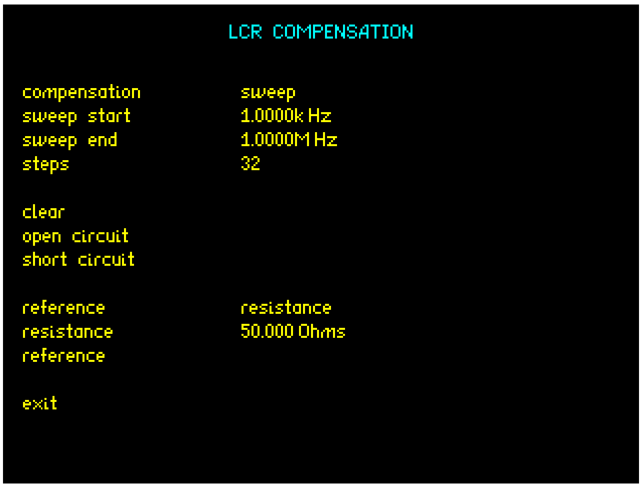
Compensation menu settings

With the PSM3750 set in LCR mode, press the “ZERO” button to display the LCR compensation screen as shown below.



Single compensation Selecting single compensation will conduct zero compensation, short or open circuit at the same desired frequency that the test will be carried out at.

Sweep compensation



Sweep compensation needs to be configured exactly the same as the sweep details for the DUT to be tested. Frequency start, frequency end and steps all need to be replicated. If “auto shunt” is selected within the LCR menu which it will be by default, then sweep compensation will be carried out on each individual shunt in turn over the sweep parameters set earlier.

INFORMATION.

When undertaking open compensation, it is advisable to use a solid piece of wire to connect to each Kelvin Lead or on each side of the Kelvin Fixture.

For short circuit compensation, it is advisable to use a solid piece of wire to connect the two Kelvin Leads together or connect between the two sides of the Kelvin Fixture.

Saved compensation

When the instrument settings are saved to a program file in the internal flash memory of the PSM3750, any single point or multiple point sweep compensation that has been undertaken will be included in that file.

When the program file is recalled any compensation settings will also be recalled and will then be applicable. Each program memory location can include its own saved Single point or multiple point sweep compensation settings, these settings will be applied when that program is recalled including after the power cycling of the instrument.

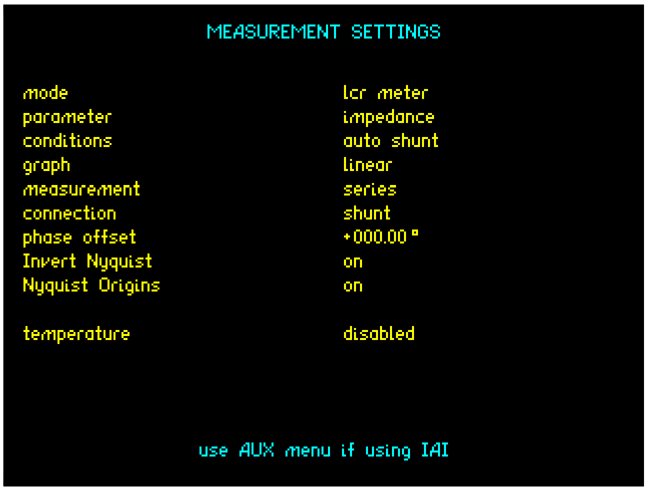
INFORMATION.

When recalling programs with saved Compensation settings it is important to consider any repositioning or replacement of cables or fixtures etc used to interface the DUT to the instrument since the compensation was originally performed. It may be necessary to repeat the Compensation procedure before performing the tests.

Nyquist Plots

The PSM3750 can display impedance on either Bode or Nyquist plots. The Nyquist plot separates the Real and Imaginary components of impedance on an X-Y plot.

To display a Nyquist plot, the PSM must be in LCR meter mode with the ***measurement*** parameter set to ***impedance*** as shown below:



There two plotting parameters specific to the Nyquist plot:

Invert Nyquist

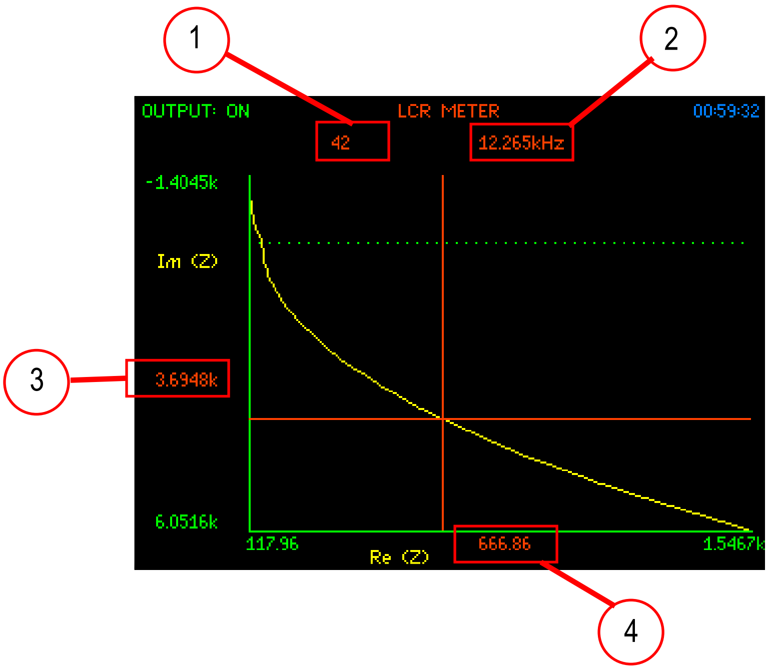
When enabled, this option inverts the Y (I_m) axis on the Nyquist plot.

Nyquist Origins

When enabled, vertical and horizontal dashed lines will indicate the zero point on both the X and the Y-axis (when zero falls within the auto-scale range).

Note: Invert Nyquist is enabled by default.

While in LCR mode, begin a sweep by pressing the *START* key and then repeatedly press the *GRAPH* key to toggle through the graphing options until Nyquist is displayed.



The axes are scaled to fit the sweep and a cursor is automatically displayed. The directional keys on the PSM's front panel can be used to navigate the cursor.

The following parameters are shown for the sweep step and are all updated by movement of the cursor:

1. Sweep step number
2. Frequency
3. Imaginary component of impedance
4. Real component of impedance

LCR meter specification

LCR meter	
frequency	10µHz to 50MHz (own generator)
measurement type	DFT analysis
measurements	L, C, R (ac), Q, tanδ, impedance, phase, admittance
	series or parallel circuit
conditions	auto, or manual
display	numeric values
	table of sweep results
	graph of any measurement
	Nyquist (Impedance only)
ranges (with external shunt)	100pF to 100µf
	1µH to 100H
	1Ω to 1MΩ
ranges	1pF to 1000µF
(with IAI2)	10nH to 10kH
	1mΩ to 500MΩ
basic accuracy	0.1% + tolerance of Shunt
sweep step rate	1/20s, 1/3s or 2.5s (approx.)

Conditions:

23ºC +/- 5ºC ambient temperature

instrument allowed to warm up for ≥30 minutes

AC+DC coupling

autoranging or manual ranging ≥ 1/3 range

using impedance interface adaptor

Harmonic Analyzer

The PSM3750 harmonic analyser computes multiple DFTs on the input waveforms in real time (refer to the section on frequency response analysis for the formulae for DFT analysis).

There are three modes of operation: single harmonic, difference thd, and series thd. In single harmonic mode, the specified harmonic is displayed both in Volts and as a ratio to the fundamental; in either thd mode, the computed thd and a specified harmonic are displayed as a ratio to the fundamental.

In difference thd mode, the thd is computed from the rms and fundamental:

$$thd = 1/h_1 \sqrt{(rms^2 - h_1^2)}$$

In series thd mode, the thd is computed from a series of up to 64 harmonics.

$$thd = 1/h_1 \sqrt{\sum_{i=2}^{i=n} h_i^2} \quad \text{where } h_i \text{ is the } i^{th} \text{ harmonic}$$

In series mode the magnitude and phase of all the harmonics can be seen as a table or the magnitudes can be displayed as a bargraph which changes in real time with the measurements. When viewing the bargraph, ZOOM+ and ZOOM- change the vertical axis by a factor of 10.

In all cases the harmonics are phase referred to CH1 fundamental so that their in-phase and quadrature components may be separately filtered to minimise noise.

The single harmonic and the thd are expressed relative to the fundamental either as a percentage or in dB, as selected via the HARM menu.

The PSM3750 can operate either in real time mode at a single frequency where the measurements are filtered and updated on the display; or it can sweep a range of frequencies and present the results as a table or graphs.

The frequency points to be measured are specified with three parameters:

number of steps, start frequency, end frequency

The PSM3750 computes a multiplying factor that it applies to the start frequency for the specified number of steps. Note that due to compound multiplication it is unlikely that the end frequency will be exactly that programmed. The frequency sweep is initiated by the START key, and when completed the data can be viewed as a table or graphs or printed out.

The window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. In real time mode the results from each window are passed through a digital filter equivalent to a first order RC low pass filter; in sweep mode each result comprises a single window without any filtering.

Very good results can be obtained in a reasonable time using the medium speed setting (e.g., 50 points x ~1/3s ≅ 17s); for the very best results, use the slow setting (50 points x ~2.5s ≅ 125s or 2 minutes, 5 seconds).

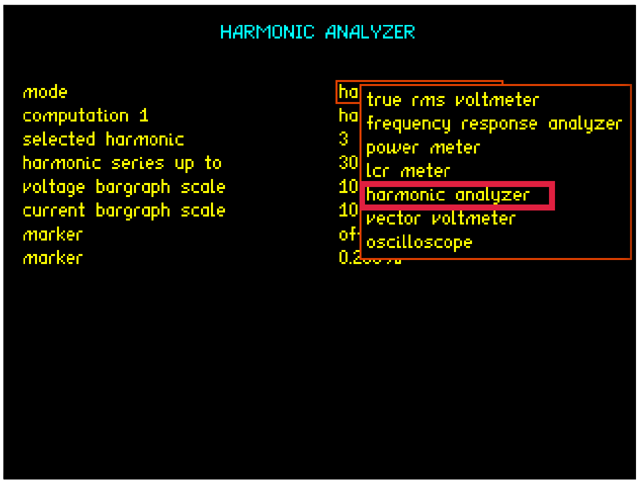
The ZOOM function can be used to select up to four parameters from the display when in real time mode. It has no function following a sweep.

Although it is most usual to use the PSM3750 generator when making harmonic measurements, there may be circumstances where this is impractical, for example measuring harmonic currents drawn from the mains. In this case, turn off the PSM3750 generator (*OUT* menu) and the frequency reference for the analysis is measured from channel 1. Provided that the signal is clean enough for an accurate frequency measurement (and for DFT analysis the frequency does need to be accurately known), then the measurements can be made reliably.

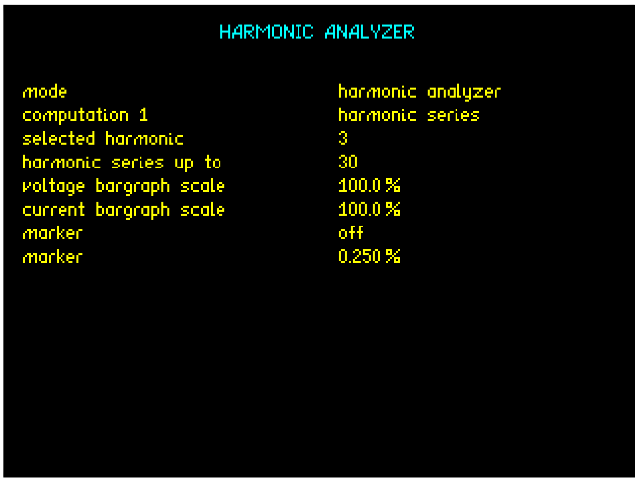
INFORMATION When using an external frequency reference there can be no sweep function.

The settings for the harmonic analyzer are configured from within the *MODE* function as there is no direct access button to press.

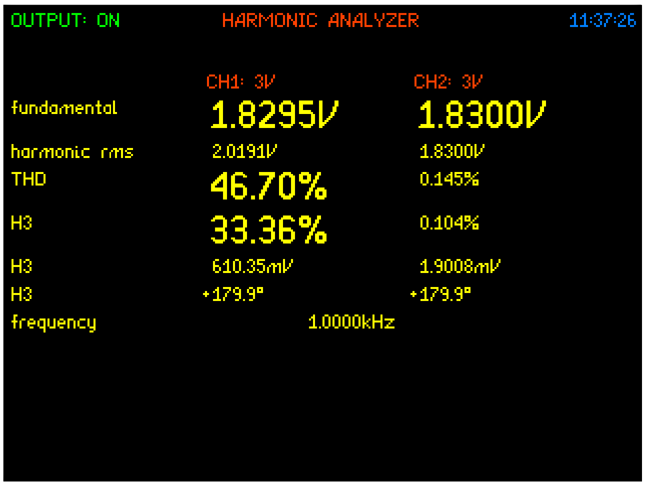
Press *MODE* and select harmonic analyzer from the dropdown menu within the mode parameter as shown below.



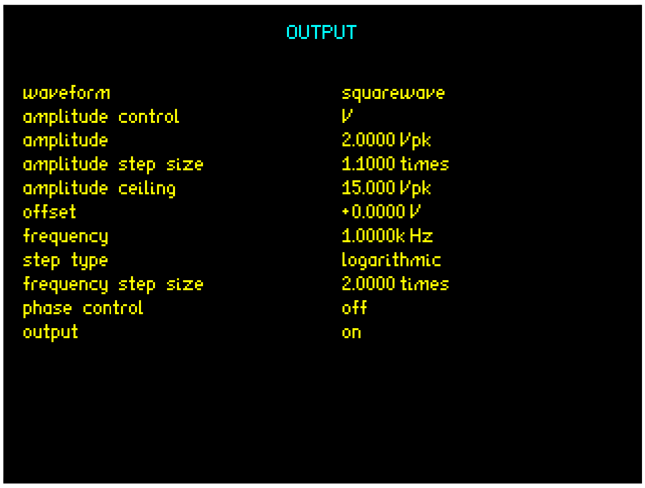
Configure all the parameters within the harmonic analyzer menu once selected



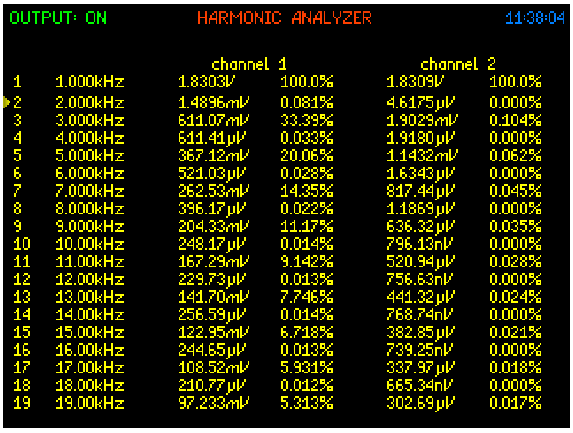
Press *ENTER* once all selections have been made, this will take you directly to the Harmonics Real time Display and results shown will be referenced to the input signal frequency as shown below.



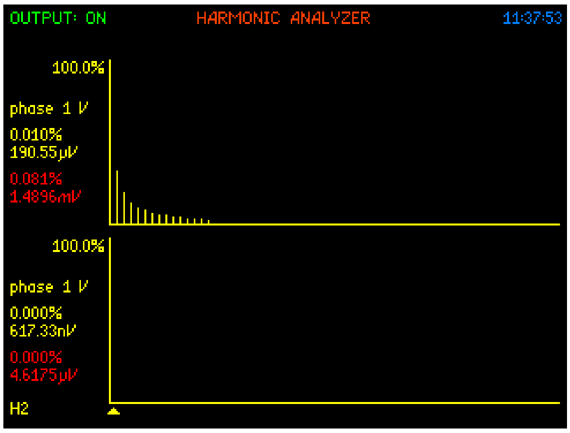
For the purpose of this manual the output signal was generated using the PSM3750's own generator as shown within the next screenshot, where it can be seen that the output frequency was set to 1 kHz.



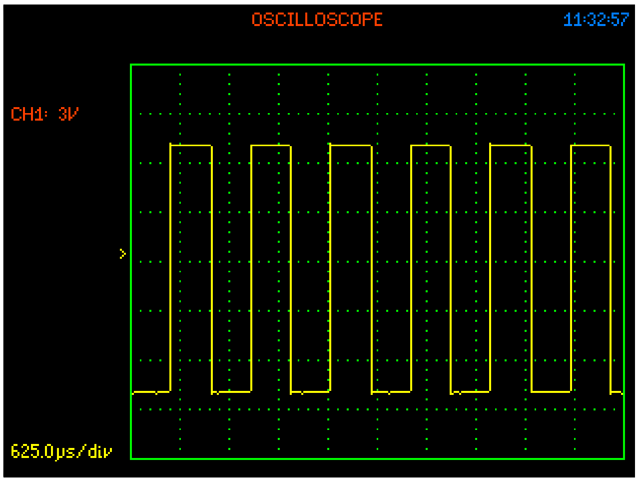
From the real time display you are able to view the collected data in either a table or bar graph format as shown below. For the bar graph data this will be represented in accordance with the settings made earlier within the harmonic analyzer menu screen.


OUTPUT: ON HARMONIC ANALYZER 11:38:04

		channel 1		channel 2	
1	1.000kHz	1.8303V	100.0%	1.8309V	100.0%
2	2.000kHz	1.4896mV	0.081%	4.6175µV	0.000%
3	3.000kHz	611.07mV	33.39%	1.9029mV	0.104%
4	4.000kHz	611.41µV	0.033%	1.9180µV	0.000%
5	5.000kHz	367.12mV	20.06%	1.1432mV	0.062%
6	6.000kHz	521.03µV	0.028%	1.6343µV	0.000%
7	7.000kHz	262.53mV	14.35%	817.44µV	0.045%
8	8.000kHz	396.17µV	0.022%	1.1869µV	0.000%
9	9.000kHz	204.33mV	11.17%	636.32µV	0.035%
10	10.00kHz	248.17µV	0.014%	796.13nV	0.000%
11	11.00kHz	167.29mV	9.142%	520.94µV	0.028%
12	12.00kHz	229.73µV	0.013%	756.63nV	0.000%
13	13.00kHz	141.70mV	7.746%	441.32µV	0.024%
14	14.00kHz	256.59µV	0.014%	768.74nV	0.000%
15	15.00kHz	122.95mV	6.718%	382.85µV	0.021%
16	16.00kHz	244.65µV	0.013%	739.25nV	0.000%
17	17.00kHz	108.52mV	5.931%	337.97µV	0.018%
18	18.00kHz	210.77µV	0.012%	665.34nV	0.000%
19	19.00kHz	97.233mV	5.313%	302.69µV	0.017%



To view the input signal within the oscilloscope mode then simply press the *SCOPE* button on the instruments front panel, this will display the waveform of the signal being received as shown.



Here we are able to view the squarewave signal that was previously set within the *OUTPUT* menu screen, and which was being analyzed for this guide.

NOTE: If the *SCOPE* button is pressed to view a waveform whilst in harmonic analyzer mode then to return to the harmonic screen the user will have to return via the *MODE* button and the ►◄▼▲ keys as stated earlier in this section.

Harmonic analyser specification

Harmonic analyser	
fundamental frequency	20mHz to 50MHz (own generator) 20mHz to 1MHz (external source)
harmonic frequency	10µHz to 1MHz
measurement type	multiple DFT analysis
measurements	single harmonic, differential thd, thd by series of harmonics
max harmonic	100
max input	±10V peak
input ranges	10V*, 3V*, 1V*, 300mV* *= High Voltage Attenuator. 500V, 300V, 100V, 30V, 10V, 3V, 1V, 300mv, 100mV, 30mV, 10mV, 3mV.
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
magnitude accuracy	0.1% of fundamental + 0.01mV + accuracy of fundamental
sweep step rate	1/20s, 1/3s or 2.5s (approx.)

Conditions:

23ºC +/- 5ºC ambient temperature

instrument allowed to warm up for ≥30 minutes

AC+DC coupling

autoranging or manual ranging ≥ 1/3 range

Vector Voltmeter [PAV key]

A vector voltmeter (or phase angle voltmeter, or phase sensitive voltmeter) measures the signal at one input compared to the magnitude & phase of the signal at a reference input. The results may be expressed as magnitude and phase, or as separate in-phase and quadrature components.

The PSM3750 measures the in-phase and quadrature components at the fundamental frequency using DFT analysis as described in the section on frequency response analysis, see FRA key. CH2, the measurement input, is phase referred to CH1, the reference input. The individual components are filtered separately to minimise the effects of noise, which would have random phase and would therefore be filtered out. The true rms of the input signals is also computed.

CH1 and CH2 may be voltage inputs or may use external shunts.

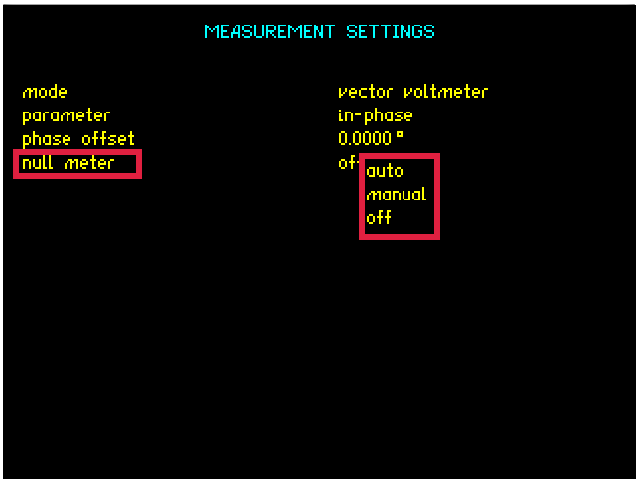
From the phase referred fundamental components, (a + jb), the following results can be derived:

magnitude	$= \sqrt{(a^2 + b^2)}$
phase	$= \tan^{-1}(b/a)$
tan ϕ	$= b/a$
in-phase ratio	$= a_2 / a_1$
LVDT (diff)	$= \text{scale} * a_2 / a_1$
LVDT (ratio)	$= \text{scale} * (m_1 - m_2) / (m_1 + m_2)$

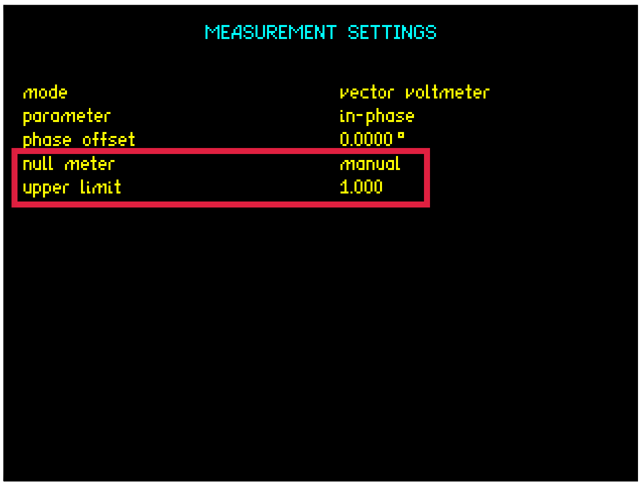
Where a_1 and a_2 are the in-phase components, and m_1 and m_2 are the magnitudes, of the signals present at CH1 and CH2 respectively.

The parameter of interest is selected via the ***vector voltmeter*** option in the *MODE* menu. The frequency and phase are always displayed.

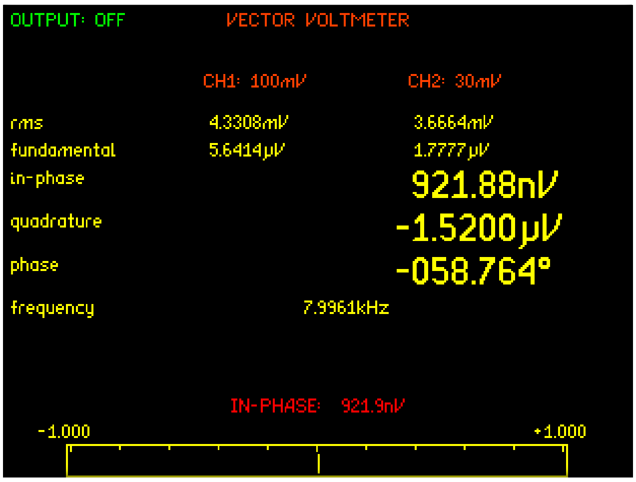
A null meter display may be selected via the ***vector voltmeter*** menu to allow adjustment of a circuit for minimum phase or component.



To activate the ***null meter*** function, from the *Mode* menu press the ► press the ▼key 4x to highlight vector voltmeter with the red box and then press the *Enter* key. Select the null meter parameter using the ▼key press the ► key to open up the drop down menu as shown. Select either ***auto*** or ***manual*** range.



Selecting “manual” will allow the user to set their own upper limit to be displayed on the bar graph within the real time display as shown below.



Within the “Real Time” display we now have the null meter at the bottom of the screen with limits shown as 1 as set within the previous screenshot.

The parameter on the display depends on the selected component:

parameter	display	null meter
in-phase		in-phase
quadrature		quadrature
tanϕ	tanϕ	tanϕ
magnitude	magnitude	magnitude
phase	phase	
rms	rms	rms2
rms2/1	rms2/rms1	rms2/rms1
in-phase ratio	in-phase ratio	in-phase ratio
LVDT diff	LVDT	LVDT
LVDT ratio	LVDT	LVDT

The null meter may be manually ranged or will automatically range as the signal varies.

There is a phase offset option that applies a vector rotation of a user selectable phase shift to the CH2 input data.

The PSM3750 can operate either in real time mode at a single frequency where the measurements are filtered and updated on the display; or it can sweep a range of frequencies and present the results as a table or graphs. Before performing a sweep, the desired parameter must be selected.

The frequency points to be measured are specified with three parameters:

number of steps, start frequency, & end frequency

PSM3750 computes a multiplying factor that it applies to the start frequency for the specified number of steps. Note that due to compound multiplication it is unlikely that the end frequency will be exactly that programmed. The frequency sweep is initiated by the *START* key, and when completed the data can be viewed as a table or graphs or printed out.

The window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. In real time mode the results from each window are passed through a digital filter equivalent to a first order RC low pass filter; in sweep mode each result comprises a single window without any filtering.

INFORMATION. The ZOOM function can be used to select up to four parameters from the display when in real time mode. It has no function following a sweep.

Although it is most usual to use the PSM3750's generator when making Phase Angle Voltmeter measurements, there may be circumstances where this is impractical, for example measuring LVDT displacement under actual circuit conditions. In this case, turn off the PSM3750's generator (*OUT* menu) and the frequency reference for the analysis is measured from channel 1. Provided that the signal is clean enough for an accurate frequency measurement (and for DFT analysis the frequency does need to be accurately known), then the measurements can be made reliably.

INFORMATION. When using an external frequency reference there can be no sweep function.

Phase Angle Voltmeter (Vector Voltmeter) Specification	
Frequency	10µHz to 50MHz (own generator) 20mHz to 1MHz (external source)
Measurement Type	DFT analysis, and true rms
Measurements	Magnitude, Phase, In-Phase & Quadrature components, TanΦ, InPhase Ratio, LVDT (diff), LVDT (ratio), Rms, Rms Ratio
Phase Resolution	0.001°
tanΦ resolution	0.0001°
Other	As FRA specifications

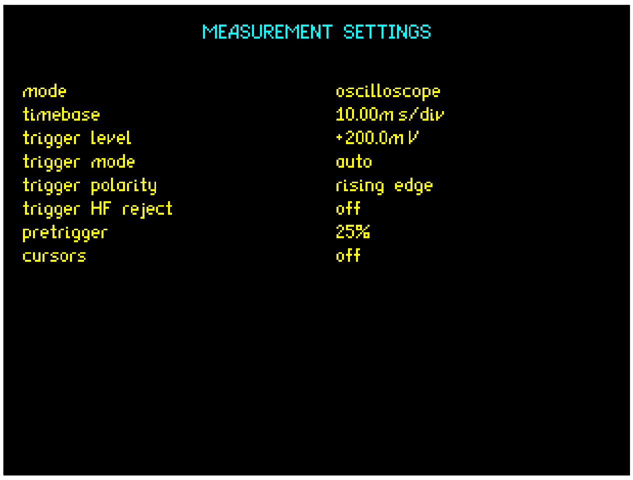
Conditions:

23ºC +/- 5ºC ambient temperature
instrument allowed to warm up for ≥30 minutes
AC+DC coupling
autoranging or manual ranging ≥ 1/3 range

Oscilloscope [SCOPE key]
The PSM3750 provides a digital storage oscilloscope function to view the waveforms being measured.

The settings for the oscilloscope are configured by pressing the *SCOPE* button twice.

Upon entering the *SCOPE* menu, the following screenshot will be displayed.



Timebase: The display for the oscilloscope is divided into 10 divisions along the time axis with the selected timebase displayed in the bottom left hand corner of the display. The timebase may be set to any real value between 15µs/div to 5s/div. Pressing the ►& ◄ keys on the main panel will adjust the timebase by a factor of 2.

Trigger Reference: The data source for the trigger can be selected to be Channel 1, Channel 2 or Channel 3 (if fitted).

Trigger Level: The trigger level is set directly in Volts in relation to the trigger reference settings and does not change if the range is changed. The trigger level is displayed by a small > on the extreme left hand edge of the display. If the trigger is set to a value above or below the range of the input channel, then a small carat ^ is shown at the top or an inverted one at the bottom of the display as appropriate.

Trigger Mode: The trigger mode may be set to be.

Auto (trigger if possible but do not wait)

Normal (wait indefinitely for trigger)

Single shot (wait for trigger then hold)

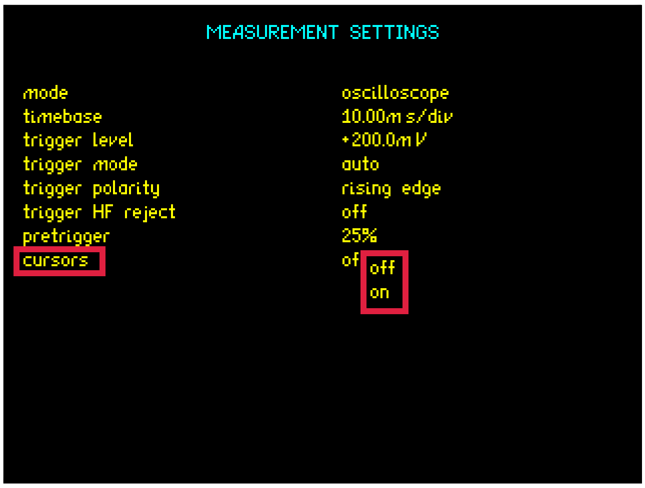
The single shot option is reset using the *TRIGGER* key

Trigger Polarity: The trigger polarity may be set to ***rising edge*** or ***falling edge***

Trigger HF Reject: Select to be either ***ON*** or ***OFF***. When set to ON a low pass filter is applied to the trigger data to stabilise the trace with noisy signals. The filter only influences the trigger detection and does not change the data displayed.

Pretrigger: The pretrigger may be set ***to none, 25%, 50%*** or ***75%*** using the drop down menu.

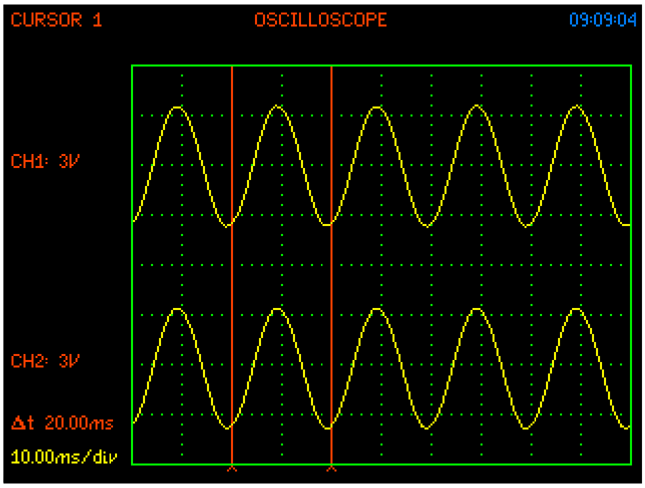
Cursors: Two cursors can be enabled on the display as per the screenshot below.



When enabled use the ▼ & ▲ keys to enable and switch between Cursor 1 and Cursor 2.

Use the ► & ◄ keys to move the selected cursor along the timescale.

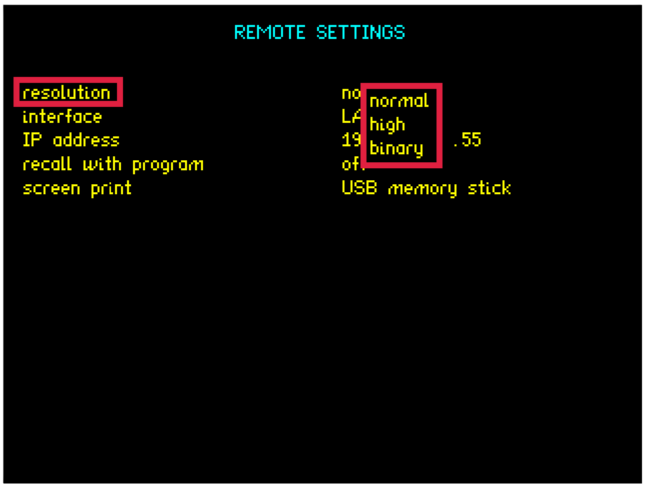
INFORMATION. When the cursors are enabled then the ◄ and ► keys no longer adjust the time base.



From this screenshot (output set to 50Hz / 2Vpk) the display shows all fundamental measurements from the position of cursor 1. Also displayed is the time difference between the 2 cursors, shown by Δ t = 20.00ms with the time base set to 10ms/div.

Using remote control [COMMS key]

The Comms Settings menu provides an interface for the user to set the method of connection and the ability to configure the ports as required.

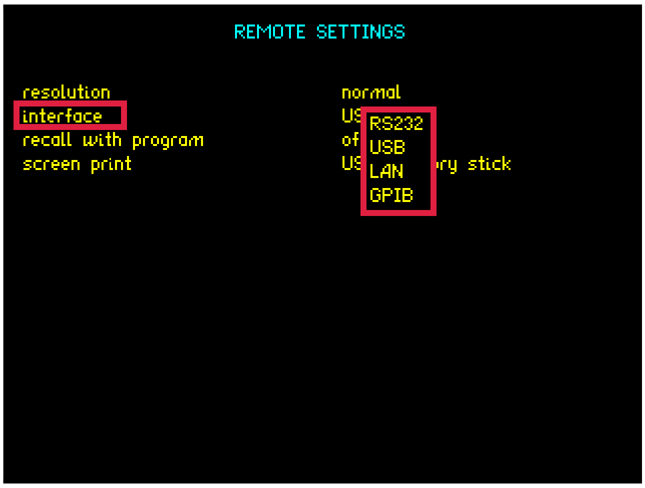


The default resolution setting for the PSM3750 is ***normal*** this will set the Data Resolution to 5 decimal points plus any exponent e.g.: +1.2345+E00.

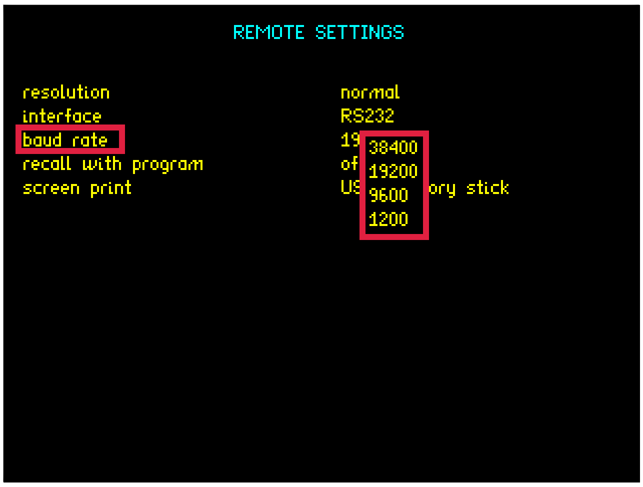
Selecting “High” will set the Data Resolution to 6 decimal points plus any exponent e.g.: +1.23456+E00.

For higher speed transfer a proprietary binary format can be selected which compresses the data into 4 bytes.

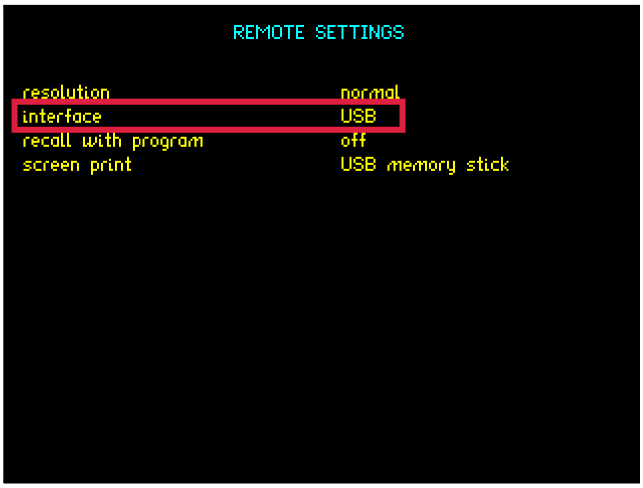
The PSM3750 is fitted as standard with an RS232 serial communications port and USB, LAN and IEEE488 (GPIB) interfaces for communication purposes between the instrument and PC.



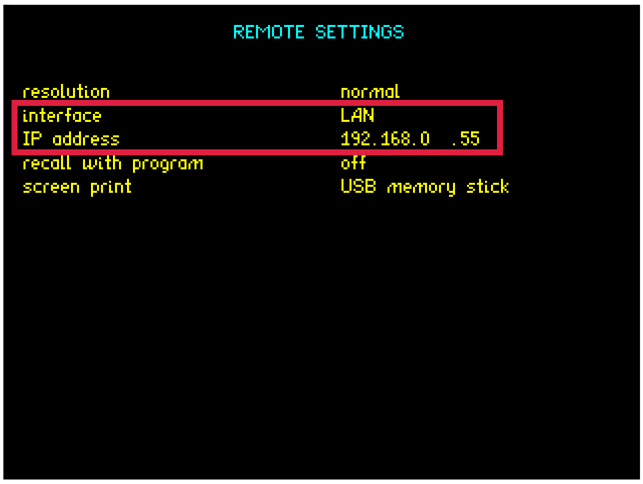
INFORMATION. Ensure that the correct interface is selected prior to attempting to communicate with the PSM3750



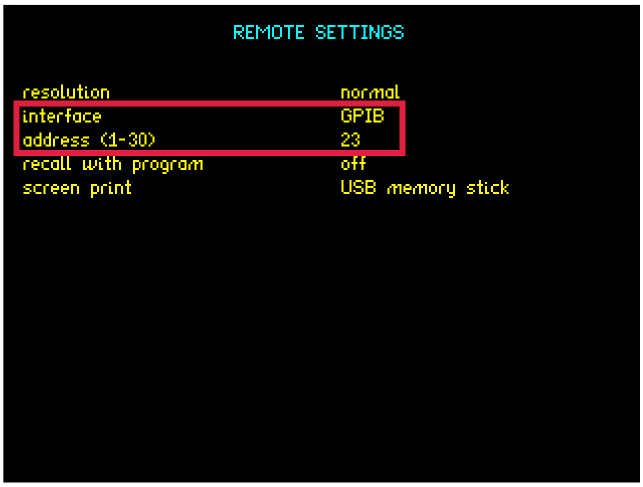
Selecting RS232 will then open up the "Baud Rate" option. Select an applicable data speed rate from the 4 options given in the drop down menu (Default Setting is 19200).



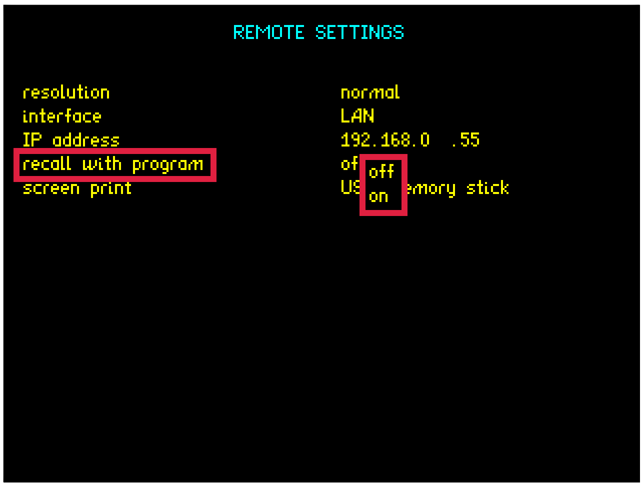
To use a USB cable to connect, set the interface parameter to read ***USB***.



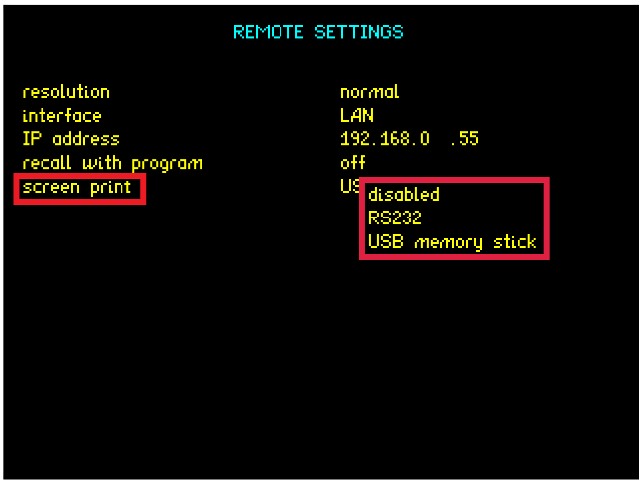
Configuring the interface to LAN will then display the IP address applicable to your instrument. This address will be required upon connection to any software to enable correct connection to the instrument; this is changed using the numerical keypad.



Configuring the instruments interface to GPIB will automatically set the IEEE address to 23 this can be changed within the address parameter in the range 0 to 30, there are (31 total possible addresses available).



The ***recall with program*** parameter will allow any pre-set Comms configuration to be recalled if saved along with a nominated program within the *PROG* settings. To recall a Comms configuration set the recall option to ***ON*** then recall the appropriate program (Remember to set this first before recalling your saved program).



The Screen Print option will allow any screen display on the PSM3750 to be copied either to an RS232 printer or USB memory stick, select the appropriate transfer method required or alternatively this parameter can be disabled. To print the screen display press and hold the *START* button for 3 seconds. A BMP file will be transferred to the memory stick.

Alternatively, the screen can be saved via PSMcomm2 software.

INFORMATION. It is advisable to only use USB sticks of 2Gb or smaller capacity

Comms protocols

The PSM3750 is fitted with an RS232, USB serial, LAN (Port No 10001) and IEEE488 (GPIB) interfaces. All the interfaces use the same ASCII protocol except for the end of line terminators:

	Rx expects	Tx sends
RS232 USB	carriage return (line feed ignored)	carriage return and line feed
LAN	carriage return (line feed ignored)	carriage return and line feed
IEEE488	carriage return or line feed or EOI	carriage return with EOI

All the functions of the PSM3750 can be programmed via either interface, and the results read back.

The commands are not case sensitive and white space characters are ignored (e.g., tabs and spaces). Replies from the PSM3750 are always upper case, delimited by commas, without spaces.

Only the first six characters of any command are important – any further characters will be ignored. For example, the command to set the generator frequency is ***FREQUE*** but the full word ***FREQUENCY*** may be sent as the redundant NCY at the end will be ignored.

Fields within a command are delimited by comma, multiple commands can be sent on one line delimited with a semi-colon e.g.

AMPLIT, 1.5; OUTPUT, ON

Mandatory commands specified in the IEEE488.2 protocol have been implemented, (e.g., ****IDN? *RST***) and all commands that expect a reply are terminated with a question mark.

The PSM3750 maintains an error status byte consistent with the requirements of the IEEE488.2 protocol (called the standard event status register) that can be read by the mandatory command ****ESR?*** (See Serial Command Summary).

The PSM3750 also maintains a status byte consistent with the requirements of the IEEE488.2 protocol, that can be read either with the IEEE488 serial poll function or by the mandatory command ****STB?*** Over RS232 or IEEE or LAN protocols.

The IEEE address defaults to 23 and can be changed via the *COMMS* menu. Setting the LAN IP address to 0.0.0.0 will enable the DHCP and the unit will obtain its IP-Address from the DHCP server. DHCP server must be present on the network for this to work. The LAN will not start normal operation until it receives an IP address from the server.

Setting the LAN IP manually will disable the DHCP and the unit will use a fixed IP address, defined by the IP Address setting in the *REMOTE* menu.

The keyboard is disabled when the instrument is set to “remote” using the IEEE. Press *HOME* to return to “local”.

RS232 data format is: start bit, 8 data bits (no parity), 1 stop bit. Flow control is RTS/CTS, baud rate is selectable via the COMMS menu. When connecting to a PC use the supplied null modem cable.

A summary of the available commands is given in the Appendix. Details of each command are given in the communication command manual.

Commands are executed in sequence except for two special characters that are immediately obeyed:

Control T (20) – reset interface (device clear)
Control U (21) – warm restart

To maintain compatibility with some communication systems, there is an optional “protocol 2” which requires a space between the command and any arguments.

Standard event status register

PON		CME	EXE	DDE	QYE		OPC

bit 0 OPC (operation complete)

cleared by most commands

set when data available or sweep complete

bit 2 QYE (unterminated query error)

set if no message ready when data read

bit 3 DDE (device dependent error)

set when the instrument has an error

bit 4 EXE (execution error)

set when the command cannot be executed

bit 5 CME (command interpretation error)

set when a command has not been recognised

bit 7 PON (power on event)

set when power first applied, or unit has reset

The bits in the standard event status register except for OPC are set by the relevant event and cleared by specific command ***(*ESR? *CLS, *RST***). OPC is also cleared by most commands that change any part of the configuration of the instrument (such as *MODE* or *START*).

Serial Poll status byte

		ESB	MAV		FDV	SDV	RDV

bit 0 RDV   (result data available)

set when results are available to be read as enabled by ***DAVER***

bit 1 SDV   (sweep data available)

set when sweep results are available to be read as enabled by ***DAVER***

bit 2 FDV   (fast data available (streaming))

set when data streaming results are available to be read as enabled by ***DAVER***

bit 4 MAV (message available)

set when a message reply is waiting to be read

bit 5 ESB   (standard event summary bit)

set if any bit in the standard event status register is set as well as the corresponding bit in the standard event status enable register (set by ****ESE***).

RS232 connections

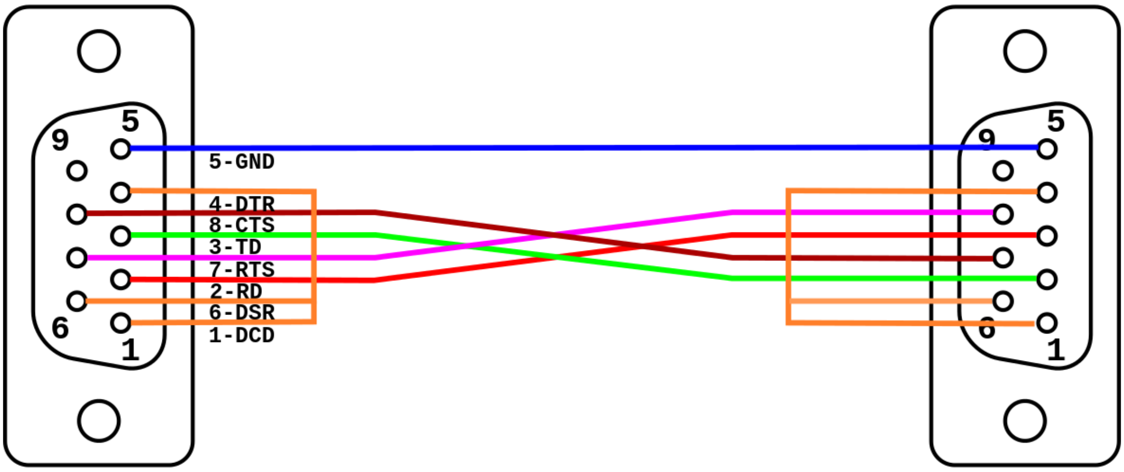
The RS232 port on the PSM3750 uses the same pinout as a standard 9 pin serial port on a PC or laptop (9-pin male ‘D’ type).

Pin	Function	Direction
1	DCD	in (+ weak pull up)
2	RX data	in
3	TX data	out
4	DTR	out
5	GND	
6	DSR	not used
7	RTS	out
8	CTS	in
9	RI	not used

The PSM3750 will only transmit when CTS (pin 8) is asserted and can only receive if DCD (pin 1) is asserted. The PSM3750 constantly asserts (+12V) DTR (pin 4) so this pin can be connected to any unwanted modem control inputs to force operation without handshaking. The PSM3750 has a weak pull up on pin 1 as many null modem cables leave it open circuit. In electrically noisy environments, this pin should be driven or connected to pin 4.

To connect the PSM3750 to a PC, use a 9 pin female to 9 pin female null modem cable:

1 & 6	-	4
2	-	3
3	-	2
4	-	1 & 6
5	-	5
7	-	8
8	-	7



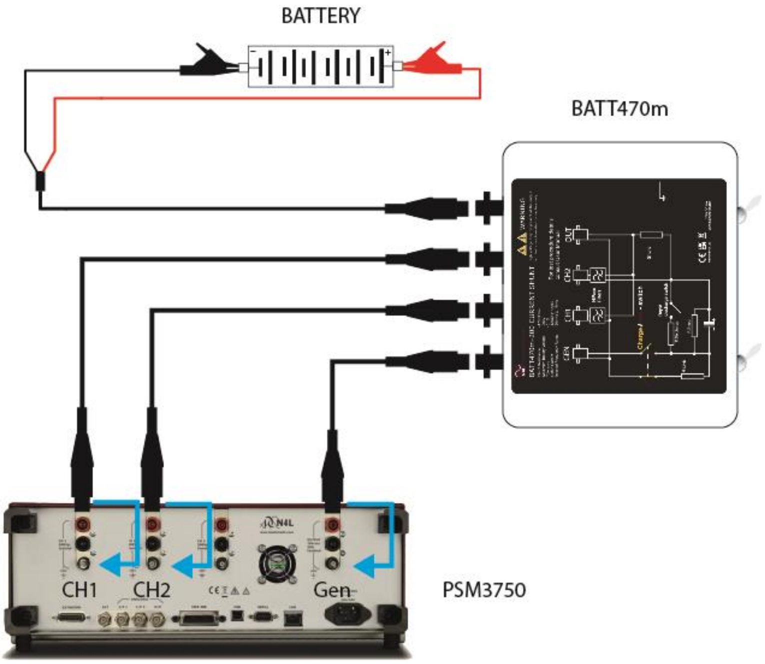
Null Modem cable pin out

EIS - Electrochemical Impedance Spectroscopy

Electrochemical Impedance Spectroscopy is performed using the following accessories.

- BATT470M 200-x EIS Current Shunt
- BNC-BNC Safety Lead
- HV BNC to 4mm Test Lead
- Pair of croc clips

Connection Diagram:

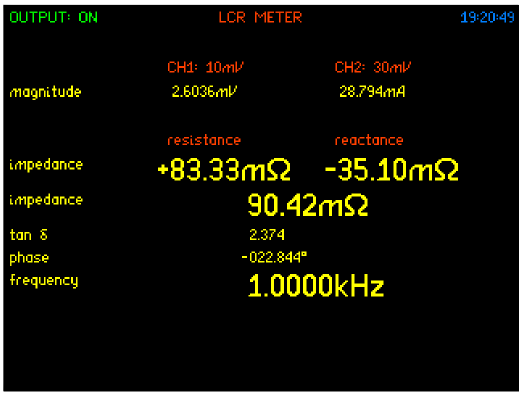


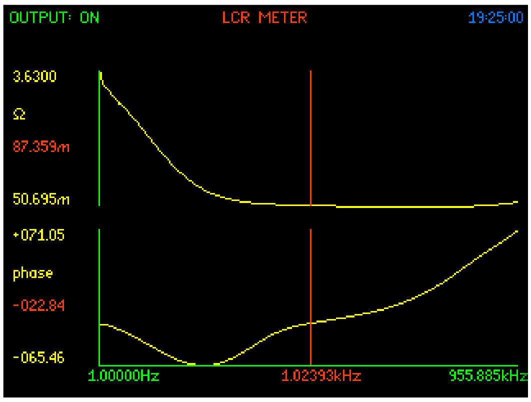
An impedance sweep can then be performed between the frequency limits of interest. This can be displayed in Nyquist form within PSMComm2 (EIS Mode) PC software if preferred.

TEST PROCEDURE:

A full description with illustrations is available in the BATT470m – 200x User manual which is available to download from the N4L website.

https://resources.newtons4th.com/manuals/





Real Time view and Graphic view of the cell impedance measurements

Trouble Shooting

Frequently Asked Questions

Q. PSM3750 won't connect to a PC running PSMComm2

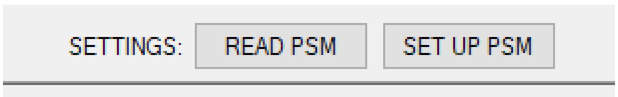
A. Check the ***interface*** parameter in the *COMMS* menu and ensure that it is set to the method used to physically connect the instrument to the PC. If using RS232 also check that the baud rate is set to 19200.

Q. When using an IAI2, the four yellow LEDs on the front of the IAI2 are flashing or there is a message on screen saying "Auxiliary Fixture Not Responding"

A. Check all the following, ensure power lead is properly fitted and supply switched on, ensure IAI2 is switched on, check that the ribbon cable is securely attached at each end.

Q. When using PSMComm2 the software settings does not match the instrument settings or vice versa.

A. Ensure that the requisite button has been pressed in PSMComm2 as shown below. If the settings are made on the instrument use the READ PSM button, if the settings are altered in PSMComm2 then use the SET UP PSM button.



Q. Error messages showing on PSMComm2 software.

A. Check that the firmware and software are the most up to date available. Both PSMComm2 and the PSM3750 firmware are available as free downloads from our website support pages. https://resources.newtons4th.com/

General Specifications

GENERAL SPECIFICATIONS	
Accuracy	Frequency ± 0.05%
	Amplitude ± 5% (10% > 50MHz)
Accuracy (with trim)	Amplitude ± 1% < 10MHz
Output Impedance	50Ω ± 2%
Output Voltage	± 15V peak (Open Circuit) *
Offset	± 10V peak maximum
Waveforms	Sine, Square, Triangular, Sawtooth, Pulse, and White noise
Frequency	10µHz to 50MHz
Output Control	10mV to 2mV steps
Type	Direct Digital Synthesis
Update Rate	210MHz
DAC Resolution	14 bit
Phase Accumulator	48 bit
Sweep Steps	Up to 2000 steps in all sweep functions
Set-up and Data Storage	Up to 100 analyzer setups, readings and up to 30sweep results can be stored internally.
Interface - standard	RS232, USB, LAN, & GPIB (IEEE488)
Real Time Clock	Time and date stamp for data stores
Data Storage	Internal 1GB flash
Display and Resolution	320 x 240 QVGA full colour – white LED backlight, 6-digit frequency, 5 digit voltage, 4 digit dBm
Power Source	90-264V rms 47-63Hz 30VA max
Operating Temperature Range	0°C to +50°C
Size	130H x 400W x 315D mm excluding feet
Weight	3.3kg (2Channel), 3.5kg (3Channel)
Operating Temperature	0°C to +50°C
Storage Temperature Range	-10°C to +60°C
Relative Humidity Range	20 to 95% non-condensing
Maximum Altitude	2,000 Metres

*The absolute amplitude of the generator signal is unimportant in FRA mode, it is only the relative magnitude between two measured inputs that are required, and the absolute amplitude is largely irrelevant in LCR mode, as it is only the relative magnitude/phase angle of two inputs that are required. In the few applications in which generator accuracy becomes important, then the ability to use the TRIM function (See page 54) provides that ability.

APPENDIX A

Default Menu settings

Key & Sub Categories	Description
ACQU	Acquisition Control: Used for configuring inputs appropriate to source and nature of signals being analyzed

Input	Channel selection dependent upon model
PSM3750-2CH	Only 2 input channels available
PSM3750-3CH	Select between 2 or 3 channel inputs

Speed	In normal acquisition mode the window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. The results from each window are passed through a smoothing filter. There are 5 pre-set speed options that adjust the nominal size of the window, and therefore the update rate and time constant of the filter. Greater stability is achieved at a slower speed at the expense of a slower update rate
Very Slow	Update rate = 10s. Results window size will update every 10 seconds
Slow	Update rate = 2.5s. Results window size will update every 2.5 seconds
Medium	Update rate = 1/3s. Results window size will update 3 times per second
Fast	Update rate = 1/12s. Results window size will update 12 times per second
Very Fast	Update rate = 1/50s. Results window size will update 50 times per second
Window	The window application will allow the user to input their own speed settings different to any of the 5 pre-set settings above
Cycles	Manually input number of measurements to be made at each measurement point, of which the average will be taken. Set between 1 and 100
Smoothing	Smoothing filter will gather the data and average out over a sliding window time scale. This is very useful when gathering data which could be affected by noise. Each speed above has its own time constant for filtering and data updates. Smoothing does not affect a single sweep as each point is a single measurement. If Sweep is set to continuous then the smoothing is applied to each new sweep result
Normal	With Normal smoothing applied the following update windows will apply to the relevant speed selected. V.Fast =0.1s, Fast = 0.4s, Medium = 1.5s, Slow = 12s, V.Slow = 48s
Slow	With Slow smoothing selected all results are X4 greater than in normal smoothing mode
None	With no smoothing to computed results the data update will be dictated by the speed only

Smoothing Response	
Auto Reset	The smoothing response is by default set to "auto reset" where the filtering described in "smoothing" is reset in response to a significant change in data. This speeds up the response of the instrument to changing conditions
Fixed Time	Auto reset can be disabled so that the filtering has a fixed time constant, which would have an exponential response to a step change

Phase Reference	In the case where there is very little signal on CH1, the reference for the phase can be set to another channel to give a more accurate measurement. This does not change the phase results it only helps to reduce the uncertainty due to noise.
Channel 1	Select to choose Channel 1 as reference
Channel 2	Select to choose Channel 2 as reference
Channel 3	Select to choose Channel 3 as reference (If fitted)

Low Frequency	When the generator is not used and so the measurement is synchronised to the input frequency measured on CH1, there is a low frequency option that extends the frequency measurement down to 10µHz. This low frequency option also applies a digital filter which can be useful when measuring in low frequency, noisy environments
Off	Select to switch this mode Off
On	Select to switch this mode On

Bandwidth	The bandwidth of the instrument usually set to "Auto" can be forced to "Wide" or "Low" when not in "Auto" mode, heterodyning is disabled
Wide	Select to set bandwidth to 5MHz
Low	Select to set bandwidth to 100KHz
Auto	Select to set bandwidth into auto mode

ACQU ADVANCED OPTIONS	
DFT Selectivity	Analysis of the **fundamental** component uses a DFT (Discrete Fourier Transform) algorithm. The selectivity of the DFT analysis is a compromise between noise rejection of frequencies close to the frequency of the fundamental component and the required stability of the frequency component
Normal	Default settings for the fundamental calculations
Narrow	Selecting "narrow" increases the selectivity of the DFT analysis (reducing the effective bandwidth at each component) which has the effect of improving the noise rejection. It does however require that the frequency of the fundamental component is more stable

Ignore Overload	In a noisy application any spikes present on the signal may push the instrument onto a higher range than is necessary for the signal being measured. If the nature of the spurious spikes is such that they do not contribute to the measurement and can safely be ignored, then the range can be manually set to the appropriate range for the signal to be measured and the instrument can be told to ignore any overload. If using this mode, it is wise to check the signal on the oscilloscope to be sure that the signal being measured is not genuinely over range
Off	Select to switch this mode Off
On	Select to switch this mode On

Frequency Lock	In a very noisy application, where the frequency of the signal is known but the instrument is unable to measure the frequency even with low frequency mode filters applied, it is possible to manually enter the frequency to be used for analysis
Normal	Utilises N4L unique signal processing techniques for fundamental frequency synchronisation including hysteresis to increase frequency noise immunity
Constant	Constant selection will allow the user to overwrite the present measured frequency with the known frequency. This entered frequency is then used for all the analysis and the frequency of the input signal is not measured

High Speed	High speed mode can be selected for data log speeds less than 100ms
Disabled	Disable high speed function
Enabled	Activate high speed data log function

DATALOG OPTIONS	
Datalog	Select the destination for the datalog RAM or USB memory stick, alternatively disable it
RAM	
Interval	Set the interval between readings
Graph	The graph can display all the parameters selected by Zoom at once or individually
Zoom 1	Enable or disable zoom 1 parameter

Zoom 2	Enable or disable zoom 2 parameter
Zoom 3	Enable or disable zoom 3 parameter
Zoom 4	Enable or disable zoom 4 parameter
USB memory stick	
Location	1-999
name	Alphanumeric characters
Interval	Set the interval between readings
Graph	The graph can display all the parameters selected by Zoom at once or individually
Zoom 1	Enable or disable zoom 1 parameter
Zoom 2	Enable or disable zoom 2 parameter
Zoom 3	Enable or disable zoom 3 parameter
Zoom 4	Enable or disable zoom 4 parameter

SWEEP	All ac measurements using the PSM3750 generator can be swept across a frequency range
Sweep Start	Manually input sweep start frequency
Sweep End	Manually input sweep end frequency

Steps	Manually enter number of steps the frequency sweep data is to be analyzed over. Up to a max of 2000 steps

Steps	
Log	Set to view the resultant data in a Logarithmic format
Linear	Set to view the resultant data in a Linear format

Sweep	
single	Single sweep
repeat	Repeating sweep

Graph 1 Scaling	The graph normally sets the Y axis automatically to the extremes of the measurement
Auto	Select to leave graph in auto mode
Manual	Select to independently manually set the Y axis
Upper limit Lower limit	Set limit Set limit
Graph 2 Scaling	The graph normally sets the Y axis automatically to the extremes of the measurement
Auto	Select to leave graph in auto mode
Manual	Select to independently manually set the Y axis
Upper limit	Set limit
Lower limit	Set limit

TRIM	The trim function is a powerful and versatile feature that allows closed loop control of the generator amplitude
ac Trim Data	
Disabled	Select to disable ac trim function
Channel 1	Select to allow the generators output to be adjusted, and maintain the measured voltage or current from CH1

AC level	
Tolerance	
Channel 2	Select to allow the generators output to be adjusted, and maintain the measured voltage or current from CH2
AC level	
Tolerance	
Channel 3	Select to allow the generators output to be adjusted, and maintain the measured voltage or current from CH3 (If fitted)
AC level	
Tolerance	

COMMS	
Resolution	Press to set the data resolution and change the format to which the instrument responds to future commands via Comms interface
Normal	Data resolution set to 5 decimal points
High	Data resolution set to 6 decimal points
Binary	Data transmitted in binary format

Interface	Communications type between instrument and pc
RS232	RS232 Comms interface
USB	USB Comms interface
LAN	LAN Comms interface
GPIB	GPIB Comms interface

Recall with Program	When enabled recalls communication port settings from any stored memory location
Off	Turn OFF this option
On	Turn ON this option

Screen Print	
Disabled	No screen print option selected
RS232	Print screen via RS232 cable i.e., to a printer
USB Memory Stick	Print screen directly onto a USB memory stick. To activate press and hold the START key for 2 seconds and then release. A BMP file is then transferred to the memory stick

ALARM	
Alarm 1 Data	Alarm on selected parameter and threshold
Zoom 1	Zoom 1 parameter selected for alarm threshold
Zoom 2	Zoom 2 parameter selected for alarm threshold
Zoom 3	Zoom 3 parameter selected for alarm threshold
Zoom 4	Zoom 4 parameter selected for alarm threshold

Alarm Type (Alarm 1)	
Disabled	No alarm
Linear	Frequency of beep increases linearly as value reaches its limit
Alarm if High	Alarm will sound if values exceed a threshold
Alarm if Low	Alarm will sound if values fall below a threshold

Outside Window	Alarm will sound if values are outside a permitted window setting
Inside Window	Alarm will sound if values are within a permitted window setting

Alarm 2 Data	Alarm on selected parameter and threshold
Zoom 1	Zoom 1 parameter selected for alarm threshold
Zoom 2	Zoom 2 parameter selected for alarm threshold
Zoom 3	Zoom 3 parameter selected for alarm threshold
Zoom 4	Zoom 4 parameter selected for alarm threshold

Alarm Type (Alarm 2)	
Disabled	No alarm
Linear	Frequency of beep increases linearly as value reaches its limit
Alarm if High	Alarm will sound if values exceed a threshold
Alarm if Low	Alarm will sound if values fall below a threshold
Outside Window	Alarm will sound if values are outside a permitted window setting
Inside Window	Alarm will sound if values are within a permitted window setting

Analogue Output	No longer supported

AUX	
None	No auxiliary device connected
IAI	Impedance Analysis Interface- converts the PSM3750 into a high performance LCR meter with true 4 wire kelvin connections that are taken directly to the component under test without the need for external shunts. Buffering, amplification, and selectable shunts provide LCR measurements over a wide frequency and impedance range

OUT	PSM3750 has a wide bandwidth, isolated, generator output that can be used as a signal generator to produce various waveforms
Waveform	
Sinewave	Select for sinewave output signal
Square wave	Select for square wave output signal
Triangle	Select for triangle output signal
Sawtooth	Select for sawtooth output signal
White Noise	Select for true white noise output signal

Amplitude Control	
V	Set amplitude as a peak output voltage
dBm	Set amplitude in dBm with reference to 600Ω load

Amplitude	Manually enter the amplitude Vpk value to be applied To the DUT

Amplitude Step Size	Manually enter a value by which the amplitude will increase / decrease in relation to pressing the up and down arrows, the new value will be displayed within the real-time display (except for the Harmonic and Power Analyzer where the up and down arrow step the selected harmonic)

Amplitude Ceiling	Amplitude ceiling represents the maximum value allowed to the output of the generator, this is used when you are using the “trim” function and do not want the output of the generator to go above a certain value, for example if the PSM output is being used to control a DC+AC load bank and you do not want the load bank to go above or below a certain resistance

Offset	Manually enter any offset to bias the signal or to null out any dc present

Frequency	Manually set the frequency of the generator. This can be adjusted by a fixed increment set within the “Frequency step size” via the left and right arrows

Step Type	
Logarithmic	dBm
Linear	V

Frequency Step Size	Manually enter a value by which the frequency will increase / decrease in relation to pressing the left and right arrows
Output	
Off	Signal generator output will be switched off
On	Select to switch on signal generator
DC Only	Select signal generators output control to be dc only

Advanced Options	
Adjust Generator	Select to adjust (trim) the generator output if required
Adjustment Factor	Adjustment to the Generator output

CH1	Channel 1 input control
Input	
Direct	Select if input signal is connected directly into the PSM3750 internal shunt connectors
External Shunt	Select if Channel 1 input signal is via an external shunt
External Attenuator	Select if Channel 1 input signal is via an external attenuator

Autoranging	
Full Autorange	Default setting. Full autoranging will be selected and implemented within the instrument
Range up Only	Selecting this option will allow the test being carried out to find the highest range via peak detection and hold on this range. Once this value has been found another test can be carried out by pressing the “Trigger” key which will restart from the minimum value parameter. Essential for low frequency measurements

Manual	Selecting this option will allow the user to set up the range from the configured measurements available. Essential for low frequency measurements

Minimum Range	Select the minimum voltage range from the drop-down menu
Coupling	
AC+DC	Default setting will allow both AC and DC signals to be calculated in all measurements
AC	Select ac for measuring signals that are biased on a dc level (such as an amplifier operating on a single supply or the output of a dc PSU)

CH2	Channel 2 input control
Input	
Direct	Select if input signal is connected directly into the PSM3750 internal shunt connectors
External Shunt	Select if Channel 2 input signal is via an external shunt
External Attenuator	Select if Channel 2 input signal is via an external attenuator

Autoranging	
Full Autorange	Default setting. Full autoranging will be selected and implemented within the instrument
Range up Only	Selecting this option will allow the test being carried out to find the highest range via peak detection and hold on this range. Once this value has been found another test can be carried out by pressing the “Trigger” key which will restart from the minimum value parameter. Essential for low frequency measurements
Manual	Selecting this option will allow the user to set up the range from the configured measurements available. Essential for low frequency measurements

Minimum Range	Select the minimum voltage range from the drop down menu

Scale Factor	Manually set the scale factor required
Coupling	
AC+DC	Default setting will allow both AC and DC signals to be calculated in all measurements
AC	Select AC for measuring signals that are biased on a DC level (such as an amplifier operating on a single supply or the output of a DC PSU)

SYS	General system options
Set Clock	Manual setting required. Use numerical keys
Set Date	Manual setting of date and year required month settings are pre-set

Display	
Colour	Select to set screen display in colour
White on Black	Select to set screen display in White font on a Black background
Black on White	Select to set screen display in Black font on a White background
Brightness	

Low	Screen brightness will be set to low
High	Screen brightness will be set to high

Phase Convention	Measurements of Phase can be expressed in one of three formats:
-180º to +180º	Commonly used in circuit analysis
0º to -360º	Commonly used in power applications
0º to +360º	Select as required

Phase Reference	Phase Reference “Sine” or “Cosine” only changes the phase of a harmonic, you will see this within Harmonic Mode only
Cosine	Select as required
Sine	Select as required
Blanking	Blanking only activates for LCR mode when compensation changes the measured value by a factor of 8 or more, the display will blank to zero
Off	Function will be disabled
On	Function will be enabled

Keyboard Beep	Audible sound when keys are pressed
Disabled	Audible sound disabled
Enabled	Audible sound enabled
High Voltage Protection Mode	When enabled autozero is disabled if any of the channels show a measurement of 100V or above
Off	Function will be disabled
On	Function will be enabled
Begin Measurements on power up	Enables and disables High Voltage Protection message when instrument is switched on.
Off	Message is displayed, press home key to continue
On	Message is disabled

Program 1-6 Direct Load	Program 1-6 may be recalled with a direct press of the function keys (FRA, PAV, LCR, RMS etc)
Disabled	Function will be disabled
Enabled	Function will be enabled

Zoom 2 High Resolution	The data displayed in zoom 2 may be displayed to one digit greater resolution than normal
Disabled	Function will be disabled
Enabled	Function will be enabled

Show Scaled Range	
Disabled	Function will be disabled
Enabled	If enabled and you set a scale factor on CH1 or CH2 the “re-scaled range” would appear in the relevant column
Step Message	
Disabled	Message will be disabled

Enabled	Message will be enabled

←System Information	The information given in this section cannot be changed by the user
Serial Number	Instruments unique serial number
Manufacturing Code	Code attributed to build date of instrument
Main release	Current firmware release installed in instrument
DSP Release	Digital Signal Processing release version
FPGA Release	Field Programmable Gate Array release version
Boot Release	Release version of instruments boot up firmware
Last Calibration	Instruments last calibration date
Auxiliary Calibration	Associated IAI auxiliary device calibration information
→ User Data	
Supervisor Access	Note (Not currently supported)
User Data	Manually enter company name
User Data	Manually enter individual or company
User Data	Manually enter unique ID for instrument
Save	Save all above settings

MODE	Function Control
True RMS Voltmeter	The RMS voltmeter measures the total rms of the signal present at the input terminals to the bandwidth of the instrument (>1MHz). Care must be taken when measuring low signal levels to minimise noise pick up on the input leads
Frequency Response Analyzer	PSM3750 Frequency response analyzer measures the gain and phase of channel 2 relative to channel 1 using a Discrete Fourier Transform (DFT) algorithm at the fundamental frequency
Power meter	The power meter measures the total power and fundamental power of the signal present at the input terminals to the bandwidth of the instrument (>1MHz). Above 5MHz only the fundamentals are measured
LCR Meter	In LCR meter mode, channel 1 measures the voltage across the component under test and channel 2 measures the current through it. To measure the current, channel 2 must be connected across an appropriate external shunt (e.g., IAI)

Harmonic Analyzer	The PSM3750 harmonic analyzer computes multiple DFT's on the input waveforms in real time
Vector Voltmeter	A phase angle voltmeter (or vector voltmeter, or phase sensitive voltmeter) measures the signal at one input compared to the phase of the signal at a reference input. The results may be expressed as magnitude and phase, or as separate in-phase and Quadrature components
Oscilloscope	The PSM3750 provides a storage oscilloscope function to view the waveforms being measured

PROG	Recall/Store/Delete of non-volatile programs
Memory	Program store / recall options
Internal	Instruments internal memory utilised to store or recall data to / from
USB Memory Stick	External USB memory stick utilised to store or recall data to / from

Data	
Program	Upload or download a program
Results	Upload or download results

Action	
Recall	Recall any **Data** selections from above
Store	Store any **Data** selections from above
Delete	Delete any **Data** selections from above
Location	999 selectable locations for data to be stored, recalled or deleted from. Each location has an associated name of up to 20 characters that can be entered by the user to aid identification
Name	User entered location name, otherwise blank

Execute	Press to recall / store or delete program

OTHER KEYS	
ZOOM +	Increases font size on selected parameters on the display screen

ZOOM -	Decreases font size on selected parameters on the display screen

REAL TIME	Press real time to return to the display screen and see all data in real time. Pressing real time will also put the display screen into hold mode

TABLE	Press table to view results either during, or at the completion of a frequency sweep in tabular format

GRAPH	Press graph during frequency sweep to view plotted data points whilst sweep is in process, or view graph plots once sweep is complete. Press “GRAPH” to move through screen display options

FRA	Direct key to Frequency Response Analyzer mode

PAV	Direct key to Vector Voltmeter mode

LCR	Direct key to Impedance Meter mode

RMS	Direct key to True RMS Voltmeter MODE

POWER	Direct key to Power Meter mode
SCOPE	Direct key to Scope mode where waveforms can be viewed from measurements being taken. The left and right directional arrows will allow the time base to be changed and the up and down directional arrows will allow the trigger level to be set

START	Start key will commence any frequency sweep. Is also the key used to initialise a screen dump of any data displayed onto a USB memory stick

STOP	Stop key will stop any frequency sweep

ZERO	Zero key will reset the inputs to zero

TRIGGER	Trigger returns display screen back to real time from a hold command. Also triggers a single shot in scope mode, all trigger settings can be found by pressing the “scope” key whilst in scope mode
ENTER / NEXT (Dual use key)	Enter / Next key will enable the user to confirm any configurations they have set within the menu’s and will scroll through the display screen whilst in scope mode

DELETE / BACK (Dual use key)	Delete / Back will enable the user to delete any inputted data or scroll back through any results screens

HOME / ESC (Dual use key)	Home / Esc will enable the user to return to the home page once data within parameters have been adjusted and entered, or will escape from any screen view and return to the selected mode’s home screen

Accessories

Supplied Standard Accessories

Leads	Power, RS232, USB
Connection cables	30Arms rated 1.5 meter long leads with 4mm – stackable terminals 1x Yellow, 1 x Red and 2x Black per phase Note 1: LC version instruments (rated at 10Arms) are supplied with 20Arms connection cables Note 2: HC version instruments (rated at 50Arms) are not supplied with connection cables or connection clips.
Connection clips	4mm terminated alligator clips – 1x Yellow, 1 x Red and 2x Black per phase
Documentation	Calibration Certificate, Both the User manual (this manual) & Communications manual are free downloads from www.newtons4th.com

N4L Software Packages

All N4L software packages are available free of charge as a downloadable file from our website https://resources.newtons4th.com/

If you are not already registered with us, then please take the time to visit our website and register by completing the registration section on the right hand side and clicking the Register key.

Once approved (within UK office hours) you will receive an email with your login details. Login on the left hand side of the screen and click the Software menu option on the far left. You will also find in the support section all the latest:

Instrument Firmware, PC Software and Manuals.

Upon initial activation of our Software with your PC you will be asked for an unlock code, these codes are readily available from your local distributor or by emailing us directly at support@newtons4th.com

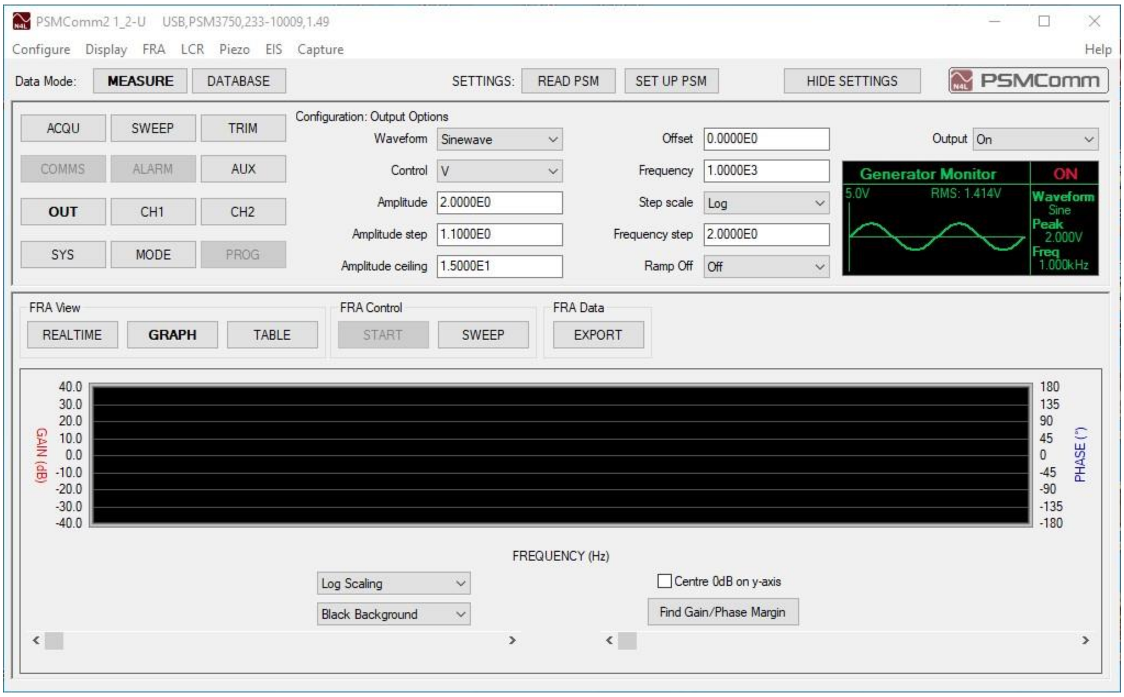
PSMComm2

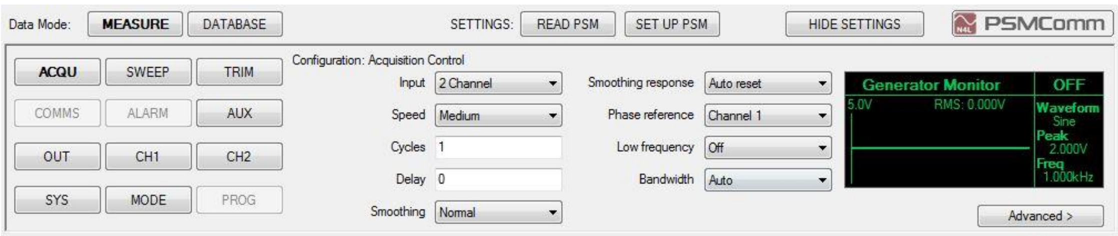
PSMComm2 is a self-contained executable software program written in C++ ™ using the Microsoft win32 graphics set.

PSMComm2 connects to the PSM 3750 via RS232, USB, and LAN. The software includes all measurement modes to reflect instrument operation.

PSMComm2 supports the ability to export text files in CSV format as well as export directly to Microsoft Excel™.

PSMComm2 is available as a free download from our website https://resources.newtons4th.com/

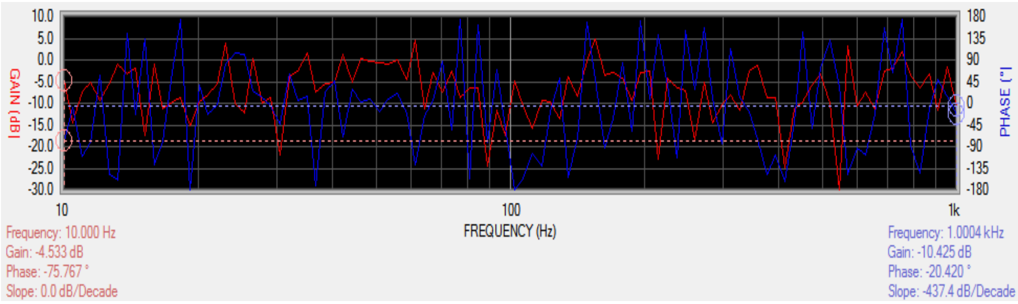




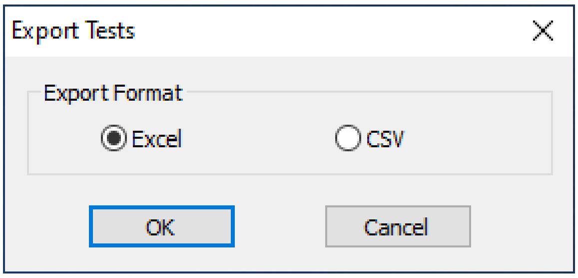
The connected instrument's settings are stored in the configuration panel and can be edited and sent back to the instrument. The menus in PSMComm2 are designed to mimic the settings made directly on the PSM3750 through the menus and keypad.

Frequency	Magnitude 1	Magnitude 2	Impedance	Phase
10.000 Hz	656.61 nV	2.4954 uA	263.13 m Ω	159.40 °
Series R	Series L	Series C	Parallel R	Parallel L
-246.31 mΩ	1.4732 mH	-171.94 mF	-281.09 mΩ	11.905 mH
Parallel C	Tanð	Q	Reactance	
-21.278 mF	2.6610	375.80 m	92.562 m Ω	

Example of real time display in LCR mode above and graphing shown below.



Along with real time display and graphing capability, the user is able to export the results to CSV or MS Excel™ file formats.



An example Excel™ export is shown below.

	A	B	C	D	E	F	G
1	PSMComm2 v1_1c					22nd May 2017 - 10:24:11	
2	N4L PSMComm2 FRA Sweep Data 1/1						
3	Steps	Frequency	Magnitude 1	Magnitude 2	Gain 1	Phase 1	Delay 1
4	1	1.00E+00	7.12E-02	1.57E-03	-3.31E+01	-1.36E+01	3.78E-02
5	2	5.15E+01	5.95E-02	1.51E-03	-3.19E+01	6.43E+00	1.91E-02
6	3	1.02E+02	7.47E-02	1.61E-03	-3.33E+01	7.40E-02	9.80E-03
7	4	1.52E+02	7.66E-02	1.54E-03	-3.39E+01	5.60E+00	6.46E-03
8	5	2.03E+02	7.14E-02	1.63E-03	-3.28E+01	8.99E+00	4.80E-03
9	6	2.53E+02	6.93E-02	1.67E-03	-3.24E+01	8.97E+00	3.85E-03
10	7	3.04E+02	7.85E-02	1.62E-03	-3.37E+01	1.34E+01	3.17E-03
11	8	3.54E+02	7.57E-02	1.60E-03	-3.35E+01	1.08E+01	2.74E-03
12	9	4.05E+02	6.90E-02	1.58E-03	-3.28E+01	1.74E+01	2.35E-03
13	10	4.55E+02	7.02E-02	1.60E-03	-3.28E+01	1.80E+01	2.09E-03
14	11	5.06E+02	7.28E-02	1.71E-03	-3.26E+01	2.28E+01	1.85E-03
15	12	5.56E+02	7.07E-02	1.65E-03	-3.26E+01	2.50E+01	1.67E-03
16	13	6.07E+02	7.25E-02	1.71E-03	-3.26E+01	3.05E+01	1.51E-03
17	14	6.57E+02	5.87E-02	1.65E-03	-3.10E+01	2.37E+01	1.42E-03
18	15	7.08E+02	6.25E-02	1.68E-03	-3.14E+01	3.39E+01	1.28E-03
19	16	7.58E+02	5.95E-02	1.76E-03	-3.06E+01	2.17E+01	1.24E-03
20	17	8.09E+02	5.11E-02	1.80E-03	-2.91E+01	2.70E+01	1.14E-03
21	18	8.59E+02	5.25E-02	1.79E-03	-2.94E+01	2.74E+01	1.07E-03
22	19	9.10E+02	5.33E-02	1.68E-03	-3.00E+01	2.13E+01	1.03E-03
23	20	9.60E+02	4.62E-02	1.67E-03	-2.88E+01	1.16E+01	1.01E-03
24	21	1.01E+03	4.56E-02	1.68E-03	-2.87E+01	2.02E+01	9.34E-04
25	22	1.06E+03	5.07E-02	1.60E-03	-3.00E+01	9.87E-01	9.40E-04

When running an LCR sweep from PSMComm2, the format of the Excel report will be adjusted to suit the type of sweep. See LCR Sweep parameter setting

LCR sweeps with the parameter set to Auto, Capacitance, Inductance, or Impedance produce report the following parameters: Frequency, Q Factor, Tan δ, Z Magnitude, Z Phase, Series L, Series C, Series R, Y Magnitude, Y phase, Parallel L, Parallel C, & Parallel R

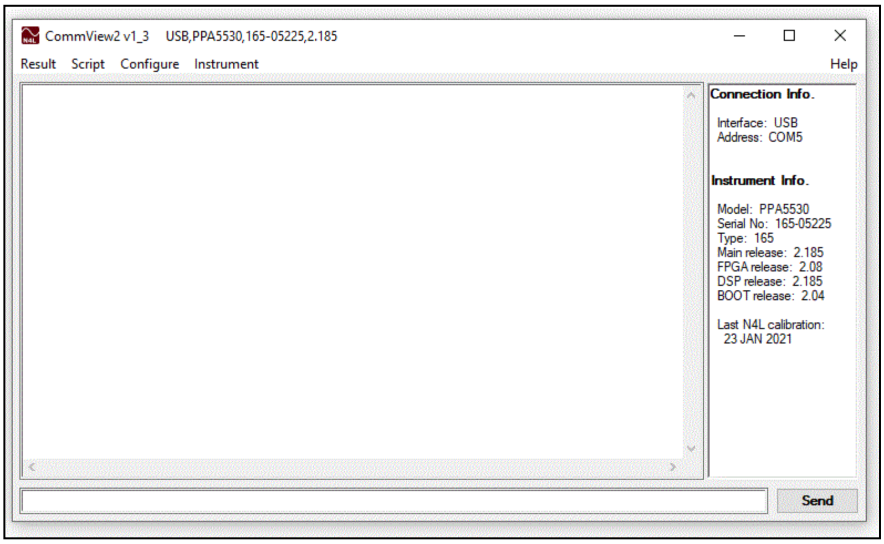
LCR sweeps, when the parameter is set to Admittance, produces the following parameters in the Excel report: Frequency, Y Real, Y Quadrature Y magnitude, Y Phase.

Examples of both are shown below.

PSMComm2 v1_3						27th June 2024 - 14:46:44
N4L PSMComm2 LCR Sweep Data 1/1						
Steps	Frequency	Q Factor	Tanδ	Z Magnitude	Z Phase	Series L
1	1.0000E+3	6.1768E+2	1.6190E-3	7.9323E+6	-8.9907E+1	-1.2625E+3
2	1.2496E+3	1.8441E+2	5.4228E-3	6.3081E+6	-8.9689E+1	-8.0342E+2
3	1.5615E+3	1.1639E+2	8.5920E-3	5.0115E+6	-8.9508E+1	-5.1076E+2

PSMComm2 v1_3						27th June 2024 - 14:46:44
N4L PSMComm2 LCR Sweep Data 1/1						
Series C	Series R	Y Magnitude	Y Phase	Parallel L	Parallel C	Parallel R
2.0064E-11	1.2842E+4	1.2607E-7	8.9907E+1	-1.2625E+3	2.0064E-11	4.8997E+9
2.0191E-11	3.4207E+4	1.5853E-7	8.9689E+1	-8.0344E+2	2.0190E-11	1.1633E+9
2.0339E-11	4.3057E+4	1.9954E-7	8.9508E+1	-5.1080E+2	2.0337E-11	5.8329E+8

PSMComm2 v1_3					27th June 2024 - 14:53:36
N4L PSMComm2 LCR Sweep Data 1/1					
Steps	Frequency	Z Real	Z Quadrature	Z Magnitude	Z Phase
1	1.0000E+3	1.4443E+0	6.5173E-1	1.5845E+0	2.4288E+1
2	1.2496E+3	1.4452E+0	8.1432E-1	1.6588E+0	2.9400E+1
3	1.5615E+3	1.4466E+0	1.0175E+0	1.7686E+0	3.5123E+1



N4L CommView2 is a self-contained executable software program written in C++™ using the Microsoft win32 graphics set.

CommView2 can connect to the PSM3750 via Serial/RS232 and where fitted LAN.

CommView2 allows strings to be sent and received between a PC and the PSM3750. The strings can be viewed in a window and optionally stored in a file. Data received from the instrument may be displayed in normal scientific notation with an identifying label.

CommView2 may be used interactively or may execute a series of commands automatically from a prepared text tile.

CommView2 may be used to upgrade the firmware in the instrument when new firmware is released.

The script file is created with any text editor and includes three types of lines (interpreted by the first character on each line):

lines beginning with " are sent to the PSM3750

lines beginning with # are commands for CommView2

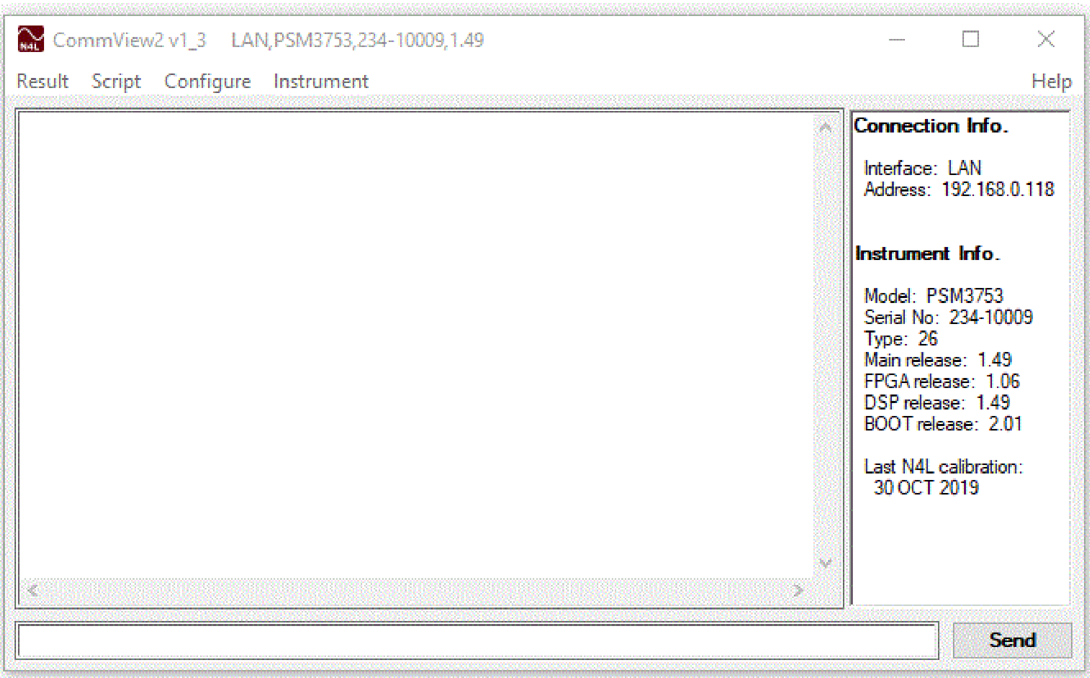
any other line is a comment.

The # commands that are recognised:

format	arguments	effect

"text	string	send text to instrument
#label,i,name	i = result index name = string	overwrites label associated with results value [n]
#pause,t	t = delay in s	delay by real number seconds
#wait,text		display text string and wait for a key press (discard key press)
#beep		sound beeper on PC
#reply,t	t = timeout in s	wait for a reply using a specified timeout
#flush		discard any received characters.
;text		comment

Other functions in CommView2:	Found within
save results	***results menu***
set COM port parameters	***configure menu***
firmware upgrade	***instrument menu***
read/store user programs	***instrument menu***



When connecting to the instrument the panel to the right hand side of the software window will display details about the instrument.

This includes:

Connection Information: Details of the interface used to connect the instrument to the PC.

Instrument Information: Instrument Model, Serial number along with firmware details.

Calibration information: Details of when the instrument was last calibrated

As with all N4L Software, it is available for free download along with a full User manual from our website. See www.newtons4th.com/support for more details.

Once registered and your account has been activated you will have access to the software and manuals download sections.

Serial command summary

command format	reply format
*CLS	
*ESE,value	
*ESE?	single integer data value
*ESR?	single integer data value
*IDN?	company,product,serial no,version
*OPC?	0 or 1
*RST	
*SRE,value	single integer data value
*SRE?	
*STB?	single integer data value
*TRG	
*TST?	single integer data value
*WAI	
ABORT	
ACTRIM,channel,level,tol	
ALARM,latch,sounder	
ALARM?	single integer data value
ALARME,value	
ALARME?	single integer data value
ALARM1,type,data,high,low	
ALARM2,type,data,high,low	
AMPLIT,amplitude AUXILI,device,value	
BANDWI,type	

BEEP	
BLANKI,on/off,threshold	
CONFIG,parameter,data	
CONFIG,parameter?	single integer or real data value
COUPLI,channel,coupling	
COUPLI,channel?	single integer data value
CYCLES,value	
DATALO,function,interval	
DATALO,start,records?	index,time,data… one record per line
DAV?	single integer data value
DAVER,value	
DAVER? DELAY,value FAST,value	single integer data value
FILTER,type,dynamics	
FRA	
FRA?	freq,mag1,mag2,dB,phase
FRA,SWEEP?	n lines of GAINPH? data
FREQUE,frequency	
FSWEEP,steps,start,end	
GAINPH	
GAINPH?	freq,mag1,mag2,dB,phase
GAINPH,SWEEP?	n lines of GAINPH? data
HARMON,scan,para,h,hmax	
HARMON? or	freq,mag1,mag2,hmag1,hmag2,h1,h2 freq,mag1,mag2,thd1,thd2,h1,h2
HARMON,SWEEP?	n lines of HARMON? data

HARMON,SERIES?	mag1,%1,ϕ1,mag2,%2,ϕ2

	1 line for each harmonic
HOLD,on/off HVHOME	
INPUT,channel,type	
INPUT,channel?	single integer data value
KEYBOA,value	
LCR,conditions,param,head	
LCR? or	freq, mag1, mag2, impedance, phase, R, L, C (series), R, L, C (parallel), tanδ, Q, reactance freq, mag1, mag2, impedance, phase, resistance, reactance, admittance, phase, conductance, susceptance
LCR,SWEEP? or	n lines of data: freq,QF,tanδ,impedance,phase,L,C,R freq,QF,tanδ,admittance,phase,L,C,R
LOWFRE,on/off MARKER,value,frequency	
MODE,type MULTIL,index,ch,function MULTIL? NEWLOC NOOVER,on/off	 Up to 60 data values selected using the MULIL command
OFFSET,offset	
OUTPUT,type,sweep	
PAV,parameter,scaling	
PAV?	freq,mag1,mag2,parameter,phase,a,b
PAV,SWEEP? PFCONV,type	n lines of VECTOR? data
PHASEM	
PHASEM?	freq,phase

PHASE,STREAM,window	phase,phase,phase,phase,phase,…….
PHCONV,convention	
PHREF,channel	
POWER,integration type	
POWER,WATTS?	W,W.f,VA,VA.f,pf,pf.f,Wdc,W.h,freq
POWER,RMS?	rms1,rms2,dc1,dc2,fnd1,fnd2,ϕ1,ϕ2
POWER,INTEGR?	Wh,Wh.f,VAh,VAh.f,pf,pf.f,Ah,Ah.f,t
PROGRAM,function,number	
PROGRAM?	CR terminated text string
RANGE,ch,ranging,range RESOLU	
RESULT,function,number RESULT?	
REZERO	
SCALE,channel,factor	
SCOPE,channel SCOPE? SCREEN? SETUP,index,data SETUP?	data for scope channel 240 lines of 40 bytes 16 lines of ASCII data
SHUNT,channel,resistance	
SHUNT,channel?	single real data value
SMOOTH,type,dynamics	
SPEED,speed[,window]	
START	
STATUS,channel?	range number,range text,over/low/ok
STOP	
SUSPEND,on/off TAGREP,on/off	

TEMPER,type,scalefactor, offset TEMPER?	 Single data value
TFA	
TFA?	freq,mag1,mag2,dB,phase
TFA,SWEEP?	n lines of GAINPH? data
USER? VARCON,type	3 CR terminated text strings
VECTOR,parameter,scaling	
VECTOR?	freq,mag1,mag2,parameter,phase,a,b
VECTOR,SWEEP?	n lines of VECTOR? data
VERSION?	datecode,cpu,dsp,fpga,boot
VRMS	
VRMS?	RMS? data followed by SURGE?
VRMS,RMS?	rms1,rms2,dc1,dc2,ac1,ac2,db1,db2
VRMS,SURGE?	pk1,pk2,cf1,cf2,surge1,surge2
WAVEFO,type WIRING,type	
ZERO	
ZERO,DELETE	
ZOOM,level,d1,d2,d3,d4	
ZOOM?	level,d1,d2,d3,d4

Available character set

The following characters can be selected in text entry mode.

The table is to be read across then down (e.g., starting at space and repeatedly pressing NEXT gives ! “ # $ % & ‘ ( ) * etc.)

<table>
<tr><td></td><td>!</td><td>“</td><td>#</td><td>$</td><td>%</td><td>&</td><td>‘</td></tr>
<tr><td>(</td><td>)</td><td>*</td><td>+</td><td>,</td><td>-</td><td>.</td><td>/</td></tr>
<tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>8</td><td>9</td><td>:</td><td>;</td><td><</td><td>=</td><td>></td><td>?</td></tr>
<tr><td>@</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr>
<tr><td>H</td><td>I</td><td>J</td><td>K</td><td>L</td><td>M</td><td>N</td><td>O</td></tr>
<tr><td>P</td><td>Q</td><td>R</td><td>S</td><td>T</td><td>U</td><td>V</td><td>W</td></tr>
<tr><td>X</td><td>Y</td><td>Z</td><td>[</td><td>\</td><td>]</td><td>^</td><td>_</td></tr>
<tr><td>‘</td><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td><td>g</td></tr>
<tr><td>h</td><td>i</td><td>j</td><td>k</td><td>l</td><td>m</td><td>n</td><td>o</td></tr>
<tr><td>p</td><td>q</td><td>r</td><td>s</td><td>t</td><td>u</td><td>v</td><td>w</td></tr>
<tr><td>x</td><td>y</td><td>z</td><td>{</td><td>|</td><td>}</td><td></td><td></td></tr>
</table>

Configurable parameters

All parameters can be accessed using the CONFIG command:

CONFIG,*parameter*?

CONFIG,*parameter,data*

Number	Function
	System parameters
1	operating mode
3	bandwidth auto or wide
4	high voltage protection mode
5	blanking disable
6	phase convention
7	main output on/off
9	keyboard beep on/off
11	low frequency mode
12	user window size
13	measurement speed
14	smoothing filter type
15	smoothing filter dynamics
16	baud rate
18	sweep steps
19	sweep start frequency
20	sweep stop frequency
21	single sweep / continuous sweep
22	auto conditions

	Input parameters
24	enable channel 1
25	enable channel 2
26	enable channel 3
27	input ranging channel 1
28	input ranging channel 2
29	input ranging channel 3
30	autoranging CH1
31	autoranging CH2
32	autoranging CH3
33	coupling CH1
34	coupling CH2
35	coupling CH3
36	scale CH1
37	scale CH2
38	scale CH3
39	external Shunt CH1
40	external Shunt CH2
41	external Shunt CH3
	Display parameters
42	zoom level
43	function zoomed on 1
44	function zoomed on 2
45	function zoomed on 3
46	function zoomed on 4
47	display type

	Signal generator parameters
48	generator frequency
49	generator amplitude
50	generator offset
51	generator waveform
52	delta frequency
53	delta amplitude
54	generator amplitude in dBm
	Datalog parameters
58	datalog memory type
59	datalog interval
	General parameters
66	program 1-6 direct load
67 69 72 73 75 78 84	DFT Type ignore Overload phase reference DFT selectivity frequency lock high speed mode input
	Power meter parameters
86	Difference THD
87	PF sign
88	Var sign

	RMS meter parameters
92	Rectified mean
93	Ratio 2
	Harmonic analyser parameters
99	computation
100	selected harmonic
101	maximum harmonic
103 104	bargraph scale (volts) bargraph scale (current)
	LCR single / sweep zero parameters
106	single / sweep compensation
107	sweep compensation start frequency
108	sweep compensation stop frequency
109	sweep compensation steps
	System parameters
111 113 114 115 117	current rating marker marker position high voltage protection message step message enable
118	display sequence
122	auxiliary device / Fixture
131	Show scaled external range
132	Zoom 2 high resolution

	LCR meter parameters
135 136 137	invert nyquist nyquist origins parameter
138	series/parallel sweep
139	graph option
140	IAI2 control
141	impedance lin/log
142	reference phase adjust value
143	reference impedance
144 145 146	reference type connection phase offset
	gain/phase analyser parameters
148	dB offset
149	gain/phase margin enable
150	computation 1
	System parameters
151	minimum number of cycles
152	delay time
153	IEEE address
154	interface enable
	Alarm functions
156	alarm data
157	type

158	high threshold
159	low threshold
160	latching type
161	sounder enable
	Alarm functions
167	alarm 2 data
168	alarm 2 type
169	alarm 2 high threshold
170	alarm 2 low threshold
	Graph functions
173	graph 2 manual/auto
174	graph 2 maximum
175	graph 2 minimum
	Phase angle voltmeter parameters
177	parameter
178	LVDT scaling
179	manual null meter ranging
180	null maximum
181	Phase offset
	Trim parameters
186	ac trim enable
188	ac trim level
190	trim tolerance

	Other parameters
192	log/linear sweep steps
193	graph 1 scaling manual/auto
194	manual graph 1 scaling maximum
195	manual graph 1 scaling minimum
198	Resolution
199	LAN IP address 3
200	LAN IP address 2
201	LAN IP address 1
202	LAN IP address 0
203	Tag comms reply with unit identifier
	Scope parameters
208	timebase
209	trigger level
210	pretrigger
211 212	trigger polarity trigger mode
215	cursors
216	trigger HF reject
	Generator parameters
219	generator ceiling
221	pulse width
222	amplitude step if dBm control
223	linear frequency step

Contact details

Please direct all queries or comments regarding the PSM3750 instrument or manual to:

Newtons4th Ltd.

1 Bede Island Road

Leicester

LE2 7EA

United Kingdom

Tel: (0116) 230 1066 international +44 116 230 1066

Fax: (0116) 230 1061 international +44 116 230 1061

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. **PSM3750 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.		