

**7600 Plus VSTM Precision
LCR Meter
Instruction Manual**
Form 150941/A1

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IET Labs www.ietlabs.com



Product will be marked with this symbol (ISO#3684) when it is necessary for the user to refer to the instruction manual in order to prevent injury or equipment damage.



Product marked with this symbol (IEC417) indicates presence of direct current.

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Warranty

Warranty

QuadTech warrants that Products are free from defects in material and workmanship and, when properly used, will perform in accordance with QuadTech's applicable published specifications. If within one (1) year after original shipment it is found not to meet this standard, it will be repaired, or at the option of QuadTech, replaced at no charge when returned to a QuadTech service facility.

Changes to the Product not approved by QuadTech shall void this warranty.

QuadTech shall not be liable for any indirect, special or consequential damages, even if notice has been given of the possibility of such damages.

This warranty is in lieu of all other warranties, expressed or implied, including, but not limited to any implied warranty or merchantability or fitness for a particular purpose.

SERVICE POLICY

QuadTech policy is to maintain product repair capability for a period of at least five (5) years after original shipment and to make this capability available at the then prevailing schedule of charges

Specifications

Measurement Parameters: Capacitance (Cs/Cp), Inductance (Ls/Lp), Resistance (Rs/Rp), Dissipation (DF) and Quality (Q) Factors, Impedance ($|Z|$), Admittance $|Y|$, Phase Angle (θ), Equivalent Series Resistance (ESR), Conductance (Gp), Reactance (Xs), Susceptance (Bp)
Any two parameters measured and displayed simultaneously
Note: s = series, p = parallel, ESR equivalent to Rs

Measurement Ranges: $|Z|$, R: 0.1 mohm to 1.0000 Mohm
C: 1.0000 nF to 0.999999 F
D: .0001 to 99.99999
Q: .0000 to 999999.9
Phase Angle: -180.0000 to +179.9999 degrees
Delta %: -99.9999 % to +99.9999 %

Measurement Accuracy:	Fast	Medium	Slow
LCR:	$\pm 0.5\%1$	$\pm 0.25\%1$	$\pm 0.05\%1$
DF:	± 0.005	± 0.0025	± 0.0005

In a range of $3\Omega \leq Z \leq 80k\Omega$, $100mV \leq \text{programmed } V \leq 1V$ or $100mV \leq (\text{programmed } I) \times (Z) \leq 1V$
At optimum test signal levels, optimum DUT value and without calibration uncertainty error.

Test Frequency: 10 Hz to 2 MHz
Resolution: 0.1 Hz from 10 Hz to 10 kHz
5 digits > 10 kHz, 4 digits > 100 kHz
Accuracy: $\pm (0.01\% + 0.10 \text{ Hz})$

¹ At optimum test signal levels, optimum DUT value and without calibration uncertainty error. Instrument accuracy reduced from nominal specifications when using 7000 accessory fixtures and cables. Best accuracy requires geometric consistency between that used during open/short zeroing and that used on fixtures and cables during actual measurement. Consistency may be difficult when using unshielded Kelvin clip and Tweezer type connections.

Specifications (continued)

Measurement Speed:	Single Measurement < 22 msec*/measurement Sequence of two measurements < 77 msec *Depending upon test frequency. Time is from IEEE command received to SRQ.
Ranging:	Automatic or Range Hold
Trigger:	Internal (automatic), Manual (front panel), and External (via IEEE-488.2 or RS-232 interfaces)
AC Test Signal:	Voltage: 20 mV to 5.0 V (open circuit) in 5 mV steps Accuracy: +/- (5% + 1 mV) < 100kHz +/- (10% + 1 mV) 100kHz +/- (20% + 1 mV) 1 MHz +/- (35% + 1 mV) 2 MHz
Display:	LCD Graphics with adjustable contrast and back light - Results of Dual Measurement Parameters in scientific notation (Angle, D and Q in engineering notation) - Deviation from Nominal of Primary Parameter - % Deviation from Nominal of Primary Parameter - Instrument Setting and Test Conditions - Sequenced Test Results Summary - No Display for maximum throughput
Interfaces:	GPIB, RS-232
Other Features:	Charged Capacitor Protection: $\sqrt{8/C}$ for $V_{max} \leq 250\text{ V}$ $\sqrt{2/C}$ for $V_{max} \leq 1000\text{ V}$ C = Capacitance in farads of the device under test Open and Short Circuit Zeroing at Multiple Frequencies Power Fail Protection (setting, results, & calibration data stored) No delay after measurement of shorted or open DUT, range held Storage and Recall Self-Test Routines at Power-up Self Accuracy Calibration and Display Contact Check between DUT and test fixture
Front Panel Test Terminals:	4 Terminal BNC connectors

Specifications (continued)

Mechanical:	Bench mount with tilt bail Dimensions: (w x h x d): 16 x 6 x 14in (410 x 150 x 360mm) Weight: 17 lbs (8kg) net, 23 lbs (10.5kg) shipping				
Environmental:	MIL-T-28800E, Type 3, Class 5, Style E & F. Operating 0 to + 50° C. Storage - 40 to + 71° C.				
Power Requirements:	90 to 250Vac 47 - 63 Hz 100W maximum				
Supplied:	Instruction Manual Power Cable Calibration Certificate Flash-118 USB Memory Stick				
Ordering Information:	<table><thead><tr><th><u>Description</u></th><th><u>Catalog No.</u></th></tr></thead><tbody><tr><td>VSTM Precision LCR Meter</td><td>7600 Plus VSTM</td></tr></tbody></table>	<u>Description</u>	<u>Catalog No.</u>	VSTM Precision LCR Meter	7600 Plus VSTM
<u>Description</u>	<u>Catalog No.</u>				
VSTM Precision LCR Meter	7600 Plus VSTM				

1.1 Unpacking and Inspection

Inspect the shipping carton before opening, if damaged contact the carriers agent immediately. Inspect the instrument for any damage. If the instrument appears damaged or fails to meet specifications notify QuadTech (refer to instruction manual front cover) or its local representative. Retain the shipping carton and packing material for future use such as returning for recalibration or service.

1.2 Product Overview

The **7600 PLUS VSTM** is an automatic, user programmable instrument for measuring seven impedance parameters. The **7600 PLUS VSTM** covers a frequency range from 100 Hz to 2 MHz with a basic measurement accuracy of 0.05%. The instrument's high resolution graphics display and keypad makes for easy menu programming. Test conditions are stored and recalled from internal memory, eliminating wasted measurement setup time. Measurements speeds over 45/sec makes the unit well suited for production applications.

The instrument's unique measurement sequencing allows up to six parameters to be measured on a single pass.

The **7600 PLUS VSTM** comes with GPIB and RS-232 interface.



Figure 1-1

7600 PLUS VSTM Precision LCR Meter

1.3 Controls and Indicators

Figure 1-2 shows the controls and indicators on the front panel of the **7600 PLUS VSTM**. Table 1-1 identifies them with descriptions and functions.

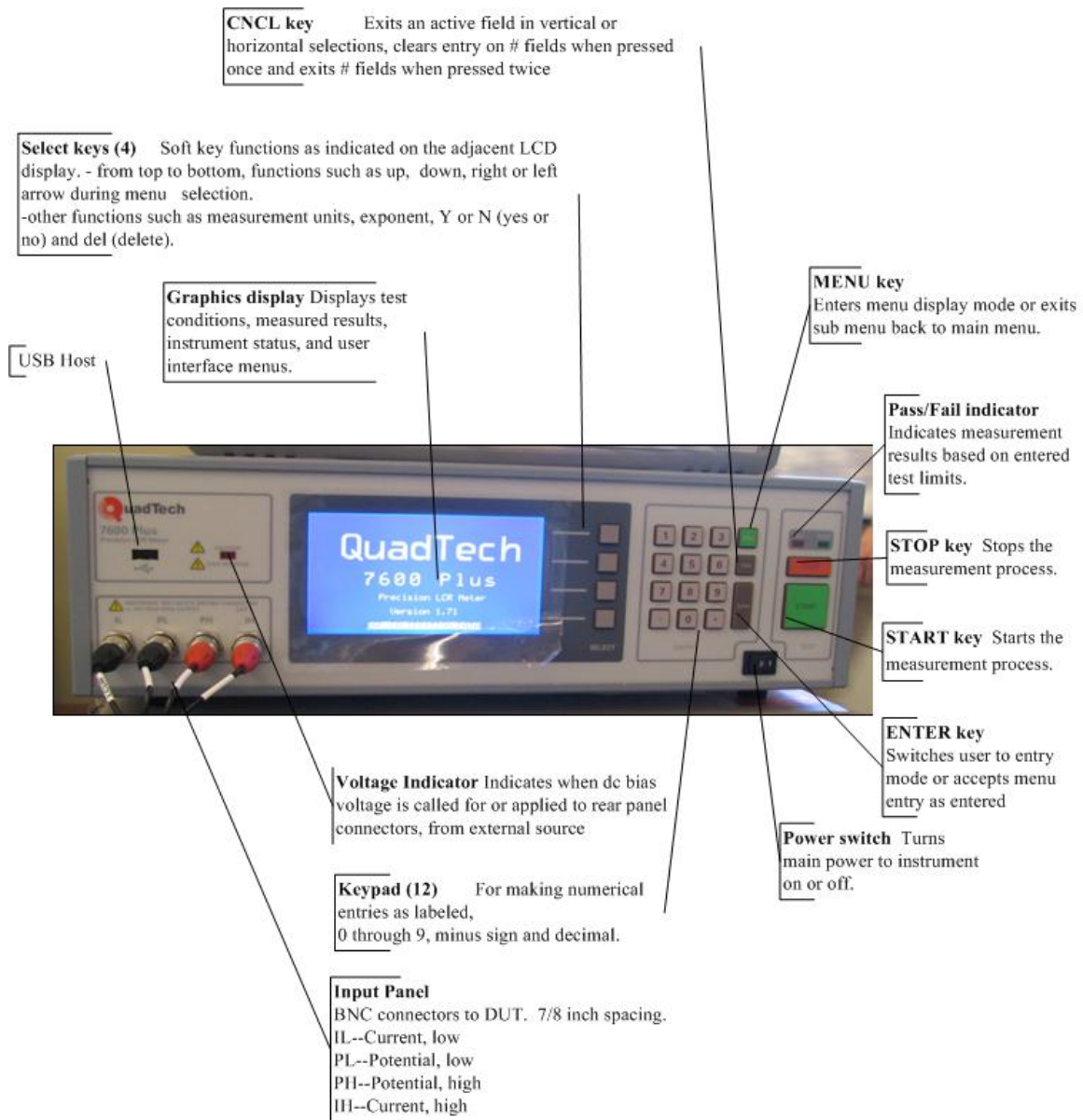


Figure 1-2 Front Panel Controls & Indicators

Table 1-1 (continued)
Front Panel Controls and Indicators

RS232 Connector

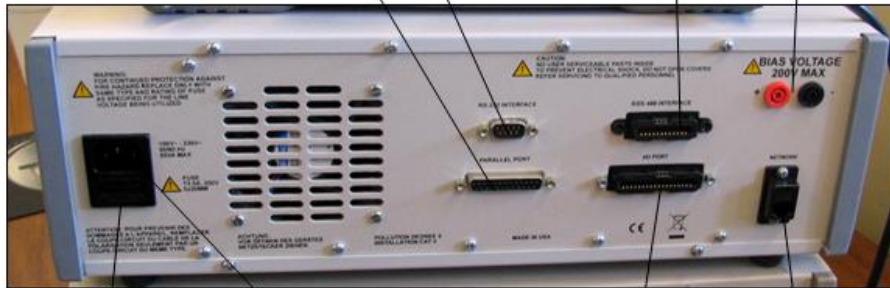
Connection according to RS232 std interface. Type DB9 (9 pin) male connector.

Parallel Port

Connection to parallel printer. Type DB25 (25 pin) female connector.

IEEE-488.2 Input/output connections according to IEEE STD-488.2. 24 pin socket for standard IEEE-488 cable.

Bias Voltage External bias input, maximum of +/-200Vdc. Contains F0.25A, 250V, 5x20mm fast blow fuse. Replace only with the same type and rating.



Fuse Drawer

Contains T2.5A, 250V, 5x20mm time-delay fuse for 115 or 220V operation. Replace only with the same type and rating.

AC Inlet Module

AC power input, filtering, fusing and switching. Use with Belden SPH-386 socket or equivalent.

I/O Port Connection to component handler. 36-pin Amp connector, mates with Amp 552302-1 plug and 552073-5 strain relief cover or ribbon cable clamp connector 553600-1 or equivalents.

Not yet implemented

Figure 1-3
Rear Panel View

1.4 Accessories Included

Table 1-3

<u>Item</u>	<u>Quantity</u>
Instruction Manual	1
Calibration Certificate	1
Power Cord	1
Fuse (T2.5A, 250V, 5x20mm, for 115/220V operation)	1
FLASH-118 512Mbyte Memory Stick	1

1.5 Installation

1.5.1 Instrument Positioning

The **7600 PLUS VSTM** contains a high resolution back lit LCD for convenient viewing. The optimum angle for viewing is straight onto the display. This means that for bench operation the front bail should sometimes be used to angle the instrument up and for rack installation it should be mounted somewhat at eye level.

1.5.2 Power Requirements

The **7600 PLUS VSTM** can be operated from a power source between 90 and 250Vac at a power line frequency of 47 to 63Hz, no line voltage switching is necessary. Power connection to the rear panel is through an ac inlet module comprised of an ac connector and fuse drawer. Before connecting the 3-wire power cord between the unit and AC power the fuse should be in accordance with the power source, T2.5A, 250V, 5x20mm (QuadTech PN520049) for 115 or 220V source. Always use an outlet which has a properly connected protection ground. The **7600 PLUS VSTM** is factory shipped with the 2.5A fuse in place. **The instrument can be damaged if the wrong fuse is installed.** To change the fuse proceed as follows:

WARNING

MAKE SURE THE UNIT HAS BEEN DISCONNECTED FROM ITS AC POWER SOURCE FOR AT LEAST FIVE MINUTES BEFORE PROCEEDING.

- Remove the **fuse drawer** by inserting a small flat head screwdriver behind the small tab to force the draw outward. Refer to Figure 1-4.
- Once the fuse draw has been completely removed from the instrument remove the **clear fuse tray** from the drawer by lifting upward slightly on the long narrow black locking tab. This will allow the fuse tray to be removed from the fuse draw. This tray contains the active fuse, left side (secured by holder) and spare fuse on the right side (if present). Refer to Figure 1-5.
- Remove the active fuse from the holder by prying upward using a small flat head screwdriver. Insert the replacement fuse into the fuse holder.
- Once the fuse has been installed in the holder and spare fuse (if desired) installed in the right side of the tray insert the tray back into the fuse drawer, push in and lock. The two silver contacts on the fuse tray should be positioned towards the outside.
- Once the fuse tray has been installed in the draw, reinstall the fuse draw back into the instrument ac inlet module, push in and lock.

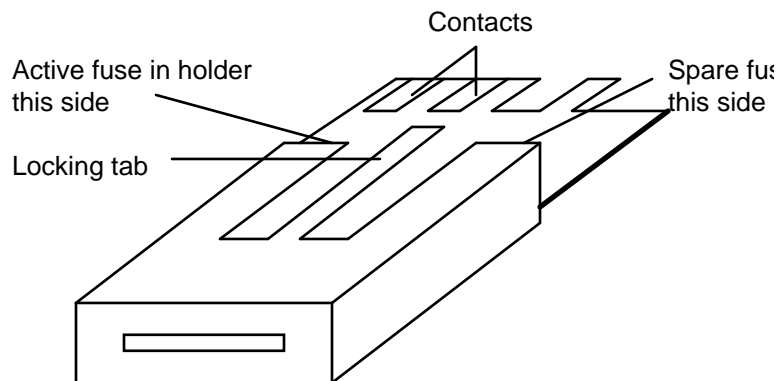


Figure 1-5
Fuse Drawer

1.5.3 Safety Symbols

The product is marked with the following safety symbols.



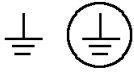
Product will be marked with this symbol (ISO#3864) when it is necessary for the user to refer to the instruction manual in order to prevent injury or equipment damage.



Product marked with this symbol (IEC417) indicates presence of direct current.



Product will be marked with this symbol (ISO#3864) when voltages in excess of 1000V are present.



Indicates the grounding protect terminal, which is used to prevent electric shock from the leakage on chassis. The ground terminal must connect to earth before using the product.

Warning Procedure can cause hazard to human if the warning is neglected.

Caution Avoid product misuse. It may cause damage to the product itself and the DUT if the caution is neglected.

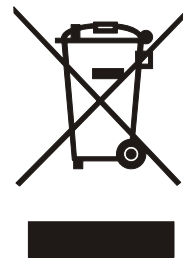
Note Important information or tips for the procedures and applications.

Warning Signal During Testing

“DANGER – HIGH VOLTAGE TEST IN PROGRESS, UNAUTHORIZED PERSONS KEEP AWAY”

1.5.4 Disposal

Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities. Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being. When replacing old appliances with new one, the retailer is legally obligated to your old appliances for disposal.



take back

2.1 General

Once the 7600 PLUS VSTM is powered up it is ready immediately for testing, at **FACTORY test conditions, by pressing the START button.** Power up factory conditions are discussed in paragraph 2.5.2. These conditions can not be changed by the user. For simplicity of understanding, descriptions and uses of all these functions refer to menu discussions in paragraph 2.6. The Contents list in the front of this manual should be used for quickly locating specific subjects of interest.

Note: For optimum measurement results at specified accuracy a 30 minute instrument warm-up period is highly recommended.

2.2 Startup

Connect the instrument power cord to the source of proper voltage. **The instrument is to be used only with three wire grounded outlets. The proper fuse must be installed as described in paragraph 1.5.2.**

Power is applied to the **7600 PLUS VSTM** by pressing the **POWER** button on the front panel. The instrument runs a self test and any error messages are displayed accordingly.

2.3 Connection to Device Under Test

The **7600 PLUS VSTM** employs a four terminal measurement configuration which permits easy, accurate and stable measurements and avoids mutual inductance, interference from measurement signals, noise and other factors inherent with other types of connections.

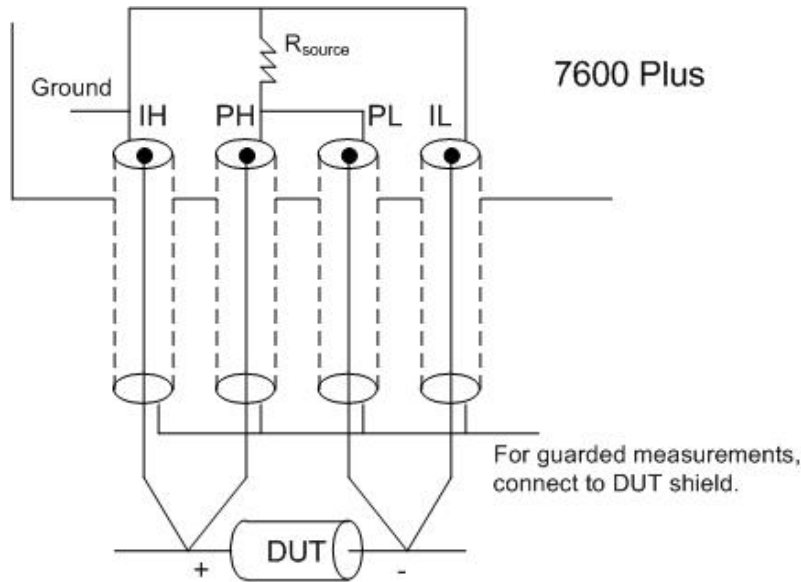


Figure 2-2
Test Lead Configuration

Figure 2-2 show the **7600 PLUS VSTM** connector configuration and a typical four terminal connection to the device under test.

2.4 Zeroing

Before making measurements, the **7600 PLUS VSTM** should be zeroed to correct for test lead and/or fixture errors. During the zeroing process corrections are calculated and stored in instrument memory and applied to ongoing measurements. Measurement accuracy is specified at the end of a QuadTech 1 meter cable. Open and short circuit zeroing should be done at the end of this cable. In order to maintain instrument accuracy with other cable lengths the instrument should be re calibrated using the alternate cable. Generally the unit should be zeroed at least once per day and each time test leads or fixture are changed. **It is not necessary to re-zero if the test frequency is changed, unless the Quick Open & Short is used.** The zeroing routine is accessed through the Utilities Menu as follows:

- Press **MENU** key
- Press **LEFT/RIGHT ARROW** to select Utilities menu
- Press **UP/DOWN ARROW** key for Open / Short
- Press **ENTER**

Follow the instructions shown on the LCD display for open and short circuit zeroing of test leads and/or fixture. During the **Open Test** the leads or fixture should be open with no component connected. During the **Short Test** leads should be connected or fixture shorted (using a clean copper wire, as short as possible). Refer to paragraph 2.6.5.3 as necessary for more detail. When zeroing, **Contact Check should be OFF, # to Average to 1 and Median OFF.**

2.5 Measurement Procedure

2.5.1 General

Whenever the 7600 PLUS VSTM is powered up it is ready immediately to begin measuring at factory test conditions. These conditions are set at the factory and can not be changed by the user. To initiate a test once a device is connected press **START**, the LCD display shows the measured results and test conditions similar to the illustration of Figure 2-3. For information on changing test conditions refer to paragraph 2-6 on Menu Functions.

Note: For optimum measurement results at specified accuracy a 30 minute instrument warm-up period is highly recommended.

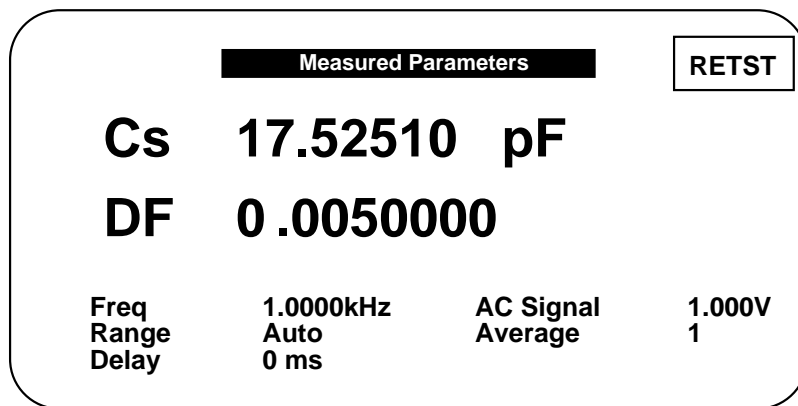


Figure 2-3
Measured Results Display

Note: In some cases this display can indicate the function **Bias, Off or On**, which is non-functional and can be ignored

2.5.2 Factory Measurement Conditions

A set of factory measurement conditions are initially established at the factory and stored in instrument memory. Factory conditions are those that determine the instruments status on power up, thus the instrument is always set to a known state before any testing begins. Refer to paragraph 2.6.5.2 under Recall Setup on the Utilities menu for changing default settings.

Factory default measurement conditions

Under Setup Menu

Primary Parameter - Auto
Secondary Parameter - None
Frequency - 1 kHz
AC Test Signal - 1V
DC Bias Voltage - Off
Range Hold - Off
Range Locked - 0
Measurement Accuracy - Medium
Delay Time - 0
to Average - 1
Contact Check - Off

Under I/O Menu

Display Type - Measured Parameters
Nominal Value - None
Result Format - Scientific
Trigger - External
Handler - Off
RS-232 - Enabled
IEEE - Disable
Print Results – Off
Results to USB - Off

Under Analysis Menu

Binning - None
Test Sequencing - Off
Parameter Sweep - Off
Median - Off
Distort Detect - Off
Load Correction - Off

Under Utilities Menu

Lockout - Off
Backlite - On

2.6 Menu Functions

2.6.1 General

All programmable functions of the Model **7600 PLUS VSTM** are controlled by easy to use menu displays. The user enters the menu mode by selecting the **MENU** key which calls up four top level menus, **Setup, I/O, Analysis** and **Utilities**. Each one of these is comprised of a sub menu list whose functions are described in detail below. Finding ones way around the menu listing is accomplished in a fashion similar to an Automatic Teller Machine (ATM) using the **UP, DOWN, RIGHT** and **LEFT** arrow keys as

indicated on the adjacent LCD display. A highlighted menu function can be controlled by selecting the ENTER key, making the desired entry or selection and pressing ENTER again to implement.

2.6.2 Setup Menu

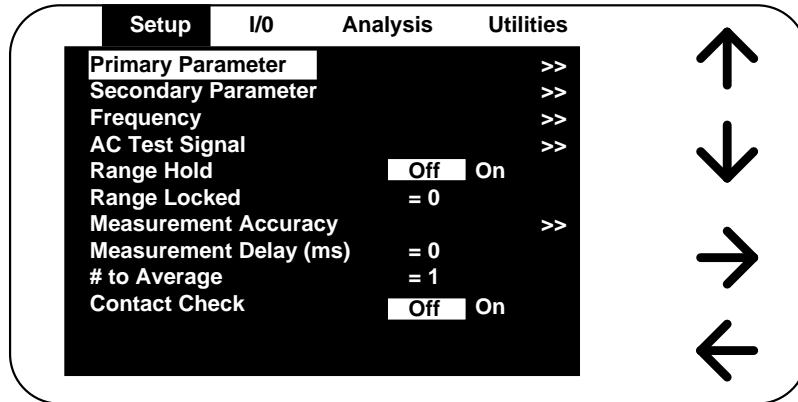


Figure 2-4
Setup Menu

The first of the four main menus is **Setup**, shown above. Each function controls a **7600 PLUS VSTM** measurement condition and is described in detail below.

Setup	I/O	Analysis	Utilities
Primary Parameter			Auto
Secondary Parameter		None	Cs
Frequency - (numeric entry)		DF	Cp
AC Test Signal - Voltage		Q	Ls
- Current		ESR	Lp
- Value - (numeric entry)		θ	Rs
DC Bias Voltage - Off		Rs	Rp
- Int		Rp	DF
- Ext		Gp	Q
Range Hold - Off		Cs	Z
- On		Cp	Y
Range Locked - (numeric entry)		Ls	θ
Measurement Accuracy - Fast		Lp	ESR
- Medium		Z	Gp
- Slow		Y	Xs
Measurement Delay - (numeric entry)		Xs	Bp
# to Average - (numeric entry)		Bp	
Contact Check - Off			
- On			

2.6.2.1 Primary Parameter

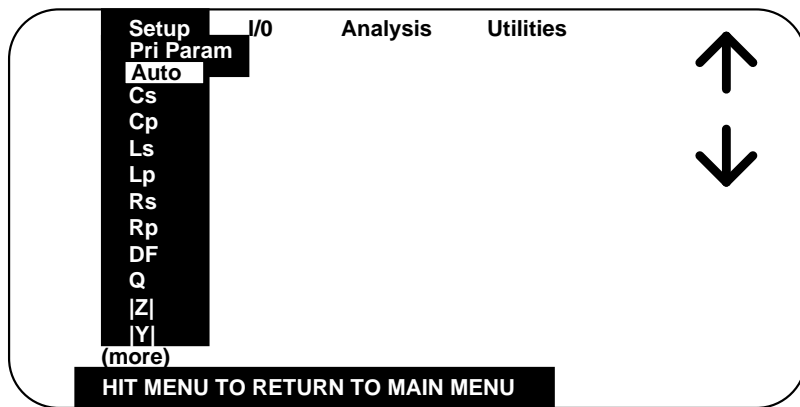


Figure 2-5
Primary Parameters

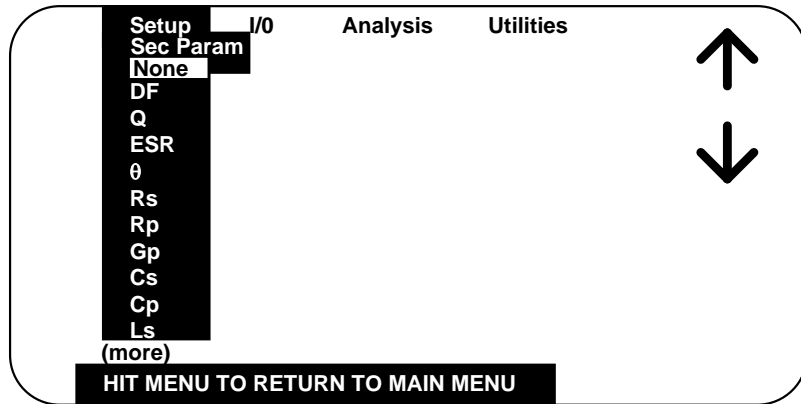
Any combination of two parameters can be measured and displayed simultaneously on the **7600 PLUS VSTM**, one referred to as the **Primary** (displayed first) and the other the **Secondary**. The instrument as powered up provides a factory primary parameter selection of Cs. The parameter selection can be chosen by the operator through menu

selection as shown in Figure 2-5 above. Besides Cs the following selections are possible and discussed in more detail below.

Note: Selection of Auto, Lp, Ls, Q, Y, GP, Xs and BP will result in incorrect VSTM Output format via GPIB and RS232.

- | | |
|------------------------------------|---|
| Cs - Capacitance in farads | Z - Impedance in ohms |
| Cp - Capacitance in farads | Y - Admittance in siemens |
| Ls - Inductance in henries | θ - Angle in degrees |
| Lp - Inductance in henries | ESR - Equivalent series resistance in ohms |
| Rs - Resistance in ohms | Gp - Conductance in siemens |
| Rp - Resistance in ohms | Xs - Reactance in ohms |
| DF - Dissipation Factor (no units) | Bp - Susceptance in siemens |
| Q - Quality Factor (no units) | |
| s = series equivalent circuit | |
| p = parallel equivalent circuit | |

2.6.2.2 Secondary Parameter



**Figure 2-6
Secondary Parameter**

As in the primary parameter selection, any one can be chosen by the operator for display. The instrument as powered up provides a factory secondary parameter of DF. The parameter selection can be chosen by the operator through menu selection as shown in Figure 2-5.

2.6.2.3 Frequency

Numerical entry accepts up to **five digits with decimal**, of the desired test frequency between 10 Hz and 2 MHz. Resolution of setting is 0.1 Hz from 10 Hz to 10 kHz, 5 digits above 10 kHz.

Units of frequency, **Hz, kHz, or MHz** are selected by the **UP/DOWN** arrow keys.

2.6.2.4 AC Test Signal

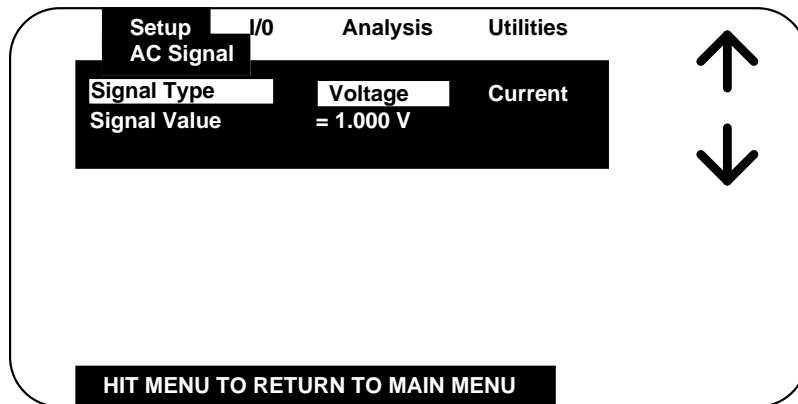


Figure 2-7
AC Test Signal

Allows selection of the AC Signal Type as a **Voltage** source or **Current** source, RIGHT/LEFT arrow keys.

With Signal Type selected as **Voltage**, Signal Value accepts entry of a value between **0.020 and 5 volts*** (open circuit) in 0.005 V steps.

With Signal Type selected as **Current**, Signal Value accepts entry of a value between **0.00025 and .1 amp** (short circuit) in 0.00005 amp steps.

Numerical values can be entered directly with units. Units for voltage value, **mV** or **V** and units of current value, **μA**, **mA**, or **A** are selected by the UP/DOWN arrow keys. Any **numerical entries with resolution greater than 0.005V (5 mV) for voltage or 0.00005A (50 μA) for current will be truncated or ignored.**

In voltage mode the selected voltage is maintained at the instrument test terminals with the terminals open, but not necessarily at the device under test. In current mode the selected current is maintained at the device under test, independent of changes in the device's impedance. It should be noted that even though the maximum programmable current is 100 mA **the instrument is limited to a compliance voltage of 3 volts* in current mode**, i.e. (I) times (Z) must be less than 3 volts otherwise erratic measurement results could occur.

The current required to test a device may exceed 100 mA if the source voltage is programmed to greater than 2.5 V. To determine the current required use the following formula:

$$I = V_{prog} \div \sqrt{(25 + R_{dut})^2 + (X_{dut})^2}$$

If the current is greater than 100 mA, reduce the program voltage, otherwise unpredictable measurement results may occur.

* 1 volt above 500 kHz, 0.5 volts above 1 MHz

2.6.2.5 Range Hold

Allows selection of Range Hold **Off** or **On**. **To eliminate operator errors in range setting and ensure specified instrument accuracy the 7600 PLUS VSTM Range Hold should generally be left Off.** There may be exceptions to this when repetitive measurements are to be made over a concentrated range of values and there is a desire to reduce test time by eliminating range switching.

- **Off** - When selected the instrument automatically **selects the optimum range** for the test voltage and test frequency selected and the impedance being measured.
- **On** - When selected the **range is held** based on the one currently selected, 1 through 59. The one currently selected is best determined by measuring the device with Range Hold to Off. Measured results outside the bounds of a selected range will be indicated by an **OVER RANGE** or **UNDER RANGE** display message.

Note:

The **7600 PLUS VSTM** provides an extensive array of range switching based on the user test conditions selected and impedance being measured. Refer to paragraph 2.6.2.6.

One of the most important uses of the range holding capability is to avoid range changes when the component is removed from a fixture when repetitive internal triggering is selected. With no component connected the instrument can go into a range search and time is lost when the next component is connected. Another use of range hold occurs when measuring components of the same nominal value whose actual values spread across the boundary of two ranges. If allowed to auto range, the units and decimal point can change with the range and confuse the operator. **It is important to note that when a range is held which is not the range the instrument auto ranging would have selected, some accuracy may be sacrificed.**

2.6.2.6 Range Locked

Accepts entry of selected measurement ranges between **0 and 59 (as listed below)**, 0 for no range locked and others for the selected range. Measurement ranges are a function of the impedance being measured (Z), selected test frequency (F) and ac test voltage (V). For best measurement results the instrument is generally recommended to operate with Range Hold to Off and Range Locked to 0. It is possible to calculate a range, based on Z, F and V, as detailed below.

Measurement Range #'s			
1	17	33	49
2	18	34	50
3	19	35	51
5	21	37	53
6	22	38	54
7	23	39	55
9	25	41	57
10	26	42	58
11	27	43	59

Determine Range where $R\# = R1 + R2 + R3$

- where R1 = 1 and $K^* = 10 \mu\text{A}$ if $F < 25 \text{ kHz}$ and $I < 10 \mu\text{A}$
= 17 and $K^* = 160 \mu\text{A}$ if $F < 200 \text{ kHz}$ and $I < 160 \mu\text{A}$
= 33 and $K^* = 2.56 \text{ mA}$ if $I < 2.56 \text{ mA}$
= 49 and $K^* = 40 \text{ mA}$ if $I \geq 2.56 \text{ mA}$
* value for K required in calculation of R3 below

$$I = \frac{V_i}{Z + 25}$$

- $V_i = 10\text{V}$ if $V \leq 0.1\text{V}$
= V if $V > 0.1$ and < 1.01
= $V/5$ if ≥ 1.01
 $V =$ programmed ac test voltage

$Z =$ impedance value Z in ohms of the device under test.

- where R2 = 0 if $(I)(Z) > 0.25$
= 1 if $(I)(Z) > 0.1$
= 2 if $(I)(Z) > 0.025$

- where R3 = 0 if $I / K > 0.25$
= 4 if $I / K > 0.1$
= 8 if $I / K > 0.025$

Note: above 1.5 MHz R2 and R3 are always 0 (zero)

AC Signal Current Mode

Measurement Range #'s

33	49	133	149
34	50	134	150
35	51	135	151
37	53	137	153
38	54	138	154
39	55	139	155
41	57	141	157
42	58	142	158
43	59	143	159

Determine Range where $R\# = R + R1 + R2 + R3$

where $R = 33$ and $R_s = 400\Omega$ if $I \leq 2.2\text{mA}$

$= 49$ and $R_s = 25\Omega$ if $I > 2.2\text{mA}$

$I =$ programmed ac test current

where $R1 = 0$ and $V_s = 1.0$ if E_{DUT} or $E_{DET} \leq 1.0$

$= 100$ and $V_s = 5.0$ if E_{DUT} or $E_{DET} > 1.0$

$E_{DUT} = (I)(Z)$ this value must be less than 3.0, reference
2.6.2.4 AC Test Signal

paragraph

$E_{DET} = (I)(R_s)$

$Z =$ impedance value Z in ohms of the device
under test (refer to Figures 2-11 and 2-12
to help determine Z in terms of capacitive
and inductive reactance).

where $R2 = 0$ if $E_{DUT}/V_s > 0.25$

$= 1$ if $E_{DUT}/V_s \leq 0.25$

$= 2$ if $E_{DUT}/V_s \leq 0.1$

where $R3 = 0$ if $E_{DET}/V_s > 0.25$

$= 4$ if $E_{DET}/V_s \leq 0.25$

$= 8$ if $E_{DET}/V_s \leq 0.1$

Selection of optimum measurement range for listed impedance of the DUT (at 1V)

Range #	Impedance in Ohms												
	1	2.5	10	40	100	400	1.6k	6.4k	25k	100k	400k	1.6M	Infinity
5	OVER	OVER	OVER	OVER	OVER	OVER	OVER	OVER	OVER	OVER	BEST	BEST	Display
1	Display	Display	Display	Display	Display	Display	Display	Display	BEST	BEST	BEST	Display	Display
2	Display	Display	Display	Display	Display	Display	Display	BEST	BEST	BEST	UNDER	UNDER	UNDER
21	OVER	OVER	OVER	OVER	OVER	OVER	OVER	BEST	BEST	Display	Display	Display	Display
17	OVER	OVER	OVER	OVER	OVER	OVER	BEST	BEST	BEST	Display	Display	Display	Display
18	Display	Display	Display	Display	BEST	BEST	BEST	UNDER	UNDER	UNDER	UNDER	UNDER	UNDER
37	OVER	OVER	OVER	OVER	OVER	OVER	BEST	BEST	Display	Display	Display	Display	Display
33	Display	Display	Display	Display	BEST	BEST	BEST	Display	Display	Display	Display	Display	Display
34	Display	Display	Display	BEST	BEST	UNDER	UNDER	UNDER	UNDER	UNDER	UNDER	UNDER	UNDER
53	OVER	OVER	BEST	BEST	Display	Display	Display	Display	Display	Display	Display	Display	Display
49	Display	BEST	BEST	BEST	Display	Display	Display	Display	Display	Display	Display	Display	Display
50	BEST	BEST	UNDER	UNDER	UNDER	UNDER	UNDER	UNDER	UNDER	UNDER	UNDER	UNDER	UNDER

OVER denotes over range
 UNDER denotes under range

BEST denotes the optimum measurement range
 Display denotes measurement range but not necessarily within specified instrument accuracy

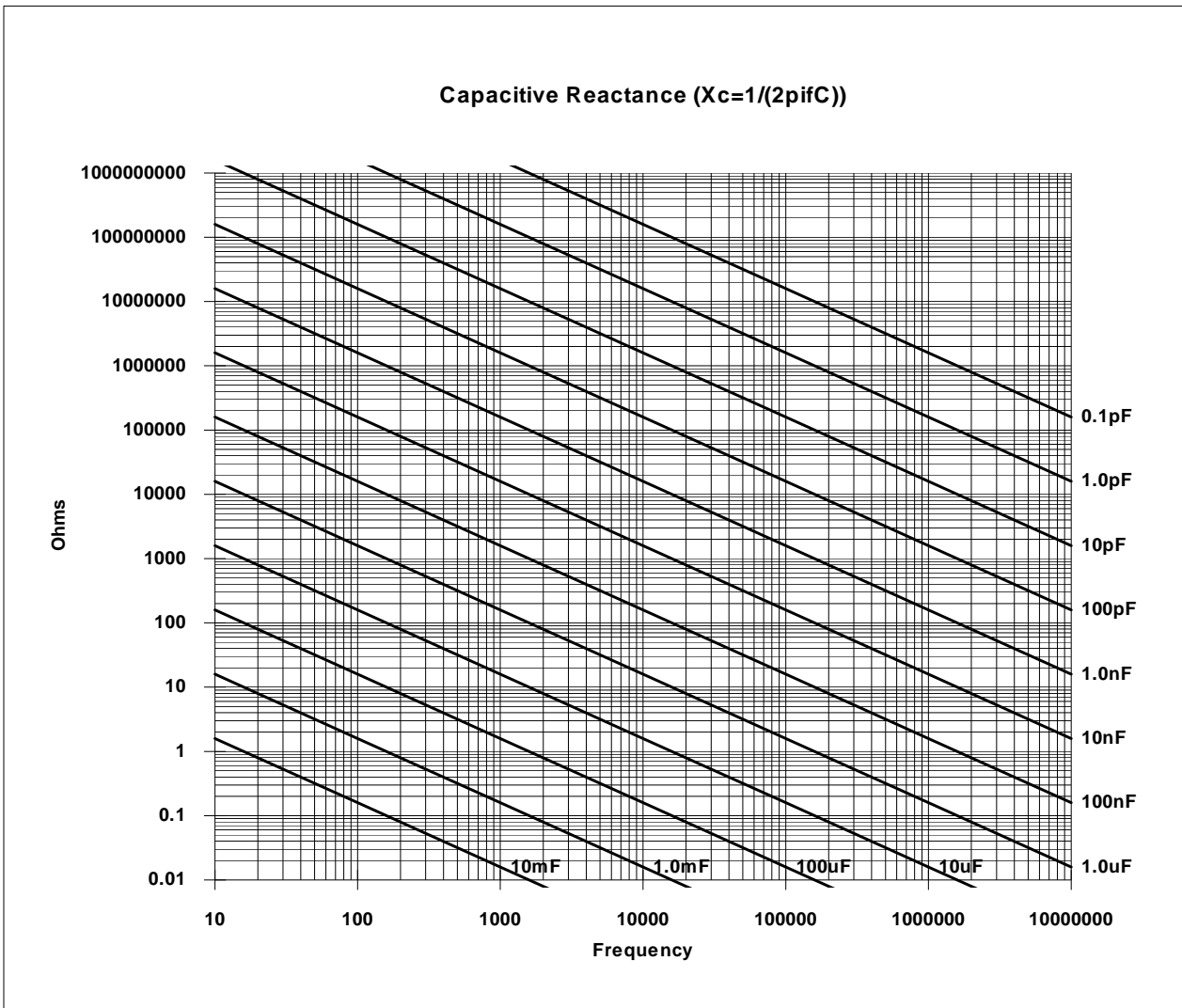


Figure 2-8
Capacitive Reactance vs. Frequency

2.6.2.7 Measurement Accuracy

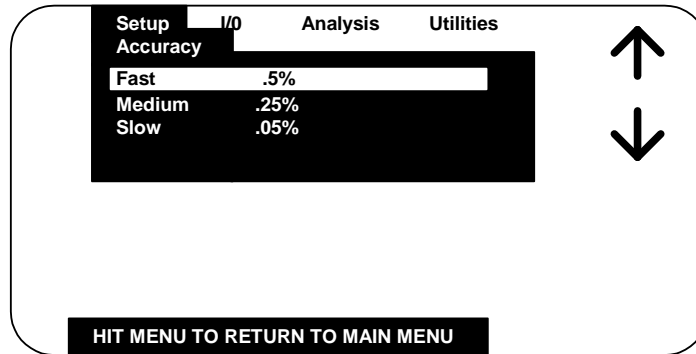


Figure 2-9
Measurement Accuracy

Allows selection of a Measurement Accuracy of **Fast**, **Medium** or **Slow**.

There is a tradeoff of measurement speed vs. accuracy. The meter will make a more precise and accurate measurement at a slower rate. The speed/accuracy tradeoff is as follows:

- **Fast** - Measurement time of 15 ms (or one frequency cycle, whichever is longer), nominal accuracy of **0.5%**.
- **Medium** - Measurement time is 125 ms, nominal accuracy of **0.25%**.
- **Slow** - Measurement time is 1 sec, nominal accuracy of **0.05%**.

2.6.2.8 Measurement Delay

Accepts entry of a delay time between **0 and 1000** in 1 ms steps. This is a programmable delay time from the internal or external trigger command to the start of the measurement. In many cases it is helpful to have a time delay before actually starting to take data. Such a delay allows time for switching transients or mechanical handling to settle.

2.6.2.9 # to Average

Accepts entry of the number of measurements to Average between **1 and 1000**. If the entered value is 1, averaging is disabled and the display is updated with each individual measurement. If the average is 2 to 1000 the final average value is displayed at the end of the measurement cycle and held until the end of the next measurement cycle.

2.6.2.10 Contact Check

Allows selection of Contact Check **Off or On**. When on, any detection of contact failure or open circuit to the device under test will be indicated prior to the measurement. A contact failure is considered to be an open circuit greater than the open circuit calibration of the instrument. **Contact Check is generally recommended in automatic handler/production type applications with the 7600 PLUS VSTM. For Contact Check operation the Range Hold must be selected ON, paragraph 2.6.2.5.**

Note:

A contact check is possible on three of the four Kelvin connections by a loss of voltage detecting technique, a failure on the PL connection can't be detected since it is at virtual ground potential, internal to the instrument. The contact check is likely to be unreliable when measuring devices of less than 100 mΩ of impedance.

2.6.3 I/O Menu

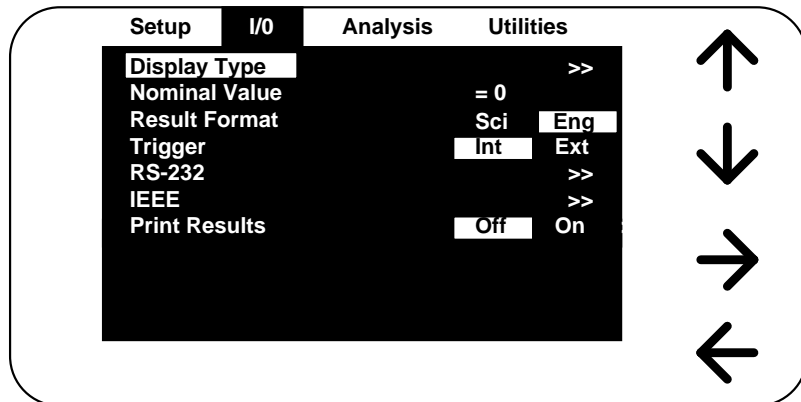
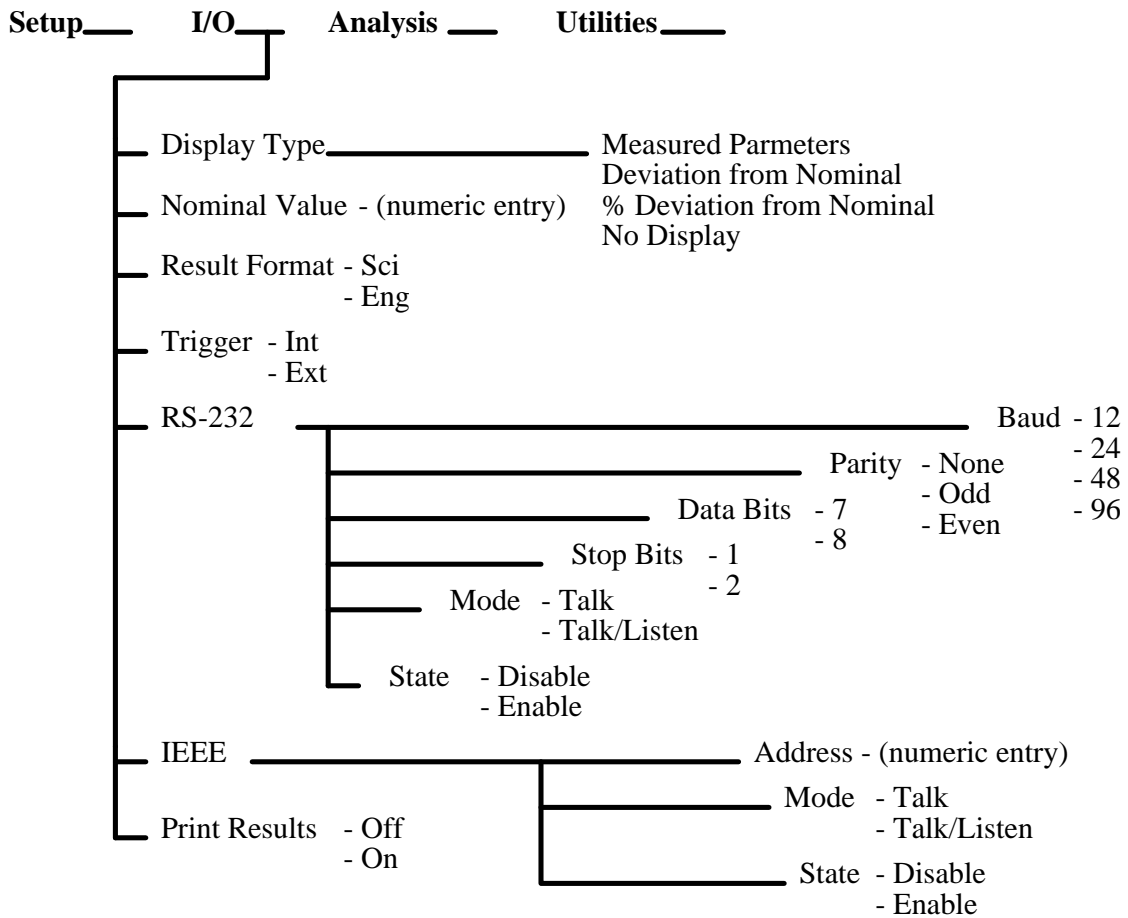


Figure 2-10
I/O Menu

The second of the four main menus is **I/O**, shown above. Each function controls measurement results or instrument I/O interface and is described in detail below.



2.6.3.1 Display Type

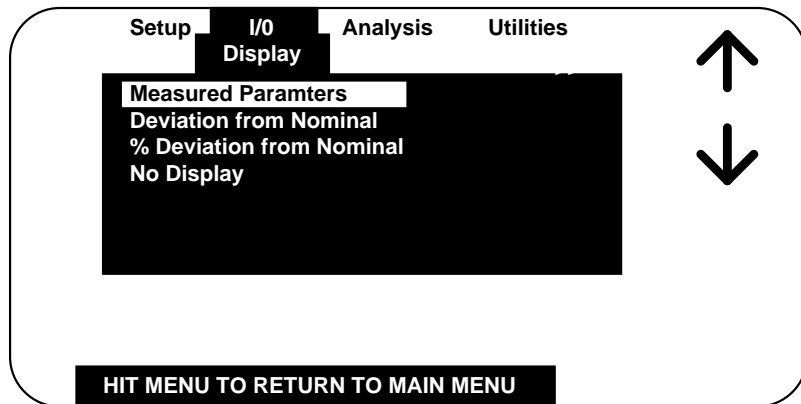


Figure 2-11
Display Type

Allows selection from seven different modes of measurement display, these being:

- **Measured Parameters** - Display is the measured values of both the primary and secondary parameter, displayed along with decimal point and units. Each value is

shown with **7 digits of resolution** (6 digits if the result is negative). The message **Measuring** is shown when a measurement is in process, with the exception of short measuring times.

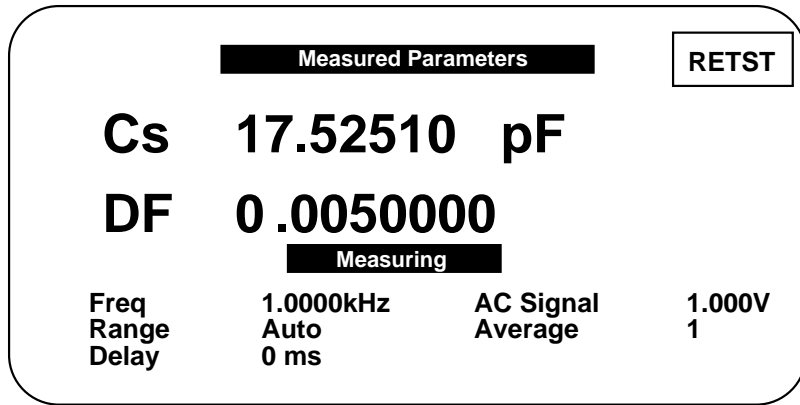


Figure 2-12
Measured Parameters Display

Note: In some cases these displays can indicate the function **Bias, Off or On**, which is non-functional and can be ignored

- **Deviation from Nominal** - Display is the difference in value above or below a stored nominal value for the primary parameter (also refer to paragraph 2.6.3.2). It should be noted that the nominal value is only shown in this display and the % Deviation display (Figure 2-14).

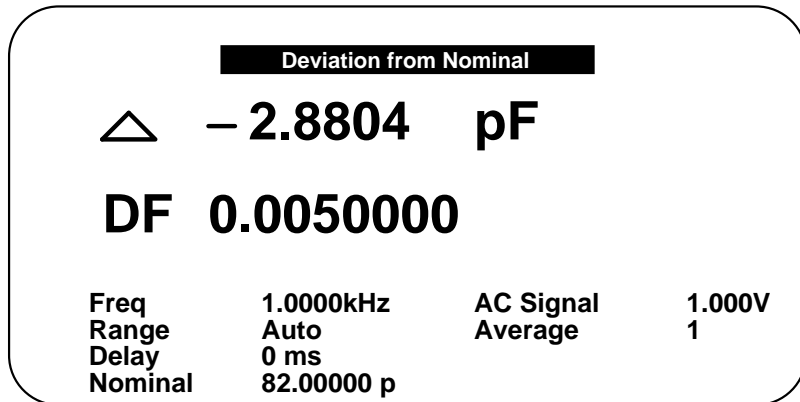


Figure 2-13
Deviation from Nominal Display

- **% Deviation from Nominal** - Display is the measurement in terms of a percent difference above or below (-) a stored nominal value (also refer to paragraph 2.6.3.2). It should be noted that the nominal value is only shown in this display and the Deviation from Nominal display (Figure 2-13).

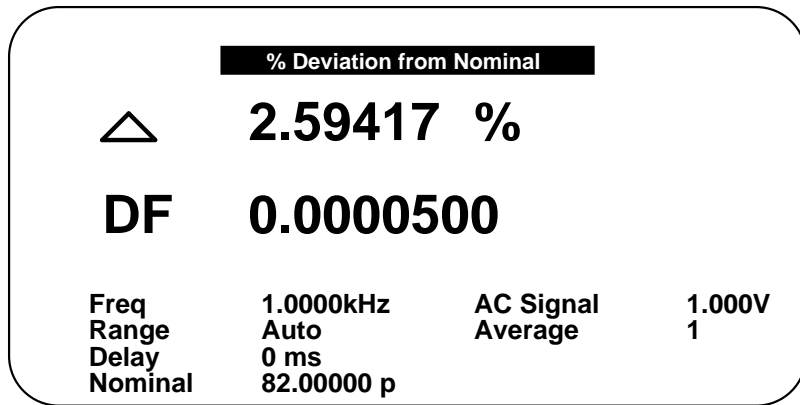


Figure 2-14
% Deviation from Nominal Display

- **No Display** - Instrument display is inhibited from indicating any measurement results. This is sometimes used for security reasons or for the purpose of reducing test time during remote operation.

2.6.3.2 Nominal Value

Allows entry of a Nominal Value for the primary parameter, which is the **basis for the measurement result in Deviation or % Deviation**. Accepts numerical entry up to seven digits with decimal. Units are selected by the UP/DOWN arrow keys and determined by the primary parameter selection, i.e. in Farads, Ohms, etc.

2.6.3.3 Result Format

Allows selection from two different measurement result formats, **SCI and ENG**, for scientific or engineering units. Scientific units are expressed as an exponent and engineering units are expressed in ohms for resistance, farads for capacitance, henries for inductance, etc. For example e^3 in scientific units can be expressed as kohms in engineering units or e^{-3} in scientific units can be expressed as mohms in engineering units, this is strictly user preference and convenience.

When scientific units are selected, the results will always be displayed as some number of digits with decimal, exponent and units. When engineering units are selected the results will be displayed as some number of digits with decimal and units.

2.6.3.4 Trigger

Allows selection of two trigger modes, **Internal** or **External**.

- Internal - Measurement trigger is **automatic and continuous** once initiated with a START.
- External - Measurement trigger is under **remote control** via front panel or IEEE-488 interface.

2.6.3.5 RS-232 Interface

Setup	I/O	Analysis	Utilities	
	RS-232			
Baud	12	24	48	96
Parity	None	Odd	Even	
Data Bits	7	8		
Stop Bits	1	2		
Mode	Talk	Talk/Listen		
State	Disable	Enable		

HIT MENU TO RETURN TO MAIN MENU

Figure 2-15
RS-232 Setup Format

Allows user setup of standard RS-232 interface formats. Choices include:

- Baud Rate** - 12, 24, 48 or 96 (for 1200, 2400, 4800, and 9600 respectively)
- Parity** - None, Even or Odd
- Data Bits** - 7 or 8
- Stop Bits** - 1 or 2
- Mode** - Talk or Talk/Listen

UP/DOWN arrow and **Enter** selects the desired format and then **LEFT/RIGHT** arrow and **ENTER** allows for selection of choices within each format.

2.6.3.6 IEEE-488.2 Interface

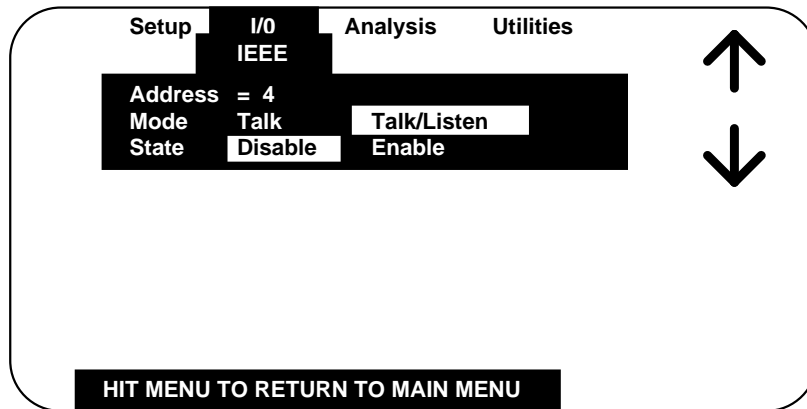


Figure 2-16
IEEE Setup Format

Allows user setup of IEEE-488 interface format. Choices include:

- Address** - 1 through 16
- Mode** - Talk or Talk/Listen
- State** - Disable or Enable

UP/DOWN arrow and **ENTER** selects the desired format and then **LEFT/RIGHT** arrow and **ENTER** allows for selection of choices within each format.

The instrument will function as either a Talk or a Talk/Listen device in a system depending on the choice made by the operator under Mode. Talk is generally suited to a simple system with no controller or other talkers, for example a printer. Talk/Listen denotes full programmability and is suited for use in a system that has a controller or computer to manage data flow. The "handshake" routine assures that the active talker proceeds slowly enough for the slowest listener.

2.6.3.7 Print Results

Allows user to output results to the parallel port (when available) by selection of **Off** or **On**.

CAUTION

Before selecting **On** make sure the printer is connected and on-line.

2.6.3.8 Results to USB

The 7600 Plus can be used with most USB memory sticks formatted FAT. The memory stick can be installed and removed at anytime. The USB stick is automatically mounted when installed. The USB host port complies with USB v2.0 standard. The USB host port is not designed to be connected to a PC, Printer or USB hub.

Allows user to store measurement results on flash drive. If a results file is not open, the user is prompted for the filename (up to 8 characters) and the file is opened.

To close a results file that is currently open, select Results to USB and close.

If a results file is open when a setup is saved, when the setup is later recalled the user will be prompted for a results file name.

When multiple tests are being conducted the results are stored to USB periodically (every 10 measurements) from an internal buffer. **To be sure of storing all results before power is shut down the file needs to be closed** as discussed earlier. It is also important to note that a file should be closed before changing or recalling a new set of test conditions, otherwise the stored measurement results would not be consistent with the setup conditions stored in the file.

The measurement results are stored as an comma separated ASCII text file under its assigned identifying number (up to 8 characters). The extension for Data is “.csv”

The test setup conditions are saved as a header at the beginning of a results file. A sample file format is shown below. Note that the results can be stored in either engineering or scientific terms dependent on what the user has selected for setup conditions. The format of the result string is as follows:

Label, Primary result, Units, Label, Secondary result, Units, Bin#<CR><LF>

Sample file format as follows.

Copyright QuadTech Inc. 2008		not printed
ENDHEADER		not printed
2000000.000000	;frequency	
5.000000	;primary parameter	
2.000000	;secondary parameter	
0.000000	;ac signal type	
0.100000	;ac signal value	
0.000000	;bias	
0.000000	;range	
1.000000	;rangelocked	
68.000000	;range relay	not printed
205.000000	;relay 2	
69.000000	;relay 3	
66.000000	;va	not printed
2.000000	;measurment speed	
0.000000	;delay time	
1.000000	;# to average	
0.000000	;contact check	
0.000000	;display type	
0.00000000009989577000	;nominal value	
0.000000	;result format	

1.000000	;trigger		
1.000000	;handler		
3.000000	;baud		
0.000000	;parity		
1.000000	;data bits		
0.000000	;stop bits		
1.000000	;rs232 mode		
1.000000	;rs232 state		
4.000000	;IEEE address		
1.000000	;IEEE mode		
0.000000	;IEEE state		
0.000000	;print results		
0.000000	;result to USB		
0.000000000000000000000000	;low limit bin 0		not printed
0.000000000000000000000000	;high limit bin 0		
0.000000000000000000000000	;nominal value bin 0		
0.000000	;limit format bin 0		
0.000000000000000000000000	;low limit bin 1		
0.000000000000000000000000	;high limit bin 1		
0.000000000000000000000000	;nominal value bin 1		
0.000000	;limit format bin 1		
0.000000000000000000000000	;low limit bin 2		
0.000000000000000000000000	;high limit bin 2		
0.000000000000000000000000	;nominal value bin 2		
0.000000	;limit format bin 2		
0.000000000000000000000000	;low limit bin 3		
0.000000000000000000000000	;high limit bin 3		
0.000000000000000000000000	;nominal value bin 3		
0.000000	;limit format bin 3		
0.000000000000000000000000	;low limit bin 4		
0.000000000000000000000000	;high limit bin 4		
0.000000000000000000000000	;nominal value bin 4		
0.000000	;limit format bin 4		
0.000000000000000000000000	;low limit bin 5		
0.000000000000000000000000	;high limit bin 5		
0.000000000000000000000000	;nominal value bin 5		
0.000000	;limit format bin 5		
0.000000000000000000000000	;low limit bin 6		
0.000000000000000000000000	;high limit bin 6		
0.000000000000000000000000	;nominal value bin 6		
0.000000	;limit format bin 6		
0.000000000000000000000000	;low limit bin 7		
0.000000000000000000000000	;high limit bin 7		
0.000000000000000000000000	;nominal value bin 7		
0.000000	;limit format bin 7		
0.000000000000000000000000	;low limit bin 8		

0.00000000000000000000	;high limit bin 8	
0.00000000000000000000	;nominal value bin 8	
0.000000	;limit format bin 8	
0.00000000000000000000	;low limit bin 9	
0.00000000000000000000	;high limit bin 9	
0.00000000000000000000	;nominal value bin 9	
0.000000	;limit format bin 9	
0.00000000000000000000	;low limit bin 10	
0.00000000000000000000	;high limit bin 10	
0.00000000000000000000	;nominal value bin 10	
0.000000	;limit format bin 10	
0.00000000000000000000	;low limit bin 11	
0.00000000000000000000	;high limit bin 11	
0.00000000000000000000	;nominal value bin 11	
0.000000	;limit format bin 11	
0.00000000000000000000	;low limit bin 12	
0.00000000000000000000	;high limit bin 12	
0.00000000000000000000	;nominal value bin 12	
0.000000	;limit format bin 12	
0.00000000000000000000	;low limit bin 13	
0.00000000000000000000	;high limit bin 13	
0.00000000000000000000	;nominal value bin 13	
0.000000	;limit format bin 13	
0.00000000000000000000	;low limit bin 14	
0.00000000000000000000	;high limit bin 14	
0.00000000000000000000	;nominal value bin 14	
0.000000	;limit format bin 14	not printed
0.000000	;secondary low	
0.000000	;secondary high	
0.000000	;sequence	
0.000000	;sequence status	printed only if sequence enabled
1000.000000	;sequence frequency	
0.000000	;sequence pri param	
0.000000	;sequence sec param	
0.000000	;sequence bias	
0.000000	;sequence ac signal type	
1.000000	;sequence ac signal value	
0.000000	;sequence delay	
0.000000	;sequence range	
0.000000	;sequence range relay	
0.000000	;sequence relay 2	
0.000000	;sequence relay 3	
0.000000	;sequence var relay	
1.000000	;sequence stop on fail	
0.000000	;sequence status	
1000.000000	;sequence frequency	

0.000000	;sequence pri param	
0.000000	;sequence sec param	
0.000000	;sequence bias	
0.000000	;sequence ac signal type	
1.000000	;sequence ac signal value	
0.000000	;sequence delay	
0.000000	;sequence range	
0.000000	;sequence range relay	
0.000000	;sequence relay 2	
0.000000	;sequence relay 3	
0.000000	;sequence var relay	
1.000000	;sequence stop on fail	
0.000000	;sequence status	
1000.000000	;sequence frequency	
0.000000	;sequence pri param	
0.000000	;sequence sec param	
0.000000	;sequence bias	
0.000000	;sequence ac signal type	
1.000000	;sequence ac signal value	
0.000000	;sequence delay	
0.000000	;sequence range	
0.000000	;sequence range relay	
0.000000	;sequence relay 2	
0.000000	;sequence relay 3	
0.000000	;sequence var relay	
1.000000	;sequence stop on fail	
0.000000	;sequence status	
1000.000000	;sequence frequency	
0.000000	;sequence pri param	
0.000000	;sequence sec param	
0.000000	;sequence bias	
0.000000	;sequence ac signal type	
1.000000	;sequence ac signal value	
0.000000	;sequence delay	
0.000000	;sequence range	
0.000000	;sequence range relay	
0.000000	;sequence relay 2	
0.000000	;sequence relay 3	
0.000000	;sequence var relay	
1.000000	;sequence stop on fail	
0.000000	;sequence status	
1000.000000	;sequence frequency	
0.000000	;sequence pri param	
0.000000	;sequence sec param	
0.000000	;sequence bias	
0.000000	;sequence ac signal type	

1.000000	;sequence ac signal value	
0.000000	;sequence delay	
0.000000	;sequence range	
0.000000	;sequence range relay	
0.000000	;sequence relay 2	
0.000000	;sequence relay 3	
0.000000	;sequence var relay	
1.000000	;sequence stop on fail	
0.000000	;sequence status	
1000.000000	;sequence frequency	
0.000000	;sequence pri param	
0.000000	;sequence sec param	
0.000000	;sequence bias	
0.000000	;sequence ac signal type	
1.000000	;sequence ac signal value	
0.000000	;sequence delay	
0.000000	;sequence range	
0.000000	;sequence range relay	
0.000000	;sequence relay 2	
0.000000	;sequence relay 3	
0.000000	;sequence var relay	
1.000000	;sequence stop on fail	
0.000000	;sweep	
0.000000	;sweep parameter	
10.000000	;sweep begin	
1000.000000	;sweep end	
0.000000	;sweep step	
0.000000	;sweep result format	
0.000000	;median	
1.000000	;correction	
25.000000	;correction primary nominal	
50.000000	;correction secondary nominal	
1.000000	;correction status	
1000.000000	;correction frequency	
49.000000	;correction range	
5.000000	;correction primary parameter	
4.000000	;correction secondary parameter	
25.17072 Ω	;correction measured primary	
-.1947500	;correction measured secondary	
-0.170725	;correction primary correction	
50.194742	;correction secondary correction	
0.000000	;enhanced distortion	
0.000000	;lockout	
1.000000	;backlite	
ENDHEADER		
Cs, 9.69573e-09, F, DF, 0.0052921, Bin, 1,,,		

printed only if sequence enabled

Cs, 9.69645e-09, F, DF, 0.0052307, Bin, 1,,,,
Cs, 9.69575e-09, F, DF, 0.0052404, Bin, 1,,,,
Cs, 9.69583e-09, F, DF, 0.0052983, Bin, 1,,,,
Cs, 9.69698e-09, F, DF, 0.0053328, Bin, 1,,,,

The number of measurement results that can be stored is dependent on available memory and length of the data string. For example; if no limit is set the measurement string contains no bin results, thus the string has fewer characters. The same is true with header information: multiple headers (different test conditions) will consume more memory.

2.6.4 Analysis Menu

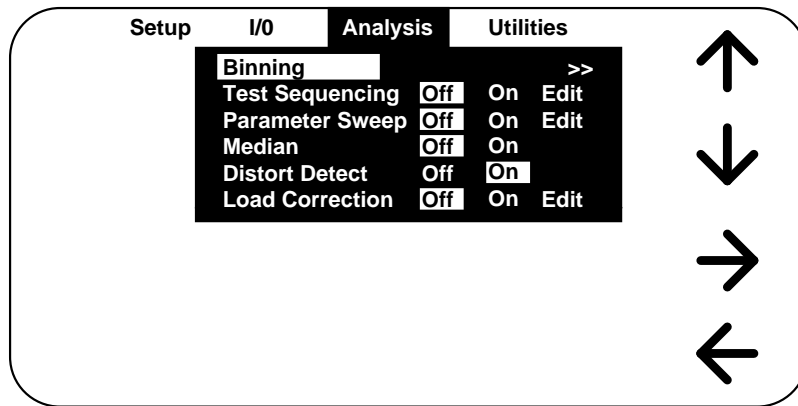
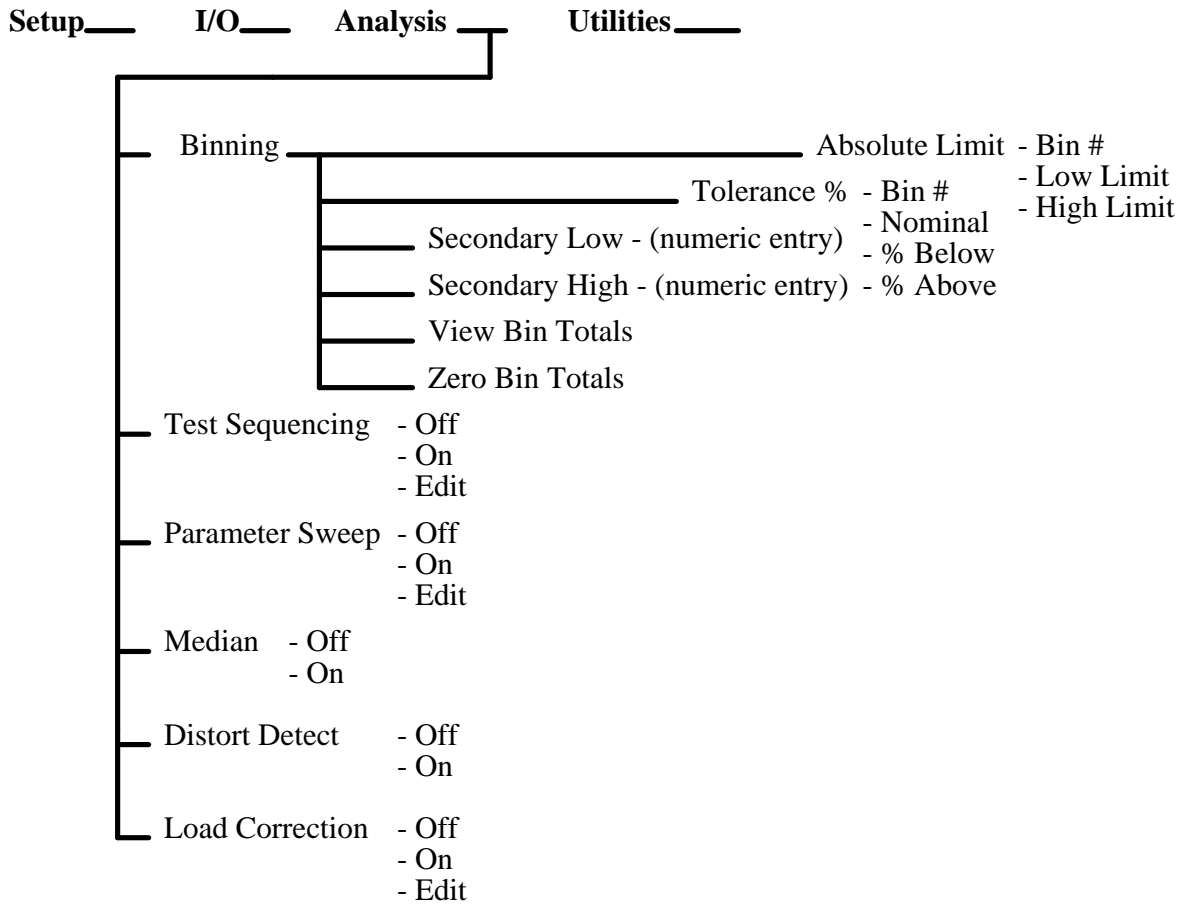


Figure 2-17
Analysis Menu

The third of the four main menus is **Analysis**, shown above.



2.6.4.1 Binning

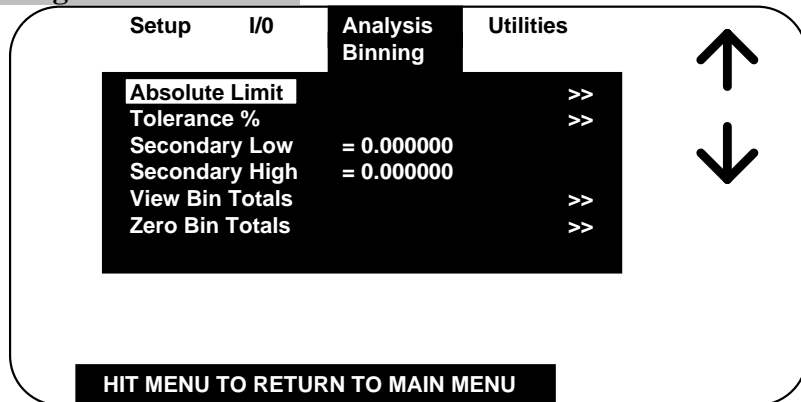


Figure 2-18 Binning

The 7600 Plus provides sorting into **15 bins** (10 pass, 4 fail and 1 for no contact). For the binning function to be enabled, one or both of the two conditions must be met:

1. Bin 1 limits must be set (non-zero).
2. Secondary parameter must be set (not NONE) and secondary low/high limits must be set (non-zero).

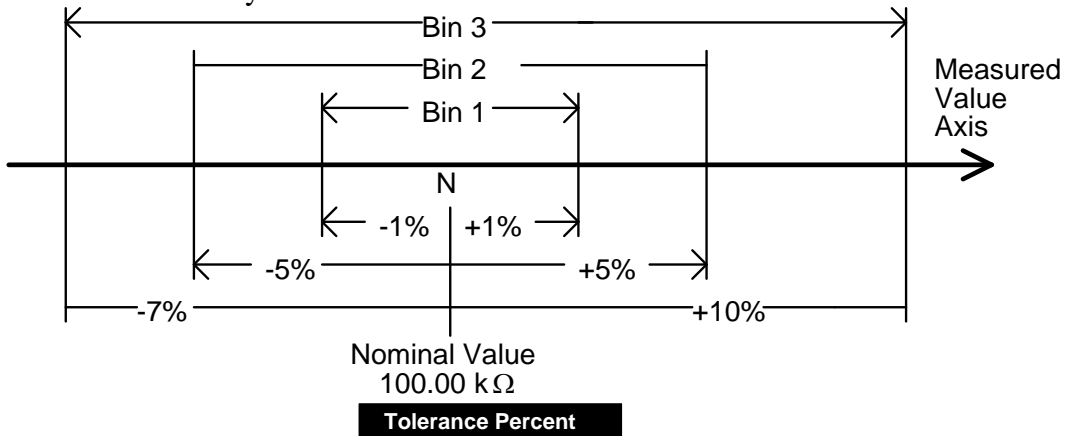
These are assigned as follows:

- Bins 1 through 10 - **Pass** bins for the primary parameter (**Pass** for secondary parameter if limit is entered)
- Bin 11 - Primary parameter **pass** and secondary parameter **fail low**
- Bin 12 - Primary parameter **pass** and secondary parameter **fail high**
- Bin 13 - Primary parameter **fail** and secondary parameter **pass**
- Bin 14 - Primary parameter **fail** and secondary parameter **fail**
- Bin 15 - **No contact**

Note:

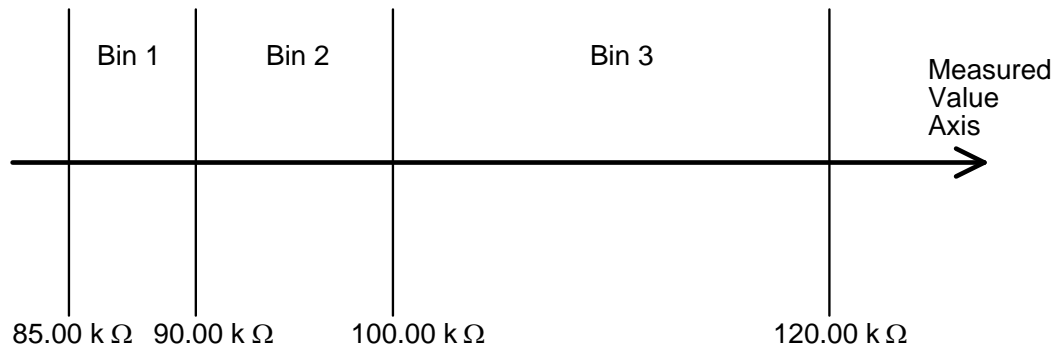
If no limit is entered for primary parameter but one is for the secondary parameter, bin assignment will be to Bin 1 for a **pass**, Bin 11 for a **fail low**, or Bin 12 for a **fail high**.

Bin assignment during the test sequencing mode of operation is entirely different. Bin limits for the primary parameter can be entered in terms of absolute value or as a percent tolerance about a defined nominal. Two of the most common methods sorting is **nested** limits and **sequential** limits. Nested limits are a natural choice for sorting by % tolerance around a single nominal value with the lower number bins narrower than the higher numbered ones. Nested limits for three bins is illustrated below, note that limits do not have to be symmetrical as shown for bin 3.



Bin	Nominal	% BELOW	% ABOVE
1	100.00 k	1.00	1.00
2	100.00 k	5.00	5.00
3	100.00 k	7.00	10.00

Sequential limits are a natural choice for sorting by absolute value. Sequential limits for three bins are illustrated below. It should be noted that the bins do not necessarily have to be adjacent. Depending on the specified limits for each they can be overlapping, adjacent or even isolated (gaps) from each other. Any overlap is assigned to the lower numbered bin and a gap would be assigned to the overall fail bin.



Absolute Limit		
Bin	Low LIMIT	High LIMIT
1	85.00 k	90.00 k
2	90.00 k	100.00 k
3	100.00 k	120.00 k

Absolute Limit

Absolute limit selection allows for entry of both **upper and lower limit for each bin in absolute value**. Valid range for each is -10^8 to 10^9 . If zero is entered for Low or High, the previous value is cleared and that bin disabled. When limits are entered in terms of absolute value the same limits will automatically be shown in terms of percent on the Tolerance Percent Display. This automatic calculation should be used cautiously; imprecise displays and missed bin assignments are possible at the range extremes. Arrow up, down, left to right to select the limit of interest in either the low or high limit column as shown below (low limit for bin 5 is chosen in this example)

Absolute Limit		
Bin	Low LIMIT	High LIMIT
1	90.00 k	110.00 k
2	100.00 k	120.00 k
3	110.00 k	130.00 k
4	120.00 k	140.00 k
5	130.00 k	150.00 k
6	140.00 k	160.00 k
7	150.00 k	170.00 k
8	160.00 k	180.00 k
9	170.00 k	190.00 k
10	180.00 k	120.00 k

Figure 2-19 Absolute Limit

Once the limit of choice is selected by **UP/DOWN, LEFT/RIGHT** arrow and **ENTER** the numerical value can be entered directly as shown below (entry is 130 in this example).

Absolute Limit		
Bin	Low LIMIT	High LIMIT
1	90.00 k	110.00 k
2	100.00 k	120.00 k
3	110.00 k	130.00 k
4	120.00 k	140.00 k
5	130	150.00 k
6	140.00 k	160.00 k
7	150.00 k	170.00 k
8	160.00 k	180.00 k
9	170.00 k	190.00 k
10	180.00 k	200.00 k

Figure 2-20 Absolute Limit (Numeric Entry)

Then arrow up or down to select units from those available (**k** is chosen in this example).

Absolute Limit		
Bin	Low LIMIT	High LIMIT
1	90.00 k	110.00 k
2	100.00 k	120.00 k
3	110.00 k	130.00 k
4	120.00 k	140.00 k
5	130 k	150.00 k
6	140.00 k	160.00 k
7	150.00 k	170.00 k
8	160.00 k	180.00 k
9	170.00 k	190.00 k
10	180.00 k	120.00 k

Figure 2-21 Absolute Limit (Engineering Units)

Press ENTER to finalize the entry, the UP/DOWN, LEFT/RIGHT arrow to choose the next limit to be entered or changed.

Tolerance Percent

Tolerance Percent selection allows for entry of both **upper and lower limit in terms of percent below or above an entered nominal (both must be entered)**. When limits are entered in terms of percent the same limits will automatically be shown in terms of absolute value on the Absolute Value Display. Arrow up, down, left to right to select the nominal value or % limit of interest as shown below. The nominal value can be entered in the same fashion as the absolute limit is entered above, numerical value, then arrow Up or Down to select units. **Valid range is -10^8 to 10^9** . If zero is entered for Nominal, the entire row is cleared and that bin disabled. The % tolerance can be entered directly in increments of 0.01%, any increments smaller than this are rounded to the closest 0.01%. **Valid range for each is 0 to 100**. If zero is entered for %Below or %Above, the previous value is cleared and that bin disabled.

Tolerance Percent				
Bin	Nominal	% BELOW	% ABOVE	
1	100.00 k	10.00	10.00	↑
2	110.00 k	10.00	10.00	↓
3	120.00 k	10.00	10.00	
4	130.00 k	10.00	10.00	
5	140.00 k	10.00	10.00	
6	150.00 k	10.00	10.00	→
7	160.00 k	10.00	10.00	
8	170.00 k	10.00	10.00	
9	180.00 k	10.00	10.00	
10	190.00 k	10.00	10.00	←

Figure 2-22 Tolerance Percent

Secondary Low

Accepts entry of numerical value for the low limit of the secondary parameter. Units are determined by the secondary parameter selection, i.e. in Farads, Ohms, Henries, etc. and selected by the UP/DOWN arrow keys. **Valid range is -10^3 to 10^4** .

NOTE:

Low limit must be less than the High limit

Secondary High

Accepts entry of numerical value for the high limit of the secondary parameter. Units are determined by the secondary parameter selection, i.e. in Farads, Ohms, Henries, etc. and selected by the UP/DOWN arrow keys. **Valid range is -10^3 to 10^4** .

NOTE:

High limit must be greater than the Low limit

View Bin Totals

Bin	Low LIMIT	High LIMIT	Total
1	90.00 k	110.00 k	250
2	100.00 k	120.00 k	100
3	110.00 k	130.00 k	90
4	120.00 k	140.00 k	80
5	130.00 k	150.00 k	75
11	PRI Pass SEC Fail LOW		60
12	PRI Pass SEC Fail HI		55
13	PRI Fail SEC Pass		50
14	PRI Fail SEC Fail		20
15	NO CONTACT		5
Totals:	Pass 595	Fail 190	785

HIT MENU TO RETURN TO MAIN MENU

Figure 2-23 Bin Totals

The total count for each bin is tracked from 0 to 999,999.

Zero Bin Totals

Bin count totals are all reset to zero when selected and returned to the Menu screen.

2.6.4.2 Test Sequencing

The **7600 PLUS VSTM** is capable of performing a sequence measurement containing up to **six different test steps**. Different measurement parameters and conditions can be defined for each test in the sequence.

Test sequencing can be selected as **Off, On or Edit**. Edit allows measurement parameters and test conditions to be changed for all six tests. It is important to note that **tests can only be enabled in sequence**, for example, one can enable tests 1 through 3 but not tests 1 and 3 only, i.e. it is not possible to skip a test.

Sequence Setup Test 1

Test 1 Status	<input type="checkbox"/> Disable	<input type="checkbox"/> Enable	
Primary Parameter			>>
Secondary Parameter			>>
Frequency			>>
AC Signal Type	<input type="text" value="Voltage"/>		
AC Signal Value	= 1.000 V		
Measurement Delay (ms)	= 0		
Range Hold	<input type="checkbox"/> Off	<input type="checkbox"/> On	
Range Locked	= 0		
Stop On Fail	<input type="checkbox"/> Off	<input type="checkbox"/> On	

HIT MENU TO RETURN TO MAIN MENU

Figure 2-24
Sequence Setup (Test Conditions)

Note: In some cases this menu can contain the function **Stop on Fail**, which in some cases may be non-functional and can be ignored.

If Range Hold is turned ON and this is the "first" sequence measurement, for each test the **7600 PLUS VSTM** automatically finds the correct range and completes a measurement (this range is saved for all future measurements) for that sequence only. It is important that the first part be "good" for the range hold to select the correct range. To repeat an auto range selection, turn sequences off and then back on again (making the next measurement taken the "first" sequence measurement).

Test conditions for each setup are selected as shown above except for the primary parameter and secondary parameter, these are selected on individual menus as shown below. To change test conditions on any or all six tests select **Prev Test** or **Next Test** to access test conditions for that test.

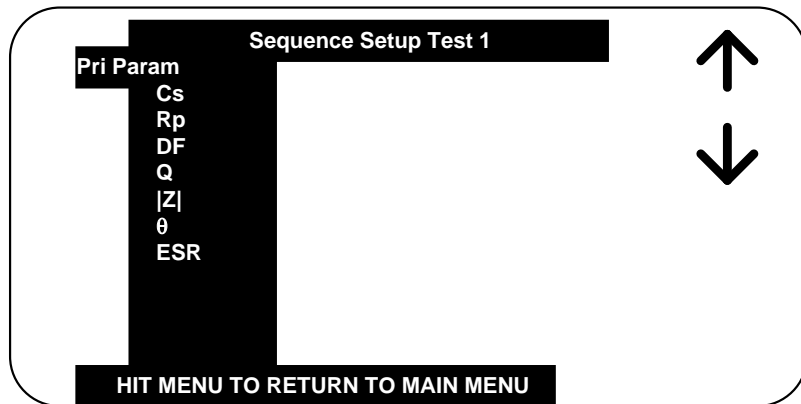


Figure 2-25
Sequence Setup (Parameter Selection)

Test conditions of measurement sequences can be stored and/or recalled as part of test setups, refer to paragraphs 2.6.5.1 and 2.6.5.2 for storing or recalling setups. If a test sequence is **stored as On**, the sequence will be executed once the Start button is pressed, if the test sequence is **stored as Off**, the sequence will be inactive until turned on.

When a test sequence is turned on the results of the sequence are shown on the summary screen shown below.

Sequence Results		
Test 1	Cs	1.561062 uF
Test 2	Cs	1.498650 uF
Test 3	Cs	1.278650 uF

Figure 2-26 Sequence Results

2.6.4.3 Parameter Sweep

The 7600 Plus is capable of displaying a **table or plot of measured results vs. a variable of frequency, voltage, or current.**

Sweep can be selected as **Off, On or Edit.** Edit allows sweep test conditions to be changed.

Setup	I/O	Analysis Sweep	Utilities
Parameter		Freq	Voltage Current
Sweep Begin	=	10.0	Hz
Sweep End	=	1.0000	kHz
Sweep Step		25	50 100 200
Sweep Format		Table	Plot

↑
↓

HIT MENU TO RETURN TO MAIN MENU

Figure 2-27 Parameter Sweep

Parameter is the variable test condition of **Frequency, Voltage or Current.**

Sweep Begin is the lower boundary of the sweep table or plot in **units of Hz, Volts or Amps.** The numerical value is entered directly and units selected by UP/DOWN arrow keys.

Sweep End is the upper boundary of the sweep in **units of Hz, Volts or Amps** and entered the same as Sweep Begin.

Sweep Step is the chosen number of increments in a sweep of **25, 50 100 or 200** where values are automatically selected, logarithmically over the specified begin to end range.

Sweep Format is selected to be **Table** as shown in Figure or **Plot** as shown in Figure .

Plot Table		
Frequency	Cs	DF
1.0000kHz	471.4576nF	0.003135
1.2915kHz	470.4563nF	0.003675
1.6681kHz	469.8878nF	0.003867
2.1544kHz	468.9983nF	0.010035
2.7825kHz	466.4532nF	0.010078
3.5938kHz	462.6634nF	0.011045
4.6415kHz	460.6645nF	0.012895
5.9948kHz	459.7892nF	0.014786
7.7426kHz	458.7845nF	0.016782
10.000kHz	456.5454nF	0.018544

Figure 2-28 Sweep Table

The sweep table lists the measurement results for primary and secondary parameter (unless none is selected) along with the test condition variable of frequency, voltage or current. A table can be comprised of 25, 50, 100 or 200 entries and the UP/DOWN arrow keys or Prev or Next Page used to scroll through the display.

NOTE:
Scroll is not functional when IEEE-488 is enabled.

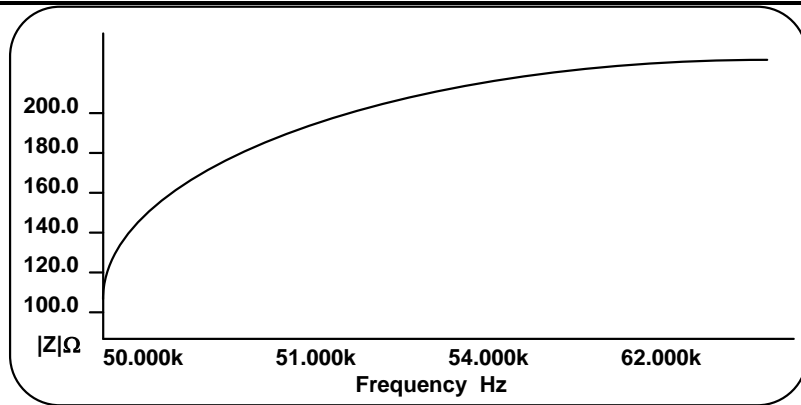


Figure 2-29 Sweep Plot

The sweep plot shows the measurement results of the primary parameter (vertical axis) vs. the variable test condition of frequency, voltage or current (horizontal axis). It should be noted that space available on the display **limits the number of graduations and resolution of axis labeling**. The horizontal axis is labeled from the **Sweep Begin to the Sweep End** values as selected by the user with two additional labels in between (chosen logarithmically). The vertical axis is labeled from the **lowest measured value to the highest measured value** with four additional labels in between (chosen linearly).

2.6.4.4 Median

Allows for the selection of Median measurement mode to be **On** or **Off**. When selected each measurement will actually be three individual measurements, the **lowest and highest values discarded and the median value displayed**.

Measurement accuracy can be improved as noted below and will be indicated on the AutoAcc display (but never less than 0.05% for primary parameter or 0.0005 for secondary parameter).

With Median set to **On**:

Divide the primary accuracy by the square root of three.

Divide the secondary accuracy by the square root of three.

Distortion Detection

Allows for the selection of Distortion Detection mode to be **On** or **Off**. When set to On, the unit will detect distortion during a measurement and indicates the message "DISTORTION" if this condition occurs. When set to Off, distortion will not be detected during a measurement.

Distortion is dependent on programmed test conditions, connection to the device, device impedance and so indicated when the signal + noise + distortion divided by the signal

exceeds 1.2. Distortion set to On is the recommended test condition and is particularly important for high precision measurements where test leads could resonate with the device under test. Distortion may want to be turned to Off in a "noisy" environment. To ensure that stored setups are backward compatible Distortion On or Off is not saved in setups stored (internally or on USB flash drive). On instrument power down the Distort Detect will be restored to its last previous state.

2.6.4.5 Load Correction

Load correction allows the user to specify the value of the component under test (user supplied standard) and apply a correction to subsequent measurements of similar components under the same test conditions. This feature corrects for instrument non-linearity and for fixture effects which can be dependent on the test frequency, test voltage level or impedance range.

Measurement accuracy is 0.25 x (normal accuracy) with Load Correction implemented and compared to user supplied standard and for the same measurement conditions. (Same measurement conditions are test voltage, test frequency and 7600 Plus measurement range.)

This increased accuracy applies in a range of:

DUT's with impedance (Z) between 3Ω and 800kΩ, with
 programmed voltage from 100mV to 1V, or from 100mV
 to (programmed current) x (Z) ≤1V.

Load correction can be selected as **Off, On or Edit**. Edit allows the primary and secondary values to be entered, the parameter for these values is defined by the Primary and Secondary Parameter in the main Setup menu. After the nominal values have been entered, if **Measure** is selected for **ON**, the user presses **START** to initiate the correction measurement. While the measurement is being made, **Measuring Correction** will be displayed. After the correction measurement the actual **Measured Primary** and **Secondary** value will be displayed along with the selected **Freq, Range, Primary** and **Secondary** parameter. During the load correction measurement the instrument is automatically placed in the Slow Measurement Accuracy mode.

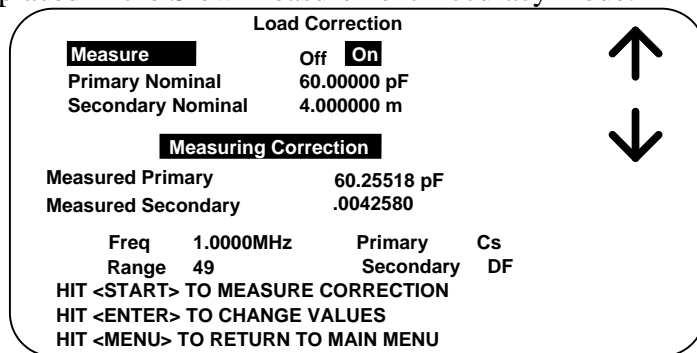


Figure 2-30 Load Correction

The Load Correction will only be made for the Frequency, Range, Primary and Secondary Parameter that was selected when the correction was determined. For example; if the correction measurement is made under the conditions of Cs, DF, at 1 MHz and range 49, these are the only conditions under which it will be applied.

2.6.5 Utilities Menu

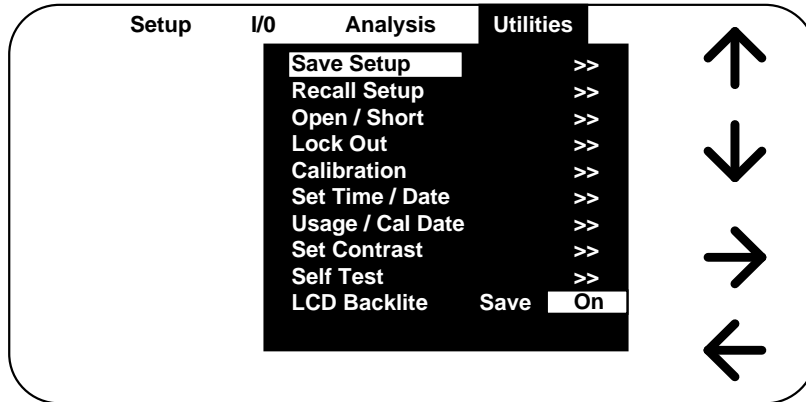
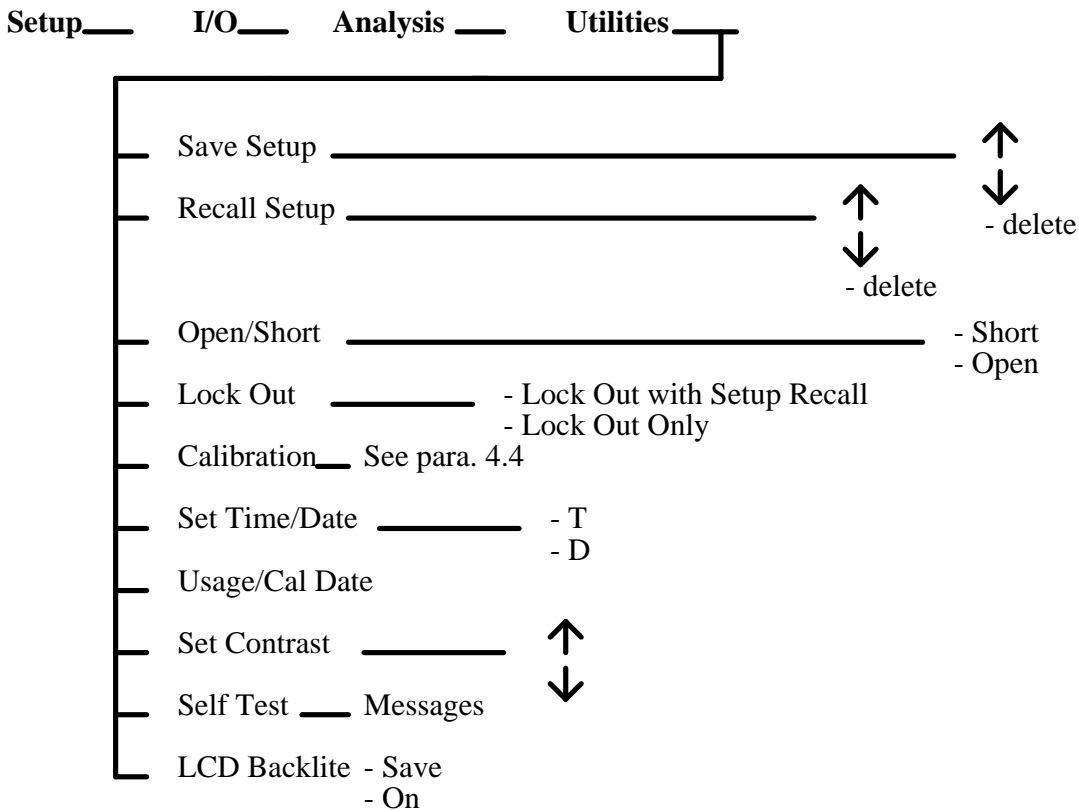


Figure 2-31
Utilities Menu

The last of the four main menus is **Utilities**, shown above. Each function is described in detail below.



2.6.5.1 Save Setup

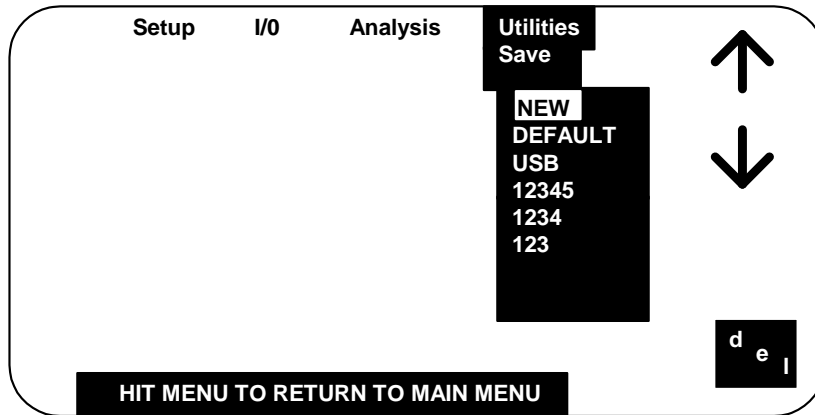


Figure 2-32
Save Setup

Allows a set of test conditions to be stored in battery-backed memory for later recall. Test conditions are those that are user programmable in the Setup and I/O menus, as discussed in paragraphs 2.6.2 and 2.6.3.

Stored setup conditions should always be backed up on paper.

To store the current set of test conditions as a new set in unit memory one needs to select **NEW** in the Save Setup menu and enter the identifying name up to 8 characters under which these conditions will be stored (allowable characters from the keypad include 0 through 9 and minus, characters can also include A through Z when operating from remote control). To save the setup under the name selected or to overwrite if the name already exists one needs to answer Yes or No, Figure 2-21.

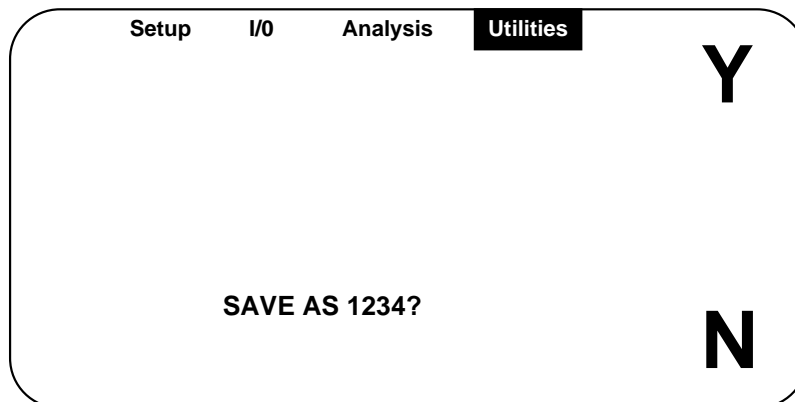


Figure 2-33
Yes or No

The **FACTORY** setup is entered by the manufacturer (QuadTech, Inc.) and can not be changed by the user. This setup can only be recalled.

Selecting **del** will delete a set of test conditions and requires a Yes or No response.

When there are more setups than can fit on the display the page down key is active. If there is less than a whole page below, the display wraps around to the previous display. Continuing to page down will eventually return to the first display of setups. The page down key is only shown when there are more setups than what is visible.

There are two ways to make the current set of test conditions overwrite an existing setup, one is to select that setup in the menu and answer Yes to overwrite and the other way is to enter the same name under New and answer Yes to overwrite.

2.6.5.2 Recall Setup

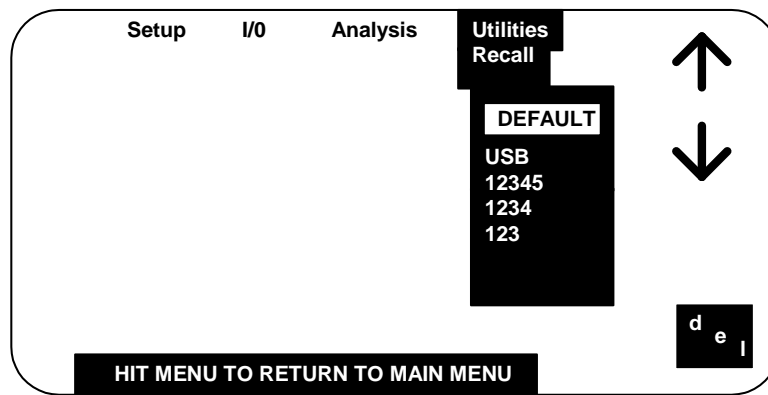


Figure 2-34 Recall Setup

Allows a previously stored set of test conditions to be recalled from instrument memory. Test conditions are those that are user programmable in the Setup and I/O menus as discussed in paragraphs 2.6.2 and 2.6.3. To recall a set of test conditions one needs to arrow down or up to the desired set. **FACTORY** a set of test conditions defined by the manufacturer and can only be recalled. Selecting **del** will delete a set of test conditions and requires a Yes or No response.

When there are more setups than can fit on the display the page down key is active. If there is less than a whole page below, the display wraps around to the previous display. Continuing to page down will eventually return to the first display of setups.

2.6.5.3 Open / Short

The zeroing process automatically measures stray parameters and retains the data, which is used to correct measurements so that results represent parameters of the DUT alone without test lead or fixture capacitance. Open and short circuit zeroing should be done at the end of any cables intended for connection to the DUT. Zeroing is recommended at the start of each work day or more often if leads, fixture or test configuration to the DUT is changed. **It is not necessary to re-zero if the test frequency is changed, unless the Quick Open & Short is used.** It is important to note, that anytime the instrument is zeroed it is done at a test voltage of 1 volt and all six test frequencies. Once Open/Short is selected in the menu and Enter key pressed the operator is prompted by instructions on the display for short or open zeroing as shown in Figure 2-25 below. When zeroing, **Contact Check should be OFF, # to Average to 1 and Median OFF.**

When the instrument measurement accuracy is selected for **SLOW** the unit will perform its Open/Short in this mode. When the instrument accuracy is selected for **MEDIUM** or **FAST** the unit will perform its Open/Short in the Medium mode. The Open/Short performed in the Slow mode is necessary only for measurements with extreme accuracy requirements at very high or low impedance. Open/Short takes about 5 minutes in the Medium mode versus about 15 minutes in the Slow mode.

When **Quick Open & Short** is selected the zeroing process is performed as prompted on the display, in much less time and **only at the frequency currently selected** on the instrument. It is important to note that the quick open and short data is no longer valid if frequency is changed, or if sequence is selected or instrument powered down.

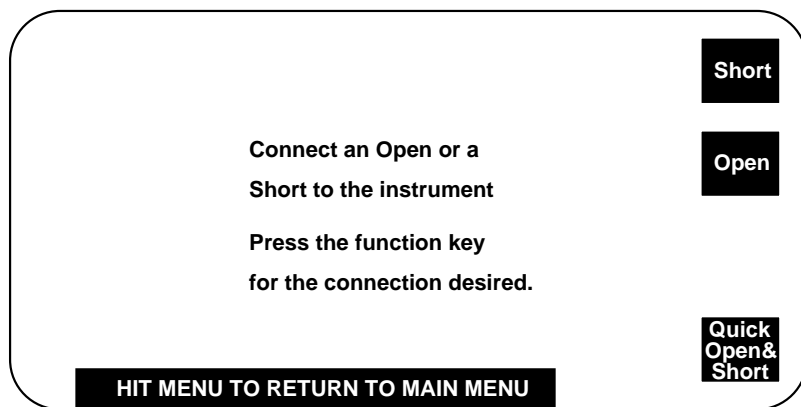


Figure 2-35 Open / Short

2.6.5.4 Lock Out



Figure 2-36 Lockout

Allows user to turn keypad lock feature on or off. There are two choices which can be selected, **lockout only** and **lockout with setup recall**. In both modes only the START, STOP and MENU on the instrument front panel are active, all other keys disabled. The difference is that in **lockout with setup recall** the menu key also allows setups to be recalled from instrument memory.

When either is selected the operator must enter a password number up to 8 characters.

CAUTION

FOR SECURITY REASONS THE PASSWORD IS NOT DISPLAYED WHEN IT IS ENTERED, SO THE PASSWORD SHOULD BE KEYED IN DISTINCTLY AND REMEMBERED. FAILURE TO REMEMBER AN ENTERED PASSWORD REQUIRES CALLING THE FACTORY FOR OVERRIDE INFORMATION.

ENTER PASSWORD
(8 CHARACTERS MAXIMUM default 760001)

* * * * *

Once the password is entered and entered again for verification, testing can begin by pressing START or the password cleared or changed by selecting MENU.

HIT <MENU> KEY TO ENTER PASSWORD
AND TO RETURN TO THE MENU
OR
HIT THE <START> KEY TO
START A MEASUREMENT

Once activated, only the START, STOP and MENU on the instrument front panel are active, all other keys are disabled. To turn the lockout feature off and reactivate menus

select MENU (select Exit Lockout in Lockout with Setup Recall mode) and enter the previous password from the keypad, the instrument will again function as normal.

If Recall Setups is chosen in the Lockout with Setup Recall mode, the instrument functions as described in paragraph 2.6.5.2 under Recall Setup.

2.6.5.5 Calibration

Refer to Calibration in Paragraph 4.4. **INSTRUMENT CALIBRATION SHOULD ONLY BE PERFORMED BY QUALIFIED SERVICE PERSONNEL.**

2.6.5.6 Set Time/Date

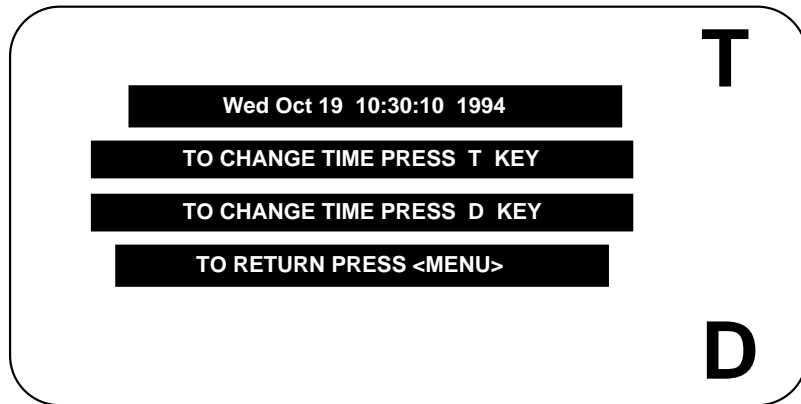


Figure 2-37 Set Time / Date

Allows resetting of time and date into unit memory. This is used as the basis for the elapsed time counter and stored calibration date.

T (time) is entered in

HOURS (up to 2 digits, 0 through 23)

MINUTES (up to 2 digits, 0 through 59)

SECONDS (up to 2 digits, 0 through 59)

D (date) is entered in

MONTHS (up to 2 digits, 1 through 12)

DAYS (up to 2 digits, 1 through 31)

YEARS (4 digits, 1992 through 2037)

Year 2000 Compliance

Once the year 2000 occurs the user must manually reset the date of the internal clock to the year 2000.

2.6.5.7 Usage/Cal Date

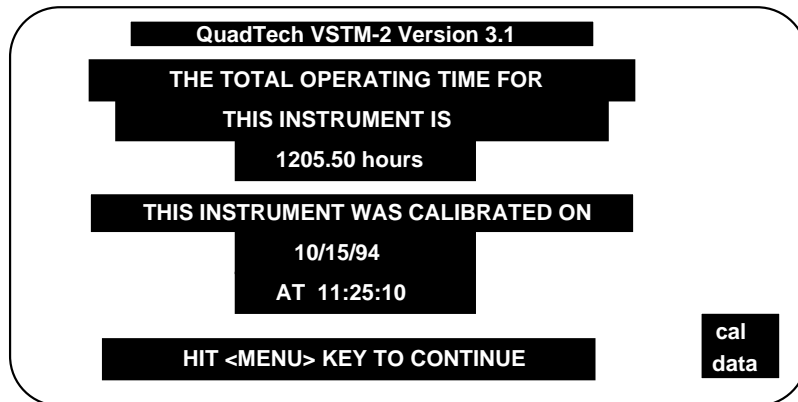


Figure 2-38 Usage / Cal Date

When selected, indicates the total elapsed time in hours that the unit has been powered up and the date of last calibration. The elapsed time is from the moment of initial use and may show some time when shipped from the factory. The calibration date is retained in instrument memory until the unit is re-calibrated and then it is updated. When **cal data** is selected, the calibrated values are shown as entered from the Report of Calibration provided with the QuadTech Calibration Kit. Refer to paragraph 4.4.

2.6.5.8 Set Contrast

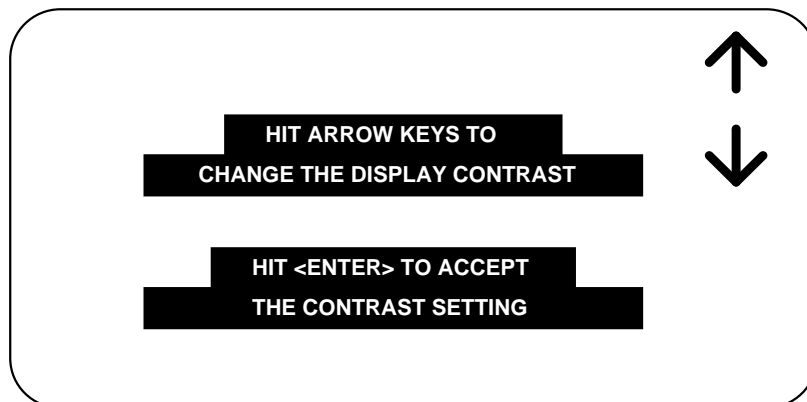


Figure 2-39 Set Contrast

Allows adjustment of contrast on the LCD display. Use Up arrow to increase contrast or Down arrow to decrease. When the instrument is powered up it returns to the last set contrast, not some nominal level.

2.6.5.9 Self Test

When selected, runs a group of internal self tests to verify that calibration and open/short data are not corrupt.

2.6.5.10 LCD Backlite

Allows the backlite on the LCD display to be **Save** or **On**. When set to **Save** the backlite turns off automatically if no keypad has been hit for 5 minutes and turns back on with the touch of any key. When set to **On** the backlite is constantly on. The **Save** mode will prolong the life of the display.

2.7 Input/Output Interface

2.7.1 IEEE-488.2 Interface

The **7600 PLUS VSTM** comes standard with IEEE-488 interface with connection through a connector (24 pin) on the rear panel. This interface can be used to connect to a system containing a number of instruments and a controller in which each meets IEEE Standard 488.2 (Standard Digital Interface for Programmable Instrumentation) Refer to Table 2-3 below for a full tabulation of connections and Table 2-4 for the command set.

The following functions have been implemented. Refer to the standard for an explanation of the function subsets, represented by the identifications below.

SH1	Source Handshake	PP1	Parallel Poll
AH1	Acceptor Handshake	DC1	Device Clear
T5	Talker	DT1	Device Trigger
L3	Listener	C0	Controller
SR1	Service Request	E2	Electrical Interface
RL1	Remote Local		

Table 2-3
IEEE-488 Interface Connections

Signal Name	Pin Number	Function
DAV	6	Low state: "Data is Available" and valid on DI01 through DI08
NRFD	7	Low state: At least one listener on the bus is "Not ready for Data".
NDAC	8	Low state: At least one listener on the bus is "Not Accepting Data".
ATN	11	"Attention" specifies 1 of 2 uses for the DI01 through DI08 lines Low state - Controller command messages High state - Data bytes from the talker device
IFC	9	"Interface Clear" Low state - Returns portions of interface system to a known quiescent state.
SRQ	10	"Service Request" Low state - a talker or listener signals (to the controller) need for attention in the midst of the current sequence of events

Table 2-3
IEEE-488 Interface Connections (continued)

Signal Name	Pin Number	Function
REN	17	"Remote Enable" Low state - enables each device to enter remote mode when addressed to listen High state - all devices revert to local control
EOI	5	"End of Identify" if ATN is in high state, then low state of EOI indicates end of a multiple-byte data transfer sequence. If ATN is in low state, then low state of EOI activates a parallel poll.
DI01	1	The 8-line data bus, which conveys interface messages (ATN low state) or device-dependent messages (ATN high state), such as remote-control commands from the controller or from a talker device
DI02	2	
DI03	3	
DI04	4	
DI05	13	
DI06	14	
DI07	15	
DI08	16	

Table 2-4

IEEE Commands

Command	Function	Parameter(s)
<u>CONFigure:</u>		
FREQuency	Set the frequency	0000000.00
PPARAmeter	Set the primary parameter	CS RP DF Q Z P(phase angle) ESR
SPARAmeter	Set the secondary parameter	N(none) CS RP DF Q Z P(phase angle) ESR
ACValue	Set the AC signal to value	0.0
RANGe	Set the range	ON OFF #(1-59)
CCHeck	Set the contact check to ON or OFF	ON OFF
DISPlay type	Set display type to	M (Measured Parameter) D (Deviation from Nominal) % (% Deviation from Nominal) N (No Display)
TRIGger	Set the trigger to	INTernal EXTernal

Table 2-4
IEEE Commands (continued)

Command	Function	Parameter(s)
<u>CONFigure:</u>		
<u>SAVe:</u>		
DUPLicate	Save setup as duplicate filename in battery backed up RAM	XXXXXXXX
NEW	Save setup as new filename in battery backed up RAM	XXXXXXXX
RECall filename	Recall setup filename from battery backed up RAM	XXXXXXXX
<u>SEQuence:</u>		
SEQuence	Set the sequence function to ON or OFF	ON OFF
TEST	Enable or Disable a test	test #(1-6) and ENable DISable
FREQuency	Set the frequency from 100 to 2000000 HZ	test # and #####.##
PPARameter	Set the primary parameter	test # and RP CS DF Q Z P(phase angle) ESR
SPARameter	Set the secondary parameter	test # and N(none) RP CS DF Q Z P(phase angle) ESR
ACValue	Set the AC signal to value	test # and 0.0
RANGe	Set the range	test # and ON OFF #(1-59)
STOP	Stop on fail	test # and ON OFF

Table 2-4
IEEE Commands (continued)

Command	Function	Parameter(s)
<u>SYSTEM:</u>		
TIME	Set the time to hours, minutes	hh:mm
DATE	Set the date to month, day, year	mm/dd/yyyy
LOCKout state	Set the front panel lockout off or on	ON OFF
ELAPsed?	Query the elapsed time the machine has run	
DCALibration?	Query the calibration date	
BLCD	Turn lcd backlite ON or OFF	ON OFF
<u>CALibrate:</u>		
DATA?	Returns the calibration data to the user	
TOC?	Returns the open circuit data to the user	
TSC?	Returns the short circuit data to the user	
WTOC	Writes the user supplied open circuit data to the instrument	
WTSC	Writes the user supplied short circuit data to the instrument	
QUICKos	Perform quick open calibration	
	IEEE wait for SRQ OPC to indicate continue	
	Send	Any command if desired to implement
	Send	Fetch? This will continue calibration
	Receive	Connect the Open Circuit. Ensure that the open is connected to the instrument
	Send	CONTINUE
	Receive	Complete (for RS232 only)
	Wait for SRQ OPC (operation complete, IEEE only)	
	Perform quick short calibration	
	Send	Any command if desired to implement
	Send	Fetch? This will continue calibration
	Receive	Connect the Short Circuit. Ensure that the short is connected to the instrument
	Send	CONTINUE
	Receive	Complete (for RS232 only)
	Wait for SRQ OPC (operation complete, IEEE only)	

Table 2-4
IEEE Commands (continued)

SHORT	<p>Perform short circuit calibration</p> <p>The procedure for performing a remote short is as follows:</p> <table border="0"> <tr> <td style="padding-right: 20px;">Send</td> <td>Any command if desired to implement</td> </tr> <tr> <td>Send</td> <td>Fetch? This will continue calibration</td> </tr> <tr> <td>Receive</td> <td>Connect the Short Circuit. Ensure that the short is connected to the instrument</td> </tr> <tr> <td>Send</td> <td>CONTINUE</td> </tr> <tr> <td>Receive</td> <td>Complete (for RS232 only)</td> </tr> <tr> <td></td> <td>Wait for SRQ OPC (operation complete, IEEE only)</td> </tr> </table>	Send	Any command if desired to implement	Send	Fetch? This will continue calibration	Receive	Connect the Short Circuit. Ensure that the short is connected to the instrument	Send	CONTINUE	Receive	Complete (for RS232 only)		Wait for SRQ OPC (operation complete, IEEE only)																
Send	Any command if desired to implement																												
Send	Fetch? This will continue calibration																												
Receive	Connect the Short Circuit. Ensure that the short is connected to the instrument																												
Send	CONTINUE																												
Receive	Complete (for RS232 only)																												
	Wait for SRQ OPC (operation complete, IEEE only)																												
OPEN	<p>Perform open circuit calibration</p> <p>The procedure for performing a remote open is as follows:</p> <table border="0"> <tr> <td style="padding-right: 20px;">Send</td> <td>Any command if desired to implement</td> </tr> <tr> <td>Send</td> <td>Fetch? This will continue calibration</td> </tr> <tr> <td>Receive</td> <td>Connect the Open Circuit. Ensure that the open is connected to the instrument</td> </tr> <tr> <td>Send</td> <td>CONTINUE</td> </tr> <tr> <td>Receive</td> <td>Complete (for RS232 only)</td> </tr> <tr> <td></td> <td>Wait for SRQ OPC (operation complete, IEEE only)</td> </tr> </table>	Send	Any command if desired to implement	Send	Fetch? This will continue calibration	Receive	Connect the Open Circuit. Ensure that the open is connected to the instrument	Send	CONTINUE	Receive	Complete (for RS232 only)		Wait for SRQ OPC (operation complete, IEEE only)																
Send	Any command if desired to implement																												
Send	Fetch? This will continue calibration																												
Receive	Connect the Open Circuit. Ensure that the open is connected to the instrument																												
Send	CONTINUE																												
Receive	Complete (for RS232 only)																												
	Wait for SRQ OPC (operation complete, IEEE only)																												
FULL	<p>Perform full calibration</p> <p>The procedure for performing full calibration is as follows:</p> <p>IEEE wait for SRQ OPC to indicate continue</p> <table border="0"> <tr> <td style="padding-right: 20px;">Send</td> <td>Any command if desired to implement</td> </tr> <tr> <td>Send</td> <td>Fetch? This will continue calibration</td> </tr> <tr> <td>Receive</td> <td>Connect the 374 Ω Standard. Ensure that the standard is connected to the instrument</td> </tr> <tr> <td>Send</td> <td>CONTINUE</td> </tr> </table> <p>IEEE wait for SRQ OPC to indicate gain cal is done</p> <table border="0"> <tr> <td style="padding-right: 20px;">Send</td> <td>Any command if desired to implement</td> </tr> <tr> <td>Send</td> <td>Fetch? This will continue calibration</td> </tr> <tr> <td>Receive</td> <td>Connect the open circuit. Ensure that the open is connected to the instrument</td> </tr> <tr> <td>Send</td> <td>CONTINUE</td> </tr> </table> <p>IEEE wait for SRQ OPC to indicate open circuit cal is done</p> <table border="0"> <tr> <td style="padding-right: 20px;">Send</td> <td>Any command if desired to implement</td> </tr> <tr> <td>Send</td> <td>Fetch? This will continue calibration</td> </tr> <tr> <td>Receive</td> <td>Connect the short circuit. Ensure that the standard is connected to the instrument</td> </tr> <tr> <td>Send</td> <td>CONTINUE</td> </tr> </table> <p>IEEE wait for SRQ OPC to indicate short circuit cal is done</p> <table border="0"> <tr> <td style="padding-right: 20px;">Send</td> <td>Any command if desired to implement</td> </tr> <tr> <td>Send</td> <td>Fetch? This will continue calibration</td> </tr> </table>	Send	Any command if desired to implement	Send	Fetch? This will continue calibration	Receive	Connect the 374 Ω Standard. Ensure that the standard is connected to the instrument	Send	CONTINUE	Send	Any command if desired to implement	Send	Fetch? This will continue calibration	Receive	Connect the open circuit. Ensure that the open is connected to the instrument	Send	CONTINUE	Send	Any command if desired to implement	Send	Fetch? This will continue calibration	Receive	Connect the short circuit. Ensure that the standard is connected to the instrument	Send	CONTINUE	Send	Any command if desired to implement	Send	Fetch? This will continue calibration
Send	Any command if desired to implement																												
Send	Fetch? This will continue calibration																												
Receive	Connect the 374 Ω Standard. Ensure that the standard is connected to the instrument																												
Send	CONTINUE																												
Send	Any command if desired to implement																												
Send	Fetch? This will continue calibration																												
Receive	Connect the open circuit. Ensure that the open is connected to the instrument																												
Send	CONTINUE																												
Send	Any command if desired to implement																												
Send	Fetch? This will continue calibration																												
Receive	Connect the short circuit. Ensure that the standard is connected to the instrument																												
Send	CONTINUE																												
Send	Any command if desired to implement																												
Send	Fetch? This will continue calibration																												

Table 2-4
IEEE Commands (continued)

for the next 4 standards

Receive	Connect the standard. Ensure that the standard is connected to the instrument
Send	CONTINUE
Send	Any command if desired to implement
Send	Fetch? This will continue calibration
Receive	Get prompt for Rnom and Qnom values at 1 kHz
IEEE wait for SRQ OPC to indicate current standard cal is done	
Send	Any command if desired to implement
Send	Fetch?
Receive	Get prompt for Rnom and Qnom values at 1 MHz
IEEE wait for SRQ OPC to indicate range cal is done	
Send	Any command if desired to implement
Send	Fetch?

after last standard

IEEE wait for SRQ OPC
RS232 wait for Complete

MEASure

Triggers a measurement of the selected type. If sequence or sweep is enabled this command will trigger those type of measurements also. The result type is set by the display type parameter.

FETCh?

Fetches the most recent measurement results. The character sequence formats are as follows:

Normal Measurements:

<primary result> < , > <secondary result> terminated by a linefeed.

The secondary parameter will be blank when the parameter is set to NONE. The actual data is in ascii format. Capacitance in microfarads, resistance, ESR, and Z in ohms. Q and DF are dimensionless.

Table 2-4
IEEE Commands (continued)

FETCh?

Sequence Measurement:

If sequenced is enabled results will be sent for each test in the sequence.

<data>,<data>,<data>,<data>,<data><NL>

IDN?

Returns instrument identification "QuadTech,VSTM2,0,software version".

ESR?

Returns the read of the event status register.

STB?

Returns the read of the status byte register.

ESE?

Returns the read of the event status enable register.

SRE?

Returns the read of the service request enable register.

ESE

Set the event status enable register. value

SRE

Set the service request enable register. value

STOP

Stops a measurement in process.

RST

Reset the buffer.

TST?

Self test query.

CLS

Clear standard event status register

Note: Any remote command can start with * symbol for IEEE 488.2 compatibility.

2.7.1.1 Formats

IEEE 488.2 enable remote programming of all instrument functions, measurement conditions and comparator settings etc. Outputs include measurement conditions, open/short corrections, and measured values.

Data Formats

Data will be transmitted in ASCII NR3 format per IEEE 488.2 sec. 8.7.4 and reproduced below. Note that there is always precisely one digit before the decimal point, and precisely three digits in the exponent.

Multiple results

For the case where a measurement produces multiple results (e.g. MEASure Cs, and DF), the individual numbers will be separated by commas per IEEE 488.2 para. 8.4.2.2.

Sequences of Test (Sequence Mode) will be treated as a single Message Unit, with results separated by commas. If a particular test has “None” selected as a secondary parameter, no place will be reserved for the null result. As an example, a sequence of three tests asking for C/D, ESR, and Z/φ would appear as follows:

<data>,<data>,<data>,<data>,<data><NL>

All response messages will be terminated by the NL character together with the EOI line asserted.

Status Byte Register

<u>Bit</u>	<u>Decimal Value</u>	<u>Use</u>
7	128	None
6	64	SRQ, SPOL Resets
5	32	Summary of Standard Event Status Register*
4	16	Message Available
3	8	None
2	4	None
1	2	None
0	1	None

*The Status Byte Register is readable via the standard STB? as defined in para. 11.2.2.2 of the IEEE spec. The STM will also implement an SRE register to enable each bit of the Status Byte Register per para 11.3.2 of the IEEE spec. This register shall be readable by a SRE? command and writeable by a SRE <#> command.

Standard Event Status Register

Bit	Decimal Value	Use
7	128	None
6	64	None
5	32	Command Error (Syntax)
4	16	Execution Error (Over Range, etc.)
3	8	No Contact
2	4	Query Error
1	2	None
0	1	Operation Complete

This register is read by executing an “ESR?” command per para. 11.5.1.2.2 (except no *). Note that this is a destructive read. Reading the register clears it. Each bit of the Event register must be enabled in order to cause the ESB bit of the Status Register to be set. This enabling is done in the Standard Event Status Enable Register by issuing an ESE command per para 11.5.1.3.

The CLS Function is not implemented.

Open Circuit & Short Circuit Data Formats (TOC/TSC)

There are 84 lines of data returned. Each line is of the following format:

<range>,<frequency>,<voltage>,<real data>,<imaginary data><cr><lf>

where the fields returned are as follows:

The range is the “outer loop” which loops from 0 to 4 where
 0 corresponds to the 95K ohm range
 1 corresponds to the 6K ohm range
 2 corresponds to the 374 ohm range
 3 corresponds to the 25 ohm range

The frequency is the “middle loop” which loops from 0 to 5 where
 0 corresponds to the 100 Hz
 1 corresponds to the 120 Hz
 2 corresponds to the 1 KHz

3 corresponds to the 10 KHz
 4 corresponds to the 100 KHz
 5 corresponds to the 1 MHz
 6 corresponds to the 2 MHz
 The voltage is the “inside loop” which loops from 0 to 2 where
 0 corresponds to the 100mV range
 1 corresponds to the 1V range
 2 corresponds to the 5V range
 The real data is a string of characters that represent a floating point number
 The imaginary data is a string of characters that represent a floating point number

Thus, the data returned would look like:

```

0,0,0,<float>,<float><cr><lf>
0,0,1,<float>,<float><cr><lf>
0,0,2,<float>,<float><cr><lf>
0,1,0,<float>,<float><cr><lf>
0,1,1,<float>,<float><cr><lf>
0,1,2,<float>,<float><cr><lf>
0,2,0,<float>,<float><cr><lf>
0,2,1,<float>,<float><cr><lf>
0,2,2,<float>,<float><cr><lf>
0,3,0,<float>,<float><cr><lf>
0,3,1,<float>,<float><cr><lf>
0,3,2,<float>,<float><cr><lf>
:
:
0,6,0,<float>,<float><cr><lf>
0,6,1,<float>,<float><cr><lf>
0,6,2,<float>,<float><cr><lf>
1,0,0,<float>,<float><cr><lf>
1,0,1,<float>,<float><cr><lf>
1,0,2,<float>,<float><cr><lf>
1,1,0,<float>,<float><cr><lf>
1,1,1,<float>,<float><cr><lf>
1,1,2,<float>,<float><cr><lf>
:
:
3,6,0,<float>,<float><cr><lf>
3,6,1,<float>,<float><cr><lf>
3,6,2,<float>,<float><cr><lf>

```

Remote Error Code Format

All errors reported via the remote interfaces (i.e. RS-232 and IEEE-488) will be reported in a seven character format. This error format applies both in Talk and Talk/Listen modes. The seven characters will always begin with an “E” followed by six digits.

The error codes are as follows:

Error conditions:	Remote error codes:
Over Range	E000001
No Contact	E000002
Over Run	E000003
Under Range	E000004
Bad Update	E000005
Over Load	E000006
Distortion	E000007
Over Flow	E000008
Default	E000009
(no password)	E000010
(no match)	E000011
(pass_not_saved)	E000012
(ieee488 init)	E000013
(too many setups)	E000014
(recall filename bad)	E000015
(invalid ac voltage)	E000016
(print error)	E000017
(no short data)	E000018
(no open data)	E000019
(password verify failure)	E000020
(bad setup data)	E000021
(bad open cal)	E000022
(bad short cal)	E000023
(bad cal)	E000024
(eng entry out of range)	E000025
(bad cal code)	E000026
(limit error)	E000027
(no param accuracy)	E000028
(bad bin checksum)	E000029
(invalid frequency)	E000030
(invalid range)	E000031
(bad quick os)	E000032
(invalid unit)	E000033
(set nominal)	E000034
(greater than 100%)	E000035
(less than -100%)	E000036

The errors will be reported in the same format as the measurements.
For example, in sequence mode where C/D detected OVER RANGE and ESR was valid, the string returned would be:

E000001,E000001,<data> terminated by the NL character together with the EOI line asserted where both the primary (C) and secondary (D) values of the first test are reported as errors (E000001), and the primary of the second test (ESR) returns valid data.

Over Flow condition: The new “Over Flow” error condition will be reported when the data to be returned via the remote does not fit into the seven digit format, i.e. the measurement results would have been truncated.

Deviation from Nominal and % Deviation from Nominal Data Formats

The formats for Deviation from Nominal and % Deviation from Nominal returned via the remote are currently not documented in the STM manual. The following details the way the results will be returned. Note: the formats have changed since the last release, therefore this applies beginning with this release.

Deviation from Nominal:

<deviation>,<secondary result> terminated by the NL character together with the EOI line asserted

Only the deviation will be sent out if the secondary parameter is set to NONE.

% Deviation from Nominal:

<% deviation>,<secondary result> terminated by the NL character together with the EOI line asserted

Only the % deviation will be sent out if the secondary parameter is set to NONE.

2.7.1.2 Sample Program for National Instruments GPIB card

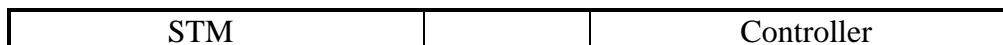
```
260 '*SAMPLE 7600 PLUS VSTM BASIC PROGRAM FOR NATIONAL
INSTRUMENTS IEEE **
' Merge National DECL.BAS here
270 ADAP$="GPIB0" : DEV4$="Dev4": R$ = SPACE$(60)
280 CALL IBFIND (DEV4$,DEV4%)
290 CLS '***** SET CONDITIONS, MEASURE, AND DISPLAY DATA
*****
300 SET$="CONF:REC DEFAULT" : CALL IBWRT (DEV4%,SET$)
310 SET$="CONF:FREQ 120.00" : CALL IBWRT (DEV4%,SET$)
320 SET$="CONF:PPAR CS" : CALL IBWRT (DEV4%,SET$)
330 SET$="CONF:SPAR DF" : CALL IBWRT (DEV4%,SET$)
350 SET$="CONF:NOM 0" : CALL IBWRT (DEV4%,SET$)
360 SET$="CONF:DISP M" : CALL IBWRT (DEV4%,SET$)
370 SET$="MEAS:" : CALL IBWRT (DEV4%,SET$)
380 FOR I = 1 TO 5000 : NEXT I
390 SET$="FETC?" : CALL IBWRT (DEV4%,SET$)
400 CALL IBRD (DEV4%,R$) : PRINT R$
410 CALL IBLOC (DEV4%)
420 END
```

2.7.2 RS232 Interface

The **7600 PLUS VSTM** comes standard with an RS-232 serial port interface, available through a connector (9 pin) on the rear panel of the instrument, for connecting to a PC. The RS-232 standard defines electrical specifications for the transmission of bit serial information. The use of the RS-232 port requires five lines, receive data, transmit data, data terminal ready, data set ready and signal ground. With some controllers additional signals may be required and are listed in Table 2-5 below. Refer to Figure 2-30 for null modem cable configuration to the standard db9 or db25 connector. **Refer to Table 2-4 for the command set which also applies to the RS-232 interface.**

**Table 2-5
RS-232 Interface Connections**

Signal Name	Pin Number	Function
Inputs:		
DCD	1	Data Carrier Detect
DSR	6	Data Set Ready
RXD	2	Receive Data
CTS	8	Clear to Send
RI	9	Ring Indicator
Outputs:		
RTS	7	Request to Send
TXD	3	Transmit Data
DTR	4	Data Terminal Ready
GND	5	Signal Ground



Pin #	Function		Pin #	Function
2	Receive data	Connect to	3	Transmit data
3	Transmit data		2	Receive data
4	Data terminal ready		6	Data set ready
5	Signal ground		5	Signal ground
6	Data set ready		4	Data terminal ready

db9 to db9 Cable Configuration

STM			Controller	
Pin #	Function		Pin #	Function
2	Receive data	Connect to	2	Transmit data
3	Transmit data		3	Receive data
4	Data terminal ready		6	Data set ready
5	Signal ground		7	Signal ground
6	Data set ready		20	Data terminal ready

db9 to db25 Cable Configuration

Figure 2-40
RS-232 Null Modem Cable Configurations

2.8 Error Messages

"AC VOLTAGE ERROR, SET TO 1V"	AC voltage level improperly set
"BAD CALIBRATION CODE ENTERED"	Calibration code incorrectly entered
"BAD CALIBRATION DATA"	Calibration incorrect, re calibrate
"BAD OPEN CALIBRATION DATA"	Repeat Open test
"BAD SETUP DATA READ FROM MEMORY"	Setup data incorrect, reload
"BAD SHORT CALIBRATION DATA"	Repeat Short test
"ELAPSED TIME ERROR, SET TO 0"	Elapsed time is incorrect and has been set to zero (battery for non-volatile memory may be defective or has been disconnected)
"ERROR DURING CALIBRATION"	Calibration incorrect, re calibrate
"ERROR DURING OPEN CALIBRATION"	Repeat Open test
"ERROR DURING SHORT CALIBRATION"	Repeat Short test
"FAILURE # SEE DOCUMENTATION"	Hardware or software failure, 1 - 99 (# list not included in this manual)
"HARDWARE TIMER FAILURE, REBOOT"	Hardware malfunction during power up
"HIGH LIMIT LESS THAN LOW LIMIT"	Limits incorrectly set
"INTERNAL HARDWARE FAILURE, REBOOT"	Hardware malfunction during power up
"LOW BATTERY VOLTAGE"	Memory backup battery, low voltage (setups and instrument zero could be lost)
"MAXIMUM # OF SETUPS REACHED"	Maximum number of files have been stored
"NO IEEE 488 INTERFACE"	Unit does not include IEEE-488
"NO PASSWORD ENTERED"	Password entry canceled, re-enter
"NO ZERO DATA FOUND"	Unit requires zeroing

"PASSWORD DID NOT MATCH"	Incorrect password entered
"PASSWORD NOT SAVED IN RAM"	Error trying to save password, repeat
"PASSWORD VERIFICATION FAILURE"	Wrong password entry for verification
"PRI & SEC MISMATCH, SET TO AUTO"	Check parameter selection
"PRIMARY = AUTO, CAN'T UPDATE AUTOACC"	Check parameter selection
"PRIMARY = AUTO, SECONDARY IGNORED"	Check parameter selection
"REMOTE COMMAND INVALID"	IEEE command is incorrect (for example: to set frequency use FREQuency)
"REMOTE COMMAND PARAMETER INVALID"	IEEE parameter is incorrect (for example: frequency parameter can be XXXXXXXX.XX)
"REMOTE COMMAND PREFIX INVALID"	IEEE command prefix is incorrect (for example: to configure unit use CONFigure)
"SHUT THE POWER OFF"	Malfunction of instrument power source
"TIME / DATE ERROR, PLEASE SET"	Reset time and date
"UNABLE TO WRITE TO REMOTE"	IEEE not setup correctly
"UNKNOWN COMMAND"	
"VALID RANGE = low value - hi value"	Entry invalid, should be between specified values

3.1 General

The **7600 PLUS VSTM** is built on QuadTech's I2000 standard instrument architecture which consists of a standard mechanical package, LCD display/keypad, microprocessor unit, digital I/O interface and power supply. The I2000 further incorporates the circuitry unique to the **7600 PLUS VSTM**, an analog instrument module and power supply.

3.2 Instrument Description

3.2.1 Basic I2000 Instrument Architecture

Processor Board

The processor board provides the basic control for the **7600 PLUS VSTM** and mimics the IBM-PC architecture. Besides the central processing unit and memory modules it includes DOS, keypad, USB and RS232 ports. The processor board is stacked on the the Analog Instrument board. The processor board has the IEEE-488 board stacked on it.

Power Supply

The power supply assembly consists of two modules, a +5V, -12V and +24V module towards the back of the instrument and a +/-12V module towards the front. The +5V supplies power to most of the instrument's basic boards/modules, including the processor board, digital I/O board, LCD display, and IEEE-488 board. It also provides power for the digital logic on the analog instrument board. The +24V of this module supplies the instrument fan and the -12V is not used. The +/- 12V module supplies most of the power to the analog instrument board.

LCD Display/Keypad Panel

The front panel user interface is comprised of a molded silicon rubber keypad that actuates a membrane switch assembly. The keypad is environmentally sealed, designed for long life and all keys with tactile feedback to the operator. The 2 1/2" x 4 3/4" LCD is a high resolution graphic display with on/off backlite for visual clarity. Both keypad and display are connected to the instrument I/O board via ribbon cables.

3.2.2 7600 PLUS VSTM Instrument Module

The instrument board, used in the Model **7600 PLUS VSTM** is the heart of the measurement system. All other boards support its operation. There are five major parts to this board: sine wave generator, voltage detector channel, current detector channel, A/D converter, and Digital Signal Processor. Each is discussed below in brief.

Sine Wave Generator

All devices under test are tested by applying a sine wave of voltage or current. The sine wave is generated by use of an IC using the Direct Digital Synthesis technique. This allows generation of all frequencies from 100 Hz to 2 MHz with a high level of resolution.

Voltage Detector Channel

The sine wave test signal is applied to the unknown through the IH and IL leads, causing a voltage to appear across the unknown. This voltage E_x is measured by the PH and PL leads, is filtered and amplified according to its level, and presented to one channel of the Dual A/D converter.

Current Detector Channel

The current flowing through the unknown is applied to a transadmittance amplifier with an internal standard in the feedback path. This arrangement causes a voltage to be generated across the standard resistor proportional to the current. This voltage is also filtered and amplified and presented to the second channel of the A/D converter.

A/D Converter

The two signals representing voltage across and current through the unknown are digitized by a dual 18 bit A/D converter. A key concept of this conversion is that the samples are taken synchronously with the digital generation of the sine wave so that phase information may be obtained.

Digital Signal Processor

The digitized voltage and current signals are applied to a high speed Digital Signal Processor where a mathematical algorithm (similar to a Fast Fourier Transform) is used to extract the in phase and quadrature portions of the signal. This information is then used to calculate the complex impedance, Z , and the complex admittance, Y of the unknown. These results are then used to compute the parameters requested by the user i.e. C, R, D, Q etc.

3.2.3 I2000 Instrument Options

IEEE-488 Board & Cable

The IEEE-488 board allows complete control over all aspects of the instrument. Any user control available through the keyboard or any information available for display can be accessed over this interface. This board is mounted towards the right rear of the unit stacked above the processor board. Connection to the IEEE-488 connector on the rear panel is made by an interconnecting cable.

Section 4

Maintenance & Calibration

4.1 General

Our warranty (at the front of the manual) attests the quality of materials and workmanship in our products. If malfunction should be suspected, or other information be desired applications engineers are available for technical assistance. Application assistance is available in the U.S. by calling 978-461-2100 and asking for Applications Support. For support outside of the United States please contact your local QuadTech distributor.

4.2 Instrument Return

Before returning an instrument to QuadTech for [Service](#) please obtain an [online Return Materials Authorization Number \(RMA#\)](#). This number, when placed on the outside of the shipping package, will speed processing at our Service Lab and will serve as a reference number for the time your unit is at QuadTech. Please contact our **Customer Care Center (CCC)** at **800-253-1230** for additional support. The CCC phone line is staffed from 8:00am to 5:00pm (EST).

It will be necessary to include a Purchase Order Number and credit card information to insure expedient processing, although units found to be in warranty will be repaired at no-charge. For any questions on repair costs or shipment instructions please contact our CCC Department at the above number. To safeguard an instrument during storage and shipping please use packaging that is adequate to protect it from damage, i.e., equivalent to the original packaging and mark the box "Delicate Electronic Instrument". Please follow online instructions for shipping materials back to QuadTech.

4.3 Calibration

4.3.1 General

Calibration of the **7600 PLUS VSTM Vishay Sprague Tantalum Meter** is recommended on an annual basis. If the unit is to be returned to QuadTech for factory calibration refer to paragraph 5.2 for instructions. **Using the procedure below the instrument can also be calibrated by a qualified service person if traceable calibration equipment and standards are available.**

CAUTION

Instrument should be powered up for a minimum of 1 hour before calibration to ensure maximum stability.

Requirements for Re calibration

Temperature stabilized room at 23 degrees C (73.4 F)
QuadTech **7000-09** Calibration Kit

4.3.2 Calibration Procedure

The cable included with the **7000-09** Calibration Kit should be used for connection to the **7600 PLUS VSTM** unless a cable of different length is to be used for testing, in this case a cable of this length should be used for calibration. It is important that the cable used remain in the same orientation throughout the calibration procedure. Maintain good metrology practices and handle the components of the calibration kit with care.

Select CALIBRATION on the Utilities menu. Once ENTER is selected the calibration code of 7600225 must be entered to continue. This code is to prevent unauthorized personnel from effecting the instrument calibration. For security reasons it may be desirable to blank out the code (above) in this instruction manual.

The step by step instructions for this procedure are shown on the instrument display.