Newtons4th Ltd

PSM 1735

Frequency Response Analyzer

User manual

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Chapter 1 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 10V peak.

The inputs must not be connected to signals greater than 10V peak.

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 this symbol is 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***

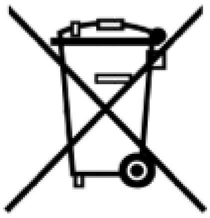
Environmental compliance

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

Chapter 2 Declaration of Conformity

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

We declare that the product:

Description: Phase Sensitive Multimeter
Model: PSM1735

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.)

Chapter 3 Preface

This manual covers the Newtons4th Ltd Phase Sensitive Multimeter PSM1735

Key Features

Wide frequency range 10µHz to 35MHz

0.01dB Gain accuracy at < 1kHz

0.01˚ Phase accuracy at < 1kHz

Frequency, Phase and Tan δ to 6 digits

Dual input channels

Signal generator 0V to ±10V 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 RS232, LAN or GPIB

Impedance Analysis Interface available

Pre-programmed application modes for -:

- Frequency Response Analysis
- Phase Angle Voltmeter
- LCR Meter
- RMS Voltmeter
- Power Analyzer
- Harmonic Analysis
- Oscilloscope

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

Microsoft, (Excel, Windows, Word, & C++) 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 PSM1735 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.

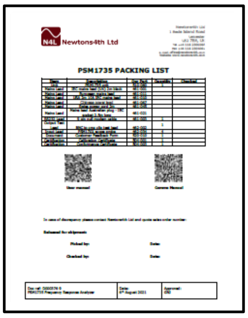
In the event of any problem with the instrument outside of the guarantee period, Newtons4th Ltd. offers a full repair and re-calibration service. It is recommended that PSM1735 is re-calibrated annually.

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

Chapter 4 Installing your PSM1735

Checking the shipped contents

Carefully unpack your PSM1735 and check the packing list that came with your instrument to verify that you have received all standard accessories and ordered items.


PSM1735 PACKING LIST

If any items are missing or damaged, please contact either Newtons4th 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 PSM1735 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

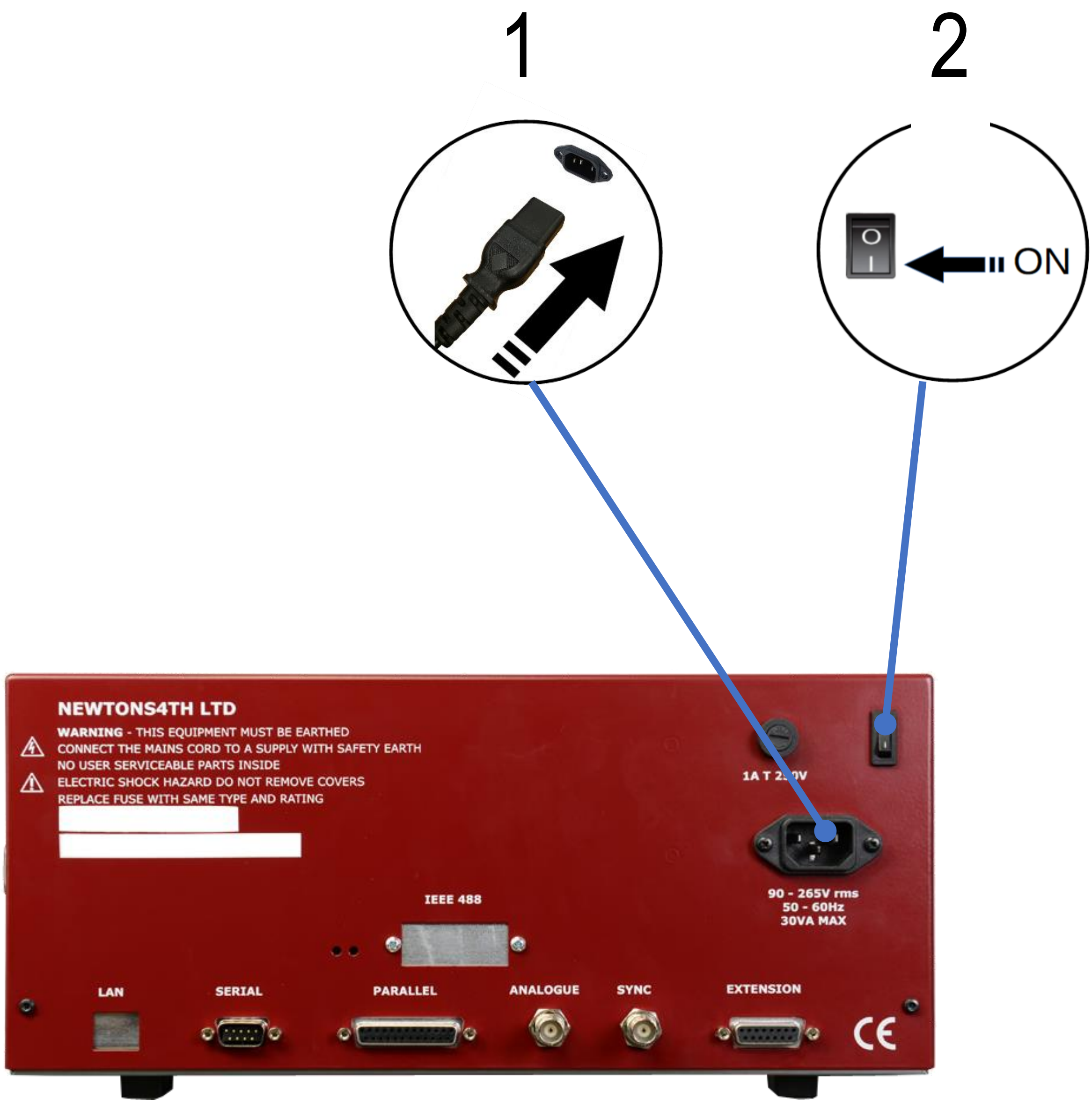
Input/Output

Characteristic	Description
Input	
Connectors	Dual Grounded BNC
Maximum Input	10V pk from earth
Output	
Connectors	Single Grounded BNC
Output Voltage (open circuit)	0V to ±10Vpk

Powering On your PSM1735

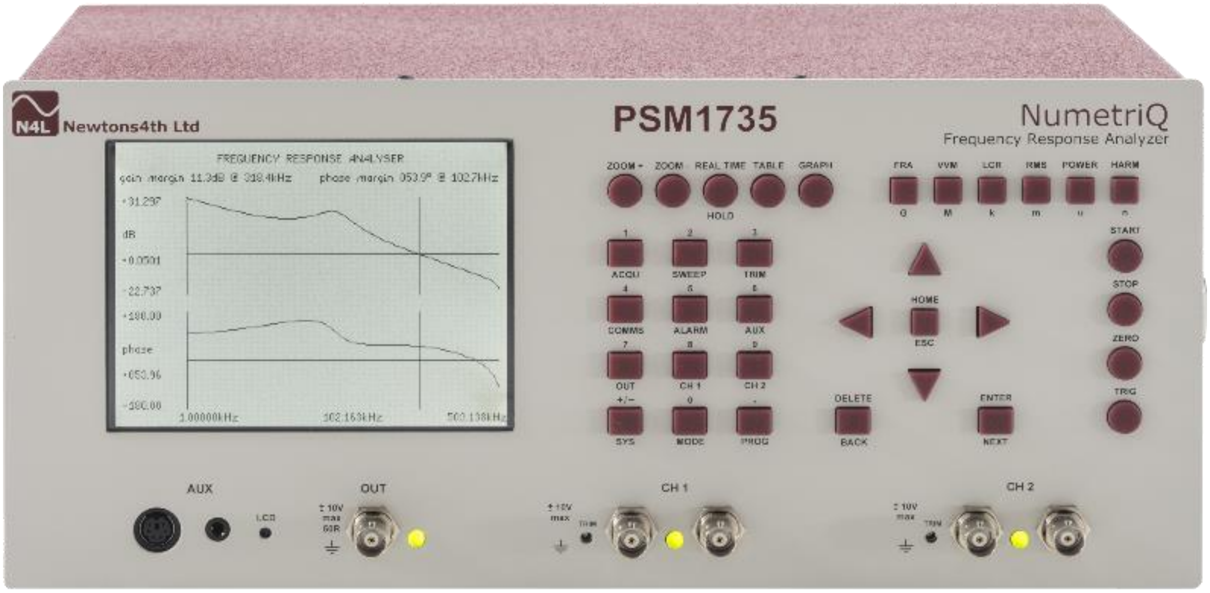
Step 1 Attach the supplied IEC power lead to the mains recepticle on the rear of the instrument

Step 2 Turn the instrument on using the On/Off switch



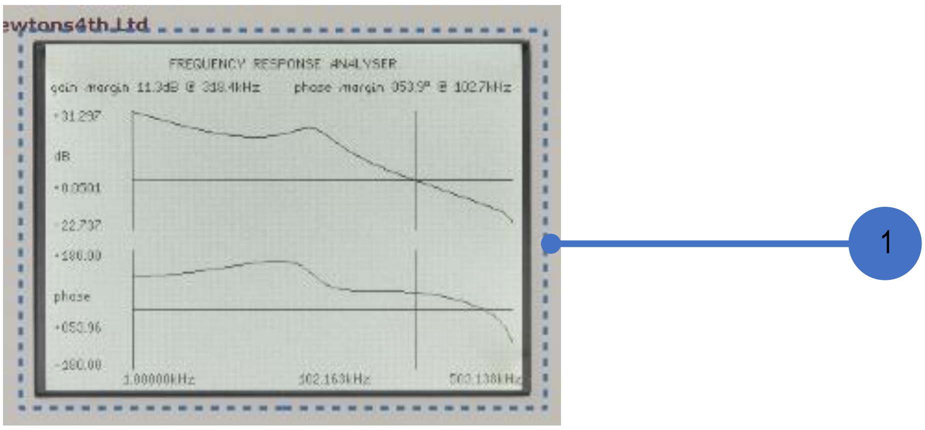
Chapter 5 Instrument Layout

Front panel Controls and Connectors



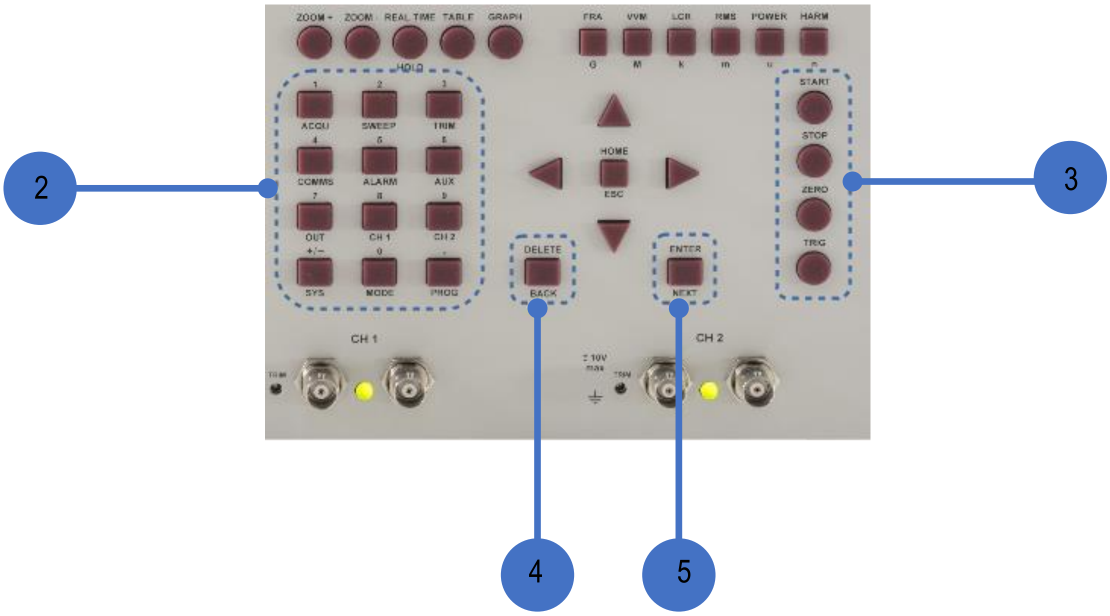
The front panel has buttons for controlling the instrument, the monochrome LCD screen, and a row of connectors at the bottom.

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



1. **LCD display**

The display shows either the chosen parameters to 5 or 6 digit resolution, graphical representations, and allows the setting of menu options.

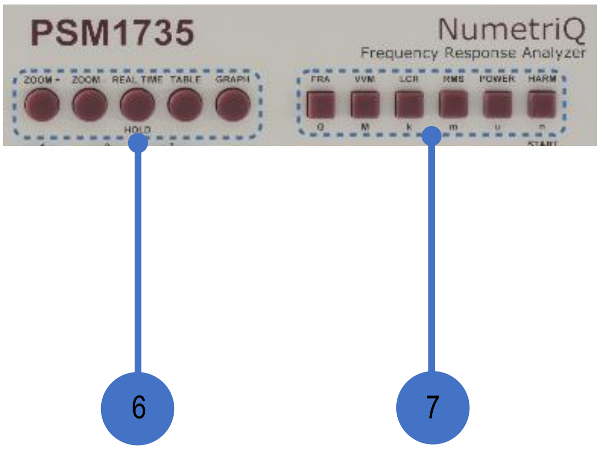


2. **Menu selection and alphanumeric entry**
   The group of 12 keys are multifunctional, they allow direct access to the setup and application setting menus as well as providing alphanumeric input where required.

3. **Action keys**
   This group of keys are used to start and stop sweeps, apply compensation, and releases instrument from HOLD.

4. **Dual use keys (Enter)**
   Enter / Next key will enable the user to confirm any settings made in the menu's.

5. **Dual use keys (Delete)**
   Delete / Back will enable the user to delete any inputted data or scroll back through any results screens

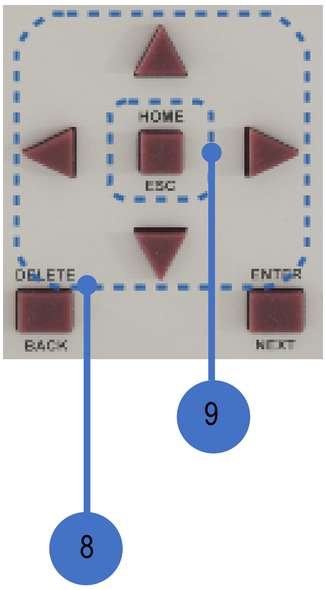


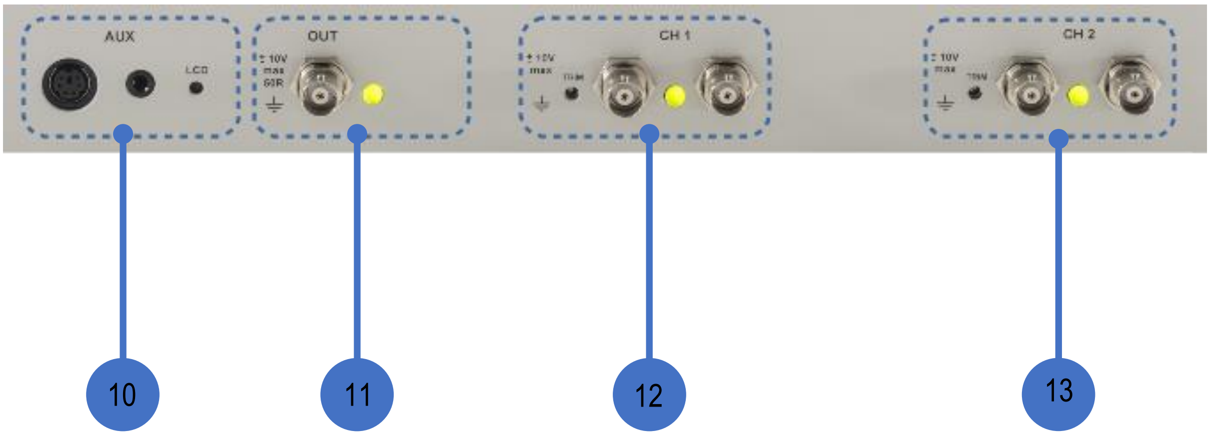
6. **Display control keys**
   This group of keys allows the user to select and highlight up to four parameters, return the screen to real time measurements, switch between tabular and graphical displays, & hold/release the real time readings

7. **Application mode direct access keys**
   The FRA, VVM, LCR, RMS, POWER, & HARM keys allow direct one key access to the appropriate application menus for setting up the instrument.

8. **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 graph mode they are used to control cursors and time-base / measurement per division respectively

9. **Home / Esc key**
   This dual use key will enable the user to return to the selected application start screen once the value has been adjusted and entered, or will escape from any screen view and return to the selected application home screen





10. UX connections

The DIN socket and 3.5mm jack socket are used by various accessories for power and control functions, see Appendix for further details of available accessories. The small adjuster marked LCD allows for display contrast adjustment

11. Generator output

The grounded BNC connector is for the 0V to ±10Vpk built in signal generator. The LED designates OFF or ON by a colour change from red to green

12. CH1 input connections

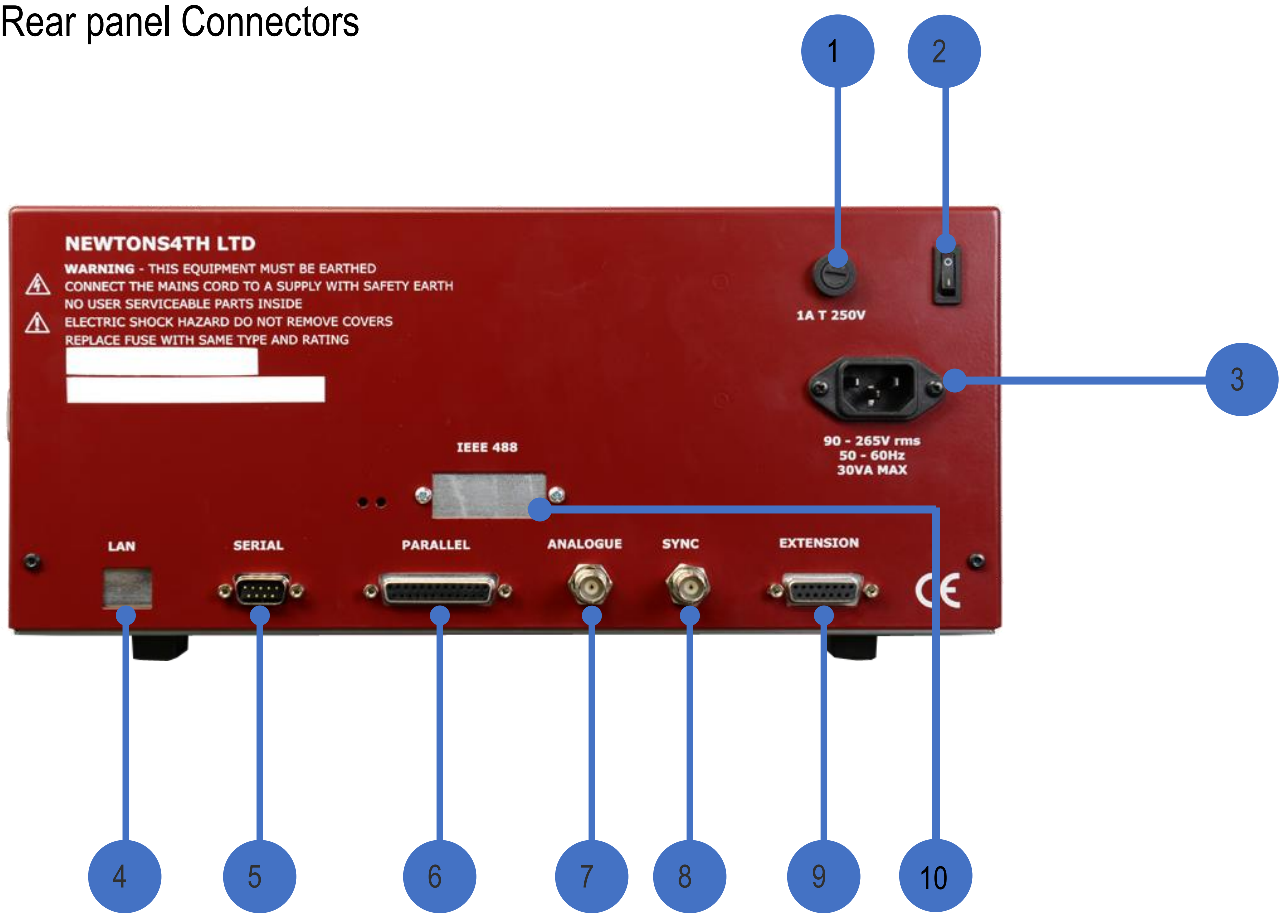
The pair of grounded BNC connectors allow the CH1 input to be connected as primary and secondary single ended input or can be used together to provide a differential input. CH1 can be selected via the CH1 menu to be a voltage or external shunt input

13. CH2 input connections

The pair of grounded BNC connectors allow the CH2 input to be connected as primary and secondary single ended input or can be used together to provide a differential input. CH2 can be selected via the CH2 menu to be a voltage or external shunt input

NOTE: The LED between each pair of channel inputs signify the ranging status, with Green signifying the range is OK, Orange signifies under ranging and a lower range should be selected, with Red signifying over ranging and a higher range should be selected

Rear panel Connectors



1. **Fuse**
   The mains supply fuse holder is fitted with a 5mm x 20mm glass cartridge 1A 250V AC, 32V DC Anti surge type T fuse, only replace with the same specification rating

2. **Mains ON/OFF Switch**
   This is the on /off mains switch for the instrument

3. **Mains IEC inlet receptacle**
   Only use the correct mains lead that was supplied with the PSM1735

4. **LAN Connection (Optional)**
   10/100 base-T Ethernet auto sensing RJ45

5. **Serial Connection**
   9 Pin D Type RS232 connection Baud rate to 19200 RTS/CTS flow control

6. **Parallel Connection**
   25 Pin D Type with 4 inputs and 8 outputs

7. **Analog Connection**
   No longer supported

8. **Sync Connection**
   Pulse synchronised to generator - BNC

9. **Extension port**
   15 Pin Female D type for N4L accessories

10. **GPIB / IEEE488 port (Optional)**
    Standard IEEE488.2 socket

Chapter 6 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 PSM1735 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 PSM1735 to best suit the intended application.

ACQU	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 PSM1735 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 PSM1735 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

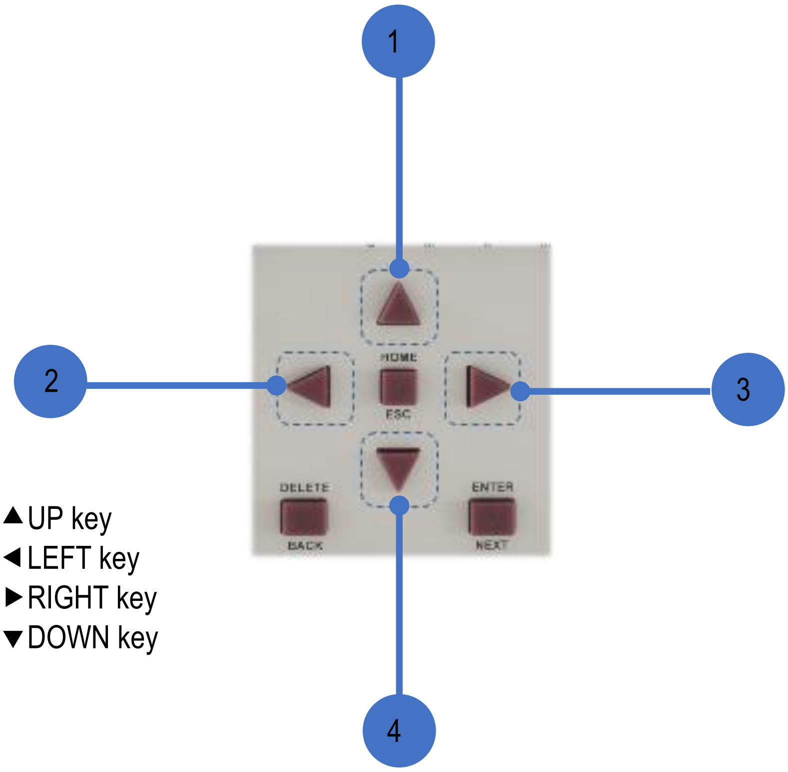
This data type is used where there are only predefined options available such as the output may be ‘on’ or ‘off’, or the bandwidth may be low, wide, or auto.

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

ACQUISITION CONTROL

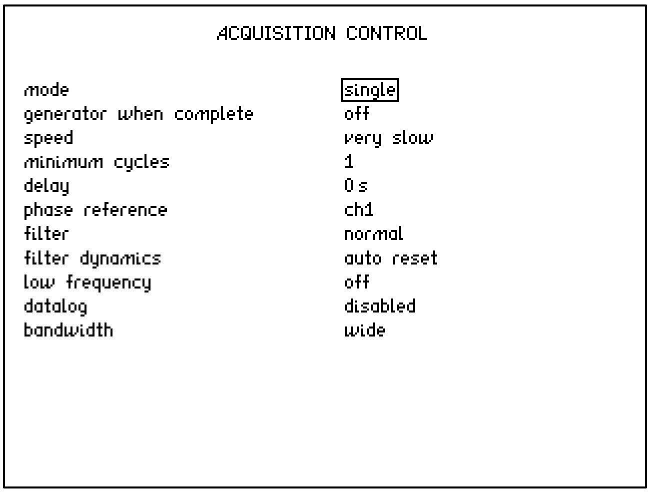
mode	single
generator when complete	off
speed	very slow
minimum cycles	1
delay	0 s
phase reference	ch1
filter	normal
filter dynamics	auto reset
low frequency	off
datalog	disabled
bandwidth	wide

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



When the flashing cursor is highlighting the parameter, 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)
window	(item 4)

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

press ► twice

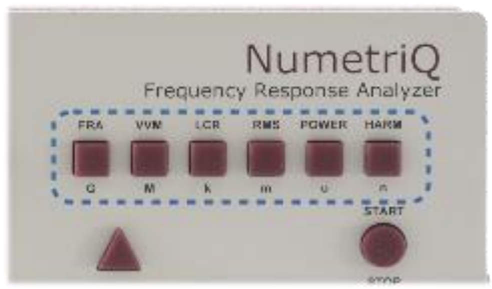
press ◄ three times

or press number *4* key

Direct numeric entry

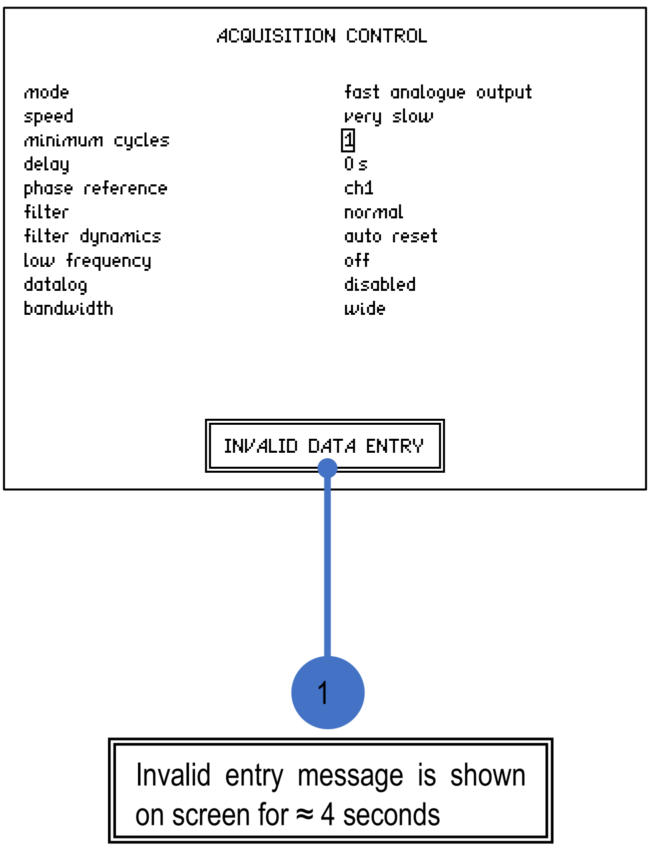
Parameters such as frequency and offset are entered as numeric characters; frequency is an example of an unsigned parameter; offset is an example of a signed parameter.

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.

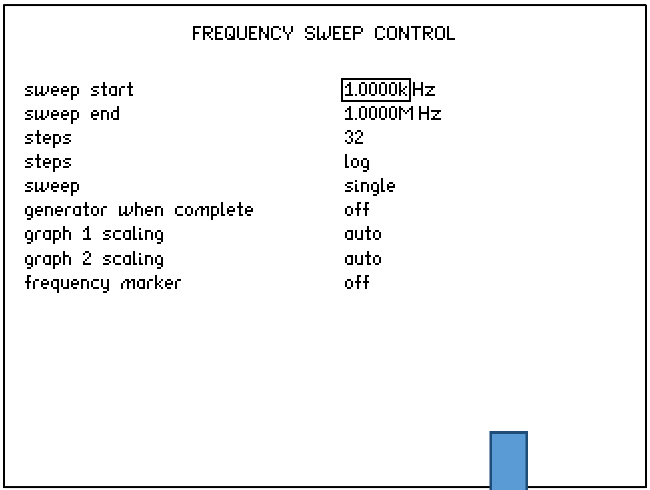
If the numeric data value is entered that is outside the valid limits for that parameter, then a warning beep is heard, and a message is displayed on the screen showing "***INVALID DATA ENTRY***" the parameter is also re-set as close to the requested value as possible. For example, the maximum amplitude of the PSM1735 generator is 10V peak; if a value of 15V is entered, a warning beep and message will be given, and the amplitude set to the maximum of 10V.



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.

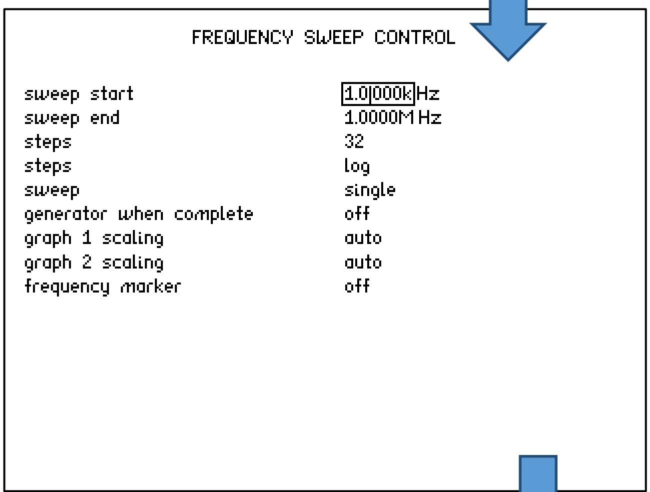
To edit an integer numeric value such as ***minimum cycles*** in the previous screen shot, use the ▼key to highlight the numeric value, in this case you would need to press the ▼key three times to highlight the ***minimum cycles*** numeric value. Once highlighted a new number will overwrite the existing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



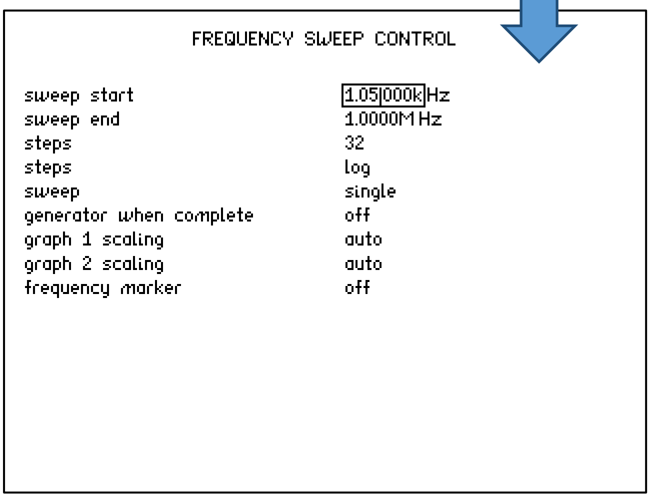
To edit a decimal numeric value such as ***start sweep*** in the *SWEEP* menu

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 7 in the diagram on page 18), 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 (*HARM*). You can continue from any one of the starting letters backwards and forwards using the ▲and ▼ keys to step forward and backwards through the ASCII character set – 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.

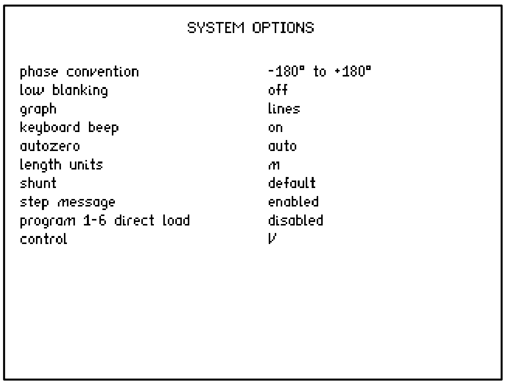
The editing keys, ►◄, *DELETE* and *ENTER* operate in the same way as for numeric entry.

User Data

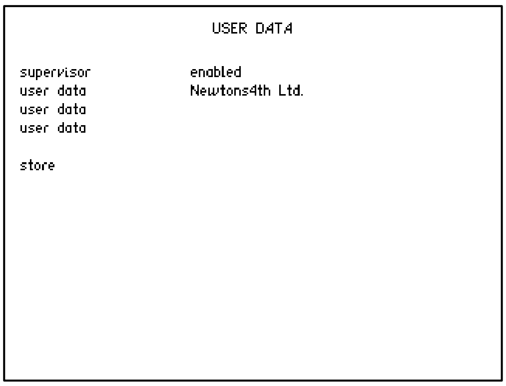
When the PSM1735 is first powered on, for approx. 4 seconds a splash screen is shown before the unit displays the default RMS Voltmeter screen. By default, the instrument model, firmware version and Newtons4th Ltd. will be displayed.

This splash screen can be edited and personalised to your company details.

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

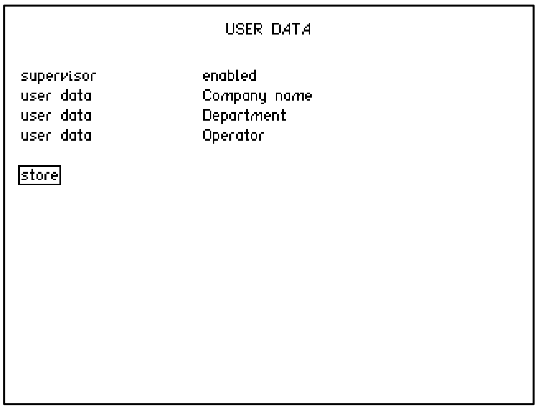


then



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

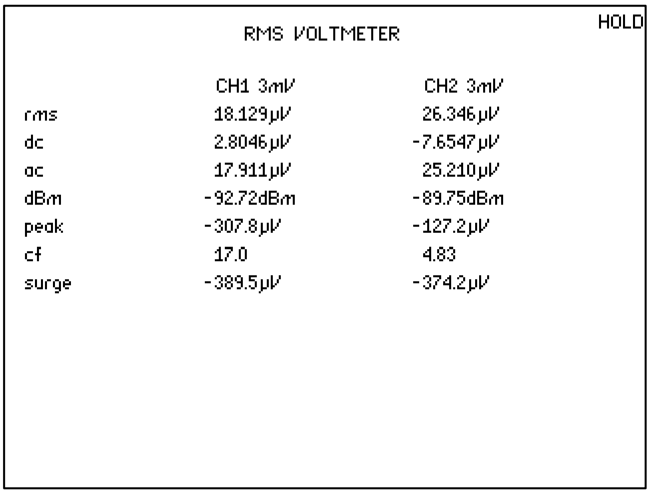
A sample of edited ***user data*** is shown here



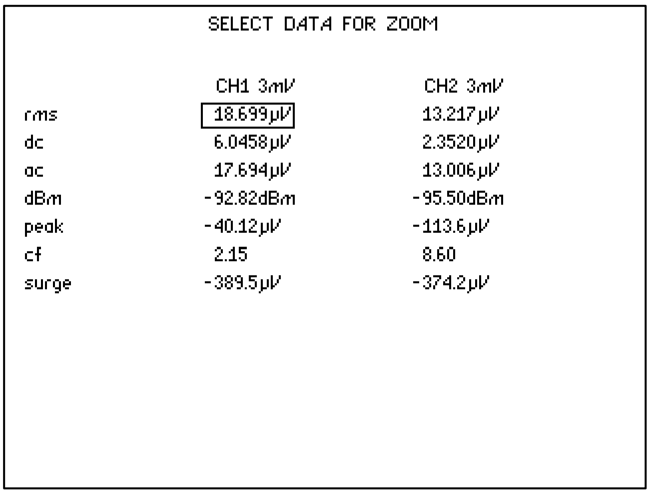
As can be seen in this screen, the 3 lines of user data have been set to “Company name”, “Department”, and “Operator”, however these can be edited by the user to read appropriately for your usage, i.e., “operator could be “Asset No.” or similar.

Special Functions

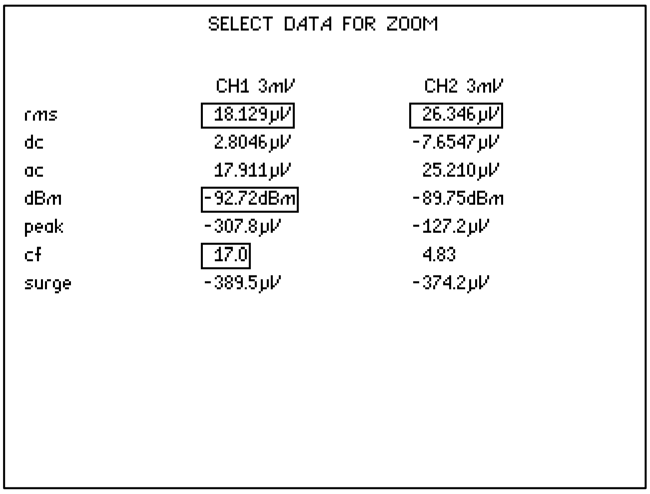
Display Zoom



The PSM1735 normally displays multiple results on the screen in a small font size. The zoom function enables the PSM1735 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.

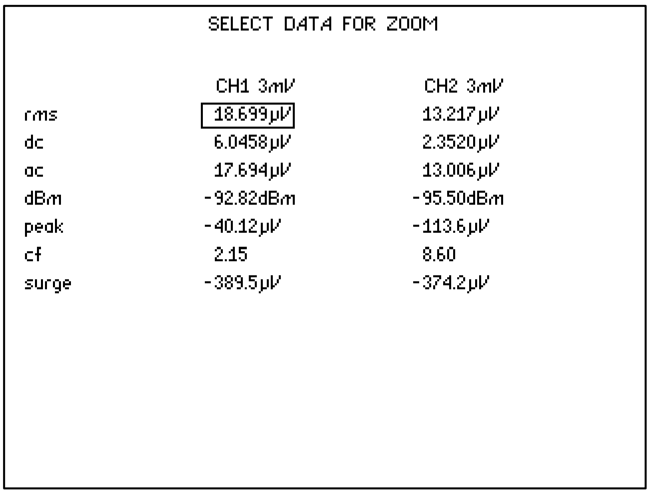


To set which parameters are to be displayed in the larger font size, first return to a no zoom condition by pressing *ZOOM-* twice, if necessary, as each press of *ZOOM-* will reduce the font zoom.

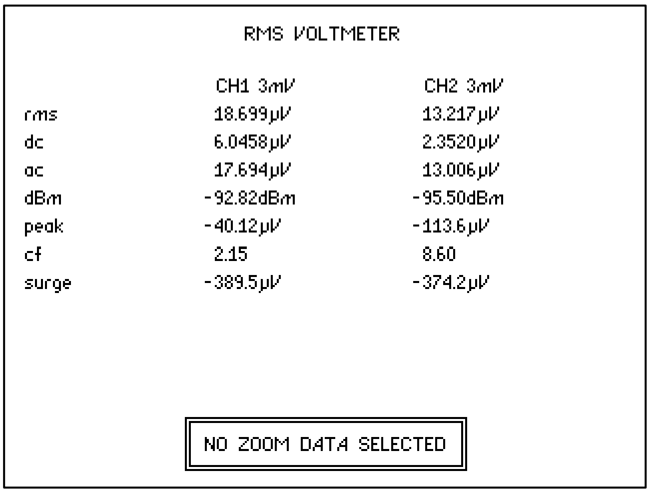


Press the *ZOOM+* key to view the presently selected data (solid non flashing highlight box), and press *DELETE* to clear the whole selection.

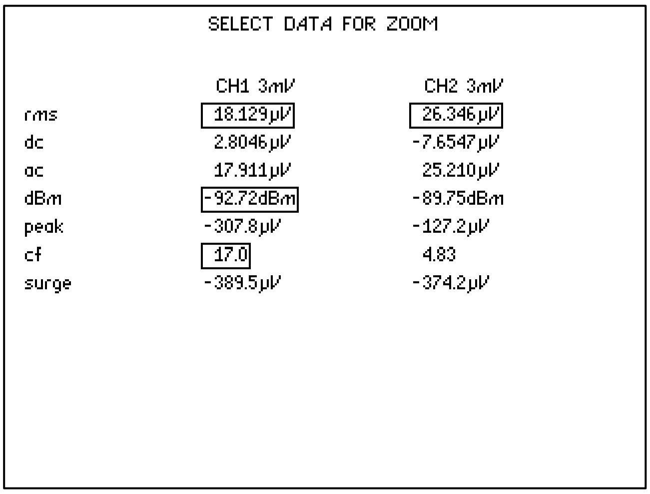
In the example shown here, if the *DELETE* key is pressed all the selected parameters will be deleted for the zoom functions.



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

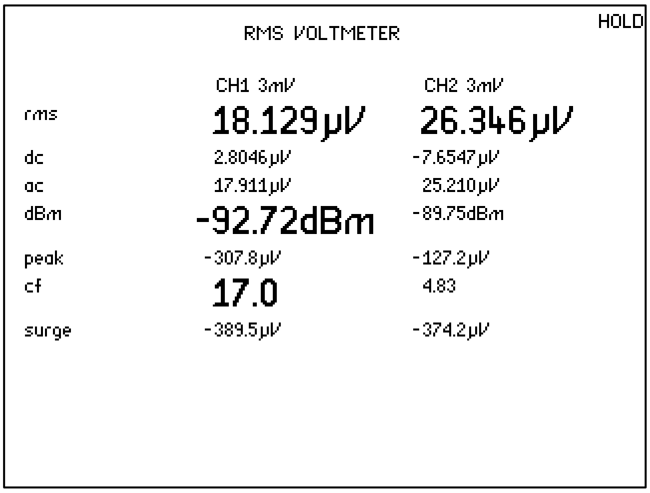


If there are no selected parameters, i.e., a solid highlight around the value and you now press *ZOOM+* a warning message will be displayed at the bottom of the screen alerting the user that no parameters have been selected for zoom.

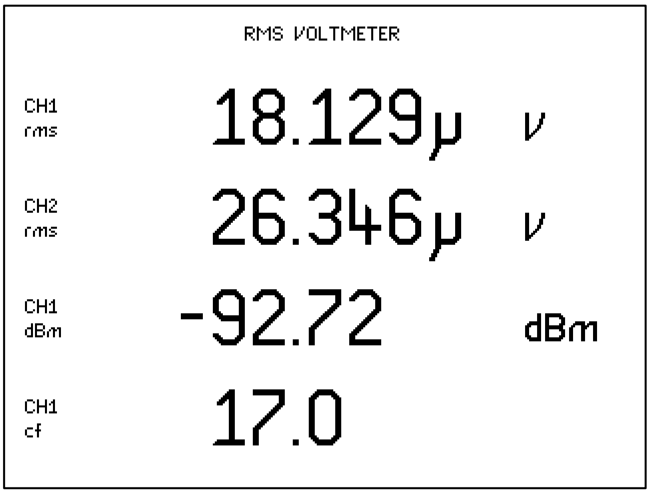


Each parameter that you want to select for zoom display can be selected by using the ▼,▲,►, &◄ keys. The ▲ & ▼ keys allow the selection of the parameters and will if continuously pressed cycle from the top to the bottom and back to the top again. Similarly, the ► & ◄ keys will swap from the CH1 parameters 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 PSM1735 supports 1-4 parameters in both zoom modes, it is not necessary to have to select four parameters. Each solid highlight signifies that the 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 PSM1735 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 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 page 29). The alarm status is also available as a logic output on the parallel port. (See item 6 on the diagram shown on page 20 & 34 for details)

The *ALARM* menu shown below

MONITOR OPTIONS

parallel port	disabled
monitor 1 data	zoom 1
analog output	disabled
alarm type	disabled
monitor 2 data	zoom 2
alarm type	disabled

Monitor 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 to zoom 4

Analog output – No longer supported

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.

Monitor 2 data, this behaves and is set up in the same way as before with the following exception that the linear alarm is only available on the first alarm.

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.

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 1/3 of the measured value respectively. The repetition rate of the sounder then varies linearly as the value changes between these thresholds.

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.

Parallel Port

The PSM1735 has a logic level parallel port with 8 output lines and 4 input lines, which can be used to interface with other parts of a test system or with a PLC.

The parallel port can be used either as a general purpose I/O port under communications control (see ***PPORT*** and ***PPORT?*** commands) or can be used as a status output:

7	6	5	4	3	2	1	0
				ALM2	ALM1	ERR	DAV

Bit 0 = Data available

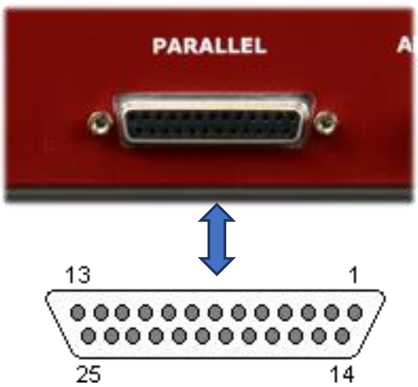
Bit 1 = data error [under or over range]

Bit 2 = alarm 1

Bit 3 = alarm 2

The status output is enabled in the ALARM menu. By selecting appropriate alarm conditions, the status output can be used as a pass/fail indicator

Parallel port pin connections:



Pin	Function	Description
2-9	Data out	D0[pin2]– D7[pin 9]
10	Data in	D2
11	Data in	D3
12	Data in	D0
13	+5V supply	50mA max
15	Data in	D1

Program store and recall

There are 100 non-volatile program locations where the settings for the entire instrument can be saved for future recall. Each of the 100 locations has an associated name of up to 24 characters that can be entered by the user to aid identification, (see Text Entry on page 26)

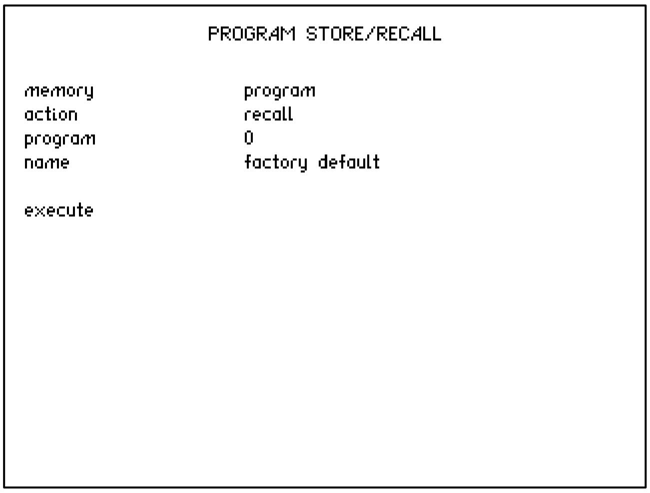
Program number 1 (if not empty) is loaded when the instrument is powered on so that the PSM1735 can be set to a user defined state whenever it is switched on. This is particularly useful to set system options such as phase convention, GPIB address etc. If no settings have been stored in program 1 then the factory default settings are loaded (program number 0).

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

Program numbers 1-6 may be recalled with a single press of the Application Direct Access keys, (item 7 on page 18) if the direct load option is selected in the system menu (see system options on page 6).

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.

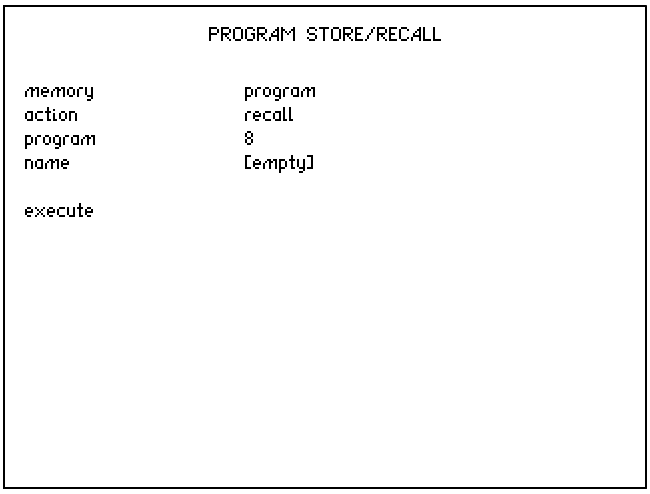


To store a configuration in any of the locations 2-100, press the ▼ key twice to highlight ***action***, then press the ► key once to select ***store***.

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*.

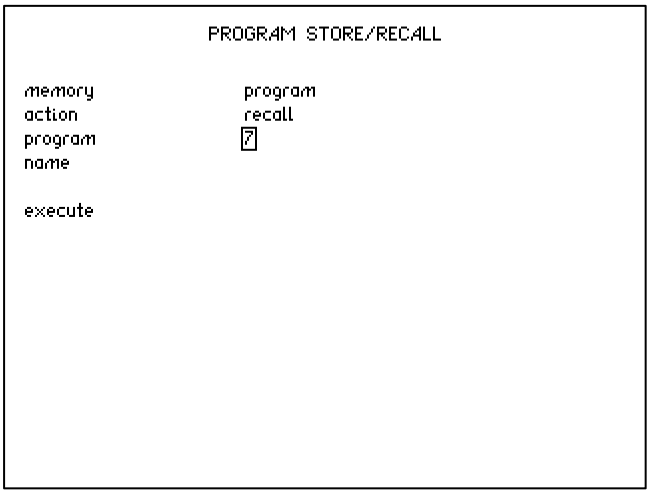
Using the ▼ key, highlight ***execute***, and press *ENTER*.

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.

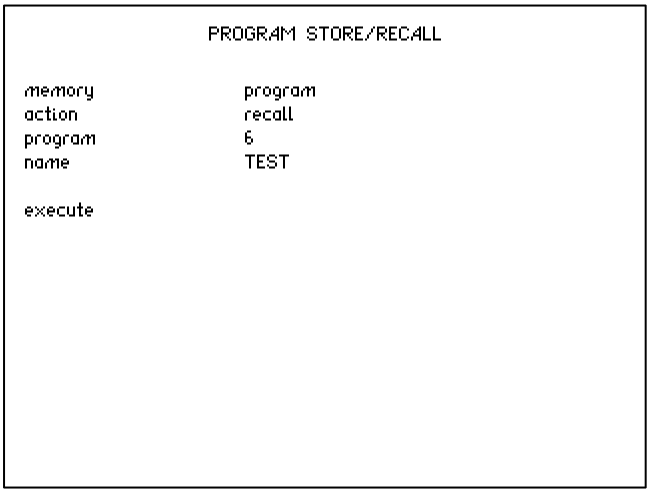


The option, name, can either display [empty] Which means there is an available slot to store settings in.

Or, if there is nothing shown against name, it is not an empty memory slot but just that the stored settings were not given a name as shown below.



.



This screen shot shows a memory slot that has program settings stored and has been labelled as TEST

CAUTION.

In the first case shown above, the memory slot 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 30 non-volatile storage locations that can store the results of frequency sweeps. Each location can store the sweep results for up to 50 points; larger sweeps can be stored in multiple locations:

frequency points in sweep	locations used per sweep	memory capacity
up to 50	1	30
51-100	2	15
101-150	3	10
151-200	4	7
201-250	5	6
251-500	8	3
501-1000	15	2
1001-2000	30	1

When storing a sweep, a text string may be entered to help identify the data.

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***.

Chapter 7 Setting up the instrument for measurements

For most applications of the PSM1735 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 PSM1735 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 PSM1735 itself. When using this normal mode of operation, the PSM1735 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 PSM1735 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
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]

Mode, there are four modes (***mode*** is the first parameter in the Acquisitions menu), normal, streaming, fast analog output, and single

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 digital filter equivalent to a first order RC low pass filter.

ACQUISITION CONTROL

mode	normal
speed	medium
minimum cycles	1
delay	0 s
phase reference	ch1
filter	normal
filter dynamics	auto reset
low frequency	off
datalog	disabled
bandwidth	auto

Streaming, this is a special high speed mode for use with communications to a PC – see section on RS232 page 106. With data streaming, when this mode is selected, the speed parameter (second parameter from the top) changes to window. The approximate window size can now be entered, and this is then adjusted so that the window is equal in length to the nearest integral number of cycles to the selected window size. For example, if 28mS was chosen as the window size and the frequency of the signal was 50Hz, the window would be set at 20mS so that it is equal to 1 cycle. Conversely if a window size of 37mS was entered, the window would be forced to 40mS or 2 cycles

ACQUISITION CONTROL

mode	streaming
window	2.5000m s
minimum cycles	1
delay	0 s
phase reference	ch1
filter	normal
filter dynamics	auto reset
datalog	disabled
bandwidth	auto

Fast analog output, this mode suppresses the display of results to speed up the processing for analog output update.

ACQUISITION CONTROL

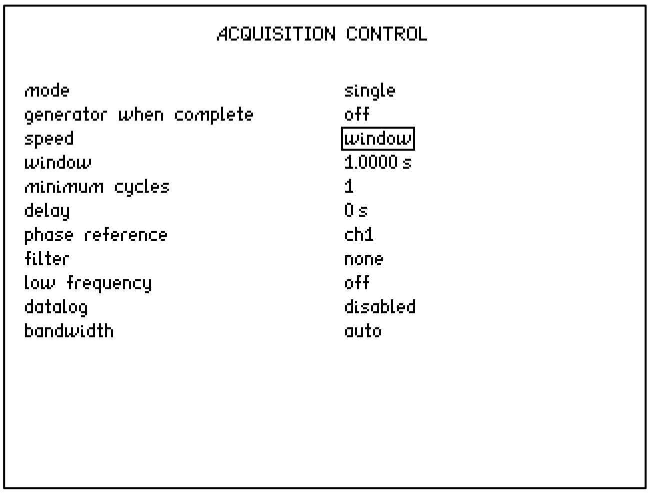
mode	fast analogue output
speed	medium
minimum cycles	1
delay	0 s
phase reference	ch1
filter	none
low frequency	off
datalog	disabled
bandwidth	auto

Single measurement mode makes individual measurements in response to a trigger – manually via the keypad or by sending the *TRG command over the communications. If this option is selected, an additional parameter is shown, generator when complete, this can be set so that after the measurement, the output can be specified to be switched off, left on, or left on with DC only. By setting the measurement window appropriately, this mode allows the output to be controlled so that it is only on for the duration of a single measurement. Note that the output will always be on for a longer duration than the window period because of settling and ranging time prior to starting the acquisition. The duration is typically 25% longer than the requested window for FRA and LCR measurement; RMS and POWER have an additional 1 second delay for DC settling.

ACQUISITION CONTROL

mode	single
generator when complete	off
speed	medium
minimum cycles	1
delay	0 s
phase reference	ch1
filter	normal
filter dynamics	auto reset
low frequency	off
datalog	disabled
bandwidth	auto

Speed, there are four pre-set speed options - fast, medium, slow, and very slow – that adjust the nominal size of the window, and therefore the update rate and the time constant of the filter. Greater stability is obtained at the slower speed, but at the expense of a slower update rate.



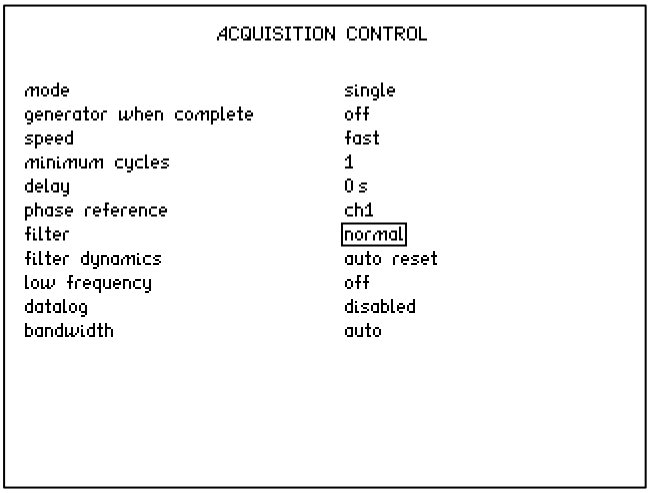
There is also a fifth setting option, window. This is used to set a specific size of the window to a value other than the pre-set speed options. To synchronise to an integral number of cycles, the window size is either reduced by up to 25% or increased as necessary.

Note that at low frequencies, the window is extended to cover a complete cycle of the input waveform even if this is a longer period than the nominal update rate.

Min cycles, as defined above, the window over which the measurements are computed is adjusted to give an integral number of cycles of the input waveform. The minimum and default is a single cycle, however this can be increased up to 100.

Delay, this sets a period of time between each sample within a sweep.

Filter, there are three options for the filter, two time constants, normal or slow, or the filter can be deselected by selecting none.



The nominal filter values are shown in the table below:

speed	update rate	normal time constant	slow time constant
fast	1/20s	0.2s	0.8s
medium	1/3s	1.5s	6s
slow	2.5s	12s	48s
very slow	10s	48s	192s

Filter dynamics, selecting normal or slow for the filter parameter adds another optional parameter – filter dynamics which has two settings depending on the selection. The filter applies an auto reset function to give a fast dynamic response to a change of measurement, or this function can be deselected, and the filter forced to operate with a fixed time constant for use with noisy signals, which would have an exponential response to a step change.

The filter dynamics are usually set to auto reset where the filtering is reset in response to a significant change in data. This speeds up the response of the instrument to changing conditions.

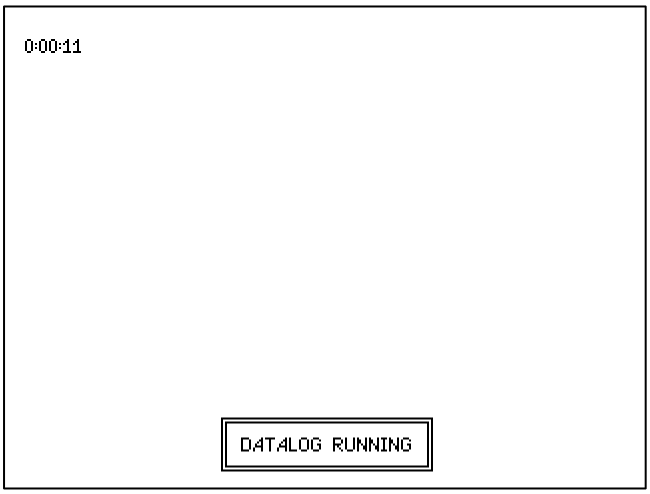
***Phase reference & low frequency**,* when the internal generator is not used, the phase reference is set to CH1, so the measurement is then synchronised to the input frequency measured on CH1. There is a low frequency option that extends the frequency measurement down to 20mHz. This low frequency option also applies a digital filter, which can be useful when measuring in a low frequency, noisy environment.

Datalog, the PSM1735 can store, and display measurements recorded at regular intervals over a set period. Each data record consists of the elapsed time and up to four data values selected by *ZOOM*. More than 8000 records can be stored if one value is selected via ZOOM; more than 3000 if four values are selected.

The actual interval between data points is governed by the measurement speed and the datalog interval. The PSM1735 stores the next available measurement after the datalog interval has elapsed: the actual elapsed time is attached to each datalog record and is displayed with the data on the table or each graph and returned with each record over the communications (RS232, LAN or GPIB).

The data values may be stored to RAM or directly into non-volatile memory as each value becomes available. The non-volatile option is useful for acquiring data over long periods, to prevent the loss of data in the event of a power failure. Data that has been stored into RAM may be subsequently transferred to non-volatile memory using the *PROG* menu. In this mode, the data may be viewed in real time, as it is being acquired.

For high speed data acquisition, the datalog interval may be set to zero so that each measurement is stored. The measurement interval is controlled with the speed option in the ACQU menu. Using the window option for speed allows for greater control of the measurement interval. In this mode, the display flashes “DATALOG RUNNING” and only shows the acquisition time. The minimum datalog interval depends on the function but is typically 10ms.



Note that in all cases the measurement interval is necessarily adjusted to be an integral number of cycles of the measured waveform.

The datalog options are set up with the ACQU menu. The datalog is started with the START key and stopped with the STOP key unless the store becomes full first. The zero reference for the elapsed time is taken as the first data measurement after START.

The data can be viewed as a table or as individual graphs. Pressing *GRAPH* steps through the graph's stored parameters. If more than 250 records have been stored, the graph can show the data for the whole period or by pressing the *ZOOM+* key the graph redraws to show 250 records about the cursor. The cursor can be moved in single steps by pressing the ► & ◄ keys or in larger steps by using the ▲ & ▼ keys. Pressing the *ZOOM-* key shows the whole data gain. Movements of the cursor are synchronised in both the *TABLE* and *GRAPH* views.

Setting datalog in the menu to disabled will clear both the graph and tabular results.

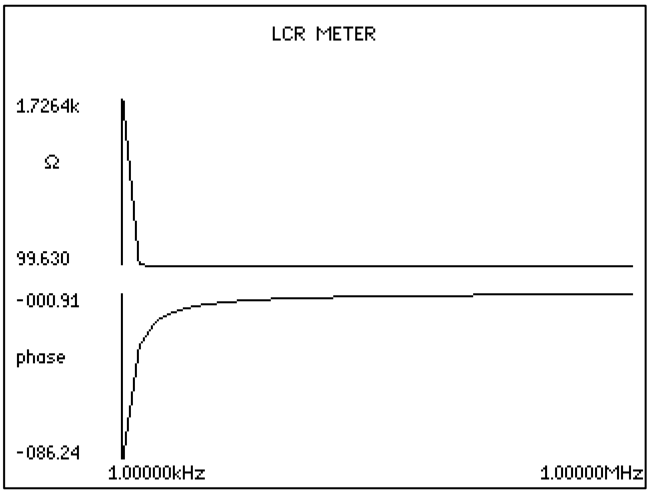
Bandwidth*,* the bandwidth of the instrument, usually set to auto by default, but it can be forced to be set to wide or low. When not in auto selection, heterodyning [3] is disabled, and the bandwidth is either 1MHz (wide) or 50kHz (low) to minimise noise when making measurements at low frequencies

Setting and running a frequency sweep [SWEEP key]

All AC measurements using the PSM1735 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.

At the end of a sweep the ***generator when complete*** may be set to be ***on***, ***off***, or ***DC*** only, the options behave the same as those set in the ***single mode*** in the *ACQU* menu options.

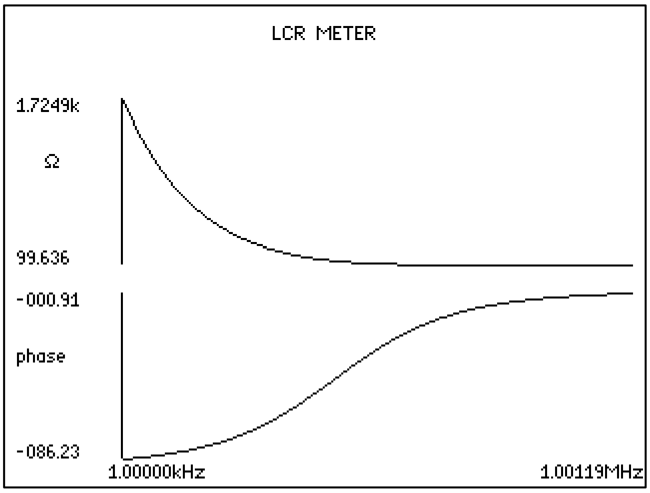
The signal amplitude and frequency settings used are those set in the generator *OUTPUT* menu. The frequency steps may be set to be logarithmically or linearly spaced. Logarithmic spacing usually gives the clearest display of frequency dependent parameters but linear spacing can be useful in some applications.



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***.

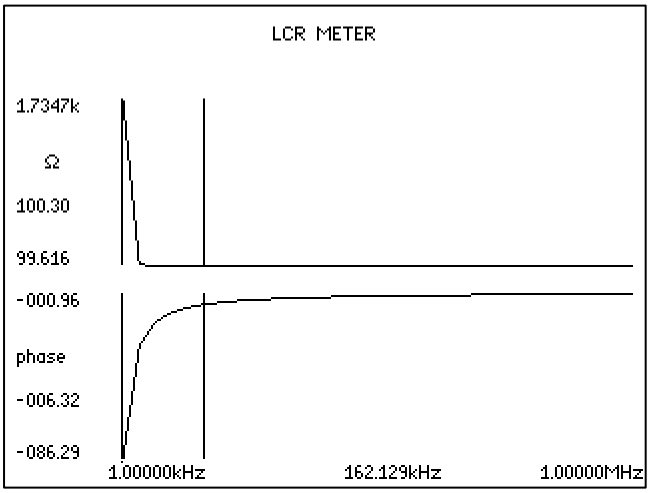
[3] Heterodyning is employed by the PSM1735 to enable the signal processing to be carried out on a lower frequency signal thus enabling a wider bandwidth capability instrument without placing undue processing load on the FPGA and DSP

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.

A vertical marker can be placed on the graph to reference a specific frequency. To set this marker, using the ▲& ▼keys highlight ***frequency marker*** and change this to ***on*** using ◄ or ► arrow keys. Once ***on*** is showing a second parameter also called ***frequency marker*** will be shown directly below the first, using the arrow keys and the numeric keys select the frequency you wish to mark and finalise the selection by pressing *ENTER* and then *HOME*.



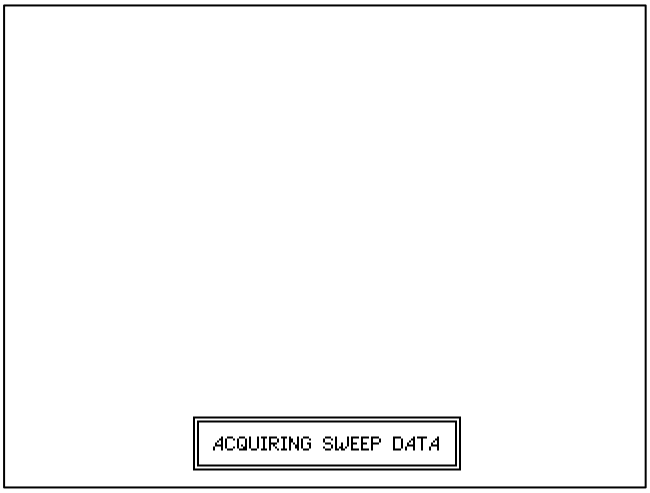
Graph showing the frequency marker.

For visual comparison to a reference part with a known response, the reference response can be kept on the display, drawn with a dotted line while new sweeps are made:

1. Set the graph scaling manually.
2. Perform a sweep with the reference part.
3. Press *ZERO* to set the reference display.
4. Perform a sweep with the part to be compared.

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.

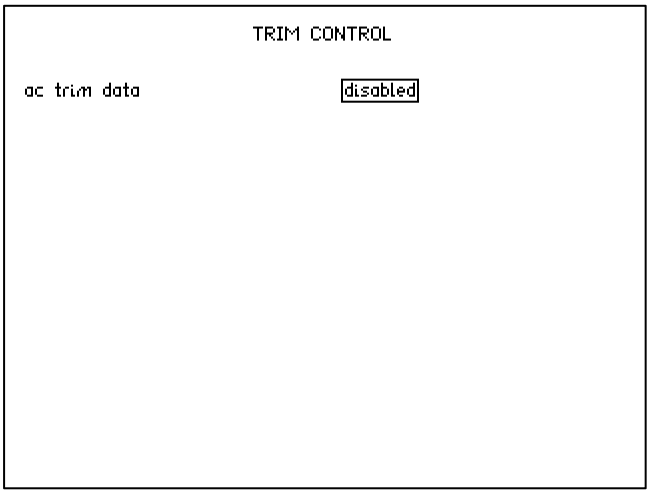
For maximum sweep speed, particularly when using a large number of points, there is a "fast sweep" mode which disables all non-essential functions, including the display, during the sweep. In this mode, the display is blank except for a flashing message "***ACQUIRING SWEEP DATA***" until the full sweep 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.



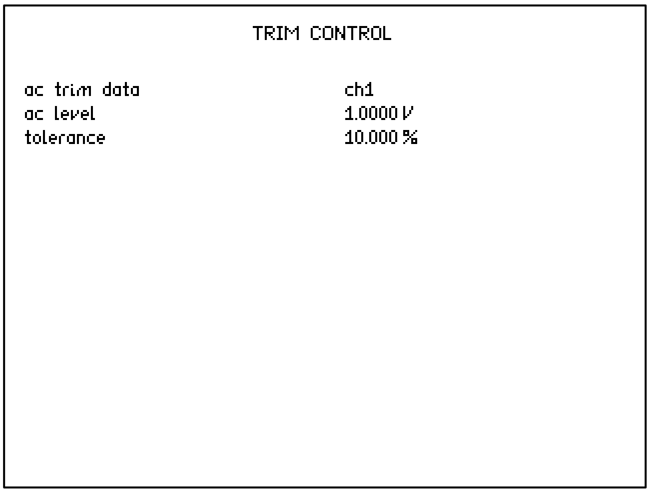
Trim Control [TRIM key]

The trim function on the PSM1735 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 and CH2 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.

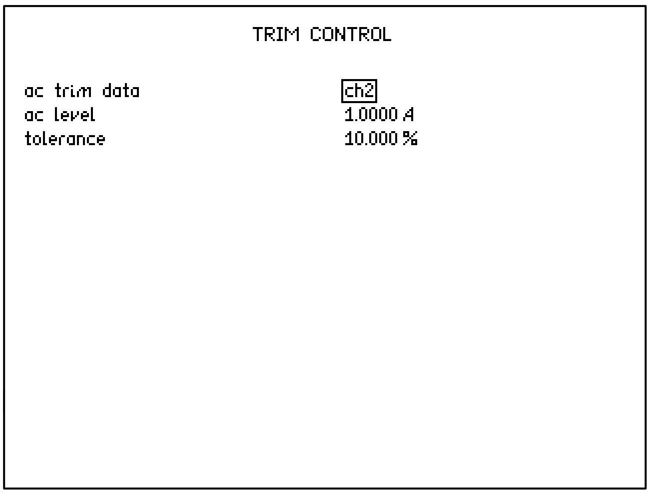
By default, when the TRIM menu screen is first entered ac trim data is set to disabled as shown in the first screen shot.



When disabled is highlighted by use of the ▼key, the first press of the ► key changes the menu to Channel 1



A second press of the ► key changes the menu to Channel 2 as shown below.



Note that Channel 2 ac level units is shown as Amps rather than Volts on the first Channel setting screen previously to reflect the differing functions of channel 1 and 2.

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.

CAUTION. Note that when dBm mode level control is selected, the trim level is entered as dBm, but the tolerance remains a linear percentage of the actual voltage, not the logarithmic dBm measure.

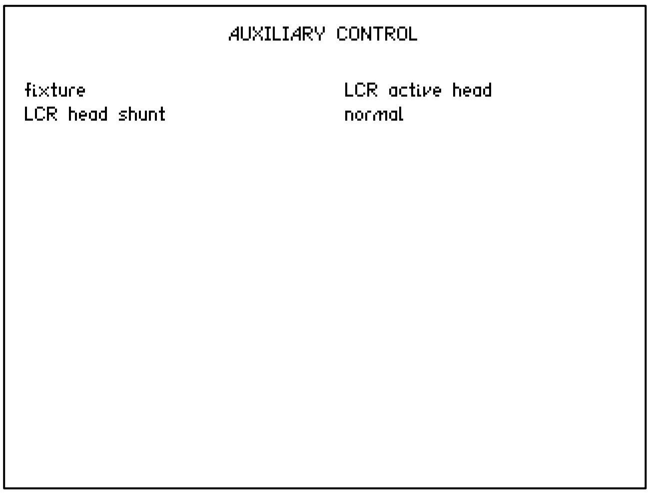
Remote communications protocols [COMMS key]

See setting up and using remote control on page 104

Auxiliary Port Settings [AUX key]

The PSM1735 can be configured for a range of accessories to be connected and used for specific analysis applications.

To select the fixture as shown below, press the ▼key and the fixture option will then show a flashing outline. To select the fixtures, use the ►and ◄ keys to cycle through the fixtures as shown in the screenshot below. If you continue to press the ► & ◄ keys the fixture option will return to the first option as shown below.



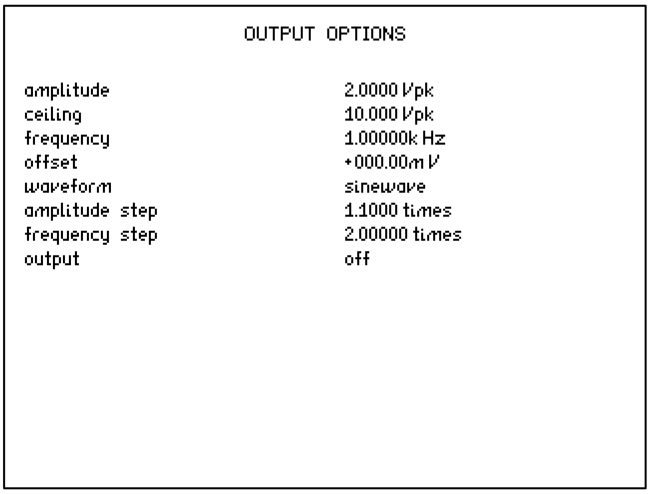
Each fixture choice may have additional menu options that can be selected by using the ▼key and the ► & ◄ keys to cycle through the settings. For details of the settings for the legacy accessories please refer to the original documentation supplied with the accessories.

LCR active head
↓
TAF01 *
↓
Impedance analyser interface
↓
Blank (for future use)
↓
High Z interface *
↓
none

* Note the two options in the menu are for compatibility with legacy accessories, see Appendix for current available accessories for the PSM1735

Signal Generator Control [OUT key]

The output for the signal generator is digitally synthesised. A 150Ms/s, DAC with output filtering, provides a sinusoid waveform, even at 35MHz, while preserving very accurate frequency control. The generator control menu is accessed by the COMMS key and the default settings are shown below.



OUTPUT OPTIONS

amplitude	2.0000 Vpk
ceiling	10.000 Vpk
frequency	1.00000k Hz
offset	+000.00m V
waveform	sinewave
amplitude step	1.1000 times
frequency step	2.00000 times
output	off

Amplitude, ceiling, frequency, offset, amplitude step, & ***frequency step*** are all adjusted as described in the Direct Numeric Entry section on page 24 The ► & ◄ keys adjust the frequency of the generator by a fixed increment stored via the *STEP* menu; 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 *STEP* menu. Both these adjustments are carried out in the main FRA display screen, see page 65

The generator ***output*** may be set to be ***on*** or ***off*** only.

There is a green LED to the right of the BNC Output connector. When extinguished the Output is switched off. When illuminated the Output is ON as shown below.

The output amplitude is controlled in 2 stages – a fine control with 11 bit resolution, and a coarse control with 8 binary weighted steps. This gives 5mV resolution at high output levels and very fine resolution at low output levels.

Peak output level	resolution
5V - 10V	5mV
2.5V – 5V	2.5mV
1.25V – 2.5V	1.25mV
0.62V – 1.25V	0.62mV
0.31V – 0.62V	0.31mV
0.15 – 0.31V	0.15mV
75mV – 150mV	75µV
>75mV	40µV

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

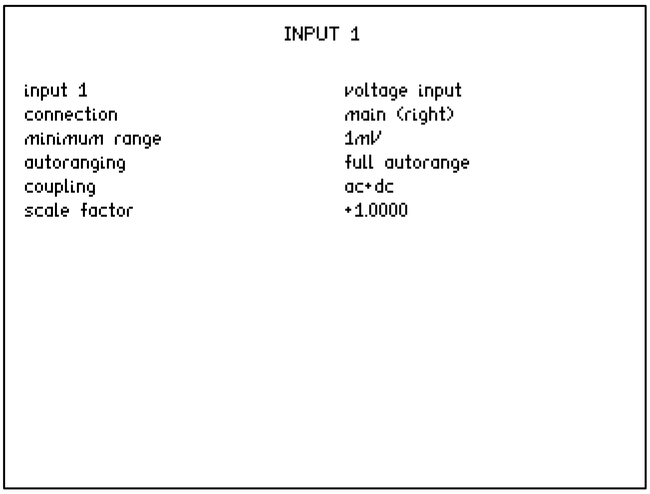
max frequency MHz	output level into 50Ω peak V	rms V
5	5	3.5
10	3	2
15	2	1.4
20	1.5	1
25	1.2	0.8
30	1	0.7
35	0.75	0.5

An offset may be added to any output to bias the signal or to null out any DC present with a resolution of +/-5mV.

Channel 1 & 2 Ranging [CH1 & CH2 keys]

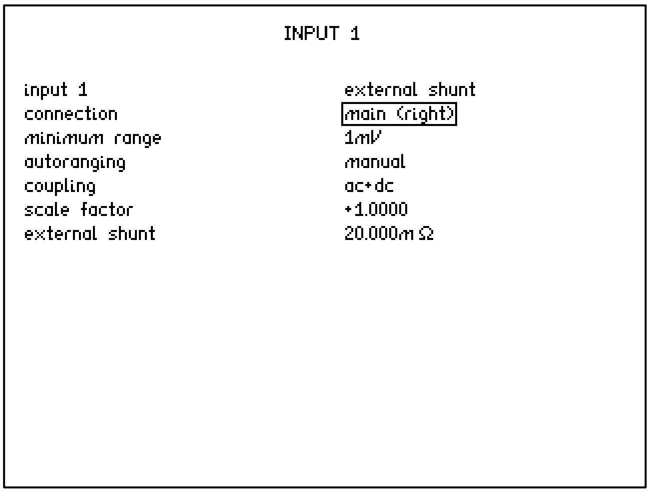
The two input channels each have two separate, ground referenced inputs that can be used independently or together as a differential input. The two channels are controlled independently but sampled synchronously.

Input, each channel may be selected to be Voltage input or external shunt

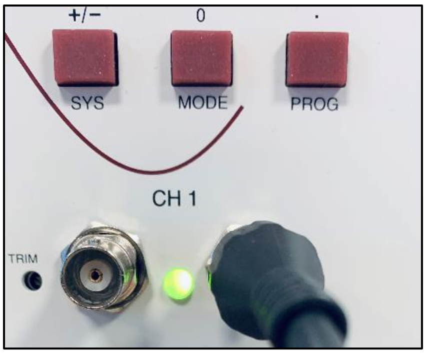


Input 1 or 2 in the case of channel 2 is selected when highlighted using the ▼ key. By pressing the ► & ◄ keys the options ***voltage input***, ***external shunt*** and ***disabled*** will cycle through.

Connection



By highlighting the connection option using the ▼ key each input channel may be selected to be used as single ended main input, single ended secondary input or differential main – secondary input as illustrated below.



Single ended main input – use right hand BNC of each pair. The screen option for this is ***main (right)*** shown in the previous screen shot.

Single ended secondary input – use left hand BNC of each pair. The screen option for this is ***secondary (left)***

Differential main -secondary input, both BNC's of each pair are connected. The screen option for this is ***differential (both)***

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 the external shunt 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 to be consistent with other instruments having single inputs so that the capacitance to ground of the probe cable screen is driven with the lower source impedance to minimise errors at high frequency.

INFORMATION.

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.

The input ranges have nominal full scale values set with a ratio of 1:√10 from 1mV to 10V. When the PSM1735 is using selective high frequency measurements (heterodyning) the ranges extend by approximately 50%. This gives the following ranges:

range	reference	nominal full scale	
		wideband	selective
1	1mV	1mV	1.5mV
2	3mV	3.16mV	5mV
3	10mV	10mV	15mV
4	30mV	31.6mV	50mV
5	100mV	100mV	150mV
6	300mV	316mV	500mV
7	1V	1V	1.5V
8	3V	3.16V	5V
9	10V	10V	10V

The maximum input signal that can be accurately measured varies with frequency:

frequency	max input level	
MHz	peak V	rms V
1	10	7
5	6	4
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

The input ranges may be selected via the ***autoranging*** parameter to be ***full autorange*** (default), ***autorange up*** or ***manual***. The start range for auto ranging may be selected with the ***minimum range*** parameter if it is known that the signal will not be below a certain level. This is set by using the ► & ◄ keys. There is also an option to ***autorange up*** so that a test may be carried out to find the highest range. Once the highest range has been determined, the range can be set to ***manual,*** and the measurement made without losing any data due to range changing. Pressing the *HOME* key (or sending ***TRG**) restarts the auto ranging from the selected ***minimum range***.

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.

For most measurement functions full auto ranging is the most suitable option, but some applications, such as where transient events are occurring, are more reliable with manual ranging. Manual ranging (or up-only auto ranging) is essential for low frequency measurements.

There is a LED between the two BNC input connectors for each channel. These LED’s change colour, the colour of the LED depends on the suitability of the selected range:

Green:	Range selection is OK.
Orange:	Under Ranging – select a lower range.
Red:	Over Ranging – Select a higher range.

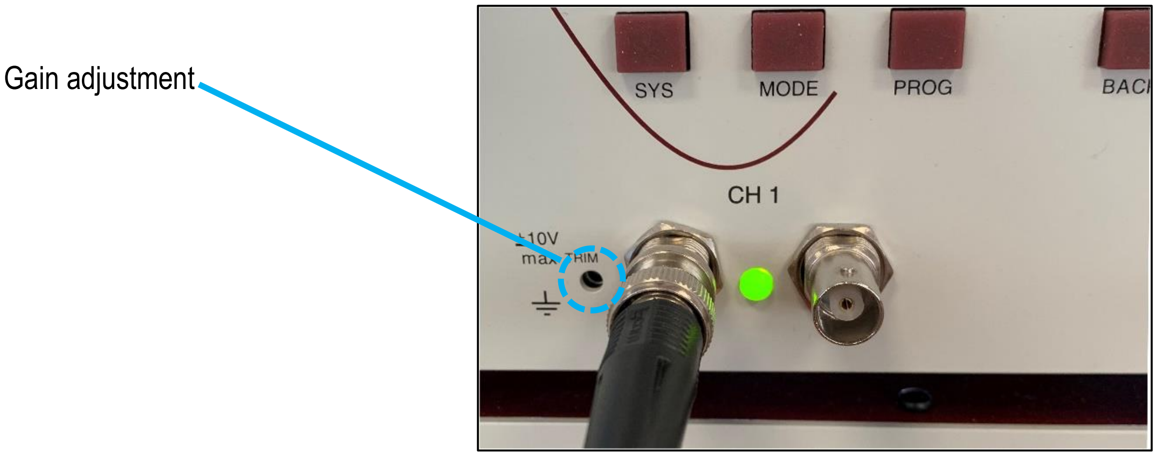
Coupling, for measuring signals that are biased on a DC level (such as an amplifier operating on a single supply or the output of a DC PSU), ***AC*** coupling can be used. ***AC+DC*** coupling is the normal option and should be used where possible.

INFORMATION Note: AC only coupling should not be used below 20Hz as the results are not meaningful.

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.

External shunt, if the channel has been set for use with an external shunt, an additional parameter ***external shunt*** is displayed at the bottom of the menu, this parameter is then used to enter the value of the shunt being used.

The secondary BNC connection on each channel has a control to adjust the gain so that common mode rejection may be maximised when using oscilloscope probes.



System Options [SYS key]

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

Main default screen

SYSTEM OPTIONS

phase convention	-180° to +180°
low blanking	off
graph	lines
keyboard beep	on
autozero	auto
length units	m
shunt	default
step message	enabled
program 1-6 direct load	disabled
control	V

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°

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

low blanking can be applied to a number of measurements so that zero is shown when the measurement is below a certain level. This blanking can be disabled if desired.

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.

autozero, this defaults to auto, which re-zeros the inputs at a set interval. In manual mode the re-zeroing is initiated by pressing the zero key.

length units, any measurements that are expressed in units of length (e.g., LVDT) can be displayed in metres or inches. The default is metres.

shunt, the value is usually selected automatically when changing the function to one that needs a current input such as power meter or LCR meter. If the shunt is set to 'manual' rather than 'default' then the shunt value will not be changed unless done so by the operator.

step message, when stepping through frequency or amplitude using the cursor keys in real time mode, a message is usually displayed showing the new value. This message can be disabled. The default is enabled.

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, HARM,* 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.

control, levels are usually expressed in volts but can be set and displayed in dBm, which is a logarithmic scale referred to 1mW in 600Ω, often used when testing communications components.

To save new system settings as default, store the setup in program location 1 so that they are reloaded on power on, see the Program store and recall section on page 34.

Pressing the ► from first ***SYSTEM OPTIONS*** menu displays the serial number, release versions, and calibration date(s) as shown below.

PSM1735 NUMETRIQ

serial number	212-02131
manufacture code	NQ4312
main release	1.61
dsp release	1.61
fpga release	1.61
boot release	1.00
last calibration	15 MAR 2019 1147 JS
aux calibration	IAI 27 SEP 2021

Pressing the ► key from the ***SYSTEM OPTIONS*** menu selects the ***USER DATA*** screen.

USER DATA

supervisor	enabled
user data	Company name
user data	Department
user data	Operator

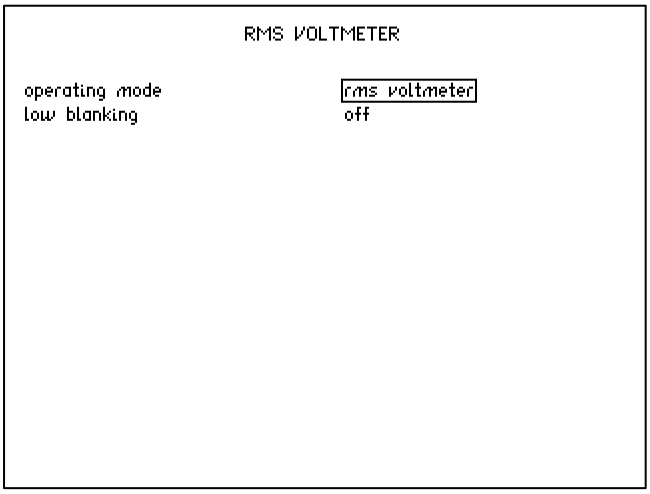
store

See the Text entry section on page 26 for more details on editing this default setting to reflect your companies' details.

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.

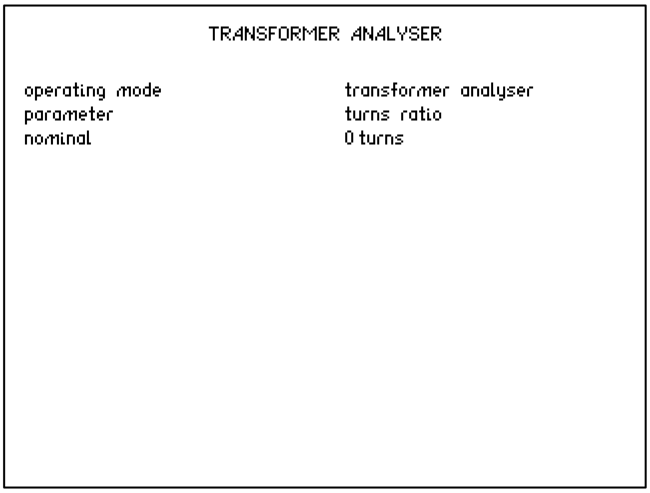
To select the operating mode option, as shown below, press the ▼key and the option will then show a flashing outline. To select the other application modes, use the ▶and ◀ keys to cycle through the applications as shown in the screenshot below. If you continue to press the ▼key the option will return 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, (see item 7 on page 16)
Each mode will offer one or more extra parameters pertinent to the application chosen. (See the application section for further details of each mode)

However, there is also an additional mode selectable from this menu of ***transformer analyser*** which does not have a direct access key on the front panel.

Rms voltmeter
↓
frequency response analyser
↓
power meter
↓
LCR meter
↓
vector voltmeter
↓
harmonic analyser
↓
transformer analyser



The ***operating mode*** parameter, gives access to twelve individual transformer specific tests (see the Transformer analyser section on page 90 for further details of each application)

INFORMTION.

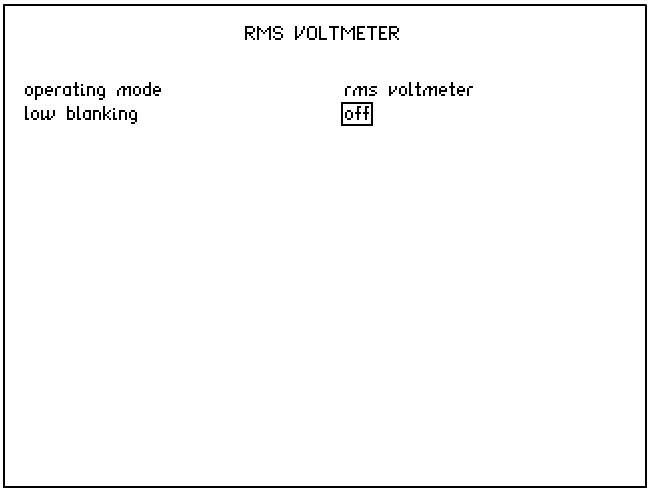
Note this application mode is included for backwards compatibility with the Transformer Analysis accessory which is a legacy accessory and is no longer available.

Chapter 8 Application Notes

The *MODE* menu or the Application mode direct access keys allow the PSM1735 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 legacy Transformer Analysis section, which is included for backward compatibility.

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 on the input leads.

The RMS voltmeter measures the elementary values:

rms, DC, peak, & surge, from these values, AC, dBm and crest factor are derived.

The rms value of a periodic waveform, v(φ), is given by:

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

For a sampled signal, the formula becomes:

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

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 PSM1735 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):

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

or $20 \log (I_{AC}/Iref)$ 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 PSM1735 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 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 – this can be disabled in the SYSTEM OPTIONS menu if required. When the internal generator is supplying the signal the window size is an integer number of the generator cycles, conversely if an external signal source is being used then the window is set to an integer number of the external signal cycles.

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 1MHz. To minimise noise, there is a 50kHz filter applied by default. To obtain the full bandwidth press the *ACQU* key, highlight ***bandwidth*** and select ***wide***.

RMS voltmeter specification

DVM	
channels	2
display	5 digits
measurement	true rms, AC, DC, dBm, peak, cf, surge
coupling	AC or AC+DC
frequency	DC to 1MHz
	(Heterodyning not available)
	20Hz to 1MHz (AC only coupling)
max input	±10V peak
input ranges	10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV, 1mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
accuracy (AC)	0.05% range + 0.05% reading + 0.1mV <1kHz
	0.05% range + 0.05% reading + 0.001%/kHz +0.1mV < 10kHz
	0.05% range + 0.05% reading + 0.002%/kHz + 0.1mV < 1MHz
accuracy (DC)	0.1% range + 0.1% reading + 0.5mV
CMRR (typical)	60dB @ 10V 50Hz
	50dB @ 10V 1kHz
	40dB @ 10V 1MHz
time constant	0.2s, 1.5s or 12s

Conditions:

23ºC +/- 5ºC ambient temperature

instrument allowed to warm up for ≥30 minutes

sinewave

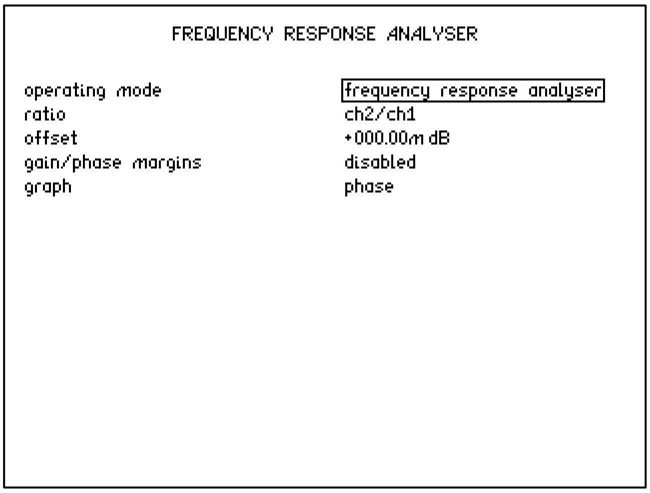
slow speed, normal filtering

AC+DC coupling

autoranging or manual ranging ≥ 1/3 range

Frequency Response Analyser

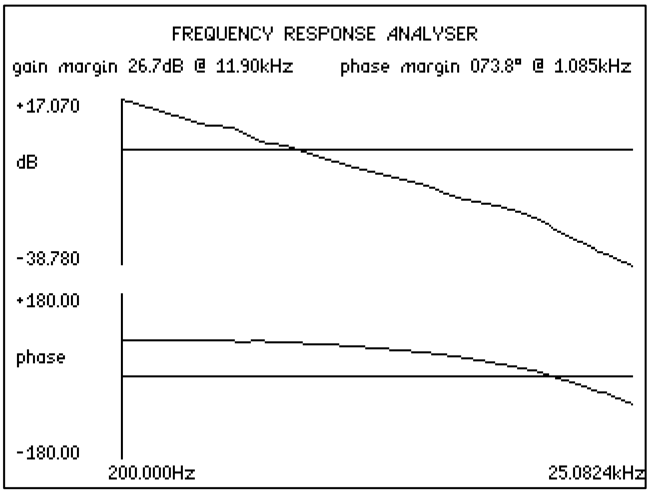
The frequency response of a system can be measured by applying a test signal, for example: an impulse from the built in signal generator to the system and measuring its response using channel 1 and 2. The PSM1735 applies a sinusoid through the bandwidth of interest and measures the output level and phase shift relative to the input.



The PSM1735 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.

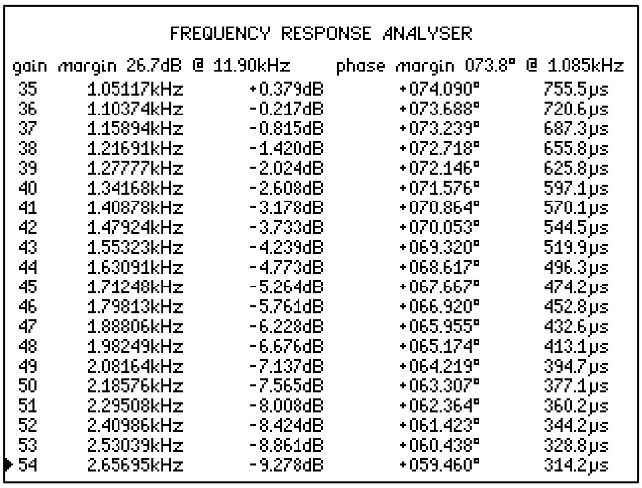
The circuit can be characterised by computing the gain and phase at several points over a swept frequency range. This gives results that show the transfer function of the circuit as a graph on the display.



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 menu prior to the sweep being initiated.

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

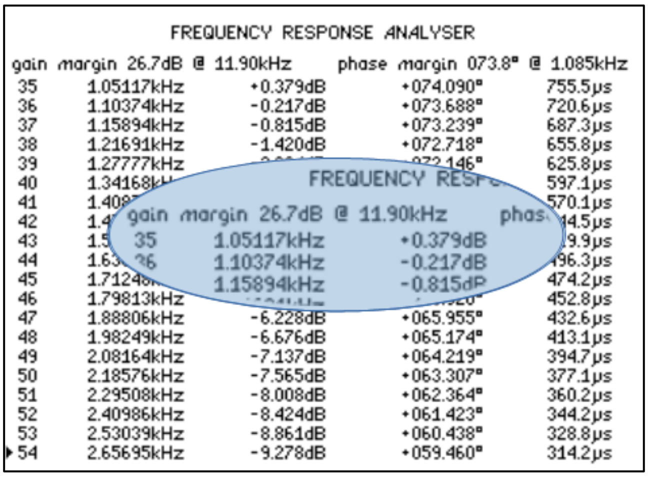
The same data will then be displayed in tabular form as shown below in the following screen shot.


FREQUENCY RESPONSE ANALYSER

gain margin 26.7dB @ 11.90kHz phase margin 073.8° @ 1.085kHz

35	1.05117kHz	+0.379dB	+074.090°	755.5μs
36	1.10374kHz	-0.217dB	+073.688°	720.6μs
37	1.15894kHz	-0.815dB	+073.239°	687.3μs
38	1.21691kHz	-1.420dB	+072.718°	655.8μs
39	1.27777kHz	-2.024dB	+072.146°	625.8μs
40	1.34168kHz	-2.608dB	+071.576°	597.1μs
41	1.40878kHz	-3.178dB	+070.864°	570.1μs
42	1.47924kHz	-3.733dB	+070.053°	544.5μs
43	1.55323kHz	-4.239dB	+069.320°	519.9μs
44	1.63091kHz	-4.773dB	+068.617°	496.3μs
45	1.71248kHz	-5.264dB	+067.667°	474.2μs
46	1.79813kHz	-5.761dB	+066.920°	452.8μs
47	1.88806kHz	-6.228dB	+065.955°	432.6μs
48	1.98249kHz	-6.676dB	+065.174°	413.1μs
49	2.08164kHz	-7.137dB	+064.219°	394.7μs
50	2.18576kHz	-7.565dB	+063.307°	377.1μs
51	2.29508kHz	-8.008dB	+062.364°	360.2μs
52	2.40986kHz	-8.424dB	+061.423°	344.2μs
53	2.53039kHz	-8.861dB	+060.438°	328.8μs
▶ 54	2.65695kHz	-9.278dB	+059.460°	314.2μs

In this example the sweep was of 100 points between 200 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 and scroll ▼ key will display data point 55 etc.


FREQUENCY RESPONSE ANALYSER

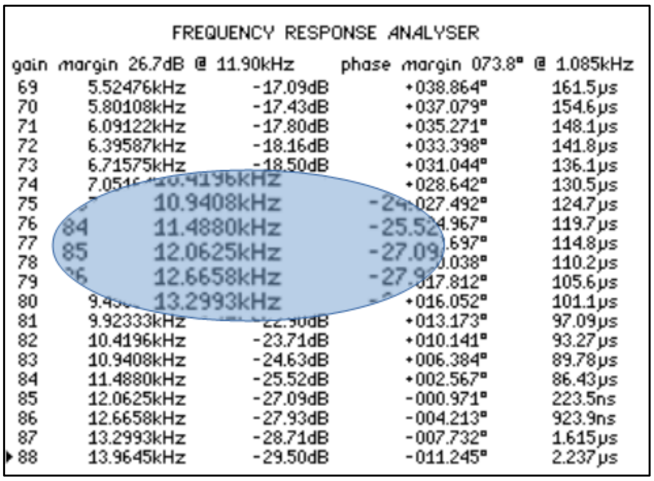
gain margin 26.7dB @ 11.90kHz phase margin 073.8° @ 1.085kHz

35	1.05117kHz	+0.379dB	+074.090°	755.5μs
36	1.10374kHz	-0.217dB	+073.688°	720.6μs
37	1.15894kHz	-0.815dB	+073.239°	687.3μs
38	1.21691kHz	-1.420dB	+072.718°	655.8μs
39	1.27777kHz	[illegible]	[illegible]	625.8μs
40	[illegible]	[illegible]	[illegible]	597.1μs
41	[illegible]	[illegible]	[illegible]	570.1μs
42	[illegible]	[illegible]	[illegible]	[illegible]
43	[illegible]	[illegible]	[illegible]	[illegible]
44	[illegible]	[illegible]	[illegible]	[illegible]
45	[illegible]	[illegible]	[illegible]	474.2μs
46	1.79813kHz	[illegible]	[illegible]	452.8μs
47	1.88806kHz	-6.228dB	+065.955°	432.6μs
48	1.98249kHz	-6.676dB	+065.174°	413.1μs
49	2.08164kHz	-7.137dB	+064.219°	394.7μs
50	2.18576kHz	-7.565dB	+063.307°	377.1μs
51	2.29508kHz	-8.008dB	+062.364°	360.2μs
52	2.40986kHz	-8.424dB	+061.423°	344.2μs
53	2.53039kHz	-8.861dB	+060.438°	328.8μs
▶ 54	2.65695kHz	-9.278dB	+059.460°	314.2μs

The phase margin for this example is 73.8˚ @ 1.085kHz.

However, this frequency is not one of the equidistance frequency steps calculated by the PSM1735 when the sweep was set up and initiated.

The expanded section which highlights data points 35 & 36 shows that 3dB point occurred between 1.05117kHz and 1.10374kHz the result displayed is interpolated to provide the 0 dB point.


FREQUENCY RESPONSE ANALYSER

gain margin 26.7dB @ 11.90kHz phase margin 073.8° @ 1.085kHz

69	5.52476kHz	-17.09dB	+038.864°	161.5μs
70	5.80108kHz	-17.43dB	+037.079°	154.6μs
71	6.09122kHz	-17.80dB	+035.271°	148.1μs
72	6.39587kHz	-18.16dB	+033.398°	141.8μs
73	6.71575kHz	-18.50dB	+031.044°	136.1μs
74	[illegible]	[illegible]	+028.642°	130.5μs
75	[illegible]	[illegible]	[illegible]	124.7μs
76	[illegible]	[illegible]	[illegible]	119.7μs
77	[illegible]	[illegible]	[illegible]	114.8μs
78	[illegible]	[illegible]	[illegible]	110.2μs
79	[illegible]	[illegible]	[illegible]	105.6μs
80	[illegible]	[illegible]	+016.052°	101.1μs
81	9.92333kHz	[illegible]	+013.173°	97.09μs
82	10.4196kHz	-23.71dB	+010.141°	93.27μs
83	10.9408kHz	-24.63dB	+006.384°	89.78μs
84	11.4880kHz	-25.52dB	+002.567°	86.43μs
85	12.0625kHz	-27.09dB	-000.971°	223.5ns
86	12.6658kHz	-27.93dB	-004.213°	923.9ns
87	13.2993kHz	-28.71dB	-007.732°	1.615μs
▶ 88	13.9645kHz	-29.50dB	-011.245°	2.237μs

The same interpolation method is used to give the gain margin of 26.7dB @11.90kHz. Data points 84 and 85 are either side of the gain margin frequency of 11.9kHz 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:

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

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))

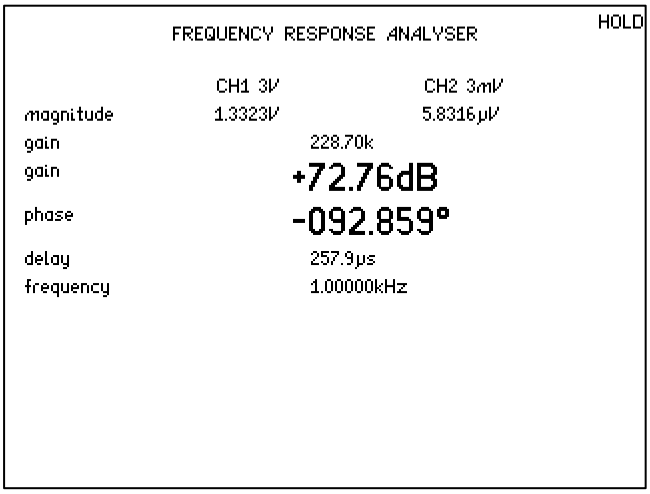
The gain is usually quoted in dB: $dB = 20 \log_{10}(gain)$

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

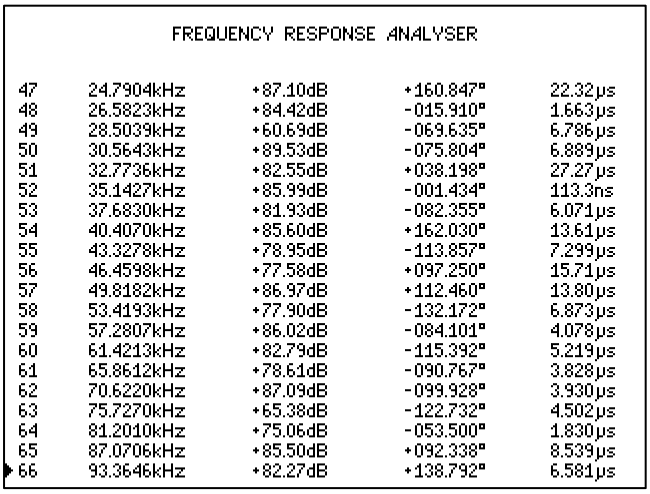
offset gain = measured dB – offset dB

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 PSM1735 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


FREQUENCY RESPONSE ANALYSER

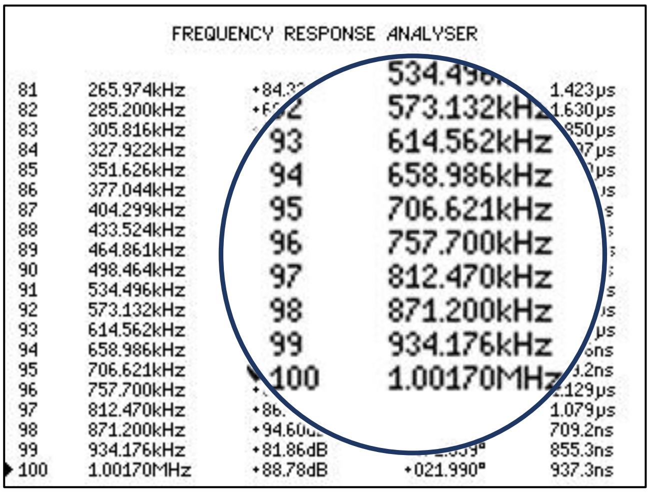
47	24.7904kHz	+87.10dB	+160.847°	22.32µs
48	26.5823kHz	+84.42dB	-015.910°	1.663µs
49	28.5039kHz	+60.69dB	-069.635°	6.786µs
50	30.5643kHz	+89.53dB	-075.804°	6.889µs
51	32.7736kHz	+82.55dB	+038.198°	27.27µs
52	35.1427kHz	+85.99dB	-001.434°	113.3ns
53	37.6830kHz	+81.93dB	-082.355°	6.071µs
54	40.4070kHz	+85.60dB	+162.030°	13.61µs
55	43.3278kHz	+78.95dB	-113.857°	7.299µs
56	46.4598kHz	+77.58dB	+097.250°	15.71µs
57	49.8182kHz	+86.97dB	+112.460°	13.80µs
58	53.4193kHz	+77.90dB	-132.172°	6.873µs
59	57.2807kHz	+86.02dB	-084.101°	4.078µs
60	61.4213kHz	+82.79dB	-115.392°	5.219µs
61	65.8612kHz	+78.61dB	-090.767°	3.828µs
62	70.6220kHz	+87.09dB	-099.928°	3.930µs
63	75.7270kHz	+65.38dB	-122.732°	4.502µs
64	81.2010kHz	+75.06dB	-053.500°	1.830µs
65	87.0706kHz	+85.50dB	+092.338°	8.539µs
66	93.3646kHz	+82.27dB	+138.792°	6.581µs

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.

The PSM1735 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 1kHz to 1MHz with 100 steps, however the end frequency was calculated to be just over the 1MHz that was originally set.



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 steps 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 *HOME* or *TRIG* restarts the real time measurement at the selected frequency.

Although it is most usual to use the PSM1735 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 PSM1735 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	10uHz to 35MHz (own generator)
	20mHz to 500kHz (external source)
max input	±10V peak
input ranges	10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV, 1mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
gain accuracy	0.01 dB + 0.0001 dB/kHz < 1MHz
	0.1 dB + 0.04 dB/MHz < 35MHz
phase accuracy	0.02° < 10kHz
	0.05° + 0.0001°/kHz < 35MHz
sweep step rate	1/20s, 1/3s or 2.5s (approx.)

Conditions:

23ºC +/- 5ºC ambient temperature

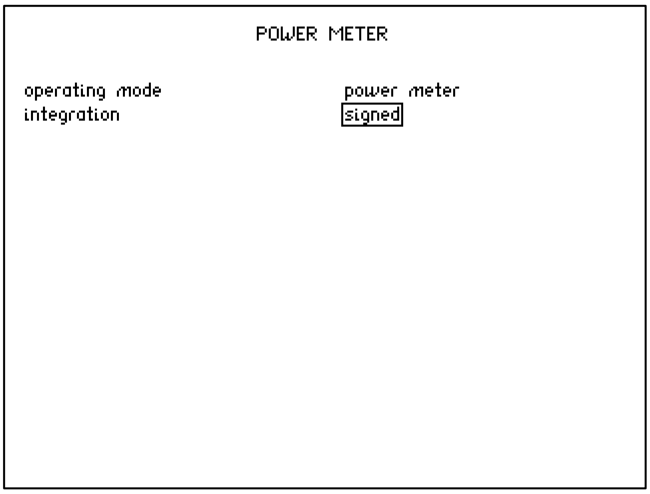
instrument allowed to warm up for ≥30 minutes

AC+DC coupling

autoranging or manual ranging ≥ 1/3 range

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 1MHz, 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 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 PSM1735 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 – this can be disabled in the SYSTEMS OPTION menu.

The high linearity of the PSM1735 allows real-time measurements be made on waveforms with periodic bursts such as low standby power PSUs. Use ***autorange up*** in the *CH1* & *CH2* menus to find the range.

The PSM1735 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
display	5 digits
measurement	W, VA, PF, fundamental, rms, phase
coupling	AC or AC+DC
frequency	DC to 1MHz
	1MHz to 35MHz (fundamentals only)
	20Hz to 35MHz (AC only coupling)
max input	±10V peak
input ranges	10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV, 1mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
accuracy (AC)	0.15% range + 0.15% reading < 1kHz
	1.5% range + 1.5% reading < 50kHz
	2% range + 8% reading < 1MHz
accuracy (DC)	0.2% range + 0.3% reading
CMRR (typical)	60dB @ 10V 50Hz
	50dB @ 10V 1kHz
	40dB @ 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

0.1% current shunt selected to give 100mV rms

LCR Meter

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 PSM1735 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.

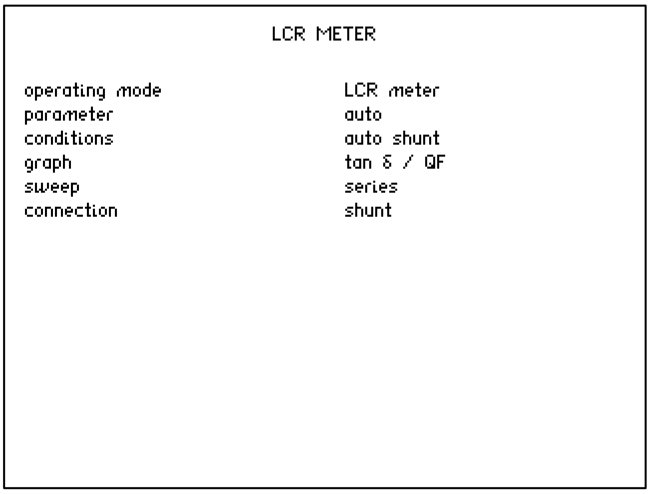
It is important to characterise the component of interest over all the frequencies that are relevant for a given application. For this reason, the LCR Active Head and IAI (see Appendix) can be used in conjunction with the PSM1735 to sweep across a frequency range.

The LCR active head fits onto the front of the PSM1735 and provides 4 wire Kelvin clip connections to the component under test. To use the LCR active head, after fitting to the PSM1735 press the *AUX* key and change the fixture parameter to ***LCR active head***. The active head provides a choice of three shunts (***normal, high***, & ***very high***), selectable from the front panel via the *AUX* menu, and buffers the signals to minimise the effects of stray capacitance and inductance.

The IAI is a separate unit that sits beneath the PSM1735 and is connected via 3 short BNC-BNC cables for the output, channel 1 primary and channel 2 primary inputs. 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 IAI 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.

To use the IAI, after fitting to the PSM1735 press the *AUX* key and change the ***fixture parameter*** to ***impedance analyzer interface***. The IAI's choice of four shunts (***low, normal, high,*** & ***very high***), are selectable from the next parameter in the AUX menu.

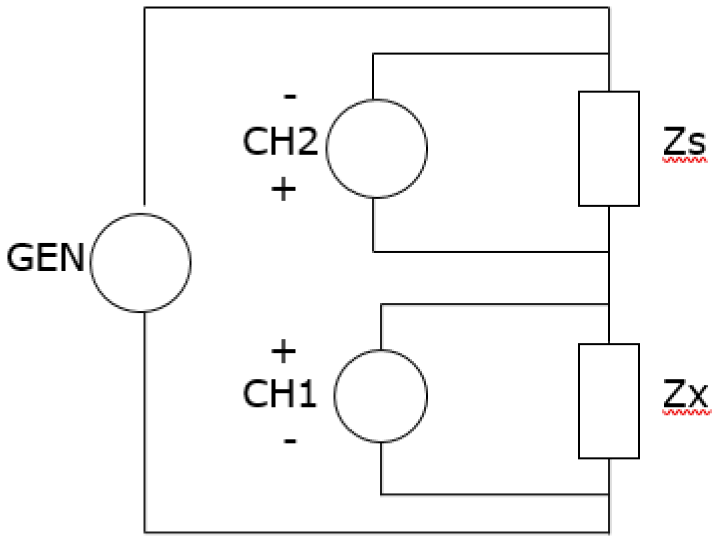
In LCR meter mode, channel 1 measures the voltage across the component under test, and channel 2 measures the current through it. To measure the current, channel 2 must be connected across an appropriate external shunt.



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

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

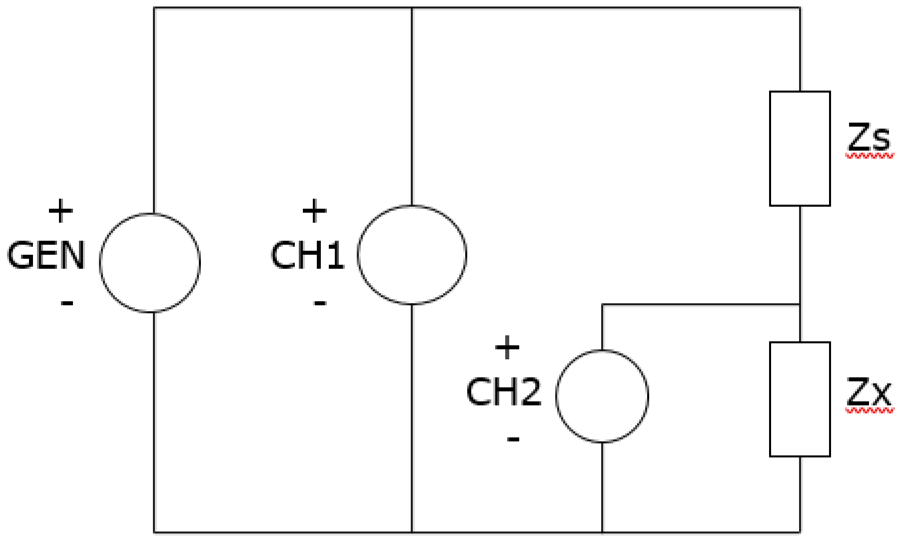
There are three manual ***connection*** options, ***shunt***, ***divider Zx low***, ***divider Zx high***.



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 PSM1735 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 PSM1735 computes the complex impedance given by:

z = v / **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, 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 PSM1735 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 PSM1735 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 PSM1735 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 circuit*** or ***parallel circuit*** must be selected for the ***sweep*** parameter shown in the screenshot above.

The frequency points to be measured are specified with 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 as described on page 42

The PSM1735 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.

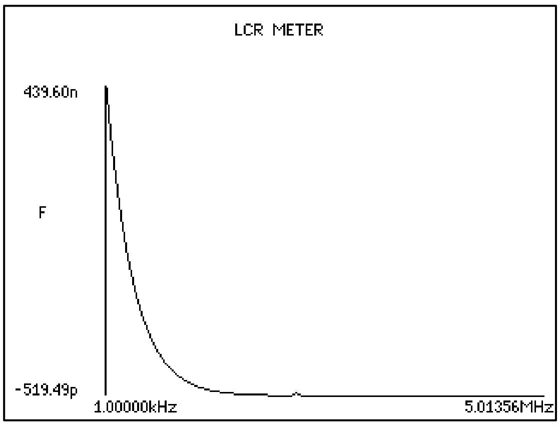
LCR METER

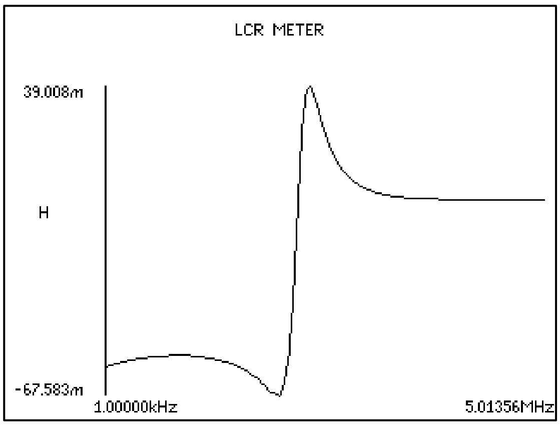
1	1.00000kHz	-57.621mH	22.909Ω	15.803
2	1.08987kHz	-57.071mH	23.890Ω	16.359
3	1.18782kHz	-56.565mH	24.866Ω	16.978
4	1.29457kHz	-56.103mH	25.907Ω	17.614
5	1.41091kHz	-55.705mH	27.219Ω	18.143
6	1.53772kHz	-55.364mH	28.490Ω	18.775
7	1.67591kHz	-55.030mH	30.353Ω	19.091
8	1.82653kHz	-54.805mH	32.302Ω	19.471
9	1.99068kHz	-54.557mH	34.631Ω	19.705
10	2.16959kHz	-54.333mH	37.238Ω	19.890
11	2.36457kHz	-54.140mH	40.552Ω	19.835
12	2.57708kHz	-53.986mH	44.127Ω	19.810
13	2.80868kHz	-53.859mH	48.841Ω	19.461
14	3.06110kHz	-53.753mH	53.603Ω	19.287
15	3.33621kHz	-53.658mH	61.193Ω	18.381
16	3.63604kHz	-53.613mH	68.120Ω	17.981
17	3.96281kHz	-53.584mH	77.314Ω	17.257
18	4.31895kHz	-53.599mH	88.610Ω	16.415
▶ 19	4.70710kHz	-53.582mH	102.38Ω	15.479
20	5.13014kHz	-53.670mH	120.14Ω	14.400

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

Step No, Frequency, Inductance or Capacitance, Resistance, and Tan δ

Pressing the GRAPH key will switch these results to a plotted graph as shown in the next two screenshots.





The first graph shows a typical capacitive plot and the second a typical inductive plot.

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 PSM1735 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 PSM1735 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.

Applying Compensation

When measuring small inductance or capacitance, it may be necessary to zero out the stray effects from the test lead/fixture connections. Press the *ZERO* key to access the compensation menu.

There are two types of compensation that can be applied:

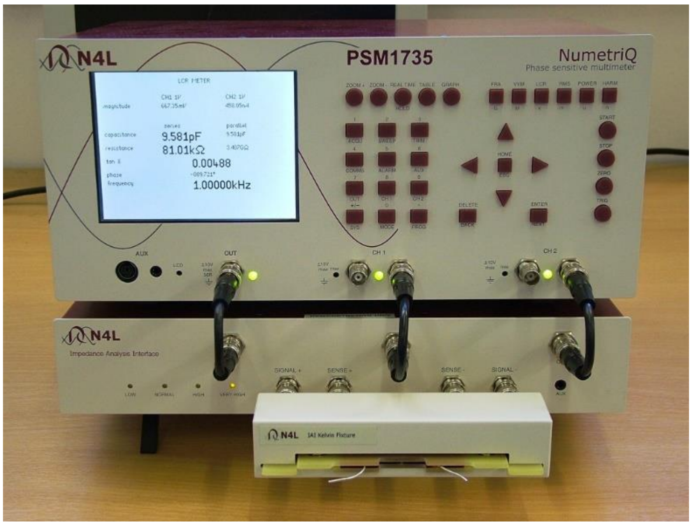
Open Circuit compensation or Short Circuit compensation

Both the above options can be applied to a single frequency or to a frequency sweep measurement.

How to apply compensation for single frequency measurement

When planning on measuring a capacitive DUT, Open Circuit compensation is used. Two pieces of single core wire are placed in the jaws of the Kelvin leads or the Kelvin fixture as shown below.

In the compensation menu, highlight ***open circuit*** and then press *ENTER* after a short time– the message ‘***OPEN CIRCUIT ZERO SET***’ will be displayed at the bottom of the screen.



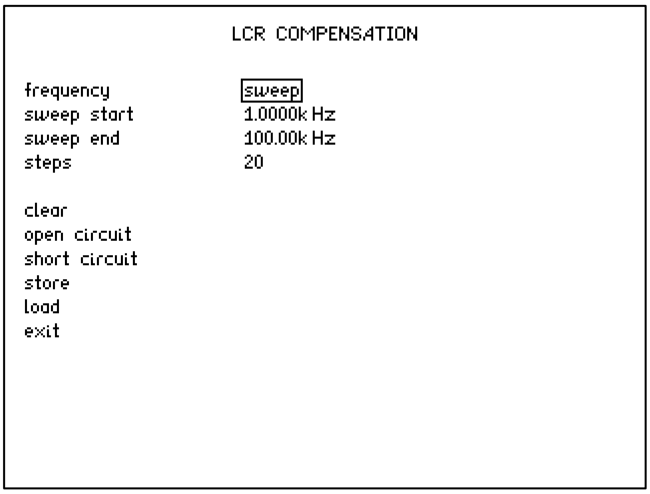
For inductance measurement compensation connect the Kelvin leads to a single piece of single core wire, or place between the jaws of the Kelvin fixture and highlight ***short circuit*** and then press *ENTER* after a short time – the message ‘***SHORT CIRCUIT ZERO SET***’ will be displayed at the bottom of the screen.

To remove the compensation, press *ZERO* to enter the compensation menu and highlight ***clear*** then press *ENTER*– the message ‘***ZERO CLEARED***’ will be displayed at the bottom of the screen.

For repeated measurements under the same test conditions (e.g., production testing of a batch of capacitors) it is possible to compensate for the inherent phase shift of the connection jig. Connect a known reference component to the system, enter the known phase shift of the component as the ***phase reference*** in the compensation menu and select ***compensate*** a message saying ‘***ZERO SET***’ will be shown at the bottom of the screen. The PSM1735 then applies a compensating vector rotation to all subsequent measurements based on the reference component.

How to apply compensation for a swept frequency measurement

As the PSM1735 provides the benefit of frequency sweep functions for all measurement modes, it is common to use the instruments to test components over a range of frequencies. In this case, the issues discussed above in relation to single frequency compensation now apply to the complete frequency range over which measurements will be made.



Here, the *ZERO* key has been pressed on the PSM1735 front panel to present the LCR Compensation screen and then by using the ▲ & ▼navigation keys, the frequency option has been changed form single to sweep.

Here it can be seen that ***sweep start, sweep end*** and ***step*** options are presented. As would be expected, sweep compensation should be performed at the same sweep range and number of steps as the sweep itself.

INFORMATION.

The default number of steps is 32 and the maximum number is 100 steps. By selecting the number of steps, a user has control over the total time required for compensation and the accuracy of compensation throughout a sweep. While interpolation between frequency steps is applied so that the frequency steps within compensation do not have to correlate with the number of steps in a measurement sweep, superior compensation over a frequency sweep range will be achieved when using the same number of steps and frequency range as those set in the sweep menu options.

Saving and recalling compensation results

Sweep compensation

Sweep compensation can be quite time consuming, especially when many steps are selected and for this reason, a Store function is provided. The ***Store*** function should be selected only when the complete compensation has been completed, i.e., if both short circuit and open circuit compensation are applied, the Store function should be used when both processes have been completed. A new sweep compensation can be made at any time without affecting the stored compensation but only one sweep compensation can be stored, therefore pressing *ENTER* to confirm ***Store*** after a new compensation has been made will overwrite the previous compensation.

The ***Load*** function will re-load the stored Sweep compensation. As the sweep compensation memory is non-volatile, the stored compensation can be loaded at any time. To ensure that users do not switch on the instrument and inadvertently make a measurement with inappropriate compensation, the default power on condition is with no compensation applied. If therefore a user wishes to apply the stored sweep compensation, they should enter the sweep compensation menu and 'load' the compensation. The applied compensation will remain active while the unit remains powered on or until the ***clear*** function is selected.

INFORMATION.

Sweep compensation can't be stored in a Program file and then recalled with the other settings.

Single frequency compensation

When using single frequency compensation, there is no separate store function as with the sweep compensation. Since the compensation of a single frequency is fast this is not an issue. The Compensation will be lost when the instrument is switched off. However, when the instrument settings are saved to a program file in the internal flash memory of the PSM1735, any single point 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 compensation settings, these settings will be applied when that program is recalled including after the power cycling of the instrument.

CAUTION.

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.

LCR meter specification

LCR meter	
frequency	10µHz to 35MHz (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
ranges (With external shunt)	100pF to 100uF
	1µH to 100H
	1Ω to 1MΩ
ranges	10pF to 1000uF
(With active head)	100nH to 10kH
	10mΩ to 100MΩ
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

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.

The PSM1735 measures the in-phase and quadrature components at the fundamental frequency using DFT analysis as described in the section on frequency response analysis on page 65. 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 will 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.

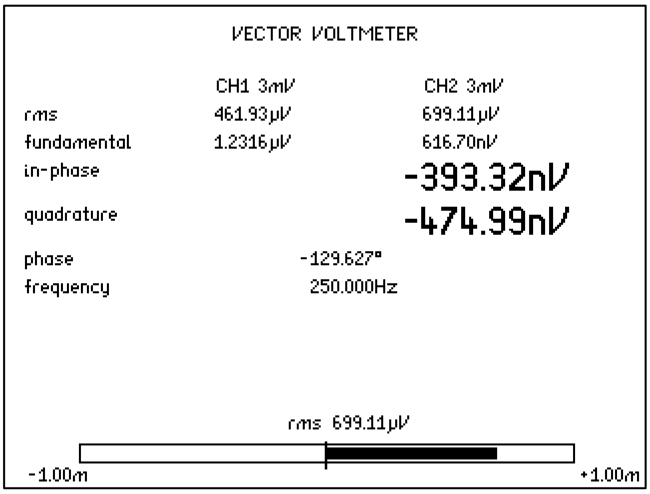
From the phase referred fundamental components, (a + jb), the following results can be derived:

magnitude	$= \sqrt{(a^2 + b^2)}$
phase	$= \tan^{-1}(b/a)$
tan ϕ	= b/a
in-phase ratio	$= a_2 / a_1$
LVDT (diff)	= scale * a_2 / a_1
LVDT (ratio)	= 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 *VVM* or *MODE* menu keys. The frequency and phase are always displayed.

A null meter display may be selected via the *VVM* menu to allow adjustment of a circuit for minimum phase or component. The parameter on the display depends on the selected component:



parameter	null meter displays	null meter units
in-phase	in-phase	Degrees
quadrature	quadrature	V or A quadrature
tanϕ	tanϕ	Degrees
magnitude	magnitude	V or A fundamental
phase	phase	Degrees
in-phase ratio	in-phase ratio	Signed decimal
rms	rms	V or A CH2
$rms_2/_1$	rms_2/rms_1	rms_2/rms_1 V or A
LVDT diff	LVDT	Displacement In or m
LVDT ratio	LVDT	Displacement In or m

The null meter may be manually ranged or will automatically range as the signal varies. When manually ranging, the *DELETE* and *ENTER* keys adjust the range by a decade.

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

The PSM1735 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***

The PSM1735 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.

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.

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 PSM1735 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 PSM1735 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 specification

Phase angle voltmeter (vector voltmeter)	
frequency	10µHz to 35MHz (own generator) 20mHz to 500kHz (external source)
measurement type	DFT analysis, and true rms
measurements	magnitude, phase, in-phase & quadrature components, tanΦ, in-phase ratio, LVDT (diff), LVDT (ratio), rms, rms ratio
max input	±10V peak
input ranges	10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV, 1mV
ranging	full auto, up only, or manual
input impedance	1M // 30pF (exc. leads)
basic accuracy	0.05% range + 0.05% reading + 0.05mV <1kHz basic + 0.001%/kHz < 10kHz basic + 0.002%/kHz < 1MHz basic + 1.6% + 0.4%/MHz < 35MHz
phase accuracy	0.01° < 10kHz 0.05° + 0.0001°/kHz < 35MHz
phase resolution	0.001°
tanΦ resolution	0.0001
CMRR (typical)	60dB @ 10V 50Hz, 50dB @ 10V 1kHz, 40dB @ 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

autoranging or manual ranging ≥ 1/3 range

Harmonic analyser

The PSM1735 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, see page 66).

There are three modes of operation: ***single***, ***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 bar graph which changes in real time with the measurements.

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 PSM1735 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 PSM1735 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.

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 PSM1735 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 PSM1735 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.

Harmonic analyser specification

Harmonic analyser	
fundamental frequency	10µHz to 500kHz (own generator)
	20mHz to 500kHz (external source)
harmonic frequency	10µHz to 1MHz
measurement type	multiple DFT analysis
measurements	single harmonic, differential thd, thd by series of harmonics
max harmonic	64
max input	±10V peak
input ranges	10V, 3V, 1V, 300mV, 100mV, 30mV, 10mV, 3mV, 1mV
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

Transformer analyser

This section is included in this manual to provide backwards compatibility to enable users of the PSM1735 to make measurements with the Transformer Analyser which is no longer manufactured.

The transformer analyser mode allows a comprehensive set of measurements to be performed on a transformer at a single frequency or automatically swept over a range of frequencies.

The tests available are:

- Turns Ratio
- Inductance
- Leakage Inductance
- AC Resistance and Q Factor
- DC Resistance
- Interwinding Capacitance
- Magnetising Current
- Return Loss
- Insertion Loss
- Single Harmonic Distortion
- Total Harmonic Distortion
- Longitudinal Balance

The transformer analyser function is invoked, and the test selected, by the *MODE* key.

Press the ▼ key to highlight the ***operating mode*** choices.

Press the ►key to cycle between the options available.

When Transformer Analyzer is shown press the ▼key to highlight the test parameter option, now press the ►key to cycle through the list of tests available.

With each test highlighted, a nominal value or values are displayed, to alter these values, press the ▼ key until the value is highlighted. Using the Numeric Keys, enter the selected value, press the *ENTER* Key to confirm the value, once all the values are entered, press the *HOME* Key followed by the *ENTER* Key to enter the chosen selection.

Connect to the DUT using x10 oscilloscope probes (set the ***fixture*** option in the *AUX* menu to ***none***, this will be the default option from bootup unless any loaded program settings have changed it to another option).

The operating conditions for the component under test may be selected manually or for some tests (such as turns ratio), the PSM1735 will automatically try to find appropriate conditions.

The PSM1735 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 required test must be selected, and parameters entered if required.

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 PSM1735 generator when performing transformer analysis, there may be circumstances where this is impractical, for example measuring the turns ratio of a transformer under load. In this case, turn off the PSM1735 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.

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

Turns ratio

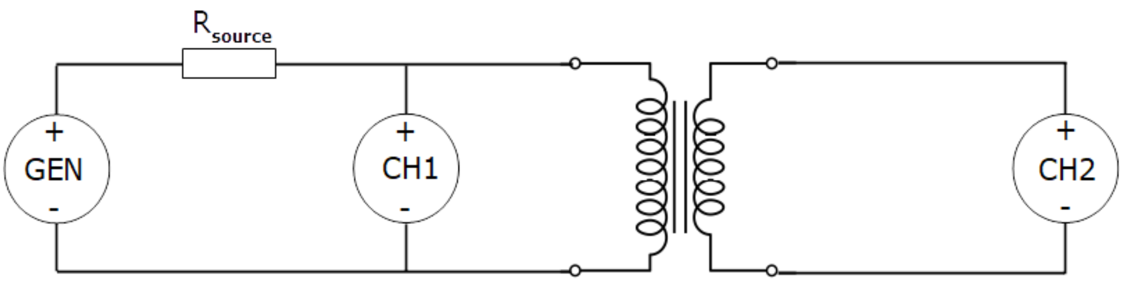
Turns ratio is computed from the real part of the complex ratio of CH2 divided by CH1 using DFT analysis at the fundamental frequency (refer to the section on gain/phase analysis for the formulae for DFT analysis, (see page 67). This technique gives good results even on 'lossy' transformers.

The polarity of the windings is indicated by a positive turns ratio for in phase windings and negative ratio for inverted windings.

A nominal number of turns may be entered if known and the PSM1735 will then also display the computed number of turns. This is set using the ***nominal*** parameter once the test has been set to turns ratio.

As the inputs are independent of the output it is possible to energise a third winding when measuring turns ratio, or only two windings may be used.

To connect a transformer for turns ratio measurement, connect the PSM1735 output to the winding to be energised, and the inputs to the two windings for the ratio.

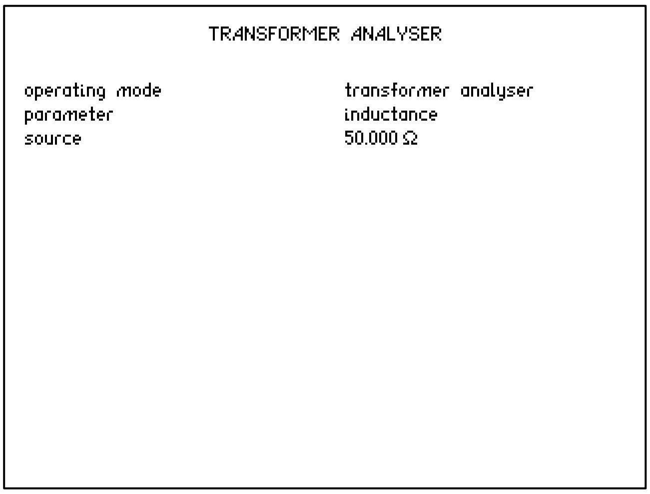


Pressing *ZERO* makes the ***turns ratio*** read 1:1, and the computed number of turns equal to the value entered via the *MODE* menu. This allows accurate testing of transformers or chokes against a known good reference. Press *ZERO* followed by *DELETE* to restore true turns ratio measurement.

Inductance & leakage inductance

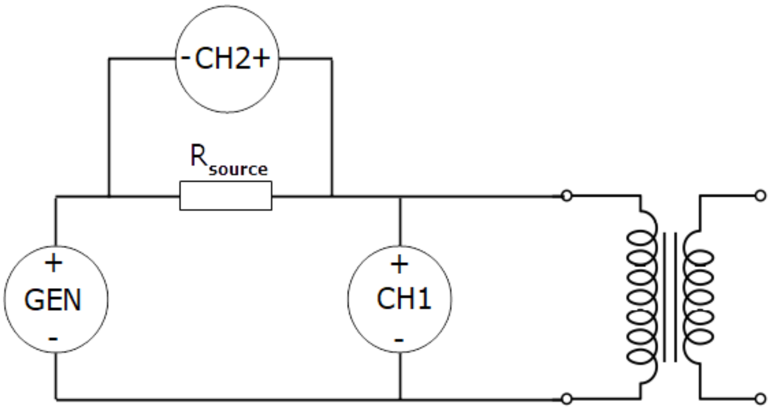
The inductance of a winding is computed from the complex ratio of CH1 (voltage across the winding) divided by CH2 (current through the winding) using DFT analysis at the fundamental frequency refer to the section on gain/phase analysis for the formulae for DFT analysis, see page 66).

CH2 is forced to be external shunt input – enter the value of the external shunt as the ***source*** resistance via the *MODE* menu.



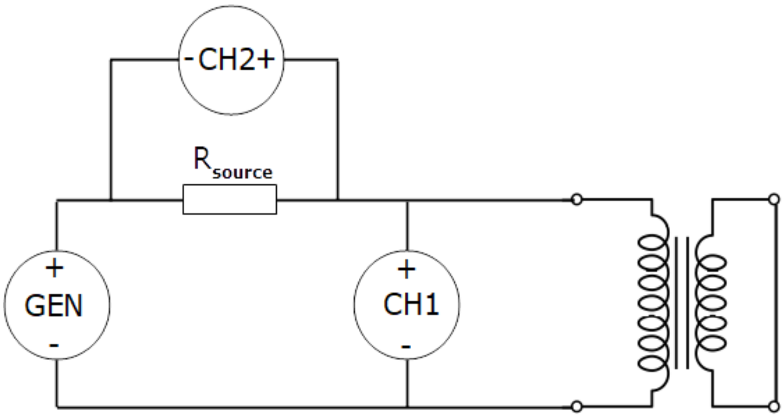
The ***source*** parameter should be set to the value of the external shunt used on CH2

To connect a transformer for inductance measurement, connect an appropriate source resistance in series with the winding and connect the PSM1735 output across the series combination of the source resistance and winding. Connect the CH1 input across the winding to measure the voltage, and CH2 across the series resistance (note that the polarity of external shunt input is the opposite of that for voltage). Leave all other windings open.



To measure leakage inductance, use the same set up as for inductance but short the other windings.

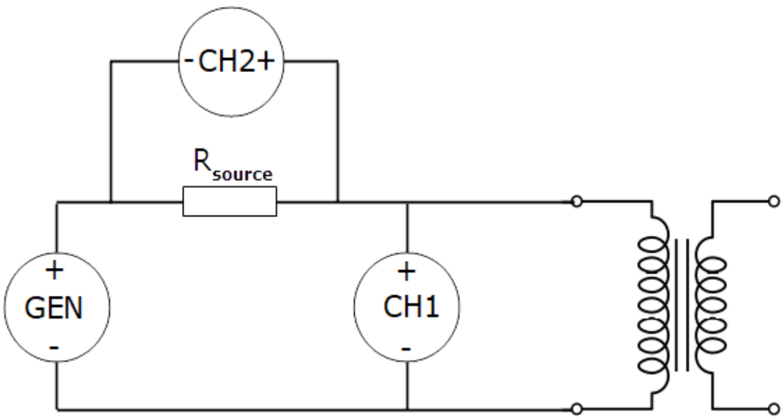
When measuring small values of inductance, it may be necessary to zero out stray effects by replacing the winding with a good short and following the short circuit compensation instructions described on page 80-81.



AC resistance and Q factor

AC resistance is measured the same way as inductance with CH1 monitoring the voltage across the winding, and CH2 monitoring the current through it via the external shunt (source resistance).

The Q factor measurement is an effective way of detecting a shorted turn – either on a transformer, or on a choke. When using suitable conditions (often very different from the normal operating conditions of the device under test) the Q factor changes dramatically when a shorted turn is present.



DC resistance

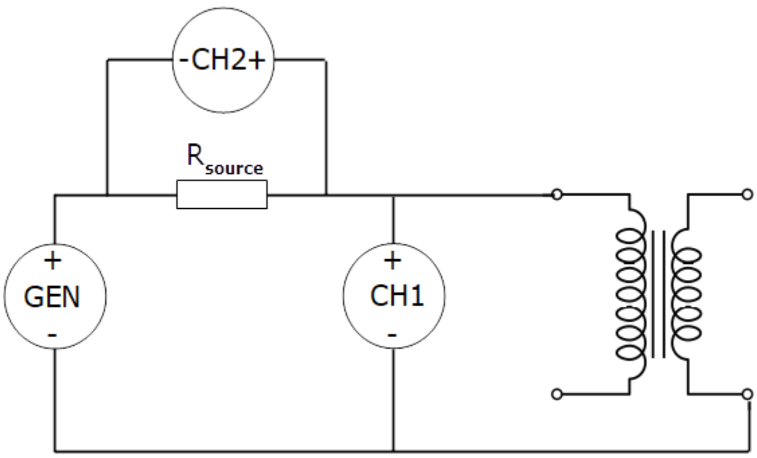
DC resistance is measured with the same circuit arrangement as inductance and AC resistance above, but DC signals are used (refer to section starting on page 62 for the formulae for DC analysis).

Interwinding capacitance

The interwinding capacitance of a transformer is computed from the complex ratio of CH1 (voltage across the transformer) divided by CH2 (current through the transformer) using DFT analysis at the fundamental frequency (refer to section on gain/phase analysis for the formulae for DFT analysis, see page 67.

CH2 is forced to be external shunt input – enter the value of the external shunt as the ***source*** resistance via the *MODE* menu.

To connect a transformer for interwinding capacitance measurement, connect an appropriate source resistance in series with one winding and connect the PSM1735 output across the transformer from the series resistance to another winding. Connect the CH1 input across the transformer from one winding to the other to measure the voltage across the windings, and CH2 across the series resistance (note that the polarity of external shunt input is the opposite of that for voltage).



When measuring small values of capacitance, it may be necessary to zero out stray effects by disconnecting the transformer and following the open circuit compensation instructions shown in the section on compensation, see page 80.

Magnetising current

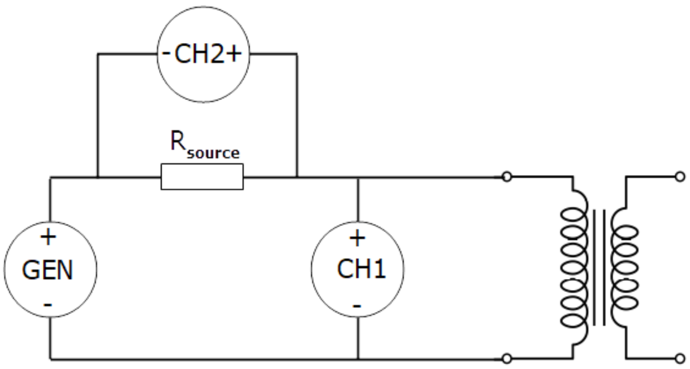
The magnetising current is the current drawn by the primary, energised under normal operating conditions but without any secondary load. It is typically measured on power transformers rather than signal transformers; it is not uncommon in these instances that a custom fixture would be used to make the connection.

The magnetising current is measured as the true rms value (refer to the section on the rms voltmeter for the formulae for rms analysis, see page 61) so that it will include all distortion components.

To connect a transformer for magnetising current measurement, connect an appropriate shunt in series with the primary. When selecting the shunt, bear in mind the current that it must pass, the resulting voltage drop across it, and the power that will be dissipated in it. Connect CH1 directly across the primary winding using a pair of appropriate probes, and CH2 across the series resistance with a second pair of probes (note that the polarity of external shunt input is the opposite of that for voltage).

CAUTION. Ensure that all probes and the series resistance are appropriate for the voltage, the current and the frequency of operation.

Energise the primary so that the voltage seen at the primary after the series resistance, is the normal operating voltage.



Return loss

Return loss is a measure of impedance mismatch in signal transformers that are terminated with the design load resistance.

The secondary winding is terminated with the appropriate load resistance and the primary is energised via a source resistance that is equal to the resistance that should be reflected from the secondary (load resistance * (turns ratio)^2). The impedance looking into the primary is measured.

If Z is the complex impedance measured at the primary, and R is the source resistance then the return loss is given by:

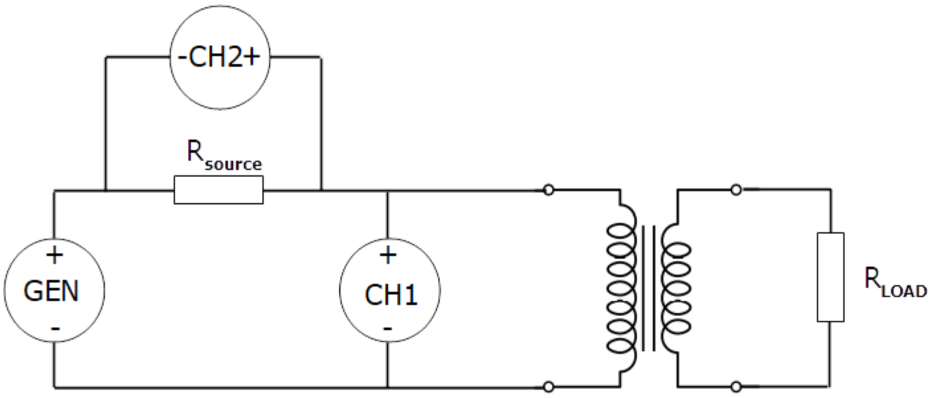
return loss = | Z+ R | / | Z - R |

Return loss is usually expressed in dB: = 20 log (| Z + R | / | Z - R |) dB

As a figure of merit, a higher value of return loss indicates a better transformer.

The circuit arrangement for return loss is the same as that for inductance measurement except that the secondary is terminated with the appropriate load resistance.

As the value of the load source resistance, R, is used in the computation, it is important that this value be entered via the *MODE* menu.



Insertion loss

Insertion loss is a measure of power loss due to impedance mismatch in signal transformers that are terminated with the design load resistance.

The secondary winding is terminated with the appropriate load resistance and the primary is energised via a source resistance that is equal to the resistance that should be reflected from the secondary (load resistance * (turns ratio)²). The voltage energising the series resistance and primary winding is measured and the voltage on the secondary is measured.

If Rs is the source resistance, the power into the transformer is computed as: $W_{in} = V_{in}^2 / 4\ R_S$

If R_L is the load resistance, the power out is computed as: $W_{out} = V_{out}^2 / R_L$

Insertion loss then is given by: Insertion loss $= W_{in} / W_{out}$

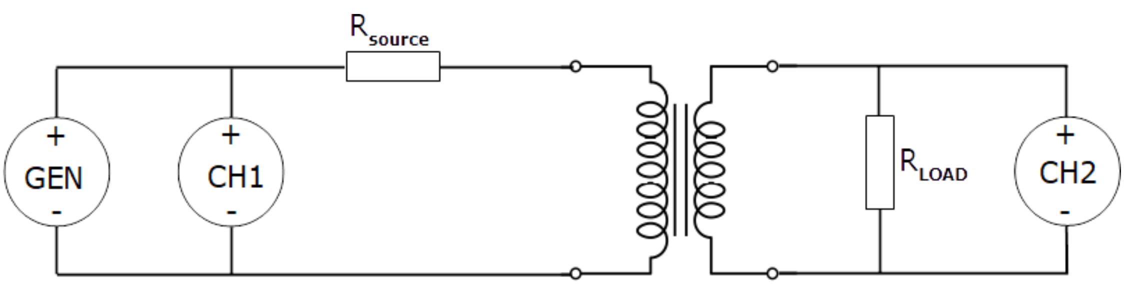
$$= (V_{in} / V_{out})^2 . R_L / 4\ R_S$$

Insertion loss is usually expressed in dB: = 10 log ((Vin / Vout)² . RL/ 4 RS) dB

As a figure of merit, a lower value of insertion loss indicates a better transformer.

To connect a transformer for insertion loss measurement, fit the appropriate source resistance in series with the primary winding then connect the PSM1735 output and CH1 differential input across the series combination of the source resistance and the primary winding. Connect the appropriate load resistance and CH2 differential input across the secondary. Remember to set CH1 and CH2 connection parameter to differential (both) input

As the values of the load resistance, R_L, and the source resistance, R_S, are used in the computation, it is important that both values are entered via the *MODE* menu.



Harmonics and distortion
Harmonic distortion introduced by a signal transformer may be measured either at a single spot harmonic or as the THD computed from a series of harmonics.

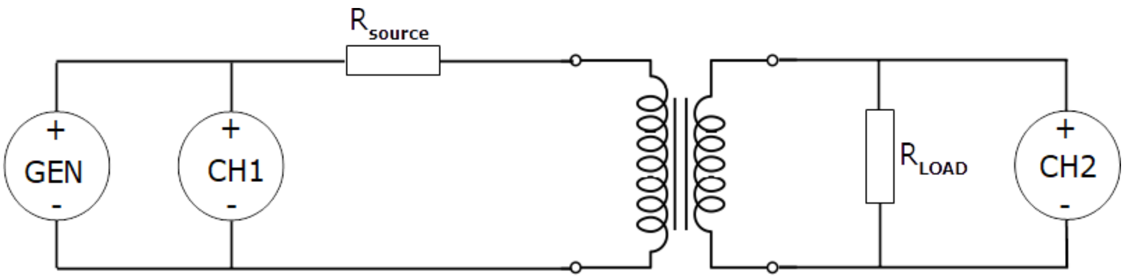
The primary of the transformer is energised either by the output of the PSM1735 or by external means and CH2 is connected across the secondary. It is usual to measure harmonic distortion with the secondary loaded.

Specify the single harmonic, or the maximum series harmonic via the *MODE* menu.

The PSM1735 analyses for up to 50 harmonics in real time, using multiple DFTs (refer to section on gain/phase analysis for the formulae for DFT analysis). Each harmonic is individually phase referenced to the fundamental so that the in-phase and quadrature components can be separately filtered. As the harmonics are usually very small, this technique is important to give adequate noise rejection.

The series harmonic data is combined to give the THD, (refer to section on page 86 on harmonic analysis for the THD formula).

The single harmonic and the THD are expressed as dB relative to the fundamental.

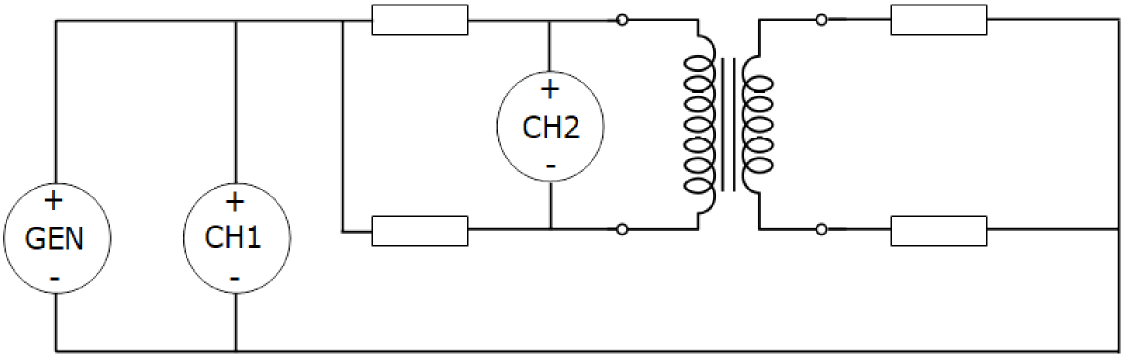


Longitudinal balance

Longitudinal balance is a measure of the common mode rejection ratio, CMRR, of the transformer.

Longitudinal balance requires external circuitry to give the required accuracy.

As a figure of merit, a higher value of longitudinal balance indicates a better transformer.



Transformer analyser specification

Transformer analyser	
frequency	10µHz to 35MHz (own generator) 20mHz to 500kHz (external source)
measurement type	DFT analysis, true rms as appropriate
measurements	turns ratio turns inductance leakage inductance AC resistance DC resistance interwinding capacitance insertion loss return loss harmonics thd longitudinal balance
conditions	auto, or manual
display	numeric values table of sweep results graph of any measurement
accuracy	refer to other functions
sweep capability	all AC functions
sweep step rate	1/20s, 1/3s or 2.5s (approx.)

Chapter 9 Setting up and using remote control

The PSM1735 is fitted with an RS232 serial communications port as standard and may have an IEEE488 (GPIB) interface or LAN interface fitted as an option, (Port No 10001). All the interfaces use the same ASCII protocol except for the end of line terminators:

Interface	Rx expects	Tx sends
RS232	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 PSM1735 can be programmed via either interface, and the results read back. When the IEEE488 interface is set to ***remote*** the RS232 port is ignored.

The commands are not case sensitive and white space characters are ignored (e.g., tabs and spaces). Replies from PSM1735 are always upper case, delimited by commas, without spaces.

Only the first six characters only of any command are significant – 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 a comma, multiple commands can be sent on one line delimited with a semi-colon e.g.

AMPLIT,1.5;OUTPUT,ON

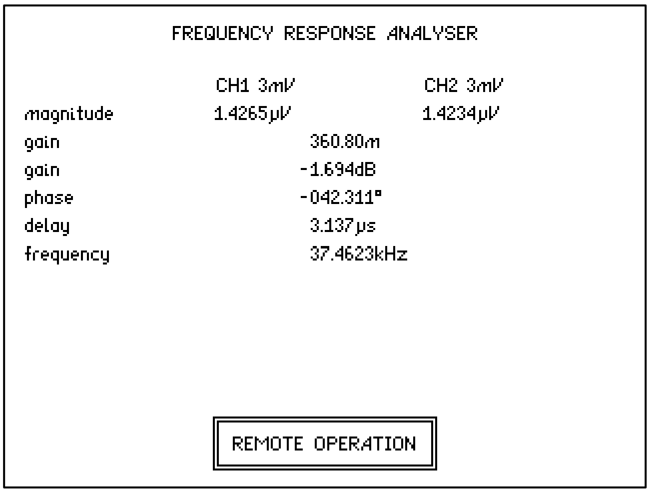
Mandatory commands specified in the IEEE488.2 protocol have been implemented, (e.g. ****IDN?, *RST***) and all commands that expect a reply are terminated with a question mark.

The PSM1735 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 section 5.1).

The PSM1735 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.

The IEEE address defaults to 23 and can be changed via the *COMMS* menu.

The keyboard is disabled when the instrument is set to “remote” using the IEEE interface or if the command ***KEYBOA,DISABL*** is sent via RS232 or LAN.



Once the keyboard is disabled pressing any key other than *HOME* will result in the ***REMOTE OPERATION*** message appearing on the display for approx. 2 seconds.

Press *HOME* to return to local control via the keyboard.

RS232 data format

The RS232 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.

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

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
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

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
		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

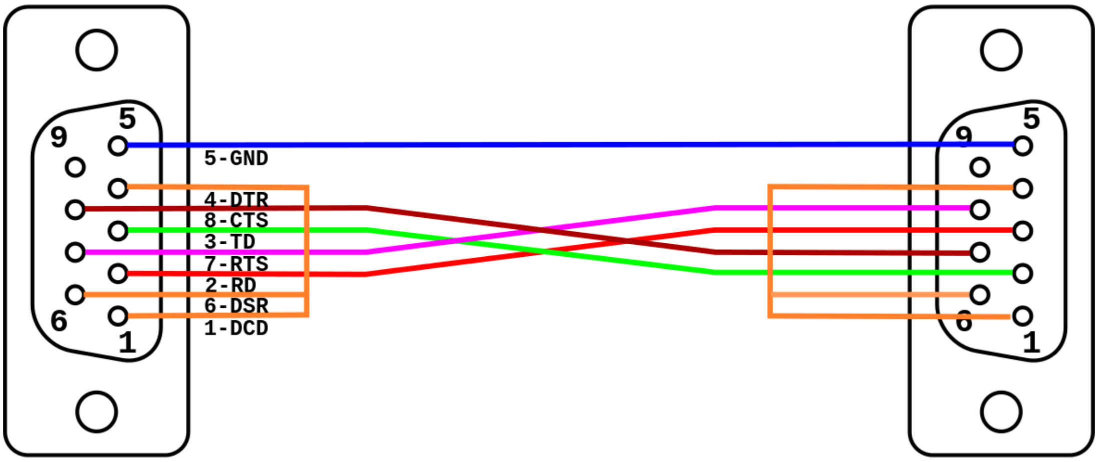
The RS232 port on the PSM1735 uses the same pinout as a standard 9 pin serial port on a PC or laptop (9-pin male 'D' type).

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 PSM1735 will only transmit when CTS (pin 8) is asserted and can only receive if DCD (pin 1) is asserted. The PSM1735 constantly asserts (+12V) DTR (pin 4) so this pin can be connected to any unwanted modem control inputs to force operation without handshaking. The PSM1735 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 PSM1735 to a PC, use a 9 pin female to 9 pin female null modem cable:

Pin(s)	Conect to	Pin(s)
1 & 6	⇆	4
2	⇆	3
3	⇆	2
4	⇆	1 & 6
5	⇆	5
7	⇆	8
8	⇆	7



Null modem serial cable pin-out

Data streaming

The phase angle voltmeter and power meter modes have the option of high speed data streaming. In this operational mode, the window width for the measurement may be specified from 660µs to 100ms and the data for each measurement window is transmitted over the communications in a continuous stream. The window is adjusted to synchronise to the measured frequency.

The PSM1735 buffers the data and transmits at the fastest rate that is possible for the chosen data link protocol with the PC. The buffer depth is over 8000 data values, so more than 5 seconds of data can be captured at the fastest rate of 1500 readings per second even if the data is not read at all. If the window size is such that the data can be read out in real-time rather than being buffered, then data streaming can continue indefinitely.

Once the data streaming window has been setup but before the streaming has been started, the display periodically shows the measured value. Once streaming has been started, the display is blanked to minimise processing overheads. Streaming can be stopped either immediately by issuing the ***ABORT*** command or may be stopped but the remaining data in the buffer continues to be transmitted until the buffer is empty. To achieve this the ***STOP*** command is used.

STREAM,ENABLE,0.01

START

read data

STOP

continues to read stored data until buffer is emptied.

Chapter 10 Trouble Shooting

Frequently Asked Questions

Q. PSM1735 won't connect to a PC running PSMComm2

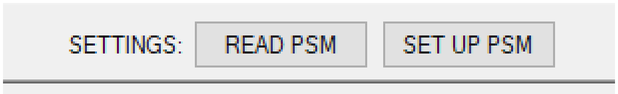
A. Check the ***interface*** parameter in the *COMMS* menu and ensure that it is set to the method used to physically connect the instrument to the PC. If using RS232 also check that the baud rate is set to 19200.

Q. When using an IAI, 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 IAI 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 PSM1735 firmware are available as free downloads from our website support pages. https://resources.newtons4th.com/

Chapter 11 General Specification

GENERAL SPECIFICATIONS	
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
Optional	LAN, GPIB
Real Time Clock	Time and date stamp for data stores
Data Storage	Internal 1GB flash
Display and Resolution	320 x 240 dot LCD – 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	170H x 350W x 250D mm approx.
Weight	4kg approx.
Storage Temperature Range	-10°C to +60°C
Relative Humidity Range	20 to 95% Non-Condensing
Maximum Altitude	2,000 Metres

Chapter 12 Appendix A

Accessories & Software

75Ω / 600Ω output adapter

The generator output from the PSM1735 has a series impedance of 50Ω. The output adapter fits directly onto the front of the instrument and provides 2 outputs:

75Ω via a BNC connector

600Ω via 4mm sockets.

There are two versions of the adapter that have different spacing between the 4mm sockets:

½" (12.5mm) as commonly used for communications.
¾" (19mm) as standard on instruments.

In both cases, the red connector carries the output signal, the green or black connector is 0V (connected to earth via the PSM1735 chassis).

The impedance conversion is resistive and does not limit the frequencies available from the generator (DC coupled). When driving into the characteristic impedance (75Ω or 600Ω as appropriate) the voltage delivered to the load will be half that delivered into open circuit.

Matching the source to the load impedance minimises reflections at higher frequencies and improves transient response, especially when driving long lengths of cable or transformers.

Part numbers	
500-005	75/600Ω adaptor with ½" spacing
500-026	75/600Ω adaptor with ¾" spacing

LCR Active Head

The PSM1735 LCR active head fits onto the front of the instrument, making connection to the output and the two inputs, to provide four BNC connections for use with Kelvin leads to connect to the component under test.

A cable from the active head connects to the AUX port on the front of the PSM1735 to allow selection of one of the three internal shunts:

shunt	value	purpose
normal	100Ω	general purpose, all frequencies
high	10kΩ	higher impedance, low to medium frequency
very high	1MΩ	impedance > 100kΩ, low frequency only

INFORMATION. Ensure the LCR Active Head option is enabled in the *AUX* menu

The active head contains high impedance buffer amplifiers that help to reduce the effect of stray capacitance and inductance.

The active head is supplied with Kelvin clip leads.

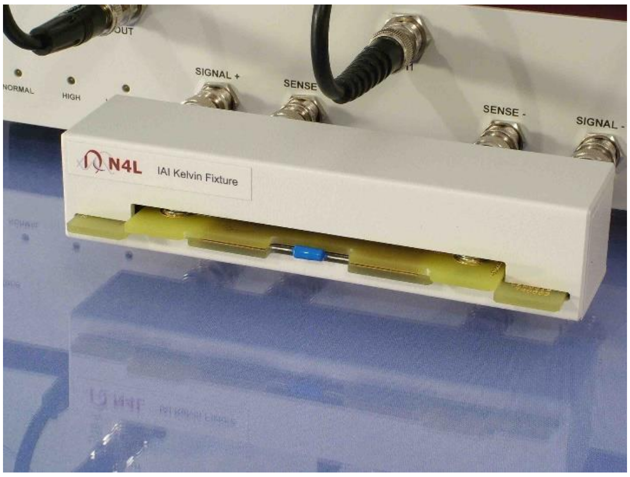
Part numbers	
500-056	LCR active head
510-013	Kelvin clip lead set

IAI

The Impedance Analysis Interface is an optional measurement interface intended to be used in conjunction with the PSM1735 to form a high accuracy Impedance Analyzer. The IAI provides all the functionality offered by the LCR Active Head but with a wider frequency and impedance measurement range plus higher nominal accuracy. This is achieved by a more sophisticated design that includes an additional internal shunt range, a current amplifier to increase low impedance signal levels and calibration together with the PSM1735 with which it will be used.

Part numbers	
510-064	IAI
510-013	Kelvin clip lead set

Kelvin Fixture



The IAI Kelvin Fixture provides an alternative interface between the component under test and the IAI/IAI2 (Impedance Analysis Interface). The IAI Kelvin Fixture is the preferred fixture when the test frequency exceeds 5MHz as it exhibits low parasitics and offers a reliable connection to the component under test.

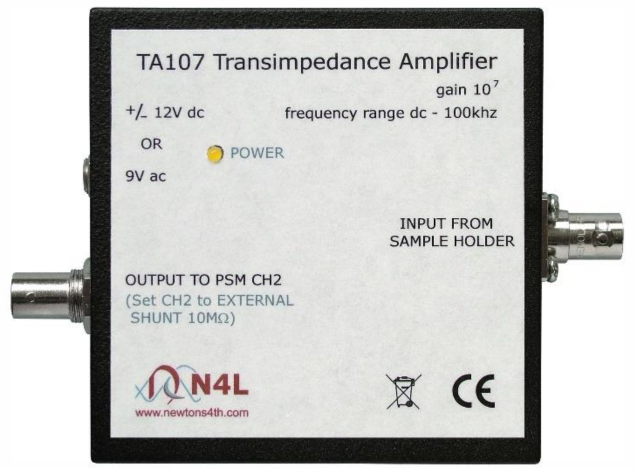
Part numbers	
510-066	Kelvin Fixture

IAI 22mm Adaptor

Third Party Impedance fixtures often feature 22mm pitch BNC spacing for connection to fixture accessories with 4x BNC terminals. N4L Impedance Analyzers use a different pitch spacing and the IAI -22mm Adapter will convert the IAI spacing to 22mm pitch. The IAI 22mm adaptor is enclosed in a metal chassis, with plastic feet and convenient BNC levers to install and remove the adaptor from the front panel of the IAI (Impedance analyzer Interface).

Part numbers	
510-413	IAI version

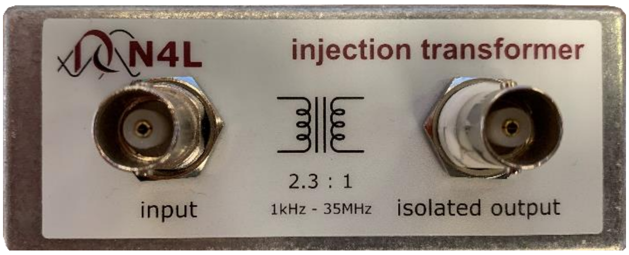
TA107 Transimpedance Amplifier



The TA107 Transimpedance Amplifier provides a solution for high impedance analysis applications by measuring the current flowing through a component or material under test with an innovative earth referenced transimpedance amplifier technique. When used with the PSM1735 the upper limit of impedance measurement range is increased to 1MΩ - 100GΩ.

Part numbers	
510-094	TA107

Injection transformer



When testing the stability of control loops it is necessary to inject a small disturbance signal into the loop. The PSM1735 output is ground referenced so it is necessary to isolate the output before it can be connected to the loop.

The standard injection transformer provides an isolated output at a reduced signal level of about 1/6 of the direct output level over a frequency range of about 10Hz to 200kHz. The high frequency injection transformer operates over a frequency range from 1kHz to 25MHz.

Connections are via BNC connectors – one is grounded to the case the other is isolated. The grounded connector should be connected to the OUTPUT connector of the PSM1735 – the isolated connector should be wired to the circuit under test.

Part numbers	
500-042	standard injection transformer
500-047	High frequency injection transformer
500-048	High Voltage injection transformer
500-070	Low frequency injection module

LSF Signal Filters

N4L LSF Filters are a range of filters specifically designed for use with the N4L range of HF current shunts.
Available as 5 kHz low pass and 50 kHz low pass for improved signal to noise ratio.

Part numbers	
510-113	LSF05 5kHz filter
510-183	LSF50 50kHz filter
510-373	HSF10m

HFR Current Shunts

The HFR series shunts provide an accurate current sensing solution for many wideband impedance measurement applications. Utilising an innovative design that is unique to N4L, each shunt will maintain its specified resistance over a frequency range from DC to 1MHz without exhibiting the phase shift normally associated with resistive
shunts.

Part numbers	
510-113	HFR010 10mOhm 20A shunt
510-312	HFR100 100mOhm 6A shunt
510-313	HFR470 470mOhm 3A shunt
510-453	HF01R 1Ohm 1A shunt

TT-HV-250 High Voltage Probe (2.5kVpk)

For High voltage applications, the use of an attenuator is required and the TT-HV-250 provides measurement up to 2.5kV

Part numbers	
462-036	TT-HV 250 High Voltage Probe (Passive)

TT-HVP-15HF High Voltage Probe (15kVpk, 10kVrms)

The TTV-HVP-15HF High Voltage Probe provides 1000:1 attenuation of voltages up to 15kV, with a bandwidth of 50MHz these probes provide high voltage accurate measurement.

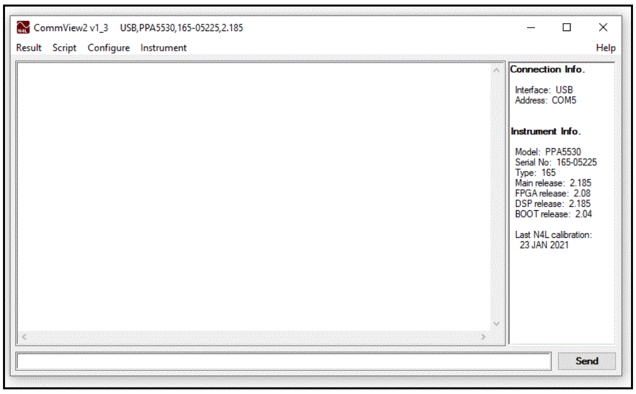
Part numbers	
462-069	TT-HVP 15HF High Voltage Probe (passive)

Attenuators

The ATT10, ATT20 and ATT1000 are BNC to BNC voltage attenuators designed for the PSM BNC inputs. They provide high accuracy wide bandwidth gain; typical applications are in situations when the output of a voltage attenuator (such as the TT-HV250) is above the 10Vpk range of the PSM1735 input.

Part numbers	
510-102	ATT10
510-103	ATT20
510-140	ATT1000

Firmware Upgrade & CommView2 PC software



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

CommView2 can connect to the PSM1735 via Serial/RS232 and where fitted, LAN.

INFORMATION. Note: While LAN can be used for running scripts, Serial/RS232 **MUST** be used for upgrading the firmware.

CommView2 allows strings to be sent and received between a PC and the PSM1735. 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 PSM1735

lines beginning with # are commands for CommView2

any other line is a comment.

The # commands that are recognised:

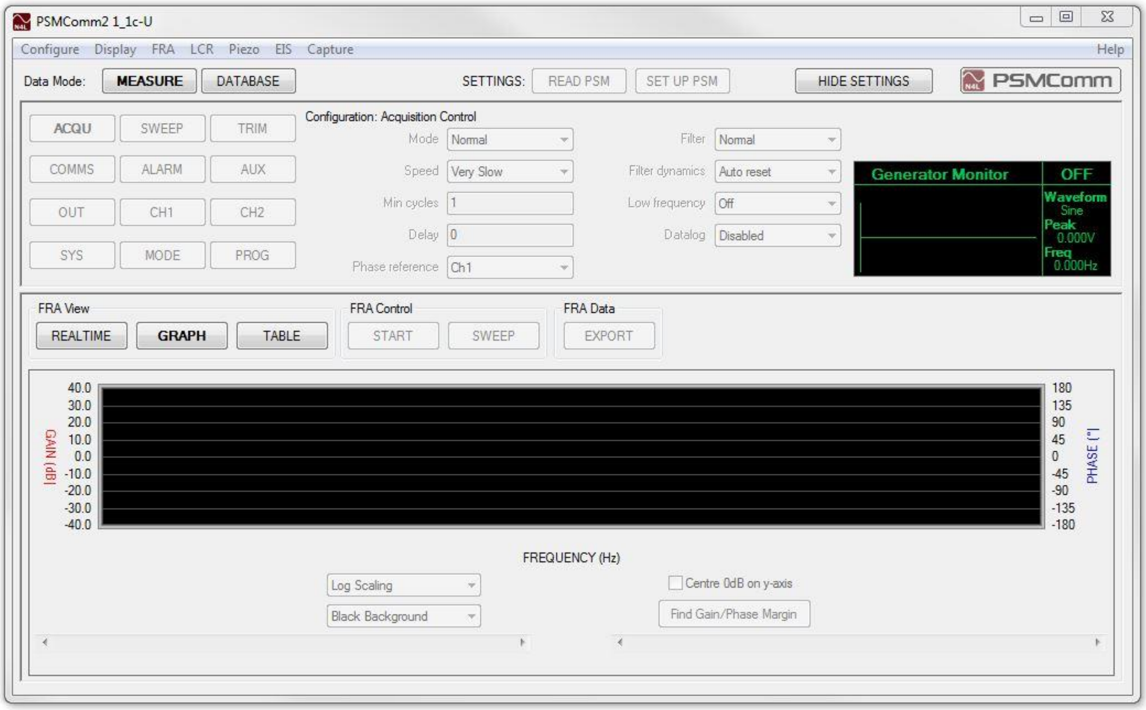
format	arguments	effect
"text	string	send text to instrument
#label,i,name	i = result index name = string	overwrites label associated with results value [n]
#pause,t	t = delay in s	delay by real number seconds
#wait,text		display text string and wait for a key press (discard key press)
#beep		sound beeper 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***

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.

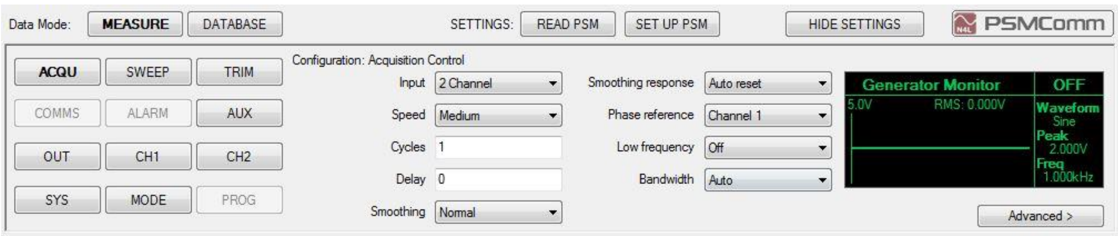
Once registered and your account has been activated you will have access to the software and manuals download sections.

PSMComm2 PC Software



PSMComm2 is a self-contained executable software program for use with the N4L PSM17xx and PSM37xx series Phase Sensitive Multimeters.

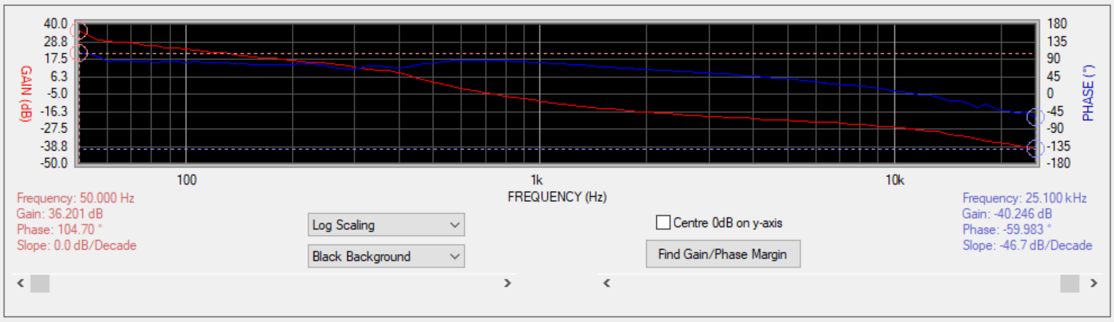
The software allows full remote control over the instrument via a serial/RS232 or LAN interfaces.



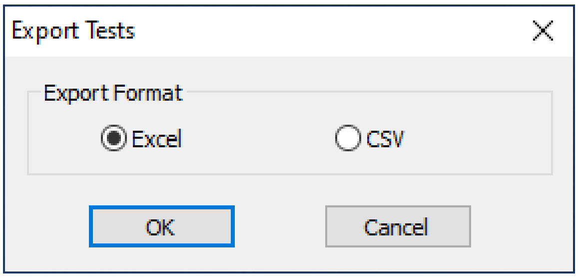
The connected instrument's settings are stored in the configuration panel and can be edited and sent back to the instrument. The menus in PSMComm2 are designed to mimic the settings made directly on the PSM1735 through the menus and keypad.

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.

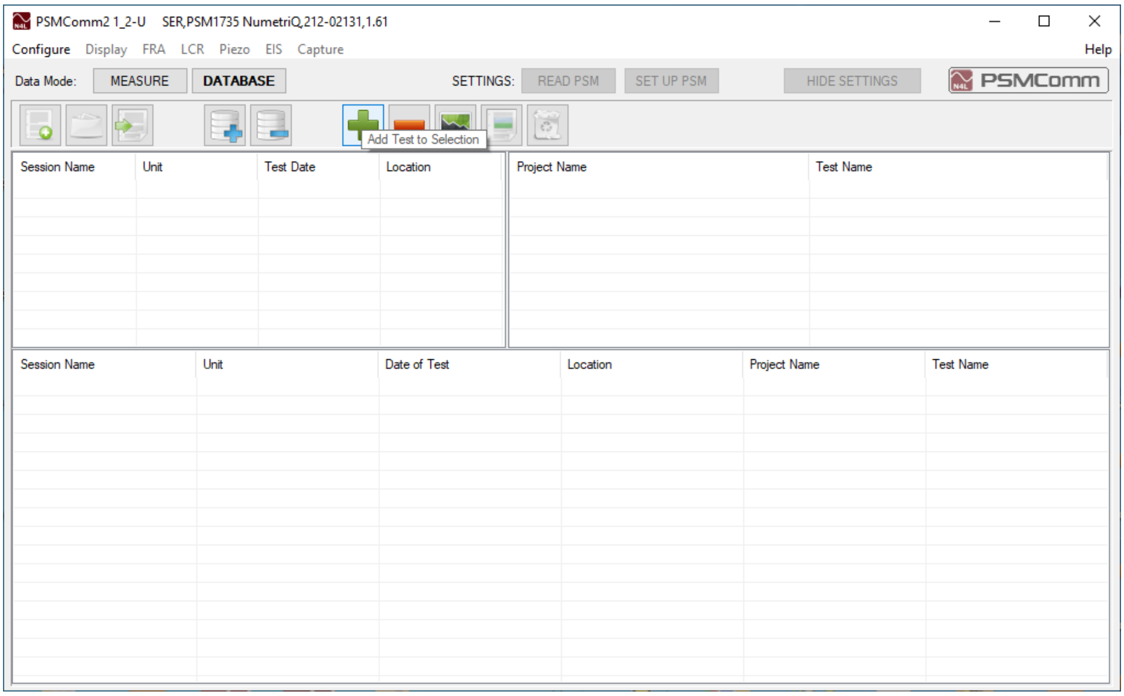


An example Excel export is shown below.

	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

PSMComm2's also has a database function.

The database is used for storing FRA plots in a reliable and reusable way. The plots can be exported to CSV & Excel as well as graphed. Multiple FRA sweeps can be graphed together, and calculations can be run on database FRA plots.



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

Chapter 13 Appendix B

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
ALARM1,type,data,high,low	
ALARM2,type,data,high,low	
ALARME,value	
ALARME?	single integer data value
AMPLIT,amplitude	
BANDWI,type	
BEEP	
BLANKI,on/off,threshold	

CALSTR?	
CALVER?	
CONFIG,parameter,data	Does not match comms manual
CONFIG,parameter?	single integer or real data value
COUPLI,channel,coupling	Does not match comms manual
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?	single integer data value
DELAY,value	
FILTER,type,dynamics	
FRA	
FRA?	freq,mag1,mag2,dB,phase,delay
FRA,SWEEP?	n lines of GAINPH? data
FREQUE,frequency	
FSWEEP,steps,start,end, type	
GAINPH	
GAINPH?	freq,mag1,mag2,dB,phase,delay
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	

INPUT,channel,type	
INTYPE,channel,type	
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,on/off,frequency	
MODE,type	
OFFSET,offset	
OUTPUT,type,sweep	
PAV,parameter,scaling	
PAV?	freq,mag1,mag2,parameter,phase,a,b
PAV,SWEEP?	n lines of sweep data
PHASE	
PHASE?	freq,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
PPORT,value	
PPORT?	single integer data value
PROGRAM,function,number	

PROGRAM?	CR terminated text string
RANGE,ch,ranging,range	
RESOLU.format	
REZERO	
RUN?	data
SCALE,channel,factor	
SHUNT,channel,resistance	
SHUNT,channel	
SINGLE,on/off	
SPEED,speed[,window]	
SSWEEP,function,number	
START	
STATUS,channel?	range number,range text,over/low/ok
STOP	
STREAM,enable,window	
STREAM,disable	
STREAM?	data, data, data, data, data, …..
SUSPEND,on/off	
TFA	
TFA?	freq,mag1,mag2,dB,phase,delay
TFA,SWEEP?	n lines of GAINPH? data
TXA,test,fixture,source,load	
TXA?	freq,mag1,mag2,parameter
TXA,SWEEP?	n lines of TXA? data
TXTEST,test,wind1,wind2	
USER?	3 CR terminated text strings
VECTOR,parameter,scaling	
VECTOR?	freq,mag1,mag2,parameter,phase,a,b
VECTOR,SWEEP?	n lines of VECTOR? data
VERSIO?	datecode,type,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	
ZERO	
ZOOM,level,d1,d2,d3,d4	
ZOOM?	level,d1,d2,d3,d4

Chapter 14 Appendix C

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.)

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

Chapter 15 Appendix D

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	Autozero manual or auto
5	Low blanking
6	Phase convention
7	Generator output on/off
8	Graph dots/lines
9	Keyboard beep on/off
11	Low frequency mode on/off
12	Speed (user window size)
13	Speed (measurement)
14	Filter type
15	Filter dynamics
16	Baud rate
18	Sweep steps
19	Sweep start frequency
20	Sweep stop frequency
21	Sweep type single / continuous
22	Conditions (LCR meter)
23	Shunt

	Input parameters
24	Input 1 (voltage/ext shunt)
25	Input 2 (voltage/ext shunt)
26	Minimum range (CH1)
27	Minimum range (CH2)
28	Autoranging (CH1)
29	Autoranging (CH2)
30	Coupling (CH1)
31	Coupling (CH2)
32	Scale (CH1)
33	Scale (CH2)
34	External shunt (CH1)
35	External shunt (CH2)
36	Connection (CH1)
37	Connection (CH2)
	General parameters
38	Resolution
39	Phase reference
	Display parameters
42	Zoom level
43	Display zoom characters on line 1
44	Display zoom characters on line 2
45	Display zoom characters on line 3
46	Display zoom characters on line 4
47	Display type
	Signal generator parameters
48	Generator frequency
49	Generator amplitude
50	Generator offset

51	Generator waveform
52	Frequency step
53	Amplitude step
54	Amplitude dBm
55	Generator after sweep
57	Generator ceiling
	Datalog parameters
58	Datalog (memory type)
59	Interval
	General parameters
64	Frequency marker enable
65	Marker frequency
66	Program 1-6 direct load
67	Parallel port
	Power meter parameters
83	Integration type
	Streaming parameters
95	Data streaming
96	Window
	Harmonic analyser parameters
99	Scan
100	Harmonic
101	Harmonics (max)
102	Parameter
103	Bargraph scale
	LCR sweep zero parameters
106	Frequency

107	Sweep start
108	Sweep end
109	Steps
	System parameters
116	Control
117	Step message
118	Display sequence
119	Length units
	Transformer analyser parameters
121	Parameter
122	Fixture
123	Winding
124	Turns ratio
125	Source
126	Load impedance
127	Nominal
	TAF control parameters
130	Source
131	Load
132	Input 1
133	Input 2
	LCR meter parameters
137	Parameter
138	Sweep (series/parallel)
139	Graph
140	LCR head shunt
141	Graph lin/log
142	Phase reference

143	Reference (value)
144	Reference (mode)
145	Connection
	gain/phase analyser parameters
147	Graph
148	dB offset
149	Gain/Phase margins
150	Ratio
	System parameters
151	Minimum cycles
152	Delay time
153	IEEE address
154	Interface
	Alarm functions (monitor 1)
156	Monitor 1 data
157	Alarm type
158	High threshold
159	Low threshold
160	Alarm latch
161	Alarm sounder
	Alarm functions (monitor 2)
167	Monitor 2 data
168	Alarm 2 type
169	High threshold
170	Low threshold
	Graph functions
173	Graph 2 manual/auto

174	Upper limit
175	Lower limit
	Phase angle voltmeter parameters
177	Parameter
178	Scale factor (LVDT)
179	Null meter
180	Upper limit
181	Offset
	Trim parameters
186	ac trim data
188	ac level
190	Trim tolerance
	Other parameters
192	Steps
193	Graph 1 scaling
194	Upper limit
195	Lower limit
196	Not currently defined
197	Not currently defined
198	Not currently defined

Chapter 16 Appendix E

Default Menu Settings

The tables show the default menu settings at bootup from Prog 0 (factory default reset)

The table header shows both the short name below the key along with the title displayed on the LCD for each menu. Below the header the parameters and their values are listed.

Menu name below key	Title displayed on LCD
parameter	value

ACQU	Acquisition Control
mode	normal
speed	medium
minimum cycles	1
delay	0s
Phase reference	ch1
filter	normal
filter dynamics	auto reset
low frequency	off
datalog	disabled
bandwidth	auto

SWEEP	Frequency Sweep Control
sweep start	1.0000 kHz
sweep end	1.0000 MHz
steps	32
steps	log
sweep	single
generator when complete	off
graph 1 scaling	auto
graph 2 scaling	auto
frequency marker	off

TRIM	Trim Control
ac trim data	disabled

COMMS	Remote Options
resolution	normal
protocol	normal
interface	RS232
baud rate	19200

ALARM	Monitor options
parallel port	disabled
monitor 1 data	zoom 1
alarm type	disabled
monitor 2 data	zoom 2
alarm type	disabled

AUX	Auxiliary Control
fixture	none

OUT	Output options
amplitude	2.0000 Vpk
ceiling	10.000 Vpk
frequency	frequency
offset	1.00000 Hz
wave form	sinewave
amplitude step	1.1000 times
frequency step	2.00000 times
output	off

CH1	Input 1
input 1	voltage input
connection	main(right)
minimum range	1mV
autoranging	full autorange
coupling	ac+dc
scale factor	+1.0000

CH2	Input 2
input 2	voltage input
connection	main(right)
minimum range	1mV
autoranging	full autorange
coupling	ac+dc
scale factor	+1.0000

SYS	System options
phase convention	-180° to +180°
low blanking	off
keyboard	on
autozero	auto
length units	m
shunt	default
step message	enabled
program 1-6 direct load	disabled
control	v

The MODE menu is context dependent, and selection of the *MODE* key will display the relevant menu for the currently selected mode from the Function Keys and allow the mode to be changed.

The last mode, Transformer Analyzer, is a legacy mode to enable the PSM1735 to be used with older, no longer available fixtures such as the TAF01 Transformer Analysis Fixture and as such is not directly supported by the PSMComm2 PC interface, although all the required results can be calculated from displayed data.

MODE	Rms Voltmeter
operating mode	rms voltmeter
low blanking	

MODE	Frequency Response Analyzer
operating mode	Frequency response analyzer
ratio	ch2/ch1
offset	+000.00m dB
gain/phase margins	disabled
graph	phase

MODE	Power meter
operating mode	power meter
parameter	auto
conditions	auto shunt
graph	Tan δ/ QF
sweep	series
connection	shunt

MODE	LCR Meter
operating mode	LCR meter
low blanking	

MODE	Vector Voltmeter
parameter	vector voltmeter
offset	in-phase
null meter	+000.00°
upper limit	1.0000

MODE	Harmonic Analyzer
operating mode	Harmonic analyzer
scan	single
parameter	%
harmonic	3

MODE	Transformer Analyzer
operating mode	transformer analyzer
parameter	turns ratio
nominal	0 turns

PROG	Program Store/Recall
memory	program
action	recall
program	0
name	factory default
execute	

Chapter 17 Appendix F

Contact details

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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.

PSM1735 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.		