1750 LCR Digibridge
Instruction Manual
Form 150458/A2

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.

<div style="border:1px solid black;padding:8px;text-align:center">

WARNING
Potentially dangerous voltages may be present on front and rear panel terminals. Follow all warnings in this manual when operating or servicing this instrument. Dangerous levels of energy may be stored in capacitive devices tested by this unit.
Always make sure the high voltage indicator is **not** on when connecting or disconnecting the device under test.

</div>

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

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

⚡ Product will be marked with this symbol (ISO#3684) when voltages in excess of 1000V are present.

Contents

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Warranty

QuadTech

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 or 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

LCR Features

Primary Display: L, C, R and $|Z|$ 5 Digit Display & LED Indicators
L: 0.0001μH – 9999.9H
C: 0.0001pF – 9999.9mF
R: 0.0001Ω – 9999.9MΩ
Z: 0.0001Ω – 9999.9MΩ

Secondary Display: D, Q, R and θ   5 Digit Display & LED Indicators
D: 0.0001 – 99999   (D with C)
Q: 0.0001 – 99999   (Q with R or L)
R: 0.0001Ω – 9999.9MΩ   (R with C)
θ: −90.00° – +90.00°

Test Voltage: 10mV – 2.5V (programmable in 10mV steps)

Test Frequency: 43 preset test frequencies from 20 Hz to 200kHz
Over 500 programmable test frequencies from 20Hz to 200kHz

Test Setups: 10 Memory Locations with Store/Recall

Measurement Rate: Slow, Medium or Fast
Up to 20 measurements/second in Fast Mode

Measurement Mode: Continuous Mode or Triggering Mode

Averaging: 0-10 measurements

Accuracy: Primary Parameter (LCR&Z) Basic Accuracy: ±0.1%
Secondary Parameter (D&Q) Basic Accuracy: ±0.001
Secondary Parameter (R) Basic Accuracy: ±0.1%
Secondary Parameter (θ) Basic Accuracy: ±0.1°

Specifications (Continued)

General Features

Bias Voltage: External: 0 - 35VDC

Constant Source: Output Source Impedance: OFF or ON (25Ω or 100Ω)

Circuit: Equivalent Series or Parallel

Interfaces: IEEE-488, Handler

Ranging: Auto Ranging with Manual Hold (7 ranges)

Binning: 9 PASS Bins for Primary Parameters (L, C, R & Z)
1 FAIL Bin for Primary & Secondary Parameters (LCR&Z and DQR&θ)

Mechanical: Bench Mount
Dimensions:(w x h x d):16.0 x 5.0 x 13.75 inches (400 x 125 x 344mm)

Weight: 14.2 lbs (6.5 kg) net, 21 lbs (9.6 kg) shipping

Environmental: Operating: 10°C to + 40oC
Storage: 0°C to + 50oC
Humidity: <85%
Warm-up Time: 30 minutes

Power:
- 90 - 125V AC
- 180 - 250V AC
- 50 or 60Hz
- 40W max, 40W typical

Supplied:
- Instruction Manual
- Calibration Certificate
- AC Power Cable
- 4 BNC to 2 Kelvin Clip Lead Set

Ordering Information:

Description	Catalog No.
1750 LCR Digibridge	1750

Accessories

Accessories Included

Item	Quantity	QuadTech P/N
AC Power Cord	1	4200-0300
0.6A Slow Blow Screw Cap Fuse 115V Operation	1	520023
0.3A Slow Blow Screw Cap Fuse 230V Operation	1	520025
4-BNC to 2-Kelvin Clips Lead Set	1	1700-03
Instruction Manual	1	150458
Calibration Certificate	1	N/A

Accessories/Options Available

Item	Quantity	QuadTech P/N
Axial/Radial Component Test Fixture	1	1700-01
Axial/Radial Remote Component Test Fixture	1	1700-02
4-BNC to 2-Kelvin Clips Lead Set	1	1700-03
4-BNC to 4-Banana Plugs Lead Set	1	1700-04
4-BNC to Chip Component Tweezers	1	1700-05

Safety Precautions

The 1750 LCR Digibridge instrument can provide an output voltage as high as 2.5VDC (35VDC external Bias Voltage) to the device under test (DUT). Although the Digibridge unit is designed with full attention to operator safety, serious hazards could occur if the instrument is used improperly and these safety instructions are not followed.

1. The 1750 Digibridge instrument is designed to be operated 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 1750 Digibridge is not connected to earth ground.
2. Tightly connect BNC cable(s) to the (silver) **HIGH (+)** terminal. If this is not done, the DUT's casing can be charged to the high voltage test level and serious injury or electrical shock hazards could result if the DUT is touched.
3. Never touch the metal of the High Voltage probe directly. Touch only the insulated parts of the lead(s).
4. 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 red **BIAS ON** light is ON.
5. Before turning on the 1750 Digibridge unit, make sure there is no device (DUT) or fixture connected to the test leads.
6. When the red **BIAS ON** LED is ON or flashing, NEVER touch the device under test, the lead wires or the output terminals.
7. Before touching the test lead wires or output terminals make sure:
    a) Any capacitive device has had enough discharge time.
    b) The red **BIAS ON** LED is OFF.
8. **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 1750 Digibridge INSTRUMENT.
9. When the 1750 Digibridge instrument is used in remote control mode, be extremely careful. The High Voltage Output is being turned on and off with an external signal.

Condensed Operating Instructions

General Information

The 1750 LCR Digibridge is an instrument for measuring primary parameters of inductance (L), capacitance (C), resistance (R) and impedance ($|Z|$). The Secondary parameters measured are dissipation factor (D), quality factor (Q), resistance (R) and phase angle (θ). Bin Number can be displayed with GO/NG indication on the front panel. Instrument preset test voltage, frequency or amperage may be selected on the front panel and shown on the fourth display. Connection to the device under test is through 4 BNC terminals on the front panel.

Start-Up

The 1750 Digibridge unit can be operated from a power source between 90 - 125VAC or 180 – 250VAC at a power line frequency of 50 or 60Hz. The standard 1750 unit is shipped from QuadTech with a 0.6A fuse in place for AC 115Voperation. A 0.3A fuse is included in the accessories package for 230V operation. The 1750 unit is shipped with the line voltage selector set for 115V.   Refer to paragraph 1.4.3 to change a fuse and to change the line voltage selector.

Connect the 1750 instrument's AC power cord to the source of proper voltage. The instrument is to be used only with 3-wire grounded outlets.

Press the [POWER] button on the front panel to apply power. To switch the power off press the [POWER] button again or if measurements are to be made proceed with Test Parameter Set-Up below. Note: the 1750 unit should warm-up for a minimum of 30 minutes prior to use.

Test Parameter Set-up

The Test Parameter Table illustrates the parameters that can be set prior to test. Refer to ¶ 2.5 for the correct connection to device under test. Refer to ¶ 2.3.7 for the correct zeroing function. Read this instruction manual in full prior to using the 1750 LCR Digibridge.

Test Parameter Table

A DISP	RANGE	B DISP	CIRCUIT	ZERO	Test Voltage	Test Frequency	BIAS	TRIGGER	Operation
L	Auto	Q	Series	Open	0.01V	20Hz	ON	EXT	Local
C	Manual	D	Parallel	Short	To	To	OFF	INT	Remote
R		R			2.50V	200kHz			
Z		θ							

Measurement Mode

1. Turn POWER ON.
2. Allow the 1750 instrument to warm-up for 30 minutes.
3. Select Primary Parameter.
4. Select Frequency.
5. Select Test Voltage.
6. Select Measurement Range.
7. Select Measurement Rate
8. Select Secondary Measurement.
9. Select Equivalent Circuit (Series or Parallel).
10. Connect Test Cables or Test Fixture.
11. Enable Zero Function.
12. Connect Device Under Test (DUT).

Figure COI-1 illustrates the connection of a device under test (DUT) to the 1750 instrument using the BNC to Kelvin Clip Lead Set provided with the unit.
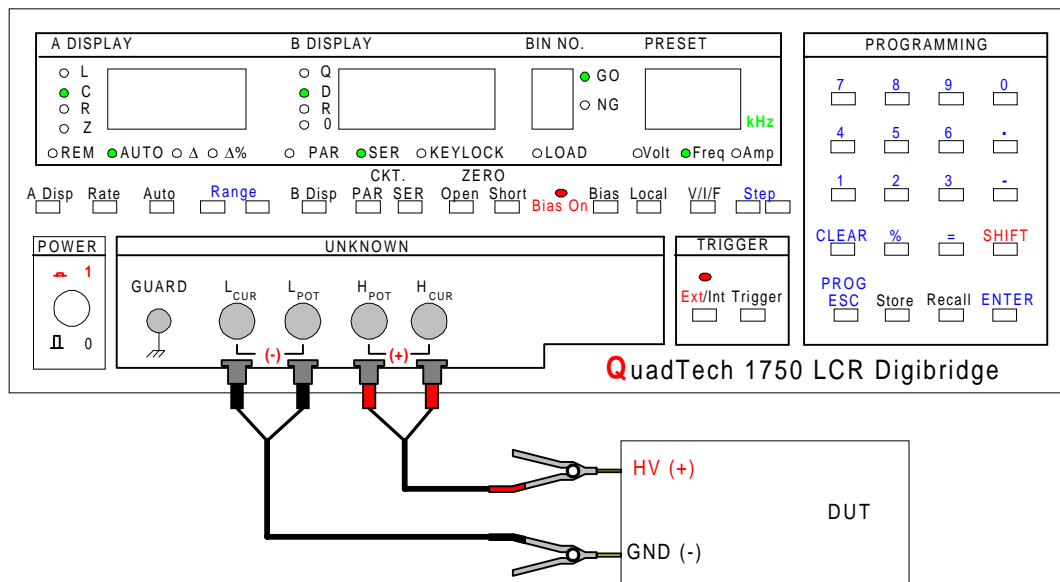

Figure COI-1: Connection to DUT using Kelvin Clip Lead Set

Section 1: Introduction

1.1   Unpacking and Inspection

Inspect the shipping container before opening. If damaged contact the carriers agent immediately. Inspect the 1750 Digibridge unit for any damage. If the instrument appears damaged or fails to meet specifications, notify QuadTech (refer to instruction manual front cover) or its local representative. Retain the shipping carton and packing material for future use such as returning for recalibration or service.

1.2   Product Overview

The 1750 LCR Digibridge is an economical, user friendly meter for production or laboratory testing of inductors, capacitors and other LCR components. The 1750 Digibridge makes primary measurements of L, C, R and Z and secondary measurements of D, Q, R and θ.   L, C, R and Z measurements are made at frequencies ranging from 20Hz to 200kHz with a basic accuracy of $\pm$0.1%(1kHz). The basic accuracy of the secondary parameters D and Q is $\pm$0.0 and for θ the basic accuracy is $\pm$0.01°. Auto/Manual Ranging is selectable for the five measurement ranges.   A Fast/Medium/Slow Measurement Rate provides speed versus accuracy capability. Bias Voltage can be applied to capacitors by connection of an external voltage source to the rear panel. Bias levels from 0V to 35VDC (External) are attainable.   The test voltage level is programmable at 0.01V to 2.50V RMS.   An internal zeroing function (Open/Short) is provided and selectable from the front panel. Displayed on the front panel are Bin Number with Go/NG indication and Preset Test voltage, frequency or amperage. Connection to the device under test (DUT) is through 4 BNC terminals on the front panel of the 1750 Digibridge unit.

1.3 Controls and Indicators

1.3.1 Front Panel Controls and Indicators

Figures 1-1 and 1-2 illustrate the controls and indicators on the front panel of the 1750 Digibridge unit. Table 1-1 identifies them with description and function.
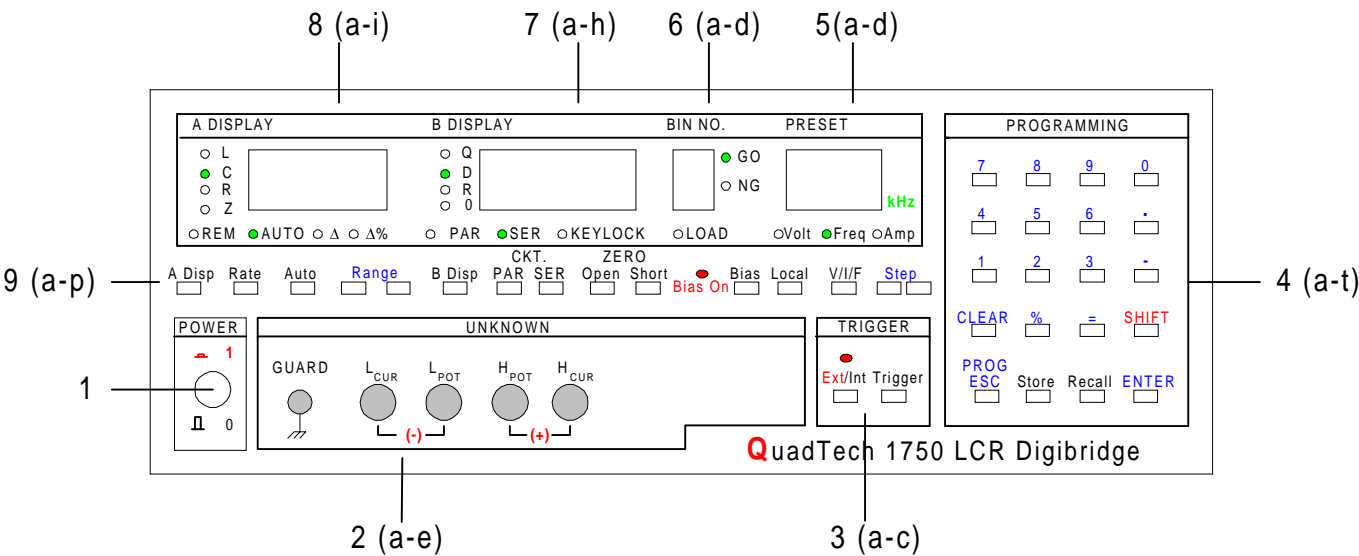

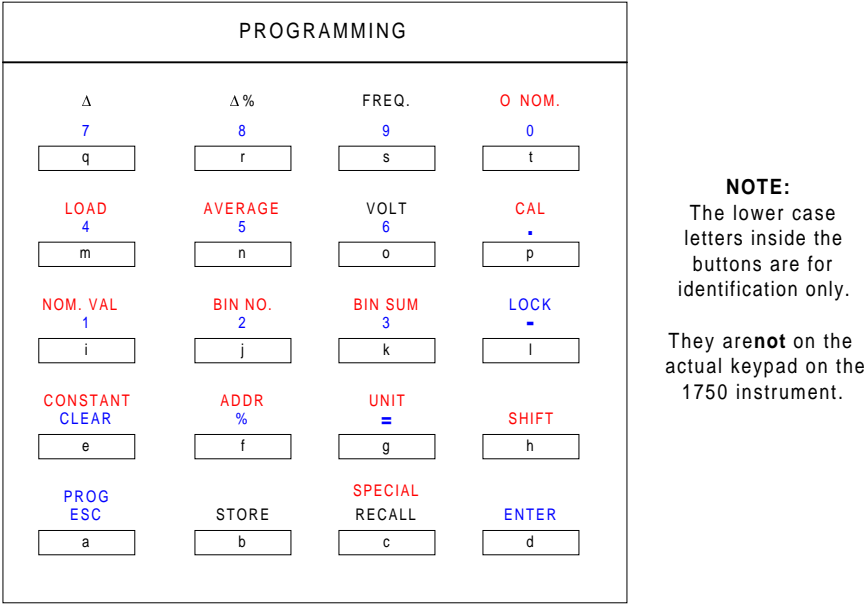**Figure 1-1: 1750 Front Panel Controls and Indicators**

Figure 1-2: Close Up 1750 Front Panel Keypad (4a-t)

Table 1-1: 1750 Front Panel Controls and Indicators

Reference Number Figures 1-1& 1-2	Name	Type	Function
1	**POWER**	Beige Push Button Switch	Apply power: 1 (ON) 0 (OFF)
2	**UNKNOWN**		
2a	GUARD	Silver Screw/Banana plug	Instrument Chassis Ground
2b	LCUR	Silver BNC Connector	Low Current Connection
2c	LPOT	Silver BNC Connector	Low Potential Connection
2d	HPOT	Silver BNC Connector	High Potential Connection
2e	HCUR	Silver BNC Connector	High Current Connection
3	**TRIGGER**		
3a	EXT.	Red LED	When lit, External Trigger is enabled
3b	EXT./INT	Beige Push Button Switch	Select External or Internal Trigger
3c	TRIG	Beige Push Button Switch	Select Trigger
4	**PROGRAMMING**		
4a	PROG/ESC	Beige Push Button Switch	Enter and Exit Programming Mode (PM)
4b	STORE	Beige Push Button Switch	Store test set up in 1 of 10 locations (0-9)
4c	RECALL SPECIAL	Beige Push Button Switch	Recall test set up. Enter Special Function Programming Mode (¶2.4.4)
4d	ENTER	Beige Push Button Switch	Accept data input in PM
4e	CLEAR CONSTANT	Beige Push Button Switch	Clear data input in PM Select Constant output source impedance
4f	% ADDR	Beige Push Button Switch	Select percent value Input IEEE-488 address (00-30)
4g	= UNIT	Beige Push Button Switch	Press = to change data in PM Enter unit of nominal or load correction values
4h	SHIFT	Beige Push Button Switch	Access programming functions labelled in red
4I	1 NOM. VAL	Beige Push Button Switch	Numerical Key Enter a value = basis of msmt result in Δ, $\Delta\%$
4j	2 BIN NO	Beige Push Button Switch	Numerical Key Assign a nominal value to a bin number (0-9)
4k	3 BIN SUM	Beige Push Button Switch	Numerical Key Select bin # and show summary of that bin
4l	– LOCK	Beige Push Button Switch	Negative Value Lock out the front panel
4m	4 LOAD	Beige Push Button Switch	Numerical Key Specify a load correction value
4n	5 AVERAGE	Beige Push Button Switch	Numerical Key Specify the number of msmts to average (0-10)
4o	6 VOLT	Beige Push Button Switch	Numerical Key Select test voltage (0.01-2.50V)
4p	. CAL	Beige Push Button Switch	Decimal Key Enter instrument calibration
4q	7 Δ	Beige Push Button Switch	Numerical Key Select results displayed as deviation from nominal
4r	8 $\Delta\%$	Beige Push Button Switch	Numerical Key Select results displayed as % deviation from nominal

Table 1-1: 1750 Front Panel Controls and Indicators (Continued)

Reference Number Figures 1-1& 1-2	Name	Type	Function
4s	9 FREQ	Beige Push Button Switch	Numerical Key Select Test Frequency (1kHz – 200kHz)
4t	0 θ NOM	Beige Push Button Switch	Numerical Key Specify a nominal value for θ (the phase angle)
5	**PRESET**		
5a	Display	3 digit	Display test voltage, frequency or current
5b	VOLT	Green LED	When lit, test voltage is shown in Preset display
5c	FREQ	Green LED	When lit, test frequency is shown in Preset display
5d	AMP	Green LED	When lit, test current is shown in Preset display
6	**BIN NO.**		
6a	Display	1 digit	Display Bin # or measurement range
6b	GO	Green LED	When lit, DUT measurement is a PASS per set limit
6c	NG	Red LED	When lit, DUT measurement is a FAIL per set limit
6d	LOAD	Green LED	When lit, Load correction value added to DUT msmt
7	**B DISPLAY**		
7a	Display	5 digit	Display Secondary Parameter (D, Q, R & θ)
7b	Q	Green LED	When lit, Quality Factor is shown on B display
7c	D	Green LED	When lit, Dissipation Factor is shown on B display
7d	R	Green LED	When lit, Resistance is shown on B display
7e	θ	Green LED	When lit, Phase Angle is shown on B display
7f	PAR	Green LED	When lit, Parallel equivalent circuit employed
7g	SER	Green LED	When lit, Series equivalent circuit employed
7h	KEY LOCK	Green LED	When lit, front panel is locked out
8	**A DISPLAY**		
8a	Display	5 digit	Display Primary Parameter (L, C, R & $|Z|$)
8b	L	Green LED	When lit, Inductance is shown on A display
8c	C	Green LED	When lit, Capacitance is shown on A display
8d	R	Green LED	When lit, Resistance is shown on A display
8e	$|Z|$	Green LED	When lit, Impedance is shown on A display
8f	REM	Green LED	When lit, unit is used in Remote control
8g	AUTO	Green LED	When lit, Auto Ranging is employed
8h	Δ	Green LED	When lit, Deviation from Nominal is displayed
8I	Δ%	Green LED	When lit, % Deviation from Nominal is displayed
9	**SELECT BUTTONS**		
9a	A DISPLAY	Beige Push Button Switch	Select Primary parameter to be displayed (LCR&Z)
9b	RATE	Beige Push Button Switch	Select Measurement Rate (Fast, Slow or Medium)
9c	AUTO	Beige Push Button Switch	Select Auto or Manual Ranging
9d	← RANGE	Beige Push Button Switch	Descend through measurement ranges
9e	RANGE →	Beige Push Button Switch	Ascend through measurement ranges
9f	B DISPLAY	Beige Push Button Switch	Select Secondary Parameter (QDR&θ)
9g	(CKT.) PAR	Beige Push Button Switch	Select Parallel equivalent circuit representation
9h	(CKT.) SER	Beige Push Button Switch	Select Series equivalent circuit representation
9I	ZERO OPEN	Beige Push Button Switch	Select Open Circuit compensation
9j	ZERO SHORT	Beige Push Button Switch	Select Short Circuit compensation
9k	BIAS ON	Red LED	Bias Voltage is present at output terminals
9l	BIAS	Beige Push Button Switch	Select Bias Voltage ON or OFF

Introduction

Table 1-1: 1750 Front Panel Controls and Indicators (Continued)

Reference Number Figures 1-1& 1-2	Name	Type	Function
9m	LOCAL	Beige Push Button Switch	Select Local Operation ON or OFF
9n	V / I / F	Beige Push Button Switch	Select Preset Voltage, Frequency or Current
9o	▼ STEP	Beige Push Button Switch	Step down through Preset values
9p	STEP ▲	Beige Push Button Switch	Step up through Preset values

1.3.2 Rear Panel Controls and Connectors

Figure 1-3 illustrates the controls and connectors on the rear panel of the 1750 Digibridge instrument.   Table 1-2 identifies them with description and function.
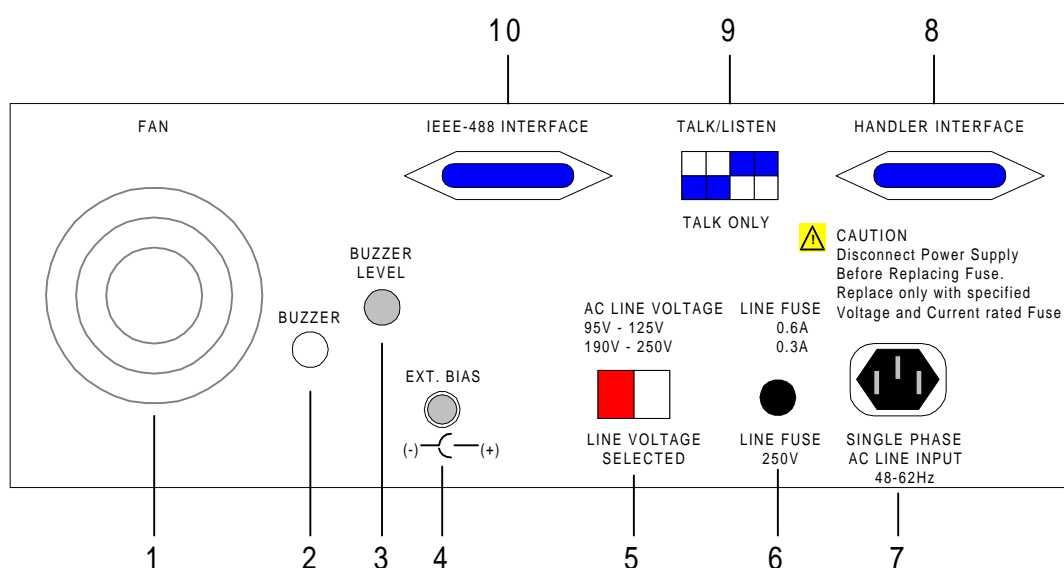

Figure 1-3: 1750 Rear Panel Controls and Connectors

Table 1-2: 1750 Rear Panel Controls and Connectors

Reference Number Figure 1-3	Name	Type	Function
1	FAN	DC 24V 0.17A Fan	Cool unit
2	BUZZER	Hole	Channel to emit buzzer signal
3	BUZZER LEVEL	Silver Rotating Knob	Turn Buzzer ON/OFF or increase/decrease level
4	EXT. BIAS	Silver BNC connector	Connection for external bias source
5	LINE VOLTAGE	Red 2-position slide switch	Select 115V or 230V operation
6	LINE FUSE	Black screw cap fuse	Short Circuit protection 0.6A fuse: 95-125V, 0.3A fuse: 190-250V
7	AC LINE INPUT	Black 3-wire AC receptacle	Input for AC power
8	HANDLER INTERFACE	Blue 24-PIN connector	Connect Handler to 1750 unit
9	TALK/LISTEN	Red 4-position DIP switch	Select Talk Listen function of 1750 unit
10	IEEE-488 INTERFACE	Blue 24-PIN connector	Connect IEEE-488 Interface to 1750 unit

1.4   Installation

1.4.1   Dimensions

The 1750 Digibridge instrument is supplied in bench configuration (a cabinet with resilient feet for placement on a table). A front bail is provided so that the unit can be tilted back for convenient operator viewing. Figure 1-4 illustrates the 1750 instrument dimensions.
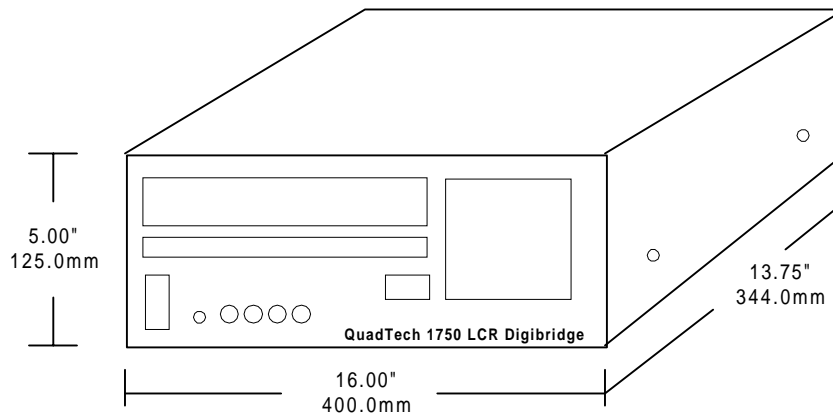

Figure 1-4: 1750 Instrument Dimensions

1.4.2   Instrument Positioning

The 1750 Digibridge instrument contains four LCD displays, a primary parameter and a secondary parameter display both with 5-digit resolution for convenient viewing. The unit also contains a 1-digit Bin No display and a 3-digit Preset display.   The optimum angle for viewing is slightly down and about 10° either side of center. For bench operation the front bail should 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. An open space of at least 3 inches (75mm) is recommended behind the rear panel.

1.4.3   Power Requirements

⚠ The 1750 Digibridge can be operated from a power source of 90 to 125VAC or 180 to 250VAC. 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 switch and fuse on the rear panel (Figure 1-5) are in accordance with the power source being used. Use a 0.6A, 250V SB fuse for 115V operation and a 0.3A, 250V SB fuse for 230V operation. Always use an outlet that has a properly connected protection ground.

Procedure for Changing A 1750 Digibridge Fuse

WARNING

MAKE SURE THE UNIT HAS BEEN DISCONNECTED FROM ITS AC POWER SOURCE FOR AT LEAST 5 MINUTES BEFORE PROCEEDING.

Figure 1-5 illustrates the voltage selector, fuse holder and inlet module on the bottom right of the rear panel. Review these instructions before removing the black screw cap fuse on the rear panel of the 1750 instrument.

- Make sure the power switch is OFF and the power cord is disconnected from the unit and the AC power source.
- Inspect if the fuse is functional by measuring resistance ($< 15\Omega$) with an ohmmeter.
- Using a flat head screwdriver, turn the screwcap about 60° counterclockwise.   The screwcap should protrude about 3.0 cm from the socket.
- Remove screwcap. Replace with new, same rated 0.6A, 250V SB or 0.3A 250V SB fuse.
- Using a flat head screwdriver, turn the screwcap about 60°clockwise.
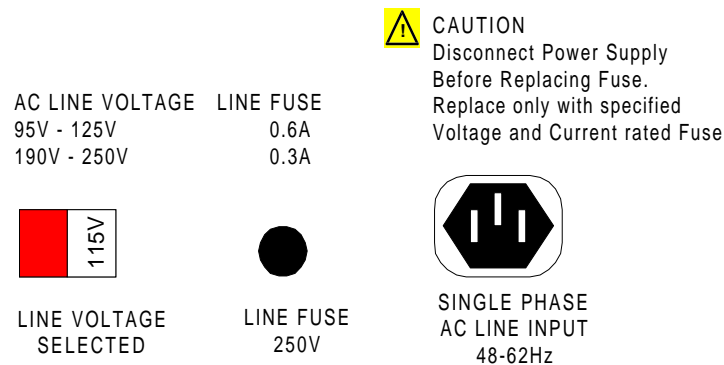- Make sure the voltage selector switch is in accordance with the power source being used.

⚠ CAUTION
Disconnect Power Supply
Before Replacing Fuse.
Replace only with specified
Voltage and Current rated Fuse

AC LINE VOLTAGE   LINE FUSE
95V - 125V   0.6A
190V - 250V   0.3A

115V

LINE VOLTAGE
SELECTED

LINE FUSE
250V

SINGLE PHASE
AC LINE INPUT
48-62Hz

Figure 1-5: Fuse & Voltage Selector (1750 Digibridge Rear Panel)

1.4.4 Safety Inspection

⚠ Before operating the instrument inspect the screw cap fuse receptacle on the rear panel of the 1750 unit to ensure that the **properly rated fuse is in place**, otherwise damage to the unit is possible. Refer to paragraph 1.4.3.

The 1750 LCR Digibridge unit 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). CE units are shipped with an approved international cord set. Make sure the instrument is only used with these cables (or other approved international cord set) to ensure 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 1750 instrument to direct sunlight, extreme temperature or humidity variations or corrosive chemicals.

WARNING
If this instrument is used in a manner not specified in this manual protection to the operator and equipment may be impaired.

Section 2: Operation

2.1   Terms and Conventions

Table 2-1: Measurement Unit Prefixes

Multiple	Scientific	Engineering	Symbol
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	u
.000000001	10^{-9}	nano	n
.000000000001	10^{-12}	pico	p
.000000000000001	10^{-15}	femto	f

Dielectric Absorption:	The physical phenomenon in which insulation appears to absorb and retain an electrical charge slowly over time. Apply a voltage to a capacitor for an extended period of time, then quickly discharge it to zero voltage. Leave the capacitor open circuited for a period of time then connect a voltmeter to it and measure the residual voltage. The residual voltage is caused by the dielectric absorption of the capacitor.
Charging Current:	An insulated product exhibits the basic characteristics of a capacitor. Application of a voltage across the insulation causes a current to flow as the capacitor charges. This current instantaneously rises to a high value as voltage is applied then exponentially decays to zero as the DUT becomes fully charged. Charging current decays to zero much faster than dielectric absorption.
Leakage Current:	The steady state current that flows through the insulation. Leakage current is equal to the applied voltage divided by the insulation resistance. Leakage current is the main measured value for AC hipot and DC hipot.

Discharge: The act of draining off an electrical charge to ground. Devices that retain charge should be discharged after an IR or DC hipot test.

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.

Inductance: Inductance is the property of a coil to oppose any change in current through it. The inductance of a coil varies as the number of turns squared (N^2). If the turns are stretched out, the field intensity will be less and the inductance will be less. The larger the radius or diameter of the coil, the longer the wire used and the greater the inductance.

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

Quality Factor: Quality factor is a measurement of the quality of an inductor: how tight the wire is wrapped (wound). The higher the Q the better the inductor. Q is equal to reactance divided by resistance. $Q = X_S / R_S$

Capacitance: The ratio of charge on either plate of a capacitor to the potential difference (voltage) across the plates. When a voltage is applied, current flows immediately at a high rate then exponentially decays toward zero as the charge builds up. If an AC voltage is applied, an AC current appears to flow continuously because the polarity of the voltage is reversed at the frequency of the applied voltage. The wave form of this current however is displaced in time from the applied voltage by 90°.

Capacitive Reactance: A measurement of the actual AC resistance of a capacitor. How effective a capacitor may be in allowing AC to flow depends upon its capacitance and the frequency used. $X_C = 1/ 2\pi fC$.

Dissipation Factor:	Dissipation factor is a measurement of the quality of a capacitor: how well it dissipates charge. The lower the D_f, the better the capacitor. Dissipation factor is equal to resistance divided by reactance. $D_f = R_S / X_S = 1/Q = \tan(90° - \theta) = \tan\delta$.
Impedance:	In AC circuits, impedance is the "AC resistance" to the flow of current through a circuit when an AC voltage is applied across the terminals of that circuit. Impedance is composed of real (in phase with voltage) and reactive (out of phase by 90°) components. $Z = E/I = R + jX$ Impedance = resistance + reactance.
Series Circuit:	Designated with a subscript S in equations and Figure 2-1.
Parallel Circuit:	Designated with a subscript P in equations and Figure 2-1.
Nominal Value:	Value inputted by operator. Devices connected to 1710 unit. If SAVE NOMINAL button is pressed, the display will show the % difference of the DUT to the Nominal Value.
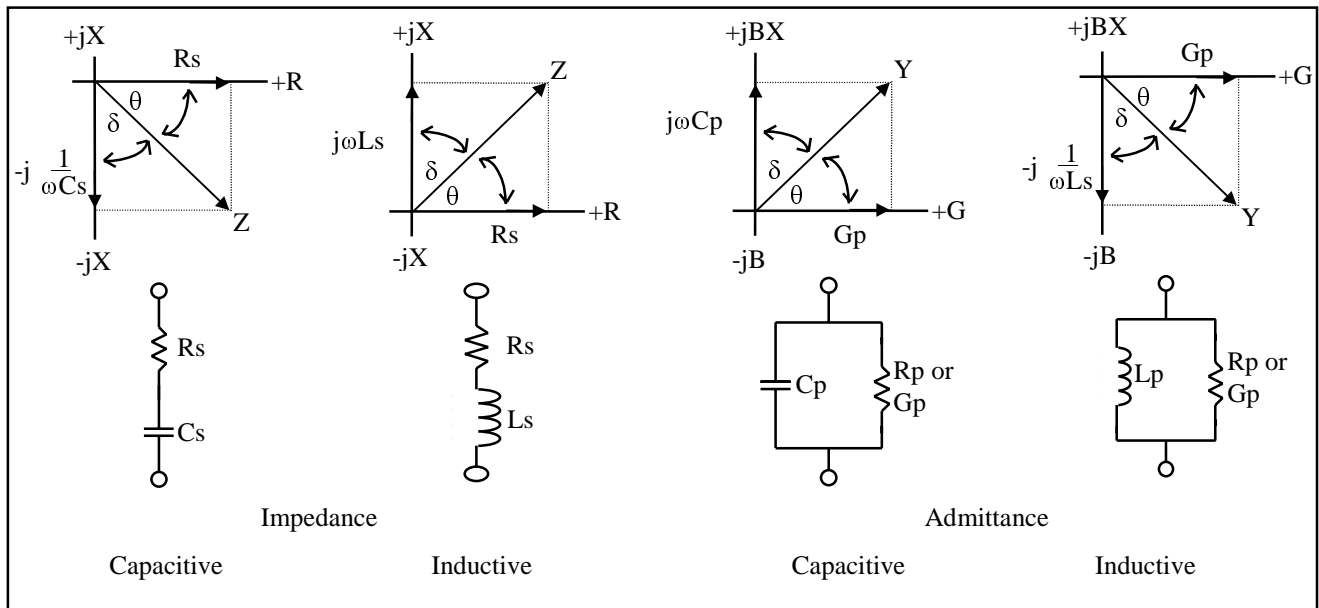
Figure 2-1: Impedance and Admittance Phase Diagrams & Equivalent Circuits

2.2 Startup

Check to make sure the line voltage selector on the rear panel of the 1750 Digibridge instrument agrees with the AC power source available, if not refer to paragraph 1.4.3.

Connect the 1750 instrument AC power cord to the source of proper voltage.   The instrument is to be used only with 3-wire grounded outlets.

WARNING
When the BIAS ON LED is ON or flashing, there is High Voltage present at the UNKNOWN (H_{POT} & H_{CUR}) terminals.

2.3 System Parameters

The system parameters of the 1750 Digibridge are illustrated in Figure 1-1, sections 9(a-p) and 3(a-c) and are enlarged in Figure 2-2 for clarity. Paragraphs 2.3.1 through 2.3.12 describe the functions of these parameters.
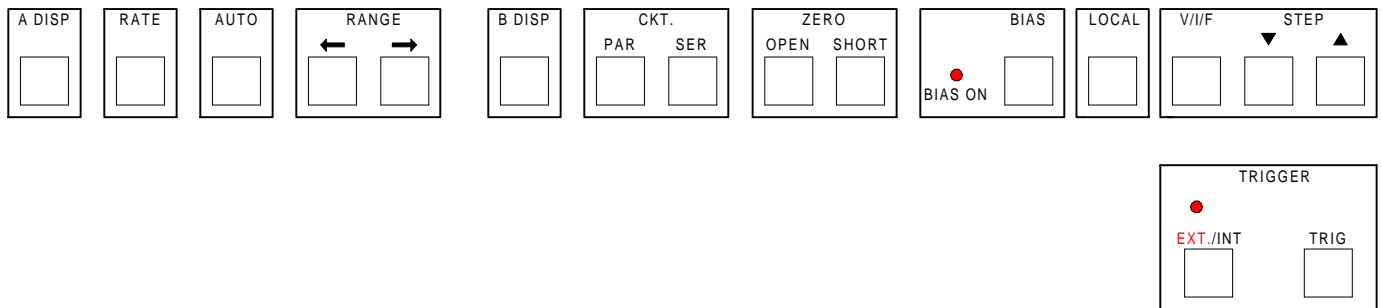
Figure 2-2: 1750 System Parameters (Front Panel View)

2.3.1 A DISP (A Display)

The [A DISP] button allows the user to select the primary measurement parameter equal to L, C, R or $|Z|$. The corresponding LED will light and the appropriate unit LED will light.

2.3.2 RATE

The [RATE] button allows the user to select the measurement rate equal to Slow, Fast or Medium.   The default measurement rate of the 1750 instrument is Fast mode.

Measurement Rate	Measurement Frequency						
	20Hz	100Hz	120Hz	1kHz	10kHz	100kHz	200kHz
Slow	900mS	630mS	630mS	580mS	580mS	610mS	610mS
Medium	880mS	194mS	164mS	140mS	135mS	135mS	133mS
Fast	880mS	194mS	164mS	67mS	65mS	65mS	63mS

2.3.3   AUTO

The [AUTO] button allows the user to select the AUTO measurement mode ON or OFF. If AUTO is enabled, the corresponding LED will light under the A Display. Press [AUTO] a second time to return to manual mode. The A Display briefly shows the measurement range ("rG--2"). The range is then shown in the Bin No display ("2").

2.3.4   RANGE

The [RANGE] button allows the user to manually select the measurement range equal to Range 1 through Range 7. Range availability is dependent upon test frequency. If the user selects a range out of specification with the device being measured the A and B displays will contain four half zero's denoting the measured parameter has exceeded the range limit.

$$\boxed{\Box\Box\Box\Box}\,{}_{M\Omega}\,\boxed{\Box\Box\Box\Box}\quad\boxed{\quad 7\quad}\quad\boxed{\quad 120\quad}{}_{Hz}$$

2.3.5   B DISP (B Display)

The [B DISP] button allows the user to select the secondary measurement parameter equal to Q, D, R or θ. The corresponding LED will light and the appropriate unit LED will light.

2.3.6   CKT.: PAR. & SER.

The equivalent circuit is selected by pressing [PAR.] for parallel or [SER.] for series. The corresponding PAR or SER LED will light indicating the equivalent circuit.

2.3.7   ZERO: OPEN & SHORT

Enable the Zero function by connecting the test cables in 'open' configuration and pressing [OPEN] then [TRIG] or by connecting the test cables in 'short' configuration and pressing [SHORT] then [TRIG]. If a FAIL message is displayed the 1750 instrument will ignore the [ZERO] data. Reconnect cables and try the [ZERO] function again. Refer to Figure 2-3 for the Kelvin Clip Leads Open & Short Configuration.

For R or L measurements, connect a short across the test cables or fixture then press the ZERO [SHORT] button. When enabled in R or L measurements, the Zero function removes the effects of any series resistance or inductance of the test cabling or fixture.

For C measurements, connect the test cables or fixture in 'open' configuration then press the ZERO [OPEN] button. When enabled in C measurements, the Zero function removes the effects of any stray capacitance or conductance of the test cabling or fixture.

Very low capacitance shielded wire should be used for cables to minimize any resonance effects in the measurement of large inductance. Test fixture extension cable can add some capacitance in parallel with the DUT due to imperfect shielding of the leads. The Zero function will compensate for capacitance between cables under normal test conditions.
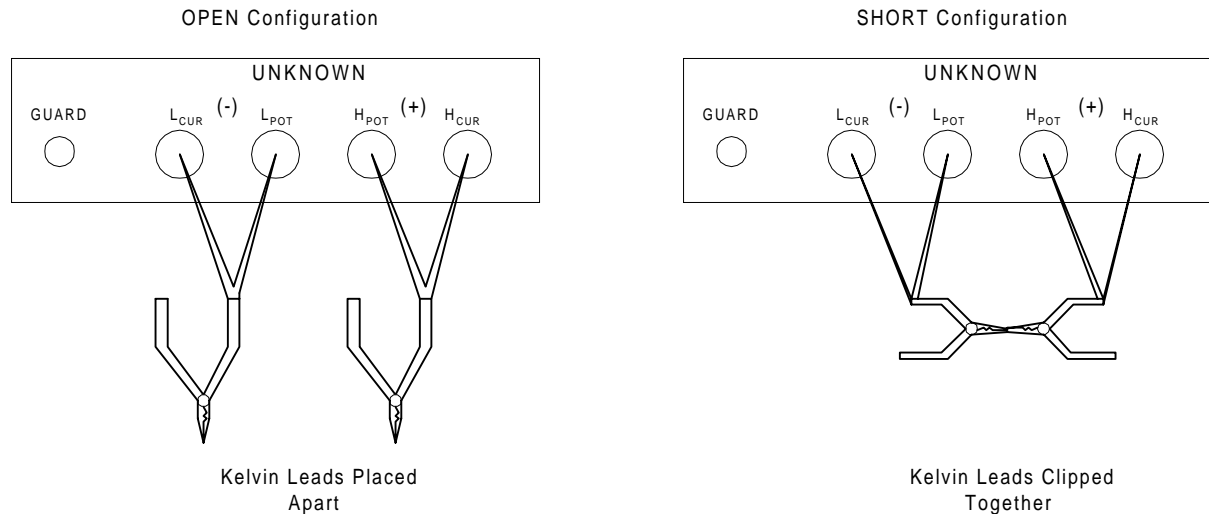
OPEN Configuration

SHORT Configuration

Kelvin Leads Placed Apart

Kelvin Leads Clipped Together

Figure 2-3: Kelvin Clip Leads: Open & Short Configuration

NOTE
Anytime the test cables or test fixture are changed, the 1750 instrument should be re-zeroed.

2.3.8 BIAS

The [BIAS] button allows the user to select the external bias function ON or OFF. When the external bias is enabled the BIAS ON LED will be lit. Connection of the external source is through the single BNC terminal on the rear panel. Bias is not floating it is connected to instrument ground. The positive (+) connector is the center of the BNC and the negative (-) connector is the BNC shield. Bias range is 0-35V.

2.3.9 LOCAL

When the 1750 instrument is used in REMOTE mode (IEEE-488 or Handler interfaces) pressing the [LOCAL] button allows the user to operate the instrument using the front panel controls.

NOTE
If the local lockout command (LLO) is sent over the IEEE-488 bus, the [LOCAL] button is INOPERATIVE.

2.3.10 V/I/F

The [V/I/F] button allows the user to select the parameter to be shown on the PRESET display.   The user can preset the test voltage (V) or test frequency (F) and monitor output current (I) through the DUT. The [V] LED will light when the test voltage is set. The test voltage range is 0.01V to 2.50V in 0.01V steps and the instrument default value is last powered down test voltage.   The [Hz] or [kHz] LED will light when the test frequency is set. There are 42 preset test frequencies from 20Hz to 200kHz or the user can program a specific frequency as in ¶ 2.4.23. The instrument frequency default value is last powered down test frequency. The [mA] LED will light when the output current is displayed.

2.3.11 STEP

The [STEP] [▼] and [▲] buttons allow the user to toggle through the instrument preset test voltages or test frequencies. Use the [V/I/F] button to select parameter then use the [STEP] [▼] or [▲] to select test voltage or frequency.

2.3.12 TRIGGER

The TRIGGER function of the 1750 instrument allows the user to select an external (EXT) or internal (INT) machine trigger. Press the [EXT./INT] button to enable the external trigger and the red LED above the [EXT./INT] button will light. Press the [TRIG] button to initiate measurement when the instrument is used in REMOTE mode.

2.4   Program Parameters

The programming parameters of the 1750 Digibridge instrument keypad are illustrated in Figure 1-1, section 4(a-t) and are enlarged in Figure 2-4 for clarity. Paragraphs 2.4.1 through 2.4.24 describe the functions of these parameters.

```
┌─────────────────────────────────────────────────────┐
│                  PROGRAMMING                          │
│  ─────────────────────────────────────────────────   │
│                                                       │
│     Δ            Δ%          FREQ.        O NOM.       │
│     7            8            9            0           │
│   ┌─────┐      ┌─────┐      ┌─────┐      ┌─────┐       │
│   └─────┘      └─────┘      └─────┘      └─────┘       │
│                                                       │
│    LOAD        AVERAGE       VOLT         CAL         │
│     4            5            6            .          │
│   ┌─────┐      ┌─────┐      ┌─────┐      ┌─────┐       │
│   └─────┘      └─────┘      └─────┘      └─────┘       │
│                                                       │
│   NOM. VAL     BIN NO.      BIN SUM       LOCK        │
│     1            2            3            -          │
│   ┌─────┐      ┌─────┐      ┌─────┐      ┌─────┐       │
│   └─────┘      └─────┘      └─────┘      └─────┘       │
│                                                       │
│   CONSTANT      ADDR         UNIT                     │
│   CLEAR          %            =          SHIFT        │
│   ┌─────┐      ┌─────┐      ┌─────┐      ┌─────┐       │
│   └─────┘      └─────┘      └─────┘      └─────┘       │
│                                                       │
│    PROG                     SPECIAL                   │
│    ESC         STORE        RECALL        ENTER       │
│   ┌─────┐      ┌─────┐      ┌─────┐      ┌─────┐       │
│   └─────┘      └─────┘      └─────┘      └─────┘       │
│                                                       │
└─────────────────────────────────────────────────────┘
```

Figure 2-4: Programming Parameters

2.4.1   PROG/ESC

The [PROG/ESC] button allows the user to enter and exit programming mode. Press [PROG/ESC] to enter programming mode. The A DISPLAY flashes the word 'Prog". The blue labeled buttons are functional in programming mode. Press [SHIFT] to select a programming parameter labeled in red or press [PROG/ESC] to exit programming mode. Table 2-2 lists the programming keys by color. Blue are functional in programming mode, red are functional after [SHIFT] has been pressed and grey are functional at all times. The [PROG/ESC] button is also used to escape from [STORE] or [RECALL] functions.

Table 2-2: Programming Keys

Blue Keys	Red Keys	Grey Keys
PROG/ESC	SHIFT	STORE
ENTER	SPECIAL	RECALL
CLEAR	CONSTANT	VOLT
%	ADDR	FREQ
1 2 3 4 5 6 7 8 9 0	UNIT	
–	NOM. VAL	
LOCK	BIN NO.	
=	LOAD	
	AVERAGE	
	CAL	
	θ NOM	

2.4.2 STORE

The [STORE] button allows the user to the present set of test conditions in one of 10 internal instrument memory locations. Press [STORE] and enter the memory location number (0-9) in which to store the present test conditions. Press [ENTER] to accept.

Press [BUTTON]   **Display will show:**

[STORE]

L		Q				GO		120	
C		D	Stor_		_	NG			
R		R							kHz
Z	Ω	0							

[=]   [2]

L		Q				GO		120	
C		D	Stor_		2	NG			
R		R							kHz
Z	Ω	0							

[ENTER]

L		Q				GO		120	
C		D			2	NG			
R		R							kHz
Z	Ω	0							

2.4.3 RECALL

The [RECALL] button allows the user to recall a set of test conditions in one of 10 internal instrument memory locations. Press [RECALL] and enter the memory location number (0-9) from which to recall a specific test condition. Press [ENTER] to accept.

Press [BUTTON]   **Display will show:**

[RECALL]

| ○ L
○ C
● R
○ Z | | MΩ | ● Q
○ D
○ R
○ 0 | RECAL | | _ | ○ GO
○ NG | 120 | kHz |

[=]   [2]

| ○ L
○ C
● R
○ Z | .0000 | MΩ | ● Q
○ D
○ R
○ 0 | RECAL | 2 | ○ GO
○ NG | 119 | kHz |

[ENTER]

| ○ L
○ C
● R
○ Z | 2.4201 | MΩ | ● Q
○ D
○ R
○ 0 | 2.5938 | 2 | ○ GO
○ NG | 2.50 | V |

2.4.4 SPECIAL

The [SPECIAL] button allows the user to access special functions within the programming mode. Press [PROG/ESC], [SHIFT] then [SPECIAL] to access the special functions listed in Table 2-3.

Table 2-3: [SHIFT] [SPECIAL] Function List

Press Program [Buttons]	Function
[SHIFT] [SPECIAL] [2]	Select Single or Multi Frequency Open/Short Zero Function
[SHIFT] [SPECIAL] [4]	Select 1320 BCS Measurement Link Function
[SHIFT] [SPECIAL] [7]	Select Measurement Range Display Function
[SHIFT] [SPECIAL] [8]	Select Median Value Display Function

2.4.4.1 Multi-Frequency Open/Short Zero

When activated, the Multi-Frequency Open/Short Zero function permits the user to change test frequencies without having to re-zero the 1750 instrument. To activate this function, press [PROG/ESC], [SHIFT], [SPECIAL] then [2]. Press [=] to switch from Single Frequency to Multi-Frequency. Press [ENTER] to accept data entry.

2.4.4.2 1320 BCS Measurement Link

When the 1320 Bias Current Source instrument is linked to the 1750 instrument, setting this function ON enables OPEN Zeroing and faster measurement. To activate this function, press [PROG/ESC], [SHIFT], [SPECIAL] then [4]. Press [=] to turn the link ON or OFF. Press [ENTER] to accept data entry.

2.4.4.3 Measurement Range Display

When the Comparison Function is disabled (NOMinal VALue is set to 0), activating the Measurement Range Display function permits the user to display the Measurement Range in the BIN NO Display. To activate this function, press [PROG/ESC], [SHIFT], [SPECIAL] then [7]. Press [=] to turn range display ON or OFF. Press [ENTER] to accept data entry.

2.4.4.4 Median Value Display

When activated, the 1750 instrument makes three (3) measurements, computes the median value and displays the median value with judgment. To activate this function, press [PROG/ESC], [SHIFT], [SPECIAL] then [8]. Press [=] to turn median value display ON or OFF. Press [ENTER] to accept data entry.

2.4.5 ENTER

The [ENTER] button permits the user to accept the data entered in programming mode.

2.4.6 CLEAR

The [CLEAR] button permits the user to clear the data currently being entered in programming mode before the [ENTER] button is pressed.

2.4.7   CONSTANT

The [CONSTANT] button permits the user to specify a constant output source resistance. In LCR testing, the output impedance of the source can be fixed at 25Ω or 100Ω. For a DUT that has variable impedance, select CONSTANT OFF for improved accuracy.   The instrument default value is OFF. To select CONSTANT, press [PROG/ESC], [SHIFT] then [CLEAR].   The display will flash "ConSt OFF 0". Press [=] [1] to select 25Ω. Press [=] [2] to select 100Ω. Press [=] [0] to select CONSTANT OFF. Press [ENTER] to accept data input.

Press [BUTTON]   **Display will show:**

[PROG/ESC]

| L C R Z | Prog MΩ | Q D R 0 | | | GO NG | 120 kHz |

[SHIFT]

| L C R Z | SHFt MΩ | Q D R 0 | | | GO NG | 120 kHz |

[CLEAR]

| L C R Z | ConSt Ω | Q D R 0 | OFF | 0 | GO NG | 120 kHz |

[=]

| L C R Z | ConSt Ω | Q D R 0 | OFF | 0 | GO NG | 120 kHz |

[2]

| L C R Z | ConSt Ω | Q D R 0 | 100 | 2 | GO NG | 120 kHz |

[ENTER]

| L C R Z | Ω | Q D R 0 | | | GO NG | 120 kHz |

2.4.8   % (Percent Value)

The [%] button permits the user to specify that the displayed value is a percent value rather than an absolute value.

2.4.9 ADDR (IEEE-488 Address)

The [ADDR] button permits the user to specify the IEEE-488 address. The instrument range is 0-30 and the default value is 3. To select the Address, press [PROG/ESC], [SHIFT] then [ADDR]. Press [=], [number of address] then [ENTER] to accept the input.

Press [BUTTON]   **Display will show:**

[PROG/ESC]

L				GO	
C	Prog	Q		NG	120
R		D			
Z	MΩ	R			kHz
		0			

[SHIFT]

L		Q		GO	
C	SHFt	D		NG	120
R		R			
Z	MΩ	0			kHz

[ADDR]

L		Q		GO	
C	GPAdr	D	3	NG	120
R		R			
Z	MΩ	0			kHz

[=]

L		Q		GO	
C	GPAdr	D	.	NG	120
R		R			
Z	MΩ	0			kHz

[5]

L		Q		2	GO	
C	GPAdr	D	5_		NG	120
R		R				
Z	MΩ	0				kHz

[ENTER]

L		Q		GO	
C		D		NG	120
R		R			
Z	MΩ	0			kHz

2.4.10 = (Equal Sign)

The [=] button permits the user to change the present test condition. In programming mode, the [=] button must be pressed to change a value. For example, press [PROG/ESC], [SHIFT], [Test Parameter to be changed], [=] then enter the new value and press [ENTER] to accept data input.

2.4.11 UNIT

The [UNIT] button permits the user to change the A DISPLAY parameter unit. The [UNIT] button is only functional in programming mode when a nominal value or load correction value is being entered. Refer to paragraphs 2.4.13 and 2.4.17 respectively.

2.4.12 SHIFT

The [SHIFT] button permits the user to select a test parameter to change in programming mode.   All programming parameters labeled in red are functional after pressing the [SHIFT] button.   These parameters are CONSTANT, ADDR, UNIT, NOM. VAL, BIN NO., BIN SUM, DELAY, LOAD, AVERAGE, CAL, RANGE, DEFAULT and θ NOM. The [SHIFT] button is functional only after pressing the [PROG/ESC] button first.

2.4.13 NOM. VAL (Nominal Value)

The [NOM. VAL] button permits the user to enter a nominal value for the primary parameter which is the basis for the measurement result in Δ or Δ%.   To enter a nominal value, press [PROG/ESC], [SHIFT] then [NOM. VAL].   The display will flash ".0000, -non-".   Press [=] and enter the nominal value of the primary parameter.   Once in [NOM. VAL], the nominal value unit can be changed by pressing [SHIFT] then [UNIT] until the corresponding unit LED lights next to the A DISPLAY.   Then enter the nominal value of the primary parameter and press [ENTER] to accept.

Press [BUTTON]   **Display will show:**

Press	A Display	B Display	C	Freq
[PROG/ESC]	Prog (MΩ)	(Q D R 0)	GO NG	120 kHz
[SHIFT]	SHFt (MΩ)	(Q D R 0)	GO NG	120 kHz
[NOM. VAL]	.0000 (MΩ)	-non-	GO NG	120 kHz
[=]	. (MΩ)	-non-	GO NG	120 kHz
[2] [0] [0]	200_ (MΩ)	-non-	GO NG	120 kHz
[ENTER]	2.4636 (MΩ)	2.5656	0 NG	120 kHz

2.4.14 BIN NO. (Bin Number)

The [BIN NO.] button permits the user to assign a nominal value to a bin number for sorting of DUT pass/fail results. There are 10 bins available. Bin 0 – 9 are PASS bins for the primary parameter. To select a bin number, press [PROG/ESC], [SHIFT], [BIN NO.], [assigned bin #], [=], [limit (% value) of primary parameter] then [ENTER] to accept data input.

Press [BUTTON]   **Display will show:**

Press [BUTTON]	Param 1		Param 2		Bin	GO/NG	Freq
[PROG/ESC]	Prog	MΩ				GO / NG	120 kHz
[SHIFT]	SHFt	MΩ				GO / NG	120 kHz
[BIN NO.]	-bin-	MΩ			——	GO / NG	120 kHz
[=]	-bin-	MΩ			——	GO / NG	120 kHz
[2]	.5000	%	-.5000	%	2	GO / NG	120 kHz
[ENTER]	.0000	%	.0000	%	2	GO / NG	120 kHz
[=]	.	%	.	%	2	GO / NG	120 kHz
[1] [.] [0] [0] [0]	1.000	%		%	2	GO / NG	120 kHz
[ENTER]	2.4471	MΩ	2.4777		0	GO / NG●	120 kHz

2.4.15 BIN SUM (Bin Summary)

The [BIN SUM] button permits the user to summarize bin results. Press [PROG/ESC], [SHIFT] then [BIN SUM]. Press the bin number to summarize. The B DISPLAY will show the number of PASS results in the selected bin. To RESET all SUMS to 0 press [SHIFT] [BIN SUM] [CLEAR].

Press [BUTTON]	Display will show:			
[PROG/ESC]	Prog Ω	Q● D R 0	GO NG	120 kHz
[SHIFT]	SHFt Ω	Q D R 0	GO NG	120 kHz
[BIN SUM]	-Sun- Ω	Q● D R 0	—— GO NG	120 kHz
[=]	-Sun- Ω	Q● D R 0	—— GO NG	120 kHz
[3]	-Sun- Ω	0 (Q● D R 0)	3 GO NG	120 kHz
[PROG/ESC] [PROG/ESC]	2.3637 Ω	2.4756 (Q● D R 0)	0 GO NG●	120 kHz

2.4.16 LOCK (Key Lock)

The [LOCK] button permits the user to lock out the front panel. Press [PROG/ESC] then [LOCK] to lock out red programming parameters. The KEY LOCK LED is lit when the LOCK is enabled. Press [PROG/ESC] then [LOCK] to disable lock out.

2.4.17 LOAD (Load Correction)

The [LOAD] button permits the user to specify a value of the component under test (user supplied standard) and apply a correction to subsequent measurements of similar components under the same test conditions. Same test conditions are defined as same test voltage, test frequency and measurement rate.   Press [PROG/ESC], [SHIFT] then [LOAD]. Press [=] and [number of bin load applies to]. Press [ENTER] to accept data input. To change unit, press [=], [UNIT], [enter value of load]

Press [BUTTON] **Display will show:**

Press [BUTTON]	L C R Z	Main display		Q D R 0	Second display	Bin	GO NG	Freq	
[PROG/ESC]	○L ○C ●R ○Z	Prog	MΩ	●Q ○D ○R ○0			○GO ○NG	120	kHz
[SHIFT]	○L ○C ●R ○Z	SHFt	MΩ	○Q ○D ○R ○0			○GO ○NG	120	kHz
[LOAD]	○L ○C ●R ○Z	-LOAD	MΩ	●Q ○D ○R ○0			○GO ○NG	120	kHz
[=] [2]	○L ○C ●R ○Z	-LOAD	MΩ	●Q ○D ○R ○0			○GO ○NG	L2_	kHz
[ENTER]	○L ●C ○R ○Z	.0000		○Q ●D ○R ○0	.0000	2	○GO ○NG	L02	kHz
[=] [UNIT]	○L ●C ○R ○Z	.	pF	●Q ○D ○R ○0	.0000	2	○GO ○NG	120	kHz
[2] [.] [5] [0] [0]	○L ○C ○R ○Z	2.500_	pF	○Q ○D ○R ○0	.0000	2	○GO ○NG	120	kHz
[ENTER]	○L ○C ○R ○Z	2.5000	pF	○Q ○D ○R ○0	.0000	2	○GO ○NG	120	kHz

2.4.18 AVERAGE

The [AVERAGE] button permits the user to specify the number of measurements to average from 0-10. The instrument default value is 0. For example set AVERAGE=10. The 1750 instrument will make 10 measurements and then display the average value. The unit will continue to take 10 measurements and display the average until the average function is disabled. To select the average function, press [PROG/ESC], [SHIFT] then [AVERAGE]. Press [=], [# of measurements to average] then [ENTER] to accept data input.

Press [BUTTON]   **Display will show:**

[PROG/ESC]

| L C R Z | Prog MΩ | Q D R 0 | | | GO NG | 120 kHz |

[SHIFT]

| L C R Z | SHFt MΩ | Q D R 0 | | | GO NG | 120 kHz |

[5]

| L C R Z | AVEG- MΩ | Q D R 0 | 1 | | GO NG | 120 kHz |

2.4.19 VOLT (Test Voltage)

The [VOLT.] button permits the user to specify the test voltage from 0.01V to 2.50V in 0.01V steps. The instrument default value is the last test setup value. Press [VOLT.]. The PRESET DISPLAY will flash. Using the numerical and decimal keys, enter the test voltage in volts from 0.01-2.50V. Press [ENTER] to accept data input.

Press [BUTTON]   **Display will show:**

[VOLT.]

| L C R Z | 2.2835 MΩ | Q D R 0 | 2.7664 | | GO NG | ——— V |

[2] [.] [5] [0]

| L C R Z | 2.2835 MΩ | Q D R 0 | 2.7664 | 0 | GO NG | 2.50 V |

[ENTER]

| L C R Z | 2.3807 MΩ | Q D R 0 | 2.5475 | 0 | GO NG | 2.50 V |

2.4.20 CAL (Calibration)

The [CAL] button permits the user to enter instrument calibration mode. Press [PROG/ESC], [SHIFT], then [CAL] to enter calibration. Refer to paragraph 4.3 for a full description of calibration. Instrument calibration should be performed by qualified service technicians.

2.4.21 Δ (Deviation from Nominal)

The [Δ] button permits the user to specify that the measurement results be displayed as the deviation from the set nominal value (¶ 2.4.13). Press [Δ] to enable the deviation function. The corresponding Δ LED will light.

2.4.22 Δ% (Percent Deviation from Nominal)

The [Δ%] button permits the user to specify that the measurement results be displayed as the percent deviation from the set nominal value (¶ 2.4.13). Press [Δ%] to enable the deviation percent deviation function. The corresponding Δ% LED will light.

2.4.23 FREQ (Test Frequency)

The [FREQ.] button permits the user to specify the test frequency from 20Hz to 200kHz. The instrument default value is the last test setup value. Press [FREQ.]. The PRESET DISPLAY will flash. Using the numerical and decimal keys, enter the test frequency in Hertz from 0.02-200kHz. Press [ENTER] to accept data input.

Press [BUTTON]   **Display will show:**

[FREQ.]

| L C **R** Z | 2.6717 MΩ | **Q** D R 0 | 2.1942 | 2 | ○ GO ○ NG | ――― kHz |

[1] [2] [2]

| L C **R** Z | 2.6717 MΩ | **Q** D R 0 | 2.1942 | 0 | ○ GO ○ NG | 122 kHz |

[ENTER]

| L C **R** Z | 2.2938 MΩ | **Q** D R 0 | 2.7391 | 2 | ○ GO ● NG | 122 kHz |

NOTE
The 500 programmable frequencies are derived using the following equation:

$$f = \frac{n}{(2^{30})} \bullet 38.4\text{MHz}$$

Where: 559 < n < 5592405
                (20Hz)   (200kHz)

2.4.24 θ NOM (θ Nominal Value)

The [θ NOM.] button permits the user to specify a nominal value for θ (the phase angle). θ must be selected as the secondary parameter on the B DISPLAY first before specifying a θ NOM value. Press [PROG/ESC], [SHIFT] then [θ NOM.]. The display will flash "-dE9-, _.0000". Press [=], [value of θ NOM in °] then [ENTER] to accept data input.

Press [BUTTON]   **Display will show:**

Press [BUTTON]	L C R Z	Main	Q D R θ	Secondary		GO NG	Freq	
[PROG/ESC]		Prog	MΩ				GO NG	120	kHz
[SHIFT]		SHFt	MΩ				GO NG	120	kHz
[θ NOM.]		-dEg-	MΩ		.0000		GO NG	120	kHz
[=]		-dEg-	MΩ		. °		GO NG	120	kHz
[1] [8] [0]		-dEg-	MΩ		180_ °		GO NG	120	kHz
[ENTER]		2.6019	MΩ		67.957 °	0	GO NG	120	kHz

2.5 Connection to Device Under Test

Figure 2-5 illustrates the connection of a device under test to the 1750 instrument using the 4-BNC to 2-Kelvin Clip cable lead set. This cable set (QuadTech P/N 1700-03) is supplied with the 1750 LCR Digibridge unit.
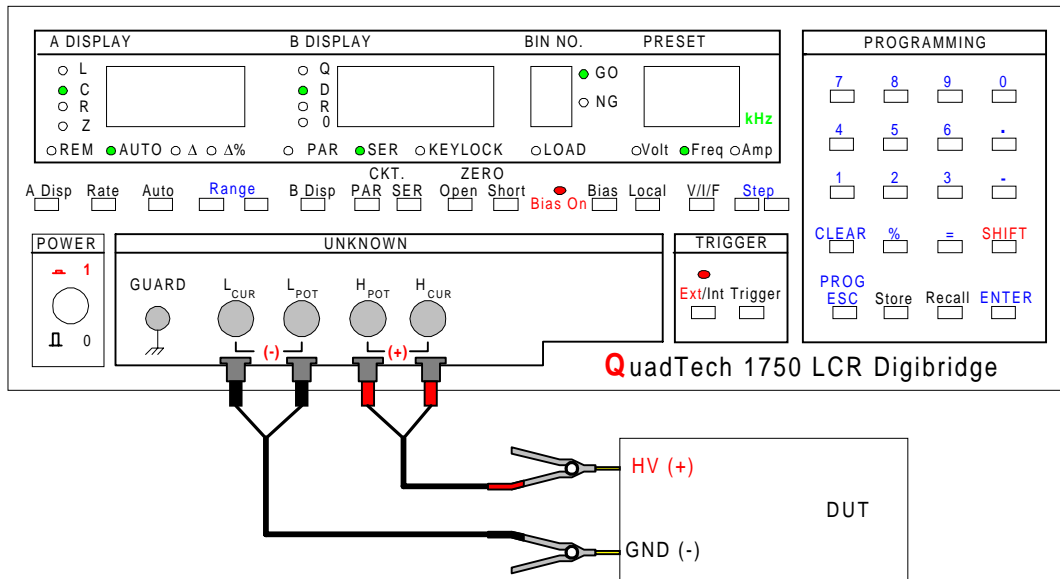
Figure 2-5: Connection to Device Under Test (DUT)
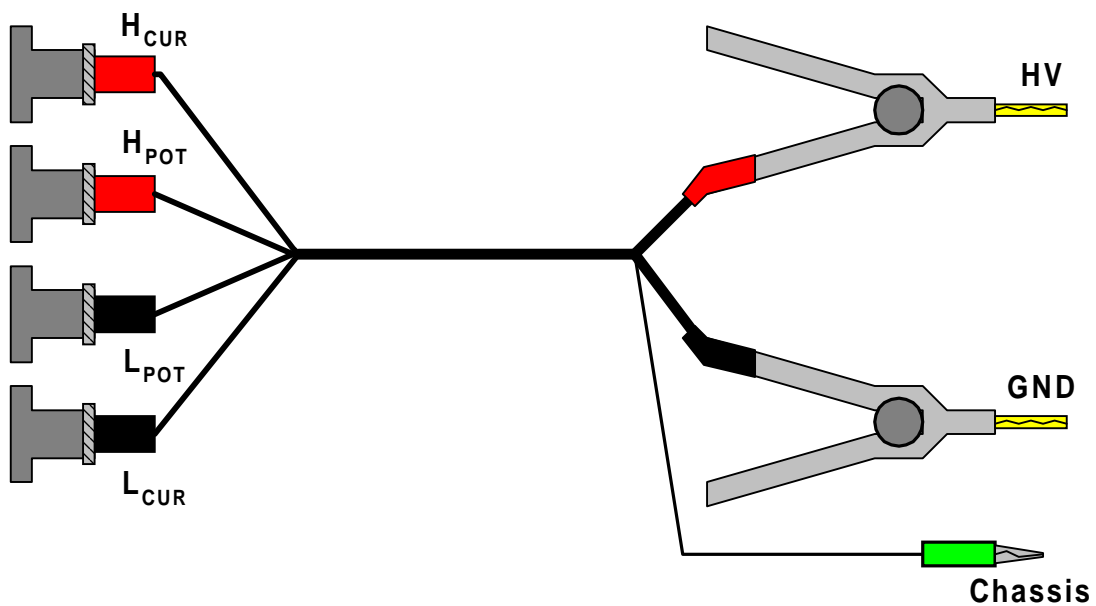
Figure 2-6: 4-BNC to 2-Kelvin Clip Leads (1700-03)

Other connectors are available as optional accessories for the 1750 Digibridge and are listed in Table 2-3.

Table 2-3: 1700 Series Digibridge Accessories

Accessory	QuadTech P/N	Figure #
Axial/Radial Component Test Fixture	1700-01	2-7
Axial/Radial Remote Component Test Fixture	1700-02	2-8
4-BNC to 2-Kelvin Clip(s) Lead Set	1700-03	2-6
4-BNC to 4-Banana Plug(s) Lead Set	1700-04	2-9
4-BNC to Chip Component Tweezers	1700-05	2-10
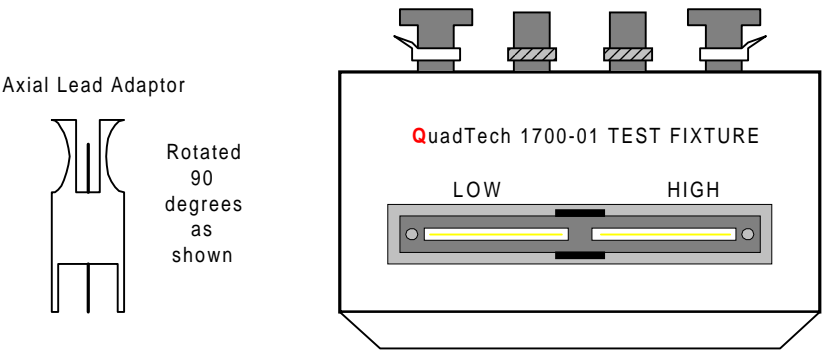
Figure 2-7: Axial/Radial Component Test Fixture (1700-01)
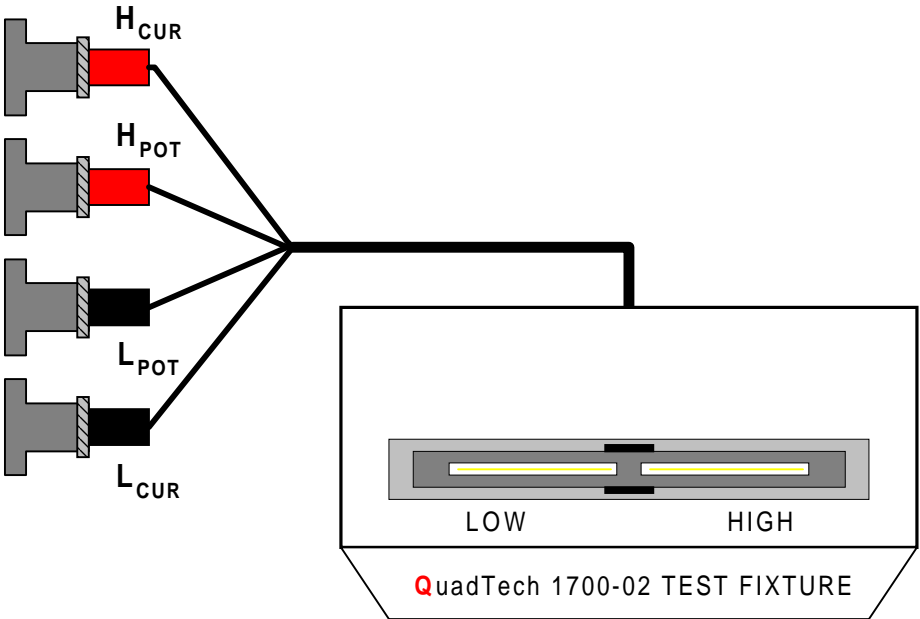
Figure 2-8: Axial/Radial Remote Test Fixture (1700-02)
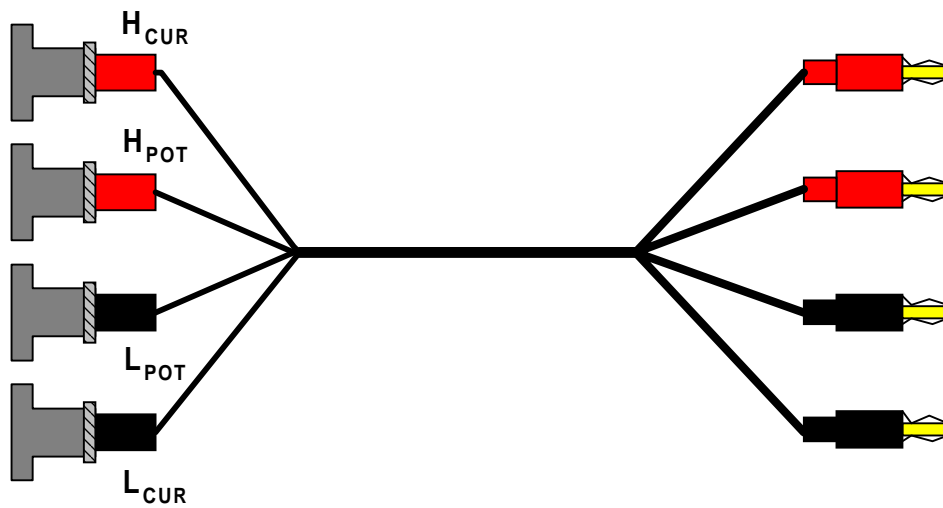
Figure 2-9: 4-BNC to 4-Banana Plug(s) Lead Set (1700-04)
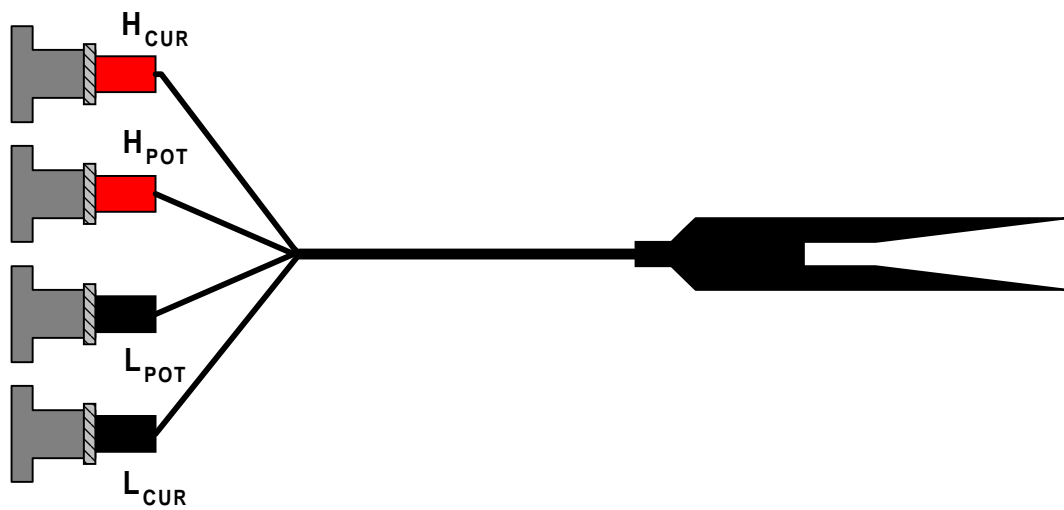
Figure 2-10: 4-BNC to Chip Component Tweezers (1700-05)

2.6   Measurement Procedure

The 1750 Digibridge instrument has continuous and triggered measurement capability. Continuous mode is the normal instrument operation mode as described in paragraph 2.6.1. Trigger mode is employed when the instrument is remotely operated via the IEEE-488 or Handler interfaces. Refer to paragraphs 3.1 and 3.2 respectively.

2.6.1   Continuous Measurement Mode

1. Turn POWER ON.
2. Allow the 1750 instrument to warm-up for 15 minutes.
3. Select Primary Parameter.
4. Select Frequency.
5. Select Test Voltage.
6. Select Measurement Range.
7. Select Measurement Rate.
8. Select Secondary Measurement.
9. Select Equivalent Circuit (Series or Parallel).
10. Connect Test Cables or Test Fixture (¶2.5).
11. Enable Zero Function (¶2.3.7).
12. Connect Device Under Test (DUT) (¶2.5).

The 1750 Digibridge will **continually** test until the DUT is disconnected. When the test leads or test fixture are changed, enable the Zero Function to compensate for series resistance and inductance or stray capacitance and conductance.

CAUTION
When testing capacitive devices using a Bias Voltage applied at the rear panel input terminals, use extreme caution. The charge stored in the capacitor can be lethal if the device is not allowed enough discharge time.

2.6.2   Trigger Measurement Mode

1.   IEEE-488 Interface is connected via rear panel to external computer (¶ 3.1).
2.   Talk/Listen DIP Switch is in appropriate position (¶ 3.1.2).
3.   Press [EXT./INT] button so that the red LED lights (indicating EXT Trigger).
4.   Connect DUT to 1750 UNKNOWN terminals (¶2.5).
5.   Press [TRIG] button to initiate triggered measurement.

2.7   BIN SORTING (Comparison Function)

2.7.1   Binning Description

If a group of similar components are to be measured, it is convenient to use the limit comparison function of the 1750 instrument to categorize the components.   For an example the 1750 instrument can be used to sort a group of nominally-valued 100nF capacitors into bins of 1%, 2%, 5%, 10%, lossy rejects and other rejects.   The bin assignment is displayed on the BIN NO. display for guidance in hand sorting.   If the HANDLER interface is activated the components are output automatically to a HANDLER for mechanized sorting.

The 1750 instrument has 10 bins for component sorting. Bins 1-9 are PASS bins for the primary parameter (L, C, R & Z). Bin 9 is the FAIL bin for the primary parameter (L, C, R & Z) when the primary is out of range of all bin limits. Bin 0 is the FAIL bin for the secondary parameter (D, Q, R & θ).

Manually entered limits are normally entered in pairs to define the upper and lower limits of a bin.   Limits are entered in the form of "nominal value" and "percent" above and below that nominal value. To set a symmetrical limit (such as ±5%) enter one "percent" value. To set a non-symmetrical pair of limits enter two "percent" values.

For a simple GO/NO-GO test, set a DQR limit in one regular bin (1-9).   Entry in additional bins will define additional GO conditions.   Make sure the unused bins are closed. Bins 0-9 are initially zero at power-up. The default DQRθ limit is "all FAIL" for D, Rs and θ.   The default DQRθ limit is "all PASS" for Rp or Q. Bins 1-9 are initially closed.

2.7.2   Sorting Sequence

The secondary parameter (D, Q, R & θ) is compared first in the sorting sequence. If the measured value compared with the limit of BIN 0 is NO GOOD (D or Rs is higher, Q or Rp is lower and/or θ is out of range) it will be sorted in BIN 0 and judged NG even if the primary parameter is in range. If the compared result is GOOD, the primary measured value (L, C, R & Z) will be compared with the limits of BINS 1 through 9 in regular sequence and sorted in the first bin range limit it meets. If the measured value is out of range of all the bin limits, it will be sorted in BIN 9 (fail) and judged NG. Figure 2-11 illustrates the 1750 instrument's sorting sequence.
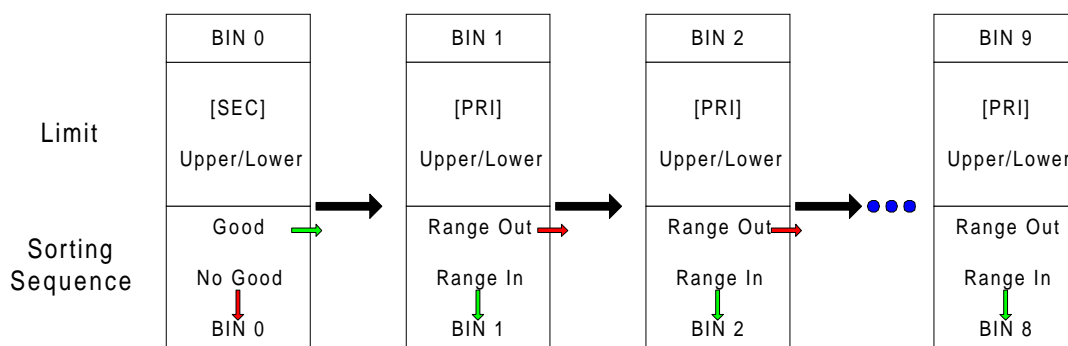
Figure 2-11: Bin Sorting Sequence

2.7.3 Binning Procedure

Before setting bin limits, set the measurement conditions as follows:

1   Select primary parameter [A DISPLAY]
2   Select secondary parameter [B DISPLAY]
3   Select test frequency and voltage [V / I / F]
4   Select equivalent circuit [SERIES] or [PARALLEL]
5   Select measurement range [RANGE]
6   Select measurement rate [RATE]
7   Select trigger mode [EXT./INT]

Now set the bin limits.

1   Set the secondary parameter limit (BIN 0). The upper limit is for D and Rs. The lower limit is for Q and Rp. If $\lvert Z \rvert$ or θ is to be measured, set the θ NOM value first then the BIN 0 limit value. The tolerance of θ is (θ NOM $\pm$ BIN 0).

2   Set the nominal value ([NOM VAL]) including value and unit.

3   Set the percentage bin limits for BINS 1-9.
The flow chart in Figure 2-12 and Table 2-4 illustrate the Bin limit entry procedure. In the flow chart the symbol *0* represents the phase angle θ.

NOTE
Pressing the [PROG/ESC] button before Step #4 will exit the user from programming mode. In Step #5, press the [PROG/ESC] button to return to STEP #3 and the entered value will be ignored. Press [CLEAR] to clear the entered value and re-enter correct value.
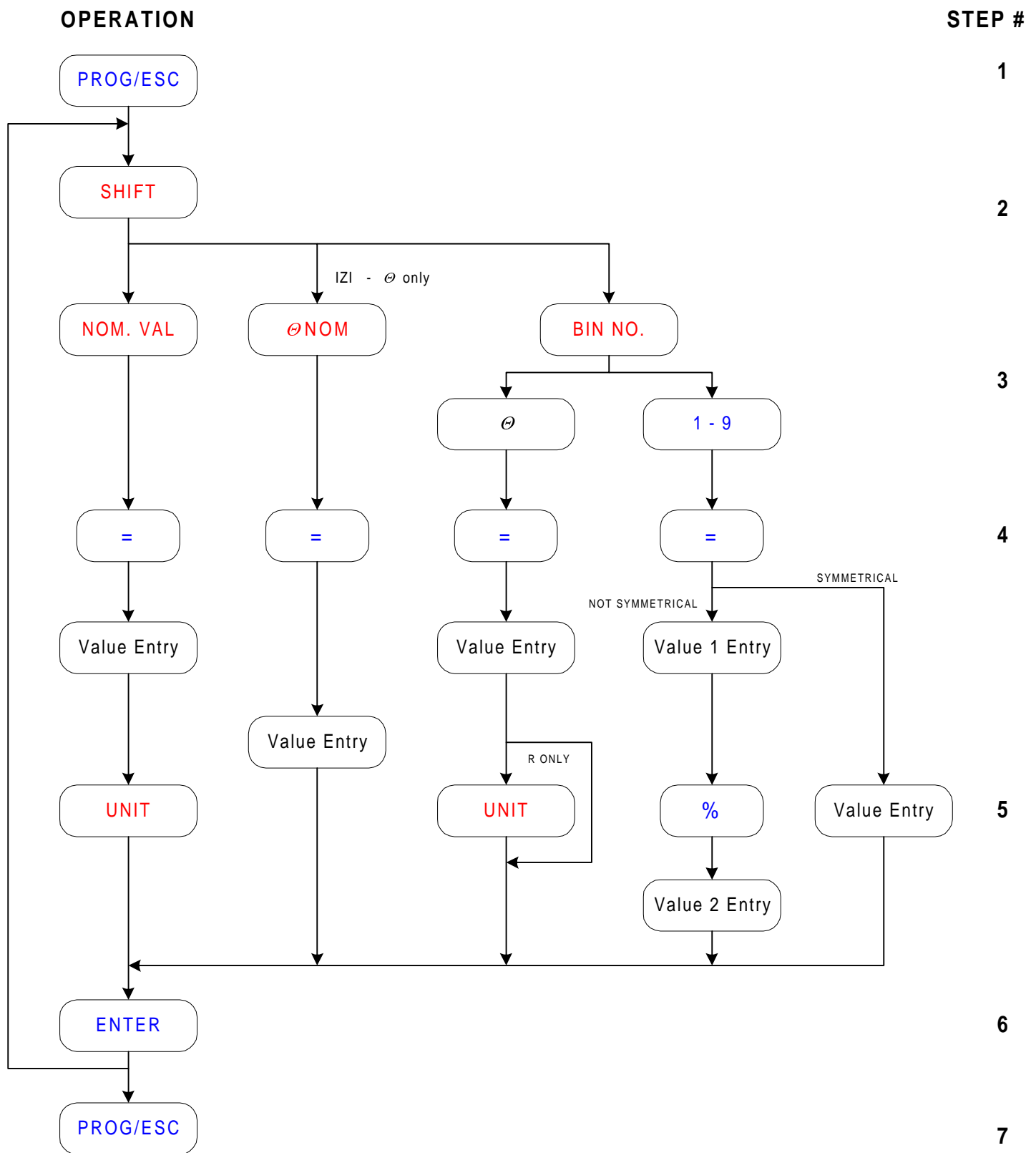
Figure 2-12: BIN Limit Entry Flowchart

Table 2-4: BIN Limit Entry Procedure

Step #	Operation	Description	A DISPLAY	B DISPLAY
1	[PROG/ESC]	Enter Programming Mode	"Prog"	
2	[SHIFT]	Enable "red" buttons	"SHFt"	
3	[NOM. VAL]	Select Nominal Value	Last set value	"-non-"
	[θ NOM]	Select θ NOM Value	"-dEg-"	Last set value
	[BIN NO.] + [θ]	Select Secondary Parameter limit	"-bin-"	Last set value
4	[=]	Change value of selected function	Last set value	Flashing cursor
5	[Numerical keys]	Enter value first	Selected	Value Entered
	[UNIT]	Change unit if necessary	Function	Flashing cursor
6	[ENTER]	Accept value entered	Same as Step #3	
7	[PROG/ESC]	Exit Programming Mode	Return to Measurement Mode	

2.7.4 Binning Example

Figure 2-13 illustrates the sorting reference for a group of capacitors having a nominal value of Cs = 0.1μF and D ≤ 0.01. The bin symmetrical limits are ±1%, ±2%, ±5%, ±10%, +20% and −80%. BIN 0 is for components with a measured D value (absolute value) that is greater than 0.01.
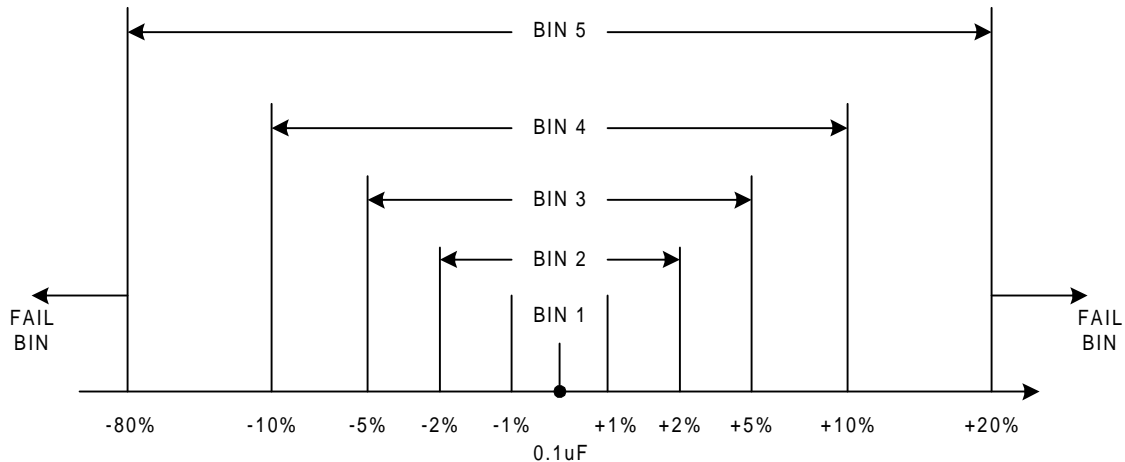
Figure 2-13: Capacitor Example Symmetrical Sorting Reference

Program the example as follows:

1   Press [SER.] to select equivalent circuit = SERIES
2   Press [A DISP] to select primary parameter = C
3   Press [B DISP] to select secondary parameter = D
4   Press [V / I / F] to set test frequency and test voltage
5   Press [PROG/ESC] to enter programming mode

6   Press [SHIFT] to enable 'red' labeled functions

7   Press [BIN NO.] [0] [=] [0] [.] [0] [1] [ENTER] to enter D limit = 0.01

8   Press [SHIFT] to enable 'red' labeled functions

9   Press [NOM. VAL] [=] [0] [.] [1] [UNIT until (μF) LED is lit] [ENTER] to enter C = 0.1μF

10   Press [SHIFT] to enable 'red' labeled functions

11   Press [BIN NO.] [1] [=] [1] [ENTER] to set BIN 1 limits = ±1%

12   Press [SHIFT] to enable 'red' labeled functions

13   Press [BIN NO.] [2] [=] [2] [ENTER] to set BIN 2 limits = ±2%

14   Press [SHIFT] to enable 'red' labeled functions

15   Press [BIN NO.] [3] [=] [5] [ENTER] to set BIN 3 limits = ±5%

16   Press [SHIFT] to enable 'red' labeled functions

17   Press [BIN NO.] [4] [=] [1] [0] [ENTER] to set BIN 4 limits = ±10%

18   Press [SHIFT] to enable 'red' labeled functions

19   Press [BIN NO.] [5] [=] [2][0] [%] [-] [8] [0][ENTER] to set BIN 5 limits = +20% and –80%.

20   Press [SHIFT] to enable 'red' labeled functions

21   Press [BIN NO.] [6] [=] [ENTER] to CLOSE BIN 6 (if it was previously open)

22   Press [PROG/ESC] to exit programming mode

2.7.5   Comparison Notes

The Comparison Function is enabled when the nominal value is set to a non-zero value. If the Comparison Function is enabled, the sorted bin # will be displayed on the BIN NO display and the corresponding judgment GO/NG LED will light. If the buzzer is ON (silver knob rear panel) it will continue to sound when GO is the judgment. To inhibit the comparison function set the nominal value equal to zero. The GO/NG LED indicators do not function and the BIN NO. display shows the measurement range.

The Δ (deviation from nominal) and Δ% (percent deviation from nominal) can be displayed when the Comparison Function is enabled. Press [Δ] or [Δ%] to select the display to show the deviation from nominal as an absolute or percent value.

At power up conditions, BINS 1-9 are initially closed so the instrument ignores the unused bins. Every unused bin must be closed by entering 0% as in Step 21, ¶2.7.4. Once a bin is closed, it remains closed until a non-zero percent limit is entered.

The limit entered for BIN 0 is either the upper or the lower limit for the secondary measurement parameter (D, Q, R & θ). The upper/lower limit selection depends on the equivalent circuit selection:

      Lower: Q, Rp (R in Parallel circuit)
      Upper: D, Rs (R in Series circuit)
      Tolerance: θ (From Nominal θ value)

When entering the primary bin limits use the [UNIT] button to change the unit of the value being entered. It is recommended to put a standard DUT in the test fixture prior to setting bin limits. The 1750 instrument will use the DUT as a reference unit during the bin limit entry procedure. Make sure that the number entered for nominal value or R limit is suited to the units on the 1750 front panel. (Ex.: 10nF equals 0.01uF)

2.7.6   GO/NG Results

If the Comparison Function (Binning) is enabled (nominal value is set to a non-zero value), the GO/NG LED indicators will function.
The GO LED lights when the DUT PASSES and DUT is put in BINS 1-9.
The NG LED lights when the DUT FAILS and DUT is put in BIN 0 (D, Q, R or θ failure) or it is put in BIN 9 (L, C, R or Z failure)

BIN 9 is the primary parameter FAIL bin.

The BIN NO display shows the bin assignment of the DUT.

2.7.7   BIN SUM Information

If the Comparison Function (Binning) is enabled, the 1750 instrument automatically keeps totals of the number of measurements assigned to each bin since instrument power up (or reset of the count to zero). The Bin Sums can be called onto the front panel display by pressing [BIN SUM] or they can be sent out over the IEEE-488 bus. The maximum component count is 99999 pieces/bin. Refer to ¶2.4.15 for instructions on checking BIN SUM results. To RESET all SUMS to 0 press [SHIFT] [BIN SUM] [CLEAR].

2.7.8   Measurement Time

When the 1750 instrument is operating in Comparison Mode, the measurement time is longer than that of Measurement Mode. Table 2-5 illustrates the typical Comparison Mode measurement time dependent upon frequency.

Table 2-5: Comparison Mode Measurement Time

Test Speed	Measurement Frequency						
	20Hz	100Hz	120Hz	1kHz	10kHz	100kHz	200kHz
Slow	900mS	630mS	630mS	580mS	580mS	610mS	610mS
Medium	880mS	194mS	164mS	140mS	135mS	135mS	633mS
Fast	880mS	194mS	164mS	67mS	65mS	65mS	63mS

NOTE
If ACQ active on HANDLER Interface, subtract 11mS for slow speed and 6mS for fast speed.
If displaying Δ or Δ% value, add 3 to 5mS.
If results are sent over IEEE-488 bus, add 3 to 6mS.

2.8   Accuracy of L C R & Z Measurements

The basic accuracy for impedance ($|Z|$) and phase angle (θ) is listed in Table 2-6. If the measurements are made at the Fast rate (65mSec/msmt at 1kHz) the accuracy figure should be doubled.

Table 2-6: $|Z|$ - θ Accuracy

$\|Z\|$ Ω		Measurement Frequency (Hz)				
		20 $\vert$ 100	1k	2k $\vert$ 10k	20k $\vert$ 100k	100k $\vert$ 200k
10M $\vert$ 1M	X	1.5%	1.0%	1.5%	7.0%	10.0%
	θ	0.7°	0.4°	0.7°	4°	6°
1M $\vert$ 100k	X	0.2%	0.15%	0.3%	1.0%	2.0%
	θ	0.15°	0.07°	0.2°	0.6°	1.2°
100k $\vert$ 10k	X	0.15%	0.15%	0.3%	1.0%	1.0%
	θ	0.1°	0.07°	0.2°	0.6°	0.6°
10k $\vert$ 1	X	0.1%	0.1%	0.1%	0.15%	0.2%
	θ	0.05°	0.03°	0.05°	0.05°	0.3°
1 $\vert$ 0.1	X	0.15%	0.1%	0.15%	0.2%	0.2%
	θ	0.06°	0.07°	0.06°	0.3°	0.3°
0.1 $\vert$ 0.01	X	0.5%	0.2%	0.5%	0.5%	1.0%
	θ	0.5°	0.1°	0.5°	0.5°	2°

L C R Accuracy:

For Q $\geq$ 10 (D $\leq$ 0.1), equals accuracy of $|Z|$ where:
$|ZL| = |2\pi fL|$
$|Zc| = |1/(2\pi fc)|$

For Q< 10 (D > 0.1), multiply L accuracy by (1 + 1/Q), multiply C accuracy by (1 + D).

D Q Accuracy:

For all D, accuracy of D = $\pm[\tan(\theta_{Acc}) \times (D^2 - 1)] / [1+D \times \tan(\theta_{Acc})]$
For Q $\leq$ 10, accuracy of Q = $\pm[\tan(\theta_{Acc}) \times (1+Q^2)] / [1-Q \times \tan(\theta_{Acc})]$
For Q $\geq$ 10, accuracy of Q = multiply accuracy by (1 + 1/Q)
θ_{Acc} = θ accuracy value listed in Table 2-6

R Accuracy (ESR, EPR):

For Q ≤ 0.1, accuracy of R = Accuracy of $|Z|$
For Q ≥ 0.1, accuracy of R = multiply accuracy by (1 + Q)
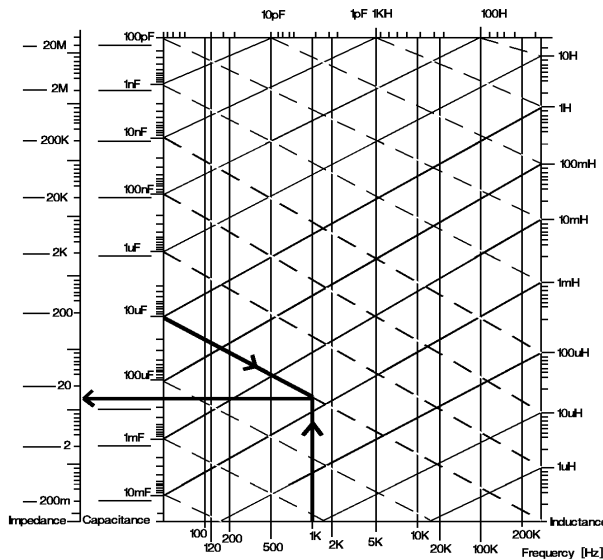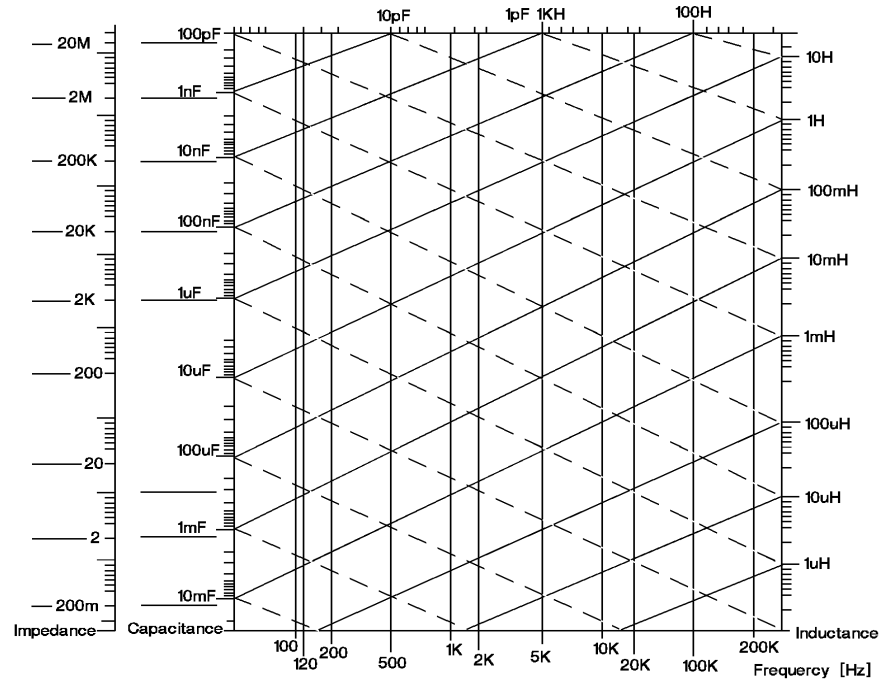
(b). C → │Z│ Conversion Table
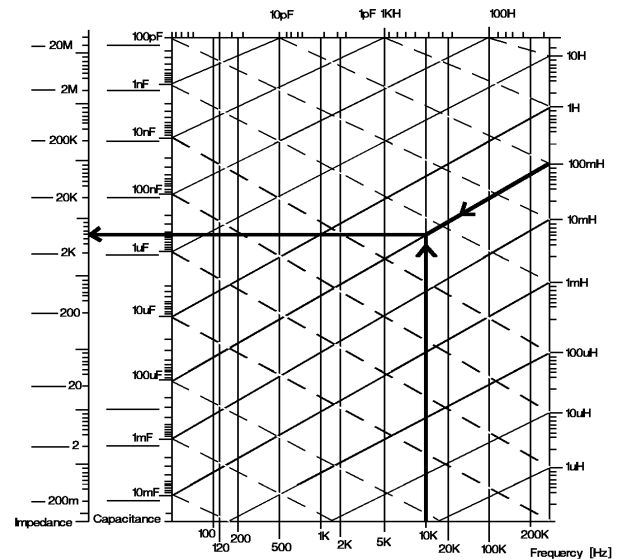
(c). L → │Z│ Conversion Table

2.9 Memory Data Storage

The 1750 Digibridge instrument has battery back-up capability to save the current power down conditions in addition to the 10 memory locations that store and recall specific test setups.

At **Power Down** the 1750 instrument automatically stores the following conditions:

1. Primary Parameter: L C R or $\lvert Z \rvert$ (Δ or Δ% if comparison enabled)
2. Secondary Parameter: Q D R or θ
3. Measurement Rate: Fast, Slow or Medium
4. Measurement Range: AUTO or Manual (HOLD)
5. Equivalent Circuit Representation: PAR or SER
6. Open/Short Zero Value
7. Test Frequency
8. Test Voltage
9. Trigger Mode: INT (Internal) or EXT (External)

If the **Comparison Function** is enabled and the keypad locked (KEY LOCK LED is lit) at power down, the 1750 instrument **also** stores:

1. Keypad Locked State (only [PROG] and [LOCK] function)
2. Nominal Value
3. Bin Limits (including nominal value)

When **STORE** is activated the 1750 instrument stores the following conditions:

1. Primary Parameter: L C R or $\lvert Z \rvert$ (but NOT Δ or Δ%)
2. Secondary Parameter: Q D R or θ
3. Measurement Rate: Fast, Slow or Medium
4. Measurement Range: AUTO or Manual (HOLD)
5. Equivalent Circuit Representation: PAR or SER
6. Test Frequency
7. Test Voltage
8. Nominal Value
9. Bin Limits (including nominal value)

NOTE
The Open/Short Zero Value is not saved when STORE function is activated.
The Trigger Mode is not saved when STORE function is activated.

Section 3: Interface

3.1   IEEE-488 Interface

The 1750 Digibridge unit can be operated by remote control using the IEEE-488 interface for data transfer. Connection is through the rear panel via a blue 24-PIN connector labeled IEEE-488 INTERFACE.   Figure 3-1 illustrates the pin configuration of the IEEE-488 interface connector. The meter side connector is a DDK 57LE-20240 or equivalent type. The cable side connector is a DDK 57-10240 or equivalent type.
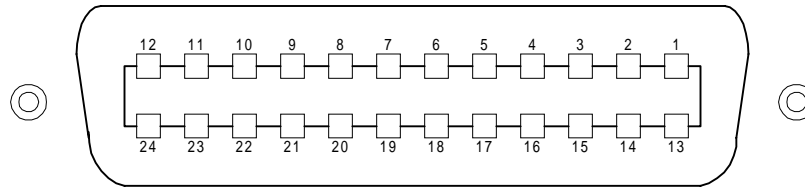
1750 IEEE-488 Interface PIN Configuration: Rear Panel View
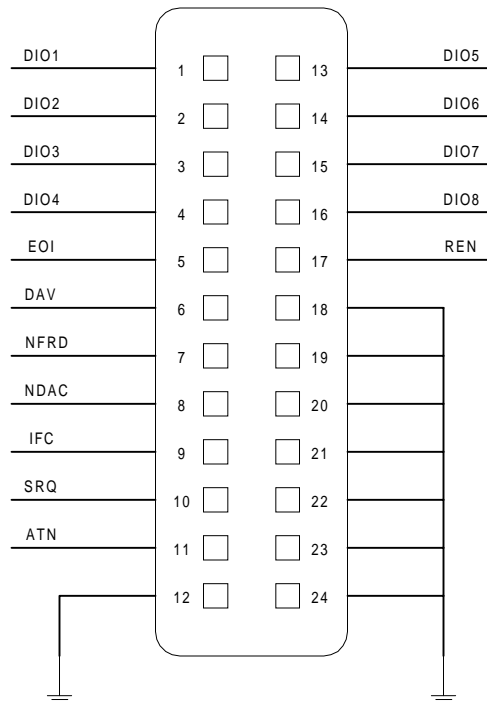
1750 IEEE-488 Interface PIN Configuration: Circuit Diagram

Figure 3-1: 1750 IEEE-488 Interface PIN Configuration

3.1.1 Interface Codes

Table 3-1 lists the IEEE-488 Interface Codes and their respective functions. All front panel functions are programmable form the bus. All data is available as output to the bus. The output form is ASCII. The interface is composed of the data bus, the handshake bus and the control bus.

Table 3-1: IEEE-488 Interface Codes

Code	Function
AH1	Acceptor Handshake (Listener)
SH1	Source Handshake (Talker)
T6	Basic Talker Function
L4	Basic Listener Function
RL1	All Remote Local Functions
PP0	No Parallel Poll Function
DC0	No Device Clear Function
DT1	Device Trigger Function
C0	No Controller Function

3.1.2 TALK/LISTEN DIP Switch

A red 4-position DIP switch labeled TALK/LISTEN, is located on the rear panel of the 1750 instrument. Figure 3-2 illustrates the TALK/LISTEN DIP Switch. Depending on the position of the DIP switch, the 1750 instrument functions as a TALK/LISTEN device or a TALK ONLY device. TALK/LISTEN mode allows full programming functions and is suitable for a system that has a controller or computer to manage data flow. TALK ONLY mode is suitable for a system that has no controller and no other talker. (Example: the 1750 instrument is connected to a printer only). Both modes provide measurement results to the listeners in the system.
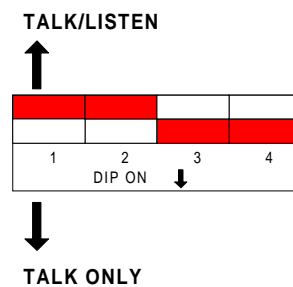
Figure 3-2: TALK/LISTEN DIP Switch

3.1.3 Interface Bus & Messages

Tables 3-2 describes the IEEE-488 Interface Bus and respective signal lines. Driving the bus on the 1750 instrument IEEE-488 Interface are DIO1-8, SRQ, NFRD and NDAC as open collectors and EOI, REN, DAV, IFC and ATN as 3 states.

Table 3-2: IEEE-488 Interface Bus

PIN #	Bus	Bus Signal Line	Description
1	Data Bus	DIO1 (Data Input Output 1)	Besides data input, the data bus is used for interface and device message input/output.
2		DIO2 (Data Input Output 2)	
3		DIO3 (Data Input Output 3)	
4		DIO4 (Data Input Output 4)	
13		DIO5 (Data Input Output 5)	
14		DIO6 (Data Input Output 6)	
15		DIO7 (Data Input Output 7)	
16		DIO8 (Data Input Output 8)	
6	Handshake Bus	DAV (Data Valid)	Indicates the data on the bus is valid.
7		NFRD (Not Ready For Data)	Indicates the Listener is ready to receive.
8		NDAC (No Data Accepted)	Indicates the Listener has finished data reception.
11	Control Bus	ATN (Attention)	Indicates the signal on the data bus carries data or an interface or a device message.
17		REN (Remote Enabled)	Switches between Remote and Local control modes.
9		IFC (Interface Clear)	Used to Reset the Interface.
10		SRQ (Service Request)	Signal sent to Talker side to call the Controller.
5		EOI (End of Identify)	Indicates end of data.

The 1750 Digibridge instrument is capable of responding to the IEEE-488 Interface messages listed in Table 3-3.

Table 3-3: IEEE-488 Interface Message Response

Interface Message	Response
GTL (Go To Local)	Only addressed devices that receive this command are set to LOCAL. Cancels the Remote Control Mode, making the front panel switches operative.

3.1.4 Listener Functions

All 1750 front panel functions can be operated by remote commands. The function is controlled by ASCII commands in a string composed of:

{Command + parameters + [END CODE]}

Between instructions (command + parameter) there is no delimiter required or a delimiter with a space " " can be used. The maximum length of the string is limited to 256 characters. If the measured result has been enabled (Table 3-5, X1-X7), the 1750 instrument will output the data asked for when the specified measurement period is finished. Table 3-5 lists the Listener Commands for the 1750 Interface. The output format of the Listener Functions is divided into four categories: LCR data, DQR data, BIN Number and BIN Summary data. Tables 3-6, 3-7, 3-8 and 3-9 detail these data output formats respectively.

Table 3-5: Listener Commands

Command	# Bytes	Parameter Selected	Parameter Type
D0	2	Bin #	Display
D1	2	Deviation %	
D2	2	Value	
D3	2	Speed Rate	
S0	2	Fast	Measurement
S1	2	Medium	Speed
S2	2	Slow	
Vv;	Floating Point	v = value (in volts)	Test Voltage
T0	2	External	Trigger Mode
T1	2	Internal	
M0	2	Inductance (L/Q)	Measurement
M1	2	Capacitance (C/D)	Parameter
M2	2	Capacitance (C/R)	
M3	2	Resistance (R/Q)	
C0	2	Parallel	Equivalent Circuit
C1	2	Series	
R0	2	Hold Range	Range Control
R1	2	Hold Range 1	
R2	2	Hold Range 2	
R3	2	Hold Range 3	
R4	2	Hold Range 4	
R5	2	Hold Range 5	
R6	2	Hold Range 6	
R7	2	Hold Range 7	
R8	2	Auto Range	

Table 3-5: Listener Commands (Continued)

Command	# Bytes	Parameter Selected	Parameter Type
Ff;	Floating Point	f = value (in kHz)	Test Frequency
X0	2	Prohibit	Output Data
X1	2	Bin #	
X2	2	DQR	
X3	2	DQR, Bin #	
X4	2	LCR	
X5	2	LCR, Bin #	
X6	2	LCR, DQR	
X7	2	LCR, DQR, Bin #	
Nn;	Floating Point	n = value (in Ω, H or F)	Nominal Value
Bbb	3	Bin #	Entry Limit
Hh;	Floating Point	h = High Limit (%)	
Ll;	Floating Point	l = Low Limit (%)	
G0	2	Start a measurement	Trigger
W0	2	Enable	Manual Start
W1	2	Prohibit	
E0	2	Prohibit Output	Bin Summary
E1	2	Enable Output	
E2	2	Zero	

Table 3-6: LCR Data Output Format

Character Sequence	Purpose	Allowed Characters	Description
1	Status	(space)	Normal operation, measurement on a basic range
		U	Under range Held
		O	Over range Held
		E	End extension of range 1 or 4
		I	Invalid measurement due to signal overload
2	Value, Delta LCR or Ratio	(space)	Normal Display
		^	Δ LCR Mode
3	Measurement Parameter	L	Inductance
		C	Capacitance
		R	Resistance
		Z	Impedance
4	Format	(space)	
5, 6	A-Units	(space) H	Henries
		MH	MilliHenries
		MF	Millifarads
		μF	Microfarads
		nF	Nanofarads
		(space) %	Deviation percentage
		(space) O	Ohms
		KO	Kilohms
7	Format	(space)	
8	Sign	(space)	Positive L, C, R, Δ% or ΔLCR
		–	Negative L, C, R, Δ% or ΔLCR
9	Number	0 1 2 3 4 5 6 7 8 9 . (space)	Measurement Value
10			
11			
12			
13			
14			
15			
16		(CR)	Carriage Return
17	Delimiter	(LF)	Line Feed Character; end of string

Table 3-7: DQR Data Output Format

Character Sequence	Purpose	Allowed Characters	Description
1	Status	(space)	Operation okay
		O	Over the range of the display
		I	Measurement wrong
2	Format	(space)	
3	Measurement Parameter	Q	Quality Factor
		D	Dissipation Factor
		R	Resistance
		S	Phase Angle (θ)
4	Format	(space)	
5	A-Units	(2 space) O	Ohms
6		(space) KO	Kilohms
7		(3 space) O	Dimensionless (Q, D)
8	Format	(space)	
9	Polarity	(space)	Positive D, Q, R, S
		–	Negative D, Q, R, S
10	Number	0 1 2 3 4 5	Measurement Value
11		6 7 8 9 .	
12		(space)	
13			
14			
15			
16		(CR)	Carriage Return
17	Delimiter	(LF)	Line Feed Character; end of string

Table 3-8: BIN Number Data Output Format

Character Sequence	Purpose	Allowed Characters	Description
1	Status	(space)	GO (BIN 1 – BIN 13)
		F	NG (BIN 0 or BIN 14)
2	Format	(space)	
3	Note	B	The word "BIN"
4		I	
5		N	
6	Format	(space)	
7	Bin Number	0 1 2 3 4 5 6 7 8 9	BIN Number Assignment, 00-14
8			
9		(CR)	Carriage Return
10	Delimiter	(LF)	Line Feed Character; end of string

NOTE
When the LCR measurement is NG, the A Display will show "F" and the IEEE-488 Interface will output 14.

Table 3-9: BIN Summary Data Output Format

Character Sequence	Purpose	Allowed Characters	Description
1	Status	(space)	GO (BIN 1 – BIN 8)
		F	NG (BIN 0 or BIN 9)
2	Format	(space)	
3	Note	B	The word "BIN SUM"
4		I	
5		N	
6		S	
7		U	
8		M	
9	Format	(space)	
10	BIN Number	0 1 2 3 4 5 6 7 8 9	Bin Summary Number, 00 – 14
11			
12	Equivalence	=	Equal
13	Sum	0 1 2 3 4 5 6 7 8 9	Total Number counted in this bin, the bin-summary number
14			
15			
16			
17			
18		(CR)	Carriage Return
19	Delimiter	(LF)	Line Feed Character; end of string

3.2   Handler Interface

On the rear panel of the 1750 Digibridge instrument is a blue 24-PIN connector labeled HANDLER INTERFACE for remote operation with a handler device. Connect the control lines to the handler. Figure 3-3 illustrates the pin configuration of the Handler Interface connector.
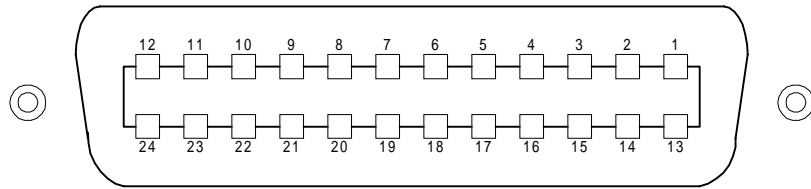
1750 Handler Interface PIN Configuration: Rear Panel View
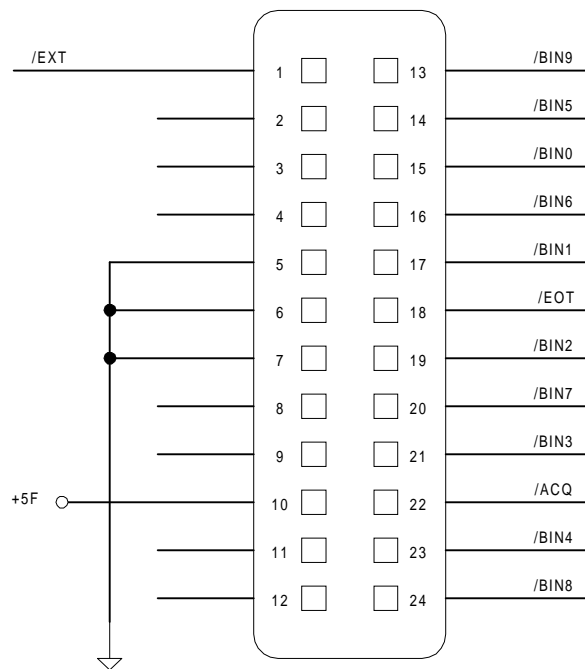
1750 Handler Interface PIN Configuration: Circuit Diagram

Figure 3-3: 1750 Handler Interface PIN Configuration

The output signal comes from open collector drivers that pull each signal line to a low voltage when the signal is active and let it float when it is inactive. Each external circuit must be powered by a positive voltage up to 30V(max), with sufficient impedance (pull-up resistors) to limit the active signal (logic-low) current to 16mA (max).

<table>
<tr><td>CAUTION
Each relay or other inductive load requires a CLAMPING DIODE (rectifier) across it. Typically, a cathode connected to the power supply end of the load.</td></tr>
</table>

Table 3-11 lists the name, pin # and function of each control signal for the 1750 instrument Handler Interface. All signals are 'active low".

Table 3-11: Handler Interface

Signal Name	PIN #	Function
	5, 6, 7	Ground Connection
	10	DC bus (+5V) available; commonly for optocouplers Limit the load to 25mA (MAX)
START	1	Initiates Measurement (External Trigger)
EOM	18	"End of Measurement", Judgment signals are valid
ACQ over	22	"Data Acquisition over", DUT removal okay
BIN 0	15	No Good because of Q, D, R or θ limit
BIN 1	17	GO, bin 1
BIN 2	19	GO, bin 2
BIN 3	21	GO, bin 3
BIN 4	23	GO, bin 4
BIN 5	14	GO, bin 5
BIN 6	16	GO, bin 6
BIN 7	20	GO, bin 7
BIN 8	24	GO, bin 8
BIN 9	9	L, C, R, $\lvert Z \rvert$ fair, No Good by default (suits no other bin)

The input signal is also active low and requires a positive-voltage external circuit which must pull the signal line down below 0.4V but not less than 0V (i.e. not negative). The logic low current is 0.4mA (maximum). For the inactive state (logic high) the external circuit must pull the signal line above +2.5V but not above +5V.

3.2.1 Handler Interface Timing

<table>
<tr><td>NOTE
To enable the Handler outputs, the 1750 instrument requires that a non-zero value
be entered for "nominal value" and the primary parameter be matched.</td></tr>
</table>

Figure 3-4 illustrates the timing diagram of the 1750 Handler Interface. The START signals are expanded for clarity. The START signal must have a duration of 1μs (minimum) in each state (high and low). If START is provided by a mechanical switch without de-bounce circuitry, the instrument may make false STARTs.
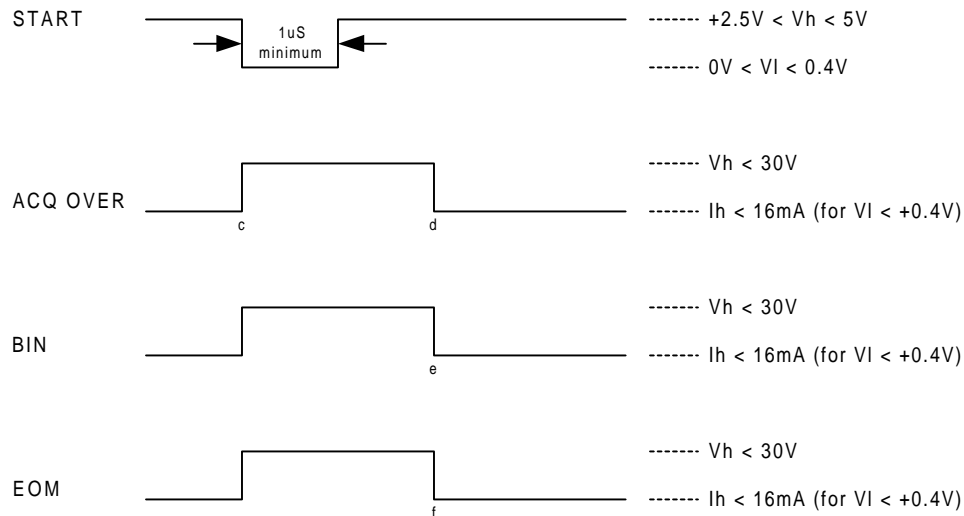
Figure 3-4: Handler Interface Timing Diagram

Measurement starts at time "c" which is essentially the same as time "a". Measurement is completed at time 'f'. Interval "a-b"(during which the DUT must remain connected for data acquisition) is considerably shorter than "a-f" the total measurement time. The DUT can be changed after "d" ("indexing on ACQ", to save time) or after "f" ("indexing on EOM", for a simpler measurement set up). After the calculation interval "d-e", measurement results are available for judgment and active lines go low. A few μsec later, EOM goes low and can be used to latch hold the result assignment. ACQ OVER, the active result lines and EOM stay low until the next START command.

3.2.2   Handler Setup

The Handler may be set up in either of two ways: "Index on EOM" or "Index on ACQ". The Handler must supply a signal to initiate measurement when it has completed connection of the DUT to the test fixture. The simpler set up is to "Index on EOM".

3.2.2.1   Index on EOM

Set up the Handler to respond to the EOM signal from the 1750 instrument. The EOM signal occurs at the "end of measurement" when the judgment result is available.   Set up the 1750 instrument to receive its START signal from the Handler's "Start measurement" signal.   (They talk to each other via their respective START signals).

3.2.2.2   Index on ACQ

Set up the Handler to respond to the ACQ OVER signal from the 1750 instrument. The ACQ OVER signal occurs when the "data acquisition" is complete. The Handler can then remove the DUT from the test fixture and replace it with another DUT while the 1750 instrument is calculating the result. This set up results in a faster measurement rate than "Indexing on EOM".

Section 4: Service & Calibration

4.1   General

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

4.2   Instrument Return

Before returning an instrument to QuadTech for service please call our **Customer Care Center (CCC)** at **800-253-1230** for Return Material Authorization (RMA). It will be necessary to include a Purchase Order Number 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". Return material should be sent freight prepaid, to:

> QuadTech, Inc.
> 5 Clock Tower Place, 210 East
> Maynard, MA 01754
>
> Attention: RMA #

Shipments sent collect can not be accepted.

4.3   Calibration

The 1750 Digibridge instrument is calibrated via an open and short compensation and range resistor calibration. Calibration should be performed under the following conditions: temperature equal to 23°C ±1.2°C and relative humidity (RH) between 35% and 55%. Allow the 1750 instrument to warm up for 30 minutes minimum prior to calibration.

4.3.1   Equipment Required

1.   95.3kΩ 0.01% Resistor, Range 1
2.   5.97kΩ 0.01% Resistor, Range 2
3.   374Ω 0.01% Resistor, Range 3
4.   24.9Ω 0.01% Resistor, Range 4
5.   5Ω 0.01% Resistor, Range 5
6.   1Ω 0.01% Resistor, Range 6
7.   0.19Ω 0.01% Resistor, Range 7
8.   4-BNC to 4-BNC Lead Set

4.3.2   Calibration Procedure

4.3.2.1   Open Circuit Compensation

Using the BNC lead set, connect the Open Circuit module to the UNKNOWN terminals on the front panel of the 1750 instrument.   Press ZERO [OPEN].   Press [TRIG].   The BIN NO display flashes through 0-9, then indicates a PASS.

4.3.2.2   Short Circuit Compensation

Using the BNC lead set, connect the Short Circuit module to the UNKNOWN terminals on the front panel of the 1750 instrument. Press ZERO [SHORT]. Press [TRIG]. The BIN NO display flashes through 0-9, then indicates a PASS.

4.3.2.3   Range Resistor Calibration

4.3.2.3.1   Range 1

Using the BNC lead set, connect the Range 1 Standard to the UNKNOWN terminals. Press [PROG/ESC], [SHIFT] and [CAL]. The "A" and "B" displays flash a "CAL ACR" message. Press [1]. The "A" display flashes last CAL value for range 1. Press [TRIG]. The BIN NO display flashes through 0-9, then indicates a PASS. Press [=] and then enter the calibrated value of the standard. Press [ENTER] to accept data input. Press [PROG/ESC] to exit programming mode.

[PROG/ESC] [SHIFT] [CAL]	-CAL-	-ACr-	-	ACr	
[1]	95.300 kΩ	.0000	1	20.0	Hz
[TRIG]	95.210 kΩ	PASS	1	20.0	Hz
[=]	. kΩ	PASS	1	20.0	Hz
[VALUE]	95.300 kΩ	PASS	1	20.0	Hz
[ENTER]	95.300 kΩ	.0000	1	20.0	Hz

4.3.2.3.2   Range 2

Using the BNC lead set, connect the Range 2 Standard to the UNKNOWN terminals. Press [PROG/ESC], [SHIFT] and [CAL]. The "A" and "B" displays flash a "CAL ACR" message. Press [2]. The "A" display flashes last CAL value for range 2. Press [TRIG]. The BIN NO display flashes through 0-9, then indicates a PASS. Press [=] and then enter the calibrated value of the standard. Press [ENTER] to accept data input. Press [PROG/ESC] to exit programming mode.

	-CAL-		-ACr-	-	ACr	
[PROG/ESC] [SHIFT] [CAL]	-CAL-		-ACr-	-	ACr	
[2]	5.9699	kΩ	.0000	2	20.0	Hz
[TRIG]	6.0344	kΩ	PASS	2	20.0	Hz
[=]	.	kΩ	PASS	2	20.0	Hz
[VALUE]	5.9699	kΩ	PASS	2	20.0	Hz
[ENTER]	5.9699	kΩ	.0000	2	20.0	Hz

4.3.2.3.3   Range 3

Using the BNC lead set, connect the Range 3 Standard to the UNKNOWN terminals. Press [PROG/ESC], [SHIFT] and [CAL]. The "A" and "B" displays flash a "CAL ACR" message. Press [3]. The "A" display flashes last CAL value for range 3. Press [TRIG]. The BIN NO display flashes through 0-9, then indicates a PASS. Press [=] and then enter the calibrated value of the standard. Press [ENTER] to accept data input. Press [PROG/ESC] to exit programming mode.

	-CAL-		-ACr-	-	ACr	
[PROG/ESC] [SHIFT] [CAL]	-CAL-		-ACr-	-	ACr	
[3]	374.00	Ω	.0000	3	20.0	Hz
[TRIG]	381.15	Ω	PASS	3	20.0	Hz
[=]	.	Ω	PASS	3	20.0	Hz
[VALUE]	374.00	Ω	PASS	3	20.0	Hz
[ENTER]	374.00	Ω	.0000	3	20.0	Hz

4.3.2.3.4   Range 4

Using the BNC lead set, connect the Range 4 Standard to the UNKNOWN terminals. Press [PROG/ESC], [SHIFT] and [CAL]. The "A" and "B" displays flash "CAL ACR" message. Press [4]. The "A" display flashes last CAL value for range 4. Press [TRIG]. The BIN NO display flashes through 0-9, then indicates a PASS. Press [=] and then enter the calibrated value of the standard. Press [ENTER] to accept data input. Press [PROG/ESC] to exit programming mode.

	-CAL-	-ACr-	-	ACr	
[PROG/ESC] [SHIFT] [CAL]	-CAL-	-ACr-	-	ACr	
[4]	24.900 Ω	.0000	4	20.0	Hz
[TRIG]	24.531 Ω	PASS	4	20.0	Hz
[=]	. Ω	PASS	4	20.0	Hz
[VALUE]	24.900 Ω	PASS	4	20.0	Hz
[ENTER]	24.900 Ω	.0000	4	20.0	Hz

4.3.2.3.5   Range 5

Using the BNC lead set, connect the Range 5 Standard to the UNKNOWN terminals. Press [PROG/ESC], [SHIFT] and [CAL]. The "A" and "B" displays flash "CAL ACR" message. Press [5]. The "A" display flashes last CAL value for range 5. Press [TRIG]. The BIN NO display flashes through 0-9, then indicates a PASS. Press [=] and then enter the calibrated value of the standard. Press [ENTER] to accept data input. Press [PROG/ESC] to exit programming mode.

	-CAL-	-ACr-	-	ACr	
[PROG/ESC] [SHIFT] [CAL]	-CAL-	-ACr-	-	ACr	
[5]	5.0000 Ω	.0000	5	20.0	Hz
[TRIG]	4.8213 Ω	PASS	5	20.0	Hz
[=]	. Ω	PASS	5	20.0	Hz
[VALUE]	5.0000 Ω	PASS	5	20.0	Hz
[ENTER]	5.0000 Ω	.0000	5	20.0	Hz

4.3.2.3.6   Range 6

Using the BNC lead set, connect the Range 6 Standard to the UNKNOWN terminals. Press [PROG/ESC], [SHIFT] and [CAL]. The "A" and "B" displays flash "CAL ACR" message. Press [6]. The "A" display flashes last CAL value for range 6. Press [TRIG]. The BIN NO display flashes through 0-9, then indicates a PASS. Press [=] and then enter the calibrated value of the standard. Press [ENTER] to accept data input. Press [PROG/ESC] to exit programming mode.

	-CAL-	-ACr-	-	ACr	
[PROG/ESC] [SHIFT] [CAL]	-CAL-	-ACr-	-	ACr	
[6]	1.0000 Ω	.0000	6	20.0	Hz
[TRIG]	.9507 Ω	PASS	6	20.0	Hz
[=]	. Ω	PASS	6	20.0	Hz
[VALUE]	1.0000 Ω	PASS	6	20.0	Hz
[ENTER]	1.0000 Ω	.0000	6	20.0	Hz

4.3.2.3.7   Range 7

Using the BNC lead set, connect the Range 7 Standard to the UNKNOWN terminals. Press [PROG/ESC], [SHIFT] and [CAL]. The "A" and "B" displays flash "CAL ACR" message. Press [7]. The "A" display flashes last CAL value for range 7. Press [TRIG]. The BIN NO display flashes through 0-9, then indicates a PASS. Press [=] and then enter the calibrated value of the standard. Press [ENTER] to accept data input. Press [PROG/ESC] to exit programming mode.

	-CAL-	-ACr-	-	ACr	
[PROG/ESC] [SHIFT] [CAL]	-CAL-	-ACr-	-	ACr	
[7]	.1900 Ω	.0000	7	20.0	Hz
[TRIG]	.1856 Ω	PASS	7	20.0	Hz
[=]	. Ω	PASS	7	20.0	Hz
[VALUE]	.1900 Ω	PASS	7	20.0	Hz
[ENTER]	.1900 Ω	.0000	7	20.0	Hz