

1730T
LCR Meter
Instruction Manual
Form 150821/A3

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The material in this manual is for informational purposes only and is subject to change, without notice. QuadTech assumes no responsibility for any error or for consequential damages that may result from the misinterpretation of any procedures in this publication.

CAUTION

Voltage may be present on front and rear panel terminals. Follow all warnings in this manual when operating or servicing this instrument. Substantial levels of energy may be stored in capacitive devices tested by this unit.

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Warranty



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

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

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

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

SERVICE POLICY

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

Specifications

Primary Parameters:	Ls, Lp, Cs, Cp, Rs, Rp and $ Z $, L2A and L2B Ls, Lp: 0.001 μ H – 99.999kH L2A, L2B: 0.001 μ H – 99.999kH Cs, Cp: 0.001pF – 9.9999F Rs, Rp: 0.01m Ω – 99.99M Ω $ Z $: 0.01m Ω – 99.99M Ω
Secondary Parameters:	D, Q, ESR, Xs, θ , N, 1/N, M, R2, and DCR D: 0.0001 – 9999 Q: 0.0001 – 9999 ESR: 0.01m Ω – 99.99M Ω Xs: 0.01m Ω – 99.99M Ω θ : -180.00° – 180.00° N: 0.001 – 9999.9 1/N: 0.001 – 9999.9 M: 0.001 μ H – 99.999kH R2: 0.01m Ω – 99.99M Ω DCR: 0.01m Ω – 99.99M Ω
Measurement Accuracy:	Basic LCR: 0.1% Basic DQ: ± 0.001
Measurement Rate:	Fast: 62 measurements/second Medium: 19 measurements/second Slow: 3 measurements/second
Measurement Mode:	Continuous or Trigger (INT, EXT or Manual)
Measurement Delay:	0 – 10 seconds in 1ms increments
Averaging:	1-256 measurements
Ranging:	Automatic or User Selectable
Equivalent Circuit:	Series or Parallel
Test Voltage:	10mV to 1.0V programmable in 10mV steps
Test Frequency:	10 User Selectable Test Frequencies: 50Hz, 60Hz, 100Hz, 120Hz, 1kHz, 10kHz, 20kHz, 40kHz, 50kHz and 100kHz Accuracy: $\pm (0.01\% \pm 0.01\text{Hz})$
Source Impedance:	100/25 Ω : 100 $\Omega \pm 5\%$ if $DUT_{IMPEDANCE} \geq 1\Omega$; 25 $\Omega \pm 5\%$ if $DUT_{IMPEDANCE} < 1\Omega$; 10 Ω /CC: 10 $\Omega \pm 10\%$ if $DUT_{IMPEDANCE} \geq 10\Omega$; CC: 100mA $\pm 5\%$ if $DUT_{IMPED} < 10\Omega$ 100 Ω : 100 $\Omega \pm 5\%$; 25 $\Omega \pm 5\%$; 25 Ω : 25 $\Omega \pm 5\%$;

Specifications (Continued)

Bias Voltage:	Internal: (R_{BIAS}) 0-5V DC, External: Programmable 0-5V DC				
Bias Current:	Internal: (R_{BIAS}) 0-200mA				
Display:	240 x 64 LCD Graphic display				
Results Format:	• Value • Deviation • %Deviation • Bin Number				
Indication:	Audible alarm programmable HI, LOW or OFF for Pass or Fail				
Setup Storage:	50 Memory Locations				
Standard Interfaces:	• IEEE-488 • Handler				
Connectors:	Front Connection: 4 BNC Sockets (L_{CUR} , L_{POT} , H_{POT} , H_{CUR}) Rear Connection: EXT Bias Terminal Strip, 1 BNC Connector GUARD: Banana Socket (Front & Rear connection)				
Front Panel Lockout:	Key Lock with or without setup recall, Back Lit Display: LOCK				
Mechanical:	Bench Mount; Dimensions: (w x h x d): 12.50 x 4.00 x 13.50") (312.5 x 100.0 x 337.5 mm)				
Weight:	12.4 lbs (5.7 kg) net, 17 lbs (7.8 kg) shipping				
Environmental:	Operating: 10°C to + 40°C, 10-90% RH Storage: 0°C to + 50°C, 10-90% RH Pollution Degree 2 Installation Category II				
Power:	• 90-125VAC • 190-250VAC • 50 or 60Hz • 65W max				
Supplied:	• Instruction Manual • Power Cable • Calibration Certificate • Kelvin Clip Lead Set				
Ordering Information:	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="border-bottom: 1px solid black; text-align: left;"><u>Description</u></td><td style="border-bottom: 1px solid black; text-align: left;"><u>Catalog No.</u></td></tr> <tr> <td>LCR Meter</td><td>1730T</td></tr> </table>	<u>Description</u>	<u>Catalog No.</u>	LCR Meter	1730T
<u>Description</u>	<u>Catalog No.</u>				
LCR Meter	1730T				

Accessories

Accessories Included

Item	Quantity	QuadTech P/N
AC Power Cord	1	4200-0300
Power Line Fuse 1A 250V SB	1	520026
Power Line Fuse 0.5A 250V SB	1	520138
Transformer Test Fixture	1	630166
Lead Set: 4 BNC Connectors to 2 Kelvin Clips	1	1700-03
Instruction Manual	1	150821
Calibration Certificate	1	N/A

Accessories/Options Available

Item	Quantity	QuadTech P/N
Axial/Radial Component Test Fixture	1	1700-01
Axial/Radial Remote Test Fixture	1	1700-02
Lead Set: 4 BNC Connectors to 2 Kelvin Clips	1	1700-03
BNC to BNC Cable Lead Set (1m)	1	7000-01
BNC to BNC Cable Lead Set (2m)	1	7000-02
Lead Set: 4 BNC Connectors to Chip Component Tweezers	1	7000-05
Low Voltage Chip Component Test Fixture	1	7000-07
50-pin micro-ribbon plug (for Handler)	1	329210
Transformer Test Fixture (standard with unit)	1	630166

NOTE:

For proper operation, the $H_{CUR}/H_{POT}/I_{CUR}/I_{POT}$ cable shields must be connected together at the DUT. This connection is already made using the 1730T recommended accessory leads. If the shields are not tied together, then at higher frequencies a resonance may occur which could cause erroneous capacitance readings.

Safety Precautions

CAUTION

The 1730T LCR Meter can provide an external bias output voltage of 5V DC to the device under test (DUT). Although the 1730T unit is a low voltage instrument, some devices tested (especially capacitors) can store charge and may cause serious hazards if not discharged properly. Follow these safety instructions.

1. Operate the 1730T unit with its chassis connected to earth ground. The instrument is shipped with a three-prong power cord to provide this connection to ground. This power cord should only be plugged in to a receptacle that provides earth ground. Serious injury can result if the 1730T unit is not connected to earth ground.
2. Tightly connect BNC cables to the silver output terminals: H_{POT} , H_{CUR} , L_{POT} , and L_{CUR} . If this is not done, the DUT's casing can be charged to the high voltage test level and injury or electrical shock hazards could result if the DUT is touched.
3. Never touch the test leads, test fixture or DUT in any manner (this includes insulation on all wires and clips) when the bias voltage is applied and the **BIAS** backlight is ON.
4. Before turning on the 1730T unit, make sure there is no device (DUT) or fixture connected to the test leads.
5. When the **BIAS** backlight is ON, 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) Make sure any capacitive device has been discharged fully.
 - b) The **BIAS** backlight 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 1730T instrument.
8. Be wary when the 1730T instrument is used in remote control mode. The bias voltage output is being turned on and off with an external signal.

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”

Disposal

Do not dispose of electrical appliances as unsorted municipal 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.



waste, use

Condensed Operating Instructions

General Information

The 1730T LCR Meter is an instrument for measuring the passive component primary parameters of inductance (L), capacitance (C), resistance (R) and impedance (Z). Secondary parameters measured are dissipation factor (D), quality factor (Q), equivalent series resistance (ESR), reactance (X), phase angle (θ), mutual inductance (M), turns ratio (N), inverse of turns ratio (1/N) and resistance (R2). Two of sixteen parameters can be measured simultaneously and the results formatted as value, deviation from nominal, %deviation from nominal or by bin number. Connection to device under test is through 4-BNC terminals on the front panel.

Start-Up

The 1730T LCR Meter can be operated from a power source between 90-125V or 190-250V AC at a power line frequency of 50 or 60Hz. The standard 1730T unit is shipped from QuadTech with a 1A fuse in place for AC 90-125V operation. (A 0.5A fuse is included for AC 190-250V operation). The 1730T unit is shipped with the line voltage selector set for 115V. Refer to paragraph 1.4.3 for instructions on changing the fuse or line voltage selector.

Connect the 1730T LCR Meter AC power cord to the source of proper voltage. Operate the 1730T instrument with its chassis connected to earth ground. The 1730T instrument is shipped with a three-prong power cord to provide this connection to ground. This power cord should only be plugged into a receptacle that provides earth ground. Serious injury may result if the 1730T instrument is not connected to earth ground.

To turn the 1730T instrument ON, press the power button on the front panel. To switch the power OFF press the button again or if measurements are to be made proceed with the Test Parameter Setup in Table COI-1. The 1730T instrument should warm up for 15 minutes prior to use.

NOTE

Please read this instruction manual in its entirety before operating this instrument. These condensed operating instructions are not a substitute for all the information provided in the remainder of this manual.

NOTE

Refer to paragraphs 2.3 through 2.4 for a full description of programming test parameters and instruction on how to store the test setup. Test parameters must be set before the 1730T instrument can be zeroed.

Condensed Operating Instructions (Continued)

There are three main menus within the 1730T LCR Meter instrument software. Familiarize yourself with these menus prior to programming a test. Figure COI-1 illustrates the MEAS DISPLAY screen and lists the functions that can be accessed by pressing the [MAIN INDEX] and [SYSTEM SETUP] keys.

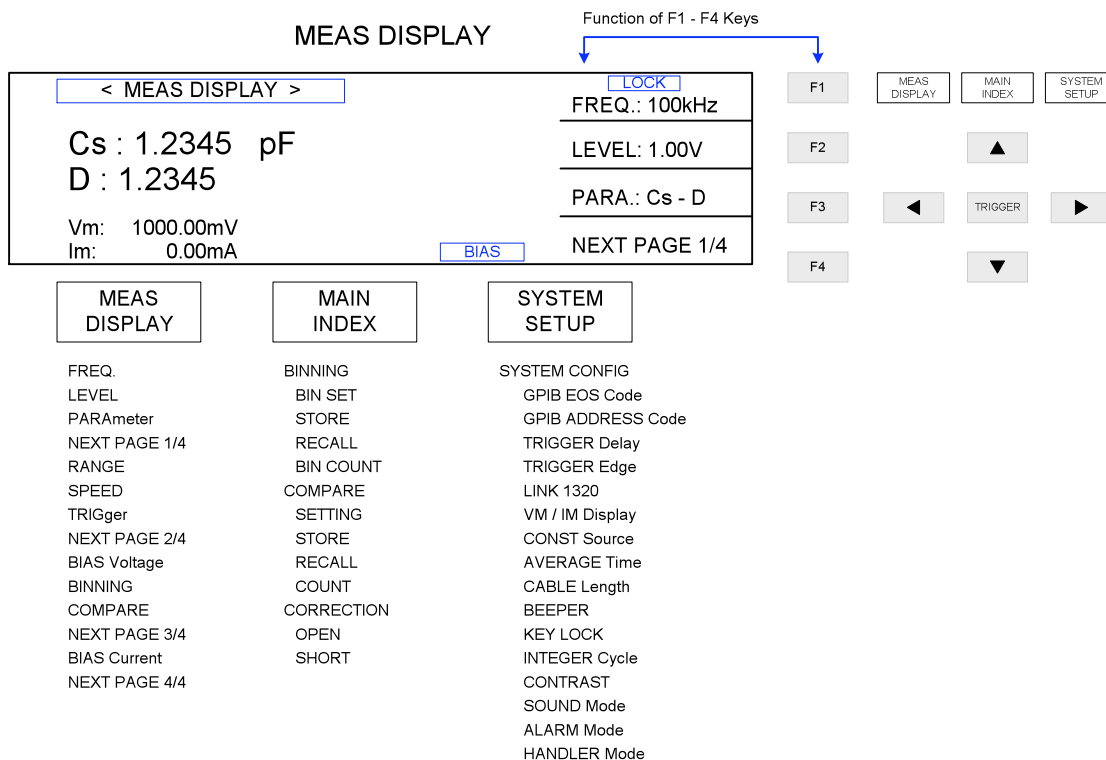


Figure COI-1: 1730T Instrument Menus

NOTE:

The function keys [F1 – F4] are used to select the parameter to change and in some menus to change the value of that selected parameter.
The function of UP/DOWN depends on the menu. In some menus, the LEFT/RIGHT keys are used to select a digit by moving the underscored cursor left or right.

NOTE:

To exit REMOTE mode press [F1] [F4] [SYSTEM SETUP].

Condensed Operating Instructions (Continued)

1. Set Test Parameters

- Press [POWER] ON.
- Allow the instrument to warm up for 15 minutes.
- Press [MEAS DISPLAY]
- Set test parameters (frequency, voltage, parameters) using the function & arrow keys.

2. Correction (Zero)

After setting your test parameters, use the correction function of the 1730T LCR Meter instrument to zero the test leads. With no device connected, connect the appropriate cable to the front panel BNC connectors. Refer to paragraph 2.6 for cable connections.

With the instrument in MEAS DISPLAY status:

1. Press [MAIN INDEX]
2. Press [CORRECTION]
3. Press [F2] = OPEN (or [F3] = SHORT) to select zero function.
4. Press [F2] = MULTI to select frequency.
5. Follow instructions on display: i.e.: “Open circuit test leads”.
6. Press [TRIGGER] button.
7. Wait while instrument gets CORRECTION value.
8. Press [ANY KEY] to return to MEAS DISPLAY status.
9. Repeat steps 3-8 for SHORT correction.

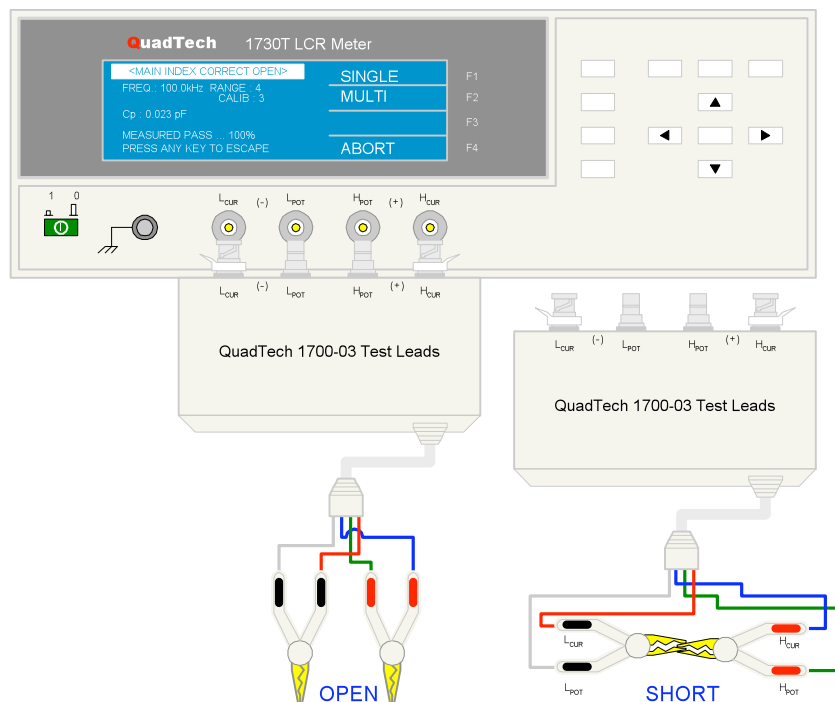
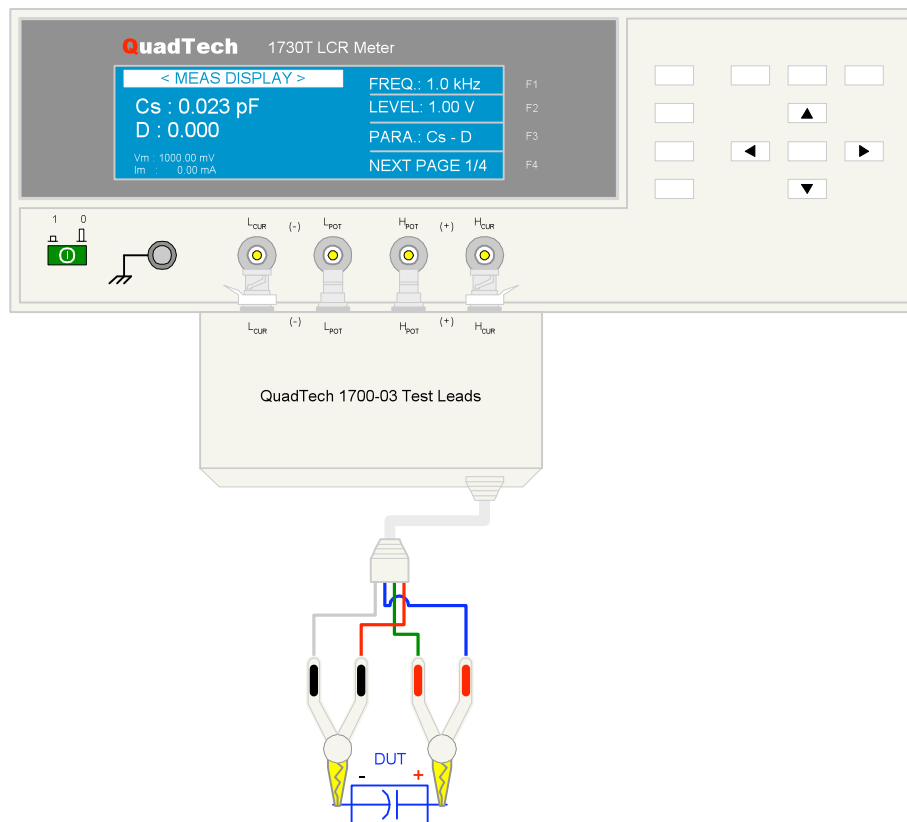


Figure COI-2: Correction OPEN & SHORT Configurations

Condensed Operating Instructions (Continued)

3. Connection to Device under Test (DUT)

Figure COI-3 illustrates the connection of the 1730T LCR Meter to a single DUT using the 1700-03 4-BNC to Kelvin Clips cable lead set. The silver BNC connectors are connected to the front panel BNC terminals on the 1730 unit: red to H_{CUR}/H_{POT} and black to L_{CUR}/L_{POT} . The red Kelvin clip is connected to the high side of the DUT and the black Kelvin clip to the low side of the DUT.



COI-3: Connection to Device under Test

4. Make a Measurement

1. Press [MEAS DISPLAY]
2. Connect device under test (DUT) to test leads.
3. Press [TRIGGER].
4. Record measurement.

NOTE:

For proper operation, the $H_{CUR}/H_{POT}/L_{CUR}/L_{POT}$ cable shields must be connected together at the DUT. This connection is already made using the 1730T recommended accessory leads.

If the shields are not tied together, then at higher frequencies a resonance may occur which could cause erroneous capacitance readings.

Section 1: Introduction

1.1 Unpacking and Inspection

Inspect the shipping carton before opening. If damaged, contact the carrier agent immediately. Inspect the 1730T LCR Meter instrument for any damage. If the instrument appears damaged or fails to meet specifications notify QuadTech (refer to instruction manual front cover) or its local representative. Retain the original shipping carton and packing material for future use such as returning the instrument for recalibration or service.

1.2 Product Overview

The 1730T LCR Meter instrument is a compact yet powerful LCR meter for production or laboratory testing of inductors, capacitors, resistors and other passive components. The 1730 instrument measures 16 parameters: L_s , L_p , C_s , C_p , R_s , R_p , D , Q , ESR, $|Z|$, X_s , θ , N , $1/N$, M , and R_2 and displays two simultaneously. Basic accuracy is $\pm 0.1\%$ for LCR and ± 0.001 for DQ measurements. Ranging is automatic or user selectable. Measurement rate is also selectable (Slow, Medium or Fast) with rates up to 62 measurements per second. Measurements can be made continuously or triggered with a programmable delay time up to 10 seconds. The IEEE-488 and Handler interfaces are standard equipment on the 1730T instrument. External bias voltage measurements are made via connection to the rear panel terminal strip and levels of 0-5V DC are possible. Internal bias voltage from 0-5V is attainable using an R_{BIAS} resistor across the rear panel terminal strip. Voltage across and current through the DUT can be monitored using the test signal. Zero the effects of stray admittance/residual impedance in the test leads with the open/short correction function. The source impedance of the 1730T instrument is selectable as 100Ω , $100/25\Omega$, 25Ω , or 10Ω constant current. Ten test frequencies are selectable from 50Hz to 100kHz. The 1730T instrument is equipped with 8 Pass/Fail bins and 50 Store/Recall memory locations. Test results can be formatted as nominal value, deviation from nominal value or %deviation from nominal value. Bin number or Pass/Fail can be displayed as well. Connection to the device under test is through 4 BNC terminals on the front panel.

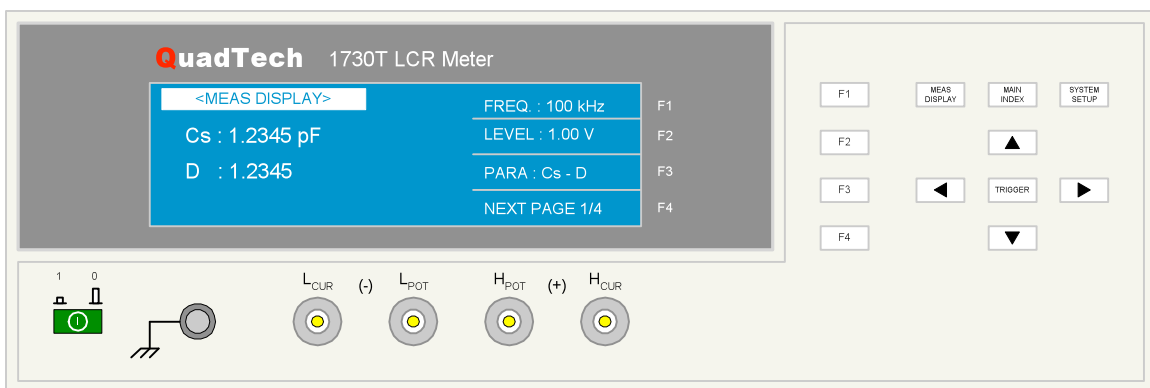


Figure 1-1: 1730T LCR Meter

1.3 Controls and Indicators

1.3.1 Front Panel Controls and Indicators

Figure 1-2 illustrates the controls and indicators on the front panel of the 1730T LCR Meter instrument. Table 1-1 identifies them with description and function.

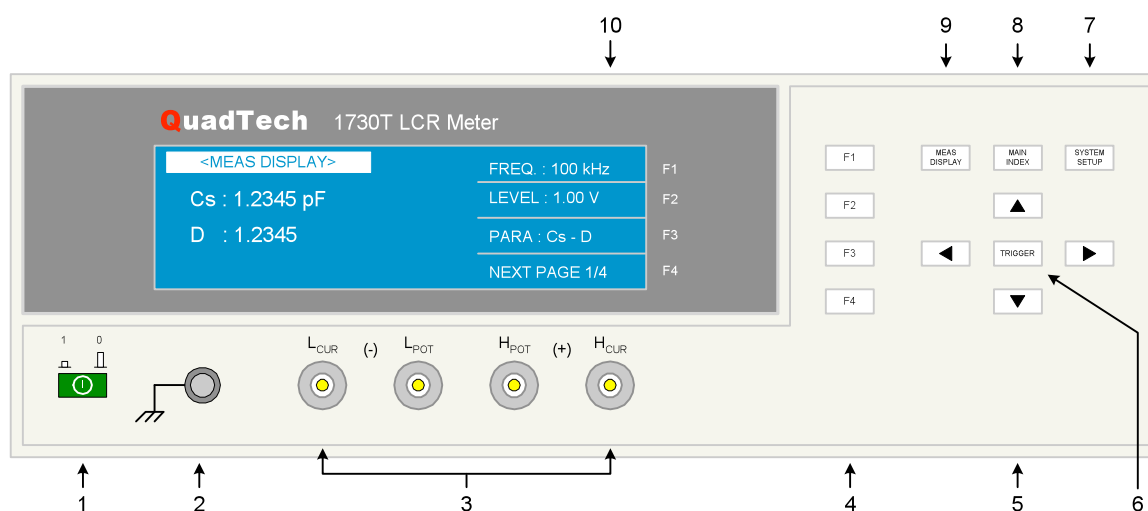


Figure 1-2: 1730T Front Panel Controls & Indicators

Table 1-1: 1730T Front Panel Controls & Indicators

Reference # Figure 1-2	Name	Type	Function
1		Green Push Button	Apply AC POWER: 1=ON, 0=OFF
2		Silver Banana Jack	Chassis ground connection
3	L _{CUR} L _{POT} H _{POT} H _{CUR}	4 silver BNC terminals	Current Drive Terminal, Low (-) Voltage Sense Terminal, Low (-) Voltage Sense Terminal, High (+) Current Drive Terminal, High (+)
4	F1, F2, F3 and F4	4 gray push buttons	Select Instrument Functions Keys perform different functions under different menus. Right side of display shows corresponding key function.
5	◀, ▼, ▶, ▲	4 gray push buttons	Move backlit box around display to choose parameter Change parameter value (increase/decrease)
6	TRIGGER	Gray push button	Initiate measurement
7	SYSTEM SETUP	Gray push button	View, Select or Change System Parameters: GPIB, Trigger, Handler, Constant source, VM/IM display, Average, Beeper, Sound, Alarm, Contrast, Integer, Cable Length, Key Lock & Link 1320
8	MAIN INDEX	Gray push button	View, Select or Change Setup & Result Parameters: Binning, Compare, Correction & Store & Recall
9	MEAS DISPLAY	Gray push button	View, Select or Change Measurement Parameters: Frequency, Voltage, Parameter (Pri/Sec), Range, Speed, Trigger, Bias Voltage, Binning and Compare
10		240 x 64 LCD display	Show measurement results as value, deviation, %deviation, bin number or pass/fail. Show programming instructions

1.3.2 Rear Panel Controls and Connectors

Figure 1-3 illustrates the controls and connectors on the rear panel of the 1730T LCR Meter instrument. Table 1-2 identifies them with description and function.

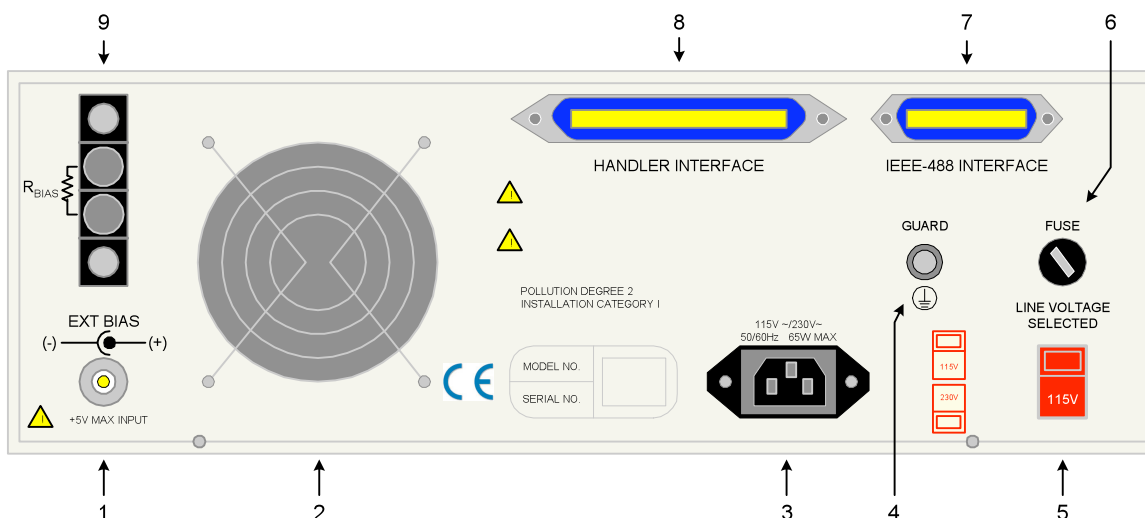


Figure 1-3: Rear Panel 1730T Instrument

Table 1-2: 1730T Rear Panel Controls & Connectors

Reference # Figure 1-3	Name	Type	Function
1	EXT BIAS	Silver BNC terminal	External Bias Voltage output connection to DUT
2	FAN	SF11580AT 115V 50/60Hz 0.10A	Cool Unit: $T \geq 50^{\circ}\text{C}$ = ON, $T < 45^{\circ}\text{C}$ = OFF
3	AC Line Input	Black 3-wire inlet module	Connection to AC power source
4	GUARD	Silver banana jack	Chassis ground connection
5	LINE VOLTAGE SELECTED	2 Red 2-position Slide Switches	Select Voltage Level corresponding to AC Source 90V – 125V: T 1.0A 250V fuse 190V – 250V: T 0.5A 250V fuse
6	FUSE	Black screw cap fuse holder	Short circuit protection T 1.0A 250V fuse for 115V operation T 0.5A 250V fuse for 230V operation
7	IEEE-488 INTERFACE	Blue 24-pin connector	IEEE-488 Interface connector for data transfer
8	HANDLER INTERFACE	Blue 50-pin connector	Handler Interface connector for remote operation
9	R_{BIAS}	Black 4-screw terminal strip	Remote connection: resistor for internal bias voltage (0-5V) and bias current (0-200mA)

1.4 Installation

1.4.1 Dimensions

The 1730T LCR Meter unit is supplied in a bench configuration, i.e., in a cabinet with resilient feet for placement on a table. A bail is provided under the front feet so that the 1730T instrument can be tilted up for convenient operator viewing.

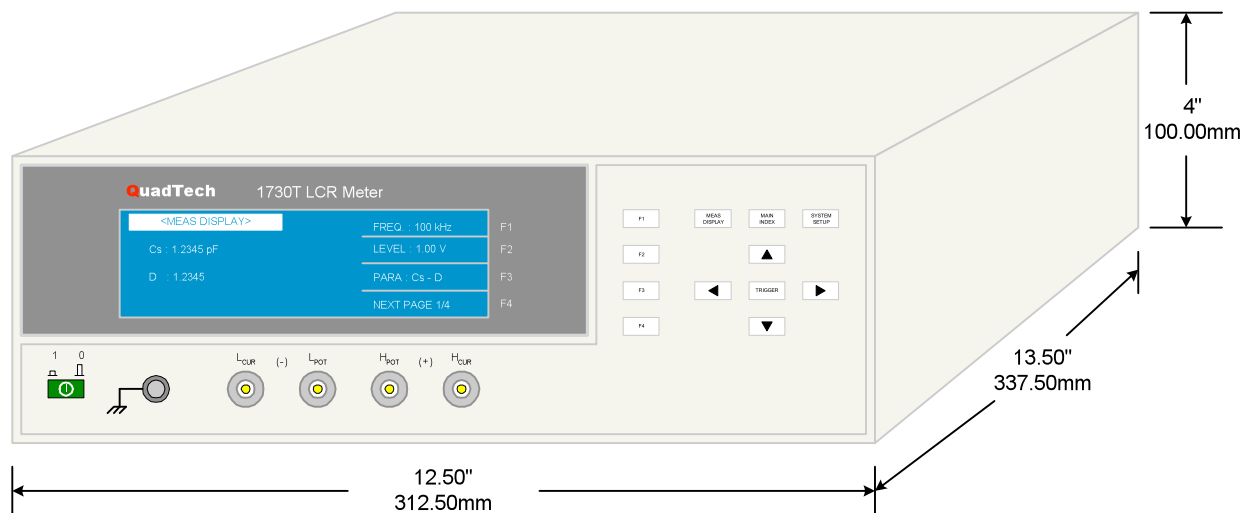


Figure 1-4: 1730T Instrument Dimensions

1.4.2 Instrument Positioning

The 1730T instrument contains one (1) graphic display for direct readout of measured parameters. The optimum angle for viewing is slightly down and about 10 degrees either side of center. For bench operation the front flip feet should always be used to angle the instrument up. In bench or rack mount applications the instrument should be positioned with consideration for ample air flow around the rear panel fan ventilation hole. An open space of at least 3 inches (75mm) is recommended behind the rear panel. Testing should be performed on a non-conductive surface. An ESD mat is not a recommended test platform.

1.4.3 Power Requirements

The 1730T can be operated from a power source of 90 to 125V AC or 190 to 250V AC. Power connection is via the rear panel through a standard receptacle. Before connecting the 3-wire power cord between the unit and AC power source, make sure the voltage selection switches on the rear panel (Figure 1-5) are in accordance with the power source being used. For a 90-125V source, use a 1A 250V fuse. For a 190-250V source, use a 0.5A 250V fuse. Always use an outlet that has a properly connected protection ground.

CAUTION

Make sure the unit has been disconnected from its AC power source for at least five minutes before proceeding.

Procedure for Changing a 1730T Instrument Fuse

Unscrew the fuse cap on the rear panel of the 1730T and pull fuse holder outward.

Once the fuse holder has been removed from the instrument snap the fuse from the holder and replace. Make sure the new fuse is of the proper rating.

Install the fuse back into the cap holder by pushing in until it locks securely in place.

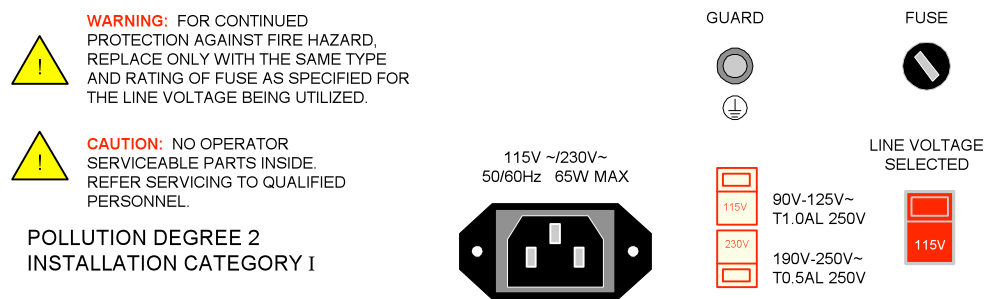


Figure 1-5: Close-Up of 1730T Rear Panel

1.4.4 Safety Inspection

Before operating the instrument inspect the fuse holder on the rear of the 1730T instrument to ensure that the properly rated fuse is in place, otherwise damage to the unit is possible. Make sure that the voltage selector switches are set in accordance with the power source in use. Refer to paragraph 1.4.3 and Figure 1-5.

The 1730T instrument is shipped with a standard U.S. power cord, QuadTech P/N 4200-0300 (with Belden SPH-386 socket or equivalent, and a 3-wire plug conforming to IEC 320). Make sure the instrument is only used with these cables (or other approved international cord set) to ensure that the instrument is provided with connection to protective earth ground.

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. Do not expose the 1730T instrument to direct sunlight, extreme temperature or humidity variations, or corrosive chemicals.

Section 2: Operation

2.1 Terms and Conventions

Table 2-1: Measurement Unit Prefixes

<u>Multiple</u>	<u>Scientific</u>	<u>Engineering</u>	<u>Symbol</u>
1000000000000000	10^{15}	Peta	P
1000000000000	10^{12}	Tera	T
1000000000	10^9	Giga	G
1000000	10^6	Mega	M
1000	10^3	Kilo	k
.001	10^{-3}	milli	m
.000001	10^{-6}	micro	μ
.000000001	10^{-9}	nano	n
.000000000001	10^{-12}	pico	p
.000000000000001	10^{-15}	femto	f

Accuracy: The difference between the measured value or reading and the true or accepted value. The accuracy of an LCR meter is typically given as a $\pm$ percentage of the measured value for primary parameters and $\pm$ an absolute value for secondary value. For example: $\pm 0.05\%$ for L, C & R and ± 0.0005 for Df.

Basic Accuracy: Basic accuracy is specified at optimum test signal, frequencies, highest accuracy setting or slowest measurement speed and impedance of the DUT. As a general rule this means 1VAC RMS signal level, 1kHz frequency, high accuracy which equates to 1 measurement/second, and a DUT impedance between 10Ω and $100k\Omega$.

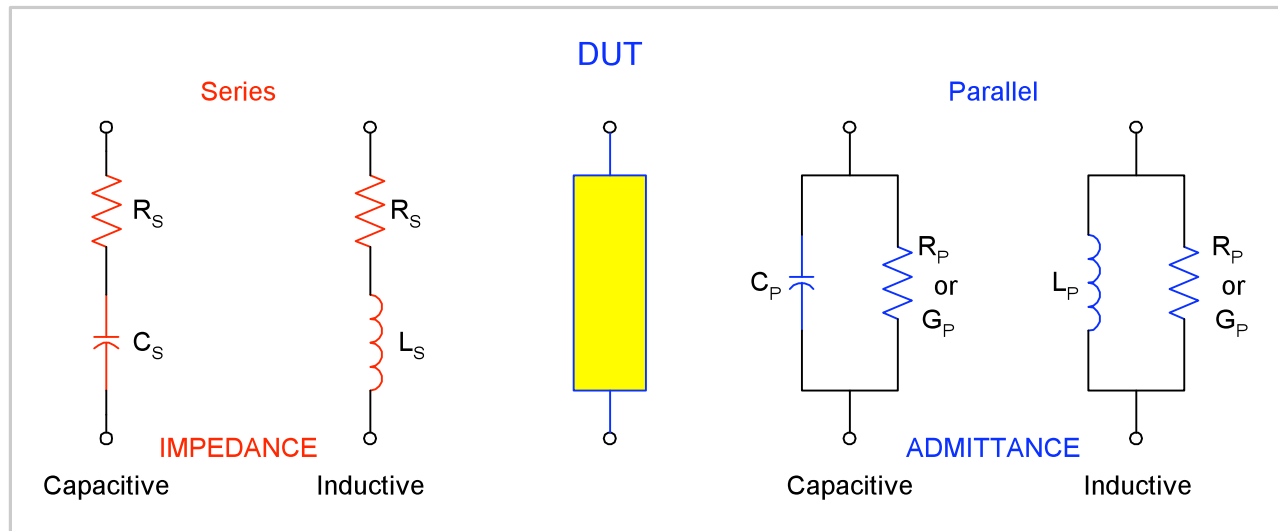
Binning: Procedure for sorting components into bins using sequential limits or nested limits.

Capacitor: Abbreviated C (as in LCR). A capacitor is passive component comprised of two conductors separated by a dielectric. A capacitor stores charge blocks DC flow and allows AC flow based on frequency and capacitor design.

Capacitance:	The measure of the ratio of charge on either plate of a capacitor to the potential difference (voltage) across the plates. Unit of measure is the Farad (F).
Capacitive Reactance:	A measurement of the actual AC resistance of a capacitor. How effective a capacitor allows AC to flow depends upon its capacitance and the frequency used. $X_C = 1 / 2\pi fC$.
Compare:	Procedure for sorting components by comparing the measured value against a known standard.
Current:	
AC:	Alternating Current. AC is an electrical current that has one polarity during part of the cycle and the opposing polarity during the other part of the cycle. Residential electricity is AC.
DC:	Direct Current. Non-reversing polarity. The movement of charge is in one direction. Used to describe both current and voltage. Batteries supply direct current (DC).
Dielectric:	A material which is an electrical insulator or in which an electric field can be sustained with a minimum dissipation of power.
Dielectric Constant:	Abbreviated K, relative dielectric constant. The dielectric constant of a material is the ratio of the capacitance of a capacitor filled with a given dielectric to that same capacitor having only a vacuum as a dielectric.
Discharge:	The act of draining off an electrical charge to ground. Devices that retain charge should be discharged after an IR test or DC hipot test.
DUT:	Device Under Test. (i.e. the product being tested).

Equivalent Circuit:

The configuration of the device under test. Is it a series or parallel equivalent circuit?



Frequency:

The rate at which current or voltage reverses polarity and then back again completing a full cycle, measured in Hertz (Hz) or cycles/second. AC Line Frequency = 50/60 Hz.

Ground:

The base reference from which voltages are measured, nominally the same potential as the earth. Ground is also the side of a circuit that is at the same potential as the base reference.

Impedance:

The AC resistance of the DUT. Impedance (Z) is a vector summation of resistance R and reactance X .

For capacitors reactance is defined as $X_C = 1/j\omega C$

For inductors reactance is defined as $X_L = j\omega L$

For resistors resistance is defined as R

Impedance is defined as $Z = \sqrt{X^2 + R^2}$

Inductor:

Abbreviated L (as in LCR). An inductor is a coil of wire. It is used to create electromagnetic induction in a circuit.

Inductance:

The property of a coil to oppose any change in current through it. If the turns (coils) of the wire are stretched out, the field intensity will be less and the inductance will be less. Unit of measure is the Henry (H).

Inductive Reactance:

A measure of how much the counter electro-magnetic force (emf) of the coil will oppose current variation through the coil. The amount of reactance is directly proportional to the current variation: $X_L = 2\pi fL$.

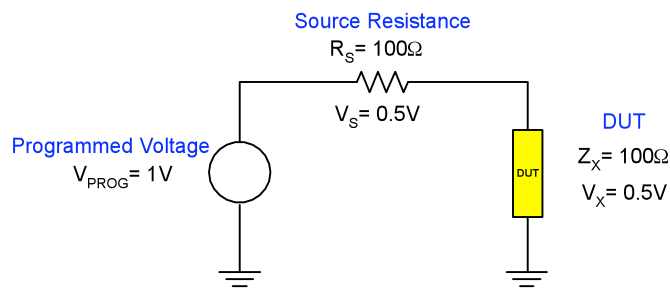
Interface:

Handler:	Device for remote control of test instrument in component handling operations.
IEEE-488:	General Purpose Interface Bus (GPIB). GPIB is an industry standard definition of a Parallel bus connection for the purpose of communicating data between devices.
RS232:	An industry standard definition for a Serial line communication link or port.
Scanner:	An electronic device designed to switch or matrix signals.
Level:	The test signal level is the programmed RMS voltage of the generator in an LCR meter. The actual test voltage across the DUT is always less than the programmed level. Refer to VM/IM feature to view actual signal across DUT.

Limits:

High Limit:	The high limit is the upper value for a test to be considered a pass. If the measured value is higher than the high limit the test is considered a fail.
Low Limit:	The low limit is the lower value for a test to be considered a pass. If the measured value is lower than the low limit the test is considered a fail.
Parameter:	Electrical property being tested. The primary parameter (L, C, R) is the first property characterized of the device under test. The secondary parameter (D, Q, θ) is the second property characterized of the device under test.
Permittivity:	Abbreviated ϵ . The dielectric constant multiplied by the dielectric constant of empty space (ϵ_0), where the permittivity of empty space (ϵ_0) is a constant in Coulomb's Law, equal to a value of 1 in centimeter-gram-second units and to 8.854×10^{-12} farads/meter in rationalized meter-kilogram-second units.
Range:	The resistance ranges the instrument uses for reference in making the measurement.

Repeatability:	The difference between successive measurements with no changes in the test setup or test conditions.
Reproducibility:	Similar to repeatability but adds the element of what could be expected under real life conditions. Reproducibility would take into account the variability in thing like fixturing where the DUT being tested is removed from the fixture and then inserted again.
Resolution:	The smallest value that can be shown on the display in a digital instrument. LCR meters typically specify a measurement range that is the largest and smallest value that can be shown on the display.
Source Impedance:	A constant source resistance of the measuring instrument used to level the voltage across the DUT to a constant voltage.



Speed:	The rate at which the instrument makes a measurement in measurements per second. Speed is inversely proportional to accuracy.
Trigger:	The device for initiating the test (applying the voltage or current).
External:	The test is initiated via an external source such as a computer with an IEEE-488 or Handler interface. One measurement is made each time the external trigger is asserted on the handler.
Internal:	The instrument continuously makes measurements.
Manual:	The operator initiates the test by pressing the [START] button. One measurement is made each time the trigger is pressed.

2.2 Startup

Check to make sure the red Line Voltage Selector switch on the rear panel agrees with the power source available. Depending on the power source the switch position should be in the up or down position as shown in Figure 1-5 (Close-Up of 1730T Rear Panel).

CAUTION

USE ALL PRECAUTIONS NECESSARY TO AVOID TOUCHING THE DEVICE UNDER TEST WHEN THE BIAS BACKLIGHT IS ON.

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 1730T instrument by pressing the green power switch on the front panel to the ON (1 position). The 1730T unit should warm up for a period of at least 15 minutes prior to measurements being made.

2.3 SYSTEM SETUP/CONFIG

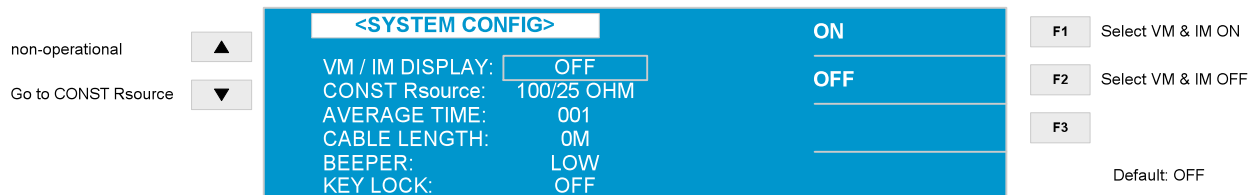
Prior to programming a test or measuring a device, set up the system controls of the 1730T instrument. To access the system controls, press [SYSTEM SETUP] then press [SYSTEM CONFIG]. Table 2-2 lists the contents of SYSTEM CONFIG.

Table 2-2: SYSTEM CONFIG

Parameter	Function	Range
VM/IM Display	Display output voltage and current	OFF/ON
CONSTant Source	Set constant source impedance	100/25 Ω , 100 Ω , 25 Ω , 10 Ω c.c.
AVERAGE Time	Set measurement average	0 – 256
CABLE Length	Set test cable length	0M, 1M, 2M or 4M
BEEPER	Set beeper loudness	OFF, LOW or HIGH
KEY LOCK	Lock out front panel programming	OFF/ON
INTEG Cycle	Set analog averaging cycle (time)	01 – 08
CONTRAST	Set display contrast	00 – 13 (dark to bright)
SOUND Mode	Set when the buzzer to sounds	PASS/FAIL
ALARM Mode	Set type of alarm signal	PULSE/CONTINUOUS
HANDLER Mode	Set handler interface mode	CLEAR/HOLD
GPIB EOS Code	Set End of String code	0Dh, 0Ah, 0Dh 0Ah
GPIB ADDRESS Code	Set interface address	00 – 30
TRIGGER Delay	Set external trigger time	0000 – 9999 ms
TRIGGER Edge	Set trigger mode	FALLING/RISING
LINK 1320	Link 1730 to 1320 bias source	OFF/ON
HARM CHECK	Check instrument status when unit is powered on.	ON/OFF

2.3.1 VM/IM Display

The voltage across the DUT and the current through the DUT can be displayed along with the measured value when VM/IM is set to ON. VM/IM can be selected OFF/ON. The instrument default setting is OFF. To change the VM/IM Display press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [$\downarrow$] until the box next to VM/IM DISPLAY is highlighted, then press [F1] = ON to display the current and voltage across the DUT, or [F2] = OFF.



2.3.2 CONST Rsource

The constant source impedance of the 1730T instrument can be set to 100/25 Ω , 100 Ω , 25 Ω , or 10 Ω CC (constant current). The instrument default setting is 100/25 Ω .

The 100/25 Ω setting allows the instrument to automatically select its impedance based on the impedance of the DUT (Z_{DUT}). If Z_{DUT} is $<10\Omega$, then the 1730T CONST Rsource = 25 Ω . If Z_{DUT} is $\geq 10\Omega$, then the 1730T CONST Rsource = 100 Ω .

The 10 Ω CC setting puts a constant current equal to 100mA across the DUT when the test voltage is set to 1V. If Z_{DUT} is $\geq 10\Omega$, then the 1730T instrument CONST Rsource = 10 Ω .

To change the source resistance press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [$\downarrow$] until the box next to CONST Rsource is highlighted, then press [F1] =100/25 Ω , [F2] =100 Ω , [F3] = 10 Ω c.c. or [F4] = Next Page. On next page [F1] = 25 Ω .



2.3.3 AVERAGE Time

The 1730T instrument can make many measurements then display the average based on what average number was selected. The range is 001 – 256 and the instrument default setting is 001. To change the number to average press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to AVERAGE TIME is highlighted, then press [F1] = DIGIT UP to increase then number of measurements to take before displaying the average or [F2] = DIGIT DOWN to decrease the number.

Go to CONST Rsource ▲

Go to CABLE Length ▼

<SYSTEM CONFIG>		DIGIT UP
VM / IM DISPLAY:	OFF	
CONST Rsource:	100 OHM	
AVERAGE TIME:	001	DIGIT DOWN
CABLE LENGTH:	0M	
BEEPER :	OFF	
KEY LOCK:	OFF	

F1

 Increase # of measurements to average

F2

 Decrease # of measurements to average

Default: 001

2.3.4 CABLE Length

Selected cable length should match length of test cables being used to minimize phase errors. The test cable length can be set as 0M, 1M, 2M or 4M. “M” denotes the length in meters. The instrument default setting is 0M. To change the cable length press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to CABLE LENGTH is highlighted, then press [F1] = 0M, [F2] = 1M, [F3] = 2M or [F2] = 4M whichever corresponds to the test cable length. After changing the cable length, run the open/short correction to obtain more accurate measurements.

Go to AVERAGE Time ▲

Go to BEEPER ▼

<SYSTEM CONFIG>		0M
VM / IM DISPLAY:	OFF	
CONST Rsource:	100 OHM	
AVERAGE TIME:	003	
CABLE LENGTH:	0M	1M
BEEPER:	OFF	2M
KEY LOCK:	OFF	4M

F1

 Select test cable = 0 meters

F2

 Select test cable = 1 meter

F3

 Select test cable = 2 meters

F4

 Select test cable = 4 meters

Default: 0M

2.3.5 BEEPER

The loudness of the beeper or audible alarm can be set to OFF, LOW or HIGH. The instrument default setting is LOW. To change the beeper loudness press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to BEEPER is highlighted, then press [F1] = OFF, [F2] = LOW or [F3] = HIGH.

Go to CABLE Length ▲

Go to KEY LOCK ▼

<SYSTEM CONFIG>		OFF
VM / IM DISPLAY:	OFF	
CONST Rsource:	100 OHM	
AVERAGE TIME:	003	
CABLE LENGTH:	1M	
BEEPER :	OFF	LOW
KEY LOCK:	OFF	HIGH

F1

 Select beeper volume = OFF

F2

 Select beeper volume = Low

F3

 Select beeper volume = High

Default: LOW

2.3.6 KEY LOCK

To lock out the front panel operations with the exception of the [TRIGGER] key, set the key lock function to ON. Press [SYSTEM SETUP], [SYSTEM CONFIG], [↓] until **OFF** is highlighted next to KEY LOCK, then press [F1] = ON. The backlit **LOCK** block will appear on the measure display. To turn the key lock function OFF: press [F1], [F4] and then [SYSTEM SETUP]. Key lock can be set ON or OFF. The instrument default setting is OFF.

Go to BEEPER

▲

Go to INTEG. Cycle

▼

<SYSTEM CONFIG>

ON

OFF

VM / IM DISPLAY: OFF

CONST Rsource: 100 OHM

AVERAGE TIME: 003

CABLE LENGTH: 1M

BEEPER : ON

KEY LOCK: OFF

F1

Select key lock = ON

F2

Select key lock = OFF

Default: OFF

IF

F1

is pressed (Key Lock = ON) the Meas Display will show

LOCK

in upper right hand corner

Press

MEAS
DISPLAY

to view

LOCK

symbol

MEAS DISPLAY

LOCK

FREQ.: 1.0 kHz

LEVEL: 1.00 V

PARA.: Cs - D

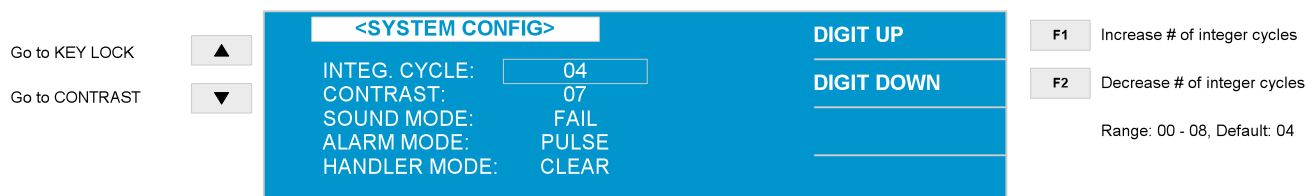
NEXT PAGE 1/3

Cs : 1.2345 pF

D : 1.2345

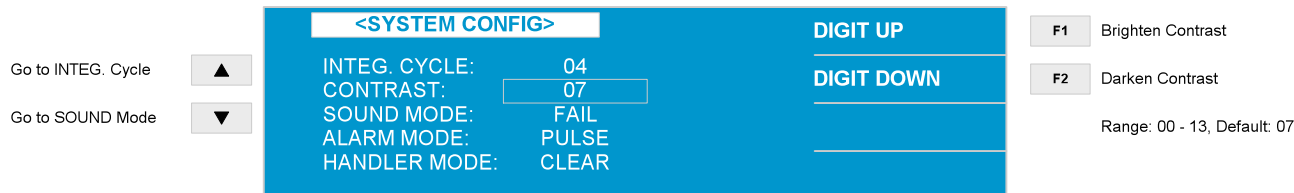
2.3.7 INTEGer CYCLE

This determines the number of cycles of a sine wave integrated together during a measurement. An integration cycle of 1 will result in the fastest possible measurement but the least accurate. The integer cycle can be set from 01 to 08. The instrument default setting is 04. To change the integer cycle press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to INTEG CYCLE is highlighted, then press [F1] = DIGIT UP to increase then number or [F2] = DIGIT DOWN to decrease the number.



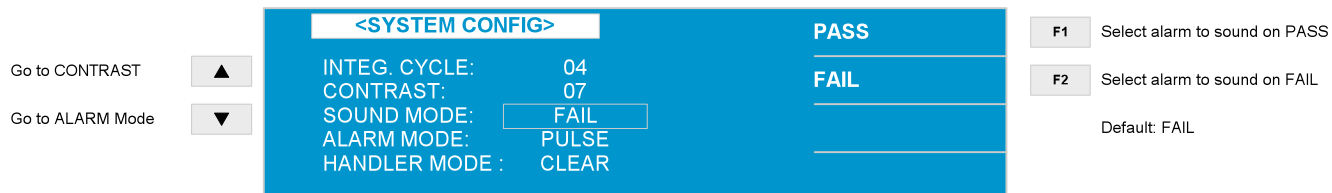
2.3.8 CONTRAST

The display contrast can be set from 00 to 13. The instrument default setting is 07. The darkest contrast is 00 the brightest is 13. To change the display contrast press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to CONTRAST is highlighted, then press [F1] = DIGIT UP to brighten the contrast or [F2] = DIGIT DOWN to darken the contrast.



2.3.9 SOUND Mode

The audible alarm can be set to sound on PASS or to sound on FAIL under high or low limit judgment in the measure display. The instrument default setting is FAIL. To change the sound mode press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to SOUND MODE is highlighted, then press [F1] = PASS for the alarm to sound on a pass result or [F2] = FAIL for the alarm to sound on a fail result.



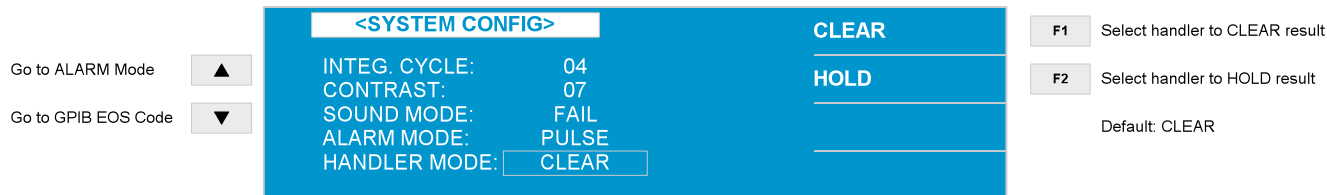
2.3.10 ALARM Mode

The type of audible alarm can be set to PULSE or CONTINUOUS during judgment in the measure display. The instrument default setting is PULSE. To change the alarm mode press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to ALARM MODE is highlighted, then press [F1] = PULSE for the alarm to sound in a pulse tone or [F2] = CONTINUOUS for the alarm to sound continuously.



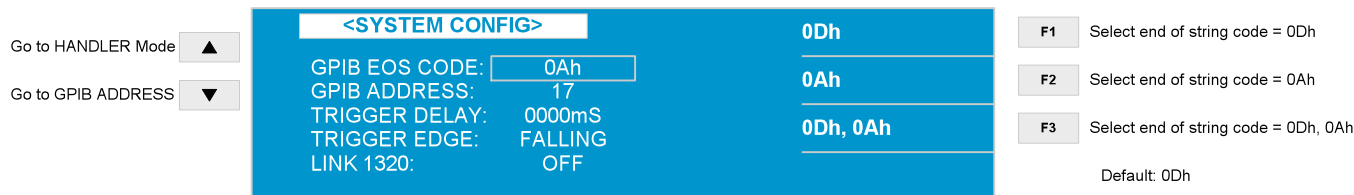
2.3.11 HANDLER Mode

The handler interface mode can be set to CLEAR or HOLD. The instrument default setting is CLEAR. When set to CLEAR, the handler interface will clear the last test result prior to each subsequent measurement. When set to HOLD, the handler interface will hold the last test result until the next measurement is made and displayed. To change the handler mode press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to HANDLER MODE is highlighted, then press [F1] = CLEAR or [F2] = HOLD.



2.3.12 GPIB EOS Code

The End of String code for the IEEE-488 interface is set as "0Dh", "0Ah" or "0Dh, 0Ah". The instrument default setting is "0Dh". To change the GPIB EOS code press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to GPIB EOS code is highlighted, then press [F1] = 0Dh, [F2] = 0Ah or [F3] = 0Dh, 0Ah.



2.3.13 GPIB Address Code

The IEEE-488 interface address can be programmed from 00 to 30. The instrument default setting is 17. To change the GPIB ADDRESS press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to GPIB ADDRESS is highlighted, then press [F1] = DIGIT UP to increase the address, or [F2] = DIGIT DOWN to decrease the address.

Go to EOS Code ▲

Go to TRIGGER Delay ▼

<SYSTEM CONFIG>

GPIB EOS CODE: 0Ah

GPIB ADDRESS: 17

TRIGGER DELAY: 0000mS

TRIGGER EDGE: FALLING

LINK 1320: OFF

DIGIT UP

DIGIT DOWN

F1 Increase IEEE-488 address

F2 Decrease IEEE-488 address

Address: 00 - 30, Default: 17

2.3.14 TRIGGER Delay

The trigger delay is the amount of time between the activation of a trigger (via IEEE, Handler or front panel) and the 1730T making the measurement. The delay time can be programmed from 0000 to 9999 milliseconds. The instrument default value is 0000 milliseconds. To change the TRIGGER DELAY press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to TRIGGER DELAY is highlighted, then press [F1] = DIGIT UP to increase the delay time, [F2] = DIGIT DOWN to decrease the delay time or [F3] = DIGIT to move over a decimal place.

Go to GPIB ADDRESS ▲

Go to TRIGGER Edge ▼

<SYSTEM CONFIG>

GPIB EOS CODE: 0Ah

GPIB ADDRESS: 17

TRIGGER DELAY: 0000mS

TRIGGER EDGE: FALLING

LINK 1320 : OFF

DIGIT UP

DIGIT DOWN

DIGIT

F1 Increase delay time

F2 Decrease delay time

Delay: 0000 - 9999ms, Default: 0000ms

2.3.15 TRIGGER Edge

Select on which edge the measurement is triggered: FALLING or RISING. The instrument default setting is FALLING. To change the TRIGGER EDGE press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to TRIGGER EDGE is highlighted, then press [F1] = FALLING or [F2] = RISING.

Go to TRIGGER Delay ▲

Go to LINK 1320 ▼

<SYSTEM CONFIG>

GPIB EOS CODE: 0Ah

GPIB ADDRESS: 17

TRIGGER DELAY: 0000mS

TRIGGER EDGE: FALLING

LINK 1320: OFF

FALLING

RISING

F1 Select FALLING edge

F2 Select RISING edge

Default: FALLING

2.3.16 LINK 1320

It is possible to link the 1730T instrument to the QuadTech 1320 Bias Current Source. The 1320 instrument is capable of producing 20A DC bias current. The 1730T instrument default setting is OFF. To change the LINK 1320 press [SYSTEM SETUP], [SYSTEM CONFIG] and the down arrow [↓] until the box next to LINK 1320 is highlighted, then press [F1] = ON or [F2] = OFF.

Go to TRIGGER Edge ▲

Go to VM / IM Display ▼

<SYSTEM CONFIG>

ON

OFF

GPIB EOS CODE: 0Ah

GPIB ADDRESS: 17

TRIGGER DELAY: 0000mS

TRIGGER EDGE: FALLING

LINK 1320 : OFF

F1 Select link to 1320 ON

F2 Select link to 1320 OFF

Default: OFF

2.3.17 HARM CHECK

To have the 1730T run an instrument status check when the instrument is powered ON, select HARM CHECK = ON. HARM CHECK can be set to ON or OFF and the instrument default value is ON. Board status is checked for the MAIN board, RAM1, Key Control, GPIB & Handler, RAM TRANSIT, EEPROM, FPGA Download and Calibration Data.

Go to LINK 1320 ▲

Go to VM / IM Display ▼

<SYSTEM CONFIG>

ON

OFF

GPIB EOS CODE: 0Ah

GPIB ADDRESS: 17

TRIGGER DELAY: 0000mS

TRIGGER EDGE: FALLING

LINK 1320 : OFF

HARM CHECK : ON

F1 Select Harm Check ON

F2 Select Harm Check OFF

Default: ON

Press Power ON

About Flash Screen

QuadTech, INC

1730T LCR Meter

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<http://www.quadtech.com>

Harm Check Flash Screen

MAIN BOARD PASSED

RAM1 PASSED

KEY CONTROL PASSED

GPIB 17 & HANDLER PASSED

RAM TRANSIT PASSED

EEPROM CHECK PASSED

FPGA DOWNLOAD PASSED

CALIBRATION DATA PASSED

2.4 MEAS DISPLAY

The 1730T instrument’s stand-by display is the MEAS DISPLAY. After power has been applied to the instrument and it cycles quickly through the information screen, the instrument reverts to the MEAS DISPLAY. To view the instrument information screen as illustrated in Figure 2.1, press [SYSTEM SETUP] then [⇐].



Figure 2.1: Instrument Information Screen

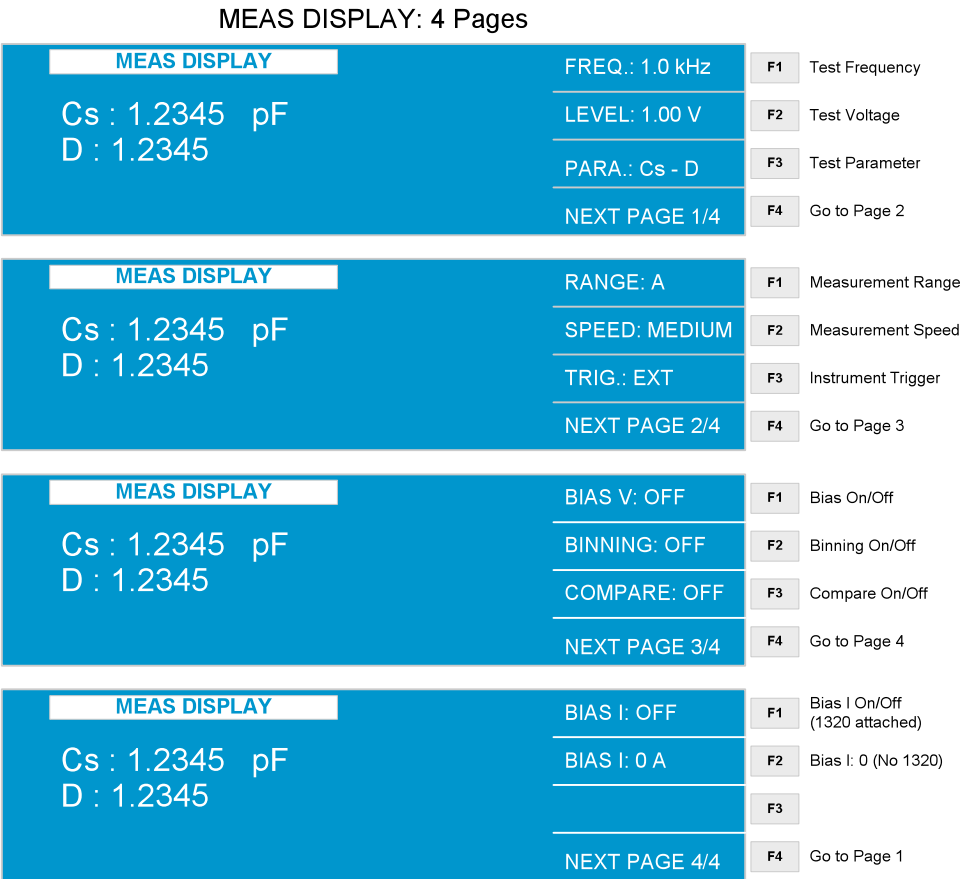


Figure 2.2: MEAS DISPLAY

Figure 2.2 illustrates the three pages of parameters that can be programmed within the MEAS DISPLAY. The binning and comparison functions are enabled/disabled in MEAS DISPLAY and programmed in MAIN INDEX. The bias voltage function is enabled/disabled in MEAS DISPLAY and programmed in SYSTEM SETUP. Paragraphs 2.4.1 through 2.4.10 explain each parameter in detail.

2.4.14 FREQuency

The 1730T instrument provides ten test frequencies from 50Hz to 100kHz including: 50Hz, 60Hz, 100Hz, 120Hz, 1kHz, 10kHz, 20kHz, 40kHz, 50kHz and 100kHz. In MEAS DISPLAY press [F1] so that the 1.0 kHz box is highlighted. Use the up arrow [$\uparrow$] key to increase the frequency value or use the down arrow [$\downarrow$] key to decrease the frequency value. The instrument default setting is 1.0kHz.

The MEAS DISPLAY screen shows the following information:

- MEAS DISPLAY
- Cs : 1.2345 pF
- D : 1.2345
- FREQ.: 1.0 kHz
- LEVEL: 1.00 V
- PARA.: Cs - D
- NEXT PAGE 1/4

The F1 function key is labeled "Select test frequency parameter". It has two arrow keys with the following options:

- $\uparrow$ 10kHz, 20kHz, 40kHz, 50kHz, 100kHz
- $\downarrow$ 120Hz, 100Hz, 60Hz, 50Hz

2.4.2 LEVEL

The test voltage can be programmed in 10mV increments from 0.01V to 1.00V. In MEAS DISPLAY press [F2] so that the 1.00 V box is highlighted. Use the up arrow [$\uparrow$] key to increase the voltage value or use the down arrow [$\downarrow$] key to decrease the voltage value in 10mV increments. The instrument default setting is 1.00V.

The MEAS DISPLAY screen shows the following information:

- MEAS DISPLAY
- Cs : 1.2345 pF
- D : 1.2345
- FREQ.: 1.0 kHz
- LEVEL: 1.00 V
- PARA.: Cs - D
- NEXT PAGE 1/3

The F2 function key is labeled "Select test voltage parameter". It has two arrow keys with the following options:

- $\uparrow$ Increase V in 0.01V increments
- $\downarrow$ Decrease V in 0.01V increments

2.4.3 PARAMeter

The 1730T instrument can measure 12 different LCR parameters and display two (primary and secondary) simultaneously. In MEAS DISPLAY press [F3] so that the C sD box is highlighted. Use the down arrow [$\downarrow$] key to change/select the primary parameter. Use the right arrow [$\Rightarrow$] key to move the highlighted box to s and use the [$\uparrow$] key to select the equivalent circuit equal to series or parallel. Use the right arrow [$\Rightarrow$] key to move the highlighted box to D and use the down arrow [$\downarrow$] key to select the secondary parameter. The instrument default setting is CsD.

The MEAS DISPLAY screen shows the following information:

- MEAS DISPLAY
- Cs : 1.2345 pF
- D : 1.2345
- FREQ.: 1.0 kHz
- LEVEL: 1.00 V
- PARA.: C s D
- NEXT PAGE 1/3

The F3 function key is labeled "Select Primary & Secondary parameter". It has three arrow keys with the following options:

- $\downarrow$ Select **Primary** parameter
C, R, Z, L
- $\Rightarrow$ Move highlighted box right
Select **Series** or **Parallel**
- $\Rightarrow$ Move highlighted box right
Select **Secondary** parameter
D, ESR, θ , X, Q

Labels with arrows point to the screen elements:

- Primary Measurement Parameter (points to 'C')
- Equivalent Circuit (points to 's')
- Secondary Measurement Parameter (points to 'D')

The programming of parameter may at first seem a little confusing but remember the highlighted box is what is selected then pressing the down arrow [↓] key will toggle through the choices. Use the right arrow [⇒] key to move the highlighted box and select the next parameter then press the down arrow [↓] key to toggle through the choices. Table 2-3 lists the primary and secondary parameters in common pair configuration that are measurable by the 1730T instrument.

Table 2-3: 1730T Measurement Parameters

Primary		Secondary					
Capacitance	Cs, Cp	D	ESR	θ	Xs	Q	
Resistance	Rs, Rp	Xs	Q	D	ESR	θ	
Impedance	Z	θ	Xs	Q	D	ESR	
Inductance	Ls, Lp	Q	D	ESR	θ	Xs	DCR
Inductance	L2A, L2B	N	1/N	M	R2		

DCR Measurement (DCR, R2)

A 4-terminal or 2-terminal DCR measurement is possible with the 1730T LCR Meter. The 4-terminal measurement is performed by selecting Ls or Lp as the primary parameter and DCR as the secondary parameter. A 2-terminal DCR measurement is made using the transformer test fixture (QuadTech P/N 630166). L2A or L2B is selected as the primary parameter and R2 is selected as the secondary parameter.

Transformer Turns Ratio Measurement (N, 1/N)

The Transformer Test Fixture (P/N 630166) is used to make turns ratio measurements on a transformer. Select the primary parameter L2A (2-terminal inductance of coil A) or L2B (2-terminal inductance of coil B). Select the secondary parameter as R2, N, 1/N or M.

R2: DCR of the main coil "L2B - R2" = DCR of coil B

N: Turns Ratio "L2B - N" = ratio of coil B to coil A $N = \frac{\text{Coil B}}{\text{Coil A}}$

"L2A - N" = ratio of coil A to coil B $N = \frac{\text{Coil A}}{\text{Coil B}}$

1/N: Inverse of Turns Ratio "L2B - 1/N" = inverse ratio of coil B to A $1/N = \frac{1}{\frac{\text{Coil B}}{\text{Coil A}}} = \frac{\text{Coil A}}{\text{Coil B}}$

"L2A - 1/N" = inverse ratio of coil A to B $1/N = \frac{1}{\frac{\text{Coil A}}{\text{Coil B}}} = \frac{\text{Coil B}}{\text{Coil A}}$

M: Mutual Inductance "L2B - M" = Mutual Inductance coil B

Use L2B as the primary parameter when measuring transformers under normal conditions. When a transformer has more turns (windings) on one side, connect the side with the most windings to the B terminals on the outside of the test fixture. Connect the side with the least amount of turns to the A terminals on the inside of the test fixture.

The Transformer Test Fixture is illustrated in Figure 2-3. The BNC terminals labeled L_{CUR} , L_{POT} , H_{POT} and H_{CUR} are connected to the front panel BNC connectors of the same name on the 1730T LCR Meter. The gray BNC to red alligator clips go to the primary winding. The gray BNC to black alligator clips go to the secondary winding.

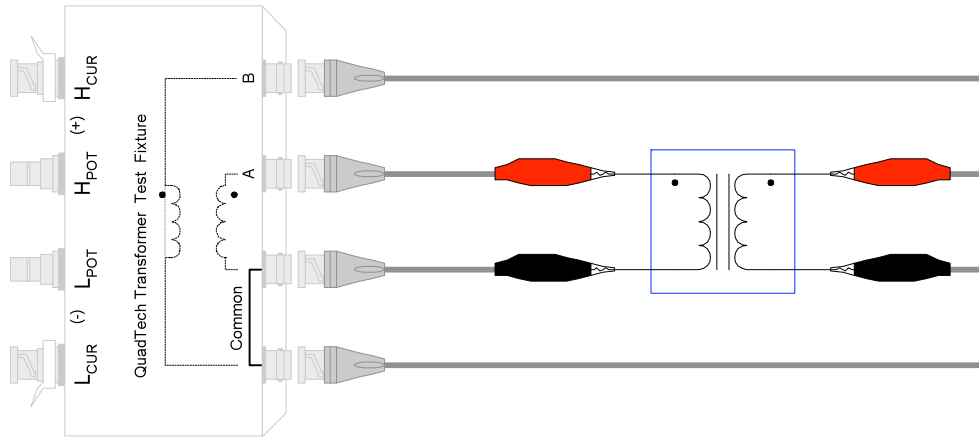


Figure 2-3a: Transformer Test Fixture

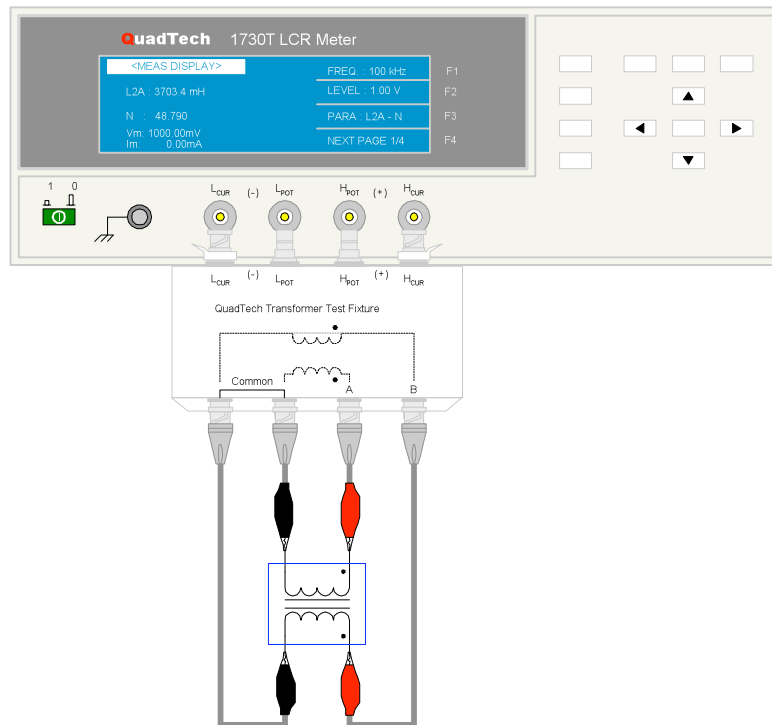


Figure 2-3b: Connection of Transformer Test Fixture to 1730T LCR Meter

2.4.4 RANGE

The 1730T instrument's measurement range can be selected as AUTO or HOLD. The instrument measurement ranges are 1MΩ, 300kΩ, 100kΩ, 30kΩ, 10kΩ, 3kΩ, 1kΩ, 300Ω, 100Ω, 10Ω, 1Ω, and 100mΩ depending on the test frequency and selected constant source impedance. In MEAS DISPLAY (Pg 2/3) press [F1] so that the **A** box is highlighted*. Use the up arrow [↑] key to increase the range value or use the down arrow [↓] key to decrease the range value. The instrument default setting is A (Auto Range).

MEAS DISPLAY

Cs : 1.2345 pF
D : 1.2345

RANGE.: **A** 100Ω

SPEED: SLOW

TRIG.: INT

NEXT PAGE 2/3

F1

Select measurement range

▲

Toggle between A and H mode

▶

Move highlighted box to value

▲

Increase range value: 300Ω, 1kΩ, 3kΩ, 10kΩ, 30kΩ, 100kΩ, 300kΩ 1MΩ

▼

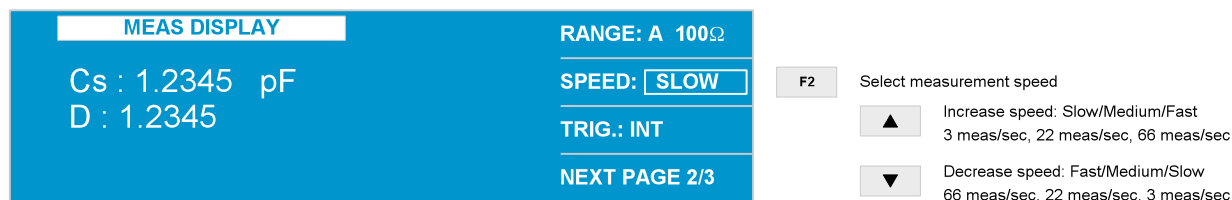
Decrease range value: 100Ω, 10Ω, 1Ω, 100mΩ

NOTE: When CONST Rsource is OFF, 300kΩ, 30kΩ, 3kΩ and 300Ω are disabled.
When Test Frequency is set to 100Hz or 120Hz, 0.1Ω is disabled.

* Use the up arrow [↑] key to toggle between A (Auto) and H (Hold). Use the right arrow [⇒] key to move the range value.

2.4.5 SPEED/Accuracy

Trading accuracy for speed, program the measurement speed of the 1730T instrument to Slow (3measurements/second), Medium (22 measurements/second) or Fast (66 measurements/second). The basic LCR accuracy (0.1%) and D accuracy (0.001) are specified for the slow measurement speed. In MEAS DISPLAY (Pg 2/3) press [F2] so that the **MEDIUM** box is highlighted. Use the up arrow [$\uparrow$] key to increase the speed or use the down arrow [$\downarrow$] key to decrease the speed. The instrument default setting is MEDIUM (22 meas/second).



The accuracy of the 1730T instrument depends on the speed of the measurement. Basic Accuracy for LCR is $\pm 0.1\%$ and basic accuracy for DQ is ± 0.001 . Basic accuracy is specified for the speed equal to 3 measurements/second, temperature = $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$, relative humidity (RH) $\leq 90\%$.

Table 2-4 lists the basic accuracy for $|Z| - \theta$. For measurements made in fast mode double the accuracy listed in Table 2-4.

Table 2-4: $|Z| - \theta$ Accuracy

Impedance	Frequency (Hz)									
$ Z $ (Ω)	50	60	100	120	1k	10k	20k	40k	50k	100k
10M	0.6%	0.6%	0.48%	0.4%	0.35%					
1M	0.8°	0.8°	0.5°	0.45°	0.4°					
1M	0.4%	0.4%	0.24%	0.20%	0.16%	0.5%	1.5%	2%	2%	2%
100k	0.6°	0.6°	0.33°	0.3°	0.08°	0.12°	0.12°	0.24°	0.24°	0.4°
100k	0.3%	0.3%	0.2%	0.2%	0.12%	0.5%	1.5%	1.8%	1.8%	2%
10k	0.4°	0.4°	0.24°	0.24°	0.06°	0.08°	0.09°	0.24°	0.24°	0.3°
10k	0.3%	0.3%	0.2%	0.2%	0.1%	0.45%	0.5%	0.6%	0.6%	0.7%
1k	0.2°	0.2°	0.2°	0.2°	0.05°	0.07°	0.08°	0.08°	0.08°	0.2°
1k	0.3%	0.3%	0.2%	0.2%	0.1%	0.2%	0.36%	0.4%	0.4%	0.45%
100	0.2°	0.2°	0.2°	0.2°	0.05°	0.07°	0.08°	0.08°	0.08°	0.2°
100	0.4%	0.4%	0.25%	0.25%	0.24%	0.26%	0.36%	0.4%	0.4%	0.5%
10	0.2°	0.2°	0.2°	0.2°	0.09°	0.09°	0.15°	0.17°	0.17°	0.2°
10	0.5%	0.5%	0.45%	0.4%	0.32%	0.35%	0.4%	0.5%	0.5%	0.6%
1	0.3°	0.3°	0.22°	0.22°	0.09°	0.15°	0.15°	0.17°	0.17°	0.2°
1	0.8%	0.8%	0.7%	0.5%	0.35%	0.35%	0.4%	0.7%	0.7%	0.9%
0.1	0.4°	0.4°	0.24°	0.24°	0.15°	0.15°	0.2°	0.26°	0.26°	0.6°

If the impedance ($|Z|$) is in the range 0.1Ω to 0.01Ω , then the following accuracy formula applies.

$Z < 0.1\Omega$:

$$|Z| \text{ Accuracy} = Z_e (\%) = A + B \times \left[\frac{100\text{m}\Omega}{|Z|} \right] + \left[\frac{C}{|Z|} \right]$$

$$\theta \text{ Accuracy} = \theta_e = \frac{180^\circ}{\pi} \times \left[Z_e \right]$$

Values for parameters A, B and C are listed in Table 2-4a

Table 2-4a: $|Z|$ - θ Accuracy for Z : 0.1Ω - 0.01Ω

Frequency Parameter		50Hz	60Hz	100Hz	120Hz	1kHz	10kHz	20kHz	40kHz	50kHz	100kHz
A		0.8	0.7	0.6	0.4	0.3	0.3	0.4	0.5	0.6	0.8
B		0.15	0.14	0.12	0.12	0.08	0.08	0.09	0.1	0.01	0.12
C	0M	0Ω	0Ω	0.001Ω	0.0012Ω	0.002Ω	0.02Ω	0.04Ω	0.08Ω	0.1Ω	0.2Ω
	1M	0.004Ω	0.006Ω	0.008Ω	0.009Ω	0.012Ω	0.07Ω	0.14Ω	0.28Ω	0.35Ω	0.7Ω
	2M	0.008Ω	0.010Ω	0.015Ω	0.017Ω	0.022Ω	0.12Ω	0.24Ω	0.48Ω	0.6Ω	-

C = Cable Length

Multiply the $|Z|$ and θ accuracy by the parameter D when the test signal level is not set to 1V. The values for D are listed in Table 2-4b. The test signal voltage is abbreviated V_{SIGNAL} and V_s in Table 2-4b.

Table 2-4b: D Value when V_{SIGNAL} is $< 1V$

Level Parameter	$1V > V_s \leq 0.5V$	$0.5V > V_s \leq 0.25V$	$0.25V > V_s \leq 0.01V$
D	1	2	$\frac{0.5V}{V_s}$

More 1730T Accuracy Formulas

L, C & R Accuracy

For $Q \geq 10$ and $(D \leq 0.1)$, $|Z| =$

$$|Z_L| = |2\pi fL|$$

$$|Z_C| = |1/(2\pi fC)|$$

For $Q < 10$ and $(D > 0.1)$,

Multiply L accuracy by $(1 + 1/Q)$

Multiply C accuracy by $(1 + D)$

D & Q Accuracy

For all D values:

$$\text{DF Accuracy} = \left[\frac{|\text{Z}| \text{ Accuracy } (\%)}{100} + \frac{\text{DF}}{50} \right] \times \left[1 + \sqrt{\frac{\text{FREQ}}{50000}} \right]$$

For all values of Q:

$$\text{Q Accuracy} = \frac{|\text{Z}| \text{ Accuracy } (\%)}{100} + \left[|Q| \left(0.02 + \frac{|\text{Z}| \text{ Accuracy } (\%)}{100} \right) \right] + \left[Q^2 \left(\frac{|\text{Z}| \text{ Accuracy } (\%)}{200} \right) \right]$$

R (ESR, EPR) Accuracy

For $Q \leq 0.1$:

Accuracy of R = Accuracy of $|Z|$

For $Q \geq 0.1$:

Multiply accuracy R by $(1 + Q)$

Figure 2-3 illustrates the frequency conversion charts for LC to Z, C to Z and L to Z.

Voltage Accuracy

For voltages less than 1V an additional error applies. Multiply the accuracy (LCRDQ) by: $[0.8 + (0.2/V_{\text{source}})]$.

1730T Accuracy Conversion Charts

Figure 2-1 LC $\leftrightarrow$ |Z| conversion

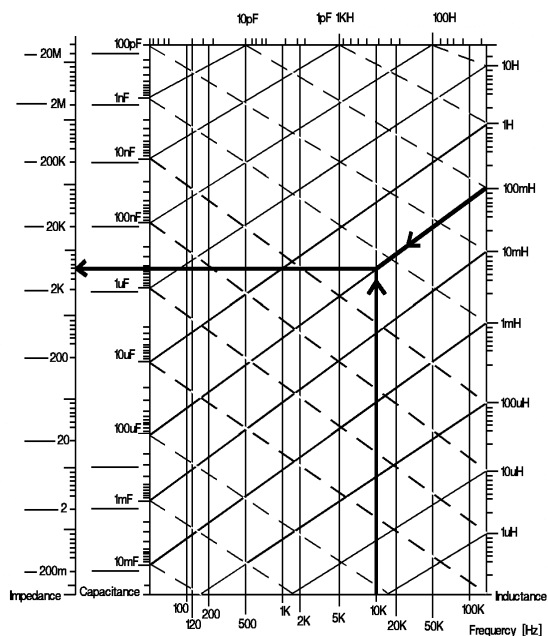
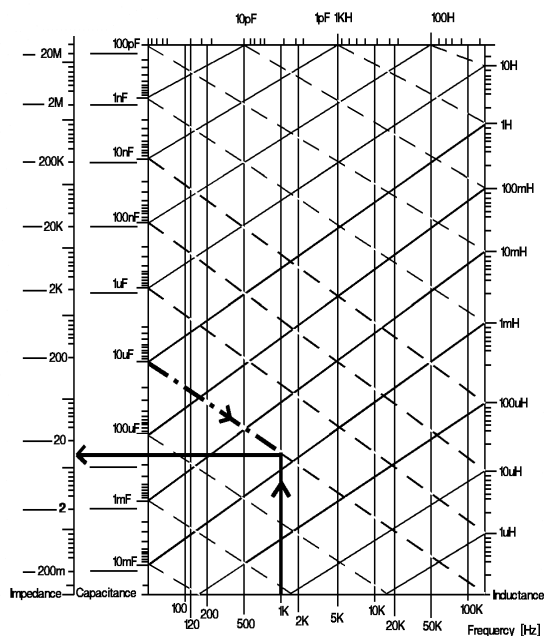
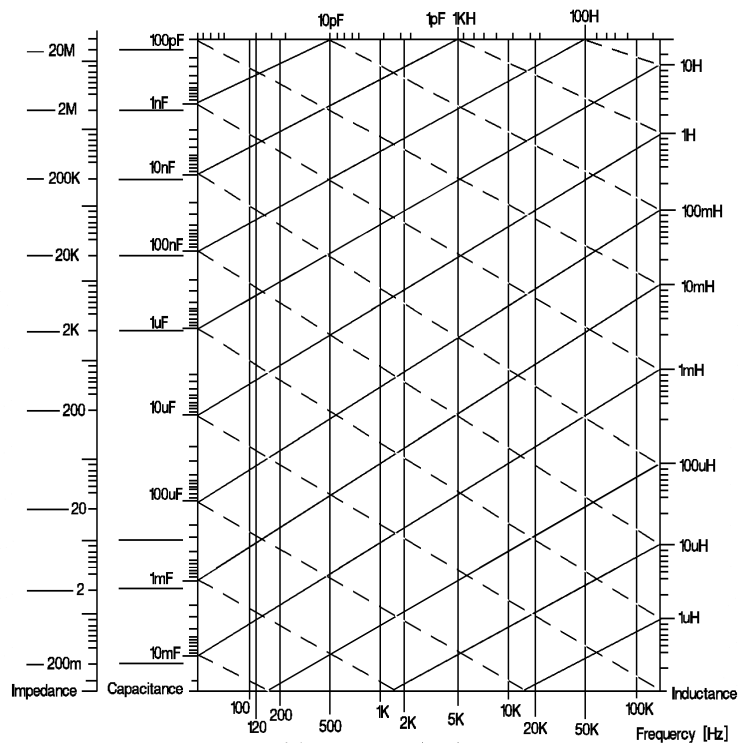


Figure 2-3: 1730T Accuracy Formula Conversion Charts

More 1730T Accuracy Formulas:

Direct Current Resistance (DCR) Accuracy: Ae%

For $R_x < 100\Omega$:

$$\text{DCR Accuracy} = \text{Ae} (\%) = A + B \times \left[\frac{R_s}{R_x} \right] + \left[\frac{C}{R_x} \right] + 0.2\text{m}\Omega$$

For $R_x \geq 100\Omega$:

$$\text{DCR Accuracy} = \text{Ae} (\%) = A + B \times \left[\frac{R_x}{R_s} \right]$$

Table 2-4d: Relationship between DCR, Rx, Rs and B

Rx	Rs	A	B
$1\text{M}\Omega \leq R_x \leq 100\text{M}\Omega$	$1\text{M}\Omega$	0.2	0.03
$100\text{k}\Omega \leq R_x \leq 1\text{M}\Omega$	$100\text{k}\Omega$	0.1	0.01
$10\text{k}\Omega \leq R_x \leq 100\text{k}\Omega$	$10\text{k}\Omega$	0.1	0.01
$1\text{k}\Omega \leq R_x \leq 10\text{k}\Omega$	$1\text{k}\Omega$	0.08	0.01
$10\Omega \leq R_x \leq 1\text{k}\Omega$	100Ω	0.08	0.01
$1\Omega \leq R_x \leq 10\Omega$	10Ω	0.1	0.01
$100\text{m}\Omega \leq R_x \leq 1\Omega$	1Ω	0.2	0.02
$0\text{m}\Omega \leq R_x \leq 100\text{m}\Omega$	$100\text{m}\Omega$	0.3	0.03

Table 2-4d: Parameter C

Length Parameter	0M	1M	2M
C	0	0.01Ω	0.02Ω

Turns Ratio Accuracy: Ne%

$$\text{N Accuracy} = \text{Ne} (\%) = [A] + [B \times N_x]$$

For A:

Parameter	50Hz	60Hz	100Hz	120Hz	1kHz	10kHz	20kHz	40kHz	50kHz	100kHz
A	0.3%	0.3%	0.25%	0.25%	0.25%	0.25%	0.25%	0.3%	0.3%	0.3%

For B:

Parameter	50Hz	60Hz	100Hz	120Hz	1kHz	10kHz	20kHz	40kHz	50kHz	100kHz
A	0.04%	0.04%	0.03%	0.03%	0.01%	0.01%	0.02%	0.03%	0.03%	0.05%

2.4.6 TRIGger

The 1730T instrument can be triggered manually, internally or externally. In MEAS DISPLAY (Pg 2/3) press [F3] so that the **INT** box is highlighted. Use the up arrow [↑] key to change the trigger or use the down arrow [↓] key to change the trigger. The instrument default setting is INT (internal trigger). When MANUAL trigger is selected, one measurement will be made each time the trigger is pressed. When EXTERNAL trigger is selected, one measurement will be made each time the external trigger is asserted by the handler. When INTERNAL trigger is selected, measurements are performed continuously when in [MEAS DISPLAY].

MEAS DISPLAY

Cs : 1.2345 pF
D : 1.2345

RANGE: A 100Ω

SPEED: MEDIUM

TRIG.: **EXT**

NEXT PAGE 2/3

Select measurement trigger

F3

▲ Select trigger: INT, MAN, EXT

▼ Select trigger: INT, MAN, EXT

2.4.7 BIAS Voltage

The 1730T instrument is capable of generating 0-5V external DC bias voltage to the device under test. When the Bias Voltage is ON, voltage can be supplied from an internal voltage supply using the R_{BIAS} resistor, or from an external supply when the external bias connector is used. To enable/disable the bias voltage function, in MEAS DISPLAY (Pg 2/3) press [F1] so that the **OFF** box is highlighted. Use the up arrow [↑] or down arrow [↓] keys or [F1] to switch the bias voltage function ON/OFF. The instrument default setting is OFF. Setting the bias voltage level is done externally.

MEAS DISPLAY

Cs : 1.2345 pF
D : 1.2345

BIAS V: **OFF**

BINNING: OFF

COMPARE: OFF

NEXT PAGE 3/3

F1

Enable/Disable bias voltage function

▲ Enable/Disable bias voltage function

▲ Enable/Disable bias voltage function

MEAS DISPLAY

Cs : 1.2345 pF
D : 1.2345

BIAS V: **ON**

BINNING: OFF

COMPARE: OFF

NEXT PAGE 3/3

F1

Enable/Disable bias voltage function

▲ Enable/Disable bias voltage function

▲ Enable/Disable bias voltage function

BIAS

This box will also be shown PAGE 1/3 when BIAS is selected ON.

NOTE:
Refer to paragraph 3.3 for a description of the bias voltage feature. Formulas for calculating the maximum bias voltage and current are listed in Tables 3-8 and 3-9.

2.4.8 BINNING

The 1730T instrument has 8 pass/fail bins for sorting components by test result. To enable/disable the binning function, in MEAS DISPLAY (Pg 3/3) press [F2] so that the **OFF** box is highlighted. Use the up arrow [↑] key or down arrow [↓] key to switch the binning function ON/OFF. The instrument default setting is OFF. Setting the bin values is done within the MAIN INDEX menu. Refer to paragraph 2.5.1 for instructions on setup of Binning.

MEAS DISPLAY	
Cs : 1.2345 pF D : 1.2345	BIAS V: OFF BINNING: OFF COMPARE: OFF NEXT PAGE 3/3

F2 Enable/Disable binning function

▲ Enable/Disable binning function

▼ Enable/Disable binning function

MEAS DISPLAY	
Cs : 1.2345 pF D : 1.2345 BIN: 0	BIAS V: OFF BINNING: ON COMPARE: OFF NEXT PAGE 3/3

F2 Enable/Disable binning function

▲ Enable/Disable binning function

▼ Enable/Disable binning function

2.4.9 COMPARE

The 1730T instrument has 8 pass/fail bins for sorting components by test result. To enable/disable the compare function, in MEAS DISPLAY (Pg 3/3) press [F3] so that the **OFF** box is highlighted. Use the up arrow [↑] key or down arrow [↓] key to switch the compare function ON/OFF*. The instrument default setting is OFF. Setting the comparison values is done within the MAIN INDEX menu. Refer to paragraph 2.5.4 for instructions on setup of Compare.

MEAS DISPLAY	
Cs : 1.2345 pF D : 1.2345	BIAS V: OFF BINNING: OFF COMPARE: OFF NEXT PAGE 3/3

Enable/Disable compare function

F3

▲ Enable/Disable compare function

▼ Enable/Disable compare function

MEAS DISPLAY	
Cs : 0.0000 pF D : 0.5002 Cs: GO D: GO	BIAS V: OFF BINNING: OFF COMPARE: ON-VAL NEXT PAGE 3/3

Enable/Disable compare function

F3

ON-VAL Absolute Value

ON-Δ Delta Absolute Value

ON-Δ% Delta Percent Absolute Value

OFF Compare Function: OFF

* Refer to “Notes on Compare Settings” on next page.

Notes on Compare Settings:

Setting COMPARE = **ON-VAL** will display the primary and secondary readings in addition to a **GO** (PASS). A **LO** reading is lower than the set nominal value and a **HI** reading is higher than the set nominal value.

Setting COMPARE = **ON-Δ** will display the difference between the measured value and the set nominal value. A **GO**, **LO**, or **HI** judgment is also displayed.

Setting COMPARE = **ON-Δ%** will display the percent difference between the measured value and the set nominal value. A **GO**, **LO**, or **HI** judgment is also displayed.

2.4.10 BIAS CURRENT

The 1730T instrument can be connected to a 1320 Bias Current Source to generate up to 100A of external DC bias current to the device under test. The 1320 Bias Current Source can generate up to 20A of current. A 1320S Slave unit can generate 20A of current. Up to 4 1320S Slave units may be connected to a 1320 Source for a total of 100A. If a 1320 is connected to the 1730T, select [LINK 1320] = ON in the MAIN INDEX menu. In MEAS DISPLAY, the BIAS I must be set ON/OFF and the level of BIAS I must be set.

NOTE:

Before BIAS I can be turned ON and a current level set, [LINK 1320] must be set to ON in the [System Config] menu under [System Setup].

BIAS I: OFF

When BIAS I is ON, current can be supplied from an external source (1320). To enable/disable the bias current function, in MEAS DISPLAY (Pg 4/4) press [F1] so that the **OFF** box is highlighted. Use the up arrow [↑] or down arrow [↓] keys or [F1] to switch the bias current function ON/OFF. The instrument default setting is OFF.

MEAS DISPLAY

Ls : 1.2345 H
Q : 1.2345

BIAS I: OFF
BIAS I: 000.000 A
NEXT PAGE 4/4

F1 Turn Bias Current Function ON/OFF
▲ ON
▼ OFF

BIAS I: 000.000A

When BIAS I is ON, current can be supplied from an external source (1320). To enable/disable the bias current function, in MEAS DISPLAY (Pg 4/4) press [F2] so that the 000.000 A box is highlighted. Use the up arrow [↑] or down arrow [↓] keys or [F2] to increase/decrease the bias current function ON/OFF. The instrument default setting is 000.000A (no 1320 connected).

MEAS DISPLAY Ls : 1.2345 H Q : 1.2345	BIAS I: ON BIAS I: 000.000 A NEXT PAGE 4/4	F2 Select Bias Current Level
MEAS DISPLAY Ls : 1.2345 H Q : 1.2345	BIAS I: ON BIAS I: <u>000.000 A</u> NEXT PAGE 4/4	▶ Move highlighted cursor to right
MEAS DISPLAY Ls : 1.2345 H Q : 1.2345	BIAS I: ON BIAS I: 0 <u>20</u> .000 A NEXT PAGE 4/4	▲ Increase Current Level to 20A

NOTE:

Before BIAS I can be turned ON and a current level set, [LINK 1320] must be set to ON in the [System Config] menu under [System Setup].

NOTE:

There are no IEEE commands for the BIAS I function on the 1730T instrument. Control of the bias current is handled via IEEE commands to the 1320 instrument.

2.5 MAIN INDEX

Within the 1730T instrument's MAIN INDEX are the Binning, Compare and Correction functions. To access these functions press [MAIN INDEX] and the display should look as shown in Figure 2-4.

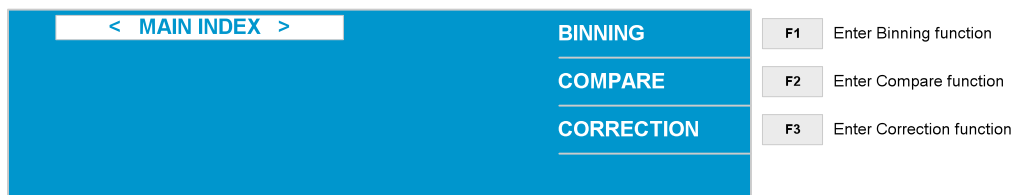
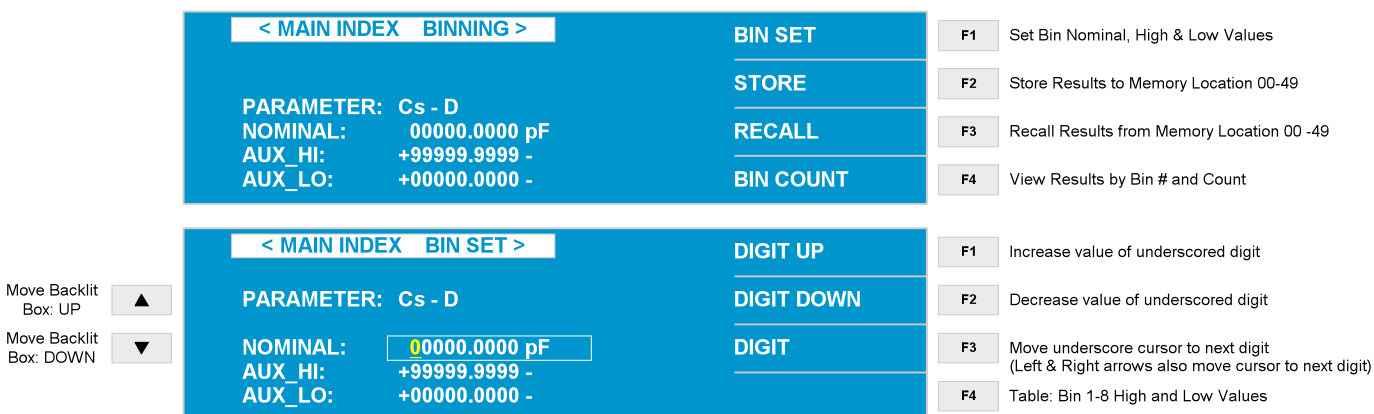


Figure 2-4: MAIN INDEX

2.5.1 BINNING

To set the bin functions for the 1730T instrument, press [MAIN INDEX] then [F1] = BINNING.



- Press [F1] = BIN SET and to enter the BIN SET Display and set the nominal, high and low values for the primary parameter.
- To select the nominal, high or low value, move the backlit box UP using the up arrow [↑] or to move it down using the down arrow [↓].
- Press [F1] = DIGIT UP to increase the value of the underscored digit.
- Press [F2] = DIGIT DOWN to decrease the value of the underscored digit.
- Press [F3] = DIGIT to move the underscored digit right. The left [←] and right [→] arrow keys also move the underscored digit left or right on a single line.
- The units of the values can be selected using the DIGIT UP and DIGIT DOWN when the underscore cursor is in the right most position.

When the nominal, auxiliary high and auxiliary low values are set, use the down [↓] arrow key to move the backlit box AUX_LO: -00000.0000 down to view bins 1-8 high and low percent settings.

BIN Set and BIN Count

After setting the AUX_LO: -00000.0000 value, press the down [↓] arrow key to view bins 1-4.
Press the down [↓] arrow key again to view bins 5-8.

Press the [MAIN INDEX] key to return to the MAIN INDEX BINNING screen.

Press the [F4] = BIN COUNT to view the bin count for bins 1-8 and the OUT bin.

NOTE:

All bins can be viewed by pressing [F4] at anytime in [MAIN INDEX_BIN SET]

Move Backlit
Box: DOWN



< MAIN INDEX BIN SET >			DIGIT UP
BIN	HI	LO	DIGIT DOWN
1	+000.00%	-000.00%	DIGIT
2	+000.00%	-000.00%	
3	+000.00%	-000.00%	
4	+000.00%	-000.00%	

- F1** Increase value of underscored digit
- F2** Decrease value of underscored digit
- F3** Move underscore cursor to next digit
- F4** Table: Bin 1-8 High and Low Values

Move Backlit
Box: DOWN



< MAIN INDEX BIN SET >			DIGIT UP
BIN	HI	LO	DIGIT DOWN
5	+000.00%	-000.00%	DIGIT
5	+000.00%	-000.00%	
7	+000.00%	-000.00%	
8	+000.00%	-000.00%	

- F1** Increase value of underscored digit
- F2** Decrease value of underscored digit
- F3** Move underscore cursor to next digit
- F4** Table: Bin 1-8 High and Low Values

PRESS

MAIN
INDEX

PRESS

F4

= BIN COUNT

BIN	COUNT	BIN	COUNT	SPEED: M
0	127	5	0	TRIG.: MAN
1	0	6	0	RANGE: AUTO
2	0	7	0	RESET
3	0	8	0	
4	0	OUT	11	
TOTAL:		138		

- F1** Change measurement speed: S/M/F
- F2** Change trigger: MAN/INT/EXT
- F3** Change range: HOLD/AUTO
- F4** Reset bin counts to 0.

In the BIN COUNT screen:

Press [F1] = SPEED to change the measurement speed equal to Fast, Medium or Slow.

Press [F2] = TRIG to change the measurement trigger equal to MANual, INTernal or EXTernal.

Press [F3] = RANGE to change the measurement range equal to Hold or Auto.

Press [F4] = RESET to clear the contents of the bins.

Press [MAIN INDEX] when finished.

BIN	COUNT	BIN	COUNT	
0	127	5	0	YES
1	0	6	0	
2	0	7	0	NO
3	0	8	0	
4	0	OUT	11	
TOTAL:		138		

F1

F2 Clear the Counts in all bins

F3 Do not clear the counts in all bins

F4

Two of the most common methods of sorting results into bins are using nested limits or sequential limits.

Nested Limits

Nested limits are a natural choice for sorting components by % tolerance around a single nominal value with the lower bins narrower than the higher numbered bins. Nested limits for three bins are illustrated in Figure 2-5. Note that the limits do not have to be symmetrical (Bin 3 is -7% and $+10\%$).

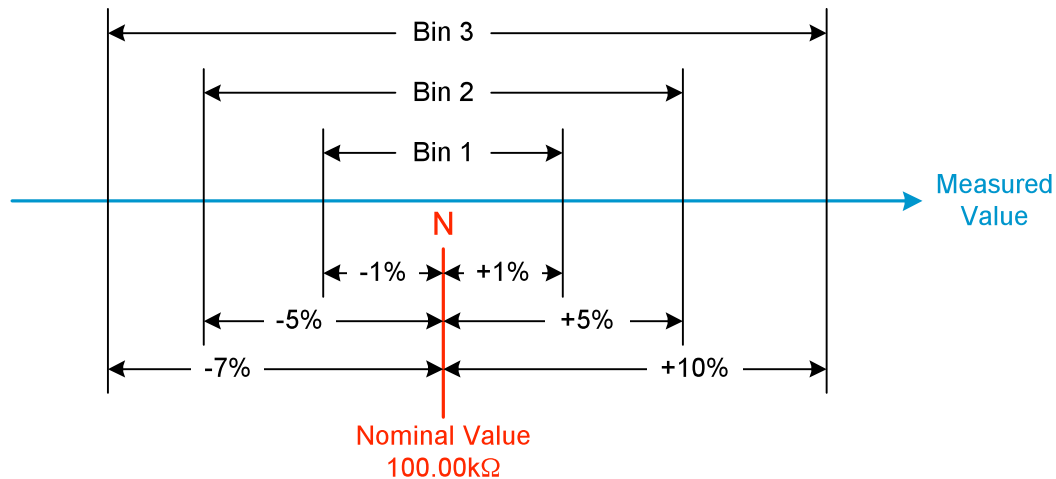


Figure 2-5: Nested Limits

Sequential Limits

Sequential limits are a natural choice when sorting components by absolute value. Figure 2-6 illustrates the use of sequential limits for a total of three bins. Sequential bins do not have to be adjacent. Their limits can overlap or have gaps depending upon the specified limit. Any component that falls into an overlap between bins would be assigned to the lower numbered bin and any component that falls into a gap between bins would be assigned to the overall fail bin.

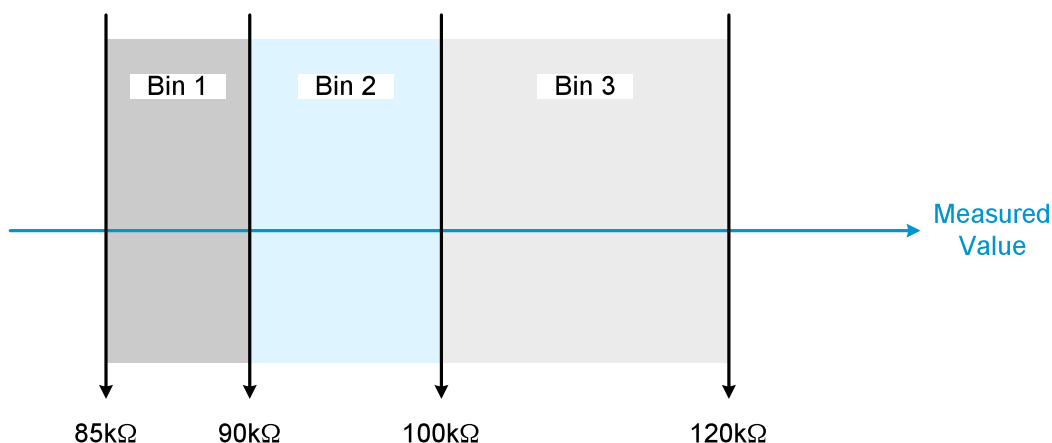


Figure 2-6: Sequential Limits

2.5.2 STORE

The 1730T instrument's STORE and RECALL functions are within the MAIN INDEX menu. Press [MAIN INDEX], press [F1] = BINNING (or [F2] = COMPARE) then press [F2] = STORE to access the store function.

		< MAIN INDEX > BINNING COMPARE CORRECTION		F1 Enter Binning function
		< MAIN INDEX BINNING > BIN SET STORE RECALL BIN COUNT PARAMETER: Cs - D NOMINAL: 00000.0000 pF AUX_HI: +99999.9999 - AUX_LO: +00000.0000 -		F1 Set Bin Nominal, High & Low Values F2 Store Results to Memory Location 00-49 F3 Recall Results from Memory Location 00 -49 F4 View Results by Bin # and Count
Go UP in memory location ▲ Go DOWN in memory location ▼	< MAIN INDEX BINNING > DIGIT UP DIGIT DOWN DIGIT ENTER STORE NUMBER: 00 PARAMETER: Cs - D NOMINAL: 00000.0000 pF AUX_HI: +99999.9999 - AUX_LO: +00000.0000 -	F1 Increase value of underscored digit F2 Decrease value of underscored digit F3 Move underscore cursor to next digit (Left & Right arrows also move cursor to next digit) F4		

TRIGGER

Press TRIGGER to store setup

 If there is already data stored in the location chosen, this message will be displayed:

< MAIN INDEX BINNING > DIGIT UP DIGIT DOWN DIGIT ENTER STORE NUMBER: 02 THIS NUMBER HAS DATA PRESS TRIGGER TO RECOVER! PRESS OTHER KEY TO ESCAPE		F1 Increase value of underscored digit F2 Decrease value of underscored digit F3 Move underscore cursor to next digit F4 Table: Bin 1-8 High and Low Values
--	--	--

When performing the STORE and RECALL functions, the 1730T instrument stores the following information:

- Frequency
- Speed
- Level
- Parameter
- Range
- All Bin setting values (excluding the Bin Counter)
- All Compare setting values (excluding the Compare Counter)

There are 50 storage locations (00 – 49) in the 1730T instrument memory.

2.5.3 RECALL

The 1730T instrument's STORE and RECALL functions are within the MAIN INDEX menu. Press [MAIN INDEX], press [F1] = BINNING (or [F2] = COMPARE) then press [F3] = RECALL to access the recall function.

< MAIN INDEX > BINNING COMPARE CORRECTION		F1 Enter Binning function F2 Enter Compare function F3 Enter Correction function
< MAIN INDEX BINNING > BIN SET STORE RECALL BIN COUNT PARAMETER: Cs - D NOMINAL: 00000.0000 pF AUX_HI: +99999.9999 - AUX_LO: +00000.0000 -		F1 Set Bin Nominal, High & Low Values F2 Store Results to Memory Location 00-49 F3 Recall Results from Memory Location 00 -49 F4 View Results by Bin # and Count
Go UP in memory location Go DOWN in memory location ▲ ▼	< MAIN INDEX BINNING > DIGIT UP DIGIT DOWN DIGIT ENTER RECALL NUMBER: <u>00</u> PRESS TRIG TO RECALL PARAMETER: Cs - D NOMINAL: 00000.0000 pF AUX_HI: +99999.9999 - AUX_LO: +00000.0000 -	
F1 Increase value of underscored digit F2 Decrease value of underscored digit F3 Move underscore cursor to next digit (Left & Right arrows also move cursor to next digit) F4		

TRIGGER

Press TRIGGER to recall setup

If there is no data stored in the location chosen, this message will be displayed:

< MAIN INDEX BINNING > DIGIT UP DIGIT DOWN DIGIT ENTER RECALL NUMBER: <u>07</u> ERROR... NO DATA PARAMETER: Cs - D NOMINAL: 00000.0000 pF AUX_HI: +99999.9999 - AUX_LO: +00000.0000 -		F1 Increase value of underscored digit F2 Decrease value of underscored digit F3 Move underscore cursor to next digit F4
--	--	--

When performing the STORE and RECALL functions, the 1730T instrument stores the following information:

- Frequency
- Speed
- Level
- Parameter
- Range
- All Bin setting values (excluding the Bin Counter)
- All Compare setting values (excluding the Compare Counter)

There are 50 storage locations (00 – 49) in the 1730T instrument memory.

2.5.4 COMPARE

To set up a comparison test, use the COMPARE function. To access the COMPARE function, press [MAIN INDEX] then press [F2] = COMPARE. Press [F1] = SETTING to set the primary nominal high and low judgment values. Press [F2] = STORE to store the current COMPARE setup or press [F3] = RECALL to recall a stored COMPARE setup. Press [F4] = COUNT to view the COMPARE results and counts.

< MAIN INDEX > BINNING COMPARE CORRECTION		F1 Enter Binning function
< MAIN INDEX COMPARE > SETTING STORE RECALL COUNT		F1 Set Primary and Secondary Nominal, High and Low Values
< COMPARE SET > DIGIT UP DIGIT DOWN DIGIT MODE: ABS		F1 Increase underscored digit
F2 Decrease underscored digit	F3 Move underscored digit left on a single line (Left and right arrows also move underscored digit)	
F4 Select Absolute or Percent (%) Value		

MAIN INDEX

 When finished SETTING Comparison values

F4

 = COUNT to view the COMPARE results and counts

< COMPARE COUNT > SPEED: F TRIG.: MAN RANGE: AUTO RESET		F1 Select measurement speed = Fast, Medium or Slow																				
<table border="0" style="width: 100%; font-size: 0.8em;"> <tr> <td>PRIMARY</td><td>COUNT</td><td>SECOND</td><td>COUNT</td></tr> <tr> <td>GO:</td><td>198</td><td>GO:</td><td>198</td></tr> <tr> <td>HI:</td><td>0</td><td>HI:</td><td>0</td></tr> <tr> <td>LO:</td><td>0</td><td>LO:</td><td>0</td></tr> <tr> <td colspan="2">TOTAL:</td><td colspan="2">198</td></tr> </table>		PRIMARY	COUNT	SECOND	COUNT	GO:	198	GO:	198	HI:	0	HI:	0	LO:	0	LO:	0	TOTAL:		198		F2 Select trigger = MAN, INT or EXT
PRIMARY	COUNT	SECOND	COUNT																			
GO:	198	GO:	198																			
HI:	0	HI:	0																			
LO:	0	LO:	0																			
TOTAL:		198																				
		F3 Select measurement range = Auto or Hold																				
		F4 Clear COMPARE count																				

Notes on Compare Settings:

Setting COMPARE = ON-VAL will display the primary and secondary readings in addition to a GO (PASS). A LO reading is lower than the set nominal value and a HI reading is higher than the set nominal value.

Setting COMPARE = ON-Δ will display the difference between the measured value and the set nominal value. A GO, LO, or HI judgment is also displayed.

Setting COMPARE = ON-Δ% will display the percent difference between the measured value and the set nominal value. A GO, LO, or HI judgment is also displayed.

2.5.5 CORRECTION

The 1730T instrument provides automatic offset for lead and/or fixture effects. During the offset process a correction is made (subtracted out) as the result of lead leakage current and stored in instrument memory to be applied to ongoing measurements. For maximum measurement accuracy it is recommended that the CORRECTION function be performed on the 1730T instrument after power up, any time the test parameters are changed and any time the test leads or fixture is changed.

Prior to performing the CORRECTION function:

- Allow the instrument to warm up for 15 minutes.
- Connect the Test cables (or fixture) to the output connectors (BNC terminals).
- Program the test steps.

With the instrument in STAND-BY status (MEAS DISPLAY shown on display):

- Press [MAIN INDEX]
- Press [F3] = CORRECTION
- Press [F2] = OPEN (or [F3] = SHORT) to select zero function.
- Press [F1] = SINGLE or [F2] = MULTI to select frequency.
- Follow instructions on display: i.e.: “Open circuit test leads”.
- Press [TRIGGER] button.
- Wait while instrument gets CORRECTION value.
- Press [ANY KEY] to return to MEAS DISPLAY status.

NOTE:

When SINGLE is selected, the 1730T instrument performs an open/short at the programmed test frequency.
When MULTI is selected, the 1730T instrument performs the open/short at all 7 test frequencies.

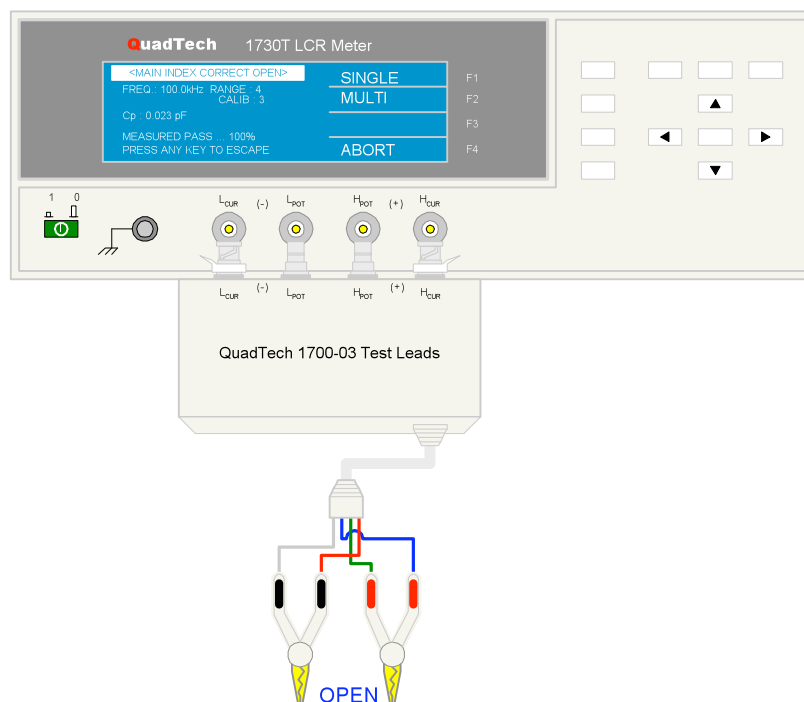
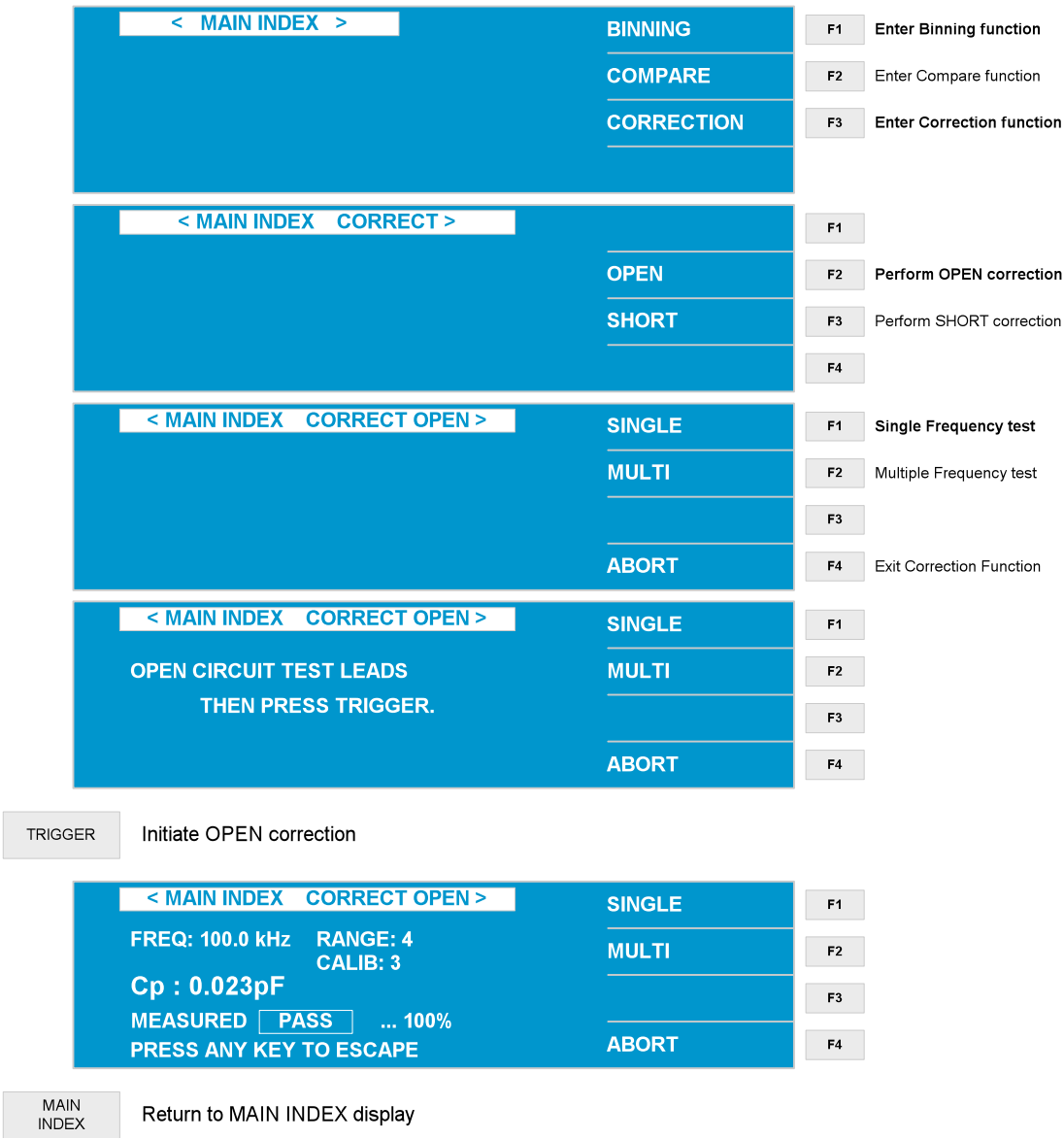


Figure 2-7: OPEN Configuration using Kelvin Clip Test Leads

CORRECTION: OPEN

Figure 2-7 illustrates the connection of the Kelvin Clip test leads for an open correction. The MAIN INDEX display menus corresponding to the OPEN operation are illustrated below.



CORRECTION: SHORT

Figure 2-8 illustrates the connection of the Kelvin Clip test leads for a short correction. The MAIN INDEX display menus corresponding to the SHORT operation are illustrated below.

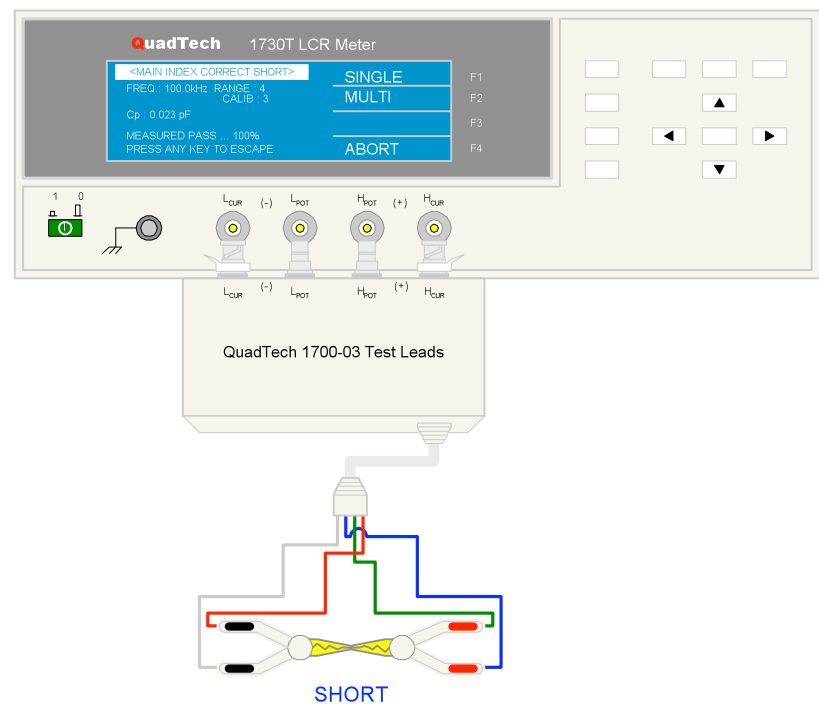
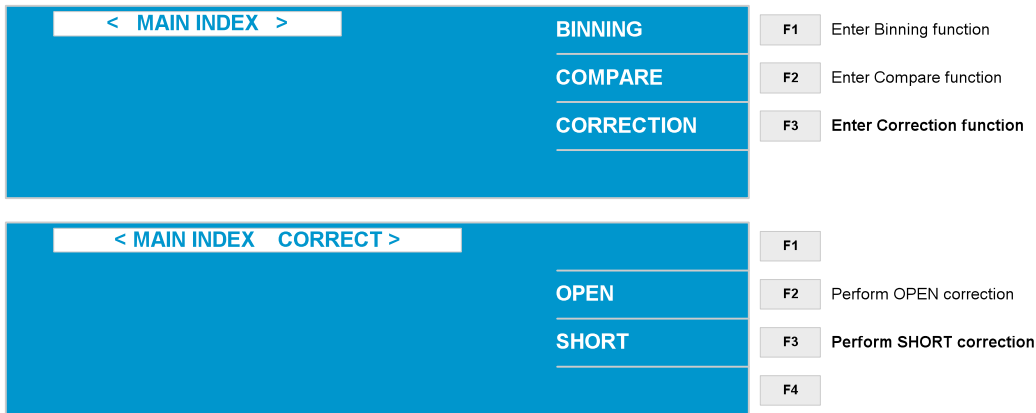


Figure 2-8: SHORT Configuration using Kelvin Clip Test Leads

To access the SHORT correction operation, press [MAIN INDEX] then [F3] = CORRECTION.



CORRECTION: SHORT - continued

Press [F3] = SHORT to select the SHORT configuration. Short test leads together then press [TRIGGER] to initiate short correction measurement.

< MAIN INDEX CORRECT SHORT >

SINGLE

MULTI

ABORT

F1

F2

F3

F4

Single Frequency test

Multiple Frequency test

Exit Correction Function

< MAIN INDEX CORRECT SHORT >

SHORT CIRCUIT TEST LEADS
THEN PRESS TRIGGER.

SINGLE

MULTI

ABORT

F1

F2

F3

F4

TRIGGER

Initiate SHORT correction

< MAIN INDEX CORRECT SHORT >

FREQ: 100.0 kHz RANGE: 10
CALIB: 1

Rs : 1.05 kΩ

MEASURED FAIL ... 0%

PRESS ANY KEY TO ESCAPE

SINGLE

MULTI

ABORT

F1

F2

F3

F4

MAIN INDEX

Return to MAIN INDEX display

NOTE:
Perform the CORRECTION functions any time the test leads or test fixtures are changed or any time the test parameters (especially constant source impedance, CONST Rsource) are changed.

NOTE:
When SINGLE is selected, the 1730T instrument performs an open/short at the programmed test frequency. When MULTI is selected, the 1730T instrument performs the open/short at all 7 test frequencies.

2.6 Connection to Device under Test

Figure 2-9 illustrates the connection of the 1730T LCR Meter to a single DUT using the 1700-03 Kelvin Clip Cable lead set. The red Kelvin clip/BNCs are connected between the H_{POT} and H_{CUR} (+) terminals on the 1730T unit and the high side of the device under test. The black Kelvin clip/BNCs are connected between the L_{POT} and L_{CUR} (-) terminals on the 1730T unit to the low side of the DUT.

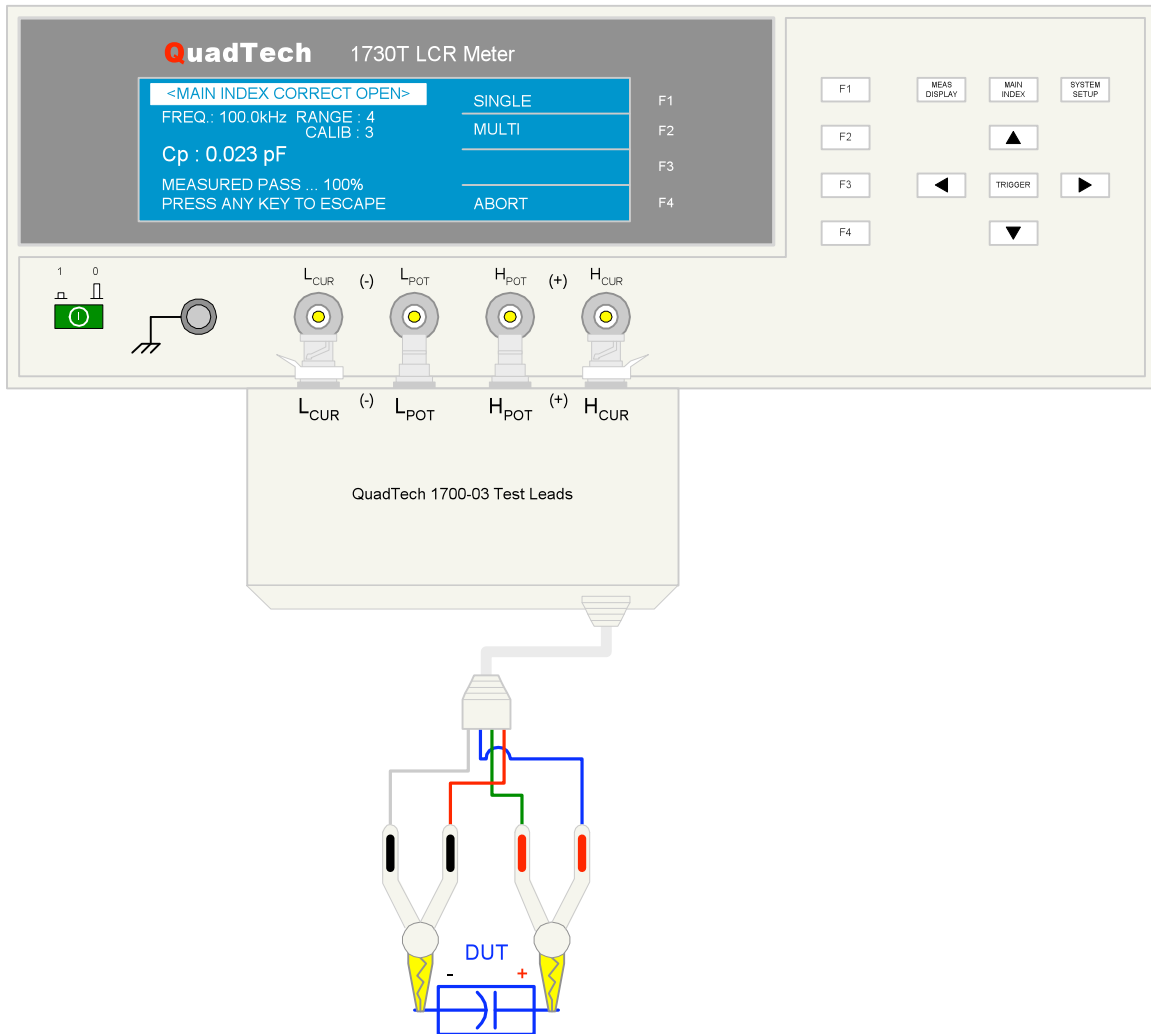


Figure 2-9: 1700-03 Kelvin Clip Test Leads

There are a variety of test leads and fixtures available for the 1730T LCR Meter as listed in Table 2-5 and illustrated in Figure 2-9 through 2-14.

Table 2-5: 1730T LCR Meter Test Leads & Fixtures

Description	QuadTech P/N	Figure
Axial/Radial Component Test Fixture	1700-01	2-10
Axial/Radial Remote Test Fixture	1700-02	2-11
Lead Set: 4 BNC Connectors to 2 Kelvin Clips	1700-03	2-9
Lead Set: 4 BNC Connectors to Chip Component Tweezers	7000-05	2-12
BNC to BNC Cable Lead Set (1m)	7000-01	2-13
BNC to BNC Cable Lead Set (2m)	7000-02	2-13
Low Voltage Chip Component Test Fixture	7000-07	2-14
Transformer Test Fixture	630166	2-15
1320 Bias Current Source	1320	2-16

NOTE:

For proper operation, the $H_{CUR}/H_{POT}/I_{CUR}/I_{POT}$ cable shields must be connected together at the DUT. This connection is already made using the 1730T recommended accessory leads. If the shields are not tied together, then at higher frequencies a resonance may occur which could cause erroneous capacitance readings.

Figure 2-10 illustrates the connection of the 1700-01 axial/radial component test fixture to the 1730T LCR Meter. Insert the axial/radial leaded component in the test fixture paying attention to the high and low designations on the test fixture.

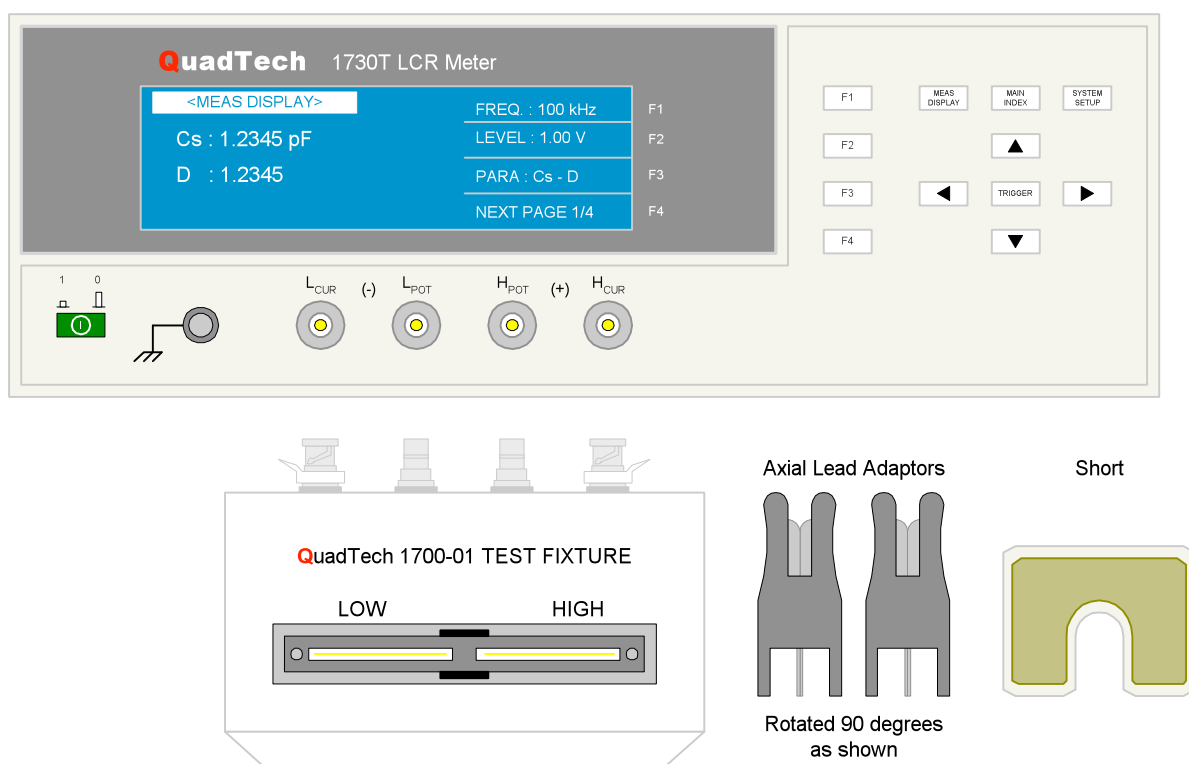


Figure 2-10: 1700-01 Axial/Radial Component Test Fixture

Connection to Device under Test – continued

Figure 2-11 illustrates the connection of the 1700-02 axial/radial remote test fixture to the 1730T LCR Meter. Insert the axial/radial leaded component in the test fixture paying attention to the high and low designations on the test fixture.

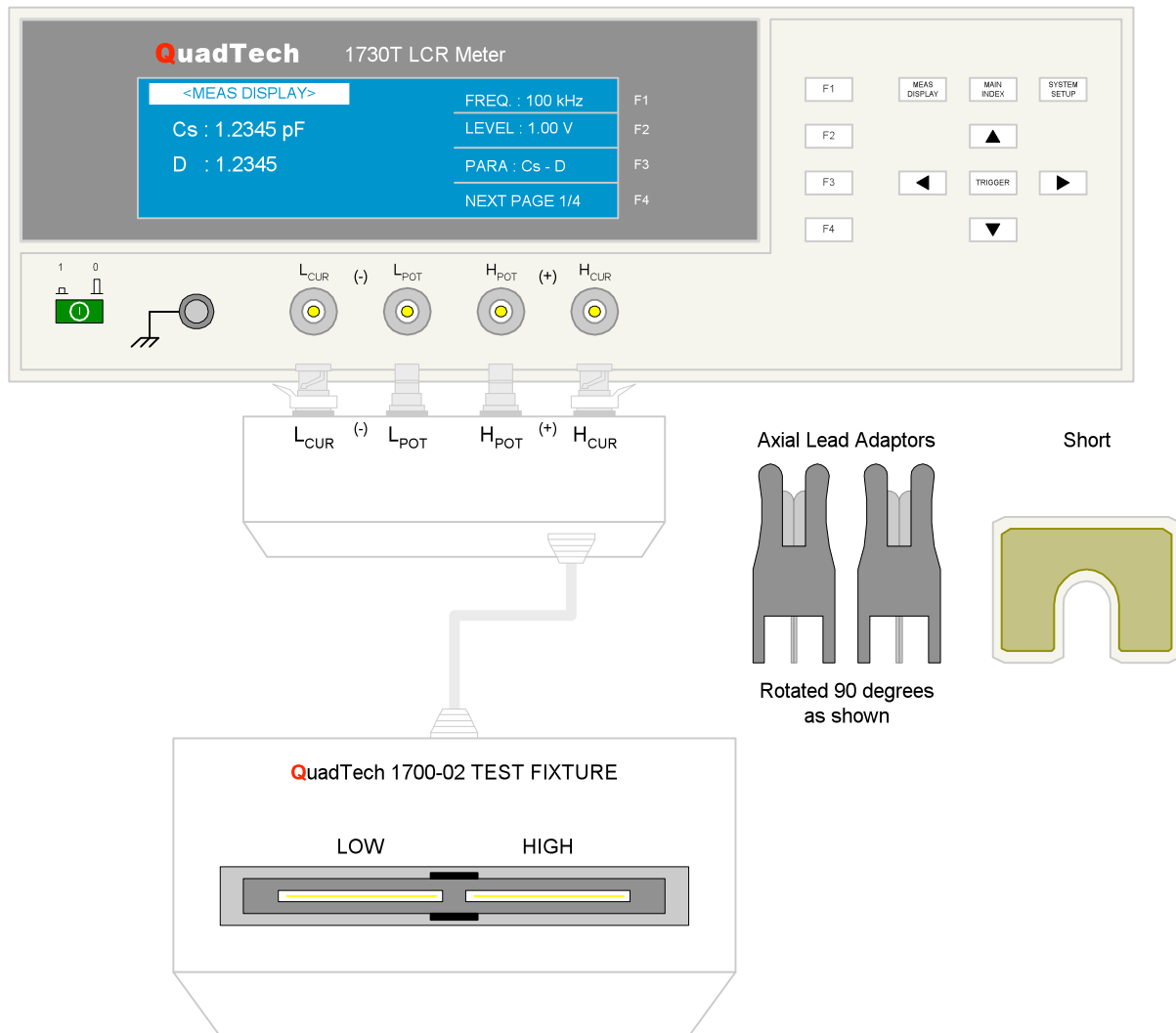


Figure 2-11: 1700-02 Axial/Radial Remote Test Fixture

Figure 2-12 illustrates the connection of the 7000-05 Component Tweezers cable lead set to the 1730T LCR Meter. The BNC labeled “IL” connects to the BNC labeled L_{CUR} . The BNC labeled “PL” connects to the BNC labeled L_{POT} . The BNC labeled “PH” connects to the BNC labeled H_{POT} . The BNC labeled “IH” connects to the BNC labeled H_{CUR} . These tweezers provide a 4-terminal connection to even the smallest of devices.

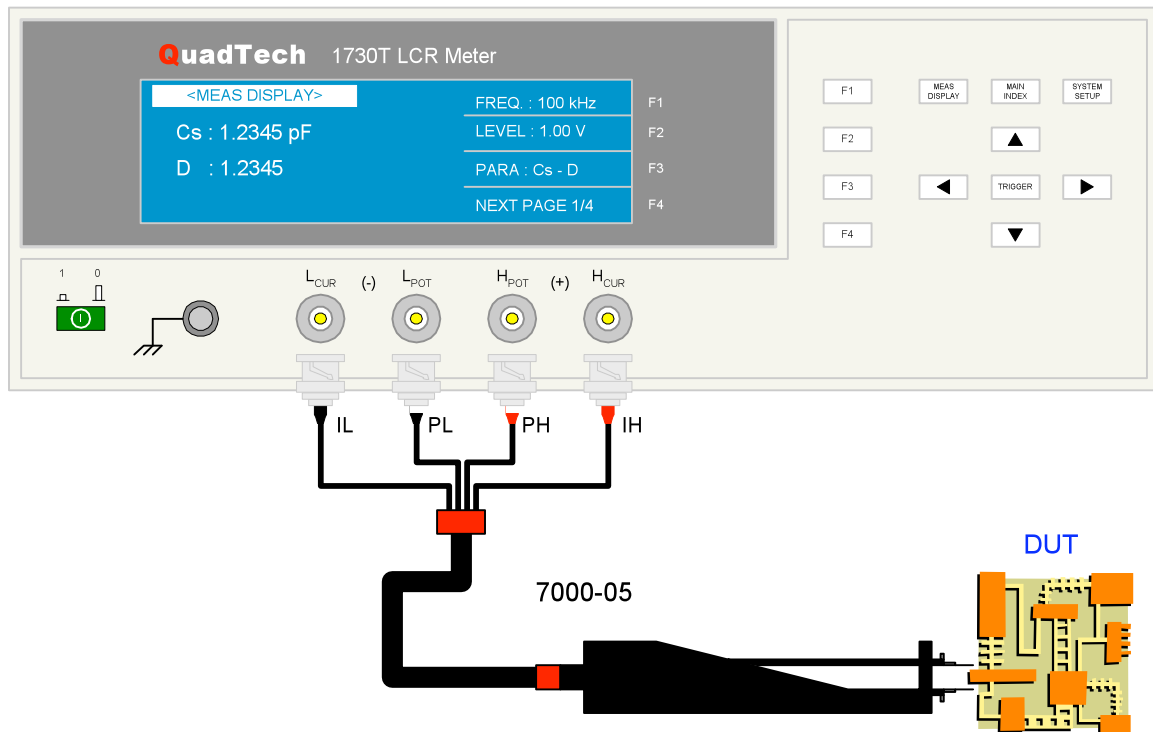


Figure 2-12: 7000-05 BNC to Chip Component Tweezers Cable Lead Set

Figure 2-13 illustrates the two 7000 Series BNC to BNC test cable lead sets available for the 1730T LCR Meter. The 7000-01 is one meter in length and the 7000-02 is two meters in length. The 1730T instrument permits the input of the test cable length for better measurement accuracy. Refer to paragraph 2.3.9, Cable Length for programming instruction. As always, each time the test cable is changed the 1730T instrument should be re-zeroed.

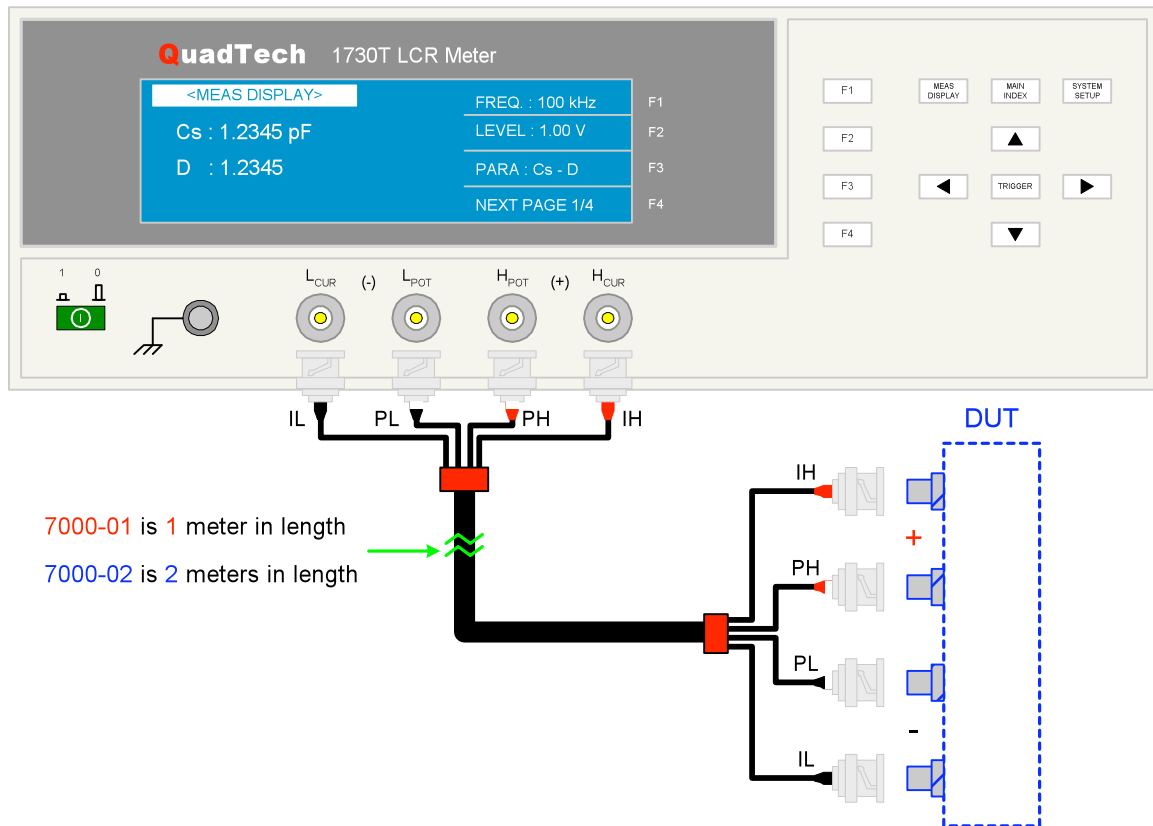


Figure 2-13: 7000-01 & -02 Cables for the 1730 LCR Meter

Figure 2-14 illustrates the 7000-07 SMD Test Fixture available for the 1730T LCR Meter. The 7000-07 Low Voltage Chip Component Test Fixture comes equipped with the 1-meter 7000-01 BNC to BNC cable lead set. The 1730T instrument permits the input of the test cable length for better measurement accuracy. Refer to paragraph 2.3.9, Cable Length, for programming instruction. As always, each time the test cable is changes the 1730T instrument should be re-zeroed.

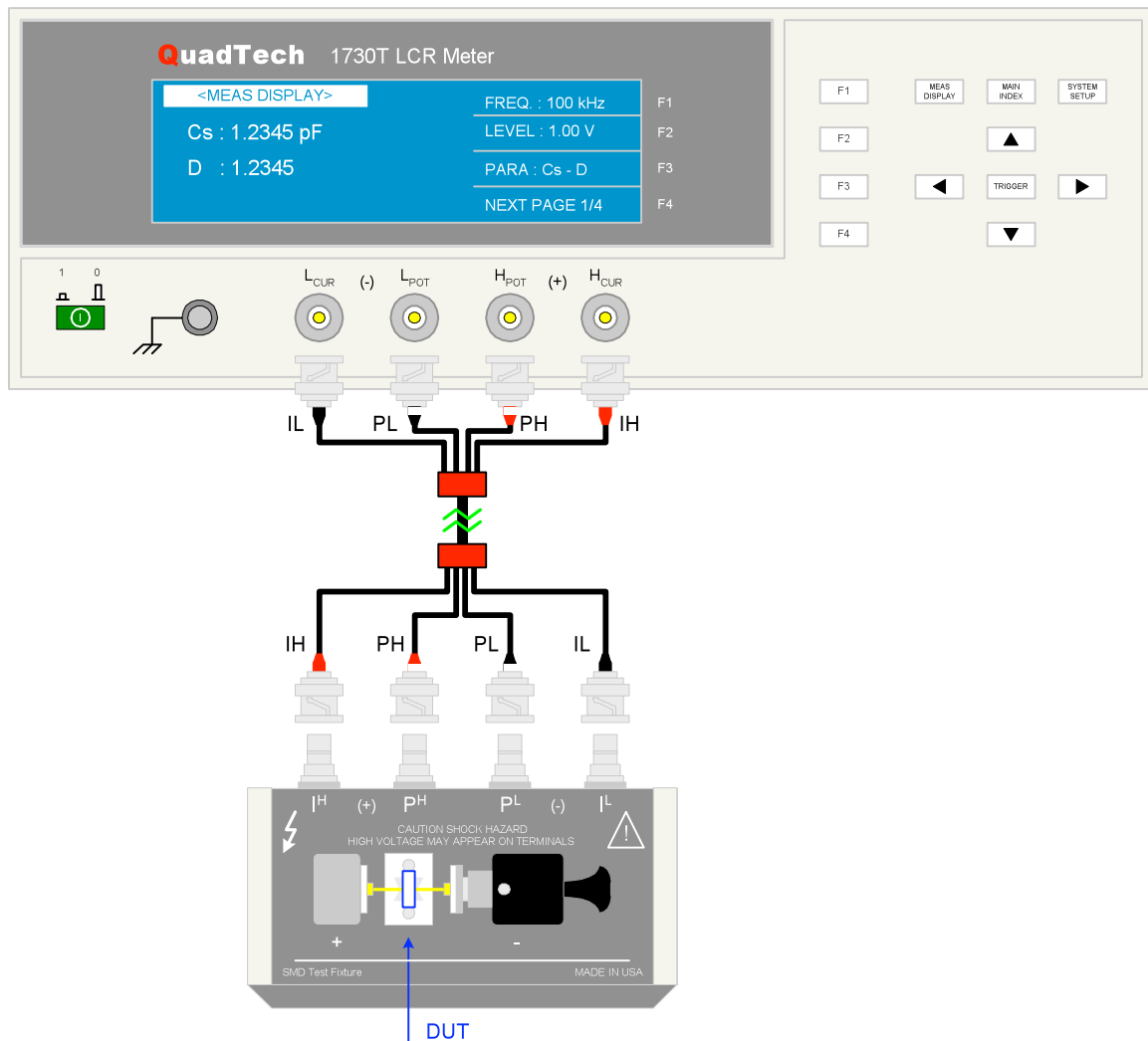


Figure 2-14: 7000-07 Low Voltage Chip Component Test Fixture

Figure 2-15 illustrates the 630166 Transformer Test Fixture connected to the 1730T LCR Meter. The 1730T instrument measures turns ratio (N), turns ratio inverse ($1/N$), mutual inductance (M) and DC resistance ($R2$) of transformers and wound components. Refer to paragraph 2.4.3, Parameter, for programming instructions for N , $1/N$, M and $R2$.

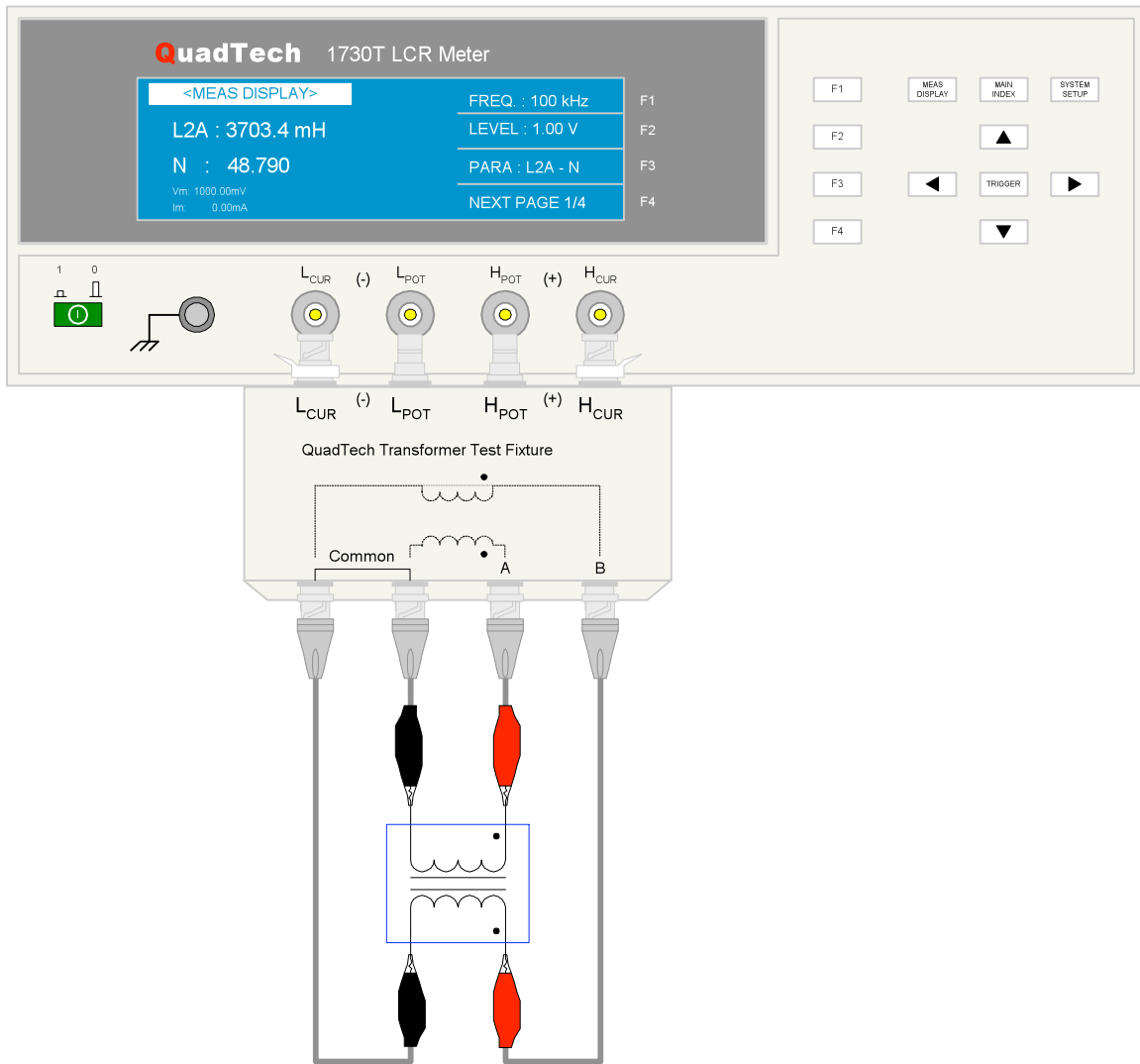


Figure 2-15: Transformer Test Fixture

Figure 2-16 illustrates the 1320 DC Bias Current Source connected to the 1730T LCR Meter using the 7000-01 BNC to BNC lead set. Refer to the 1320 Instruction Manual (150414) for programming instructions. In this 1730T instruction manual paragraphs 2.3.16 “Link 1320” and 2.4.10 “Bias Current” contain instructions for the 1730T regarding bias current settings.

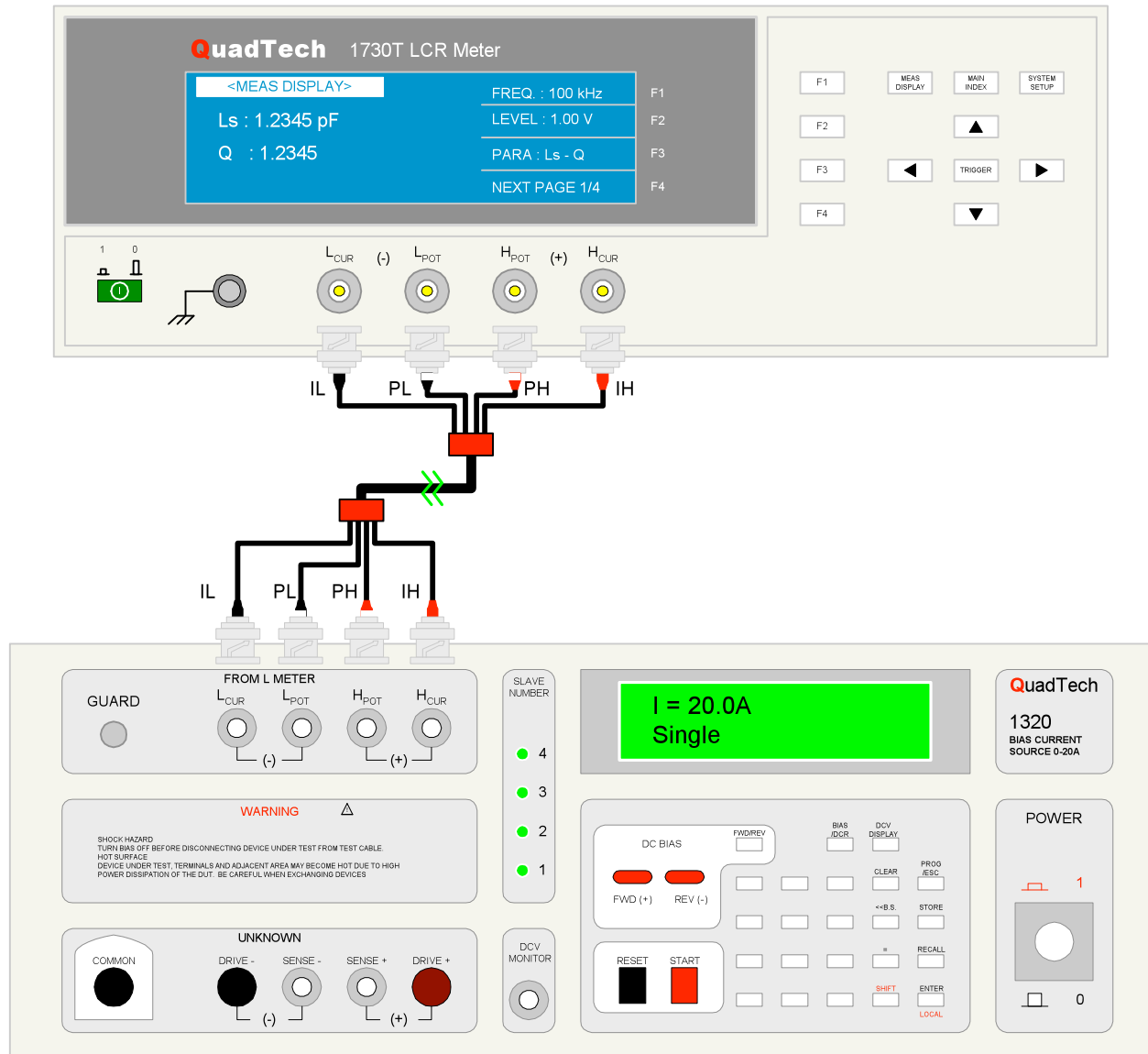


Figure 2-16: Connection of the 1730T to the 1320 BCS

2.7 Measurement Procedure

Before a measurement is made verify the following:

1. 1730T instrument [POWER] ON.
2. 15-minute warm-up.
3. Test parameters programmed and shown on MEAS DISPLAY.
4. Test cables or fixture connected.
5. CORRECTION function initiated.
6. Device under test connected.

The operator has the option of performing a test at power-up conditions (test conditions at which the instrument was last powered down) or recalling one of 50 stored test setups. Refer to paragraphs 2.4 – 2.5 for test programming and storage/recall instructions.

To initiate a test:

- Press [TRIGGER].
- The test voltage is shut **off** when all test steps are completed,
- **OR** when a test result is judged a FAIL per programmed test limits.
- The test result is displayed on MEAS DISPLAY

The 1730T instrument judges the measurement value based on the BINNING and COMPARE functions set up previously. Refer to paragraphs 2.5.1 and 2.5.4 for instructions on setting these judgment parameters. Upon completion of the test the output voltage is terminated and the display shows the test result.

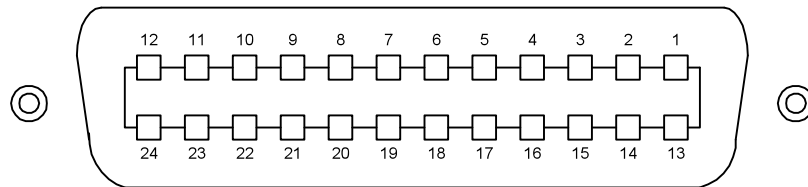
Section 3: Interface

3.1 IEEE-488 Interface

3.1.1 Pin Configuration

The 1730T instrument comes standard with an IEEE-488 interface as illustrated in Figure 3-1. Connection is through the blue 24-pin connector labeled ‘IEEE-488 INTERFACE’ on the rear panel of the 1730T instrument. This interface can be used to connect a system containing a number of instruments and a controller in which each meets IEEE Standard 488.2 (Standard Digital Interface for Programmable Instrumentation).

1730T IEEE-488 Interface PIN Configuration: Rear Panel View



1730T IEEE-488 Interface PIN Designation

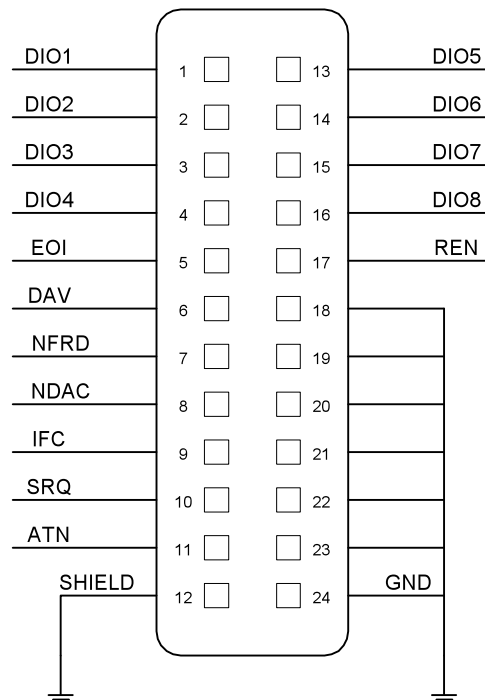


Figure 3-1: IEEE-488 Interface Pin Configuration

Table 3-1 lists the IEEE-488 Interface pin designations by pin number, signal name and pin function. Bus and driver information is also listed.

Table 3-1: IEEE-488 Interface Pin Designations

Bus	Driver	Signal Name	Pin Number	Function
Handshake	3 States	DAV	6	Low State: “Data is Available” and valid on DI01 through DI08
	Open Collector	NRFD	7	Low State: At least one Listener on the bus is “Not Ready For Data”
	Open Collector	NDAC	8	Low State: At least one Listener on the bus is “Not Accepting Data”
Control	3 States	ATN	11	“Attention” specifies 1 of 2 uses for the DI01 through DI08 lines: Low State: Controller command messages High State: Data bytes from the Talker device
	3 States	IFC	9	“Interface Clear” Low State: Returns portion of interface system to a known quiescent state
	Open Collector	SRQ	10	“Service Request” Low State: A Talker or Listener signals (to the controller) need for attention in the midst of the current sequence of events.
	3 States	REN	17	“Remote Enable” Low State: Enables each device to enter remote mode when addressed to listen. High State: All devices revert to Local control.
	3 States	EOI	5	“End of Identify” If ATN is in HIGH state, then EOI LOW state indicates the end of a multiple-byte data transfer sequence. If ATN is in LOW state, then EOI LOW state indicates a parallel poll.
Data	Open Collector	DI01	1	The 8-Line Data Bus. If ATN is in LOW state, then the bus conveys interface messages. If ATN is in HIGH state, then the bus conveys device-dependent messages. (Example: carries remote control commands from the controller or from a talker device)
		DI02	2	
		DI03	3	
		DI04	4	
		DI05	13	
		DI06	14	
		DI07	15	
		DI08	16	

3.1.2 IEEE-488 Interface Function Codes and Messages

The IEEE-488 (GPIB) address is defined under the SYSTEM SETUP in the SYSTEM CONFIG menu. Press [SYSTEM SETUP], then the numerical key [F3] to enter the SYSTEM CONFIG menu. Press down arrow [↓] to enter the GPIB ADDRESS code. To select a new IEEE-488 address, use the function keys. Refer to paragraph 2.3.2 for more information. The default setting for the IEEE address is 17.

Table 3-2 defines the IEEE-488 interface codes and their function. Table 3-3 defines the IEEE-488 interface messages the 1730T instrument responds to and their function.

Table 3-2: IEEE-488 Interface Functions

Code	Function
SH1	Source Handshake (Talker)
AH1	Acceptor Handshake (Listener)
T6	Basic Talker Function
	Serial Poll Function
	Listener-specified Talker Release Function
	No TALK-ONLY Function
L4	Basic Listener Function
	Talker-specified Listener Release Function
SR1	Service Request Function
RL1	All Remote/Local Functions
PP0	No Parallel Poll Function
DC1	Device Clear Function
DT1	Device Trigger Function
C0	No Controller Functions

Table 3-3: IEEE-488 Interface Messages

Interface Message	Function	Description
GTL	Go To Local	Only addressed devices that receive this command are set to local mode. Cancels the remote control mode, making the front panel switches operative.

NOTE:

To exit REMOTE Mode, press [F1] [F4] [SYSTEM SETUP]

Table 3-4 lists the IEEE-488 interface commands the 1730T instrument accepts to set or query a parameter value. Paragraphs 3.1.3 through 3.1.5 detail the command function, format, return value and description.

Table 3-4: IEEE-488 Commands

Command	Name	Function	Output Format
*CLS	Clear Status	Clear standard event status register. Clear status bit group register except for bit 4 (MAV)	
*ESE	Event Status Enable	Enable standard event status register value.	0 – 255
*ESE?	Event Status Enable	Query standard event status of device enable register	0 – 255
*ESR?	Event Status Register	Query standard event register value of device. After this command, the standard register is cleared to 0.	0 – 255
*IDN?	Identification	Query/Read basic device data. (A comma separates the identification fields.)	4 ID: Manufacturer, Device Model, Serial Number, Firmware Version
*OPC	Operation Complete	Operation is complete.	0
*OPC?	Operation Complete	Query operation complete.	1
*RST	Reset	Reset Device.	
*SRE	Service Request Enable	Enable service request register value.	0 – 255
*SRE?	Service Request Enable	Query/Read service request register value.	0 – 255
*TRG	Trigger Bus	Trigger the 1730T instrument	
*TST?	Self Test	Perform self test & report error	0 = no error 1 = RAM1 2 = RAM2 4 = EEPROM 8 = FPGA 16 = Cal Data 32 = Main Board 64 = Key Control
*SAV	Save	Save current status to memory.	1 – 50
*RCL	Recall	Recall saved status from memory.	1 – 50

Status Byte Register

The Status Byte Register is composed of 8 bits that summarize the status data. The Status Byte Register can be read using either *STB? or SPOLL. Both return a decimal expression of the contents of the register. Status Byte Assignments are listed in table 3-5.

Status Byte Register

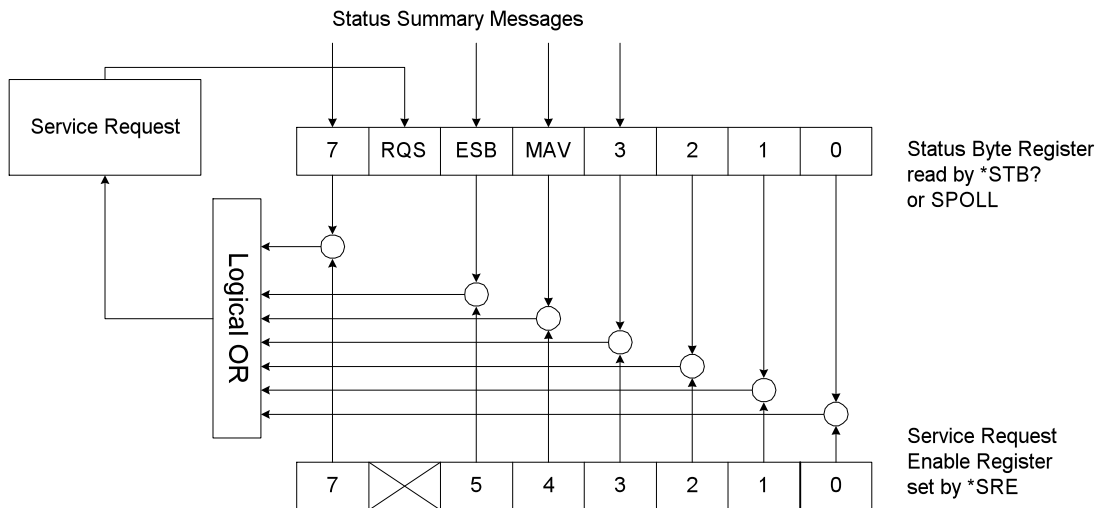


Figure 3-2a: Status Byte Register

Table 3-5 Status Byte Assignments

Bit No.	Bit Weight	Description
7	128	Operation Status Register Summary
6	64	Request Service
5	32	Standard Event Status Register Summary
4	16	Message Available
3	--	
2	--	Always 0
1	--	Always 0
0	--	Always 0

Standard Event Status Register

The Standard Event Status Register is composed of 8 bits. The Status Byte Register can be read using the *ESR? and can be set using the *ESE command. Standard Event Status Register Assignments are listed in table 3-6.

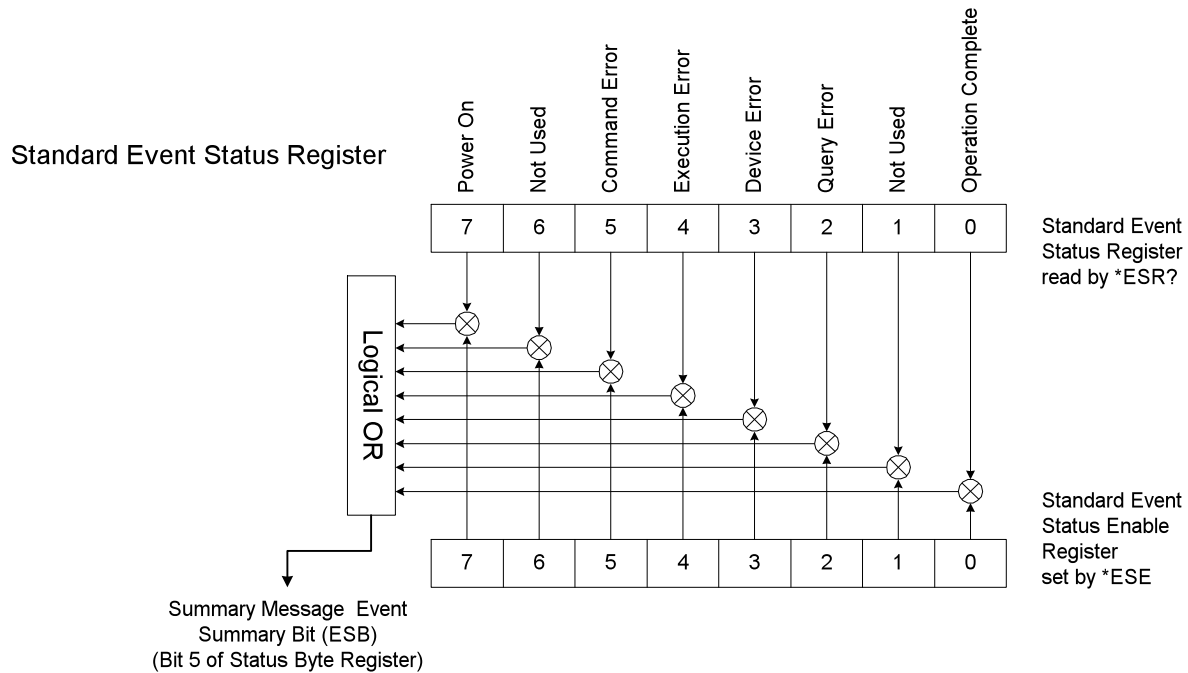


Figure 3-2b: Standard Event Status Register

Table 3-6: Standard Event Status Register

Bit No.	Bit Weight	Description
7	128	Power On: 1730T turned OFF or ON
6	--	Always 0
5	32	Command Error: Syntax error or GET* received inside program
4	16	Execution Error: Parameter outside of limits
3	8	Device Error: Error Queue is full
2	4	Query Error: No data in the output buffer
1	--	Always 0
0	1	Operation Complete: 1730T has completed all tests

* GET: Ground Execute Trigger: A command error may occur when the 1730T receives a Ground Execute Error within a program message.

Standard Operation Status Registers

There are two Standard Operation Status Registers: Operation Status and Questionable Status. The Questionable Status group is accessed using the STATus subsystem commands. Both the Operation Status and Questionable Status contain a condition register, an event register and an enable register.

The condition register reflects the internal status of the 1730T LCR Meter. Each time the status of the 1730T instrument changes then the condition register will change from a “1” to a “0” or from a “0” to a “1”. The bits of the event register correspond to the bits of the condition register. When a condition register bit changes from a “1” to a “0” (all bits except 8 & 9), a transition filter reports an event to the event register. Bit number 8 & 9 change from a “0” to a “1”. The enable register enables the corresponding bit in the event register to set the status summary bit (bit 7 or 3) in the Status Byte Register.

Standard Operation Status Register

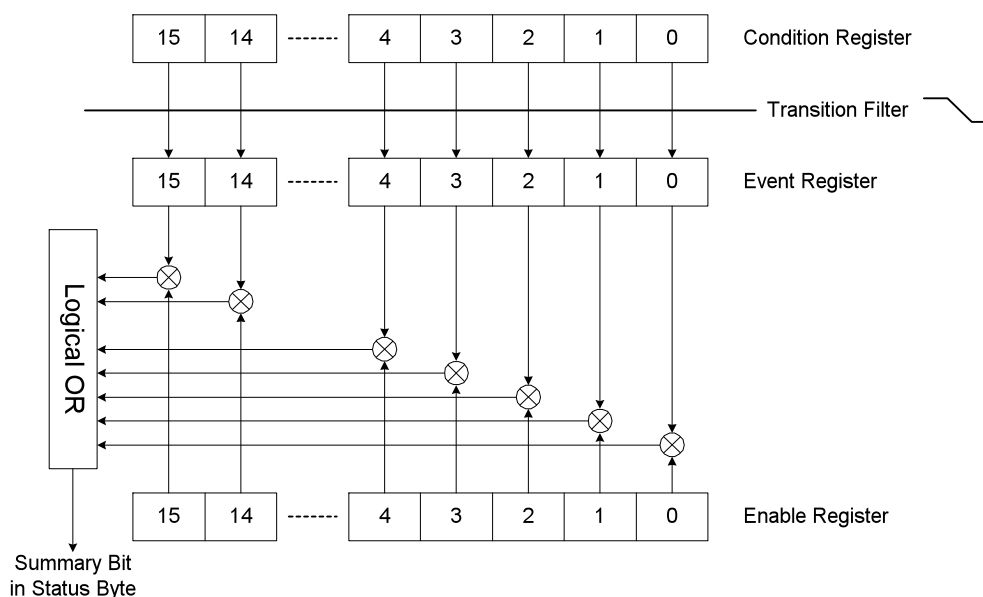


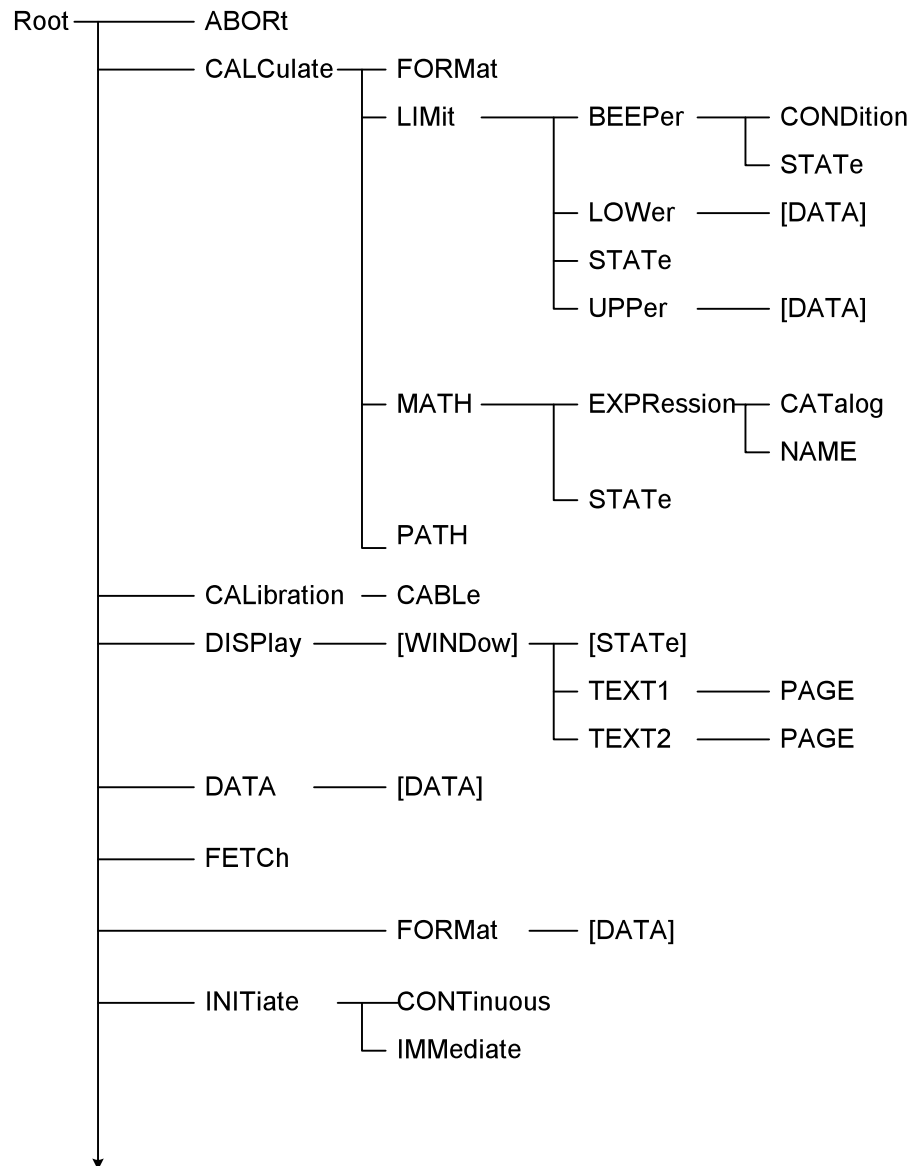
Figure 3-2c: Standard Operation Status Register

Tables 3-7: Standard Operation Status Register Assignments

Bit No.	Bit Weight	Description
10-15	--	Always 0
6	--	Always 0
5	32	Waiting for Trigger: Set when 1730T can accept a trigger
4	16	Measuring: Bit is set when 1730T is making a measurement
3	8	Always 0
2	4	Ranging: Bit is set when 1730T changes range
1	2	Settling: Waiting for test signal to stabilize before making a measurement
0	--	Always 0

3.1.3 IEEE-488 Commands

Figure 3-3 illustrates the programming commands accepted by the IEEE-488 interface of the 1730T instrument. The commands are written in tabular format as a single reference to view all the commands. The command format and examples are detailed in paragraphs 3.1.4 – 3.1.5.



Continued on next page.

Figure 3-3a: IEEE-488 Commands

IEEE-488 Commands – continued:

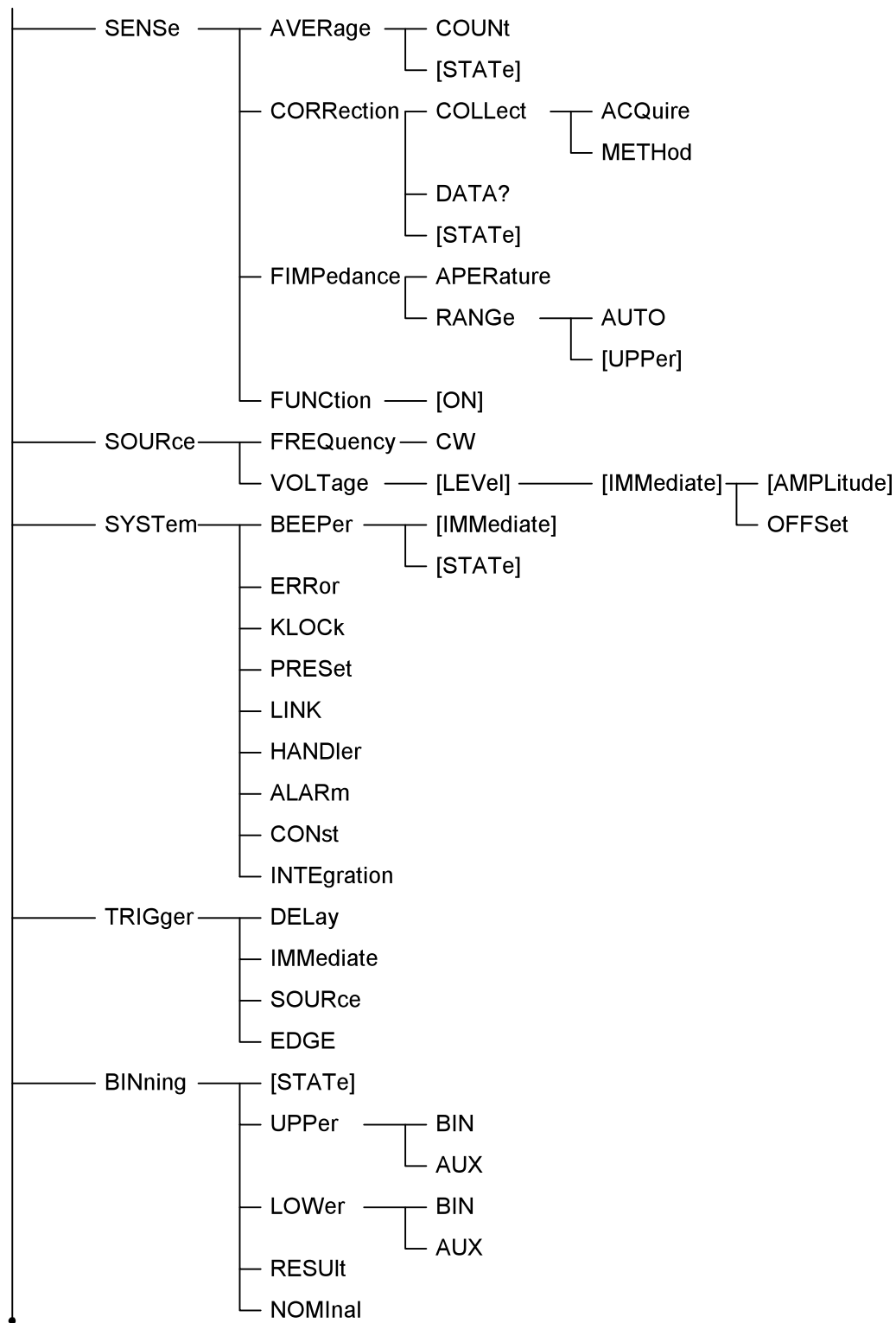


Figure 3-3b: IEEE-488 Commands

3.1.4 IEEE-488 Command Format

The IEEE-488 commands are configured in Root format. There are six levels of the instruction from top to bottom. Follow the specific path (as illustrated in Figure 3-3) to configure a specific command. The colon at the beginning of each line denotes that all line signals are root. Use a colon (:) to separate levels. Use the semicolon (;) to separate two commands on the same line.

For example, to format the command for the NAME function, use this path:

```
:CALCulate:MATH:EXPReSSion:NAME
```

To format the NAME and CATalog function, use two single commands:

```
:CALCulate:MATH:EXPReSSion:NAME  
:CALCulate:MATH:EXPReSSion:CATalog
```

or use the single command:

```
:CALCulate:MATH:EXPReSSion:NAME;CATalog
```

If the command is a setting, then put the parameter after the instruction. If the command is an inquiry, then put a question mark (?) after the instruction.

For example, to set the frequency to 1kHz:

```
:SOURce:FREQuency[:CW]1kHz
```

To inquire what the frequency is set to:

```
:SOURce:FREQuency[:CW]?
```

The lowercase letters and portion in parenthesis can be omitted so the above instruction can be rewritten as:

```
:SOUR:FREQ;
```

The Ending Code can be any type in Table 3-8.

Table 3-8: IEEE-488 Interface Ending Codes

Ending Code
[CR] (0Dh)
[LF] (0Ah)
[CR] (0Dh) + [LF] (0Ah)

3.1.5 IEEE-488 Commands - Detailed

The IEEE commands listed in Figure 3-3 are detailed in paragraphs 3.5.1.1 – 3.1.5.55 including command, parameter, return value, function, and description. **Note:** Numerical data is transferred via one of three methods: integer format, fixed decimal format or floating point decimal format. Refer to Figure 3-4.

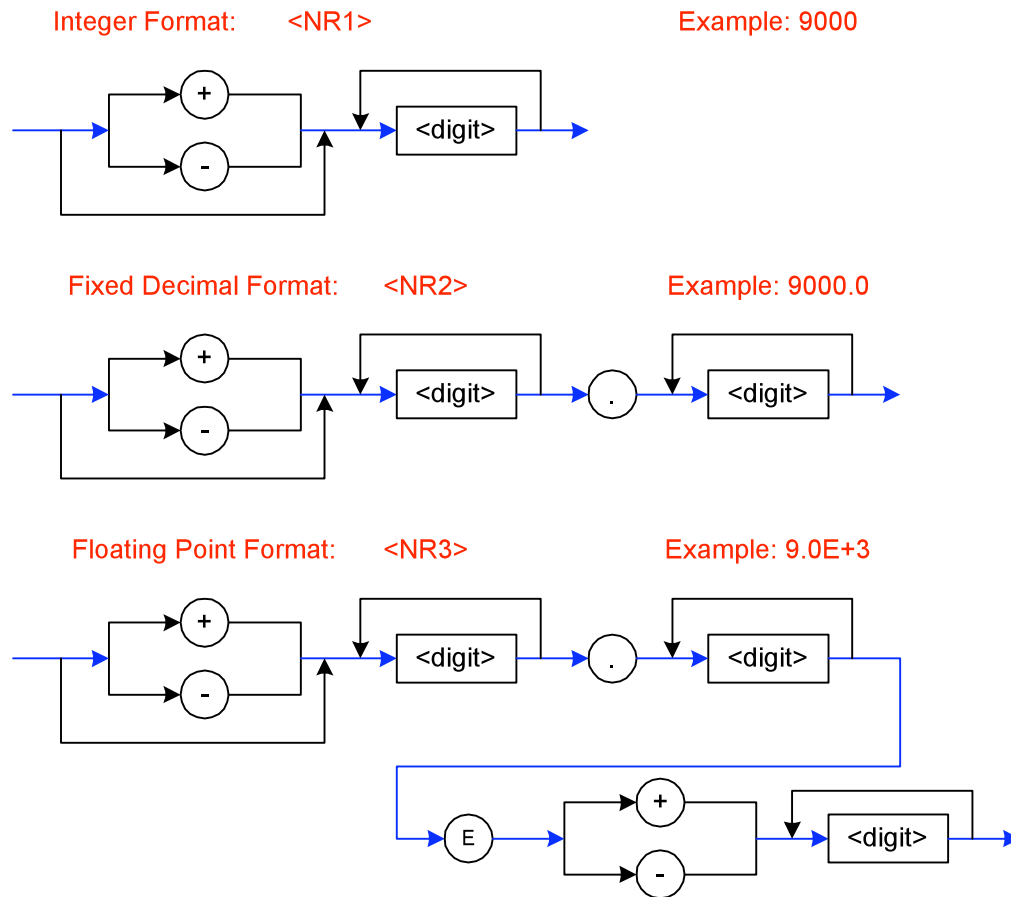


Figure 3-4: Numerical Data Transfer

3.1.5.1 ABORt

Instruction: ABORt
Parameter: None
Return Value: None
Function: Terminate Trigger in process. Reset Trigger.

3.1.5.2 CALCulate1:FORMat

Instruction: CALCulate1:FORMat
 Parameter: {REAL | MLINear | CP | CS | LP | LS | ZS | RS | RP}
 Return Value: {REAL | MLINear | CP | CS | LP | LS | ZS | RS | RP}
 Function: Set or Query the primary measurement parameter.
 Description: REAL Impedance, Real
 MLINear Impedance, absolute value
 CP Equivalent parallel capacitance
 CS Equivalent series capacitance
 LP Equivalent parallel inductance
 LS Equivalent series inductance
 ZS Equivalent series impedance
 RS Equivalent series resistance
 RP Equivalent parallel resistance

3.1.5.3 CALCulate2:FORMat

Instruction: CALCulate2:FORMat
 Parameter: {IMAGinary | PHASe | D | Q | REAL | RS | XS}
 Return Value: {IMAGinary | PHASe | D | Q | REAL | RS | XS}
 Function: Set or Query the secondary measurement parameter.
 Description: IMAGinary Impedance, Imaginary
 PHASe Phase angle
 D Dissipation factor
 Q Quality factor
 REAL Impedance, Real
 RS Equivalent series resistance
 XS Equivalent series reactance (imaginary)

Parameter	SENS:FUNC:ON	CALC1:FORM	CALC2:FORM
Z – θ R – X	“FIMPedance”	MLINear REAL	PHASe IMAGinary
Cp – D Cp – Q Cp – Rp	“FADMittance”	CP	D Q Rp
Cs – D Cs – Q Cs – Rs	“FIMPedance”	CS	D Q REAL
Lp – D Lp – Q Lp – Rp	“FADMittance”	LP	D Q REAL
Ls – DCR Lp – DCR	“FIMPedance”, “FRESistance” “FADMittance”, “FRESistance”	LS LP	REAL REAL
L2 – N L2 – 1/N L2 – M L2 – R2	“FIMPedance”, “VOLTage:AC” “FIMPedance”, “VOLTage:AC” “FIMPedance”, “FADMittance” “FIMPedance”, “FADMittance”	LS	REAL INV LP REAL

3.1.5.4 **CALCulate{1 | 2}:LIMit:BEEPer:CONDition**

Instruction: CALCulate{1 | 2}:LIMit:BEEPer:CONDition
Parameter: {FAIL | PASS}
Return Value: None
Function: Set condition upon which Beeper sounds.
Description: FAIL Beeper sounds when comparison result is a FAIL
 PASS Beeper sounds when comparison result is a PASS

3.1.5.5 **CALCulate{1 | 2}:LIMit:BEEPer:STATe**

Instruction: CALCulate{1 | 2}:LIMit:BEEPer:STATe
Parameter: {ON (1) | OFF (0)}
Return Value: {1 | 0}
Function: Set or query status of beeper.
Description: (1) Turn on Beeper
 (0) Turn off Beeper

3.1.5.6 **CALCulate{1 | 2}:LIMit:BEEPer**

Instruction: CALCulate{1 | 2}:LIMit:BEEPer
Parameter: {OFF (0) | LOW (1) | HIGH (2)}
Return Value: {0 | 1 | 2}
Function: Set or query if beeper is ON or OFF.
Description: (0) Turn off Beeper
 (1) Turn on Beeper (LOW)
 (2) Turn on Beeper (HIGH)

3.1.5.7 **CALCulate{1 | 2}:LIMit:LOWer[:DATA]**

Instruction: CALCulate{1 | 2}:LIMit:LOWer[:DATA]
Parameter: {The lower limit value | MAXimum | MINimum}
Return Value: The lower limit value, the format is <NR3> (Floating point)
Function: Set or query the lower limit value.
Description: MINimum -9.999E14
 MAXimum 9.999E14

3.1.5.8 **CALCulate{1 | 2}:LIMit:STATe**

Instruction: CALCulate{1 | 2}:LIMit:STATe
Parameter: {ON (1) | OFF (0)}
Return Value: {1 | 0}
Function: Set or query if the Compare function is ON or OFF.
Description: ON (1) Turn on Compare function
 OFF (0) Turn off Compare function

3.1.5.9 CALCulate{1 | 2}:LIMit:UPPer[:DATA]

Instruction: CALCulate{1 | 2}:LIMit:UPPer[:DATA]
Parameter: {The upper limit value | MAXimum | MINimum}
Return Value: The upper limit value, the format is <NR3> (Floating point)
Function: Set or query the upper limit value.
Description: MINimum -9.999E14
MAXimum 9.999E14

3.1.5.10 CALCulate{1 | 2}:MATH:EXPRession:CATalog

Instruction: CALCulate{1 | 2}:MATH:EXPRession:CATalog
Parameter: None
Return Value: Bias absolute value (DEV) or percent value (PCNT)
Function: Send back the parameter to use with
CALCulate{1 | 2}:MATH:EXPRession:NAME

3.1.5.11 CALCulate{1 | 2}:MATH:EXPRession:NAME

Instruction: CALCulate{1 | 2}: MATH:EXPRession:NAME
Parameter: {DEV | PCNT}
Return Value: {DEV | PCNT}
Function: Set the Compare function value to deviation or percent deviation.

3.1.5.12 CALCulate{1 | 2}:MATH:STATe

Instruction: CALCulate{1 | 2}:MATH:STATe
Parameter: {ON (1) | OFF (0)}
Return Value: {1 | 0}
Function: Set or query if CALCulate{1 | 2}: MATH:EXPRession:NAME is ON or OFF.
Description: ON (1) Turn on CALCulate{1 | 2}: MATH:EXPRession:NAME
OFF (0) Turn off CALCulate{1 | 2}: MATH:EXPRession:NAME

3.1.5.13 CALCulate{1 | 2}: PATH?

Instruction: CALCulate{1 | 2}: PATH?
Parameter: None
Return Value: FORM, MATH, LIM
Function: Send back CALCulate subsystem according to performance sequence of
CALCulate subsystem.

3.1.5.14 CALCulate{3 | 4}:MATH:STATe

Instruction: CALCulate{3 | 4}:MATH:STATe
Parameter: {ON (1) | OFF (0)}
Return Value: {1 | 0}
Function: Set or query if VM/IM function is ON or OFF.
Description: CALCulate3 Set current value (IM)
CALCulate4 Set voltage value (VM)
ON (1) Turn on VM/IM function
OFF (0) Turn off VM/IM

3.1.5.15 CALibration:CABLe

Instruction: CALibration:CABLe
Parameter: {0 – 4 meters}
Return Value: {0 | 1 | 2 | 4}
Function: Set the test cable length.

NOTE:

CALC1 refers to primary parameter, CALC2 to secondary parameter.

3.1.5.16 :DATA[:DATA]

Instruction: :DATA[:DATA]
Parameter: {REF1 | REF2}
Return Value: The nominal value in <NR3> format (-9.999E14 to 9.999E14)
Function: Set the Primary or Secondary nominal value.
Description: REF1 Nominal value of primary parameter
REF2 Nominal value of secondary parameter

3.1.5.17 :DATA[:DATA]?

Instruction: :DATA[:DATA]?
Parameter: {REF1 | REF2}
Return Value: The nominal value in <NR3> format (-9.999E14 to 9.999E14)
Function: Query the Primary or Secondary nominal value.
Description: REF1 Nominal value of primary parameter
REF2 Nominal value of secondary parameter

3.1.5.18 DISPlay[:WINDow][:STATe]

Instruction: DISPlay[:WINDow][:STATe]
Parameter: {ON (1) | OFF (0)}
Return Value: {1 | 0}
Function: Set or query if the LCD display is ON or OFF.

3.1.5.19 DISPlay[:WINDow]:TEXT1:PAGE

Instruction: DISPlay[:WINDow]:TEXT1:PAGE
Parameter: {1 | 2}
Return Value: {1 | 2}
Function: Set or query which screen is shown.
Description: 1 Measuring screen
2 Comparison screen

3.1.5.20 DISPlay[:WINDow]:TEXT2:PAGE

Instruction: DISPlay[:WINDow]:TEXT2:PAGE
Parameter: {1 | 2 | 3 | 4}
Return Value: {1 | 2 | 3 | 4}
Function: Set or query which page of MEAS DISPLAY is shown.
Description: 1 Page 1 of MEAS DISPLAY (Freq, Level, Parameter)
2 Page 2 of MEAS DISPLAY (Range, Speed, Trigger)
3 Page 3 of MEAS DISPLAY (Bias, Binning, Compare)
4 Page 4 of MEAS DISPLAY (Bias I, Bias I)

3.1.5.21 FETCh?

Instruction: FETCh?
Parameter: None
Return Value: <STATE>, <DAT1>, <DAT2>, <CMP1>, <CMP2>
Function: Get the result from the INITiate function.
Description: <STATE> Measuring status
1 Normal
2 Overload
3 DUT disconnected
<DAT1> test value of primary parameter
<DAT2> test value of secondary parameter
When the Compare function is enabled, results are:
<CMP1> comparison value of primary parameter
<CMP2> comparison value of secondary parameter
0 No secondary parameter
1 Test value in range
2 Test value too high
4 Test value too low
8 DUT disconnected

NOTE: Use the *TRG command to initiate a measurement and get the data back in a single command.
--

3.1.5.22 FORMat[:DATA]

Instruction: FORMat[:DATA]
Parameter: {ASCII}
Return Value: ASK
Function: Set or query the format of the numerical data being transferred.

3.1.5.23 INITiate[:IMMediate]

Instruction: INITiate[:IMMediate]
Parameter: None
Return Value: None
Function: Immediately initiate all sequences.

3.1.5.24 INITiate:CONTInuous

Instruction: INITiate:CONTInuous
Parameter: {ON (1) | OFF (0)}
Return Value: {1 | 0}
Function: Set or query if the Trigger is ON or OFF.
Description: ON (1) Turn on Trigger
OFF (0) Turn off Trigger

3.1.5.25 [SENSe]:AVERage:COUNT

Instruction: [SENSe]:AVERage:COUNT
Parameter: {1 ~ 256}
Return Value: {1 ~ 256}
Function: Set or query the averaging number.

3.1.5.26 [:SENSe]:CORRection:COLLect[:ACQuire]:STANdard

Instruction: [:SENSe]:CORRection:COLLect[:ACQuire]:STANdard
Parameter: {1 | 2}
Return Value: None
Function: Perform OPEN or SHORT correction procedure.
Description: 1 Perform OPEN correction procedure
2 Perform SHORT correction procedure
Open Example: SENSe:CORR:COLL:STAN1

3.1.5.27 [:SENSe]:CORRection:COLLect:METHod

Instruction: [:SENSe]:CORRection:COLLect:METHod
Parameter: {REFL2}
Return Value: {REFL2}
Function: Set or query the measured tolerance's correction procedure.
Description: REFL2 OPEN/SHORT correction procedure

3.1.5.28 [:SENSe]:CORRection:DATA?STANdard

Instruction: [:SENSe]:CORRection:DATA?STANdard
Parameter: {1 | 2}
Return Value: Two numerical correction values in <NR3> format
Function: Query the numerical correction value.
Description: STANdard 1 OPEN correction value: G, B
STANdard 2 SHORT correction value: R, X

3.1.5.29 [:SENSe]:FIMPedance:APERature

Instruction: [:SENSe]:FIMPedance:APERature
Parameter: 0.025 (Fast), 0.065 (Medium), 0.500 (Slow)
Return Value: 0.025 (Fast), 0.065 (Medium), 0.500 (Slow)
Function: Set or query the measurement speed.

3.1.5.30 [:SENSe]:FIMPedance:RANGe:AUTO

Instruction: [:SENSe]:FIMPedance:RANGe:AUTO
Parameter: {ON (1) | OFF (0)}
Return Value: {1 | 0}
Function: Set or query if the Auto Range is ON or OFF.
Description: ON (1) Turn on Auto Range
OFF (0) Turn off Auto Range

3.1.5.31 [:SENSe]:FIMPedance:RANGe[:UPPer]

Instruction: [:SENSe]:FIMPedance:RANGe[:UPPer]
Parameter: {Measured value range | UP | DOWN}
Unit: [MOHM | KOHM | OHM | mOHM], default is OHM
Return Value: {Measured value range} in <NR3> format
Function: Set or query which Measurement Range is enabled.
Description: UP Go to previous range
DOWN Go to next range
Range Values: 1M Ω , 300k Ω , 100k Ω , 30k Ω , 10k Ω , 3k Ω , 1k Ω , 300 Ω , 100 Ω , 10 Ω , 1 Ω , 0.1 Ω .

Note: When CONST Rsource is OFF, 300k Ω , 30k Ω , 3k Ω and 300 Ω are disabled.
When Test Frequency is set to 100Hz or 120Hz, 0.1 Ω is disabled.

3.1.5.32 [:SENSe]:FUNction[:ON]

Instruction: [:SENSe]:FUNction[:ON]
 Parameter: {FIMPedance | FADMITTANCE}
 Return Value: {FIMPedance | FADMITTANCE}
 Function: Set or query the equivalent circuit measurement mode.
 Description: FIMPedance Series equivalent circuit
 FADMittance Parallel equivalent circuit

3.1.5.33 [:SENSe]:FUNction:CONCurent

Instruction: [:SENSe]:FUNction:CONCurent
 Parameter: {ON | OFF | 1 | 0}
 Return Value: {1 | 0}
 Function: Set or query the transformer measurement mode (DCR, L2, N, M and R2).
 Description: ON (1) Transformer mode ON
 OFF (0) Transformer mode OFF

Note: The instructions: [:SENSe]:FUNction[:ON] and CALCulate{1 | 2}:FORMat must be used with the [:SENSe]:FUNction:CONCurent instruction.

When the SENSE:FUNCTion:CONCurent is OFF:	
<SENSOR_FUNCTION>	Measurement Function
"FIMPedance"	Impedance measurement – Series equivalent circuit
"FADMittance"	Admittance measurement – Parallel equivalent circuit
When the SENSE:FUNCTion:CONCurent is ON:	
"FIMPedance", "FRESistance"	DCR measurement – Series equivalent circuit
"FADMittance", "FRESistance"	DCR measurement – Parallel equivalent circuit
"VOLTage:AC", "IMPedance"	Transformer Turns Ratio (N) measurement
"IMPedance", "FADMittance"	Transformer Mutual Inductance (M) measurement
"IMPedance", "RESistance"	Transformer DC Resistance (R2) measurement

Parameter	SENS:FUNC:ON	CALC1:FORM	CALC2:FORM
Z – θ R – X	"FIMPedance"	MLINear REAL	PHASe IMAGinary
Cp – D Cp – Q Cp – Rp	"FADMittance"	CP	D Q Rp
Cs – D Cs – Q Cs – Rs	"FIMPedance"	CS	D Q REAL
Lp – D Lp – Q Lp – Rp	"FADMittance"	LP	D Q REAL
Ls – DCR Lp – DCR	"FIMPedance", "FRESistance" "FADMittance", "FRESistance"	LS LP	REAL REAL
L2 – N L2 – 1/N L2 – M L2 – R2	"FIMPedance", "VOLTage:AC" "FIMPedance", "VOLTage:AC" "FIMPedance", "FADMittance" "FIMPedance", "FADMittance"	LS	REAL INV LP REAL

3.1.5.34 SOURce:FREQuency[:CW]

Instruction: SOURce:FREQuency[:CW]
Parameter: Test Frequency
Unit: [Hz | kHz], default is Hz
Return Value: {Test Frequency} in <NR3> format
Function: Set or query the test frequency.
Range Values: 50Hz, 60Hz, 100Hz, 120Hz, 1kHz, 10kHz, 20kHz, 40kHz, 50kHz & 100kHz

3.1.5.35 SOURce:VOLTage[:LEVel][:IMMediate][AMPLitude]

Instruction: SOURce:VOLTage[:LEVel][:IMMediate][AMPLitude]
Parameter: Test Voltage
Return Value: {Test Voltage} in <NR3> format
Function: Set or query the test voltage.
Range Values: 0.02 ~ 1Vrms, Resolution is 10mV

3.1.5.36 SOURce:VOLTage[:LEVel][:IMMediate]:OFFSet:STATe

Instruction: SOURce:VOLTage[:LEVel][:IMMediate]:OFFSet:STATe
Parameter: {ON (1) | OFF (0)}
Return Value: {1 | 0}
Function: Enable/Disable the DC bias voltage function.
Description: ON (1) Enable bias voltage
OFF (0) Disable bias voltage

3.1.5.37 SYSTem:ALARm

Instruction: SYSTem:ALARm
Parameter: {PULSe | CONTinuous}
Return Value: {PULSe | CONTinuous}
Function: Set the mode the alarm will sound in.

3.1.5.38 SYSTem:BEEPer:STATe

Instruction: SYSTem:BEEPer:STATe
Parameter: {OFF (0) | ON, LOW (1) | ON, HIGH (2)}
Return Value: {0 | 1 | 2}
Function: Set the loudness of the beeper.

3.1.5.39 SYSTem:CONSt

Instruction: SYSTem:CONSt
Parameter: Constant Source Resistance
Return Value: {100/25 | 100 | 25 | 10c}
Function: Set the constant source resistance.

3.1.5.40 SYSTem:ERRor?

Instruction: SYSTem:ERRor?
Parameter: None
Return Value: Error message
Function: Query if there are any system errors.

3.1.5.41 SYSTem:HANDler

Instruction: SYSTem:HANDler
Parameter: {CLEAR|HOLD}
Return Value: {CLEAR|HOLD}
Function: Set the Handler to clear result or hold result for each test.

3.1.5.42 SYSTem:INTEgration

Instruction: SYSTem:INTEgration
Parameter: {0 - 8}
Return Value: {0|1|2|3|4|5|6|7|8}
Function: Set the integer cycle (# of sine waves integrated together per measurement).

3.1.5.43 SYSTem:KLOCK

Instruction: SYSTem:KLOCK
Parameter: {ON (1)|OFF (0)}
Return Value: {1|0}
Function: Set or query if the Key Lock function is ON or OFF.
Description: ON (1) Turn on Key Lock
OFF (0) Turn off Key Lock

3.1.5.44 SYSTem:PRESet

Instruction: SYSTem:PRESet
Parameter: None
Return Value: None
Function: Set the instrument to initial default values.

3.1.5.45 SYSTem:VERSion

Instruction: SYSTem:VERSion
Parameter: None
Return Value: None
Function: Set the instrument software version and date.

3.1.5.46 TRIGger:DELay

Instruction: TRIGger:DELay
Parameter: Trigger Delay Time
Unit: [MS | S], default is S
Return Value: {Trigger Delay Time} in <NR3> format
Function: Set or query the trigger delay time.
Range Values: 0 ~ 9999ms

3.1.5.47 TRIGger:[IMMediate]

Instruction: TRIGger:[IMMediate]
Parameter: None
Return Value: None
Function: Set the instrument to trigger immediately.

3.1.5.48 TRIGger:SOURce

Instruction: TRIGger:SOURce
Parameter: {BUS | EXTeRnal | | INTeRnal | MANual}
Return Value: {BUS | EXTeRnal | | INTeRnal | MANual}
Function: Set or query the trigger mode.
Description: BUS Bus trigger
EXTeRnal External trigger
INTeRnal Internal trigger
MANual Manual trigger

3.1.5.49 BINning:UPPer:BIN

Instruction: BINning:UPPer:BIN{1-8}
Parameter: {? | <number> (NR3 mode)}
Return Value: {The upper limit value of each BIN}
Function: Sets the upper limit value of each bin. Value is +999.99 to -999.99%

3.1.5.50 BINning:UPPer:AUX

Instruction: BINning:UPPer:AUX
Parameter: {The upper limit value (NR3 mode) of the secondary parameter}
Return Value: {The upper limit value (NR3) of secondary parameter}
Function: Sets the AUX HIGH value for binning. (The upper limit of parameter B)

3.1.5.51 BINning:LOWer:BIN

Instruction: BINning:LOWer:BIN{1-8}
Parameter: {?|<number> (NR3 mode)}
Return Value: {The low limit value of each BIN}
Function: Sets the low limit value of each bin. Value is +999.99 to -999.99%

3.1.5.52 BINning:LOWer:AUX

Instruction: BINning:LOWer:AUX
Parameter: {The low limit value (NR3 mode) of the secondary parameter}
Return Value: {The low limit value (NR3) of secondary parameter}
Function: Sets the AUX LO value for binning. (The low limit of parameter B)

3.1.5.53 BINning:NOMInal

Instruction: BINning:NOMInal
Parameter: {The nominal value (NR3 mode) of the primary parameter}
Return Value: {The nominal value (NR3) of primary parameter}
Function: Sets the NOMINAL value for binning. (The nominal value of parameter A)

3.1.5.54 BINning:STATe

Instruction: BINning:STATe
Parameter: {ON (1)|OFF (0)}
Return Value: {1|0}
Function: Set the Binning function: ON or OFF.
Description: ON (1) Binning is ON
OFF (0) Binning is OFF

3.1.5.55 BINning:RESUlt

Instruction: BINning:RESUlt
Parameter: none
Return Value: {Binning Result (+0 ~ +9)}
Function: Get the Binning Result: +0, +1 ~ +8, +9.
Description: +0 Binning is OFF or the sequence result is 0 (secondary parameter failed).
+1 ~ +8 Primary and Secondary parameter pass for limits set for specific bin.
+9 The secondary parameter passed, the primary parameter failed.

3.1.6 Binning Example

Here is an example to program the bin limits for a binning operation. In this example Bin1 has a high/low limit of $\pm 1.2\%$. Bin2 has a high/low limit of $\pm 2.2\%$. Both nested around the nominal value of $100\text{m}\Omega$.

NOTE:

The Bin function is turned on **after** the bin limits are set.

:BINning:NOMInal 100e3;	Sets the nominal value to 100m
:BINning:UPPer:AUX 1;	Sets the AUX-HI limit value to 1
:BINning:LOWer:AUX 0;	Sets the AUX_LO limit value to 0
:BINning:UPPer:BIN1,+1.2;	Sets the Bin1 HI limit value to +1.2%
:BINning:LOWer:BIN1,-1.2;	Sets the Bin1 LO limit value to -1.2%
:BINning:UPPer:BIN2,+2.2;	Sets the Bin2 HI limit value to +2.2%
:BINning:LOWer:BIN2,-2.2;	Sets the Bin2 LO limit value to -2.2%
:BINning:STATe ON;	Enables Binning function
:BINning:RESUlt?	Query the Binning result

Results

+0	Binning result is Bin0 = Secondary parameter failed
+1 - +8	Binning result is Bin1 to Bin8 = Primary and secondary parameters pass (within the limits set for bins 1-8).
+9	Binning result is Bin9 = Secondary pass, primary fail

3.1.7 Compare Example

Here is an example to program the nominal, high and low limits for a compare operation. In this example the 1730T instrument is programmed with the primary parameter Rs and the secondary parameter Q at 1kHz and 1V. The auto range is OFF and the 100Ω Range is selected. The primary nominal value is set to 24.9Ω, the primary low limit is set to 20Ω and the primary high limit is set to 30Ω. The Compare display selected is “ON-VAL”. **NOTE:** the Compare function is turned on **after** the limits are set.

```
NI = 0
datakeep$ = "no"
passall$ = "yes"
If NI = 1 Then
Open "gpib0" For Output As #1
Open "gpib0" For Input As #2
Print #1, "ABORT"
Print #1, "RESET"
Print #1, "gpibeos lf"
Else
Open "\dev\ieeeout" For Output As #1
IOCTL #1, "BREAK"
Print #1, "RESET"
Open "\dev\ieeegin" For Input As #2
Print #1, "TERM LF"
End If
K2 = 1000
fr = 100000
cmdl$ = "C"

Print #1, "output 17; TRIG:SOUR ext"
For G = 1 To k2: Next G
Print #1, "output 17; :SOUR:FREQ "; 1000
For G = 1 To k2: Next G
Print #1, "output 17; :SENS:FIMP:APER 0.500"
For G = 1 To k2: Next G
Print #1, "output 17; :SOUR:VOLT 1e0"
For G = 1 To k2: Next G
Print #1, "output 17; :CAL:CABL 1"
For G = 1 To k2: Next G
Print #1, "output 17; :CALC2:FORM Q"
For G = 1 To k2: Next G
Print #1, "output 17; :CALC1:FORM RS"
For G = 1 To k2: Next G
Rem now for bin limits
Print #1, "output 17; :data ref1,24.9;"
For G = 1 To k2: Next G
Print #1, "output 17; :sens:fimp:rang:auto off"
For G = 1 To k2: Next G
Print #1, "output 17; :sens:fimp:rang 100"
For G = 1 To k2: Next G
Print #1, "output 17; :CALC1:lim:lower 20"
For G = 1 To k2: Next G
Print #1, "output 17; :CALC1:lim:upper 30"
For G = 1 To k2: Next G
Print #1, "output 17; :CALC1:lim:state on"
For G = 1 To k2: Next G
Print #1, "output 17; :CALC1:math:state on"
For G = 1 To k2: Next G
Print #1, "output 17; :disp:wind:text1:page2"
For G = 1 To k2: Next G
```

3.1.8 Sample IEEE-488 Basic Program

Included herein is a sample Basic program.

NOTE:

Refer to: <http://www.quadtech.com> for the latest sample programs that may be available.

```
NI = 0
IF NI = 1 THEN
OPEN "gpib0" FOR OUTPUT AS #1
OPEN "gpib0" FOR INPUT AS #2
PRINT #1, "ABORT"
PRINT #1, "RESET"
PRINT #1, "gpibeos lf"
ELSE
OPEN "\dev\ieeeout" FOR OUTPUT AS #1
IOCTL #1, "BREAK"
PRINT #1, "RESET"
OPEN "\dev\ieeein" FOR INPUT AS #2
PRINT #1, "TERM LF"
END IF

k2 = 1000
fr = 100000
Cmdl$ = "C"

Print "Configuring the 1730T"

PRINT #1, "output 17; TRIG:SOUR BUS"
FOR g = 1 TO k2: NEXT g
PRINT #1, "output 17; :SOUR:FREQ "; fr
FOR g = 1 TO k2: NEXT g
PRINT #1, "output 17; :SENS:FIMP:APER 0.500"
FOR g = 1 TO k2: NEXT g
PRINT #1, "output 17; :SOUR:VOLT 1e0"
FOR g = 1 TO k2: NEXT g
PRINT #1, "output 17; :CAL:CABL 1"
FOR g = 1 TO k2: NEXT g
PRINT #1, "output 17; :FIMP:RANG:AUTO ON"
FOR g = 1 TO k2: NEXT g
PRINT #1, "output 17; :CALC1:FORM REAL"
FOR g = 1 TO k2: NEXT g
PRINT #1, "output 17; :CALC2:FORM IMAG"
FOR g = 1 TO k2: NEXT g

IF cmdl$ = "C" THEN
PRINT #1, "output 17; :CALC2:FORM D"
PRINT #1, "output 17; :CALC1:FORM CP"
ELSEIF cmdl$ = "R" THEN
PRINT #1, "output 17; :CALC2:FORM Q"
PRINT #1, "output 17; :CALC1:FORM RS"
ELSEIF cmdl$ = "L" THEN
PRINT #1, "output 17; :CALC1:FORM LS"
PRINT #1, "output 17; :CALC2:FORM Q"
END IF

PRINT #1, "output 17;*TRG"
FOR g = 1 TO k2: NEXT g
PRINT #1, "enter 17"
REM get and parse return data

INPUT #2, s1$
INPUT #2, f3$
INPUT #2, f6$

PRINT "Data is:",s1$,f3$,f6$
```

3.2 Handler Interface

The 1730T instrument comes standard with a Handler interface as illustrated in Figure 3-5. Connection is through the blue 50-pin connector on the rear panel of the 1730T instrument.

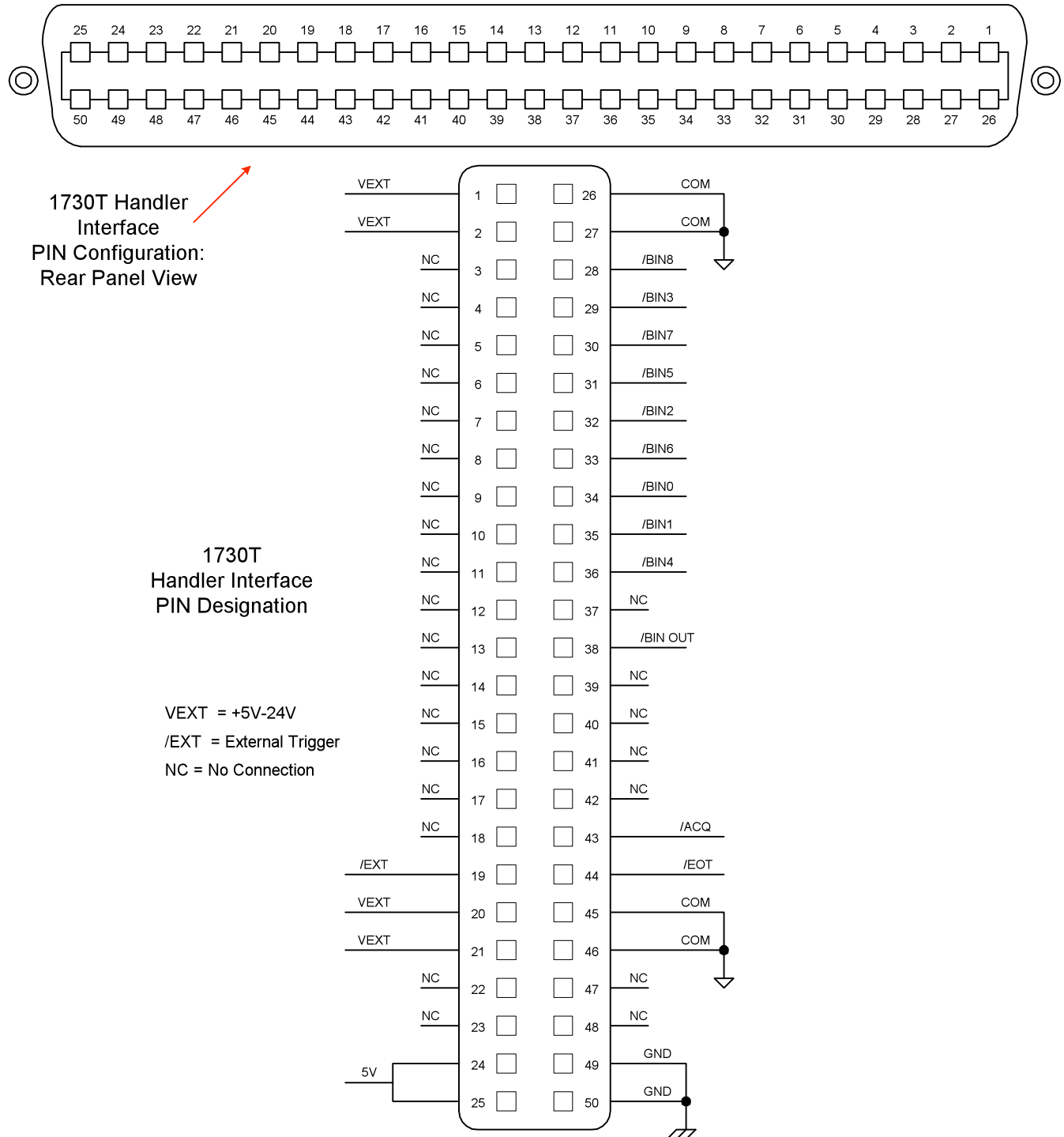


Figure 3-5: Handler Interface Pin Configuration

Paragraph 2.3.16 contains the instructions for changing the Handler mode. Paragraphs 2.3.3 and 2.3.4 contain instructions for setting the Trigger Delay time and selecting the Trigger Edge. Figure 3-6 illustrates the Trigger function.

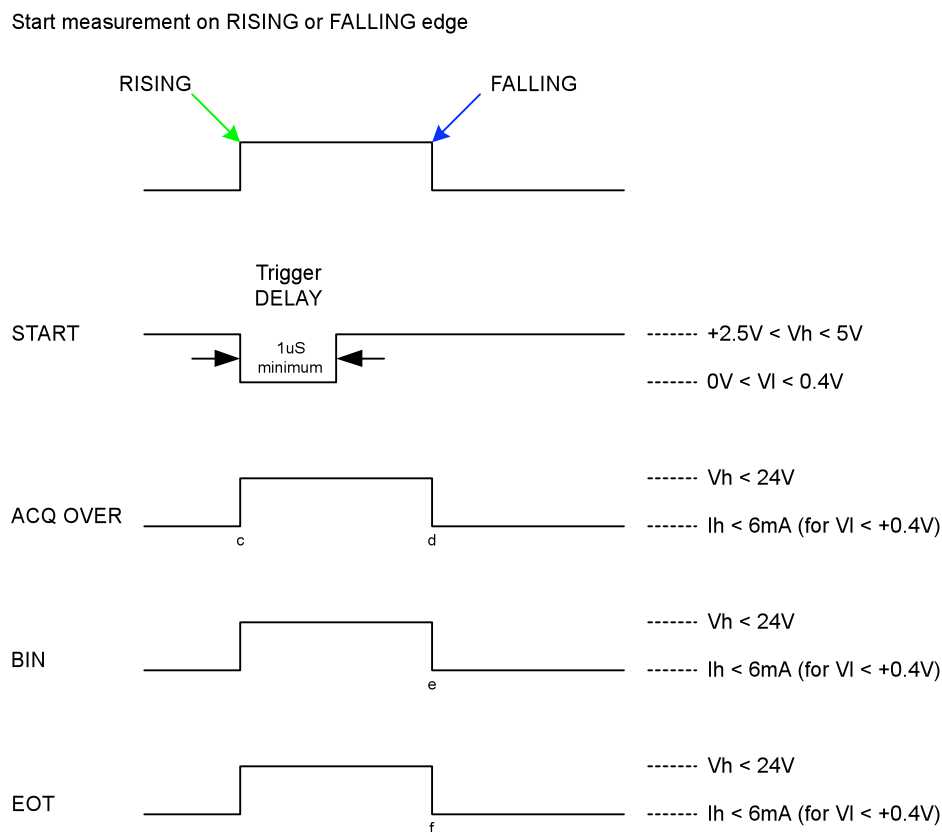


Figure 3-6: Trigger

Output Signals

The output lines of the 1730T Handler interface are open collector drivers that pull each signal line to a low voltage, signal ground when the signal is active (true). Each external line should be pulled up (with a resistor) to a positive voltage between 5V and 24V. The pull-up resistor must limit the current to $< 6mA$ for a signal of a comparison function and to $< 5mA$ for a control signal (EOT).

Figure 3-7 illustrates the connection of the handler interface to the main board on the 1730T.

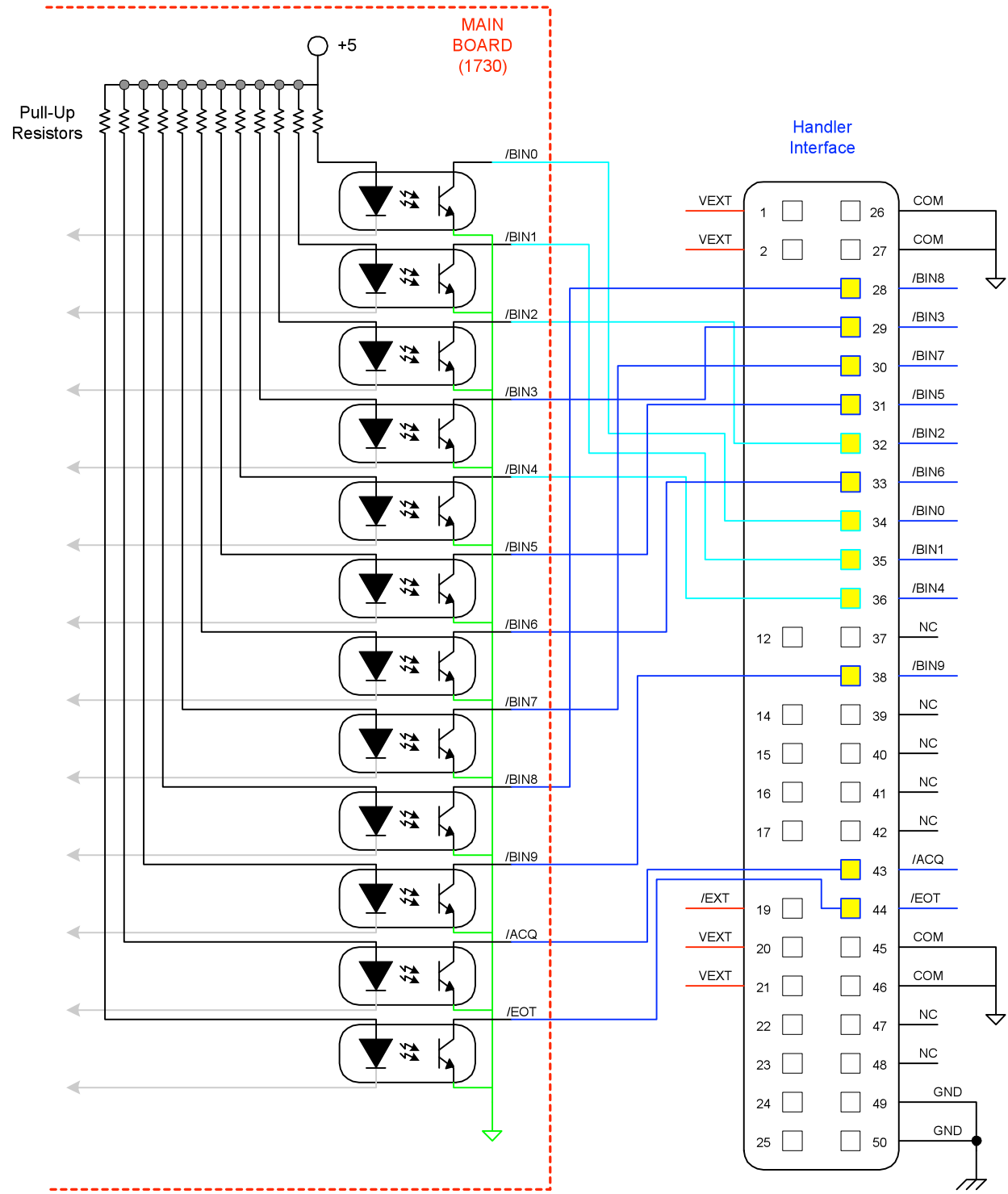


Figure 3-7: Connection of 1730T Handler Interface to Main Board

The input signal to the 1730T Handler interface is active low and requires a positive external voltage to pull the signal down below 0.4V, ground. The connection of pin 19 (/EXT), the external trigger input signal, is illustrated in Figure 3-8.



A basic example of an external trigger (START) connection is illustrated in Figure 3-9. A switch is inserted between pins 19 and 50. A green LED is connected between pins 1, 25 and 35 (Bin 1).

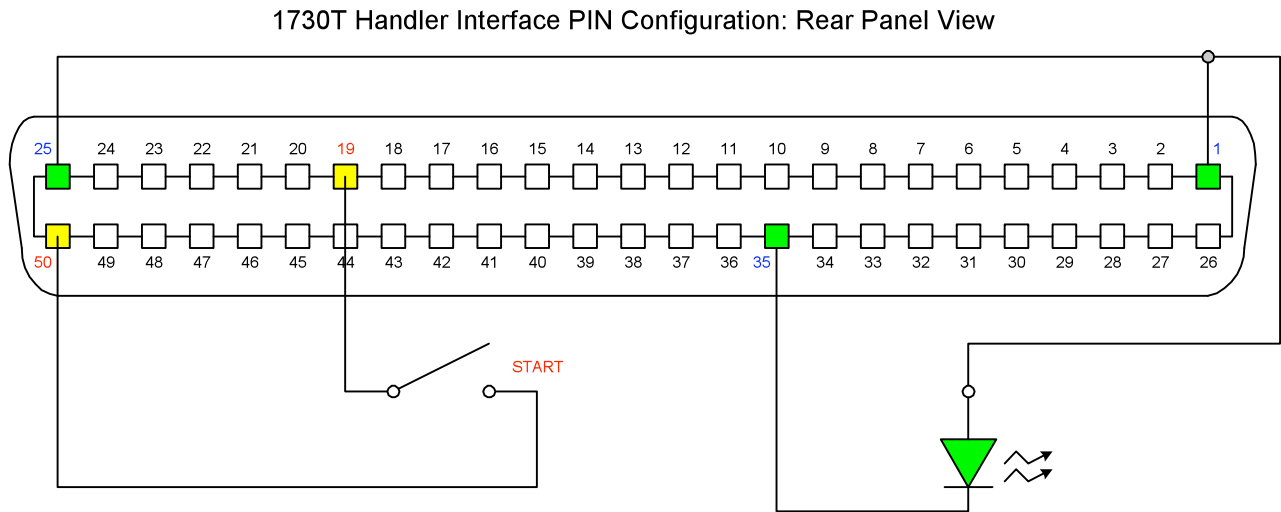


Figure 3-9: Sample External Trigger Connection

3.2.1 Handler Pin Assignments for Binning Operation

Table 3-9 lists the pin assignments when the handler interface on the 1730T instrument is performing a Binning operation. The device under test is sorted by test value. The test limits can be set as absolute value or percent value.

Table 3-9: Handler Pin Assignments for Binning

Pin	Name	Description
1 – 2	VEXT	External DC voltage: 5V ~ 24V
3 – 18	X	No connection
19	/EXT	External trigger
20 – 21	VEXT	External DC voltage: 5V ~ 24V
22 – 25	X	No connection
26 – 27	COM	Common Ground
28	BIN 8	Primary parameter pass (within Bin 8 limits)
29	BIN 3	Primary parameter pass (within Bin 3 limits)
30	BIN 7	Primary parameter pass (within Bin 7 limits)
31	BIN 5	Primary parameter pass (within Bin 5 limits)
32	BIN 2	Primary parameter pass (within Bin 2 limits)
33	BIN 6	Primary parameter pass (within Bin 6 limits)
34	BIN 0	Secondary parameter fail
35	BIN 1	Primary parameter pass (within Bin 1 limits)
36	BIN 4	Primary parameter pass (within Bin 4 limits)
37	X	No connection
38	BIN 9	Primary parameter fail
39 – 42	X	No connection
43	ACQ	Received data, ready to accept next
44	EOT	End of Test
45 – 46	COM	Common Ground
47 – 48	X	No connection
49 – 50	GND	Chassis Ground

NOTE:

When applying VEXT, common ground (COM: pins 45 and 46) must be connected to chassis ground (GND: pins 49 and 50).

3.2.2 Handler Pin Assignments for Compare Operation

Table 3-10 lists the pin assignments when the handler interface on the 1730T instrument is performing a Compare operation. The device under test is being compared against a standard of known value. High and low limits can be defined as absolute value or percent value.

Table 3-10: Handler Pin Assignments for Compare

Pin	Name	Description
1 – 2	VEXT	External DC voltage: 5V ~ 24V
3 – 18	X	No connection
19	/EXT	External trigger
20 – 21	VEXT	External DC voltage: 5V ~ 24V
22 – 25	X	No connection
26 – 27	COM	Common Ground
28	A HI	Primary parameter fail high (test value above high limit)
29	A GO	Primary parameter pass (test value within limits)
30	A LO	Primary parameter fail low (test value below low limit)
31	B HI	Secondary parameter fail high (test value above high limit)
32	B GO	Secondary parameter pass (test value within limits)
33	B LO	Secondary parameter fail low (test value below low limit)
34	B NG	Secondary parameter fail (No Good)
35	GO	
36 – 37	X	No connection
38	A NG	Primary parameter fail (No Good)
39 – 42	X	No connection
43	ACQ	Received data, ready to accept next
44	EOT	End of Test
45 – 46	COM	Common Ground
47 – 48	X	No connection
49 – 50	GND	Chassis Ground

NOTE:

When applying VEXT, common ground (COM: pins 45 and 46) must be connected to chassis ground (GND: pins 49 and 50).

3.3 Bias Voltage

Figure 3-10 illustrates the two connectors on the rear panel of the 1730T instrument used for bias voltage (or current) applications. The R_{BIAS} connector is a black 4-screw terminal strip with two screws active. The EXT BIAS connector is a silver BNC terminal.

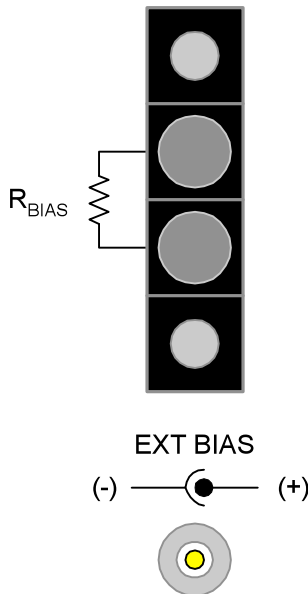


Figure 3-10: Bias Voltage Connectors

A fixed resistor or potentiometer can be connected to R_{BIAS} to provide an internal bias voltage or current to the device under test (DUT). In [MEAS DISPLAY] select Bias Voltage = ON. The value of the resistor placed across the R_{BIAS} terminals determines the bias voltage output. The R_{BIAS} output range is from 0V – 5V. The polarity is always positive. Refer to Table 3-12.

NOTE:

To prevent damage to the 1730T instrument, do **not** use the R_{BIAS} resistor if the EXT BIAS connector is used.

R_{BIAS} can also be used as a bias current source. The output current is determined by the resistor value and the selected source impedance value with a maximum bias current equal to 200mA and a compliance voltage of 5.0V. The calculation of the Bias Current is affected by the Constant Source (impedance) mode as listed in Table 3-11.

Use the EXT BIAS BNC connector if an external power supply is to be used rather than R_{BIAS} .

Table 3-11: DC Bias Current and Source Impedance

Constant Rs Mode	Output Range	Output Current of Measuring Terminal A	I DC (RDC < 100mΩ)	Maximum Ouput Current
25Ω	25Ω	$\left[5V \times \left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \right] / \left[25 + R_{DC} \right]$	$\left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \times 200mA$	200mA
100Ω	100Ω	$\left[5V \times \left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \right] / \left[100 + R_{DC} \right]$	$\left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \times 50mA$	50mA
100/25Ω	100Ω (Z ≥ 1Ω)	$\left[5V \times \left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \right] / \left[100 + R_{DC} \right]$	$\left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \times 50mA$	50mA
	25Ω (Z < 1Ω)	$\left[5V \times \left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \right] / \left[25 + R_{DC} \right]$	$\left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \times 200mA$	200mA
10Ω/CC	Not used.			

Table 3-12 DC Bias Voltage and Source Impedance

Constant Rs Mode	Output Range	Output Current at Testing Terminal VDC	V DC (RDC > R _O)	Maximum Ouput Voltage
25Ω	25Ω	$\left[\left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \times 5V \right] \times \left[\frac{R_{DC}}{25 + R_{DC}} \right]$	$\left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \times 5V$	5V
100Ω	100Ω	$\left[\left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \times 5V \right] \times \left[\frac{R_{DC}}{100 + R_{DC}} \right]$		
100/25Ω	100Ω (Z ≥ 1Ω)	$\left[\left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \times 5V \right] \times \left[\frac{R_{DC}}{100 + R_{DC}} \right]$		
	25Ω (Z < 1Ω)	$\left[\left[\frac{1k\Omega}{1k\Omega + R_{BIAS}} \right] \times 5V \right] \times \left[\frac{R_{DC}}{25 + R_{DC}} \right]$	-----	-----
10Ω/CC	Not used.			

Section 4: Service & Calibration

4.1 General

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 800-253-1230 and asking for Applications Support. For support outside of the United States, please contact your local [QuadTech Distributor](#).

4.2 Instrument Return

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

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

4.3 Calibration

Calibration of the 1730T LCR Meter instrument is completed at the factory and includes a NIST calibration certificate. Verification of instrument operation and accuracy is recommended on an annual basis. Accurate operation of the 1730T instrument is confirmed using the 1730T-TP Verification Procedure.

4.3.1 1730T Verification Procedure

This section outlines the relevant information to verify performance of the 1730T LCR Meter. It is recommended that performance be performed at least once a year using this outline procedure. Instrument should be warmed up for a minimum of 15 minutes prior to verification. Verification should be performed under the following conditions: Temperature equal to $23^{\circ}\text{C} \pm 1.2^{\circ}\text{C}$ and Relative Humidity (RH) between 35% and 55%.

Recommended standards are listed below. All standards should be traceable to a National Laboratory such as N.I.S.T. with calibrated values for primary and secondary parameters at the required test frequencies. QuadTech's verification conforms to ANSI Z540 and QuadTech recommends that the calibrated values for the primary and secondary standards have an uncertainty 4 times better than the primary and secondary accuracy specified in the Verification Data Sheet. If the calibrated values for the standards used do not have an uncertainty of 4 times better than the specified accuracy of the 1730T the uncertainty of the standard should be added to the specified accuracy of the 1730T. For example: if the calibrated value of the $500\text{m}\Omega$ standard is $495.0\text{m}\Omega \pm 1\%$ at 100Hz, the expected reading on the 1730T would be $495.0\text{ m}\Omega \pm 1.7\%$ (1% for the standard accuracy plus 0.7% for the 1730T accuracy). This also applies for secondary parameters as well.

Primary and secondary accuracy specifications given in the Verification Data Sheet are based upon the accuracy formulas in section 2.4.5 of this manual.

Measurement Standards

Inductance Standards 4 Terminal

Inductor	10 μH (nominal value)
Inductor	100 μH (nominal value)
Inductor	1000 μH (nominal value)

Standard Open and Short

Resistance Standards 4 Terminal

Resistor	95K ohm (nominal value)
Resistor	6K ohm (nominal value)
Resistor	374 ohm (nominal value)
Resistor	25 ohm (nominal value)
Resistor	5 ohm (nominal value)
Resistor	500m ohm (nominal value)

Capacitance Standards 2 or 4 Terminal

Capacitor	50pF (nominal value)
Capacitor	100pF (nominal value)
Capacitor	200pF (nominal value)
Capacitor	500pF (nominal value)
Capacitor	1000pF (nominal value)
Capacitor	0.1 μF (nominal value)
Capacitor	0.05 μF (nominal value)
Capacitor	0.02 μF (nominal value)
Capacitor	0.01 μF (nominal value)
Capacitor	0.002 μF (nominal value)

Measurement Procedure

The 1730T should be set to the following:

[SYSTEM SETUP] [SYSTEM CONFIG]

Integration Cycle = 4

Average = 1

Cable Length = 1M

Const Rsource = 25ohms

[MEAS DISPLAY]

Range: = Auto

Level: 1Volt

Speed: = Slow

Trigger = Manual

BiasV = Off

Binning = Off

Compare = Off

Connections to all standards should be via a 1-meter cable.

A multiple frequency open and short correct should be performed prior to any measurements. See paragraph 2.5.5 for information on performing an open and short correction.

Connect each standard listed in the Verification Data Sheet and select the test frequency in the [MEAS DISPLAY] menu of the 1730T. Record the results in the Verification Data Sheet.

4.3.2 1730T Verification Data Sheet

R500M

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.70%	0.0070
1000			1			0.25%	0.0025
10000			1			0.30%	0.0030
100000			1			0.90%	0.0091

R25

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.25%	0.0035
1000			1			0.24%	0.0016
10000			1			0.26%	0.0016
100000			1			0.50%	0.0035

R374

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.20%	0.0035
1000			1			0.10%	0.0009
10000			1			0.20%	0.0012
100000			1			0.45%	0.0035

R6K

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.20%	0.0020
1000			1			0.10%	0.0010
10000			1			0.45%	0.0045
100000			1			0.70%	0.0071

R95.3K

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.20%	0.0020
1000			1			0.12%	0.0012
10000			1			0.50%	0.0051
100000			1			2.00%	0.0213

L10uH

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
1000			1			0.36%	0.1405
10000			1			0.30%	4.5965
100000			1			0.60%	70.4830

L100uH

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
1000			1			0.50%	0.0652
10000			1			0.35%	1.6276
20000			1			0.36%	5.4100
100000			1			0.50%	102.9650

L1000uH

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			3.68%	0.0300
1000			1			0.41%	0.2781
10000			1			0.26%	8.9862
100000			1			0.45%	74.8312

C50pF

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
1000			1			0.35%	0.0040
10000			1			0.50%	0.0072
100000			1			2.00%	0.0483

C100pF

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
1000			1			0.35%	0.0040
10000			1			0.50%	0.0072
100000			1			2.00%	0.0483

C200pF

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.35%	0.0037
1000			1			0.16%	0.0018
10000			1			0.50%	0.0072
100000			1			0.70%	0.0169

C500pF

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.35%	0.0037
1000			1			0.16%	0.0018
10000			1			0.50%	0.0072
100000			1			0.70%	0.0169

C1000pF

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.35%	0.0037
1000			1			0.16%	0.0018
10000			1			0.50%	0.0072
100000			1			0.70%	0.0169

C2nF

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.20%	0.0021
1000			1			0.12%	0.0014
10000			1			0.45%	0.0065
100000			1			0.45%	0.0109

C10nF

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.20%	0.0021
1000			1			0.12%	0.0014
10000			1			0.45%	0.0065
100000			1			0.45%	0.0109

C20nF

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.20%	0.0021
1000			1			0.10%	0.0011
10000			1			0.20%	0.0029
100000			1			0.50%	0.0121

C50nF

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.20%	0.0021
1000			1			0.10%	0.0011
10000			1			0.20%	0.0029
100000			1			0.50%	0.0121

C100nF

Freq	Pri. Actual	Sec. Actual	Voltage	Primary Meas.	Sec. Meas.	Pspec	Sspec
100			1			0.20%	0.0021
1000			1			0.10%	0.0011
10000			1			0.20%	0.0029
100000			1			0.50%	0.0121