♦ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ♦

7660

Precision LCR Meter
User and Service Manual

Visit www.ietlabs.com for manual revision updates

7660 im/August 2023

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WARRANTY

We warrant that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable IET specifications. If within one year after original shipment, it is found not to meet this standard, it will be repaired or, at the option of IET, replaced at no charge when returned to IET. Changes in this product not approved by IET or application of voltages or currents greater than those allowed by the specifications shall void this warranty. IET shall not be liable for any indirect, special, or consequential damages, even if notice has been given to 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 OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

WARNING

OBSERVE ALL SAFETY RULES
WHEN WORKING WITH HIGH VOLTAGES OR LINE VOLTAGES.

Dangerous voltages may be present inside this instrument. Do not open the case
Refer servicing to qualified personnel

HIGH VOLTAGES MAY BE PRESENT AT THE TERMINALS OF THIS INSTRUMENT

WHENEVER HAZARDOUS VOLTAGES (> 45 V) ARE USED, TAKE ALL MEASURES TO AVOID ACCIDENTAL CONTACT WITH ANY LIVE COMPONENTS.

USE MAXIMUM INSULATION AND MINIMIZE THE USE OF BARE CONDUCTORS WHEN USING THIS INSTRUMENT.

Use extreme caution when working with bare conductors or bus bars.

WHEN WORKING WITH HIGH VOLTAGES, POST WARNING SIGNS AND KEEP UNREQUIRED PERSONNEL SAFELY AWAY.

CAUTION

DO NOT APPLY ANY VOLTAGES OR CURRENTS TO THE TERMINALS OF THIS INSTRUMENT IN EXCESS OF THE MAXIMUM LIMITS INDICATED ON THE FRONT PANEL OR THE OPERATING GUIDE LABEL.

Contents

Figures

Revisions

Firmware	Date	Change
1.04	August 18, 2023	Initial release with Eurofin comments
1.06	September 2023	Clarify operation of Range Lock

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CE Declaration of Conformity

According to EN ISO/IEC 170501:2010

Manufacturer's Name: IET Labs, Inc

Address: 99 Powerhouse Road #302, Roslyn Heights, NY 11577

Declare that:

Product Name: Precision LCR Meter

Model Number: 7660 Series

Product Options: Covers all product options and accessories

In accordance with the following Directives:

Low Voltage Directive 2014/35/EU (as amended)

(See Eurofins LVD Report 7660 Series)

EMC Directive 2014/30/EU (as amended)

(See Eurofins CE_Verification of Compliance_C234151)

RoHS Directive 2011/65/EU (as amended)

Has been designed and manufactured to the following Specifications:

EN 61010-1:2010/A1:2019 (Eurofins Report EFTW126746A)
EN IEC 61010-2-030:2021 (Eurofins Report EFTW126746B)
BS EN 61010-1:2010+A1:2019
BS EN 61010-2-030:2021+A11:2021
EN 61326-1:2021
BS EN IEC 61326-1:2021
EN IEC 61326-2-1:2021
BS EN IEC 61326-2-1:2021
EN IEC 61000-3-2: 2019+A1:2021
BS EN IEC 61000-3-2:2019+A1:2021
EN 61000-3-3: 2013+A2:2021
BS EN 61000-3-3: 2013+A2:2021
EN 55011:2016+A2:2021
BS EN 55011:2016+A2:2021
RoHS EN IEC 63000:2018

I, the undersigned, hereby declare that the equipment specified above has been designed to comply with the relevant sections of the above referenced Specifications. The unit complies with all essential requirements of the Directive(s).

Signed:  Date of Issue: August 21, 2023

Safety Symbols

General definitions of safety symbols used on the instrument or in manuals are listed below.

Caution symbol: the product is marked with this symbol when it is necessary for the user to refer to the instruction manual.

Hazardous voltage symbol: the product is marked with this symbol when high voltage maybe present on the product and an electrical shock hazard can exist.

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

Direct current.

Alternating current.

Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

On supply.

Off supply.

Hot surface. Avoid contact. Surfaces are hot and may cause personal injury if touched.

Disposal

Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

This product complies with the WEEE Directive (2002/96/EC) marking requirements.

The affixed label indicates that you must not discard this electrical/ electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE directive Annex 1, this product is classified as a “Monitoring and Control instrumentation” product.

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 take back your old appliances for disposal.

Proposition 65 Warning for California Residents

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov.

This product may contain chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm

Safety Precautions

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific WARNINGS elsewhere in this manual may impair the protection provided by the equipment. Such noncompliance would also violate safety standards of design, manufacture, and intended use of the instrument.

IET Labs assumes no liability for the customer's failure to comply with these precautions.

The 7660 complies with INSTALLATION CATEGORY I as well as POLLUTION DEGREE 2 in IEC61010-1.

If an instrument is marked CAT I (IEC Measurement Category I), or it is not marked with a measurement category, its measurement terminals must not be connected to line-voltage mains.

The 7660 is an indoor use product.

DANGEROUS PROCEDURE WARNINGS

Comply with all WARNINGS - Procedures throughout in this manual and instructions on the instrument protect you from potential hazard. These instructions contained in the warnings must be followed**.**

BEFORE APPLYING POWER

Verify that all safety precautions are taken. Make all connections to the instrument before applying power. Note the instrument's external markings described under "Safety Symbols".

GROUND THE INSTRUMENT

This is a Safety Class I instrument. To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The power terminal and the power cable must meet International Electrotechnical Commission (IEC) safety standards.

• DO NOT Operate in an Explosive Atmosphere

• For Safety the 7660 chassis must be used only with the supplied 3 prong power cord

• Do not operate the instrument in the presence of inflammable gasses or fumes

• Operation of any electrical instrument in such an environment clearly constitutes a safety

hazard

• Use Caution around live circuits and whenever hazardous voltages > 45 V are present

• Operators must NOT remove instrument covers

• Component replacement and internal adjustments must be made by qualified maintenance

personnel only

• DO NOT substitute parts or modify the instrument

• When working with high voltages; post warning signs, train personnel and keep unauthorized

personnel away.

Do not apply any voltage or currents to the terminals of the instrument in excess of the maximum limits indicated in the specifications section of this manual.

7660 Specifications

Applications of the 7660 Precision LCR Meter:

The 7660 Precision LCR Meter is designed for various applications to measure the electrical characteristics of passive components, including inductors, capacitors, and resistors.

Its primary applications are as follows: quality assurance inspection, research and development, educational purposes, calibration in laboratory and others.

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	LAN	
|Z|, R, X:	000.0001 mΩ to 99.99999 MΩ	
Ranges:	|Y|, G, B:	00000.01 µS to 9.999999 MS
	C:	00000.01 fF to 9.999999 F
	L:	0000.001 nH to 99.99999 H
	D:	.0000001 to 99.99999
	Q:	.0000001 to 999999.9
	Phase Angle:	-180.0000 to +179.9999 degrees
	Delta %:	99.9999 % to +99.9999 %

Measurement		Fast	Medium	Slow
Accuracy:	LCR:	± 0.5%[1]	± 0.25%[1]	± 0.05%[1]
	DF:	± 0.005	± 0.0025	± 0.0005

[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.

0.25 x (normal accuracy) with Load Correction implemented and compared to user supplied standard.

In a range of 3Ω ≤ Z ≤ 80kΩ, 100mV ≤ programmed V ≤ 1V or

100mV ≤ (programmed I) x (Z) ≤ 1V

Test Frequency: 10 Hz to 2 MHz

Resolution: 6 digits or 0.05 Hz

Frequency accuracy: ± (0.01% + 0.10 Hz)

Measurement Speed:

Max:	120 meas/sec
Fast:	120 meas/sec
Medium:	16 meas/sec - 8 meas/sec below 150kHz
Slow:	2 meas/sec – 1 meas/sec below 150kHz

* may be longer, depending on test conditions & frequency

Ranging: Automatic, Range Hold, or User-Selectable

Source Impedance: 25Ω, 400Ω, 6.4 kΩ or 100 kΩ, measurement range dependent

Trigger: Internal (automatic); External (via handler, LAN, USB, RS-232 or GPIB interfaces)

AC Test Signal Voltage: 20 mV to 5.0 V (open circuit) in 5 mV steps, <500kHz

20 mV to 1.0 V (open circuit) in 5 mV steps, ≥500kHz to≤1MHz

20 mV to 0.5 V (open circuit) in 5 mV steps, >1MHz

Accuracy: ± (5% + 1 mV) < 100kHz

± (10% + 1 mV) 100kHz to 500kHz

± (20% + 1 mV) 500kHz to 1MHz

± (35% + 1 mV) > 1MHz

AC Test Signal Current: 250 µA to 100 mA (short circuit) in 50 µA steps

Max Compliance: 3V < 500kHz, 1V from 500kHz - 1MHz; 0.5V > 1MHz

Accuracy: ± (5% +50 µA) < 100kHz

± (10% +50 µA) 100kHz to 500kHz

± (20% +50 µA) 500kHz to 1MHz

± (35% +50 µA) > 1MHz

Bias Voltage: Internal: 2.0 V External: 0 to ±200 V

Display: 7.0" TFT, 800×480 color screen
Results of Dual Measurement Parameters in engineering (6 digits) or scientific (6 digits) notation
Deviation from Nominal of Primary Parameter
% Deviation from Nominal of Primary Parameter
Instrument Setting and Test Conditions
Bin Limits and Pass/Fail Results
Plot of Primary Measurement Parameter vs. Test Conditions
Table of Measurement Parameters vs. Test Conditions
Sequenced Test Results Summary

Limit Detection: 15 bins total (10 pass, 4 fail, 1 no contact)
Interfaces: USB host Port, USB Type B, RS-232, Handler, GPIB and LAN
Front Panel Four terminal (BNC)

Environmental: MIL-T-28800E, Type 3, Class 5, Style E & F.
Operating: 0^{o} to + 50^{o} C.

Storage and transportation environmental conditions: - 10^{o} to + 60^{o} C.
Humidity: < 75% for 11^{o} C to 30 ^{o} C operating
Altitude: <2000m, Installation Category II, Pollution Degree 2
Mechanical: Bench mount with tilt bail
Dimensions: (w x h x d): 410 x 150 x 360mm
Weight: 8kg net, 10.5kg shipping

Power Requirements: 100 to 240Vac±10% 50 - 60 Hz 100W maximum

Other Features: Charged Capacitor Protection: $\sqrt{8/C}$ for Vmax ≤ 250 V
$\sqrt{2/C}$ for Vmax ≤ 1000V
C = Capacitance in farads of the device under test
Measurement Delay programmable from 0-1000 ms in 1 ms steps

	Measurement Averaging programmable from 1-512
	Median value Mode
	Open and Short Circuit Zeroing at Multiple Frequencies
	Power Fail Protection (setting, results, & calibration data stored)
	Storage and Recall – Internal Memory, USB, ASCII format
	Self-Test Routines at Power-up
	Contact Check
Supplied:	Instruction Manual, Power Cable, Calibration Certificate

Ordering Information Catalog No.:

7660 Precision LCR Meter	**7660**
Options & Accessories:	
Rack Mount Kit	7000-00
BNC Cable Set, 1 meter	1689-9602
BNC Cable Set, 2 meters	1689-9602-2
Kelvin Clip Leads	1700-03
Alligator Clip Leads	7000-04
Chip Component Tweezers	7000-05
Low Voltage Axial/Radial Lead Component Test Fixture	7000-06
Low Voltage Chip Component Test Fixture	7000-07
Calibration Kit	7000-09
RS232 Null Modem Cable	630158

1 Introduction

1.1 Unpacking and Inspection

Inspect the shipping carton before opening; if damaged, contact the carrier's agent immediately. Inspect the instrument for any damage. If the instrument appears damaged or fails to meet specifications, notify IET Labs or its local representative. Retain the shipping carton and packing material for future use such as returning for re calibration or service.

1.2 Product Overview

The 7660 Precision LCR Meter is an automatic, user-programmable instrument for measuring a wide variety of impedance parameters. The 7660 covers a frequency range from 10 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. Extensive pass/fail binning capability and measurements speeds of up to 120/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. Additionally, a parameter can be plotted against a test condition variable, an invaluable technique for component design and product evaluation.

The 7660 comes with RS-232, handler, USB host port, USB Type B, GPIB and LAN interfaces, all standard for remote control via a PC or other controller.

The USB host port is included for program/data storage of test conditions and for transferring screenshots to a PC. The 7660 can be used with most USB memory sticks that are FAT16/FAT32 format; maximum consumption current must be below 500 mA. 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.

1.3 Purpose of the 7660 precision LCR Meter

Purpose of the 7660 Precision LCR Meter:

The 7660 Precision LCR Meter is designed for various applications to measure the electrical characteristics of passive components, including inductors, capacitors, and resistors.
Its primary applications are as follows:

- Quality Assurance Inspection
- Research and Development
- Educational Purposes
- Calibration in Laboratory

Figure 1 7660 Precision LCR Meter

1.4 Controls and Indicators

Figure 2 shows the controls and indicators on the front panel of the 7660.

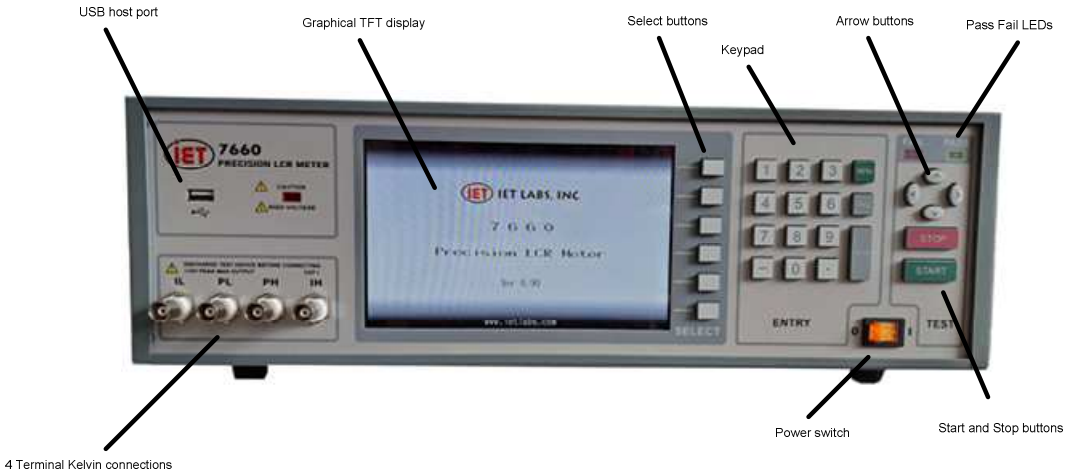


Figure 2 Front Panel Controls & Indicators

Figure 3 shows the controls and indicators on the rear panel of the 7660.

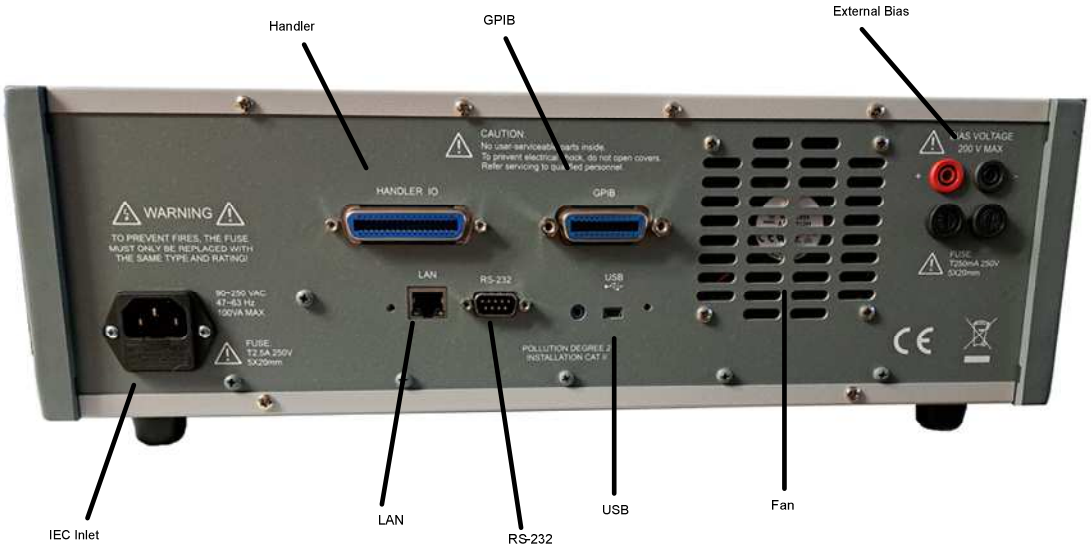


Figure 3 Rear Panel Controls & Indicators

1.5 Accessories Included

7660 Instruction Manual	1
Calibration Certificate	1
Power Cord (CE units with international cord set)	1
Fuse (T1.6A, 250V, 5x20mm, for 115/220V operation)	1
	1

1.6 Accessories/Options Available

Rack Mount Kit	7000-00
BNC Cable Set, 1 meter	1689-9602
BNC Cable Set, 2 meters	1689-9602-02
Kelvin Clip Leads	1700-03
Alligator Clip Leads	7000-04
Clip Component Tweezers	7000-05
Low Voltage Axial/Radial Lead Component Test Fixture	7000-06
Low Voltage Chip Component Test Fixture	7000-07
Calibration Kit	7000-09
RS232 Null Modem Cable	630158

1.7 Installation

The 7660 contains a high resolution TFT display 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.

1.7.1 Power Requirements

The 7660 Precision LCR Meter can be operated from a power source between 90 and 240Vac at a power line frequency of 50 and 60 Hz, 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. Always use an outlet that has a properly connected protection ground. Before connecting the 3-wire power cord between the unit and AC power, verify the fuse is in accordance with the power source, T1.6A, 250V, for 115 or 220V source. The 7660 is factory shipped with the 1.6A fuse in place. The instrument can be damaged if the wrong fuse is installed. To change the fuse, proceed as follows:

Procedure

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 4.

Once the fuse drawer 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 drawer. This tray contains the active fuse, left side (secured by holder) and spare fuse on the right side (if present).

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 drawer back into the instrument ac inlet module, push in and lock.

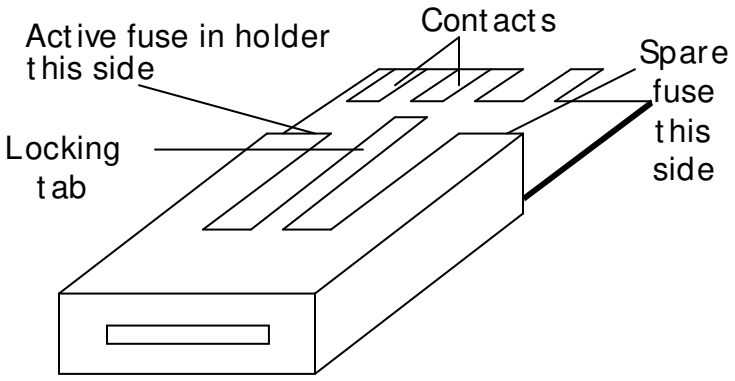


Figure 4 Fuse Drawer

1.7.2 Safety Inspection

WARNING

If this instrument is used in a manner not specified in this manual, the operator and the equipment are at risk.

1. Never touch the metal of the High Voltage probe directly. Touch only the insulated parts of the lead(s).
2. Never touch the test leads, test fixture or DUT in any manner (this includes insulation on all wires and clips) when the high voltage is applied and the red DANGER light is ON.
3. Before turning on the Guardian unit, make sure there is no device (DUT) or fixture connected to the test leads.
4. After each test, press the [STOP] (red) button for safety. This terminates the high voltage being applied to the output terminals.
5. When the red DANGER LED is lit or flashing, NEVER touch the device under test, the lead wires or the output terminals.

6. Before touching the test lead wires or output terminals make sure :
    a) The red [STOP] button has been pressed
    b) The red DANGER LED is OFF.
7. In the case of an emergency, turn OFF the POWER switch using a “hot stick” and disconnect the AC power cord from the wall. DO NOT TOUCH THE INSTRUMENT.
8. Position the equipment so it is easy to disconnect. Disconnect by means of the power plug or power connector.
9. If the DANGER LED does not go off when the [STOP] button is pressed, immediately stop using the tester. It is possible that the output voltage is still being delivered regardless of the TEST ON/OFF control signal.
10. When the instrument is remotely controlled, be extremely careful. The High Voltage Output is being turned On/Off with an external signal.

CAUTION

Before operating the instrument, inspect the power inlet module on the rear of the 7660 to ensure that the **properly rated fuse is in place**, otherwise damage to unit is possible.

When the 7660 is installed in a rack (using the IET Labs 7000-00 Rack Mount Kit) verify the unit is **secured using the cabinet mounting rails** and not solely by the front panel angle brackets.

In bench or rack mount applications, the instrument should be positioned with consideration for **ample airflow**. Verify an open space of at least 3 inches (75mm) behind the rear panel. The surrounding environment should be **free from excessive dust** to prevent contamination of electronic circuits.

The 7660 is shipped with a standard U.S. power cord, IET Labs PN 4200-0300 (with Belden SPH-386 socket or equivalent, and 3 wire plug conforming to IEC 320) or with an approved international cord set. Make sure the instrument is only used with these cables (or other approved international cord set) that ensures the instrument is provided with **connection to protective earth ground.**

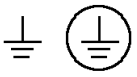
1.7.3 Safety Symbols

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.

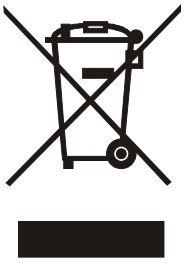
Caution Avoid product misuse. It may cause damage to the product itself and the DUT if the caution is neglected.

Note Important information or tips for the procedures and applications.

Warning Signal During Testing

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

1.7.4 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 take back your old appliances for disposal.

2 Operation

Once the 7660 is powered up it is ready immediately for testing, at default test conditions, by pressing the START button. Any of these conditions and all other instrument operations can be changed by easy-to-use menu functions, for simplicity of understanding, descriptions and uses of all these functions refer to menu discussions starting on page 13. The Contents list in the front of this manual should be used for quickly locating specify subjects of interest.

2.1 Startup

Connect the instrument power cord to the source of proper voltage. **The instrument is to be used only with three-wire grounded outlets.**

Power is applied to the 7660 by pressing the **POWER** button on the front panel. The instrument runs a self test and any error messages are displayed accordingly.

2.2 Connection to Device Under Test

The 7660 unit employs a four terminal measurement configuration that permits easy, accurate and stable measurements and avoids mutual inductance, interference from measurement signals, noise and other factors inherent with other types of connections. To maintain measurement integrity IET Labs makes available a number of accessory cable sets and fixtures for connection directly to the front panel BNC connectors. Refer to section 1.6 on page 5 for a list of available accessories.

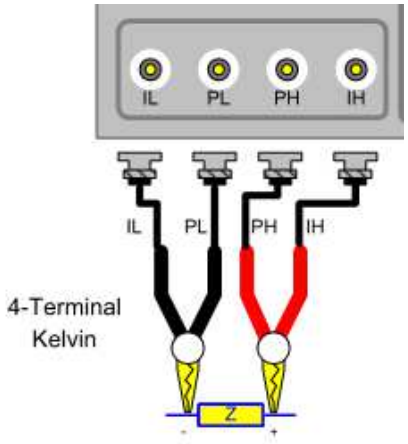


Figure 5 Test Lead Configuration

Figure 5 shows the 7660 connector configuration and a typical four terminal connection to the device under test. **H and L on the 7660 denote polarity of AC test signal at the measurement terminals as well as + and - polarity of DC bias voltage when applied to the DUT.**

WARNING

When DC bias is applied, the PH connection carries a positive DC voltage with respect to ground.

2.3 Zeroing

Before making measurements, the 7660 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 the IET Labs one meter cable (7000-01). Perform the Open and Short circuit zeroing with the cables and fixtures to be used during testing. In order to maintain instrument accuracy with other cable lengths the instrument should be re calibrated using the IET Labs 7000-09 Calibration Kit and the alternate cable. Generally the unit should be zeroed at least once per day and each time test leads or fixture is changed. **It is not necessary to re-zero if the test frequency is changed.** The zeroing routine is accessed through the Utilities Menu as follows:

1. Press **MENU** key
2. Press **LEFT/RIGHT ARROW** to select Utilities menu
3. Press **UP/DOWN ARROW** key for Open / Short
4. Press **ENTER**

Follow the instructions shown on the TFT 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). When zeroing, **Contact Check should be OFF, # to Average to 1 and Median OFF.**

2.4 Measurement Procedure

Whenever the 7660 is powered up it is ready immediately to begin measuring at default test conditions. Initially, these conditions will be set to factory default but can be changed by the user and stored to overwrite factory default. **To initiate a test once a device is connected press START,** the TFT display shows the measured results and test conditions similar to the illustration of Figure 6.

NOTE:

For optimum measurements, warm up for 30 minutes.

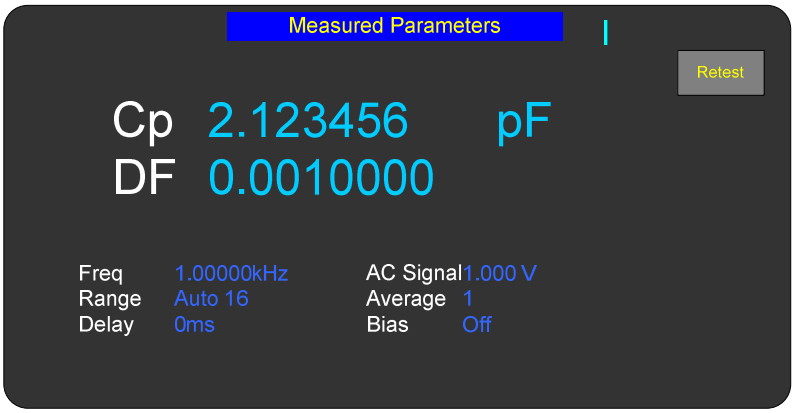


Figure 6 Measured Results Display

2.4.1 Default Measurement Conditions

A set of default measurement conditions are initially established at the factory and stored in instrument memory. Default 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. These conditions can be changed by the user for tailoring to a specific application. Refer to section 2.9.1 on page 50.

2.5 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

Under I/O Menu

Display Type - Measured Parameters

Nominal Value - None

Result Format - Engineering

Trigger - External

Handler - Off

Interface: RS-232 – Enabled

Under Analysis Menu

Binning - None

Test Sequencing - Off

Parameter Sweep - Off

Median – Off

Under Utilities Menu

Open – On

Short - On

Load Correction – Off

Cable Length – 1 m

2.6 Menu Functions

All programmable functions of the 7660 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 using the **UP, DOWN, RIGHT** and **LEFT** arrow keys. **A red menu function can be controlled by selecting the ENTER key, or entering the desired entry or selection.**

2.6.1 Setup Menu

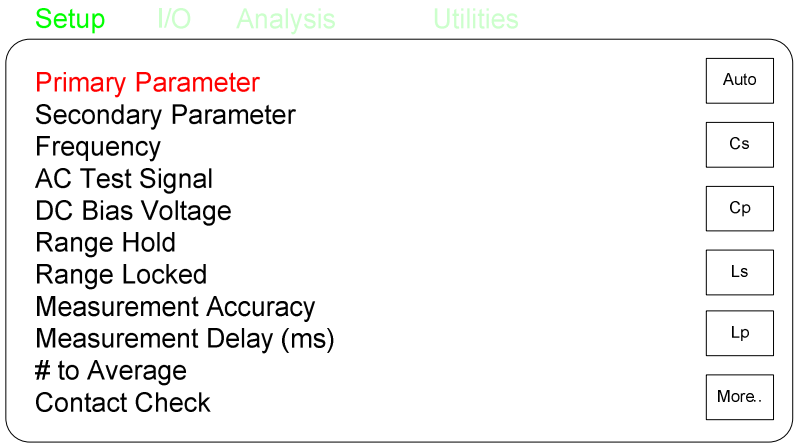


Figure 7 Setup Menu

The first of the four main menus is **Setup**, shown above. Each function controls a 7660 measurement condition and is described in detail below.

Setup I/O Analysis Utilities

- Primary Parameter {Auto, Cs, Cp, Ls, Lp, Rs, Rp, DF, Q, |Z|, |Y|, Ø, |ESR|, GP, Xs, Bp}
- Secondary Parameter {None, DF, Q, |ESR|, Ø, Rs, Rp, GP,Cs, Cp, Ls, Lp, |Z|, |Y|, Xs, Bp, }
- Frequency <numeric entry>
- AC Test Signal <numeric entry 10 Hz – 2 MHz>
- DC Bias Voltage {Off, Internal, External}
- Range Hold {Off, On}
- Range Locked <numeric entry 1 – 16>
- Measurement Accuracy {Max., Fast, Medium, Slow}
- Measurement Delay <numeric entry 0 – 1000 ms>
- # to Average <numeric entry 1 - 512>

2.6.2 Primary Parameter

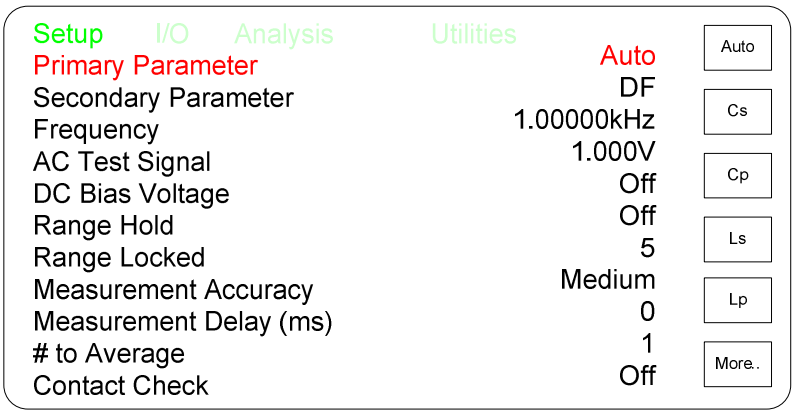


Figure 8 Primary Parameters

Additional Parameters not shown are selected by pressing the **More… SELECT** key

Any combination of two parameters can be measured and displayed simultaneously on the 7660, one referred to as the **Primary** (displayed first) and the other the **Secondary**. The instrument as powered up provides a default primary parameter selection of Auto, a feature which enables any passive component to be measured without knowing what type of component it is. Depending on the component type the primary and secondary default could be Cs & DF, Rs & Q, or Ls & Q. The parameter selection can be chosen by the operator through menu selection. Besides Auto, the following selections are possible and discussed in more detail below.

Cs - Capacitance in farads

Cp - Capacitance in farads

Ls - Inductance in henries

Lp - Inductance in henries

Rs - Resistance in ohms

Rp - Resistance in ohms

DF- Dissipation Factor (no units)

Q - Quality Factor (no units)

s = series equivalent circuit

p = parallel equivalent circuit

|Z| - Impedance in ohms

|Y| - Admittance in siemens

θ - Angle in degrees

|ESR|-Equivalent series resistance in ohms

Gp - Conductance in siemens

Xs - Reactance in ohms

Bp - Susceptance in siemens

An impedance that is neither a pure resistance nor a pure reactance can be represented at any specific frequency by either a series or a parallel combination of resistance and reactance. Such a representation is called an equivalent circuit. The value of the primary measurement of a device depends on which equivalent circuit, series or parallel, is chosen to represent it. The manufacturer or user of a device specifies how a device is to be measured (usually series) and at what frequency. If this is not known, be sure to specify if the results were series or parallel and what the measurement frequency was.

Series and parallel equivalent circuits for a lossy inductor and lossy capacitor are shown in Figure 9.

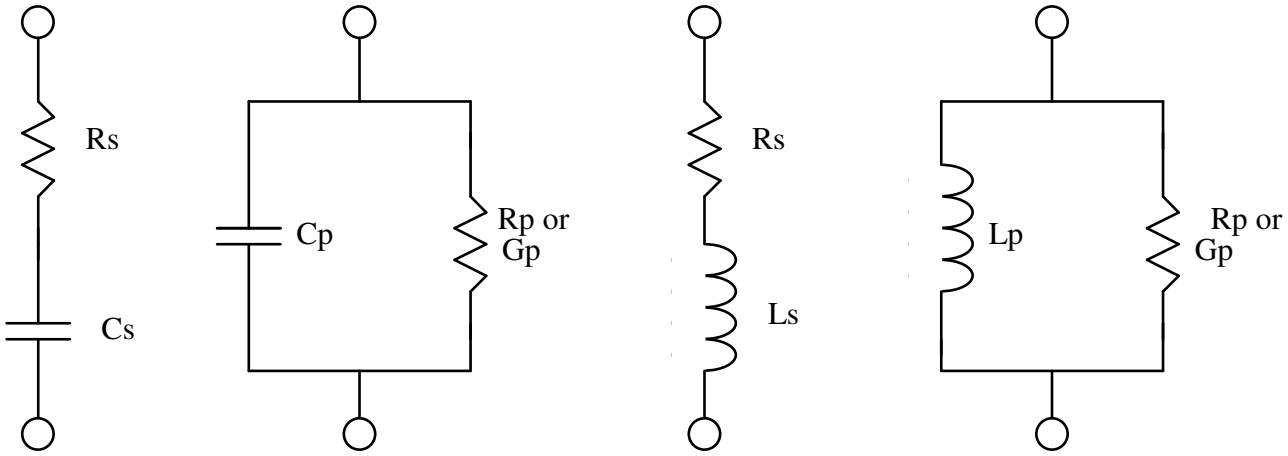


Figure 9 Series and Parallel Circuits for both Capacitive and Inductive Impedances

Impedance is the parameter used to characterize electronic sensors, components, materials and circuits. Impedance $|Z|$ is defined as the opposition a device or circuit offers to the flow of ac current at a particular frequency and generally represented as a complex quantity consisting of a real part (resistance, R) and imaginary part (reactance, jX). Impedance can be expressed using the rectangular coordinate form ($R + jX$) or polar form as magnitude and phase angle ($|Z| \angle\theta$). Figure 10 shows the mathematical relationship between R, X, $|Z|$, and θ for both inductive and capacitive devices. In some cases it becomes mathematically practical to represent impedance using the reciprocal where $1/|Z| = |Y| = G + jB$, where $|Y|$ represents admittance, G conductance, and B susceptance. This mathematical relationship is shown in Figure 11 for inductive and capacitive devices.

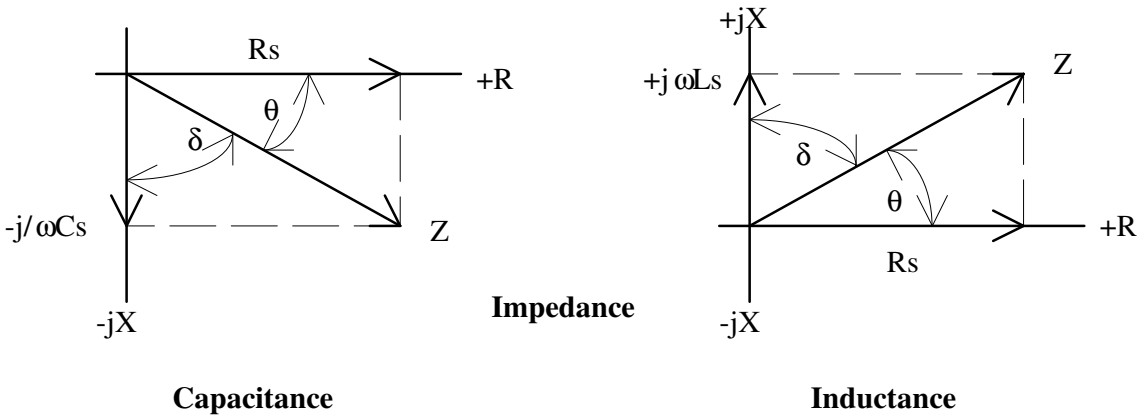


Figure 10 Phase Diagrams of Impedance

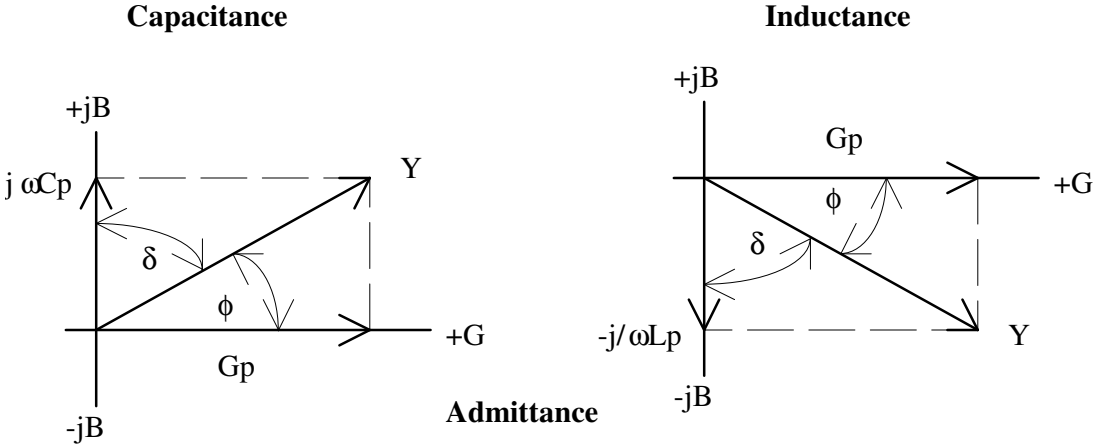


Figure 11 Phase Diagrams of Admittance

Quality factor (Q) is used as a measure of a reactance's purity (how close it is to being a pure reactance, i.e. no resistance) and defined as the ratio of the energy stored in a device to the energy dissipated by the device. Q is dimensionless and is expressed as Q = X/R = B/G. One can see that Q is the tangent of the angle θ. Q is commonly applied to inductors and for capacitors the term generally used to express purity is Dissipation Factor (D), which is the reciprocal of Q.

Any parameter, primary or secondary, can be chosen as the default parameter at power up.

2.6.3 Secondary Parameter

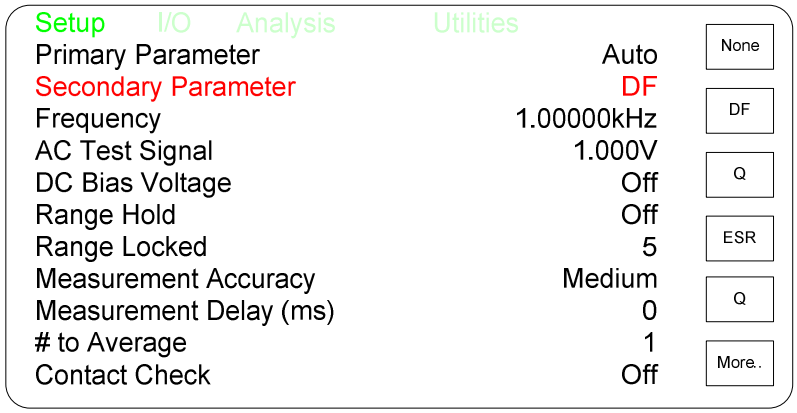


Figure 12 Secondary Parameter

Additional Parameters not shown are selected by pressing the **More.. SELECT** key

As in the primary parameter selection, any one parameter can be chosen by the operator for display. The instrument as powered up provides a default secondary parameter. When the default primary parameter is Auto the secondary parameter is dependent and determined by it. If the primary default is Cs the secondary defaults to D. If the primary default is Ls or Rs the secondary defaults to Q. The parameter selection can be chosen by the operator through menu selection.

2.6.4 Frequency

Numerical entry accepts up to **six digits with decimal**, of the desired test frequency between 10 Hz and 2 MHz. Resolution of setting is 0.01 Hz from 10 Hz to 10 kHz, 6 digits above 10 kHz.

Units of frequency, **Hz, kHz, or MHz** are selected by using **SELECT** keys.

2.6.5 AC Test Signal

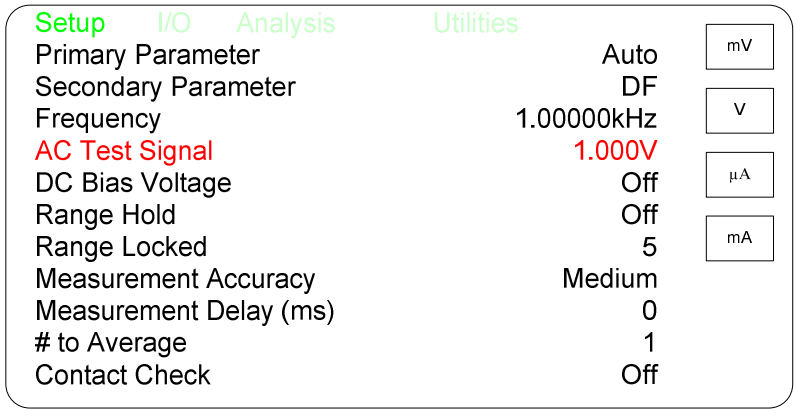


Figure 13 AC Test Signal

Allows selection of the AC Signal Type as a **Voltage** source or **Current** source and **Level**

Use ENTRY keys to enter a value then select units for voltage or current

For **Voltage**, enter a value between 0**.020 and 5 volts*** (open circuit) in 0.005 V steps.

For **Current,** enter 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, or mA** are selected using the **SELECT** 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.**

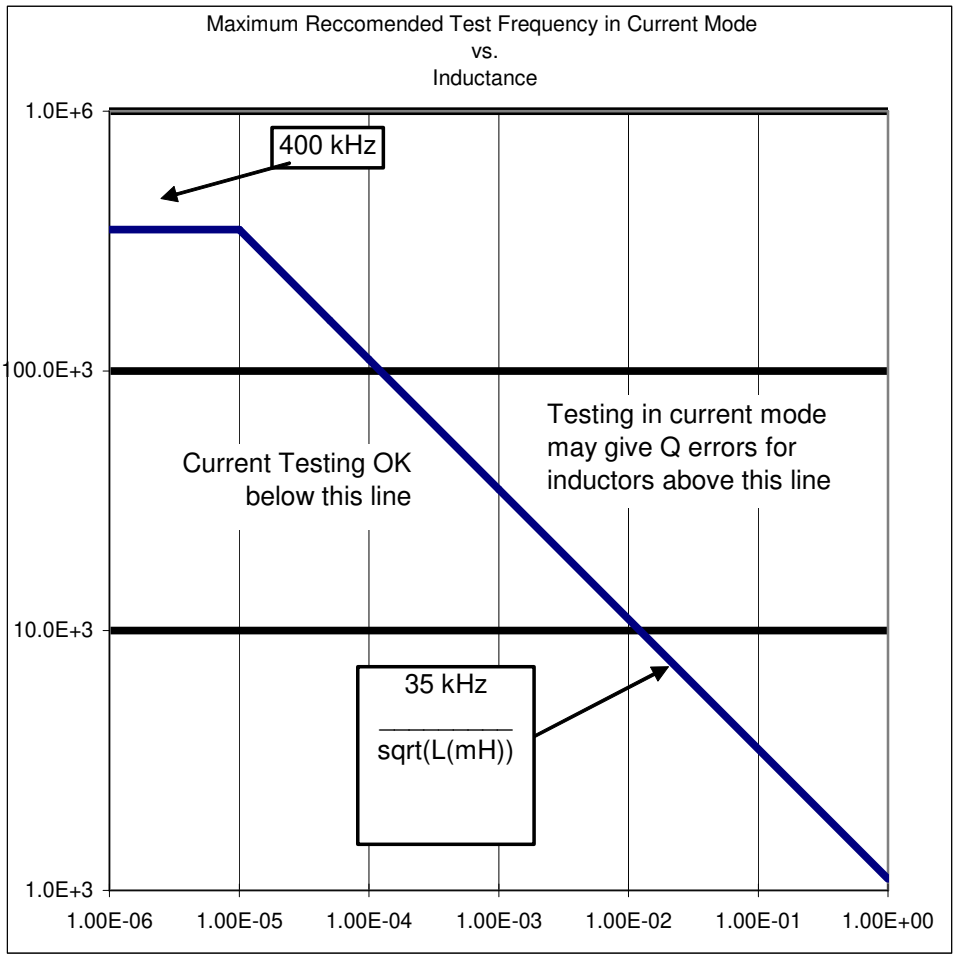
In voltage mode the selected voltage is maintained at the instrument test terminals with the terminals open, but not necessarily at the device under test. In current mode the selected current is maintained at the device under test, independent of changes in the device's impedance. It should be noted 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



Maximum Test Frequency vs. Measured Inductance (In Current Mode)

2.6.6 DC Bias Voltage

⎓ Allows selection of a dc Bias Voltage of **Off, Internal or External.**

- **Off** - When selected **no dc bias** voltage is applied to the device under test.
- **Int** - When selected an internal bias voltage of **2 volts** is applied to the device under test. Internal bias cannot be programmed if the AC Test Signal is programmed for > 4V at 500kHz.
- **Ext** - When selected an external bias voltage between **0 and ±200 volts** can be applied to the device under test by way of the rear panel external bias connection.

CAUTION

Make sure the **AC test Signal is selected for VOLTAGE and not Current** before switching to INT (internal) or EXT (external) bias. This also applies to the instrument's Default setup at power-up or any setups recalled from memory, they **MUST be set to VOLTAGE** before applying bias. If programmed to CURRENT the instrument can sustain damage from any external source or from a charge stored on the device under test

WARNING

When using external bias, unit must be programmed for EXT bias before the external bias supply is connected to the 7660.

External bias supply must be returned to zero volts and turned off before switching back to the OFF or INT mode.

The **BIAS ON indicator**, adjacent to the BNC measurement terminals, serves to indicate if external bias has been called for. It indicates that external bias connections have been switched in, **but not necessarily the presence of external bias.**

When dc bias is to be applied to a device observe the correct polarity when connecting the bridge or inserting the device in a test fixture. **Bias POSITIVE polarity is applied to the high terminals (PH, IH)**, and **bias NEGATIVE polarity applied to the low terminals (PL, IL)**. It is good practice to wait approximately 1 second after initiating a measurement before taking a reading, this allows the device to stabilize after bias is applied. When the instrument is triggered remotely, a programmed delay is advisable to ensure that the device has stabilized.

If bias is required at voltages other than the internal 2 volts, an external bias can be used as discussed below.

- **Be sure that the voltage does not exceed ±200 volts.**
- A current limiting voltage supply is recommended, with a limit set at 200 mA.
- **The bias supply must be floating, DO NOT connect either side to ground.** When using a single polarity supply for positive or negative biasing, observe proper polarity when connecting to the 7660. For positive bias the positive output of the supply must be connected to **Bias Voltage +** and the negative to **Bias Voltage -.** The opposite is true for negative bias, the negative output of the supply must be connected to the **Bias Voltage +** and the positive to **Bias Voltage -.**

- Generally the external circuit must provide switching for both application of bias after the device is connected and discharge before it is removed.
- A well-filtered supply is recommended. Hum can affect some measurements, particularly at power line frequencies. When applying a bias voltage there are effects to be aware of in watching for stabilization of the DUT: voltage and capacitance. Besides charging to a final voltage, there is also the stabilization of capacitance value itself. For example, some electrolytic capacitors respond slowly to a change in applied voltage, therefore the capacitance can be changing well after the voltage is stable. In general DC bias should only be applied to capacitors, **unreliable measurement results can occur if DC bias is applied to low impedance devices.** When applying external bias on capacitors below 200pF with an AC signal level below 100mV the instrument can exhibit excessive noise.

2.6.7 Range Hold

Allows selection of Range Hold **Off** or **On** and works in conjunction with the **Range Locked** field.

To eliminate operator errors in range setting and ensure specified instrument accuracy the 7660 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 16. The Range will be shown in the **Range Locked** field and on the measurement display as Range: Hold <n>. The range 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 7660 unit provides an extensive array of range switching based on the user test conditions selected and impedance being measured.

Range	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	2.5Ω	6.25Ω	24.9Ω			400Ω	1.6KΩ	4KΩ		6.4KΩ	25KΩ	64KΩ		100KΩ	400KΩ	1MΩ
Zx Hi (Ω)	3.15	9.15	125			2100	8400	∞		32K	128K	∞		525K	2.1M	∞
Zx Low (Ω)	0	2.81	7.56			76	1093	3335		5570	23.5K	59.35K		92.9K	373K	933K
F1: ≤ 50KHz	F1	F1	F1			F1	F1			F1	F1			F1	F1	F1
F2: ≤ 250KHz	F2	F2	F2			F2	F2			F2	F2	F2				
F3: > 250KHz	F3	F3	F3			F3	F3	F3								
Source Impedance	24.9Ω	24.9Ω	24.9Ω			400Ω	400Ω	400Ω		400Ω	400Ω	400Ω		400Ω	400Ω	400Ω

Table 1 Ranges and source impedance

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.**

Under certain circumstances high Q inductors can cause extraneous overload conditions if they are tested at frequencies where the inductor resonates with the test leads. This situation can be avoided by one or more of the following: test at a voltage substantially below full scale voltage for a given range; use low capacitance cables; or test at a frequency below the resonant frequency of the inductor with the test leads.

2.6.8 Range Locked

Accepts entry of selected measurement ranges between **0** and **16**. An error of **Invalid range selected** will be shown if the measurement range selected is not valid for the current setup. When a range is entered, **Range Hold** will be turned **On.** When the range is set to **0, Range Hold** will be set to **Off** to enable **Auto Range.** Setting **Range Hold** to **Off** will also enable **Auto 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**.

2.6.9 Measurement Accuracy

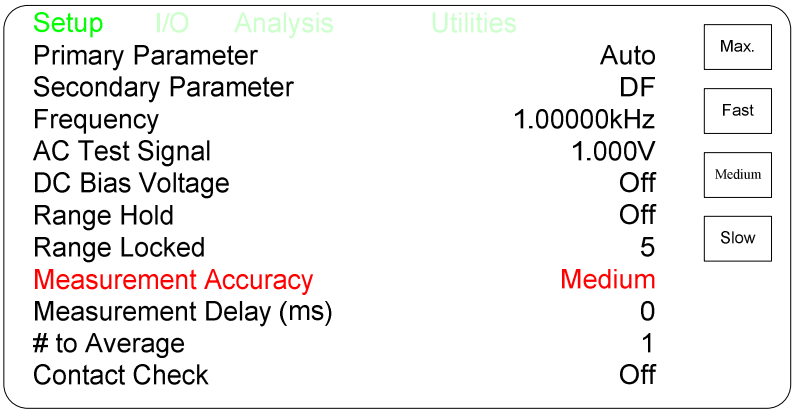


Figure 14 Measurement Accuracy

Allows selection of Measurement Accuracy/Speed of **Max., Fast, Medium** or **Slow.**

The accuracy of 0.05%, 0.25% and 0.5% are best case accuracy based upon the speed selected.

See Section 2.9.3 for the actual measurement accuracy based upon DUT and measurement setup.

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:

- **Max.** – Maximum rate of measurement
- **Fast** - Measurement time of 8.333 ms (or one frequency cycle, whichever is longer), nominal accuracy of **0.5%**.

- **Medium** - Measurement time is 125 ms, nominal accuracy of **0.25%.**

  Note: Above 150kHz Measurement time is 62.5 ms

- **Slow** - Measurement time is 1 sec, nominal accuracy of **0.05%.**

  Note: Above 150kHz Measurement time is 0.5 s

NOTE:

Measurement times may be longer depending on frequency and other test conditions. One complete cycle of stimulus voltage is required for measurement.

For example: at 10 Hz, 100 ms (1 cycle) is required just to collect data.

2.6.10 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.

2.6.11 # to Average

Accepts entry of the number of measurements to Average between **1 and 512.** If the entered value is 1, averaging is disabled and the display is updated with each individual measurement. If the average is 2 to 512 the final average value is displayed at the end of the measurement cycle and held until the end of the next measurement cycle.

Measurement accuracy can be improved as noted (but never less than 0.05% for primary parameter or 0.0005 for secondary parameter).

If the number to average is greater than 1:

Divide the primary accuracy by the square root of the number to average.

Divide the secondary accuracy by the square root of the number to average.

2.6.12 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 7660. For Contact Check operation, the Range Hold must be selected ON**.

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.

2.7 I/O Menu

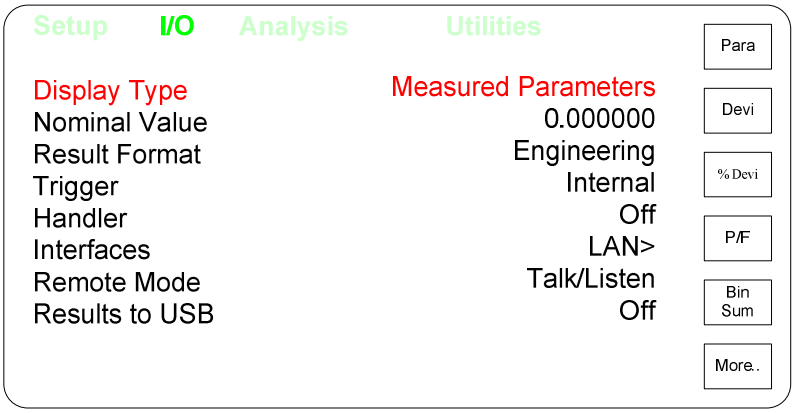


Figure 15 I/O Menu

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.

Setup I/O Analysis Utilities

- Display Type {Measured Parameters, Deviation from Nominal, % Deviation from Nominal, Pass/Fail, Bin Summary, Bin Number, No Display}
- Nominal Value <numeric entry>
- Result Format {Sci., Eng.}
- Trigger {Internal, External}
- Handler {On, Off}
- Interfaces>> RS-232 >>
  - Baud {1200,2400,4800,9600,19200, 38400,56000,115200,230400,460800}
  - Parity {None, Odd, Even}
  - Data Bits {7, 8}
  - Stop Bit {1, 2}
  - IEEE >>
  - Address <numeric entry 1 – 16>
  - LAN >>
  - IP Config {Auto DHCP, Manual}
  - Configuration
  - USB VCP
- Remote Mode {Talk/Listen, Talk}
- Results To USB{Off, On}

2.7.1 Display Type

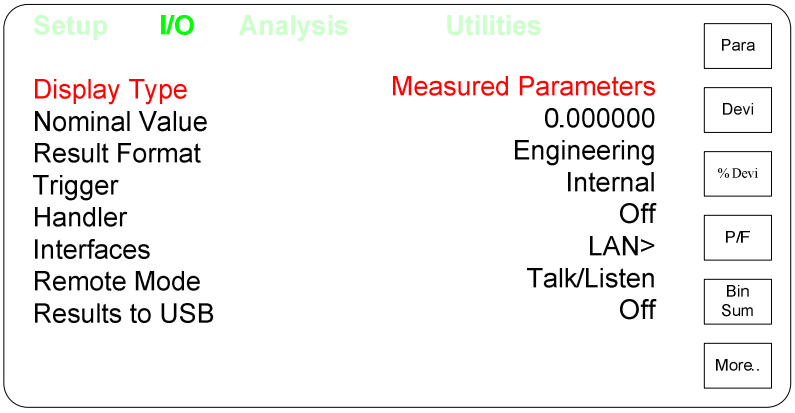


Figure 16 Display Type

Use the **SELECT** keys to select **Display Type**, additional display types not shown are selected by pressing the **More.**. **SELECT** key

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

2.7.2 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 a blue bar is shown when a measurement is in process, and the bar turns 45 degrees with each measurement, with the exception of short measuring times.

NOTE: Setting Bin Limits also controls the color of the Measured Parameter. i.e. if the Primary Parameter is within limits so pass, the measured value will be green otherwise red. The normal color for measured parameters is light blue.

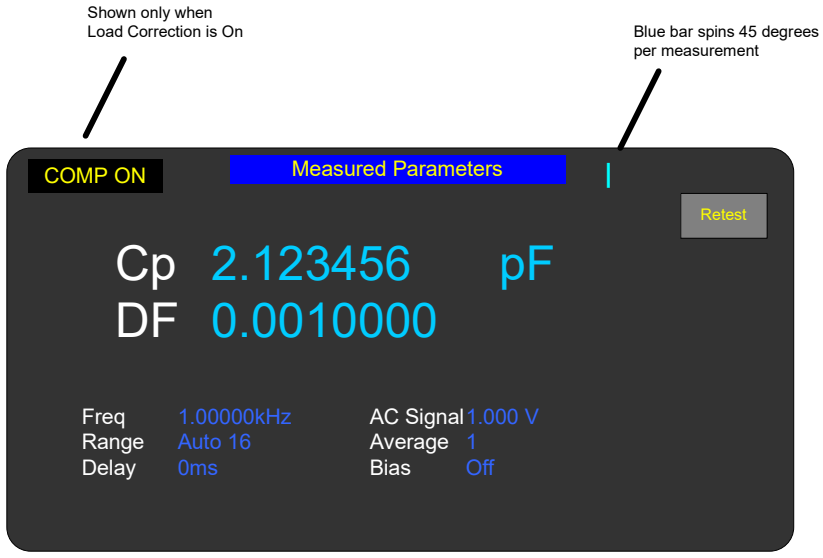


Figure 17 Measured Parameters Display

2.7.3 Deviation from Nominal –

Display is the difference in value above or below a stored nominal value for the primary parameter. It should be noted that the nominal value is only shown in this display and the % Deviation display.

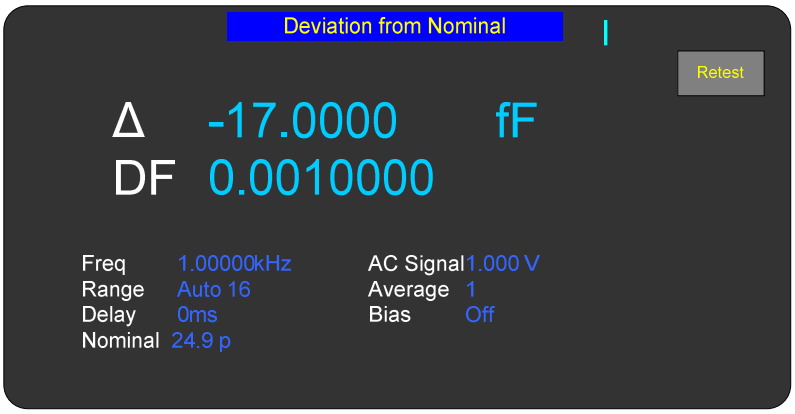


Figure 18 Deviation from Nominal Display

2.7.4 % Deviation from Nominal –

Display is the measurement in terms of a percent difference above or below (-) a stored nominal value. It should be noted that the nominal value is only shown in this display and the Deviation from Nominal display.

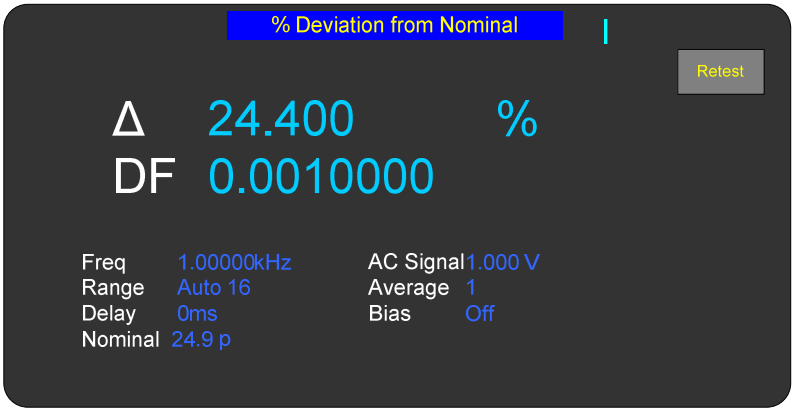


Figure 19 % Deviation from Nominal Display

2.7.5 Pass/Fail –

Display is measured results as a pass or fail only based on entered binning limits.

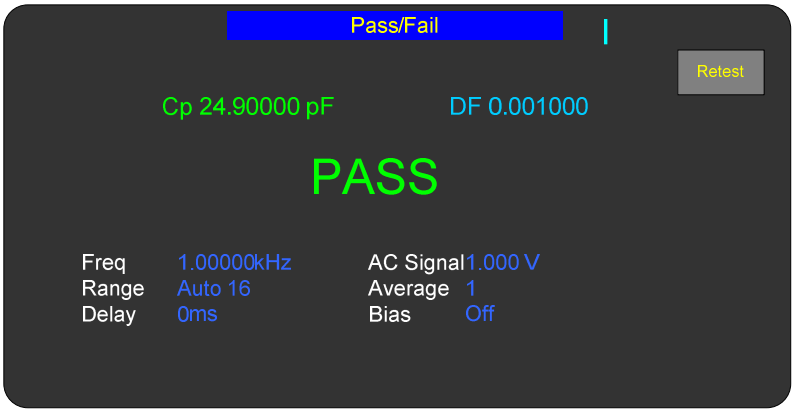


Figure 20 PASS/FAIL

2.7.6 Bin Summary –

Display is a summary of the entered bin limits and the total number of measurements made which meet the requirements of that bin since the bin counter was last reset.

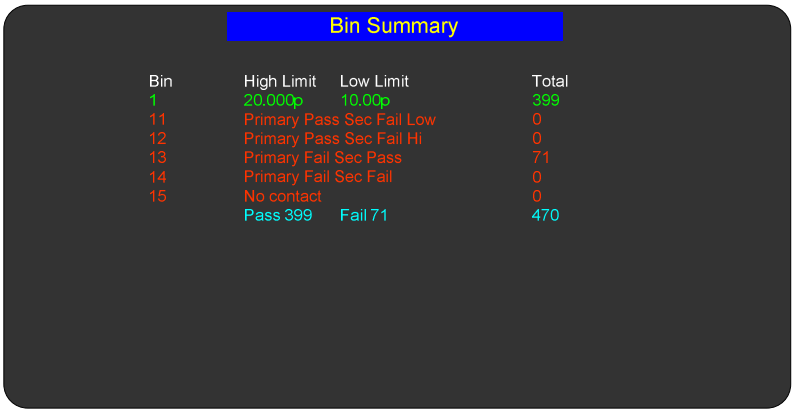


Figure 21 Bin Summary Display

2.7.7 Bin Number –

Display is a bin assignment, along with the currently programmed test conditions, for the most recent measurement result.

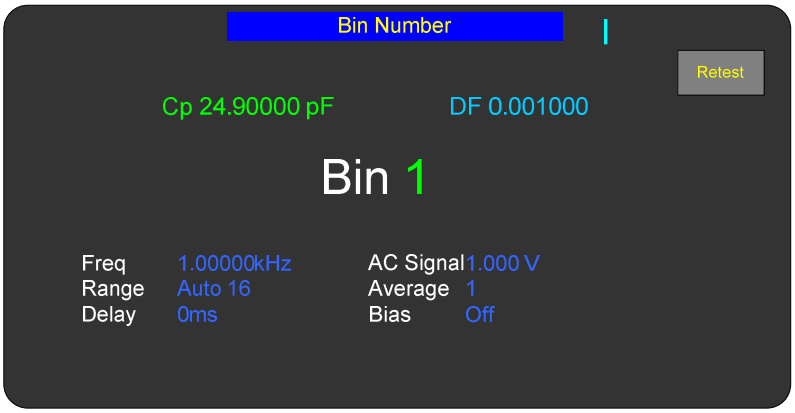


Figure 22 Bin Number Display

2.7.8 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.

2.7.9 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. Prefixes are selected by the **SELECT** keys.

NOTE:

The nominal value has no relationship to nominal values entered during binning setup.

2.7.10 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 kΩ in engineering units; or e^{-3} in scientific units can be expressed as mΩ 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 is selected the results will be displayed as some number of digits with decimal and units.

2.7.11 Trigger

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

- Internal - Measurement trigger is **automatic and continuous** once initiated with a START. If the STOP key is pressed in the middle of a measurement (with Range Hold set to OFF) any measurement range indication or displayed results is invalid.
- External - Measurement trigger is under **remote control** via front panel, handler, RS 232 or IEEE-488 interface.

2.7.12 Handler Interface

Allows user to turn Handler Interface function **On or Off.** When On is selected the input and output lines on the rear panel I/O interface connector are acknowledged. When Off is selected they are ignored.

2.7.13 Interfaces

Allows user to select which Interface: **Off, RS-232, GPIB, LAN** or **USB** is active and **Config** the selected interface.

The RS-232 and GPIB interface operation and commands are compatible with the 7600 Plus Precision LCR Meter.

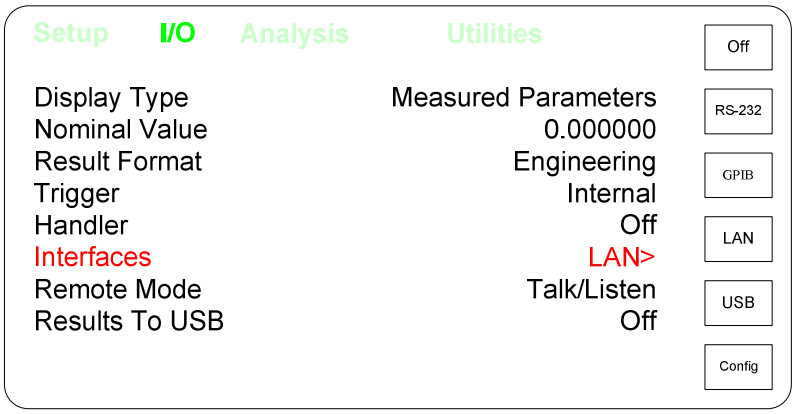


Figure 233 Interface Selection

2.7.14 RS-232 Interface

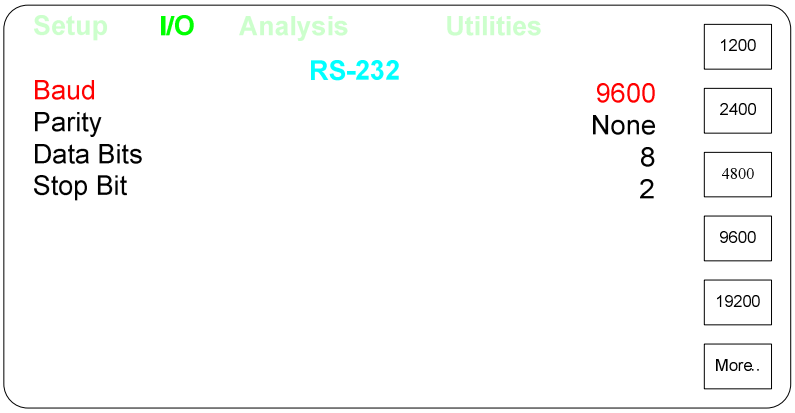


Figure 24a RS-232 Setup Format

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

Pressing the **ENTER** button key allows access to the **RS-232** menu.

Use the **UP/DOWN** arrows and use the **SELECT** keys to select the desired settings.

Use the **MENU** key to return to the **I/O** Menu.

2.7.15 IEEE-488.2 GPIB Interface

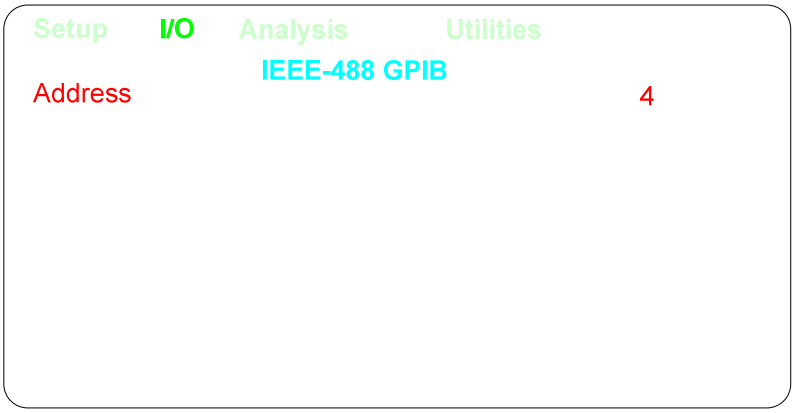


Figure 25 IEEE-488 GPIB Setup

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

Address - 1 through 16

Pressing the **ENTER** button allows access to the **IEEE** menu.

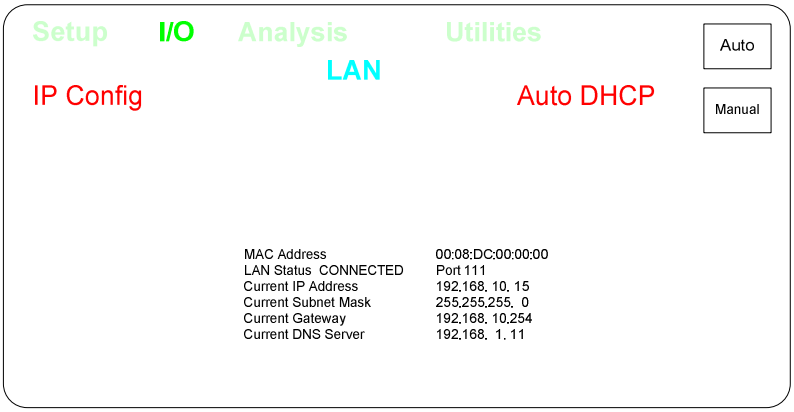
Use the **UP/DOWN** arrows and use the **SELECT** keys or **ENTRY** keys to select the desired settings.

Use the **MENU** key to return to the **I/O** Menu.

2.7.16 LAN

Allows user setup of the LAN interface settings. Choices include:

Auto DHCP - Automatic Selection (Recommended)
Manual - Allows user to enter: ip address, subnet mask, gateway and DNS server



Pressing the **ENTER** button allows access to the **LAN** menu.

Use the **UP/DOWN** arrows and use the **SELECT** keys or **ENTRY** keys to select the desired settings.

Use the **MENU** key to return to the **I/O** Menu.

An example of using NI Max and TCPIP Socket for communication to the 7660 via LAN can be found at the link below.

https://www.ietlabs.com/pdf/application_notes/035217 Using NI Max and TCPIP Socket to communicate to the 7660.pdf

2.7.17 USB

Allows user to select the **USB** interface. This is a **USB VCP** Virtual COM Port via the USB Type B connector on the rear panel. When connected to a Windows 10 PC the USB VCP driver should be automatically installed. This requires a USB Cable - USB A to USB B Cable - M/M.

2.7.18 Remote Mode

Allows user to select Talk or Talk/Listen Modes for the interface chosen.

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.

2.7.19 Results to USB

The 7660 Plus can be used with most USB memory sticks, mass storage class, FAT16/FAT32 format; maximum consumption current must be below 500 mA. 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.

Once the USB flash drive has been mounted a green flash drive symbol appears in the lower right corner of the screen.

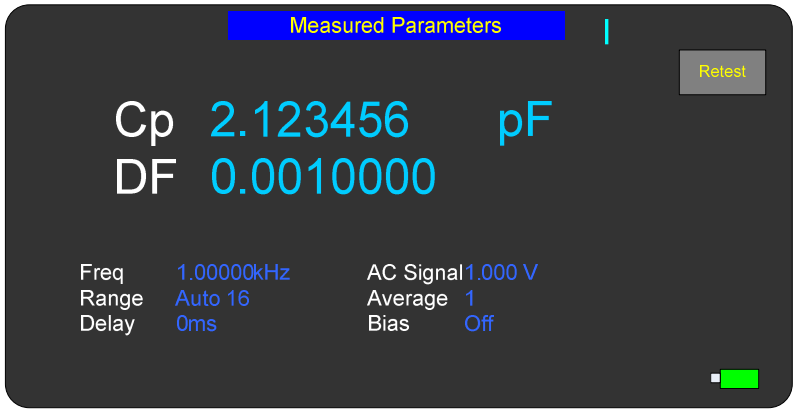


Figure 24a USB flash drive symbol

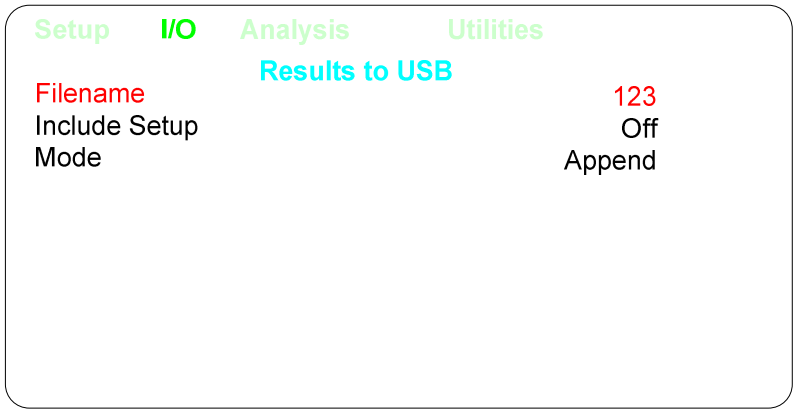


Figure 24b Results to USB Menu

Allows user to store measurement results on flash drive. Enter the **Filename**, **Include Setup** allows the setup can be included or not and then select the **Mode** to **Append** to an existing file or **Create** a new file.

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

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 if **Include Setup** is **On**.

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.

Sample file

Cp,104.3390,pF,DF,-0.2682363,,,,,,,

Cp,120.7021,pF,DF,-0.2217292,,,,,,,

Cp,86.14821,pF,DF,-0.4639516,,,,,,,

Cp,105.1857,pF,DF,-0.5262653,,,,,,,

Cp,112.0749,pF,DF,-0.3781399,,,,,,,

Cp,122.5613,pF,DF,-0.2167675,,,,,,,

2.7.20 USB Screenshots

The 7660 can be used with most USB memory sticks, mass storage class, FAT16/FAT32 format; maximum consumption current must be below 500 mA. 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.

Once the USB flash drive has been mounted a green flash drive symbol appears in the lower right corner of the screen.

This allows the user to take screenshots of data or any menu screen by then pressing the CNCL key twice.

This is ideal for creating reports and directly inserting an image of the screen into a report.

The file will be saved in BMP format under the sequential name SCRXXXX.BMP

2.8 Analysis Menu

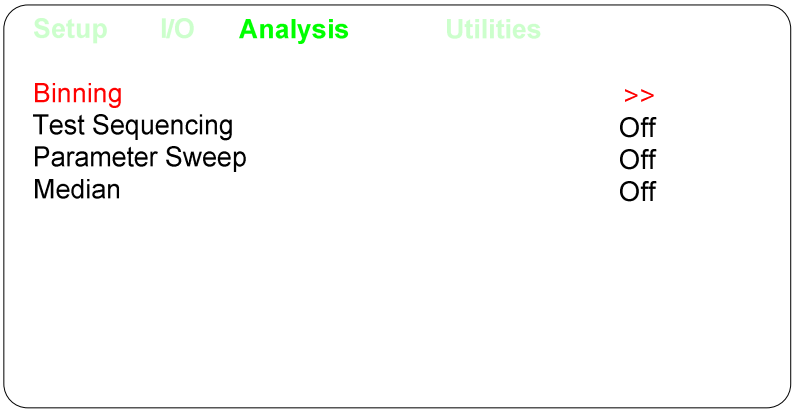
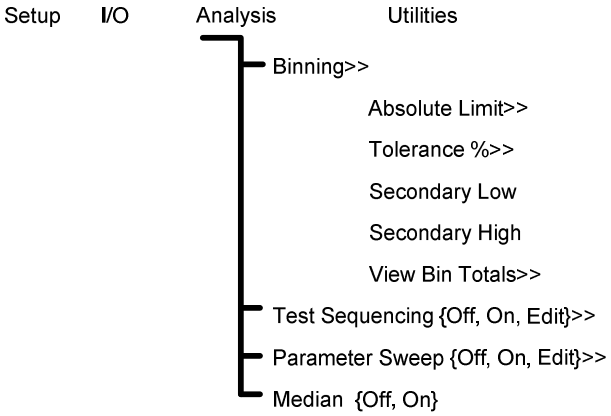


Figure 26 Analysis Menu

The third of the four main menus is **Analysis,** shown above. Each function controls the analysis of measurement results and is described in detail below.



2.8.1 Binning

Figure 27 Binning

The 7660 provides sorting into **15 bins** for Pass/Fail. 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 HI and Low Limits must be set (not Off).

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**

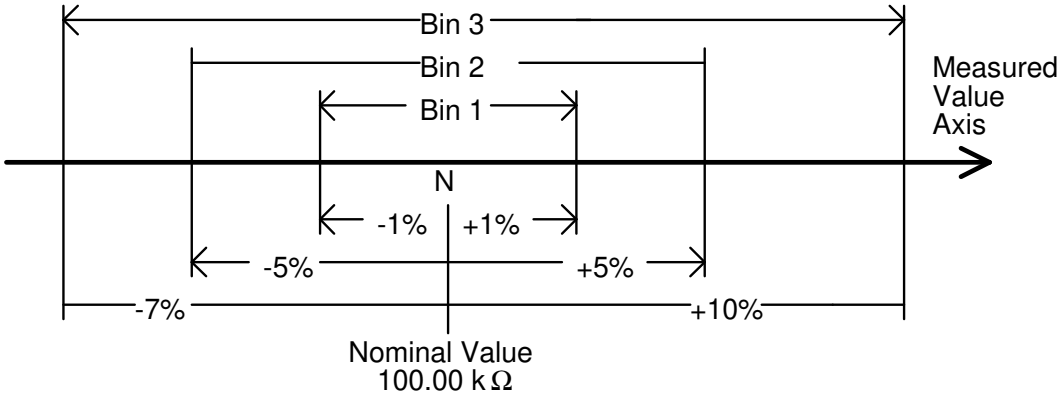
Bin 15 - **No contact**

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.**

NOTE: Setting Bin Limits also controls the color of the Measured Parameter. i.e. if the Primary Parameter is within limits, so pass the value will be Green otherwise red. The normal color for measured parameters is light blue.

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

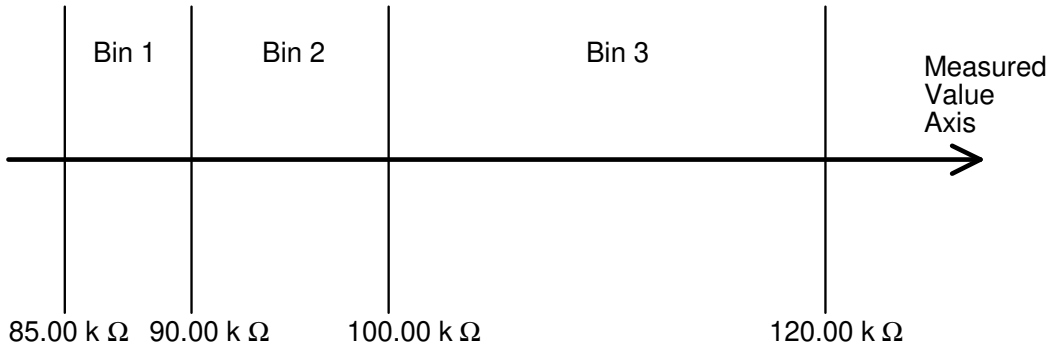
higher numbered ones. Nested limits for three bins is illustrated below, note that limits do not have to be symmetrical as shown for bin 3.



Tolerance Percent

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

2.8.2 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^{18} to 10^{18}.** 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)

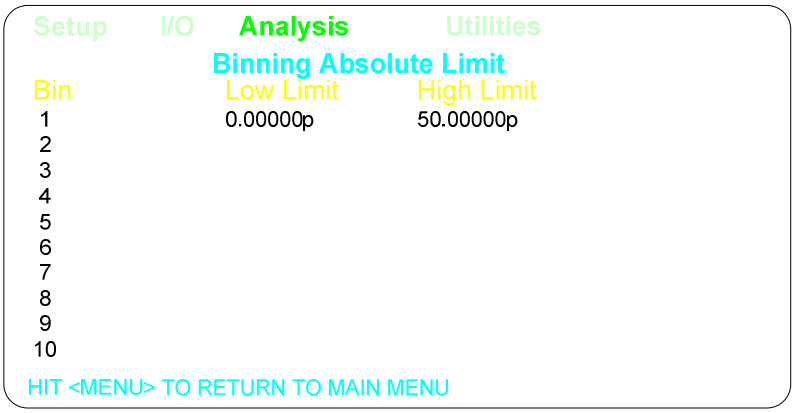


Figure 28 Absolute Limit

Once the limit of choice is selected by **UP/DOWN, LEFT/RIGHT** arrows, the numerical value can be entered directly as a number and prefixes can be selected using the **SELECT** keys.

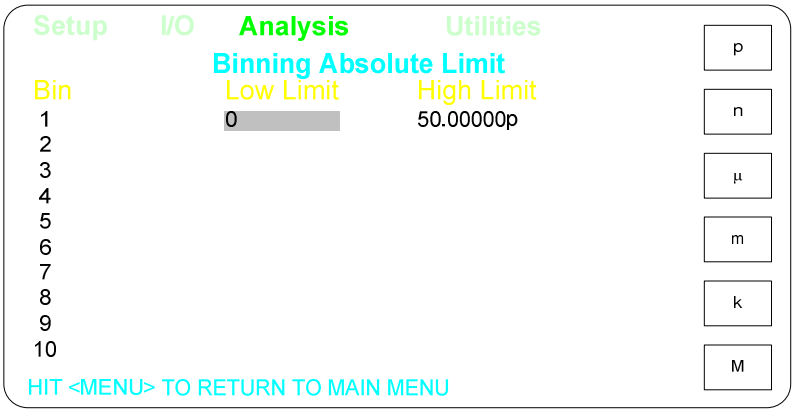


Figure 29 Absolute Limit (Numeric Entry)

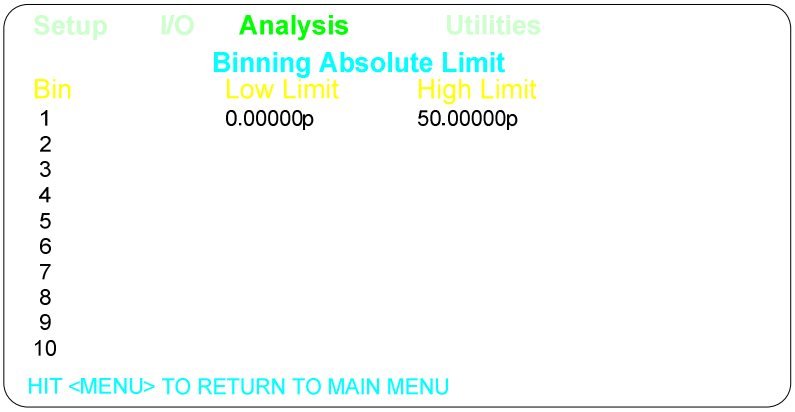


Figure 30 Absolute Limit (Engineering Units)

Selecting a prefix will finalize the entry, use the UP/DOWN, LEFT/RIGHT arrow to choose the next limit to be entered or changed.

2.8.3 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, the numerical value can be entered directly as a number and prefixes can be selected using the **SELECT** keys. **Valid range is -10^{18} to 10^{18}.** 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.

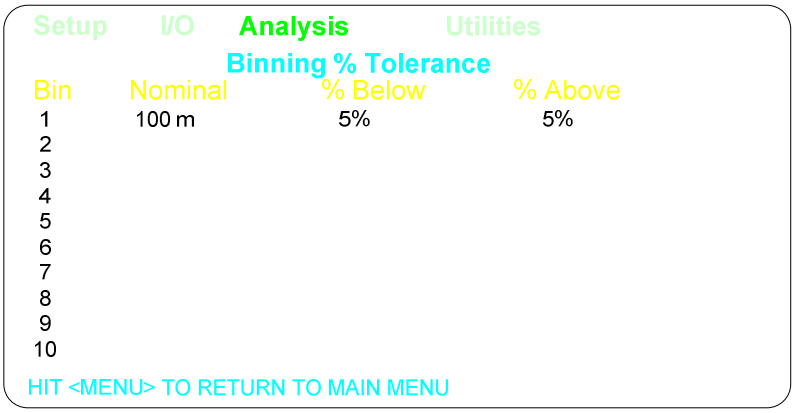


Figure 31 Tolerance Percent

2.8.4 Secondary Low

Accepts entry of numerical value for the low limit of the secondary parameter. The numerical value can be entered directly as a number. **Valid range is -10^{3} to 10^{4}.**

NOTE:

Low limit must be less than the High limit

2.8.5 Secondary High

Accepts entry of numerical value for the high limit of the secondary parameter. The numerical value can be entered directly as a number. **Valid range is -10^{3} to 10^{4}.**

NOTE:

High limit must be greater than the Low limit

2.8.6 View Bin Totals

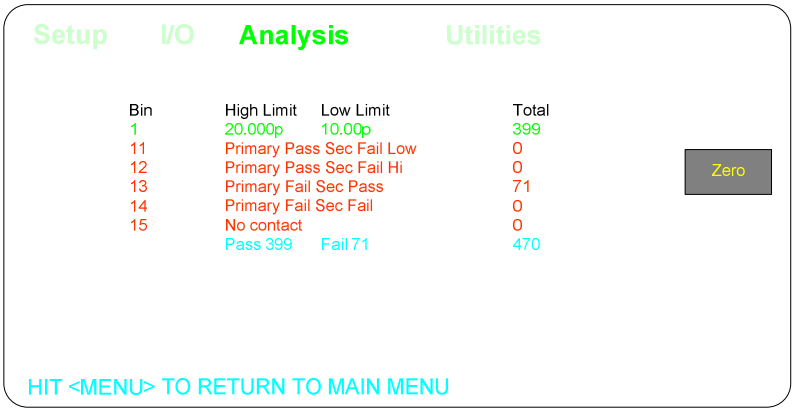


Figure 32 Bin Totals

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

2.8.7 Zero Bin Totals

Press the Zero button to zero all Bin count totals. A Yes and No button will be shown to verify you want to zero the totals.

2.8.8 Test Sequencing

The 7660 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. For optimum measure speed performance, whenever possible, set test conditions of test 1 to be the same as default conditions.

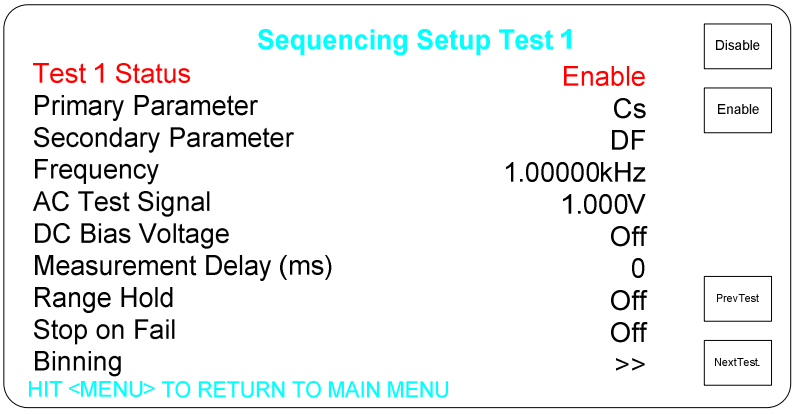


Figure 33 Sequence Setup (Test Conditions)

If Range Hold is turned ON and this is the "first" sequence measurement, for each test the 7660 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, secondary parameter and binning, 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.

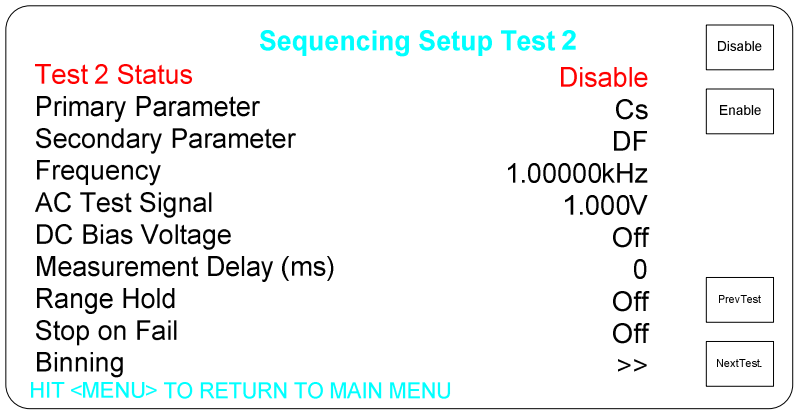


Figure 34 Sequence Setup (Test 2)

Bin assignment in the test sequence mode is defined as follows:

Bin #	**Assigned**
Bin 1	Test 1 (Primary parameter, fail)
Bin 2	Test 1 (Secondary parameter, fail)
Bin 3	Test 2 (Primary parameter, fail)
Bin 4	Test 2 (Secondary parameter, fail)
Bin 5	Test 3 (Primary parameter, fail)
Bin 6	Test 3 (Secondary parameter, fail)
Bin 7	Test 4 (Primary parameter, fail)
Bin 8	Test 4 (Secondary parameter, fail)
Bin 9	Test 5 (Primary parameter, fail)
Bin 10	Test 5 (Secondary parameter, fail)
Bin 11	Test 6 (Primary parameter, fail)
Bin 12	Test 6 (Secondary parameter, fail)
Bin 13	Unused
Bin 14	Pass Bin

Bin 15 Contact Check, fail

For the binning function to be enabled, Bin 1 limits must be set (non-zero). If zero is entered for Low or High, the previous value is cleared and that bin disabled. **Valid range for primary or secondary is -10^{18} to 10^{18}.** All sequence binning limits must be entered on the display shown below and NOT the standard binning displays.

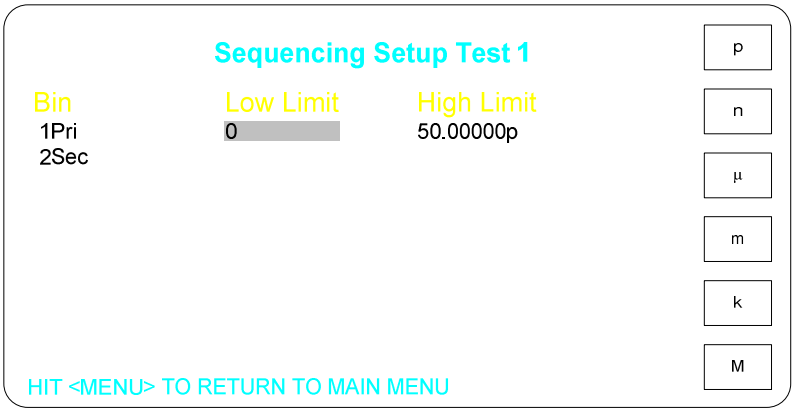


Figure 35 Sequence Binning

Test conditions of measurement sequences can be stored and/or recalled as part of test 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.

Note that a sequence (of up to six tests) can be terminated on any test of the sequence if the user has specified **Stop on Fail** for that test. If Stop on Fail is not selected the sequence continues until a failure occurs in a test where Stop on Fail has been enabled or until the whole sequence has been completed. Once a sequence is complete, it will be binned to the first fail bin (1 thru 12) or if all tests pass, binned into the overall pass bin (14).

When a test sequence is turned on the results of the sequence are shown on the summary screen shown below. Measured values outside of specified limits are highlighted.

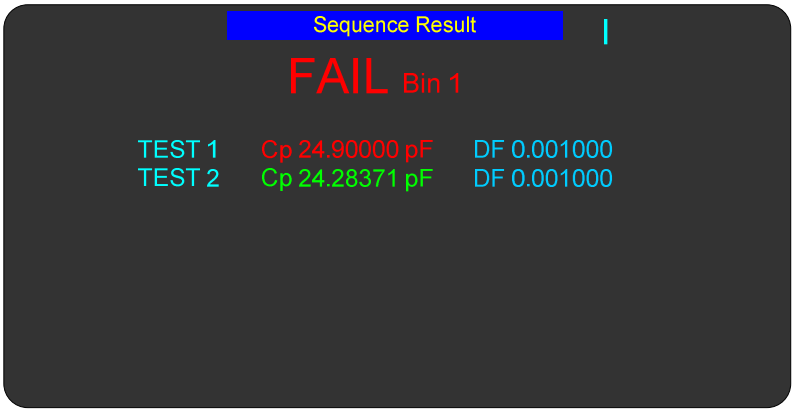


Figure 36 Sequence Results

2.8.9 Test Sequencing

The 7660 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.

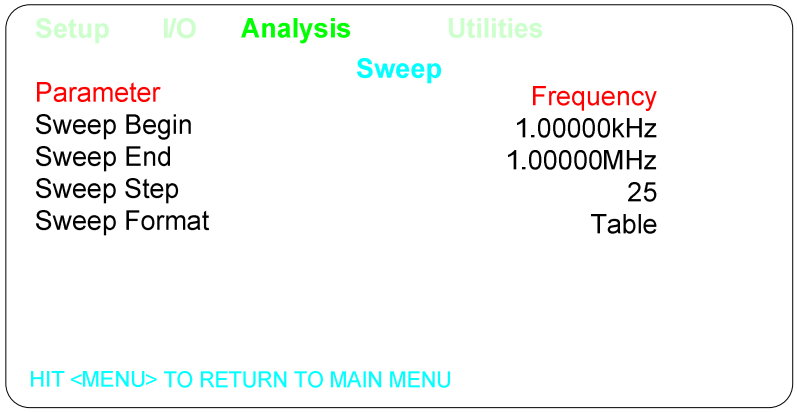


Figure 37 Parameter Sweep

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 selecting a prefix using the SELECT buttons will finalize the entry.

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 250** where values are automatically selected, Log or Linear over the specified begin to end range.

Sweep Type chooses if the steps are logarithmically or linearly spaced over the specified begin to end range.

Sweep Format is selected to be **Table** as shown in Figure 38 or **Plot** as shown in Figure 39.

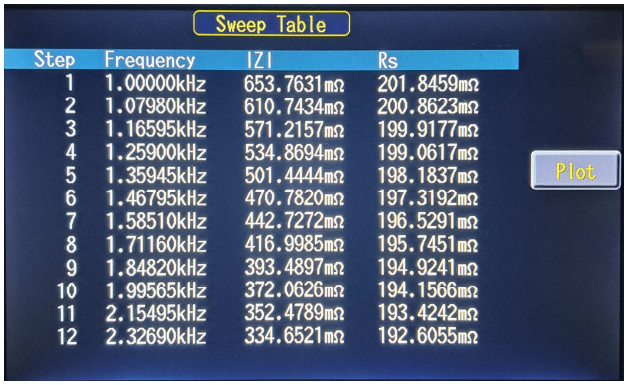


Figure 38 Sweep Table

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.

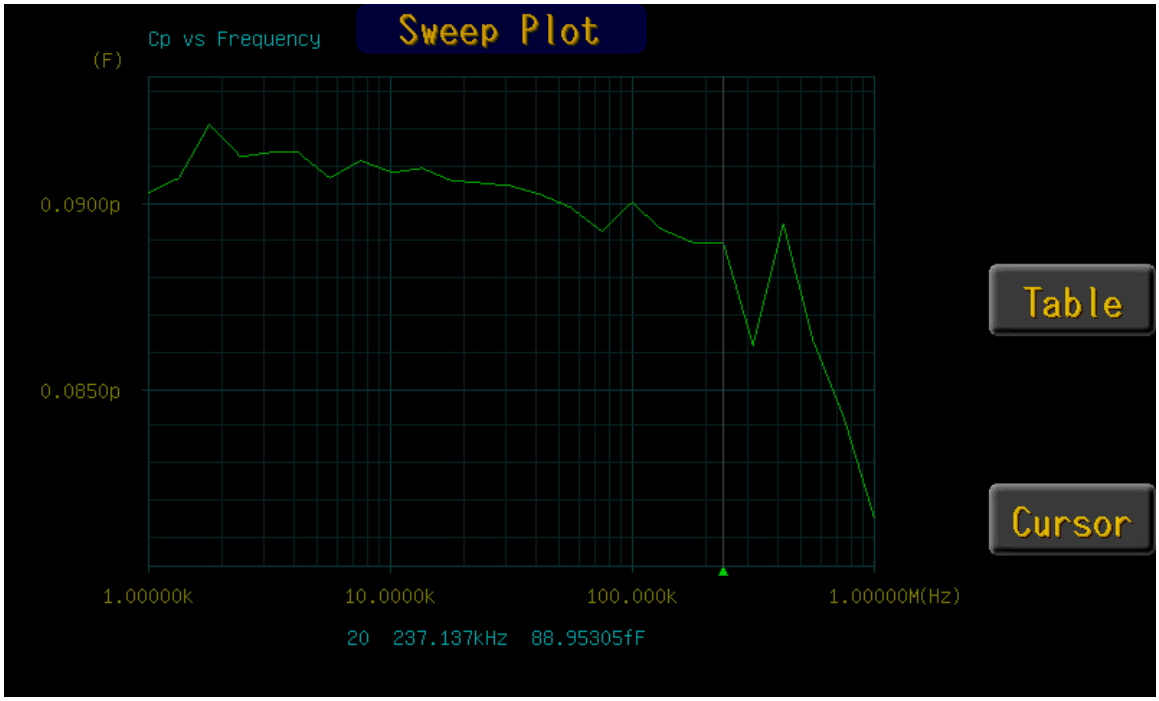


Figure 39 Sweep Plot

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).

The Sweep Plot also can show an interactive **Cursor** that can be controlled using the arrow keys to show frequency and measured value. Pressing the **Cursor** softkey will make the cursor appear or disappear.

2.8.10 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 (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.

2.9 Utilities Menu

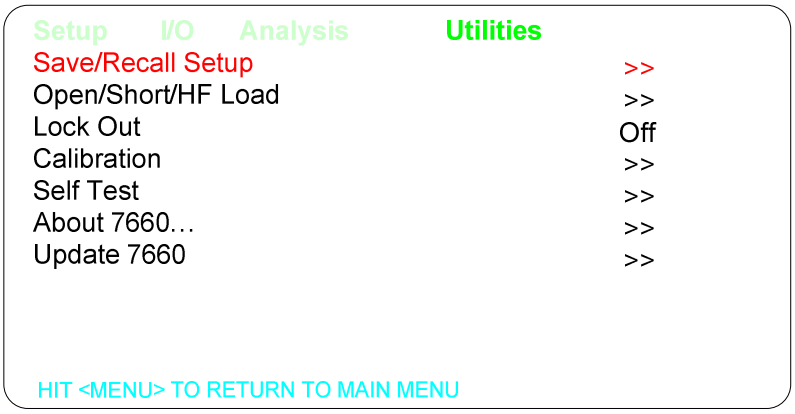


Figure 40 Utilities Menu

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

Setup I/O Analysis Utilities

- Save/Recall Setup>>
  - Source
  - New
  - Save
  - Recall
- Open/Short/HF/Load Correction >>
  - Open{Off, On, Measure}
  - Short{Off, On, Measure}
  - High Frequency{Off, On, Measure}
  - Load{Off, On, Edit}
  - Cable Length{0 m,1 m,2 m}
- Lock Out {Off, L/Only,L/Recall}
- Self Test
  - Self Test>>
  - Keypad Test>>
  - Handler Test>>
  - Rear Fan {On, Off}
- Calibration {password}
- About 7600…>>
- Update 7660>>

2.9.1 Save Setup

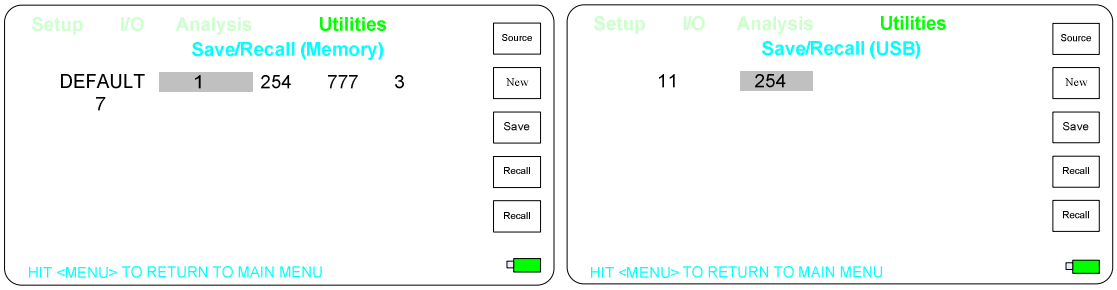


Figure 41 Save Setup (Memory or USB)

Allows a set of test conditions to be stored in instrument memory or on USB flash disk for later recall. Test conditions are those that are user programmable in the Setup and I/O menus. Internal **Memory** or **USB** are shown in brackets and can be changed by selecting **Source**.

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). To save the setup under the name selected or to overwrite if the name already exists one needs to answer Yes or No.

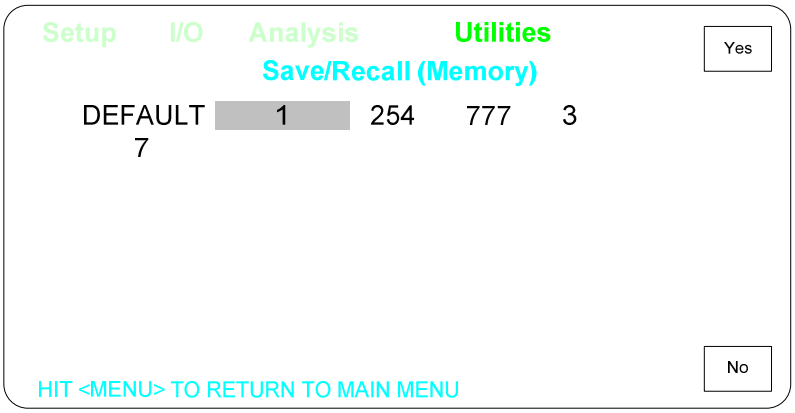


Figure 42 Yes or No

To make the current set of test conditions the default (at power up) one needs to select **DEFAULT** in the Save Setup menu and overwrite the conditions currently stored. To prevent overwriting the default setup by mistake an additional level of safety exists where the operator is required to respond with Yes or No.

Selecting **del** will delete a set of test conditions and requires a Yes or No response. **DEFAULT** setup cannot be deleted memory.

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.

File format for storing test conditions is the same as shown under Results to USB (page 33), all lines shown are saved as setup. The extension of a Setups file is ".c6r". The setup files are compatible with 7600 Model B. The only difference is the extension. Changing the extension from Model B files to ".c6r" will allow files to be recalled in the 7660.

2.9.2 Recall Setup

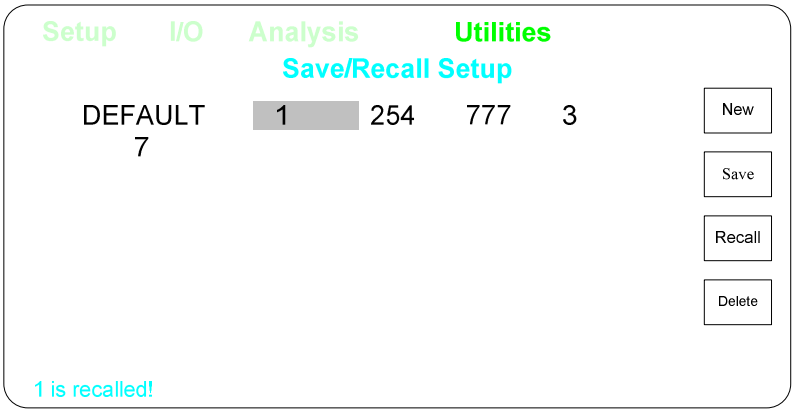


Figure 43 Recall Setup

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. To recall a set of test conditions one needs to arrow down or up to the desired set. **DEFAULT** is always one of the set of test conditions that can be recalled as discussed in the previous paragraph. 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.

2.9.3 Setup Accuracy

Calculated accuracy is based upon the instruments currently selected test conditions, as shown in the example below and **in accordance with the formulas for fast, medium or slow accuracy.** Factors affecting this calculation include frequency, ac test signal level, measurement accuracy and # to average, all test conditions under operator control on the Setup Menu. The selection of Median, on the Analysis Menu, also has an affect on the accuracy calculation.

The Accuracy, Average and Median can be changed on this screen as instructed for the purpose of evaluating their effect on the instrument accuracy calculation and the changes implemented if the operator so chooses. The frequency, AC signal or parameter selection can only be changed on the Setup menu.

The measured accuracy of the 7660 is based upon the formulas below where A% = calculated primary accuracy for C, X, B with D < 0.1 and R, L, G with Q < 0.1 for optimum signal levels and test conditions.

For C, X, and B, with D > 0.1, multiply A% by $\sqrt{1+D^2}$

For R and G, with Q > 0.1, multiply A% by $\sqrt{1+Q^2}$

For L, with Q < 10, multiply A% by $\sqrt{1+ 1/Q^2}$

Multipliers do not apply to 1 MHz Special Case Accuracy

For Fast Mode, R, L, C, X, G, B, |Z|, and |Y|

$$A\% = \pm\left[0.25 + \left(\left(0.25 + \frac{.125}{|Z_m|} + \left(|Z_m| * 10^{-6}\right)\right) * \left(\frac{0.2}{V_s} + 0.8 * \frac{V_{fs}}{V_s} + \frac{(V_s - 1)^2}{4}\right) * \left(0.4 + \frac{F_m}{10^4} + \frac{400}{F_m}\right)\right)\right] * K_t$$

For Medium Mode, R, L, C, X, G, B, |Z|, and |Y|

$$A\% = \pm\left[0.125 + \left(\left(0.125 + \frac{.1}{|Z_m|} + \left(|Z_m| * 10^{-6}\right)\right) * \left(\frac{0.2}{V_s} + 0.8 * \frac{V_{fs}}{V_s} + \frac{(V_s - 1)^2}{4}\right) * \left(0.4 + \frac{F_m}{3 * 10^4} + \frac{300}{F_m}\right)\right)\right] * K_t$$

For Slow Mode, R, L, C, X, G, B, |Z|, and |Y|

$$A\% = \pm\left[0.025 + \left(\left(0.025 + \frac{.09}{|Z_m|} + \left(|Z_m| * 10^{-7}\right)\right) * \left(\frac{0.2}{V_s} + 0.8 * \frac{V_{fs}}{V_s} + \frac{(V_s - 1)^2}{4}\right) * \left(0.7 + \frac{F_m}{10^5} + \frac{300}{F_m}\right)\right)\right] * K_t$$

V_S = Test voltage in voltage mode, I * Z_m in current mode*

Z_m = Impedance of DUT F_m = Test frequency

K_t = 1 for 18° to 28°C, 2 for 8° to 38°C, and for 4 for 5° to 45°C

* For I * Z_m > 3, accuracy is not specified

V_{FS} = 5.0 for 1.000V < V_S ≤ 5.000V

1.0 for 0.100V < V_S ≤ 1.000V

0.1 for 0.020V ≤ V_S ≤ 0.100V

For Zm > 4* Z_{RANGE} multiply A% by 2

For Zm > 16* Z_{RANGE} multiply A% by 4

For Zm > 64* Z_{RANGE} multiply A% by 8

	In Voltage Mode	In Current Mode
where	100kΩ for Zm ≥ 25kΩ	400Ω for i < 2.5mA
Z_{RANGE} =	6kΩ for 1.6kΩ ≤ Zm < 25kΩ	25Ω for i > 2.5mA
	6kΩ for Zm > 25kΩ and Fm > 25kHz	
	400Ω for 100Ω ≤ Zm < 1.6kΩ	
	400Ω for Zm > 1.6kΩ and Fm > 250kHz	
	25Ω for Zm < 100Ω	

NOTE: Calculated Rs accuracy applies only when device under test is primarily reactive

Calculated ESR accuracy applies only when device under test is primarily capacitive

The unit is unspecified for Fm > 1.0 MHz and Vs > 0.5V and for Fm > 500 kHz and Vs > 1.0V

D Accuracy

$$= \left[\frac{A\%}{100} + \frac{|D|}{50}\right] * \left[1 + \sqrt{\frac{F_m}{5 * 10^4}}\right]$$

Q Accuracy

$$= \frac{A\%}{100} + \left[\frac{A\%}{100} + \frac{1}{50}\right] * |Q| + Q^2\left[\frac{A_n}{100} + \frac{A\%}{500}\right]$$

θ Accuracy

$$= \frac{A\%}{20} * \left(\frac{180}{\pi}\right)$$

ESR Accuracy

$$= \left(\frac{A\%}{100}\right) * Z_m$$

D = DF of unknown Q = Q of unknown

A% = calculated primary accuracy for all cases

1 MHz Special Case Accuracy

(1 MHz, C = 100pF to 1000 pF, Z_m 158 to 1.6kΩ, D or Q < 0.01, voltage mode, V_S ≤ 1V)

Fast Mode Accuracy

$$A\% = \pm\left[\frac{A_n}{0.05} * \left(.067 * \left(1 + \frac{.2}{V_s} + \frac{V_s^2}{4}\right)\right) * \left(\frac{(2 * V_{FS} - V_s)}{V_{FS}}\right) + (A_n - .05)\right] * K_t$$

A_n = nominal accuracy 0.5.

Medium Mode Accuracy

$$A\% = \pm\left[\frac{A_n}{0.05} * \left(.067 * \left(0.8 + \frac{.2}{V_s} + \frac{V_s^2}{4}\right)\right) * \left(\frac{(2 * V_{FS} - V_s)}{V_{FS}}\right) + (A_n - .05)\right] * K_t$$

A_n = nominal accuracy 0.25.

Slow Mode Accuracy

$$A\% = \pm\left[\frac{A_n}{0.05} * \left(.067 * \left(0.55 + \frac{.2}{V_s} + \frac{V_s^{\,2}}{4}\right)\right) * \left(\frac{(2 * V_{FS} - V_s)}{V_{FS}}\right) + (A_n - .05)\right] * K_t$$

A_n = nominal accuracy 0.05.

NOTE:

Accuracy given by the equations is the measurement accuracy relative to calibration standards. Total accuracy equals the relative measurement accuracy plus the calibration uncertainty of the calibration standards.

2.9.4 Open / Short Compensation

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. Measurement accuracy is specified at the end of the IET Labs one meter cable (7000-01). Open and short circuit zeroing should be done with the cable to be used.

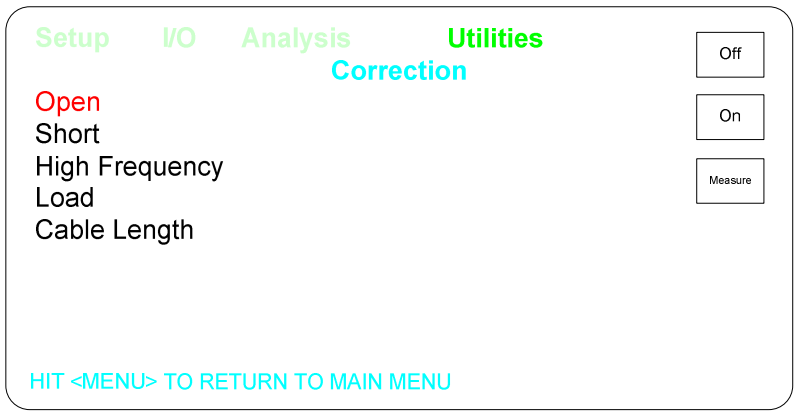
Note: **Cable Length** should be changed to match the cable length being used.

Zeroing is recommended at the start of each use or more often if leads, fixture or test configuration to the DUT are changed. **It is not necessary to re-zero if the test frequency is changed.** It is important to note, that anytime the instrument is zeroed it is done at a test voltage of 1 volt and frequencies of 10, 50, 100Hz, 1, 5, 10, 25, 50, 100, 250, 500, 750kHz, 1, 1.25, 1.5, 1.75 and 2MHz.

Once Open/Short is selected in the menu, follow the prompts on the screen for short or open zeroing as shown in Figure 44 below.

Open or Short takes approximately 30 seconds.

Please note that it is recommended that Open and Short both be ON and then save the setup as DEFAULT to ensure each time the 7660 is turned on, open and short compensation will be ON.



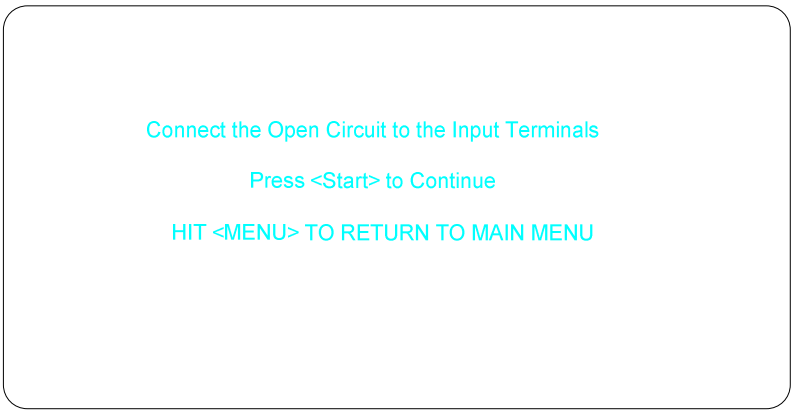


Figure 44 Open / Short

2.9.1 High Frequency

HIGH FREQUENCY **MEASURE** SHOULD ONLY BE PERFORMED BY QUALIFIED SERVICE PERSONNEL.

High Frequency correction improves measurement of Df, when measuring capacitors.

When measuring capacitors or devices such as dielectric cells High Frequency should be **On**.

When measuring Q on devices that primarily are resistive or inductive, High Frequency should be turned **Off**.

High Frequency provides a correction for Df at frequencies above 500 kHz.

The High Frequency Measure has already been done at the factory.

High Frequency Measure should be done by authorized personnel only. This requires R3 from the 7000-09 Calibration Kit in order to perform High Frequency Measure.

Open and Short compensation should be performed using the open and short from the 7000-09 Calibration Kit.

Attached the R3 374 Ω standard to the 7660 using the standard 1689-9602 1 meter bnc to bnc cable.

Once High Frequency is selected in the menu, press **Measure** and a prompt will indicate to make sure that R3 is connected to the 7660 and follow the prompts on the screen to perform the High Frequency Compensation.

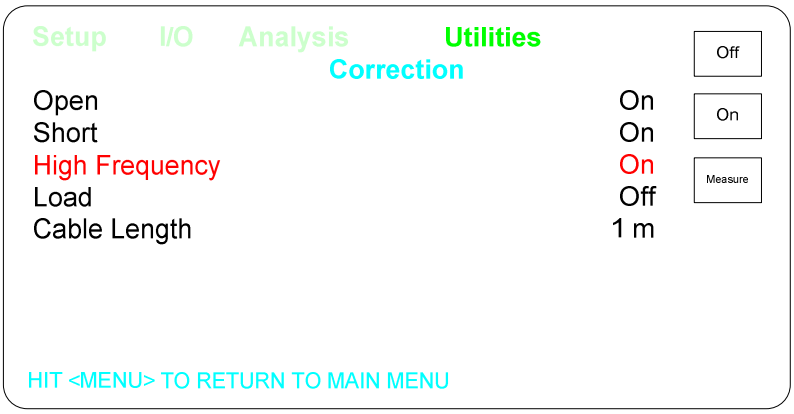


Figure 45 High Frequency

2.9.2 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 7660 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.

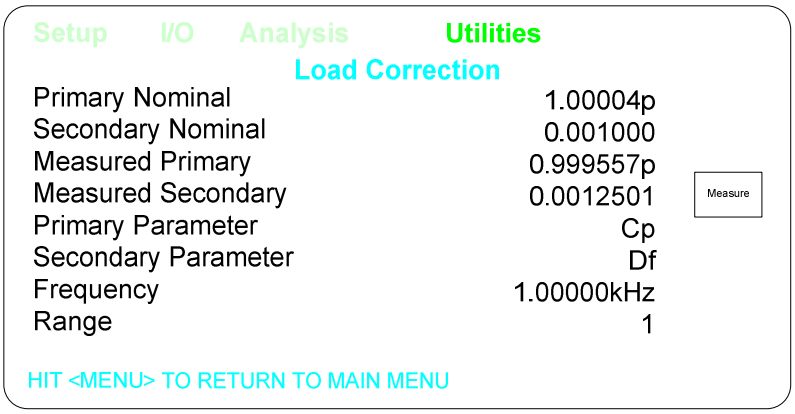


Figure 45 Load Correction

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 16, these are the only conditions under which it will be applied.

2.9.3 Cable Length

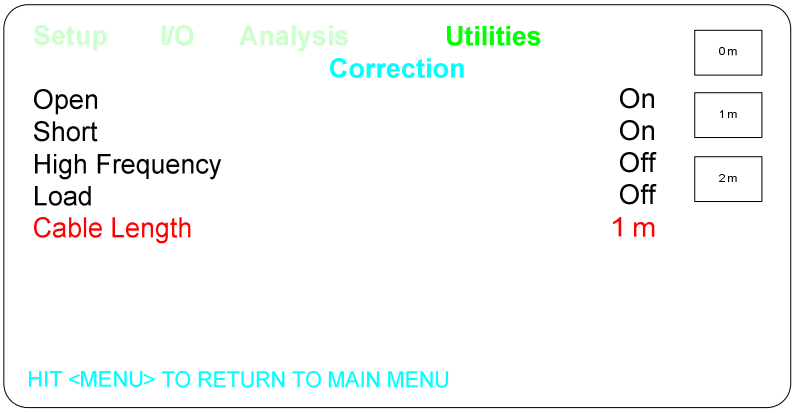


Figure 46 Cable Length

Allows user to select either 0 m(direct connection to the front panel), 1 m or 2 m cable length. This setting compensates at higher frequencies for phase shifts due to the length of the cable.

2.9.1 Lock Out

When selected, no changes can be made to settings of the instrument until the correct password is entered. Lock Out can be set to **Off**, **L/Only** or **L/Recall**. **L/Only** will only allow measurements or to enter password to exit **Lock Out**. **L/Recall** will allow recall of setups in addition to measurements or exit **Lock Out**.

The user can enter up to an 8-digit password, you will also have to Verify the password. The factory override is 760001.

2.9.2 Calibration

Refer to Calibration on page 91. **INSTRUMENT CALIBRATION SHOULD ONLY BE PERFORMED BY QUALIFIED SERVICE PERSONNEL.**

2.9.3 Self Test

Enters another menu which contains Rear Fan, Self Test, Keypad Test and Hander Tes..

2.9.4 Rear Fan

When selected, the rear fan can be turned on or off. It is recommended the fan be ON when in use, to ensure the 7660 meets specifications. The default is ON and this setting cannot be saved to memory.

2.9.5 Keypad Test

When selected, allows the user to press each key on the front panel to verify operation.

2.9.6 Handler Test

When selected, cycles each line on the hander high momentarily. This allows a quick way of verify handler connections.

2.9.7 About 7660

When selected, shows serial number, firmware, software version and similar information about the system.

2.9.8 Update 7660

Provides a facility to update the firmware. NEVER do this without being sent the proper files from IET Labs.

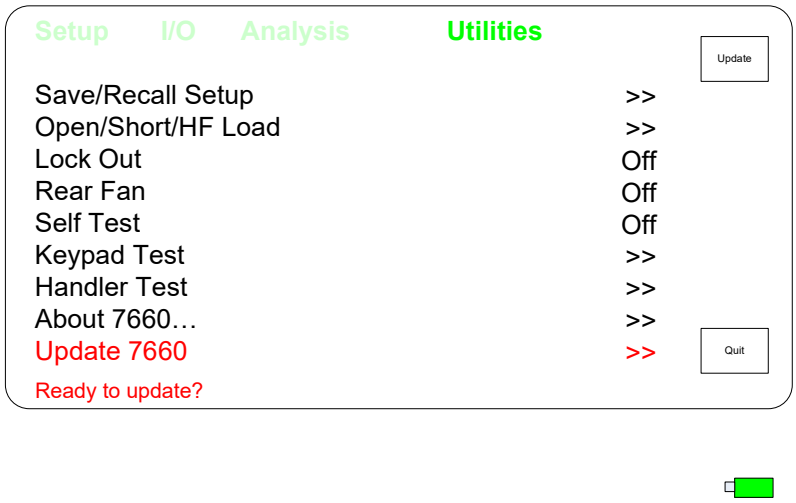
Be sure that the update programs are placed in the following path of the USB flash drive.
Software : \IET7660\BIN\IET7660A.BIN

Firmware : \IET7660\BIN\IET7660B.BIN

Firmware : \IET7660\BIN\IET7660C.BIN

Turn on the 7660, press the **Menu** button and use the **arrow** keys to get into the function **Update 7660** in the **Utilities** menu.

Press **Enter** button with **Update 7660** highlighted.



Ready to update? will be shown on the screen.

Insert the USB flash drive with the bin files in the correct directory into the **USB Host Port** on the front of the 7660.

Press the **Update** Select key.

The screen will indicate if the update was successful.

Only if something goes wrong during the update process and/or the screen is blank after updating. First verify the directory structure and files on the usb stick. Turn the 7660 Off, press and hold the top softkey, turn the 7660 On, keep holding the top softkey until the danger light flashes. Insert the usb stick containing the update files. The 7660 will perform the update process from the usb stick.

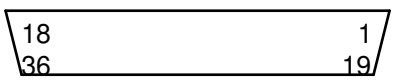
2.10 Handler Interface

The 7660 comes standard with an automatic component handler I/O interface port available through a 36 pin Centronics type connector located on the rear panel of the instrument. This port outputs signals to indicate measurement in process, measurement completed, and bin sorting judgments. The Handler Interface also has inputs for an external trigger signal and a safety interlock signal. All output lines are negative true, optically isolated, open collector. Pull-up resistors to allow operation from +5V to +24V logic must be implemented externally. Inputs are optically isolated, and can be current driven from either positive or negative true logic. Current limiting resistors to allow operation from +5V to +24V logic must be implemented externally.

Refer to Table 1 for signal names, pin numbers and functions as necessary for cable connections.

Table 1 I/O Interface Connections

Signal Name	Pin Number	Function
-Bin1	1	Bin Sorting Results (Bin1-Bin10)
-Bin2	19	All signals active low, open collector
-Bin3	2	
-Bin4	20	
-Bin5	3	
-Bin6	21	
-Bin7	4	
-Bin8	22	
-Bin9	6	
-Bin10	24	
-Bin11	7	Primary parameter pass, secondary fail low
-Bin12	25	Primary parameter pass, secondary fail high
-Bin13	8	Primary parameter fail, secondary pass
-Bin14	26	Primary parameter fail, secondary fail
-Bin15	9	No Contact
-Bin16	27	Unused
-EOT	29	End of Test, test completed; bin and measurement data valid.
-BUSY	30	Measurement/comparison in progress
TRIG+	14	Trigger high input
TRIG-	16	Trigger low input
START+	34	Isolated Trigger high input
START-	35	Isolated Trigger low input source
GND	11, 15, 33	System common
IGND	5, 10, 23, 28	Isolated common
+5V	12, 32	System +5V through 100 Ω
INT+	13	Interlock high input from external source
HTC	31	Handler timing control



Pin Configuration (Viewed from Rear Panel)

CAUTION

Do not apply an external source in excess of 5 volts with jumpers JP2401, JP2402, or JP2403 in place, otherwise the instrument can be damaged. The instrument is shipped with these jumpers in place and must be removed for optical isolation. These jumpers are discussed below.

The operation of START and TRIG circuits is identical. Both inputs are active low, for optical isolation they require a positive +5 to +24V external source and current limiting resistor to operate. START is always optically isolated. TRIG can be converted to a *isolated active low input* by removing jumper JP2402 on the I/O PCB. Both signals are open collector OR'ed on the I/O PCB; current flowing through the isolator input on either signal causes a single Start line to be pulled low.

The INTerlock signal can be optically isolated, and also requires a positive +5 to +24V external source and current limiting resistor to operate. This signal can be converted to a *isolated active low input* by removing jumper JP2403 on the I/O PCB. Current flowing through the isolator input causes the internal Interlock line to be driven low.

All bin and control outputs can be active low optically isolated open - collector drivers that pull each signal line to IGND (isolated common) when asserted. All outputs require a positive +5 to +24V external source (referenced to IGND) and pull-up resistor to operate as fully isolated signals. IGND can be isolated from system GND by removing jumper JP2401 on the I/O PCB. With jumper JP2401 in place, optical isolation is defeated, which allows the outputs to be pulled up to the system +5V with external resistors.

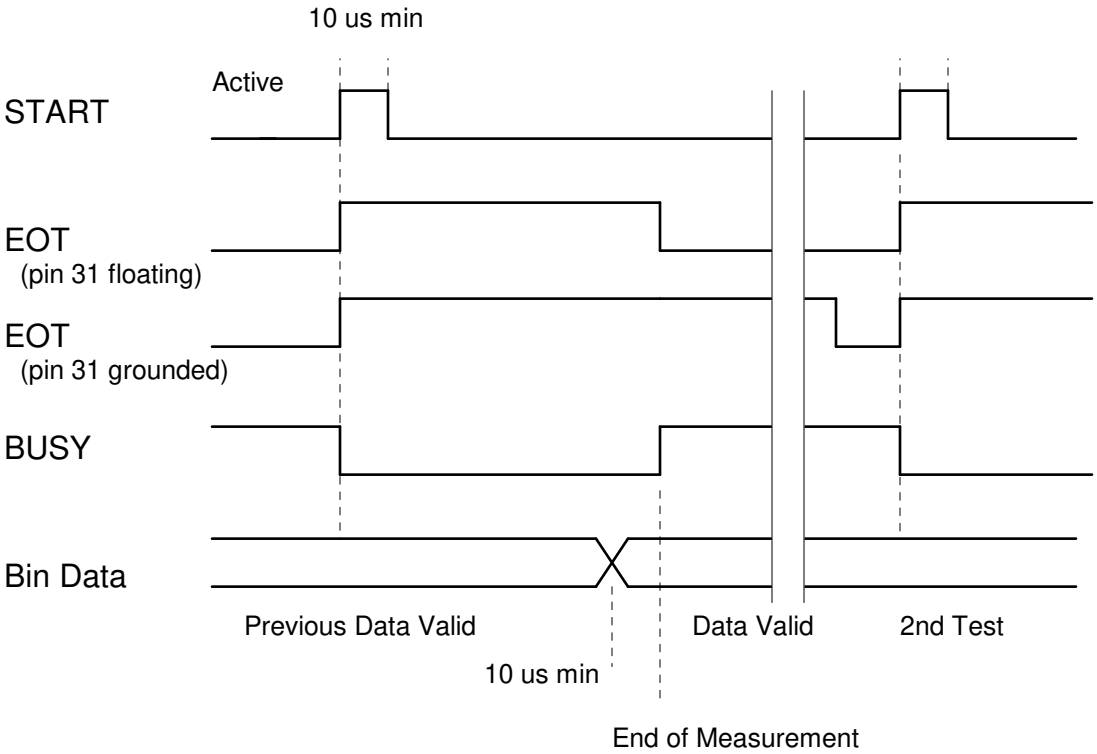


Figure 47 I/O Interface Timing

Test Initiation

A test is initiated by activating either the START± or TRIG± inputs.

The BUSY line is asserted low to indicate that a measurement is in progress.

The EOT line is de-activated (asserted high) to indicate that the end of the test had not been reached

Binning data from the previous test is still valid.

During a Test

- The START± or TRIG± inputs are released and return to their inactive state.
- The BUSY line is held low to indicate the 7660 is making a measurement.
- The EOT line is held high (inactive) until the 7660 is done making a measurement and bin data is valid.

End of Test

- The BUSY line is returned to high impedance (de-activated) to indicate that the 7660 is done making a measurement and to signal the automatic component handler to advance the DUT to the binning station and insert the next DUT.
- Simultaneously, the EOT line is asserted low to indicate that the test is completed, bin data lines and measurement data are valid and can be read from the IEEE or RS-232 ports. Data must be valid a minimum of 10us before the trailing edge of BUSY and EOT.
- All data for the current test is valid, and will remain valid until the end of the next test. This includes comparator bins 1-10, primary and secondary parameter bins 11-15, and analog measurement data.

Electrical Characteristics

Inputs: START±, TRIG±

Condition	Input Current	Input Voltage
Active High		
Signal+ current driven, Signal- @ IGND	5 - 50 mA	5 - 24V
Active Low		
Signal-current driven, Signal+ @ V+(ext)	5 - 50 mA	5 - 24V

Outputs:-Bin1 -Bin16, -EOT, -BUSY

Condition	Sink Current	Output Voltage	
		Low	*High*
Binning signals	200 mA max (150mW)	≤ 0.5V	5 – 40V
Control signals	200 mA max (150mW)	≤ 0.5V	5 – 40V

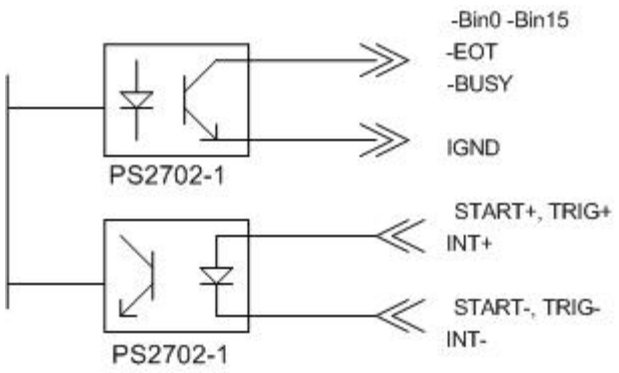


Figure 48 I/O Interface Isolation

The outputs are optically isolated for added interfacing flexibility and to increase reliability by reducing noise pickup and ground loop interference. The optocouplers use open collectors, and can sink up to 200mA of current provided by an external source at up to 40V. No provisions for pull-up resistors are provided on - board. The isolated ground return can be floated, or connected to the 7660 system ground for use with isolated handlers. The isolators are driven by inverting high current buffers.

All inputs are also optically isolated. Both anode and cathode of the input opto-isolators are available in the handler interface connector. Active high inputs can be achieved by grounding the cathode ("-" signal) and driving the anode ("+" signal), while connecting the anode to the external supply and sinking current through the cathode will result in active low drive. No provisions for current limiting resistors are provided on - board. All inputs are reverse bias protected; max. 5V reverse voltage, 50mA (60mW).

2.11 RS-232 and USB Type B Interface

The 7660 has an RS-232 interface with connection through a 9 pin Dsub connector on the rear panel. The RS-232 interface requires a standard 9 pin null modem cable for proper operation.

The USB-Type B interface requires a standard Type B USB cable. The driver will automatically be loaded when using Windows 10 computers.

Both the RS-232 and USB-Type B interfaces can be used to control and collect data from the 7660. Refer to Table 2 for the command set.

2.12 GPIB/IEEE-488.2/RS-232/LAN/USB Commands

The 7660 has a GPIB, RS-232, LAN and USB interfaces with connection on the rear panel. These interfaces can be used to connect to a system containing a controller. Refer to Table 2 for the command set.

All commands maybe followed with a "?" to query current parameter.

i.e. Conf:freq? will return current value for frequency "+1.000000E+03"

Table 2 Remote Commands

Command	Function	Parameter(s)
CONFigure:		
FREQuency	Set the frequency from 10 to 2000000 Hz	0000000.00
PPARameter	Set the primary parameter	A(auto) CS CP LS LP RP RS DF Q Z Y P(phase angle) ESR GP XS BP
SPARameter	Set the secondary parameter	N(none) CS CP LS LP RP RS DF Q Z Y P(phase angle) ESR GP XS BP
ACTYpe	Set the AC test signal type to	V I
	This command should be set prior to setting the ACValue.	
ACValue	Set the AC signal to value	0.0
BIAS	Set the bias to	INT EXT or OFF
RANGe	Set the range	AUTO or HOLD or #(1-59)
MACcuracy	Set the measurement accuracy	SLOw MEDium FASt
TDELay	Set the measurement delay	#####
AVERage	Set # to average	###
MEDian	Set the median function to ON or OFF	ON OFF
DISTortion	Set distortion detection to ON or OFF	ON OFF
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) B (Bin Number) S (Bin Summary) P (Pass/Fail) N (No Display)
TRIGger	Set the trigger to	INTernal EXTernal
NOMinal	Set the nominal value (for deviation or % deviation)	floating point #

CONFigure:

BINNing:

bin#

ABS*	Set the low & high limit for the bin	low high (floating point #'s)
TOL	Set the % below, % above and nominal value	% below % above nominal (3 floating point #'s w/space between)
SECondary	Set the secondary low & high limit	low high (floating point #'s)
TRESet	Reset the bin totals to zero	
SUMMary?	Retrieve the bin summary data	
FRESult	Set the result format to	SCIentific ENGineering
HANDler (state)	Turn handler port OFF or ON	ON OFF
RPRint	Turn print results ON or OFF	ON OFF
RUSBppy:	Results to USB	
DUPLicate	Save results as duplicate filename on flash drive	xxxxxxxx
NEW	Save results as new filename on flash drive	xxxxxxxx
APPend	Append results to existing filename	xxxxxxxx
CLOSe	Close results of filename	xxxxxxxx

SWEep:

PARameter	The parameter to sweep	F (frequency)

		V (voltage)
		I (current)
BEGin	The beginning value	floating point number
END	The ending value	floating point number
STEP	The step to increment during the sweep	10 25 50 100 200
RDISplay	The result display for the sweep	T (table) P (plot)
SWEep	Set the sweep function to ON or OFF	ON OFF
VALid?	Is filename valid to save to battery backed up RAM?	
	* Example CONF: BINN: BIN1: ABS 100 300	

CONFigure:

SAVe:

DUPLicate xxxxxxxx	Save setup as duplicate filename in battery backed up RAM	
NEW	Save setup as new filename in battery backed up RAM	
RECall filename	Recall setup filename from battery backed up RAM	
FVALid?	Is filename valid to save to flash drive?	xxxxxxxx

FSAVe:

DUPLicate	Save setup as duplicate filename on flash drive	xxxxxxxx
NEW	Save setup as new filename on flash drive	xxxxxxxx
FRECall filename	Recall setup filename from flash drive	xxxxxxxx
RVALid?	Is results filename valid?	xxxxxxxx

SEQuence:

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 10 to 2000000 HZ	test # and ######.##
PPARameter	Set the primary parameter	test # and A(auto) RS RP LS LP CS CP DF
		Q Z Y P(phase angle)
		ESR GP XS BP
SPARameter	Set the secondary parameter	test # and N(none) RS RP LS LP CS CP DF Q Z Y
		P(phase angle)ESR

		GP XS BP
ACTYpe	Set the AC test signal type to	test # and V I
	(This command should be set prior to setting the ACValue)	
ACValue	Set the AC signal to value	test # and 0.0
BIAS	Set the bias to	test # and INT EXT
		or OFF
RANGe	Set the range	test # and ON OFF
TDELay	Set the measurement delay	test # and ####
STOP	Stop on fail	test # and ON OFF

LOAd correction:

NOMinals	Set primary & secondary nominal values	primary secondary (floating point #'s)

Example: conf:load:nom 1e-12 0.001

this will set primary to 1p and secondary to 0.001

MEAsure	Perform the Correction Measurement and set Load Correction to On
ON	Set Load Correction to ON (valid only if a Correction Measurement has previously been made
OFF	Set Load Correction to Off

CALibrate:

SHORt — Perform short circuit calibration

The procedure for performing a remote short is as follows:

IEEE wait for SRQ OPC to indicate continue

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 — Perform open circuit calibration

The procedure for performing a remote open is as follows:

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)	

MEAS

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 name> <tab> <primary result> <tab> <units> <secondary result name> <secondary result> <tab> <units> <tab> <bin or tab> <tab> <#> <tab> <pass string or fail string or tab> <tab> <retest or tab> terminated by a linefeed.

The secondary parameter will be blank when the parameter is set to NONE.

Sweep Measurement:

If sweep is enabled, fetch will give all of the results based on the number of steps selected with the normal measurement format. For example if Sweep is set for 50 measurements then after sending Fetch? there will have to be 50 reads to retrieve all 50 measurements.

FETCh?

Sequence Measurement:

If sequence is enabled, results will be sent for each test enabled.

1st line: <pass/fail bin> <tab> <#>,

additional lines for tests enabled: <test> <tab> <#> <tab> <primary result> <tab> <units> <tab> <secondary results> <tab> <units> <tab> <fail or tab>, .last line for tests enabled: <test> <tab> <#> <tab> <primary result> <tab> <units> <tab> <secondary results> <tab> <units> <tab> <fail or tab> terminated by a linefeed.

Bin Summary Measurement:

Bins 1 - 10

<bin> <tab> <#> <tab> <low limit> <tab> <# or tab> <tab> <high limit> <tab> <# or tab> <tab> <total> <tab> <#> terminated by a linefeed.

Bins 11 - 15

<bin> <tab> <#> <tab> <bin description> <tab> <total> <tab> <#> terminated by a linefeed.

Last Line

<totals:> <tab> <pass> <tab> <#> <tab> <fail> <tab> <#> <tab> <#> <tab> <total> terminated by a linefeed.

LOADFEtch?

Returns load correction status Valid, measured primary & secondary values

or

Invalid

***IDN?**

Returns instrument identification "IET Labs,7600Plus,xx...xx,software version".

***ESR?** x denotes serial number up to 10 digits

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

***RST**

Reset the buffer

***TST?**

Self test query

***CLS**

Clear standard event status register

Note: Remote command can start with or without * symbol for compatibility.

2.13 Formats

IEEE 488.2 enables 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 IEEE488.2 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 IEEE488.2 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

Bit	Decimal Value	Use
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 Regester is readable via the standard STB? as defined in para. 11.2.2.2 of the IEEE spec. The 7660 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	Power Up Since Last Query
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, page 69 (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.

2.13.1 Sample Program for National Instruments GPIB card

```
260 '*SAMPLE 7660 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$="CONF:FREQ 1000.00"    : CALL IBWRT (DEV4%,SET$)
320   SET$="CONF:PPAR CS"         : CALL IBWRT (DEV4%,SET$)
330   SET$="CONF:SPAR DF"         : CALL IBWRT (DEV4%,SET$)
340   SET$="CONF:MAC ENH"         : CALL IBWRT (DEV4%,SET$)
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
```

2.14 Operation with Accessories

A wide selection of accessories such as test leads, cables and fixtures are available from IET Labs to enhance the operation of the 7660 Precision LCR Meter.

NOTE:

Instrument accuracy can be reduced from nominal specifications when using some 7000 accessory fixtures and cables. Best accuracy requires geometric consistency between that utilized during open/short zeroing and that utilized on fixtures and cables during the actual measurement process. This consistency may be especially difficult to achieve when using unshielded Kelvin clip and tweezer type connections.

2.14.1 Rack Mount Kit (7000-00)

The 7000-00 Rack Mount Kit is used to install the 7660 in a rack mount configuration. The main components of the kit include front handles, front angle brackets, rear vertical trim pieces and rear support brackets. Assembly instructions (IET Labs Form # 150077) are provided with the kit.

2.14.2 BNC Cable Set, 1 Meter (1689-9602), 2 Meter (1689-9602-02)

The 1689-9602 and 1689-9602-02 are BNC to BNC cable sets used for connecting fixtures, component handlers or other measurement devices to the measurement terminals of the 7660. The only difference between the two is that the 1689-9602 cable is 1 meter in length and the 1689-9602-02 is 2 meters in length.

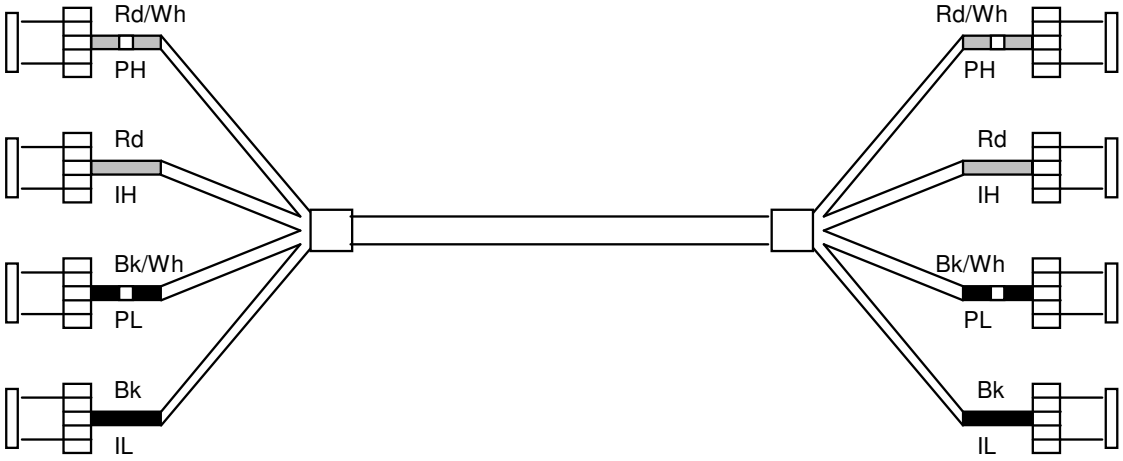


Figure 49 BNC Cable Sets

Connection to 7660:

Connect to 7660	Cable Marking/Color	Connection to DUT
PH (potential, high)	PH (Red/white)	Positive (+) terminal of DUT
IH (current, high)	IH (Red)	Positive (+) terminal of DUT
PL (potential, low	PL (Black/white)	Negative (-) terminal of DUT
IL (current , low)	IL (Black)	Negative (-) terminal of DUT

Note: H and L denote polarity of AC test signal at 7660 measurement terminals as well as the + and - polarity of DC bias voltage when applied.

2.14.3 Kelvin Clip Leads (1700-03)

The 1700-03 Kelvin Clip Leads provide a means for easily making four-terminal connections to passive sensors and components when they are tested by the 7660. This cable is especially useful for testing low-impedance devices that have large or non-standard terminations, devices such as electrolytic capacitors and inductors.

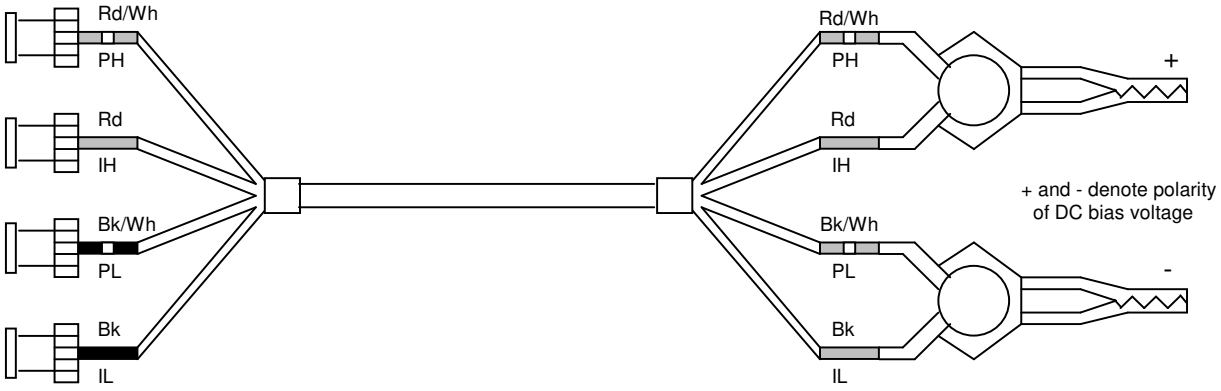


Figure 50 Kelvin Clip Leads

For this accessory an additional accuracy (for parameters listed) must be added to the standard instrument accuracy

C: ± 1.5 pF R: ± 10 mΩ L: ± 100 nH

Q: for R > 100 Ω, ± 9 * Freq * R * 10^{-12} ppm

for R < 100 Ω, ± (R/Freq) * 10^{-6} ppm

Measurement accuracy is very sensitive to connection geometry. The same connection geometry must be used for open/short compensation as for connection to the device under test.

Connection to 7660:

Connection to the 7660 is made through four shielded cables with BNC connectors that mate directly with the measurement terminals of the 7660. The cables are color coded to facilitate proper connections as detailed below.

Connect to 7660	Cable Marking/Color	Connection to DUT
PH (potential, high)	PH (Red/white)	Positive (+) terminal of DUT
IH (current, high)	IH (Red)	Positive (+) terminal of DUT
PL (potential, low	PL (Black/white)	Negative (-) terminal of DUT
IL (current, low)	IL (Black)	Negative (-) terminal of DUT

NOTE:

H and L denote polarity of AC test signal at 7660 measurement terminals as well as the + and - polarity of DC bias voltage when applied

Open/Short Zeroing:

When these Kelvin Test Leads are used, an open/short-circuit "zeroing" procedure should be done (page 11) to correct for residual resistance and inductance. The following diagram shows how to connect the clips for the short-circuit "zero."

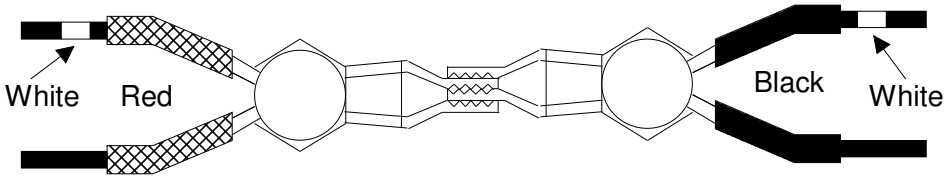


Figure 51 Kelvin Test Leads Open/Short Zeroing

2.14.4 Alligator Clip Leads (7000-04)

The 7000-04 Alligator Clip Leads is generally used to connect to devices that are multi-terminal, physically large or otherwise unsuited for one of the remote test fixtures. The lead set is consists of a BNC to BNC cable, four banana plug adapters and four alligator clips. One of the banana plug adapters is supplied with a pigtail for connecting a "guard" if necessary.

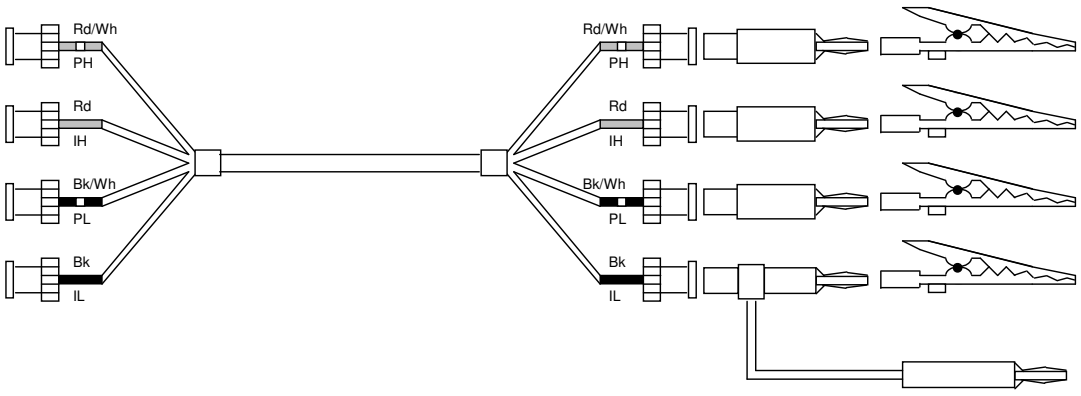


Figure 52 Alligator Clip Leads

For this accessory an additional accuracy (for parameters listed) must be added to the standard instrument accuracy

C: ± 1.0 pF R: ± (10 mΩ + R/5 * 10^6)

Q: ± 50 ppm

for R > 100 Ω, ± 4 * Freq * R * 10^{-13} ppm

Measurement accuracy is very sensitive to connection geometry. The same connection geometry must be used for open/short compensation as for connection to the device under test.

Connection to 7660:

Connect to 7660	Cable Marking/Color	Connection to DUT

PH (potential, high)	PH (Red/white)	Positive (+) terminal of DUT
IH (current, high)	IH (Red)	Positive (+) terminal of DUT
PL (potential, low	PL (Black/white)	Negative (-) terminal of DUT
IL (current, low)	IL (Black)	Negative (-) terminal of DUT
		Guard of DUT

NOTE:

H and L denote polarity of AC test signal at 7660 measurement terminals as well as the + and - polarity of DC bias voltage when applied

2.14.5 Chip Component Tweezers (7000-05)

The 7000-05 Chip Component Tweezers can handle small unleaded "chips" or SMDs (surface mounted devices), passive sensors, and components for testing on the 7660. A four-terminal Kelvin connection extends to the tip of the tweezers where the measurement becomes two-terminal, therefore series impedance of the connecting cables and internal tweezer connections do not affect the measurement. The small amounts of residual-tip resistance and inductance can be automatically corrected by using the 7660 shorting function with the tips pressed together. Guard shields between the tweezer blades minimize capacitance between them. A correction for this small capacitance can be made using the 7660 open circuit test with the tips held at a spacing equal to that of the component's contact spacing.

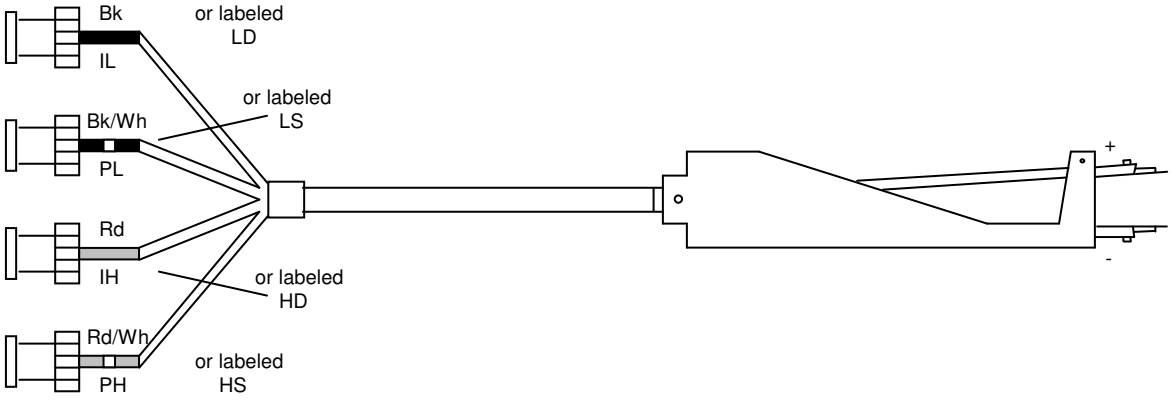


Figure 53 Chip Component Tweezers

For this accessory an additional accuracy (for parameters listed) must be added to the standard instrument accuracy

C: ± 1.5 pF R: ± 10 mΩ L: ± 100 nH

Q: for R > 100 Ω, ± 9 * Freq * R * 10^{-12} ppm

for R < 100 Ω, ± (R/Freq) * 10^{-6} ppm

Measurement accuracy is very sensitive to connection geometry. The same connection geometry must be used for open/short compensation as for connection to the device under test.

Connection to 7660:

Connect to 7660	Cable Marking	Connection to DUT
PH (potential, high)	PH (Rd/Wh) or HS	+ to positive (+) terminal of DUT
IH (current, high)	IH (Rd) or HD	+ to positive (+) terminal of DUT
PL (potential, low	PL (Bk/Wh) or LS	- to negative (-) terminal of DUT
IL (current, low)	IL (Bk) or LD	- to negative (-) terminal of DUT

The PH (HS) and IH (HD) cables connect to the fixed arm of the tweezers (+) and the PL (LS) and IL (LD) cables connect to the movable arm of the tweezers (-). To ensure valid measurements it is especially important to observe the correct polarity when DC bias is to be used.

2.14.6 Low V, Axial/Radial Lead Component Test Fixture (7000-06)

The 7000-06 Test Fixture, along with the BNC to BNC cable provided, is a method of convenient, reliable, guarded 4-terminal connection of radial and axial leaded sensors and components to the 7660. The 7000-06 consists of the test fixture and two axial lead adapters.

Figure 54 Low V, Axial and Radial Lead Component Test Fixture

For this accessory an additional accuracy must be added to the standard instrument accuracy

For 1 MHz Special Case Accuracy

Primary readings: ± 0.06%

Secondary readings: ± 600 ppm

Connection to 7660 (using 7000-01 or 7000-02 BNC Cable Sets):

Connect to 7660	Cable Marking/Color	Connect to Test Fixture
PH (potential, high)	PH (Red/white)	PH
IH (current, high)	IH (Red)	I H
PL (potential, low	PL (Black/white)	PL
IL (current, low)	IL (Black)	IL

If the device under test (DUT) is a radial lead component it can be inserted directly into the fixture slots. The slots accommodate wires with diameters from 0.25 mm to 1 mm

(AWG 30 to AWG 18 wire). If the DUT is an axial-lead component the two axial lead adapters should be installed in the fixture (by pushing vertically downward) and the component installed in them. These adapters accommodate wire with diameters up to 1.5 mm (AWG 15 wire). When removing, lift with a gentle tilt left or right, **never forward or back.**

2.14.7 Open/Short Zeroing:

Instrument zeroing should be performed once the test fixture is connected. For an open, a lead should be inserted in the + slot and another lead in the - slot to ensure good contact between the wiper blades, and for a short the + and - contacts should be shorted together with bus wire, the larger the better, but in accordance with wire sizes discussed above. It should be noted that if measurements are to be made on the very lowest range (20 mΩ full scale), readings could be in error, although small, by the resistance value of the short itself. The approximate value of the shorting wire can be determined by zeroing the instrument using the standard 4-terminal Kelvin clips and then measuring the resistance of the shorting wire.

2.14.8 Low V, Chip Component Test Fixture (7000-07)

The 7000-07 Test Fixture, along with the BNC to BNC cable provided, is a method of convenient, reliable, guarded 4-terminal connection of chip or surface mount sensors and components.

Figure 55 Low V Chip Component Test Fixture

Maximum Frequency:

2 MHz

Typical Residual Parameters (after performing open/short at DUT terminals):

C: < 0.15 (1 + 0.002/f)pF L: < 10 (1 + 0.002/f)nH R: < 1 (1 + f^2)mΩ

where f = measurement frequency in MHz

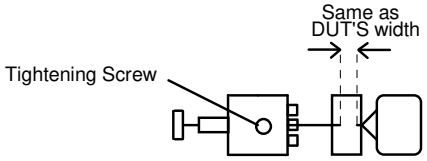
Connection to 7660 (using 7000-01 or 7000-02 BNC Cable Sets):

Connect to 7660	Cable Marking/Color	Connect to Test Fixture
PH (potential, high)	PH (Red/white)	PH
IH (current, high)	IH (Red)	I H
PL (potential, low	PL (Black/white)	PL
IL (current, low)	IL (Black)	IL

Open/Short Zeroing:

Instrument zeroing should be performed once the test fixture is connected. Refer to the instrument zeroing instructions for further information. For an OPEN the DUT should be removed but the fixture spacing should be the same as the device. This can be done by tightening the screw that holds the contact, as shown below. For a SHORT the fixture contacts should be shorted together with a shorting block equivalent to spacing of the device under test.

Use of this fixture may result in an incremental error due to residuals at DUT terminals. Verify with a known standard and apply this offset to final measurements.



2.14.9 Calibration Kit (7000-09)

The 7000-09 Calibration kit consists of four calibration resistors, an open-circuit module and a short-circuit module. These standards are NIST traceable and used to re calibrate the 7660 Precision LCR Meter. The four calibration resistors have nominal values of 24.9, 374 Ω; 5.97 and 95.3 kΩ. R and Q values are given for all four resistors at 1 kHz, R and Q values are also given at 25 kHz for the 95.3 kΩ resistor, 250 kHz for the 5.97 kΩ resistor and both 500 kHz and 1 MHz for the other two resistors. Use the 1 MHz for calibration of 7660. Refer to Calibration on page 91.

Figure 56 Calibration Kit

2.14.10 Connection to "Type 874" Connectors

There are times when it may be desirable to connect the 7660 to type 874 coaxial connectors that are found on some impedance standards. This connection can be made using either the 1689-9602 or 1689-9602-02 BNC to BNC Cable, two BNC Tees and two BNC to 874 adapters (see below).

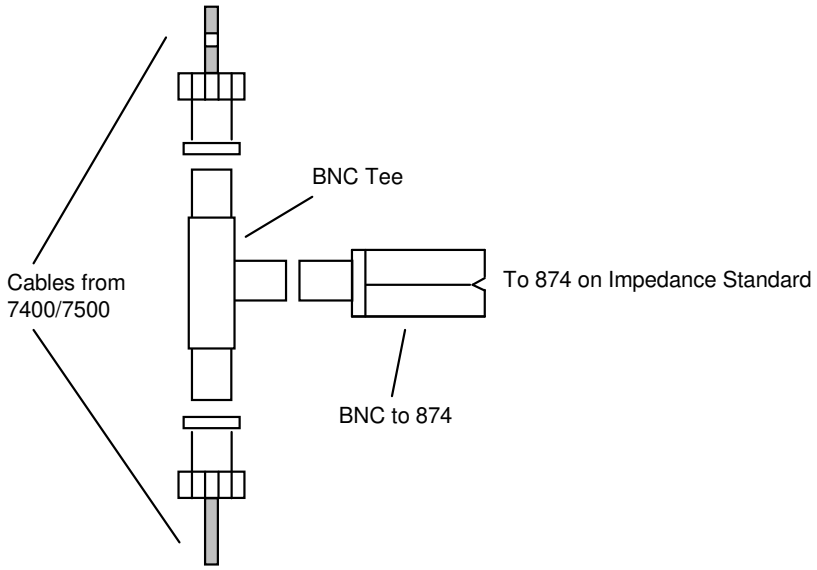


Figure 57 Connection to 874 Connectors

3 Error Messages

"AC CURRENT ERROR, SET TO 250µA" AC current level improperly set

"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

"BIN CHECKSUM ERROR, TOTALS SET TO 0" Bin count incorrect

"CRC ERROR ON USB" Stored setup lost or corrupt (cyclic-redundancy-check)

"CURRENT MODE, BIAS SET TO OFF"

"DISK WRITE PROTECT ERROR" Flash drive is write protected

"ELAPSED TIME ERROR, SET TO 0" Elapsed time is incorrect and has been set to zero (battery for non-volatile memory may be defective)

"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)

"FILE ACCESS VIOLATION" File selected from flash drive is Read Only

"FILE DOES NOT EXIST" File name incorrect

"FILE EXISTS" File already exists under the chosen name

"FLASH DRIVE NOT READY" Flash drive defective or not inserted

"GENERAL FAILURE, USB" Flash drive defective or not inserted

"HANDLER PORT FAILURE" I/O port malfunction during power up

"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

"INVALID FREQUENCY SELECTED" Select a valid frequency

"INVALID RANGE SELECTED" Select another range

"LOW BATTERY VOLTAGE" Memory backup battery indicates 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 INTERLOCK SIGNAL" Open interlock connection at rear panel I/O Port

"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

"QUICK OPEN / SHORT INVALID, RE-ZERO"

"REMOTE COMMAND INVALID" IEEE or RS232 command is incorrect (for example: to set frequency use FREQuency)

"REMOTE COMMAND PARAMETER INVALID" IEEE or RS232 parameter is incorrect (for example: frequency parameter can be XXXXXXX.XX)

"REMOTE COMMAND PREFIX INVALID" IEEE or RS232 command prefix is incorrect (for example: to configure unit use CONFigure)

"SHUT THE POWER OFF" Malfunction of instrument power source

"SWEEP BEGIN & END ARE EQUAL" Sweep range improperly set

"SWEEP BEGIN / END VALUES TOO CLOSE" Sweep range improperly set

"SWEEP BEGIN VALUE GREATER THAN END" Sweep range improperly set

"TIME / DATE ERROR, PLEASE SET" Reset time and date

"TOO MANY KEYS, LAST KEY IGNORED" Too many keys for entry field

“UNABLE TO READ FROM FLASH DRIVE" Flash drive defective or not inserted

"UNABLE TO READ THAT FILENAME" Selected file unreadable, improper format

"UNABLE TO WRITE TO REMOTE" IEEE or RS232 not setup correctly or IEEE not present

"UNKNOWN COMMAND"

"UNKNOWN UNIT" Flash drive is not recognized (not present or defective)

"USB MEDIA DEFECT" Flash drive defective

"USB READ FAULT" Flash drive defective or not inserted

"USB SAVE ERROR" Setup not properly saved

"USB SECTOR UNFORMATTED" Flash drive is not formatted

"USB SEEK ERROR" Flash drive defective or not inserted

"USB WRITE FAULT" Flash drive defective or not inserted

"VALID RANGE = low value - hi value"	Entry invalid, should be between specified values

4 Theory

The 7660 Precision LCR Meter consists of a standard mechanical package, TFT display/keypad, various PCBs, and power supply. Basic Instrument Architecture

4.1.1 Processor Board

The processor board provides the basic control for the 7660.

4.1.2 Power Supply

The power supply assembly consists of a single switching power supply.

4.1.3 TFT 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 with all keys providing tactile feedback to the operator. The 2 1/2" x 4 3/4" TFT is a high resolution graphic display for visual clarity.

7660 Main Analog Board

The Instrument Board, used in the Model 7660 Precision LCR Meter, is the heart of the measurement system. 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.

4.1.4 Sine Wave Generator

All devices under test are tested by applying a sine wave of voltage or current. The sine wave is generated by an IC using the Direct Digital Synthesis technique. This allows generation of all frequencies from 10 Hz to 2 MHz with a high level of resolution.

4.1.5 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, Ex, is measured by the PH and PL leads, filtered and amplified according to its level, and presented to one channel of the Dual A/D converter.

4.1.6 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.

4.1.7 A/D Converter

The two signals representing ‘voltage across’ and ‘current through’ the unknown are digitized by a dual 18-bit A/D converter. Samples are taken synchronously with the digital generation of the sine wave to obtain phase information.

4.1.8 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) extracts 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, L, D, Q etc.

4.1.9 Interface Board

Control available through the keyboard or available for display can be accessed over this interface.

5 Maintenance & Calibration

Our warranty (at the front of this manual) attests to 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 516-334-5959. For support outside of the United States, please contact IET Labs Inc.

5.1 Bias Voltage Fuse Replacement

There are two bias voltage fuses. The fuses are type F0.25A, 250V, 5x20mm fast blow. Replace only with the same rated fuse. **Make sure the instrument is off and disconnected from its ac power source.** The fuses are located on the rear panel of the instrument.

5.2 IEC Inlet Module

There is a single mains fuse. The fuse is a T1.6A, 250V, 5x20mm for 115 or 220V source. **Make sure the instrument is off and disconnected from its ac power source.** The fuse is located on the rear panel of the instrument in the IEC Inlet Module. The fuse tray pulls out to access the fuse. For safety only replace with the same type and fuse rating.

5.3 Care of Display Panel and Cleaning

Use caution when cleaning the display, not to scratch it or get cleaning substances into the instrument.

Use only a soft cloth with a mild glass cleaner or soap and water on the cloth. This is done on an as necessary basis or annually.

Cleaning of the external chassis and front panel overlay can be cleaned with a soft cloth with soap and water on a cloth or other cleaners than are not abrasive.

Do not use abrasive cleaners that could scratch the display, chassis or overlay.

Internal cleaning of the instrument is not generally required. If during repair or part replacement the inside of the chassis has excessive dust use compressed air to remove the dust.

5.4 Safety Inspection

Before operating the instrument, inspect the power inlet module or the rear panel to ensure that the **properly rated fuse is in place**, otherwise damage to the unit is possible. Refer to paragraph 2.2.

The instrument is shipped with a standard U.S. power cord, IET Labs P/N 4200-0300 and 3-wire plug conforming to IEC 320. Make sure the instrument is only used with these

cables (or other approved international cord set) which ensures that the instrument is provided with **connection to protective earth ground.**

On an annual basis the power cord should be inspected for damage or cuts. If found damaged or cut replace the power cord.

The surrounding environment should be **free from excessive dust** to prevent contamination of electronic circuits. The surrounding environment should also be **free from excessive vibration**. The instrument should be positioned with consideration for ample air flow to the right side vents an open space of at least 75mm (3 inches) is recommended from the right side panel. Do not expose the instrument to direct sunlight, extreme temperature or humidity variations, or corrosive chemicals.

5.5 Inspection Interval

On an annual basis the power cord should be inspected for damage or cuts. If found damaged or cut replace the power cord.

The chassis, overlay and display should be cleaned annually.

The accessories such as 1700-03 Kelvin Clip leads should be inspected for damage, fraying and condition of the gold plating on the clips.

The tips of the 1700-03 clips can be cleaned with denatured alcohol or mild non-abrasive cleaner using a cloth or cotton swab. The 1700-03 should not be submersed in liquid during cleaning or operation.

If the gold plating is worn or cable frayed on the 1700-03 these should be replaced. The 1700-03 cannot be repaired.

5.6 Top Cover Removal

WARNING

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

Removal of instrument covers may constitute an electrical hazard and should be accomplished by qualified personnel only.

CAUTION ESD SENSITIVE

STATIC SENSITIVE DEVICES - USE STATIC CONTROL WRIST STRAP WITH STATIC CONTROL WORK SURFACE.

Remove the 4 screws on the top rear edge of the top cover. The top cover can then be lifted up starting at the rear.

Install the top cover by placing the front of the cover into the slot of the front top rail. Then engage the left and right sides of the cover with the chassis.

Install the 4 screws to attach the top cover.

5.7 Spare Parts

7660 Parts List (IET Cage Code: 62015)

Line #	Qty	IET Part Number	Description
1	1	7660 Chassis	Top Cover, overlay, rear panel and chassis complete
2	1	QT1-0023	AC Inlet Module
3	2	7660footbail	Front and rear feet includes bail
4	1	Little Fuse 021801.6MXP	Fuse,1.6 T, 5-20 mm, slow blow
5	1	7660InternalCables	Ground Cable, Pwr supply cable, TFT cable , AC harness and keypad cable
6	1	7660 Power Supply	Switching Power Supply
7	1	7660 Display and Keyboard Assembly	Display and Keypad board complete
8	1	7660 Main Board	Mainboard complete programmed and calibrated
9	1	7660 CPU and Adapter Board	CPU Board and Adapter Board complete
10	1	520065-1	Power Switch, Illuminated
11	1	7660 Interface Board	Interface board GPIB,USB,LAN
12	1	7660 Fan	Cooling Fan

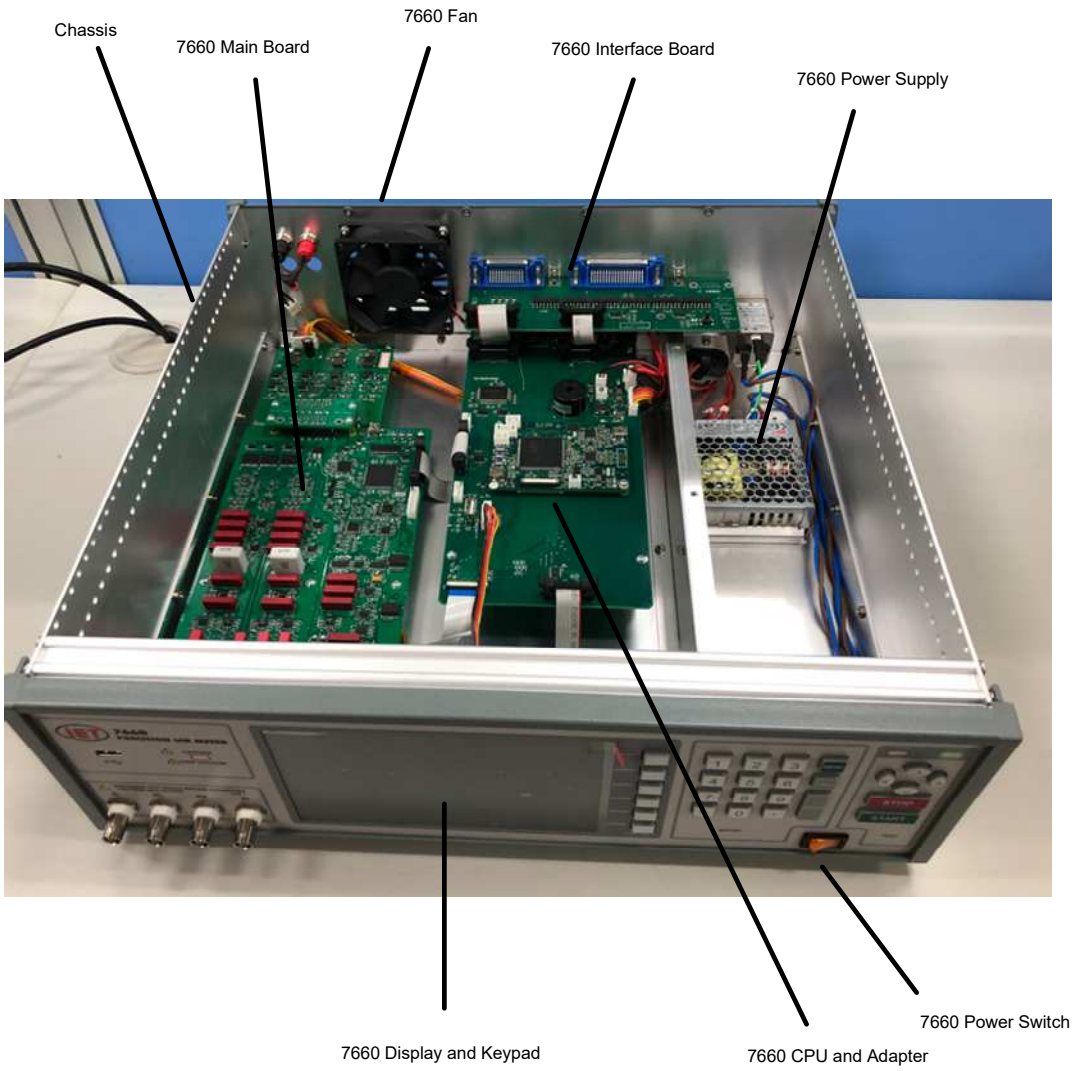


Figure 58 Calibration Kit

5.8 Troubleshooting

The troubleshooting technique for the 7660.

The main parts are;

7660 Main Circuit Board

7660 Keypad and Display Assembly

7660 Power Supply

7660 CPU and Adapter Board

Unit does not power up

Check power to unit from ac outlet and power cord

Check minas fuse

Check power supply voltages

Unit does not make accurate measurements

Perform calibration to see what calibration points fail

Perform adjustment procedure Section 5.9 or return to IET for repair or calibration

Return for repair to IET Labs Inc.

Display or Keypad Issues

If the keys become sticky 7660 Display and Keyboard Assembly

If the display becomes dim or cracked then replace 7660 Display and Keyboard Assembly

5.9 Calibration/Adjustment

Calibration of the 7660 Precision LCR Meter is recommended on an annual basis using a combination of resistance and capacitance standards.

If the unit is to be returned to IET Labs for factory calibration, refer to section 5.9.2 for instructions.

Using the procedure below, the instrument can also be adjusted by a qualified service person if traceable calibration equipment and standards are available.

CAUTION

To ensure maximum stability, the instrument should be powered up for a minimum of 1 hour before calibration.

5.9.1 Requirements for Re calibration

Temperature stabilized room at 23 degrees C (73.4 F)

IET Labs 7000-09 Calibration Kit

Select CALIBRATION on the Utilities menu.

Once ENTER is selected the calibration code of 7660225 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 is shown on the instrument display.

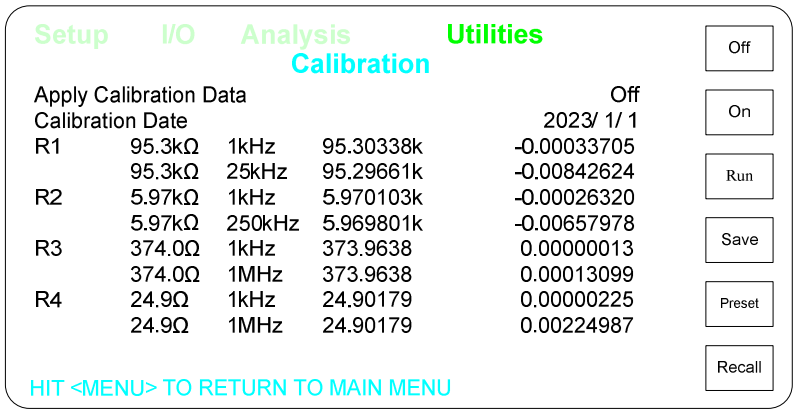


Figure 59 Calibration Screen

The applied calibration data can be turned **Off** or **On** using the softkeys.

Use the **arrow** keys to move through the fields, enter the calibration date, and then all Resistance and Q values for the 7000-09 Calibration Kit being used.

One all values have been entered press the **Run** key so start the calibration process.

This will go to a **Calibration Run Screen** to perform Open, Short, R3, R4,R2 and R1. See Figure 60. These should be performed in the order of top to bottom. The connection of the standard is checked prior to performing the calibration. A green bar will show progress and which have been completed.

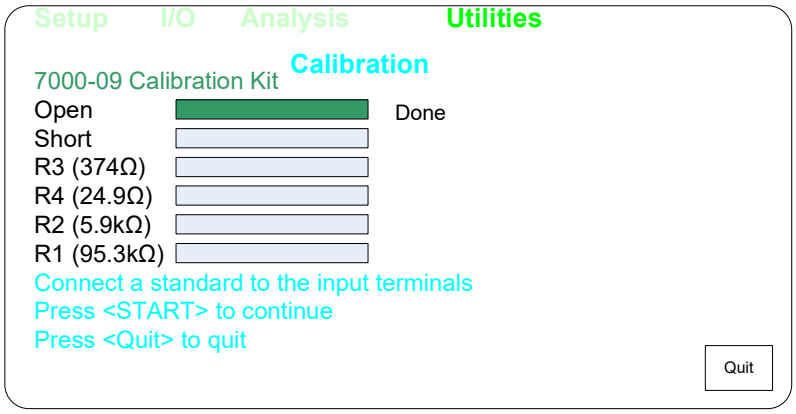


Figure 60 Calibration Run Screen

The **Save** key can be used to save the new calibration values.

The **Preset** key can be used to load the original R and Q calibration values.

The **Recall** key can be used to load the original calibration data.

5.9.2 Instrument Return

Before returning an instrument to IET Labs 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 IET Labs. Please contact our **Sales Department** at **516-334-5959** for additional support.

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 IET Labs.