

# 1320 Bias Current Source Instruction Manual

Form 150414/A2

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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.

## 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.



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.



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## Warranty

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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.



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## Specifications

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### General Features

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Bias Current:	Range	Accuracy	Resolution
	0.000A - 1.000A	$\pm [1\% + 3\text{mA}]$	0.001A
	1.01A - 5.00A	$\pm (2\%)$	0.001A
	5.05A - 20.00A	$\pm (3\%)$	0.01A
	20.01A- 20.0(1+X)A	$\pm (5\%)$	0.1A

X = Number of 1320S (Slave) instruments connected.

DC Resistance:	Range	Measure Range	Measure Current	Accuracy
	20m $\Omega$	0.00-19.99m $\Omega$	2A	$\pm(2\% + 0.07\text{m}\Omega)$
	200m $\Omega$	0.0-199.9m $\Omega$	2A	$\pm(2\% + 0.2\text{m}\Omega)$
	2 $\Omega$	0.000-1.999 $\Omega$	20mA	$\pm(3\% + 0.002\Omega)$
	20 $\Omega$	0.00-19.99 $\Omega$	20mA	$\pm(3\% + 0.02\Omega)$
	200 $\Omega$	0.0-199.9 $\Omega$	20mA	$\pm(3\% + 0.2\Omega)$

**DC Voltage:**  $\pm(2\% + 0.05\text{V})$

<b>Driver Capacity:</b>	Maximum Value of Unknown DCR:	RDC max = $6.5/I$ ( $\Omega$ )
	Maximum Value of Unknown Inductance:	Lmax = $8/I$ (H)
	Maximum Open Circuit Time:	Tmax = 1.5 (sec)
	Maximum Drive Voltage:	DCVmax = 6.5 (V)

I = Set Current in amps (A)

**Interface:** • IEEE-488 • Handler • Slave

**Display:** LCD 16 character length x 2 character depth

**Mechanical:** Bench Mount  
Dimensions (w x h x d): 16.5 x 7.0 x 12.0 inches (412.5 x 175 x 300mm)

**Weight:** 26lbs (12kg) net, 33lbs (15kg) shipping

**Environmental:** Operating: 0°C to + 40°C  
Storage: -10° to + 50°C  
Humidity: < 80 %  
Warm-up Time: 30 minutes

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## Specifications (Continued)

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### General Features

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- Power:**
- 95 - 125V AC
  - 190 - 250V AC
  - 50 or 60Hz
  - 650W MAX

- Supplied:**
- Instruction Manual
  - Calibration Certificate
  - AC Power Cable
  - Lead Set

<b>Ordering Information:</b>	<u>Description</u>	<u>Catalog No.</u>
	1320 Bias Current Source	1320
	1320S Bias Current Slave	1320S



## Accessories

### Accessories Included

Item	QTY	QT P/N
AC Power Cord	1	4200-0300
10A Slow Blow 20mm Fuse 115V Operation	1	520107
5A Slow Blow 20mm Fuse 230V Operation	1	520108
Red Banana/BNC & Black Banana/BNC to Kelvin Clip Lead Set	1	1320-01
Instruction Manual	1	150414
Calibration Certificate	1	N/A
IEEE-488 Interface	1	Standard
Handler Interface	1	Standard
Slave Interface	1	Standard

### Accessories/Options Available

Item	QTY	QuadTech P/N
Red Banana/BNC & Black Banana/BNC to Kelvin Clip Lead Set	1	1320-01
4-BNC Test Leads Box to 4-BNC Test Leads Box Set	1	1320-02
4-BNC to 4-BNC Cable Lead Set (16")	1	1320-03
24-Pin Interconnect Cable (Connect QT 1750)	1	1320-05
36-Pin Interconnect Cable (Connect QT 7000)	1	1320-06
37-Pin Interconnect Cable (Connect QT 1900)	1	1320-07
1320S Bias Current Source Slave Instrument	1	1320S
40A BNC/Spade to Alligator Clip Lead Set	1	1320S-01
20cm (8") Spade to Spade Connector Cable Set (3)	1	1320S-02
100cm (40") Spade to Spade Connector Cable Set (3)	1	1320S-03
25-Pin Interconnect Cable (Connect Slave to Master)	1	1320S-04



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## Safety Precautions

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**The 1320 Bias Current Source instrument can provide a bias current as high as 20A DC to the device under test (DUT). Although the 1320 Bias Current 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 1320 Bias Current unit should 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 1320 Bias Current unit 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 **DC BIAS [FWD (+) or REV (-)]** light is on.
5. Before turning on the 1320 Bias Current unit, make sure there is no device (DUT) or fixture connected to the test leads.
6. When the red **DC BIAS [FWD (+) or REV (-)]** LED is lit 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 **DC BIAS [FWD (+) or REV (-)]** 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 1320 Bias Current INSTRUMENT.**
9. When the 1320 Bias Current instrument is used in remote control mode, be extremely careful. The High Voltage Output is being turned on and off with an external signal.



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# Condensed Operating Instructions

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## General Information

The 1320 Bias Current Source is an instrument that provides 0.0 – 20.0A of Bias Current. A maximum of 5 units can be connected in parallel to obtain an output equal to 100A. External resistance (DCR) and Inductance (L) can be measured through connection of DUT to 2 BNC/2 Banana UNKNOWN terminals. An oscilloscope or voltmeter can be connected to the DCV MONITOR to monitor the change in DC voltage at the test terminals.

## Start-Up

The 1320 Bias Current unit can be operated from a power source between 95 - 125VAC or 190 - 250VAC at a power line frequency of 50 or 60Hz. The standard 1320 unit is shipped from QuadTech with a 10A fuse in place for AC 115V operation. A 5A fuse is included in the accessories package for 230V operation. The 1320 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 1320 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 1320 unit should warm-up for a minimum of 30 minutes prior to use.

## Test Parameter Set-up

The test parameters listed in Table COI-1 can be set prior to test. For a single point current measurement just the MODE and I (Current) need to be set.

Name	Parameter	Range	Default Value
I/F	Interface	0=SC, 1=HAN, 2=32X	0
I	Bias Current	-20.0A to 20.0A	Last Test Setup
MODE	Output Current Mode	0=SG, 1=MM, 2=MA	0
ADDRESS	IEEE-488 Address	1-30	1
TIMER	Timer	ON or OFF	OFF
DELAY. T	Delay Time	0-100 seconds	0
STEP.N	Step Number	1-21	1
LOOP	Loop	ON or OFF	OFF

# Condensed Operating Instructions (Continued)

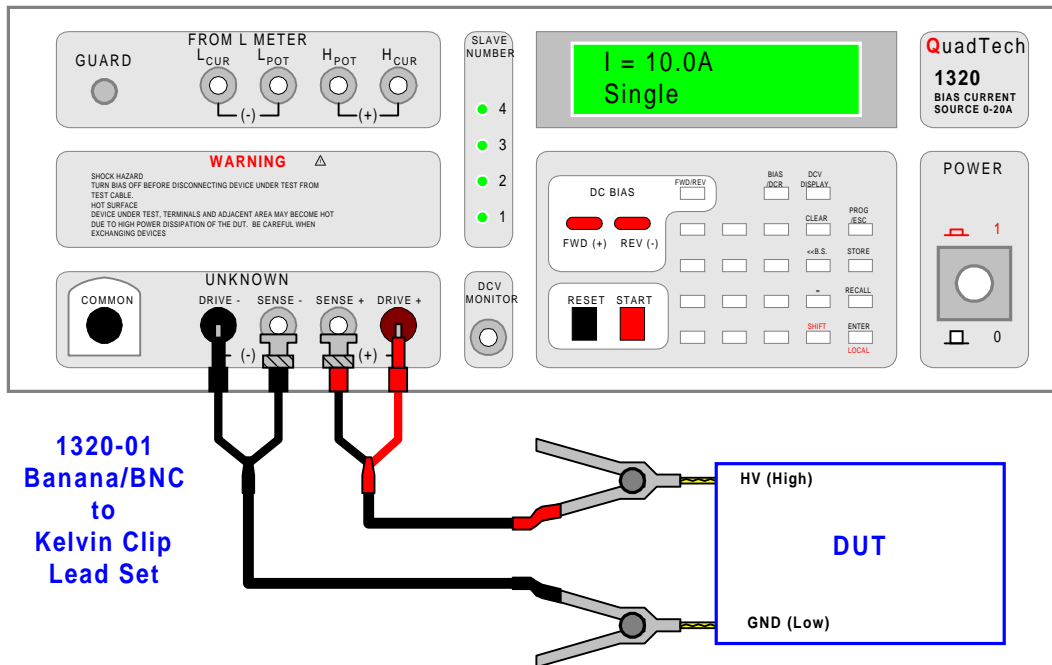
## Measurement Mode

1. Turn POWER ON.
2. Allow the 1320 BCS instrument to warm-up for 30 minutes.

**EXAMPLE: Single Point, Reverse Bias Current equal to 3.000A.**

3. Select Test (Bias/DCR).  
Press [BIAS/DCR]
4. Select Test MODE.  
Press [PROG] [SHIFT] [MODE] [=] [0] [ENTER]
5. Select Bias Current value (I).  
Press [=] [-3.000] [ENTER]  
Press [PROG] to exit programming mode.
6. Connect Test Cables or Fixture
7. Zero Test Cables (or Test Fixture)
8. Connect Device under Test (DUT)
9. Press red [START] button to initiate test.
10. Press black [RESET] button to terminate current to DUT.

Figure COI-1 illustrates the connection of a single DUT to the 1320 “UNKNOWN” terminals using the BNC/Banana to Kelvin Clip Lead set provided with the unit.



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

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## Section 1: Introduction

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### 1.1 Unpacking and Inspection

Inspect the shipping container before opening. If it is damaged contact the carriers agent immediately. Inspect the 1320 Bias Current 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 1320 Bias Current Source is programmable DC current source and DCR meter for production and laboratory testing of inductors. The 1320 Bias Current Source provides 0-20A DC Bias and measures external resistance (DCR). A maximum of 5 units can be connected in parallel to obtain 100A of DC Bias Current. Accuracy of the bias current output in the 1A range is  $\pm 1\% \pm 3\text{mA}$  with a resolution of 0.001A. The 5A range has an accuracy of  $\pm 2\%$  and a resolution of 0.001A. The 20A range has an accuracy of  $\pm 2\%$  and a resolution of 0.01A. At the 100A range the accuracy of the DC Bias Current output is  $\pm 5\%$  and the resolution drops to 0.1A. The 1320 instrument is connected to an inductance meter ('to L Meter') using 4 BNC to BNC cables (1320-03). The set of 2 Binding Posts and 2 BNC terminals labeled UNKNOWN are connected to the DUT using the 1320-01 cable lead set provided with the 1320 unit.

The DC Bias current is selectable as forward or reverse and is programmable from -20.0A to 20.0A. Test conditions are stored and recalled from 50 internal memory locations. The 1320 instrument also has the capability of performing up to 21 steps (tests) in any one test setup. An internal timer can be selected on/off and a delay time from 0-100 seconds can be programmed for any test. Current Output Mode is selectable as single, multiple manual or multiple automatic for multi-point current inductance testing.

Standard rear panel interfaces, for remote operation or communication with other instrumentation, include an LCR Link, a Slave Link, an IEEE-488 interface and a Handler interface. Up to 30 IEEE-488 addresses are programmable.

### 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 1320 Bias Current unit. Table 1-1 identifies them with description and function.

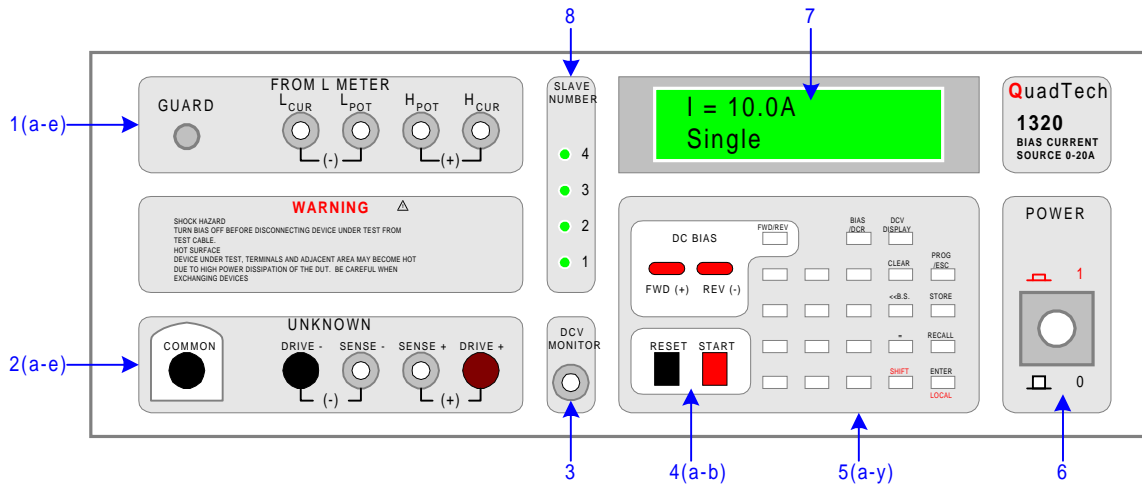
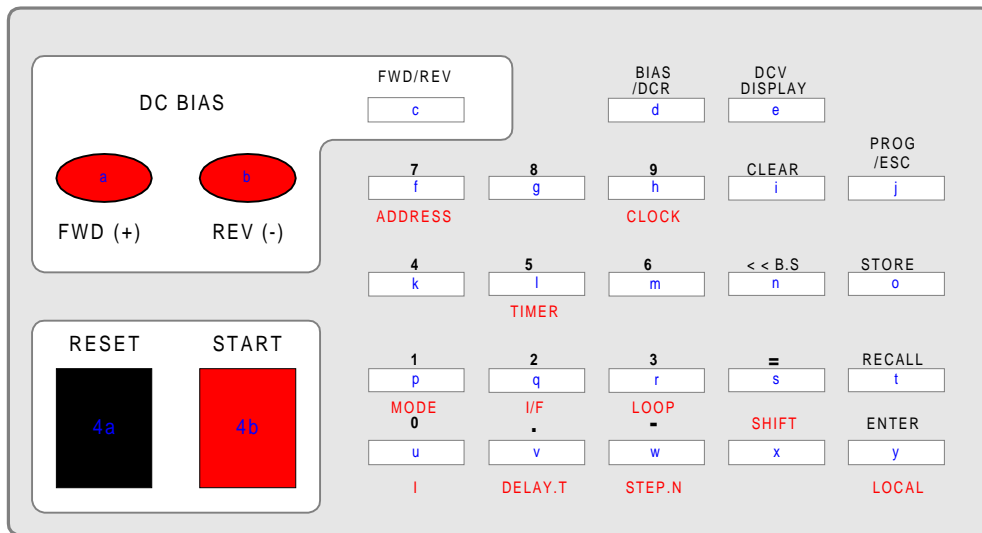


Figure 1-1: 1320 Front Panel Controls and Indicators



The lower case blue letters on the keys do **NOT** appear on the 1320 keypad. They are for illustrative purposes only.

Figure 1-2: Close-up 1320 Front Panel Keypad (4a-b, & 5a-y)



**Table 1-1: 1320 Front Panel Controls and Indicators**

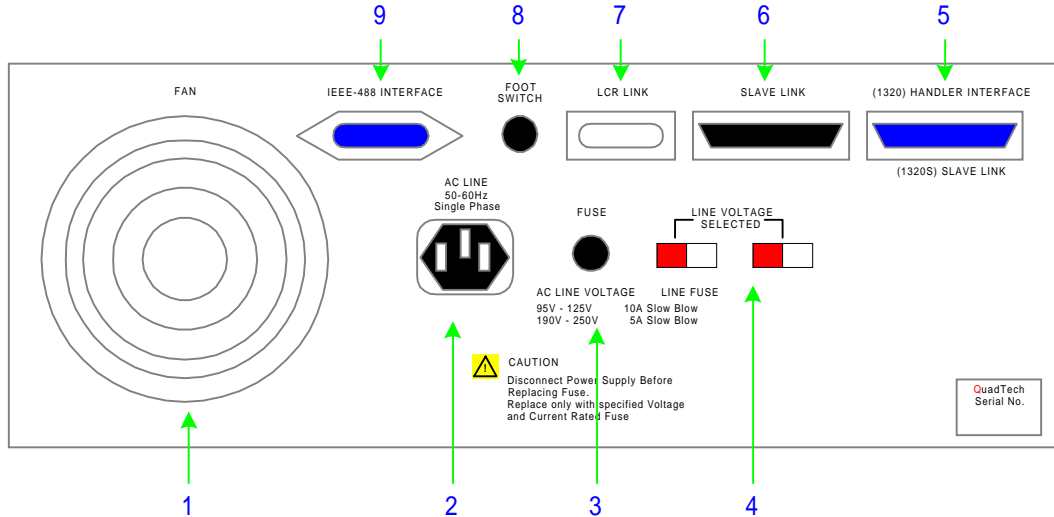
Reference Number Number Figures 1-1 & 1-2	Name	Type	Function
1	<b>FROM L METER</b>		
a	GUARD	Silver Screw/Banana Plug	Instrument Chassis Ground
b	L <sub>CUR</sub>	Silver BNC Connector	Low Current Terminal (-)
c	L <sub>POT</sub>	Silver BNC Connector	Low Potential Terminal (-)
d	H <sub>CUR</sub>	Silver BNC Connector	High Potential Terminal (+)
e	H <sub>POT</sub>	Silver BNC Connector	High Potential Terminal (+)
2	<b>UNKNOWN</b>		
a	COMMON	Black Banana Plug terminal	Current Source Common Terminal
b	DRIVE-	Black Banana Plug terminal	Current Drive (-) Low Terminal
c	SENSE-	Silver BNC Connector	Voltage Sense (-) Low Terminal
d	SENSE+	Silver BNC Connector	Voltage Sense (+) High Terminal
e	DRIVE+	Maroon Banana Plug terminal	Current Drive (+) High Terminal
3	DCV MONITOR	Silver BNC Connector	Connect voltmeter or oscilloscope to view changes in DC voltage at test terminals
4	<b>RESET / START</b>		
a	RESET	Black Push Button Switch	Stop Current Output at test terminals
b	START	Red Push Button Switch	Start Current Output at test terminals
5	<b>DC Bias &amp; Keypad</b>		
a	FWD (+)	Red LED	When lit, Output Current is FORWARD Current
b	REV (-)	Red LED	When lit, Output Current is REVERSE Current
c	FWD/REV	White Push Button Switch	Select FORWARD or REVERSE Output Current
d	BIAS/DCR	White Push Button Switch	Press to show DC Resistance (DCR) on display
e	DCV DISPLAY	White Push Button Switch	Press to show DC Voltage (DCV) drop on display
f	7 ADDRESS	White Push Button Switch	Numerical key. Set an IEEE-488 Address (1-30)
g	8	White Push Button Switch	Numerical key.
h	9 CLOCK	White Push Button Switch	Numerical key. Display Date (M-D-Y), Time (H:M:S)
i	CLEAR	White Push Button Switch	Clear the input value
j	PROG/ESC	White Push Button Switch	Select PROGRAM mode
k	4	White Push Button Switch	Numerical Key.
l	5 TIMER	White Push Button Switch	Numerical Key. Select Timer ON or OFF
m	6	White Push Button Switch	Numerical Key.
n	◀ ◀ B.S	White Push Button Switch	Single Back Space Key or back to last setup key
o	STORE	White Push Button Switch	Store the present test setup
p	1 MODE	White Push Button Switch	Numerical Key. Select Mode: 0=Single, 1=Multi (manual), 2= Multi (Auto)
q	2 I/F	White Push Button Switch	Numerical Key. Select Control Mode 0=Auto Control, 1=Handler, 2= 2200 ATTS

**Table 1-1: 1320 Front Panel Controls and Indicators (Continued)**

Reference Number Number Figures 1-1 & 1-2	Name	Type	Function
r	3 <b>LOOP</b>	White Push Button Switch	Numerical Key. <b>Select Current Measure 0=OFF, 1=ON</b>
s	=	White Push Button Switch	Equal Sign
t	RECALL	White Push Button Switch	Recall Setup in memory
u	0 <b>I</b>	White Push Button Switch	Numerical Key. <b>Select Current: -20.0 to 20.0A</b>
v	. <b>DELAY. T</b>	White Push Button Switch	Decimal Key. <b>Select Delay Time: 0-100seconds</b>
w	- <b>STEP.N</b>	White Push Button Switch	(-) Minus Key <b>Select Step Number: 1-21</b>
x	<b>SHIFT</b>	White Push Button Switch	<b>To Select Key function labeled in RED</b>
Y	ENTER <b>LOCAL</b>	White Push Button Switch	Enter test value. <b>Return unit to front panel operation</b>
6	POWER	Beige 2 position P-B Switch	Provide power. 1 = ON, 0 = OFF
7	DISPLAY	16 x 2 character LCD display	Display Test Setup and Results
8	SLAVE NUMBER	Green LED's labeled: 1, 2, 3, & 4	Indicate which Slave is active

### 1.3.2 Rear Panel Controls and Connectors

Figure 1-3 illustrates the controls and connectors on the rear panel of the 1320 Bias Current unit. Table 1-2 identifies them with description and function.



**Figure 1-3: 1320 Rear Panel Controls and Connectors**

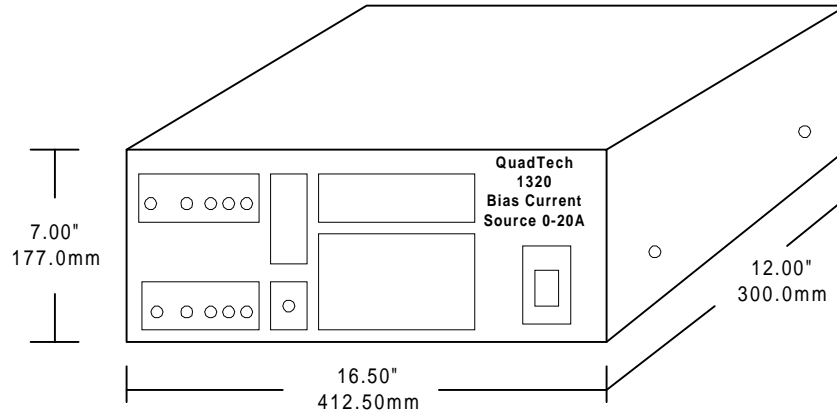
**Table 1-2: 1320 Rear Panel Controls and Connectors**

Reference Number Figure 1-3	Name	Type	Function
1	FAN	AC120V 50/60Hz Fan	50°C On/Off Fan
2	AC LINE	Black 3-wire AC receptacle	Input for AC power
3	FUSE	Black Screw Cap Fuse	Short Circuit Protection 10A for 95 – 125V Operation 5A for 190 – 250V Operation
4	Line Voltage	Red 2-position slide switch	Select 115V or 230V Operation
5	Handler Interface	Blue 24-Pin Connector	Connect Handler
6	Slave Link	Black 25-Pin Connector	Connect Slave
7	LCR Link	Silver 9-Pin Connector	Connect 2200 ATTS (or other LCR meter)
8	Foot Switch	Black ¼" phone jack receptacle	Connect Foot Switch
9	IEEE-488 Interface	Blue 24-Pin Connector	Connect IEEE-488

## 1.4 Installation

### 1.4.1 Dimensions

The 1320 Bias Current unit 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 1320 instrument dimensions.




**Figure 1-4: 1320 Instrument Dimensions**

### 1.4.2 Instrument Positioning

The 1320 Bias Current instrument contains one (16 x 2 character) LCD display with 5-digit resolution for convenient viewing. 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

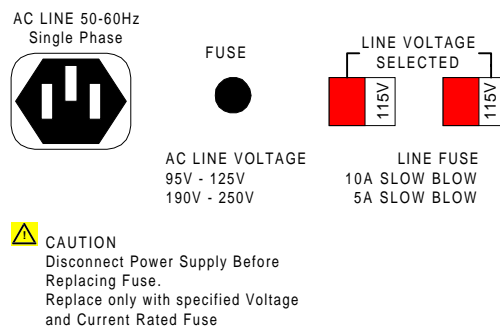
 The 1320 Bias Current Source can be operated from a power source of 95 to 125VAC or 190 to 250VAC. Power connection is via the rear panel through a standard receptacle. Before connecting the 3-wire power cord between the unit and AC power source make sure the voltage selection switch and fuse on the rear panel (Figure 1-5) are in accordance with the power source being used. Use a 10A, 250V SB fuse for 115V operation and a 5A, 250V SB fuse for 230V operation. Always use an outlet that has a properly connected protection ground.

#### Procedure for Changing A 1320 Bias Current Instrument 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 a close up of the rear panel. Remove the black screw cap fuse on the rear panel of the 1320 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 screw cap about  $60^\circ$  counterclockwise. The screw cap should protrude about 3.0 cm from the socket.
- Remove screw cap. Replace with new, same rated 10A, 250V SB fuse for AC 115V operation or 5A 250V SB fuse for AC 230V operation.
- Using a flat head screwdriver, turn the screw cap about  $60^\circ$  clockwise.
- Make sure the voltage selector switch is in accordance with the power source being used.



**Figure 1-5: 1320 Fuse & Voltage Selector (Rear Panel)**

#### 1.4.4 Safety Inspection



Before operating the instrument inspect the screw cap fuse receptacle on the rear panel of the 1320 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 1320 Bias Current 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). Make sure the instrument is only used with the cable supplied (or other approved international cord set) to ensure that the instrument has a secure **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 1320 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.**

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## Section 2: Operation

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### 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	u
.000000001	$10^{-9}$	nano	n
.000000000001	$10^{-12}$	pico	p
.00000000000001	$10^{-15}$	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.

**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 Insulation Resistance or DC hipot test.
Frequency:	The rate at which current or voltage reverses polarity then flows back again, completing a full cycle. Frequency is measured in hertz (Hz) or cycles/second. Normal AC line frequency equals 50/60Hz.
Ground:	The base reference from which voltages are measured nominally the same potential as the earth. 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 with the number of turns squared ( $N^2$ ). The larger the radius or diameter of the coil, the longer the wire used and the greater the inductance.
Inductive Reactance:	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. 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 waveform of this current however is displaced in time from the applied voltage by $90^\circ$ .



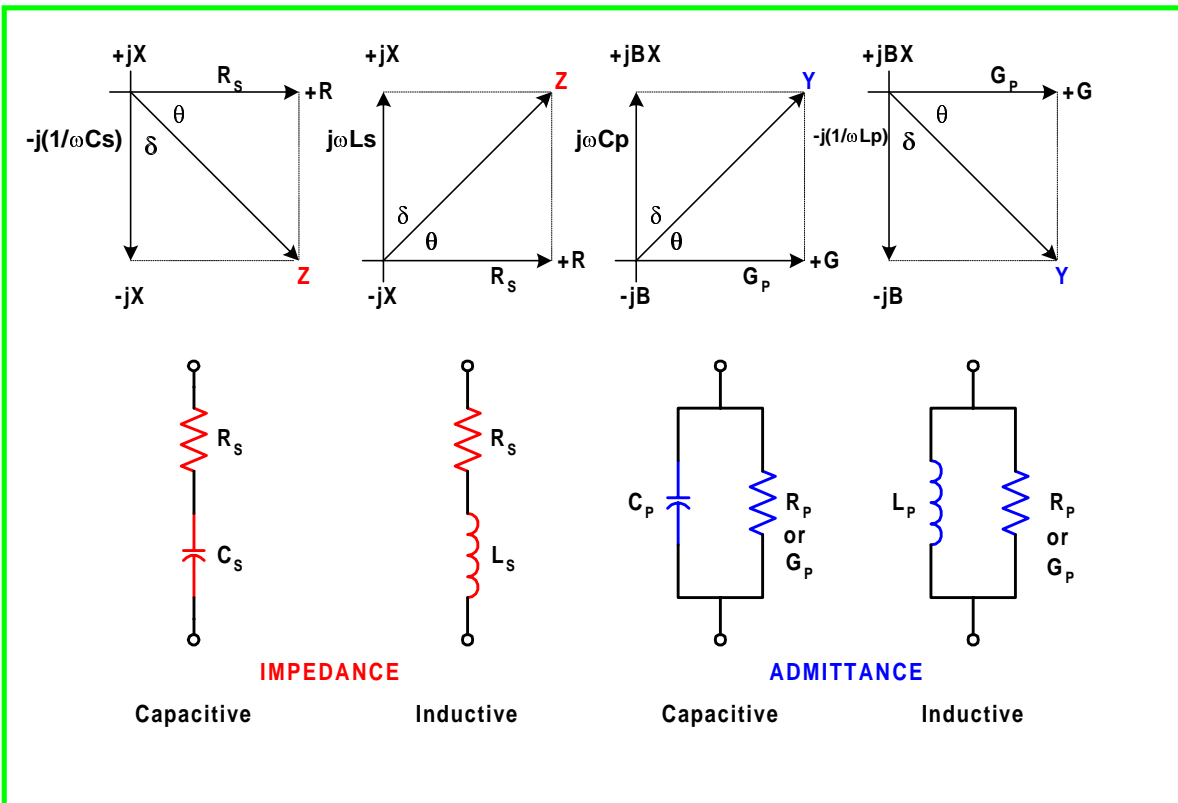
Capacitive Reactance: A measurement of the actual AC resistance of a capacitor.  
 $X_C = 1 / 2\pi fC$ .

Dissipation Factor: Dissipation factor is a measurement of the quality of a capacitor: The lower the  $D_f$ , the better the capacitor. Dissipation factor is equal to resistance divided by reactance.  $D_f = R_s / X_s = 1/Q = \tan(90^\circ - \theta) = \tan\delta$ .

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  $90^\circ$ ) 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.



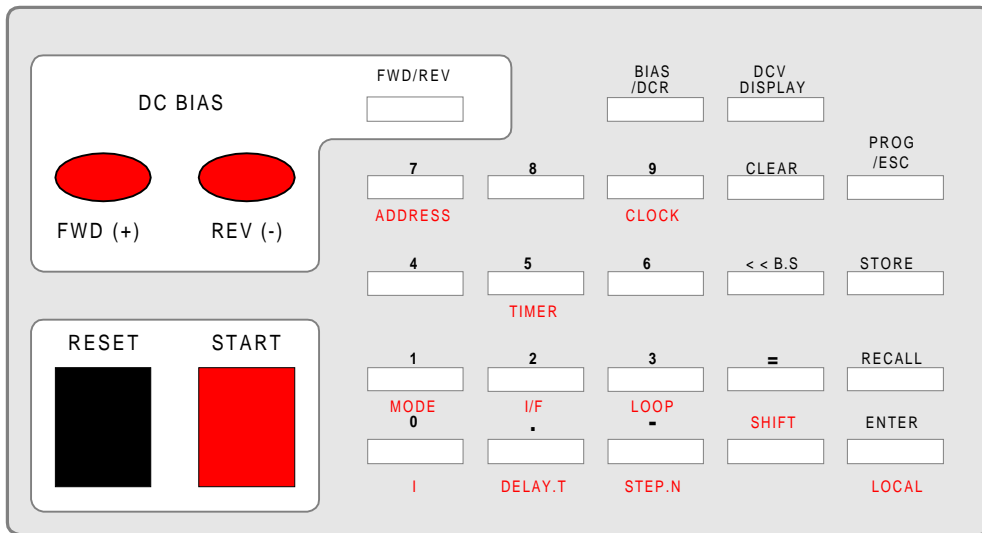
**Figure 2-1: Impedance and Admittance Phase Diagrams & Equivalent Circuits**

## 2.2 System Parameters

The system parameters of the 1320 Bias Current Instrument are defined in Table 2-2 with parameter name, range and default value. The default value listed in Table 2-2 is the initial instrument default value. When the instrument is powered up it defaults to last powered-down conditions. Paragraphs 2.2.1 through 2.2.20 detail the functions of all the keys illustrated in Figure 1-2. When powered-up, the 1320 unit immediately indicates the model number, software version & date; a “Check RAM” message and then automatically displays the test conditions at which the unit was last powered down.

**Table 2-2: 1320 System Parameters**

Name	Parameter	Range	Default Value
I/F	Interface	0=SC, 1=HAN, 2=32X	0
I	Bias Current	-20.0A to 20.0A	Last Test Setup
MODE	Output Current Mode	0=SG, 1=MM, 2=MA	0
ADDRESS	IEEE-488 Address	1-30	3
TIMER	Timer	ON or OFF	OFF
DELAY. T	Delay Time	0-100 seconds	0
STEP.N	Step Number	1-21	1
LOOP	Loop	ON or OFF	OFF



**Figure 2-2: 1320 Keypad**

### 2.2.1 SHIFT

The [SHIFT] key allows the user to access the functions labeled in red on the front panel keypad. These functions are LOCAL, STEP.N, DELAY.T, I, MODE, I/F, LOOP, TIMER, ADDRESS and CLOCK.

**NOTE**

The [PROG/ESC] key must be pressed **FIRST** in order for the [SHIFT] key to be operative.

Press [PROG/ESC]: Display Reads: "PROGRAM"

Press [SHIFT]: Display Reads: "SHIFT"

Press [red function key] Press [=] and enter parameter value(s).

When programming is complete, press [PROG/ESC] to exit program mode.

### 2.2.2 I/F (Interface)

The [I/F] key allows the user to select the interface used with the 1320 instrument: 0=SC or 1=HAN. Pressing the [0] key initiates SC or "Self Control" mode (no interface or an L METER attached). The high/low current output and high/low current switching is internally controlled by the 1320 in SC mode.

Pressing the [1] key initiates Handler control. In HAN mode, the current output is controlled by the 1320 and current switching is controlled by the Handler (ACQ OVER signal control).

Press:	Display Reads:
[PROG]      [SHIFT]      [I/F]	I/F = SELF_CTRL 0: SC, 1: HAN
[=]	I/F = _ 0: SC, 1: HAN
[1]      [ENTER]	I/F =HANDLER 0: SC, 1: HAN
[PROG]	I = -3.000 A Single

Table 2-3 lists the QuadTech LCR instrumentation that is compatible with the 1320 Bias Current Source instrument. When the 1320 instrument IEEE-488 interface is connected and an address defined (§2.2.5), all settings are controlled by the IEEE-488 interface, not the 1320 instrument.

**Table 2-3: Compatible QuadTech LCR Instrumentation**

Series	Model #	Frequency Specification	Compatible Interface	
			Handler	IEEE-488
1700	1750	12Hz – 200kHz	√	√
1900	1910	20Hz – 1MHz	√	√
	1920	20Hz – 1MHz	√	√
	1930	100Hz – 100kHz	√	√
7000	7400	10Hz – 500kHz	√	√
	7600	10Hz – 2MHz	√	√

**2.2.2 I (Bias Current)**

The [I] key allows the user to enter a bias current. The bias current range is -20.0A to 20.0A and the instrument default value is the last test setup. A negative current value is considered a reverse bias current and a positive current value is considered a forward bias current. For example, to enter a reverse bias current of 3.000A, press [PROG/ESC] [SHIFT] [I] [=] [-] [3.000] [ENTER].

**Press:**

**Display Reads:**

[PROG]      [SHIFT]      [I]

I = -2.00A -20.00 - 20.00 A
--------------------------------

[=]

I = _ -20.00 - 20.00 A
---------------------------

[-3.000]      [ENTER]

I = -3.000 -20.00 - 20.00 A
--------------------------------

[PROG]

I = -3.000 A Single
------------------------

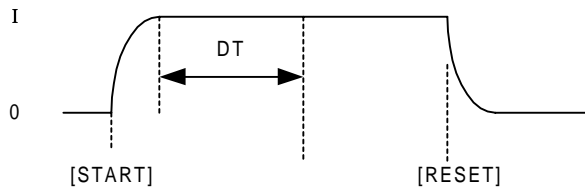
### 2.2.3 MODE

The [MODE] key allows the user to specify the output current mode as SG, MM or MA. Press the [0] key to select SG or single point current testing. Press [1] to select MM or manual multiple point current testing. This is applicable for multi-point current inductance testing and manual recording of the measured result. The Fix Clearance (measure points n, I1, In) and Non-Fix Clearance (n, I1, I2, In) need to be set in MM mode. Press the [2] key to select MA or automatic multiple point current testing. Set a longer delay time in MA mode.

Figure 2-3 illustrates the Single Point Current Mode. Current value (I) and Delay Time (DT) need to be set in SG mode.

#### Single Point Current Mode (Mode=0)

##### Auto Control Mode (I/F=0)

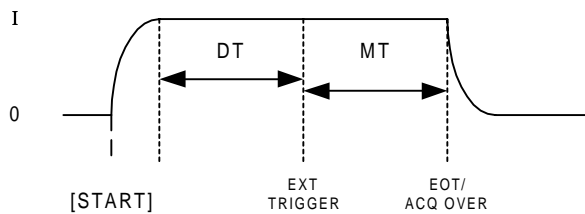


DT = Delay Time

MT = Measurement Time

(L Meter Measuring Time)

##### Handler Mode (I/F=1)

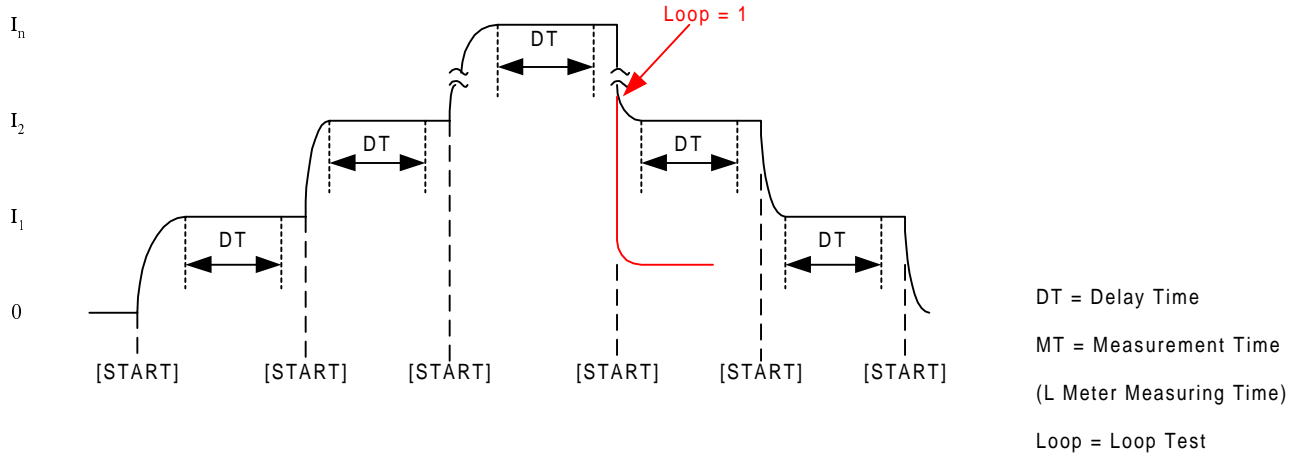


**Figure 2-3 Single Point Current Output Mode (Mode=0)**

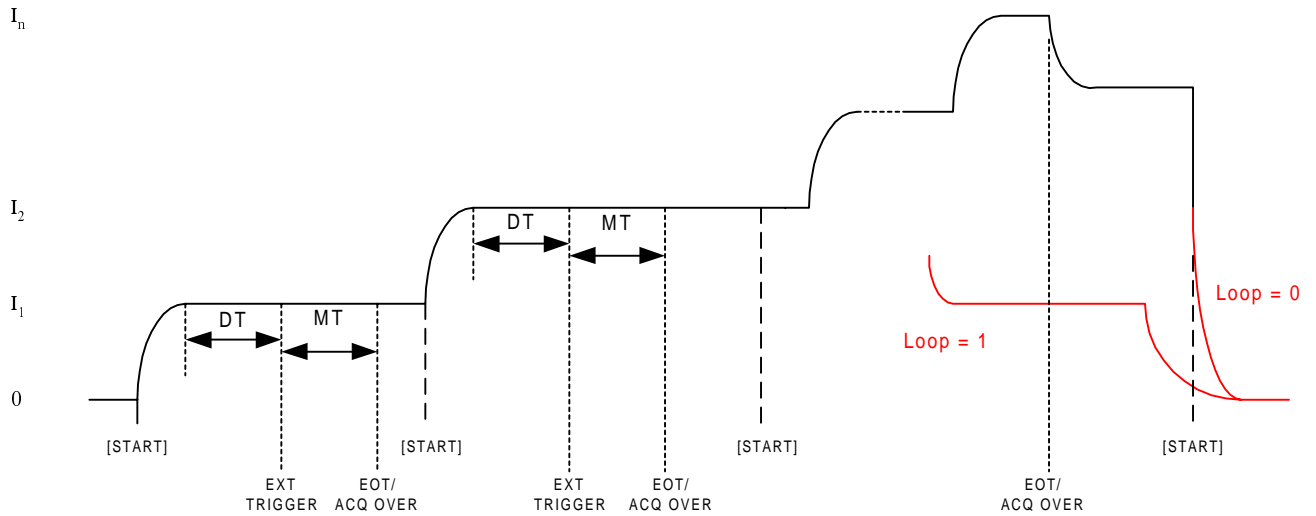
Figure 2-4 illustrates the Multi-Point Manual Current Mode. For a unit interval, the measured points ( $n$ ,  $I_1$  and  $I_n$ ) and Delay Time (DT) need to be set in MM mode. For a non-unit interval, the measured points ( $n$ ,  $I_1$ ,  $I_2 \dots I_n$ ) and Delay Time (DT) need to be set in MM mode.

### Multi-Point Manual Current Mode (Mode=1)

#### Auto Control Mode (I/F=0)



#### Handler Mode (I/F=1)

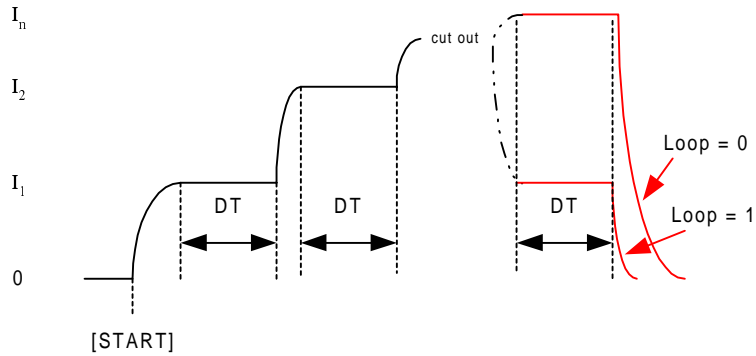


**Figure 2-4: Multi-Point Manual Current Output Mode**

Figure 2-5 illustrates the Multi-Point Auto Current Mode. Set a longer Delay Time (DT) in MA mode.

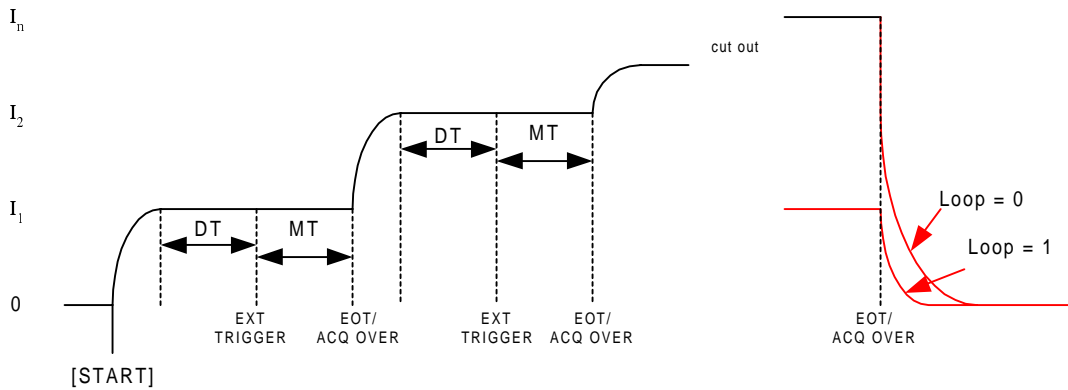
### Multi-Point Auto Current Mode (Mode=2)

#### Auto Control Mode (I/F=0)



DT = Delay Time  
 MT = Measurement Time  
 (L Meter Measuring Time)  
 Loop = Loop Test

#### Handler Mode (I/F=1)



**Figure 2-5: Multi-Point Auto Current Output Mode**

For illustrative purposes, the process of selecting MM and MA mode is shown below. The current test points are I1 = 2.00A, I2 = -2.00A, and I3 = 3.00A.

Press:			Display Reads:
[PROG]	[SHIFT]	[MODE]	MODE = Single 0: SG, 1: MM, 2:MA
[=]	[1]		MODE = MULTI. MAN _ 0: SG, 1: MM, 2: MA
[ENTER]			STEP NUMBER = 3 1 - 21
[ENTER]			Unit Interval? N 0: No, Other: Yes
[0]	[ENTER]		I1 = 2.00 A -20.00 - 20.00 A
[ENTER]			I2 = -2.00 A -20.00 - 20.00 A
[ENTER]			I3 = 3.00 A -20.00 - 20.00 A
[PROG]			STEP NUMBER = 3 Multi Manu



MA (Multiple Auto) mode and a unit interval are selected in this example.

Press:	Display Reads:
[PROG]      [SHIFT]      [MODE]	MODE = Single 0: SG, 1: MM, 2:MA
[=]            [2]	MODE = MULTI. AUTO _ 0: SG, 1: MM, 2: MA
[ENTER]	STEP NUMBER = 3 1 - 21
[ENTER]	Unit Interval? N 0: No, Other: Yes
[1]	Unit Interval? Y 0: No, Other: Yes
[ENTER]	I1 = -2.00 A -20.00 - 20.00 A
[ENTER]	I3 = 3.00 A -20.00 - 20.00 A
[ENTER]	DELAY. T = 30.0 sec 0 - 100 sec
[PROG]	STEP N = 3 Multi Auto

### 2.2.5 ADDRESS

The [ADDRESS] key allows the user to specify an IEEE-488 address. The IEEE-488 address range is 1 - 30 and the instrument default value is 3.

Press:	Display Reads:
[PROG] [SHIFT] [ADDRESS]	ADDRESS = 3 1 - 30
[=]	ADDRESS = _ 1 - 30
[1] [ENTER]	ADDRESS = 1 1 - 30
[PROG]	I = -3.000 A Single

### 2.2.6 CLOCK

The [CLOCK] key allows the user to specify the date and time. The date format is: (MM-DD-YY) and the time format is: (HH:MM:SS).

Press:	Display Reads:
[PROG] [SHIFT] [CLOCK]	06 - 01 -99 (M-D-Y) 10 : 15 : 48 (H:M:S)
[=]	_6 - 01 -99 (M-D-Y) 10 : 15 : 48 (H:M:S)
[0] [6] [0] [2] [9] [9] [1] [0] [1] [5] [5] [2]	_6 - 02 -99 (M-D-Y) 10 : 15 : 52 (H:M:S)
[PROG]	06 - 02 -99 (M-D-Y) 10 : 16 : 52 (H:M:S)

## 2.2.7 TIMER

The [TIMER] key allows the user to enable/disable the internal timer circuit. The Timer range is ON or OFF and the instrument default value is OFF. To select the TIMER ON, press [PROG/ESC] [SHIFT] [TIMER] [=] [1] [ENTER]. The user then inputs the start time in HH: MM: SS format to initiate the TIMER. Press [PROG/ESC] to exit TIMER setting. To disable the TIMER, press [PROG/ESC] [SHIFT] [TIMER] [=] [0] [ENTER].

Press:	Display Reads:
[PROG] [SHIFT] [TIMER]	TIMER = OFF 0: OFF, 1: ON
[=]	TIMER = _ 0: OFF, 1: ON
[1]	TIMER= 1 _ 0: SG, 1: MM, 2: MA
[ENTER]	TIMER SETTING: HH : MM : SS (H : M: S)
[=]	TIMER SETTING: _ H : MM : SS (H : M: S)
[1] [2] [2] [7] [3] [0]	TIMER SETTING: 12 : 27 : 30 (H : M: S)
[PROG]	I = -3.000 A Single

### 2.2.8 DELAY. T (Delay Time)

The [DELAY.T] key allows the user to program a delay time to stabilize output current in a test setup. The Delay Time range is 0 – 100 seconds and the instrument default value is 0. To enter a delay time, press [PROG/ESC] [SHIFT] [DELAY.T] [=] [30] [ENTER]. Press [PROG/ESC] to exit Delay Time setting.

Press:	Display Reads:
[PROG] [SHIFT] [DELAY.T]	DELAY.T = 0 0 - 100 sec
[=]	DELAY.T = _ 0 - 100 sec
[3] [0] [ENTER]	DELAY.T = 30 0 - 100 sec
[PROG]	I = -3.000 A Single

### 2.2.9 STEP.N (Step Number)

The [STEP.N] key allows the user to program a step number in a test setup for multi-point current scanning and measuring. The Step Number range is 1-21 and the instrument default value is 1. To select a Step Number, press [PROG/ESC] [SHIFT] [STEP.N] [=] [1]. Press [PROG/ESC] to exit Step Number setting.

Press:	Display Reads:
[PROG] [SHIFT] [STEP.N]	STEP.N = 1 1 - 21
[=]	STEP.N = _ 1 - 21
[3] [ENTER]	Unit Interval ? Y 0: No, Other: Yes
[0] [ENTER]	I1 = 2.00 A -20.00 - 20.00 A
[ENTER]	I2 = -2.00 A -20.00 - 20.00 A
[ENTER]	I3 = 3.00 A -20.00 - 20.00 A
[PROG]	I = 2.000 A Single

### 2.2.10 LOOP

The [LOOP] key allows the user to select the current measuring loop. The LOOP range is OFF [0] or ON [1] and the instrument default value is OFF. Setting the Loop=0, means the instrument measures a 'normal' current loop ( $I=I_1, I_2, \dots, I_n$ ). Setting the Loop=1, means the instrument measures a 'go to and return' loop ( $I=I_1, I_2, \dots, I_n, I_{n-1}, \dots, I_2, I_1$ ). The 'Go To and Return' Loop is applicable to analysis of iron core characteristics such as magnetic residue and magnetic saturation.

Press:	Display Reads:
[PROG] [SHIFT] [LOOP]	LOOP = OFF 0: OFF, 1: ON
[=]	LOOP = _ 0: OFF, 1: ON
[1] [ENTER]	LOOP = ON 0: OFF, 1: ON
[PROG]	I = -3.000 A Single

### 2.2.11 LOCAL

The [LOCAL] key allows the user to select the 1320 front panel operational when the instrument is being used in the IEEE-488 remote state.

Press:	Display Reads:
[SHIFT] [LOCAL]	PROGRAM

#### NOTE

If the local lockout (LLO) function is enabled by the IEEE-488 port, then the [LOCAL] key on the 1320 front panel is inoperative.

## 2.2.12 PROG/ESC

The [PROG/ESC] key allows the user to enter/exit the programming mode.

Press:	Display Reads:
[PROG/ESC]	PROGRAM

In programming mode, the user can enter the bias current, delay time, mode, interface, address, step number or current loop. Example: program a single point, reverse bias 3A current test. Press [PROGRAM] [SHIFT] then [MODE]. Press [=] then [0] to select SG mode that is equal to a single point current test. Display will revert to current setup with "I = 2.00 A, -20.00 - 20.00 A". Press [=]. Enter a reverse 3A current by pressing [-] [3.000] [ENTER]. Display will show "I = -3.000, -20.00 - 20.00 A". Press [PROG/ESC] to accept and exit programming mode.

Press:	Display Reads:
[PROG]    [SHIFT]    [MODE]	MODE = SINGLE 0: SG, 1: MM, 2: MA
[=]	MODE = _ 0: SG, 1: MM, 2: MA
[0]	MODE = SINGLE    _ 0: SG, 1: MM, 2: MA
[ENTER]	I = 2.00 -20.00 - 20.00 A
[=]	I = _ -20.00 - 20.00 A
[-]        [3.000]    [ENTER]	I = -3.000 A -20.00 - 20.00 A
[PROG]	I = -3.000 A Single

### 2.2.13 STORE

The [STORE] key allows the user to store the present test setup in one of 50 internal memory locations. Example: Store test setup in location 3. Press [STORE]. Display shows last storage setup. Press [=]. Storage location space flashes on display. Press [3] [ENTER]. Display reverts back to test setup.

**NOTE**

The memory is “write-over” memory so if new data is stored to a memory location with data already in it, the old data of that location will be written over.

Press:	Display Reads:
[STORE]	STORE = 2 0 - 49
[=]	STORE = _ 0 - 49
[3]      [ENTER]	I = 3.000 A Single

The 1320 instrument has two memory storage methods: AUTO (power down conditions) and STORE ([STORE] command activated). Table 2-4 lists the test parameters that are saved under power down conditions or the [STORE] command.

**Table 2-4: 1320 Memory Storage**

Memory Storage Method	
AUTO (Power Down)	[STORE]
ADDRESS	
MODE	MODE
I/F	I/F
LOOP	LOOP
I	I
STEP.N	STEP.N
DELAY.T	DELAY.T
TIMER	TIMER
FWD/REV	FWD/REV
CLOCK	



## 2.2.14 RECALL

The [RECALL] key allows the user to recall a test setup from one of 50 internal memory locations. If the user recalls an empty memory location then the display prompts “No data!”. Example: Recall test setup in location 2. Press [RECALL]. Display shows last recall location. Press [=]. Recall location space flashes on display. Press [2] [ENTER]. Display shows test setup in memory location 2.

Press:	Display Reads:
[RECALL]	RECALL = 3 0 - 49
[=]	RECALL = _ 0 - 49
[2] [ENTER]	I = - 2.000 A Single

## 2.2.15 CLEAR

The [CLEAR] key allows the user to clear the line of a present test entry or test setup.

**NOTE**

This key also allows the user to clear ALL of memory by pressing [PROG] [SHIFT] [CLEAR] [1].  
The display immediately prompts the user to shut the power OFF.  
**ALL MEMORY IS THEN CLEARED.**

### 2.2.16 ◀◀ B.S

The [◀◀ B.S] key allows the user to backspace when entering test setups. Instead of clearing the whole line, the user can backspace by single characters.

#### NOTE

This key also allows the user to clear ALL of memory by pressing [PROG] [SHIFT] [◀◀ B.S] [1].  
The display immediately prompts the user to shut the power OFF.  
**ALL MEMORY IS THEN CLEARED.**

Press:

[PROG]      [SHIFT]      [B.S]

[1]

Display Reads:

ARE YOU SURE ?  
1: YES, OTHER: NO

Please...  
POWER OFF

### 2.2.17 ENTER

The [ENTER] key allows the user to input and accept data in the Programming mode. In the Recall or Store mode, the [ENTER] key confirms (accepts) the recalled or stored setup.

### 2.2.18 DCV Display

The [DCV Display] key allows the user to select the DC Voltage Drop shown on the display. In the test state, press [DCV Display] to have the DC Voltage Drop exhibited on the second line of the display. If the 1320 instrument does NOT display DCV readings when the [DCV DISPLAY] button is pressed, then:

1. Press [PROG/ESC]
2. Press [SHIFT]
3. Press [I/F]
4. If top of display shows 'I/F = Handler', press [=] [0]. Display must now show 'I/F = Self\_CTRL'.
5. Press [PROG/ESC] to exit.
6. Press [START]. Wait for test to finish, then press [DCV DISPLAY]. The 1320 will now display DCV readings.

#### NOTE

The [DCV DISPLAY] functions in SINGLE mode only.  
DCV Display is not available when the 1320 instrument is in Multi-Manual or Multi-Auto mode and/or I/F is set to Handler.

### 2.2.19 BIAS/DCR

The [BIAS/DCR] key allows the user to toggle between DC Bias Current Output and a DCR (DC Resistance) test. Press [BIAS/DCR] then press [START] to measure the DC resistance of the DUT and show it on the display.

Press:		Display Reads:
[BIAS/DCR]	1x	<div style="border: 1px solid black; padding: 5px; width: fit-content;">I = -1.000A Single</div>
[BIAS/DCR]	2x	<div style="border: 1px solid black; padding: 5px; width: fit-content; text-align: center;">DCR TEST</div>

### 2.2.20 FWD/REV

The [FWD/REV] key allows the user to select the direction (bias) of the current. FWD (Forward) current has a positive value. The DC BIAS FWD (+) light indicates the output current is forward current. REV (Reverse) current has a negative value. The DC BIAS REV (-) light indicates the output current is reverse current.

## 2.3 Startup

Check to make sure the line voltage selector on the rear panel of the 1320 Bias Current instrument agrees with the AC power source available, if not refer to paragraph 1.4.3.

Connect the 1320 instrument AC power cord to the source of proper voltage. The instrument is to be used only with 3-wire grounded outlets.

## 2.4 Zero Function

When the 1320 Bias Current Source is connected to an LCR meter ('to L METER') with a Zero (or Offset) function, zero the test leads connected to the 1320 BCS UNKNOWN terminals with an OPEN connection and a SHORT connection. Connect the test leads in OPEN configuration and follow the LCR Meter's open circuit compensation procedure. Connect the test leads in SHORT configuration and follow the LCR Meter's short circuit compensation procedure. Some LCR Meters may fail in OPEN configuration due to a lower noise allowance capability. If this happens, disconnect the test leads from the 1320 BCS and zero the LCR Meter. If the impedance of the UNKNOWN is  $<10\text{k}\Omega$ , the affected accuracy will be within instrument specification.

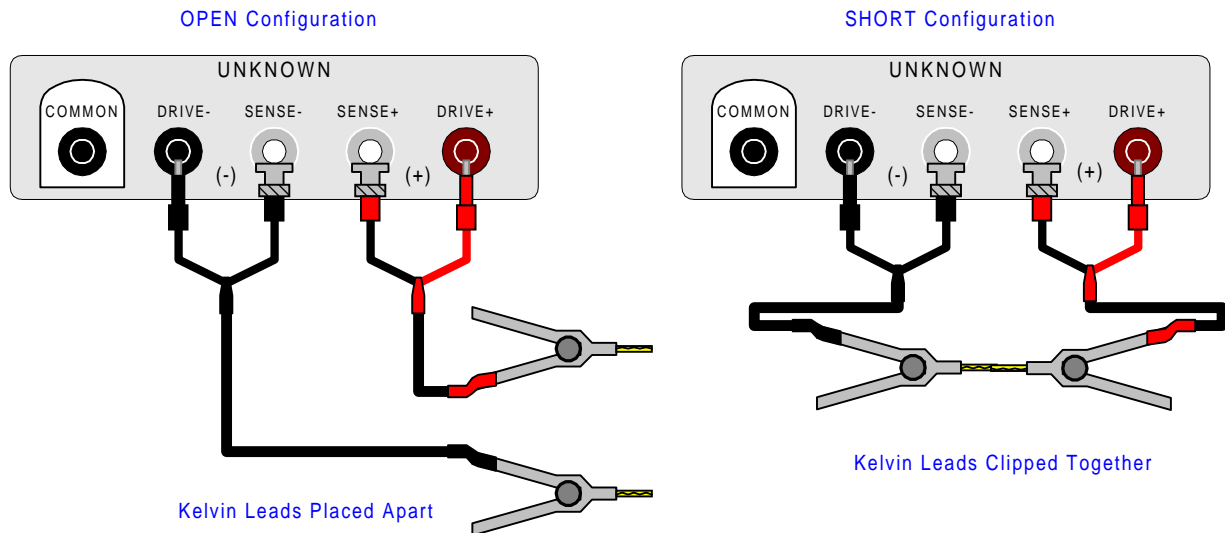


Figure 2-6: Lead Connections for Zero Function

### WARNING

When the DC BIAS [FWD (+) or REV (-)] LED is lit or flashing, there is high current present at the UNKNOWN [SENSE+ & DRIVE+] terminals.

## 2.5 Connection to Device Under Test

### 2.5.1 Connection to a Single DUT

Figure 2-7 illustrates the connection of a device under test to the 1320 instrument using the Red/Black Banana/BNC to Kelvin Clip Cable Lead set. This cable set (QuadTech P/N 1320-01) is supplied with the unit and is illustrated in Figure 2-8.

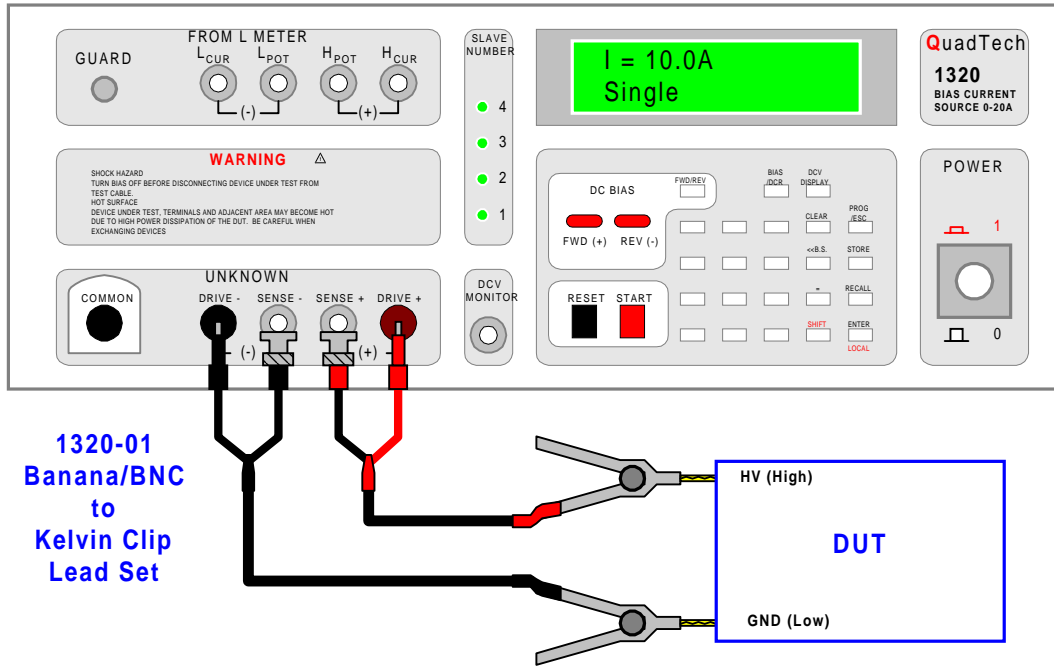


Figure 2-7: Connection to Device Under Test (DUT)

Connect the red banana plug to the maroon DRIVE+ terminal and the red BNC socket to the SENSE+ terminal on the 1320 front panel. Connect the red Kelvin clip to the HIGH terminal of the DUT. Connect the black banana plug to the DRIVE- terminal and the black BNC socket to the SENSE- terminal on the 1320 front panel. Connect the black Kelvin clip to the LOW terminal of the DUT.

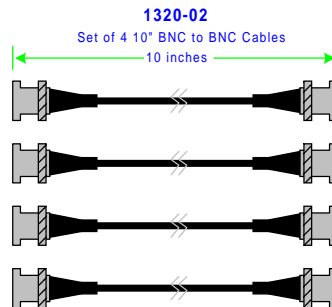


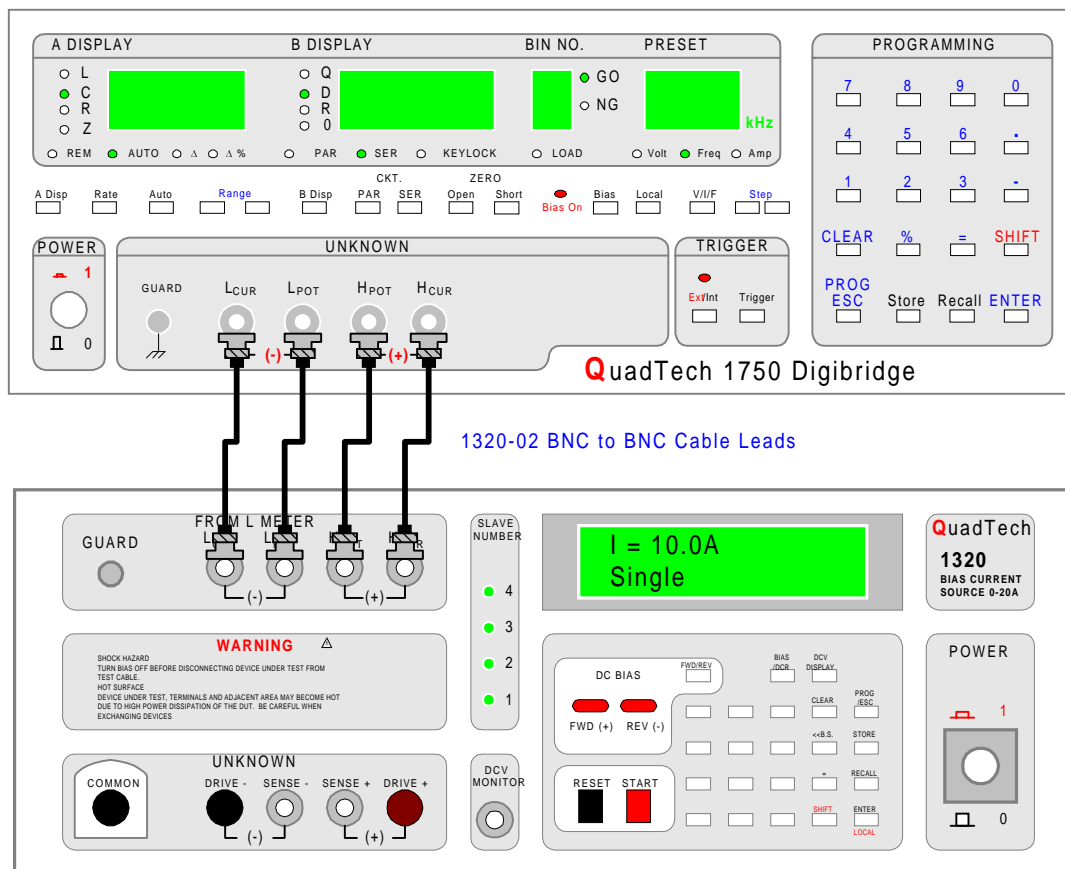
Figure 2-8: 1320-02 Test Leads

## 2.5.2 Connection to a 1750 Digibridge

The 1320 Bias Current Source can easily be connected to other LCR instrumentation. Figure 2-8 illustrates the set of 4 BNC to BNC cables (P/N 1320-02) used to connect the 1320 Current Source to an LCR Meter with BNC output terminals. Figure 2-9 illustrates the front panel connection of the 1320 Bias Current Source to the 1750 Digibridge instrument. Connect the two instruments using the 1320-03 cable lead set. Connect the BNC leads from the 1320 Current Source to the 1750 Digibridge as illustrated in Figure 2-10 and listed in Table 2-5.

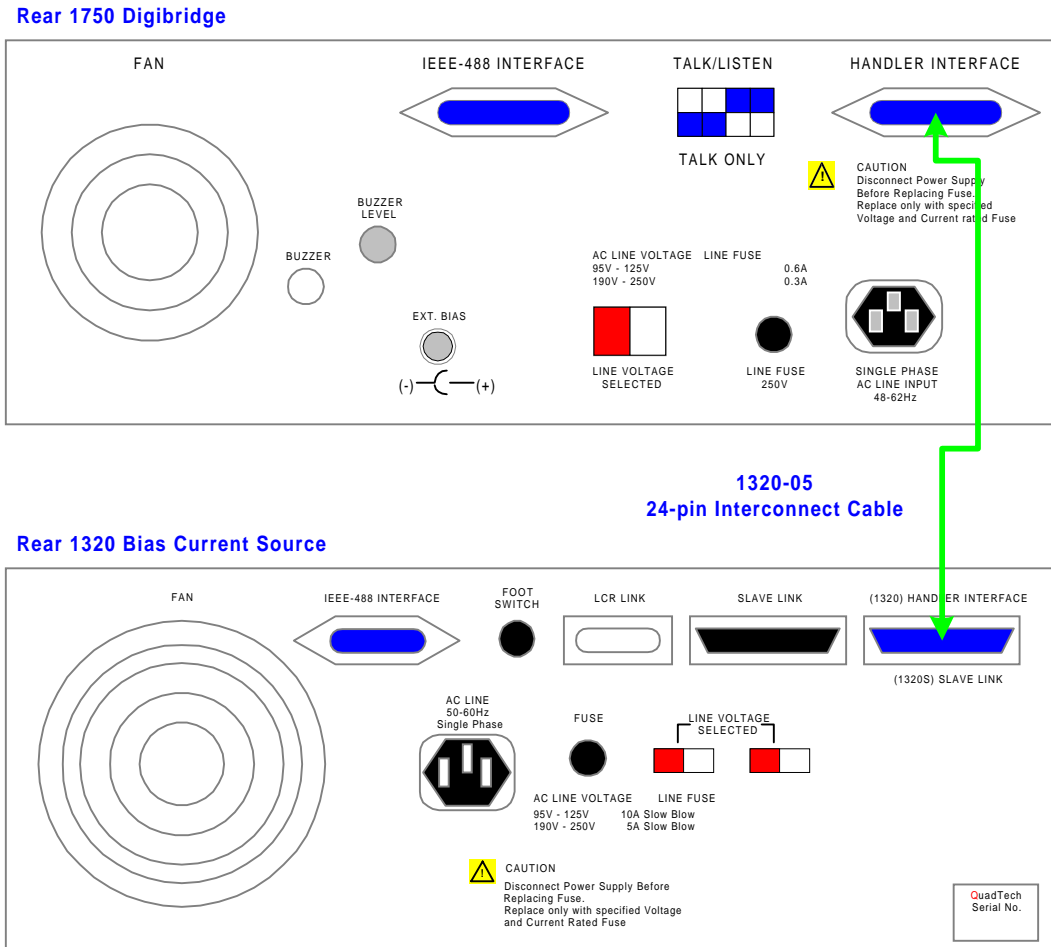
**Table 2-5: 1320-03 Lead Connections**

1320 FROM L METER Terminal	1320-03 Lead	1750 UNKNOWN Terminal	7000 Output Terminal	1910 Output Terminal
H <sub>POT</sub>	<b>PH</b> (Red/White)	H <sub>POT</sub>	PH	PH
H <sub>CUR</sub>	<b>IH</b> (Red)	H <sub>CUR</sub>	IH	IH
L <sub>CUR</sub>	<b>IL</b> (Black)	L <sub>CUR</sub>	IL	IL
L <sub>POT</sub>	<b>PL</b> (Black/White)	L <sub>POT</sub>	PL	PL



**Figure 2-9: Front Panel Connection 1320 to 1750 Digibridge**

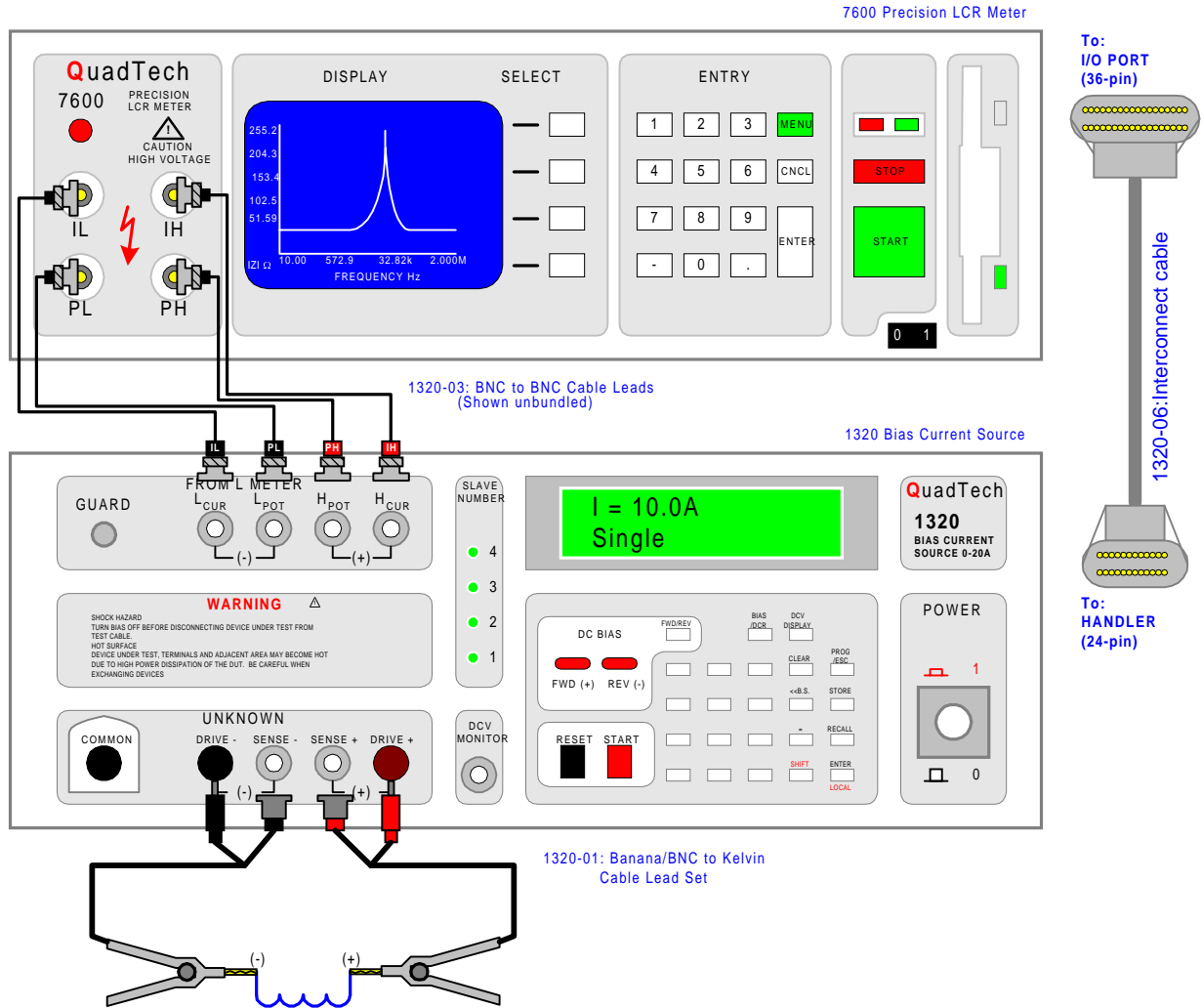
Figure 2-10 illustrates the rear panel connection of the 1320 Current Source to the 1750 Digibridge via the 1320-05 24-pin interconnect cable. Connect the 24-pin interconnect cable between the HANDLER interface on the 1320 unit and the HANDLER interface on the 1750 unit.



**Figure 2-10: Rear Panel Connection 1320 to 1750 Digibridge**

### 2.5.3 Connection to a 7000 Series Precision LCR Meter

Figure 2-11 illustrates the front panel connection of the 1320 Bias Current Source to the 7600 Precision LCR Meter. Connect the two instruments using the 1320-03 cable lead set. Connect the BNC leads from the 1320 Current Source to the 7600 LCR Meter as illustrated in Figure 2-11 and listed in Table 2-5.



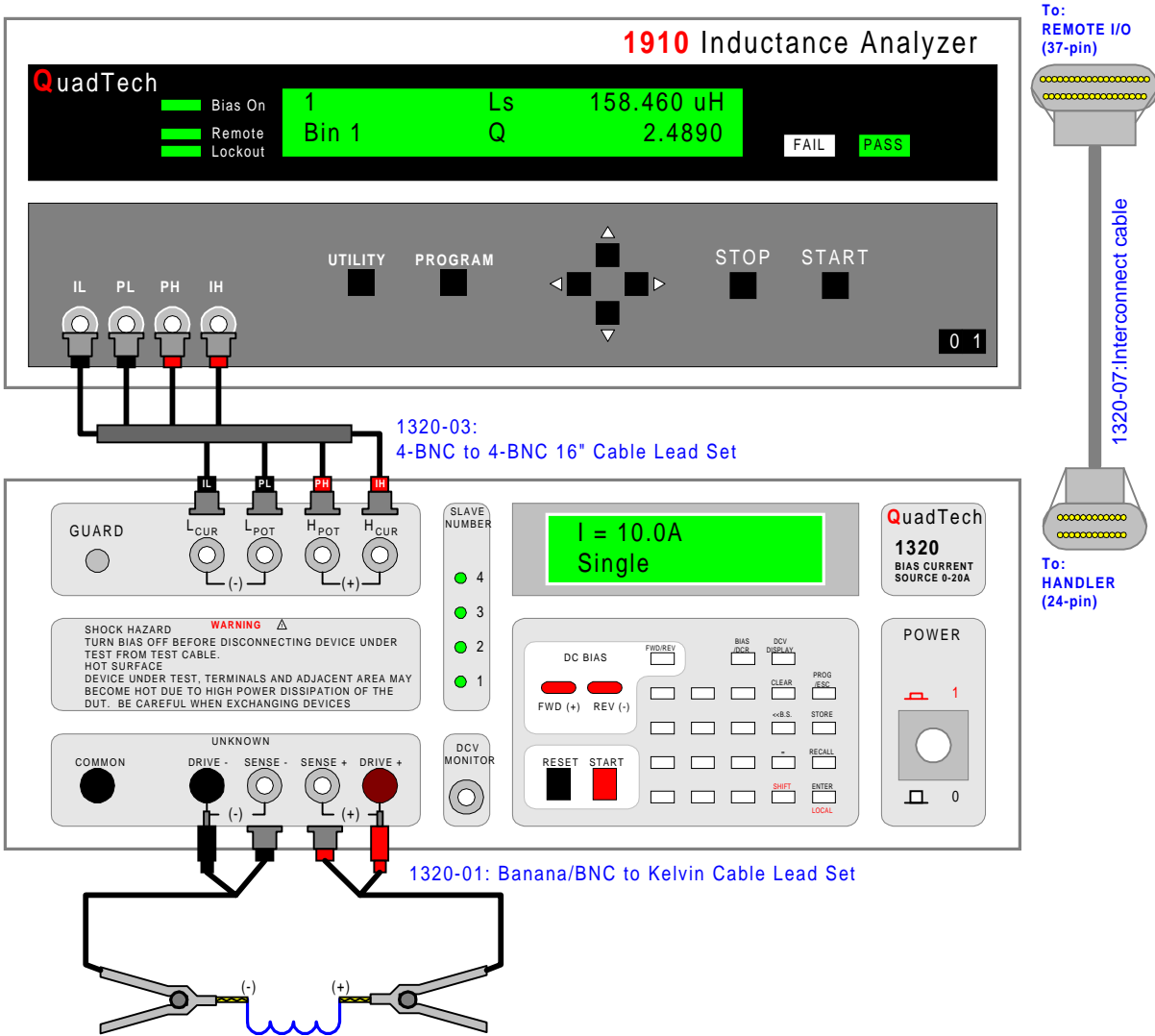
**Figure 2-11: Connection of 1320 Current Source to 7000 Series Meter**

Using the 1320-06 Interconnect Cable, connect the 24-pin connector to the “HANDLER INTERFACE” terminal on the rear of the 1320 unit and connect the 36-pin connector to the “I/O PORT” terminal on the rear of the 7000 Series unit.



## 2.5.4 Connection to a 1900 Series Precision Impedance Meter

Figure 2-12 illustrates the front panel connection of the 1320 Bias Current Source to the 1910 Inductance Analyzer. Connect the two instruments using the 1320-03 cable lead set. Connect the BNC leads from the 1320 Current Source to the 1910 Inductance Analyzer as illustrated in Figure 2-12 and listed in Table 2-5.



**Figure 2-12: Connection of 1320 Current Source to 1910 Inductance Analyzer**

Using the 1320-07 Interconnect Cable, connect the 24-pin connector to the “HANDLER INTERFACE” terminal on the rear of the 1320 unit and connect the 37-pin connector to the “REMOTE I/O” terminal on the rear of the 1910 unit.

When an LCR meter is linked to the 1320 BCS instrument, additional error is incurred. This error can be broken down into three factors: impedance ( $E_Z$ ), frequency ( $E_F$ ) and current ( $E_I$ ). The additional error was calculated under the following measurement conditions.

1. QuadTech 1750 LCR Meter
2. Measurement Speed = Slow or Medium
3. Test Voltage = 0.25Vrms
4. 1320-02: 4-BNC Test Leads Box to Test Leads Box Set
5. SHORT zero compensation performed
6. Temperature = 23°C ±5°C
7. Quality Factor (Q) > 1

**Additional Impedance Error ( $|Z|$ ):**

$$|Z| = \pm 1\% (1 + E_Z + E_F + E_I)$$

$E_Z$  = UNKNOWN impedance factor error

$E_F$  = Instrument frequency factor error

$E_I$  = Instrument current factor error

If Q < 10, multiply  $|Z|$  by  $(1 + 1/Q)$

**Unknown Impedance Factor ( $E_Z$ )**

UNKNOWN Impedance ( $\Omega$ )	- 1 $\Omega$	1 - 1k $\Omega$	1k $\Omega$ -
$E_Z$	5 log 1/ Z	0	5 (log  Z  - 3)

**Instrument Frequency Factor ( $E_F$ )**

Frequency Range (Hz)	20 - 100Hz	100 - 1kHz	1k - 100kHz	100k - 300kHz	300k - 1MHz
$E_F$	3	1	0	1	3

**Instrument Current Factor ( $E_I$ )**

Current Range (A)	0 - 1A	1 - 5A	5 - 20A	20 - 100A
$E_I$	0	1	2	4

**Additional Impedance Error ( $Z_L$ ) due to inductance:**

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

f = measurement frequency

L = measured inductance

### Additional Phase Angle Error ( $\theta E$ )

$$\theta E = \frac{ZE [\%]}{\pi (100)} [^\circ]$$

### Additional Quality Factor Error (QE)

$$QE = \pm \frac{[\tan\theta E (1 + Q^2)]}{(1 - Q \tan\theta E)}$$

When  $Q < 10$ , multiply QE by  $(1 + 1/Q)$

### Additional ESR (Equivalent Series Resistance) Error

The ESR error is part of the  $|Z|$  error.

### Example of Additional Error Calculation

Calculate the added L-Q error.

Measuring Conditions:

Inductance:	1mH
Quality Factor:	20
Measurement Frequency:	10kHz
DC Bias Current:	1A

1. Calculate Impedance ( $|Z_L|$ ) to obtain Inductance error (LE)

$$|Z_L| = 2\pi \times 10k \times 1mH = 62.8$$

Check Tables:  $E_z = 0$ ,  $E_F = 0$ ,  $E_I = 0$

$$LE = |Z| = \pm 1\% (1 + E_z + E_F + E_I)$$

$$LE = |Z| = \pm 1\% (1 + 0 + 0 + 0)$$

$$LE = |Z| = \pm 1\% (1)$$

$$LE = |Z| = \pm 1\%$$

2. Phase Angle ( $\theta E$ )

$$\theta E = \frac{ZE [\%]}{\pi (100)} [^\circ] \quad \theta E = \frac{80 [\pm 1]}{\pi (100)} [^\circ] \quad \theta E = \pm 0.573^\circ$$

3. Quality Factor (QE)

$$QE = \pm \frac{[\tan\theta E (1 + Q^2)]}{(1 - Q \tan\theta E)} \quad QE = \frac{[.01 \times 401]}{[(1-20 \times .01)]} \quad QE = \pm 5$$

## 2.6 Measurement Procedure

The 1320 BCS System Parameters are specified in paragraph 2.2. Table 2-2 details each parameter's range and default value (if applicable). The 1320 BCS instrument is capable of supplying bias current or performing a DC resistance measurement.

### 2.6.1 Bias Current Source Measurement

To use the 1320 Bias Current Source instrument as a current source, follow the programming instructions listed below. Figure 2-20 details the full Programming Parameters in flowchart form and Table 2-6 describes the operation steps.

#### Bias Programming Instructions

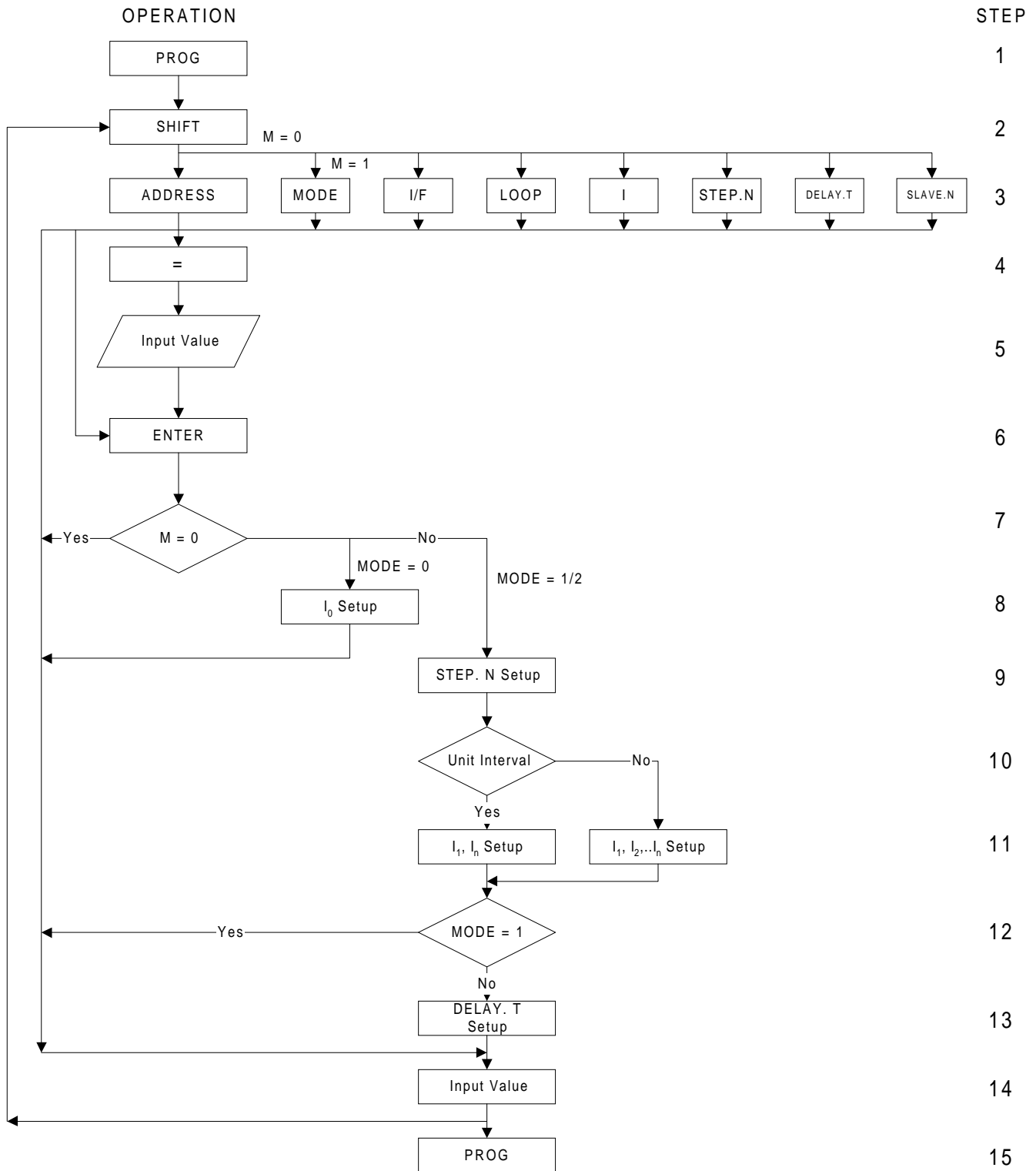
1. Turn POWER ON [1].
2. Allow the 1320 instrument to warm-up for 15 minutes.
3. Select TEST = BIAS  
Press [BIAS/DCR] so display reads "I = 2.000A" (Last test setup)
4. Select MODE = 0 (Single), 1 (Multi/Manual) or 2 (Multi/Auto)  
Press [PROG/ESC] [SHIFT] [MODE] [=] [0]
5. Select CURRENT = Value from -20.00 to 20.00A  
Press [PROG/ESC] [SHIFT] [I] [=] [-3.000] [ENTER]

#### NOTE

**If MODE has just been programmed, then press only: [=][-3.000] [ENTER]**

It is possible to now zero the test cables, connect the device under test and press the START button. Or continue programming other test variables as specified below.

6. Select CURRENT LOOP = OFF (0) or ON (1).  
Press [SHIFT] [LOOP] [=] [0] [ENTER]
7. Select TIMER = OFF (0) or ON (1).  
Press [SHIFT] [TIMER] [=] [1] [ENTER]  
Enter the time the TIMER will be turned on: [HH] [MM] [SS].  
Press [PROG/ESC] to exit TIMER setting
8. Connect Test Cables or Test Fixture (¶2.5).
9. Enable Zero Function (¶2.4).
10. Connect Device under Test (DUT) (¶2.5).
11. Press red [START] button to initiate test.
12. Press black [RESET] button to terminate current at output terminals.



**Figure 2-20: Programming Parameters Flowchart**

**Table 2-6: Programming Parameters**

<b>STEP #</b>	<b>Press [BUTTON]</b>	<b>Operation Description</b>
1	[PROG/ESC]	Enter programming Mode
2	[SHIFT]	Select a setup parameter
3	[ADDRESS]	Setup IEEE-488 address
	[MODE]	Select Current Output Mode
	[I/F]	Select Interface (Instrument Control) Mode
	[LOOP]	Select Current Loop Test (Points a-b, b-a)
	[I]	Select Current Output Value
	[STEP.N]	Select Number of Current Measuring Points
	[DELAY.T]	Select Delay Time
	[SLAVE.N]	Select SLAVE
4	[=]	Change the setup value
5	Program Key	Numerical, Decimal & Minus keys used to Input a Value
6	[ENTER]	Accept Input Value and Continue to next setup parameter
7	MODE flag marks judgement	To select MODE judgement or not
8	When MODE=0, Setup I	Setup Current
9	When MODE=1/2, Setup STEP.N	Setup # of Current Measuring Points
10	Select Clearance	Select Clearance of Current Measuring Points
11	Setup I1, In	1320 will average clearance values
	Setup I1, I2, ...In	User judges clearance values
12	MODE = 1 or 2 judgement	Select MODE 1 or MODE 2 judgement
13	When MODE=2, Setup DELAY.T	Setup Delay Time
14	Input value	Input Value using Numerical, Decimal & Minus keys
15	[PROG]	Exit Programming Mode

### 2.6.1.1 Programming Example #1: Single Point Current

Single Point Current Test, 5A Output, Auto Control Mode.

Press [BUTTON]	Display will show:
[PROG/ESC]	PROGRAM
[SHIFT]	SHIFT _
[I]	I = 0.00 A -20.00 - 20.00 A
[=]	I = _ _ -20.00 - 20.00 A
[5]	I = 5 _ _ -20.00 - 20.00 A
[ENTER]	I = 5.00 -20.00 - 20.00 A
[SHIFT]	SHIFT _
[MODE]	MODE = Single 0: SG, 1: MM, 2: MA
[=]	MODE = _ 0: SG, 1: MM, 2: MA
[0]	MODE = Single _ 0: SG, 1: MM, 2: MA
[ENTER]	MODE = Single 0: SG, 1: MM, 2: MA
[SHIFT]	SHIFT _
[I/F]	I/F = SELF _ CTRL 0: SC, 1: HAN, 2: 32X
[=]	I/F = _ 0: SC, 1: HAN, 2: 32X
[0]	I/F = SELF _ CTRL _ 0: SC, 1: HAN, 2: 32X
[ENTER]	I/F = SELF _ CTRL 0: SC, 1: HAN, 2: 32X
[PROG/ESC]	I = 5.000 A Single

### 2.6.1.2 Programming Example #2: Multi-Point Current

Multi-Point Current Test, 1750 plus Handler, 0-10A Clearance, 0.5A, 21 points, Auto Control Mode, 5 second Delay Time.

Press [BUTTON]	Display will show:
[PROG/ESC]	PROGRAM
[SHIFT]	SHIFT _
[I/F]	I/F = SELF _ CTRL 0: SC, 1: HAN, 2: 32X
[=] [1] [ENTER]	I/F = Handler 0: SC, 1: HAN, 2: 32X
[SHIFT]	SHIFT _
[MODE]	MODE = Single 0: SG, 1: MM, 2: MA
[=] [2]	MODE = Multi Auto _ 0: SG, 1: MM, 2: MA
[ENTER]	STEP NUMBER = 1 1 -21
[=]	STEP NUMBER = _ 1 -21
[2] [1] [ENTER]	Unit Interval ? N 0: No, Other: Yes
[=] [1]	Unit Interval ? Y _ 0: No, Other: Yes
[ENTER]	I1 = 0.000 A -20.00 - 20.00 A
[=] [0]	I1 = 0 _ -20.00 - 20.00 A
[ENTER]	I21 = 0.000 A -20.00 - 20.00 A
[=] [1] [0]	I21 = 10 _ -20.00 - 20.00 A
[ENTER]	DELAY. T = 0.5 sec 0 - 100 sec
[=] [5] [ENTER]	DELAY. T = 5 0 - 100 sec
[PROG/ESC]	STEP N : 21 Multi Auto



### 2.6.1.3 Programming Example #3: Multi-Point Current Loop

Multi-Point Current Test, 1750 plus Handler, 0-10A Clearance, 0.5A, 21 points, Multi

Press [BUTTON]	Display will show:
[PROG/ESC]	PROGRAM
[SHIFT]	SHIFT _
[I/F]	I/F = SELF _ CTRL 0: SC, 1: HAN, 2: 32X
[=] [1] [ENTER]	I/F = Handler 0: SC, 1: HAN, 2: 32X
[SHIFT]	SHIFT _
[MODE]	MODE = Single 0: SG, 1: MM, 2: MA
[=] [1]	MODE = Multi MAN _ 0: SG, 1: MM, 2: MA
[ENTER]	STEP NUMBER = 21 1 -21
[=]	STEP NUMBER = _ 1 -21
[2] [1] [ENTER]	Unit Interval ? N 0: No, Other: Yes
[=] [1]	Unit Interval ? Y _ 0: No, Other: Yes
[ENTER]	I1 = 0.000 A -20.00 - 20.00 A
[=] [0]	I1 = 0 _ -20.00 - 20.00 A
[ENTER]	I21 = 0.000 A -20.00 - 20.00 A
[=] [1] [0] [ENTER] [ENTER]	I21 = 10.000 A -20.00 - 20.00 A
[SHIFT] [LOOP]	LOOP = OFF 0: OFF, 1: ON
[=] [1] [ENTER]	LOOP = ON 0: OFF, 1: ON
[PROG/ESC]	STEP N : 21 Multi Manu

Manual operation, Current Loop test (test points a-b, b-a).

## 2.6.2 DC Resistance (DCR) Measurement

The 1320 instrument is capable of measuring Direct Current Resistance (DCR).

### **CAUTION**

**Make sure the LCD display reads “DCR TEST”. Otherwise, in Bias Current Output mode, the DUT could be damaged due to heat caused by high current.**

To make a DCR measurement, press [BIAS/DCR] so that display reads “DCR TEST”. The [BIAS/DCR] key toggles between “PROGRAM” and “DCR TEST”. Connect device under test to UNKNOWN terminals. Press red [START] button. Display will go through Range Resistors (R6-R1) and then show the Range # and current value and the DCR value. A DC Bias LED (FWD or REV) will light indicating the direction of the current.

#### **Press [BUTTON]**

[BIAS/DCR]

[START]

[RESET]

#### **Display will show:**

DCR TEST

R1 = 2.000 A  
DCR = 0.07 mΩ

DCR TEST

### **CAUTION**

**During DCR Test do not touch the test cables or DUT. The emf of the inductor could cause a shock hazard.**

In Auto Range Mode, if the DCR of the UNKNOWN is too large, the 1320 instrument will hold in Range 5 and the display will read “R5=0.020A” “DCR=OVER”.

### 2.6.3 Error Messages

The 1320 instrument may display one of two error messages if there is an error during the measurement procedure. If there is a problem with the current source, the display will read “I SRC ERROR”. If there is a problem with the voltage sink, the display will read “V SNK ERROR”. Refer to Table 2-7.

**Table 2-7: 1320 Error Messages**

<b>Error Message</b>	<b>Possible Cause</b>	<b>Remedy</b>
“I SRC ERROR” “Press Reset”	BIAS ON No Loading or Bad Contact	Check contacts
	BIAS ON Loaded, but DCR too large	
	BIAS ON Loaded, but L too large	Increase delay time (>1.5sec) so that set current can be reached.
“V SNK ERROR” “Press Reset”	Exterior Cable Connected incorrectly	Connect DRIVE+ and COMMON to UNKNOWN. Float DRIVE-
	Internal Circuit Electronic Breakdown	Contact QuadTech for instrument service information.

If either of the error messages is displayed, follow this procedure:

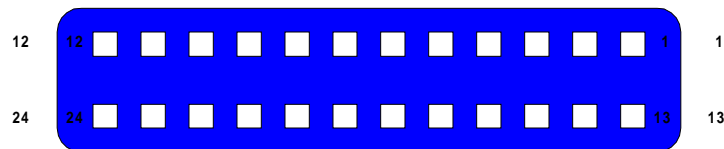
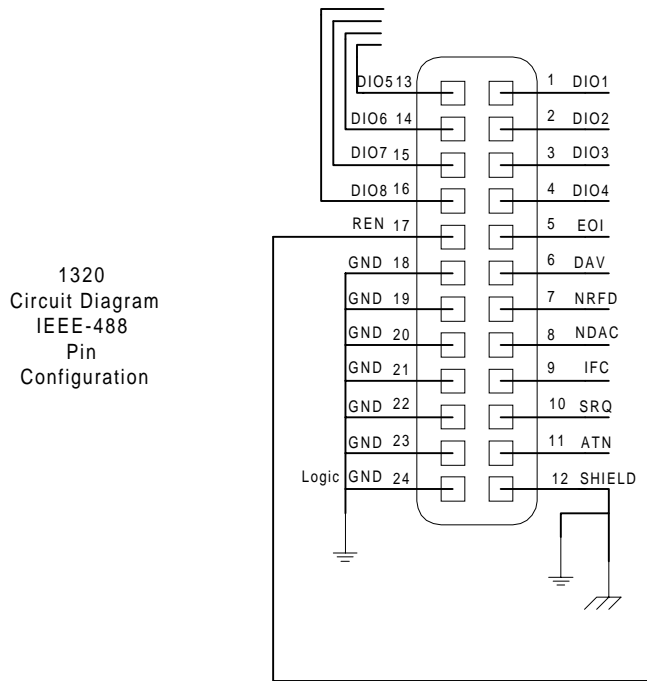
1. Press the black [RESET] button.
2. Disconnect DUT from instrument (test leads).
3. SHORT test leads.
4. Press the red [START] button.
5. Check the LCD display, if the error message has disappeared then the internal circuit is okay and the problem could be with the DUT connection. If the error message has not disappeared, contact QuadTech for instrument service.

## Section 3: Interface

### 3.1 IEEE-488 Interface

#### 3.1.1 Pin Configuration

The 1320 BCS unit comes standard with a 24-Pin IEEE-488 Interface for remote operation of the unit and for data transfer. Figure 3-2 illustrates the pin configuration of the IEEE-488 interface connector. The meter side connector is a DDK 57 LE-20240 or equivalent. The cable side connector is a DDK 57-10240 or equivalent. The drivers DIO 1-8, SRQ, NRFD and NDAC are active low, open collector signals. Drivers EOI, REN, DAV, IFC and ATN are signal states.



1320 Rear Panel View IEEE-488 Pin Configuration

**Figure 3-2: 1320 IEEE-488 Interface**

### 3.1.2 Address Change

The IEEE-488 address is defined using the [ADDRESS] key on the front panel. The range is 1-30 and the default setting is 3. Table 3-1 illustrates how to set the address to 6 as an example.

**Table 3-1: Setting the IEEE-488 Address**

Press [BUTTON]	DISPLAY WILL SHOW:
[PROG/ESC]	PROGRAM
[SHIFT]	SHIFT
[ADDRESS]	ADDRESS = 3 1 - 30
[=]	ADDRESS = _ 1 - 30
[6] [ENTER]	ADDRESS = 6 1 - 30
[PROG/ESC]	I = 2.000 A Single

### 3.1.3 Interface Codes

Table 3-2 lists the IEEE-488 Interface codes and their functions. All front panel functions are programmable from the bus. All data is available as output to the bus. The output form is ASCII.

**Table 3-2: IEEE-488 Interface Codes**

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	All Service Request Functions
RL1	All Remote-Local Functions
PP0	No Parallel Poll Functions
DC1	Device Clear Function
DT1	Device Trigger Function
C0	No Controller Functions

### 3.1.4 Interface Bus & Messages

Table 3-3 details the IEEE-488 Interface bus which is comprised of a data bus, handshake bus and a control bus. Pin numbers, bus assignment, signal line and description are provided.

**Table 3-3: 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 that data on the data bus is valid.
7		NRFD (Not Ready For Data)	Indicates that Listener is ready to receive.
8		NDAC (No Data Accepted)	Indicates that Listener has finished data reception.
11	Control Bus	ATN (Attention)	Indicates a 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 by Talker side to call the Controller
5		EOI (End of Identify)	Indicates the End of Data.

The 1320 instrument is capable of responding to the IEEE-488 Interface messages listed in Table 3-4.

**Table 3-4: 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.

### 3.2.5 Listener Functions

All 1320 front panel functions can be operated by remote commands. The interface 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 an error has occurred with the input command, the display will show the message “ERROR X”. The input commands are divided into two groups: Common Command and System Command.

#### 3.2.5.1 Common Commands

The Common Command does not pertain to measurement. It is used to manage the macro and to store data. All common commands begin with an \* (asterisk). Table 3-5 lists the Common Commands and their respective functions.

**Table 3-5: Common Commands**

<b>Command</b>	<b>Function</b>	<b>Remark</b>
*IDN?	Interrogate: Manufacturer, Model # Firmware Release Version	Respond: Quadtech, Inc. 1320 Bias Current Source 0-20A VER:X.XX
*RCL?	Interrogate: Recall location n	Respond: 0-49
*RCLn	Recall setting in n location	n = 0 - 49
*RST	Reset the 1320 unit	
*SAV?	Interrogate: What is saved in location n	Respond: 0-49
*SAVn	Save setting in n location	n = 0 - 49

### 3.2.5.2 System Commands

The System Command is used to control, set and check the 1320 instrument states. Table 3-6 lists the System Commands and their respective functions.

**Table 3-6: System Commands**

Command	Function	Remark
CLER	Clear IEEE-488 remote control, return to Front Panel Control	
CURRn	Set Current in Single Mode (Mode=0). Unit = A	n = -20 – 20, Note 1
CURR?	Query Current Value (in A) in Single Mode	Response: -100 – 100
CURR:STEPn1:n2	Set Current Steps in Mode 1: n1=step value, n2=current value	n1 = 2-21, n2=-20-20, Note 1
CURR:STEPn1?	Query each step's current value	Response: -100 – 100
DDCV:ON	Turn ON DCV function in Mode=0 and DCR Test selected	ON: Open
DDCV:OFF	Turn OFF DCV function in Mode=0 and DCR Test selected	OFF: Close
DDCV?	Query DCV Value (in Volts)	Response: x.xxV
DELAYn or (DELAN)	Set Delay Time (in Seconds)	n = 0.00 – 100
DELAY? or (DELA?)	Query Delay Time Value (in Seconds)	Response: 0.00 – 100
LOOP:ON	Set Current LOOP State ON	ON: Open
LOOP:OFF	Set Current LOOP State OFF	OFF: Close
LOOP?	Query Current LOOP State	Response: 0 (OFF) or 1 (ON)
MODEn	Set Mode State	n = 0 (Single) or 1 (Multi Man)
MODE?	Query Mode State	n = 0, 1, 2
DATE <u>D</u>	Set Date: <u>D</u> is MM-DD-YYYY format	Example May 12 1999 <u>D</u> = 05-12-99
DATE?	Query Date (MM-DD-YYYY) and Time (HH:MM:SS)	Response: MM-DD-YYYY HH:MM:SS
RESET or (RESE)	Stop Current Output (End Test)	
START or (STAR)	Initiate Current Output (Start Test)	
STEPn	In Mode 1, set step value	n = 2 – 21
STEP?	Query Step value	Response: 2 – 21
SLAVE? or (SLAV?)	Query which 1320S instrument is linked to unit	Response: 0 – 4
TEST:BIAS	Go to Current Test Mode	
TEST:DCR	Go to DCR Test Mode	
TEST:DCR?	Query DCR value	Response: range, current and Resistance
TEST:FWD	In Mode=0 and DCR selected, Set Forward Current	FWD: Forward Direction
TEST:REV	In Mode=0 and DCR selected, Set Reverse Current	REV: Reverse Direction
TIMER:ON	In Mode = 0, Set Timer ON	ON: Open
TIMEROFF	In Mode = 0, Set Timer OFF	OFF: Close
TIMER:FWD	Set Timer Direction = Forward	FWD: Forward Direction
TIMER:REV	Set Timer Direction = Reverse	REV: Reverse Direction
TIMER <u>D</u>	Set the Timer's Time: <u>D</u> is Hour:Minute:Second format	Example: 3hrs, 5 min, 10sec <u>D</u> : 03:05:10
TIMER?	Query Timer Value	Response: Xhour:Xmin:Xsec
TYPEn	Set Interface Mode	n = 0 (1320 Self Control) or n = 1 (1320+Handler+LCR)
TYPE?	Query Interface Mode	Response: 0, 1



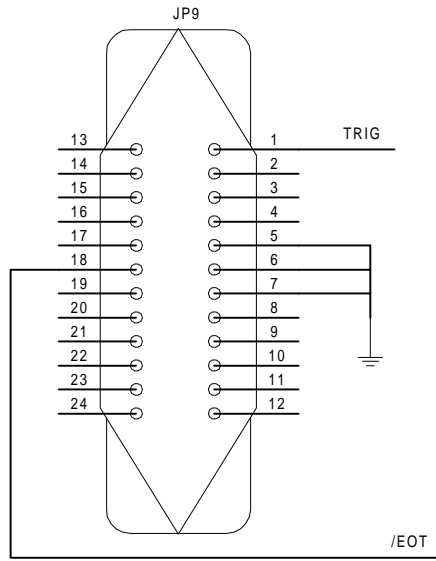
### 3.3 Handler Interface

The 1320 BCS unit has a Handler interface to connect the unit to an LCR meter. When the 1320 [START] button is pressed, the 1320 will initiate a measurement when any programmed delay time has elapsed. Table 3-7 lists the signal names, pin numbers and functions of the handler interface. The output signal START is normally low and triggered to open collector. The maximum drive voltage of the open collector is 30V and the maximum current is 100mA. The input signal EOT is active low. There is a low to high dwell time of 40 $\mu$ S minimum.  $+2.0V \leq V_H < 5V$ .  $0V \leq V_L \leq +0.8V$ . The EOT signal completes inductance measurement and cuts off or changes the current output. The EOT signal from the LCR meter is /ACQ OVER (Data Acquisition Over).  $V_H < 30V$  and  $I_L < 16mA$  (for  $V_L < 0.4V$ ).

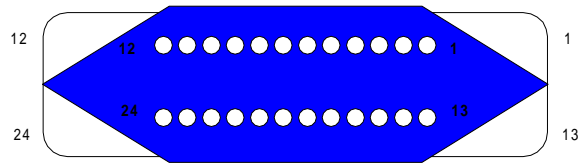
**Table 3-7: Handler Interface**

Signal Name	PIN Number	Function
<b>Inputs</b>		
	1, 2, 3, 4, 8, 9, 10, 11, 12 13, 14, 15, 16, 17, 19, 20 21, 22, 23, 24	Unused
	5, 6, 7	Ground Connection
/EOT	18	End of Test Terminate Current Output
<b>Outputs</b>		
START	1	Initiates Measurement (External Trigger)

Figure 3-3 illustrates the pin configuration of the 1320 24-pin handler interface. Figure 3-4 illustrates a timing diagram of the 1320 handler interface. The START signal has a minimum 40 $\mu$ S duration for current to stabilize. In regards to the /EOT signal, at point (time) b, the 1320 has triggered the LCR meter measurement. At point (time) f the RESET button has been pressed and the current terminated. The time (b-f) is equal to the LCR meter measurement time.

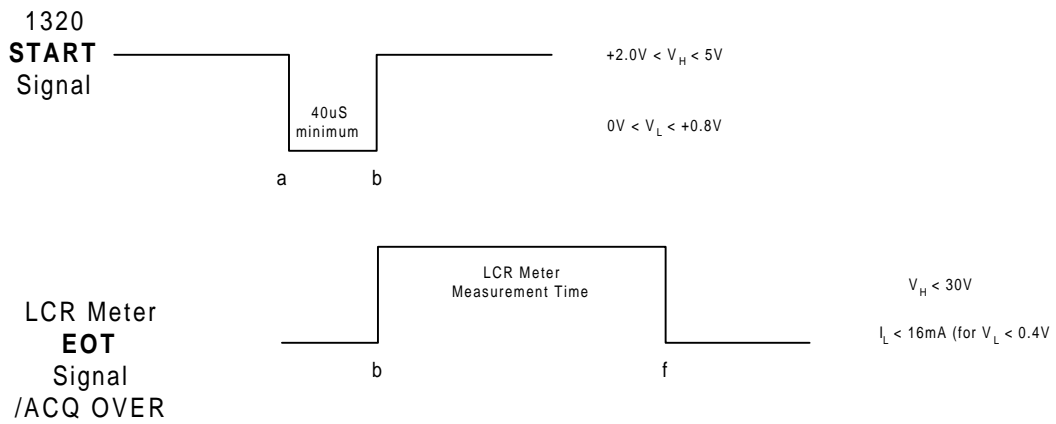


1320 Circuit Diagram HANDLER Pin Designation



1320 Rear Panel View HANDLER Pin Configuration

**Figure 3-3: Pin Configuration of 1320 Handler Interface**



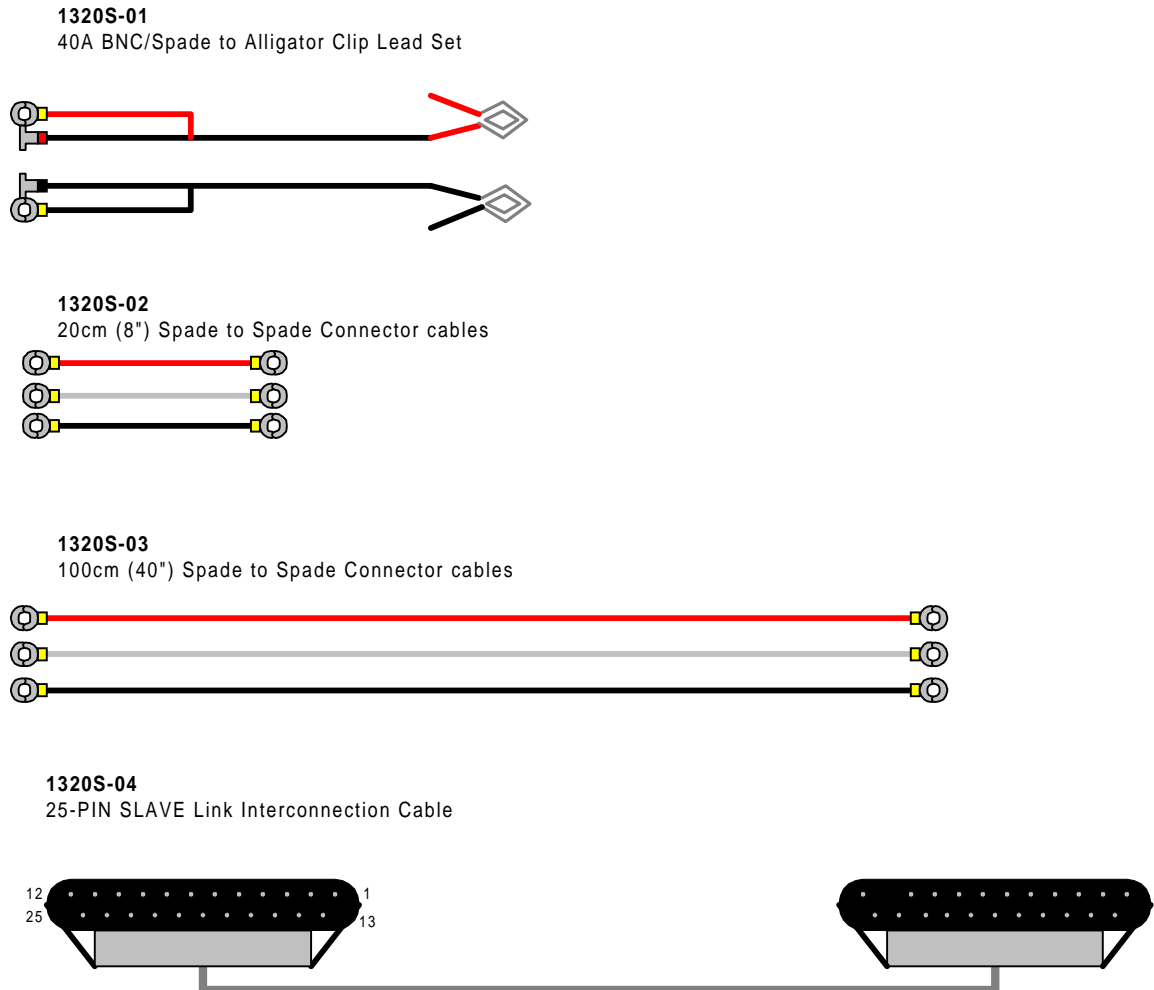
**Figure 3-4: Timing Diagram 1320 Handler Interface**

### 3.4 1320S Bias Current Source Slave

A Bias Current Source Slave instrument is available to extend the 1320 instrument's current source capability to a maximum of 100A DC. Up to 4 1320S Slave units can be connected in parallel with the 1320 instrument to produce 100A of current. Front and rear panel connections are necessary as described in paragraph 3.4.3. Table 3-8 lists the standard accessories that are included with the 1320S Slave unit. Figure 3-5 illustrates the standard slave accessories.

**Table 3-8: 1320S Slave Accessories**

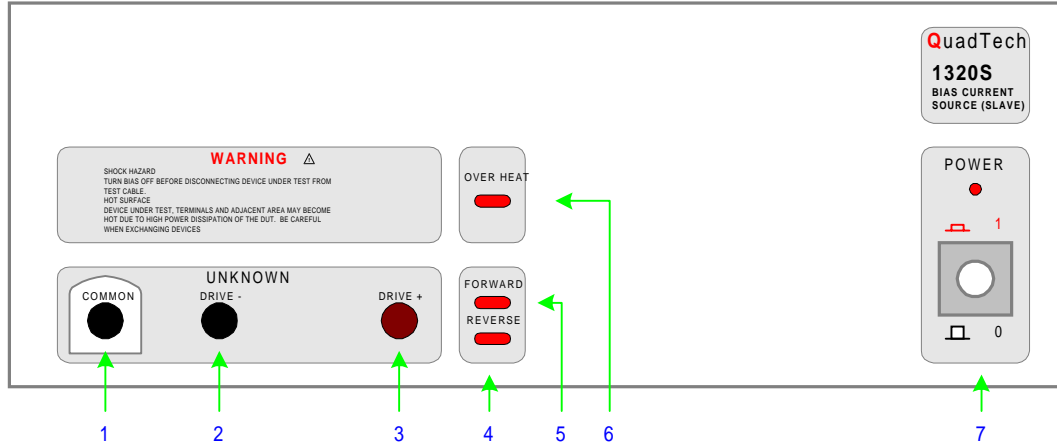
Item	Quantity	QT P/N
40A BNC/Spade to Alligator Clip Lead Set	1	1320S-01
20cm (8") Spade to Spade Connector Cables (Set of 3)	1	1320S-02
100cm (40") Spade to Spade Connector Cables (Set of 3)	1	1320S-03
25-PIN SLAVE Link Interconnection Cable	1	1320S-04



**Figure 3-5: 1320S Slave Accessories**

### 3.3.1 1320S Front Panel Controls and Indicators

Figure 3-6 illustrates the controls and indicators on the front panel of the 1320S instrument. Table 3-9 describes them with description and function.



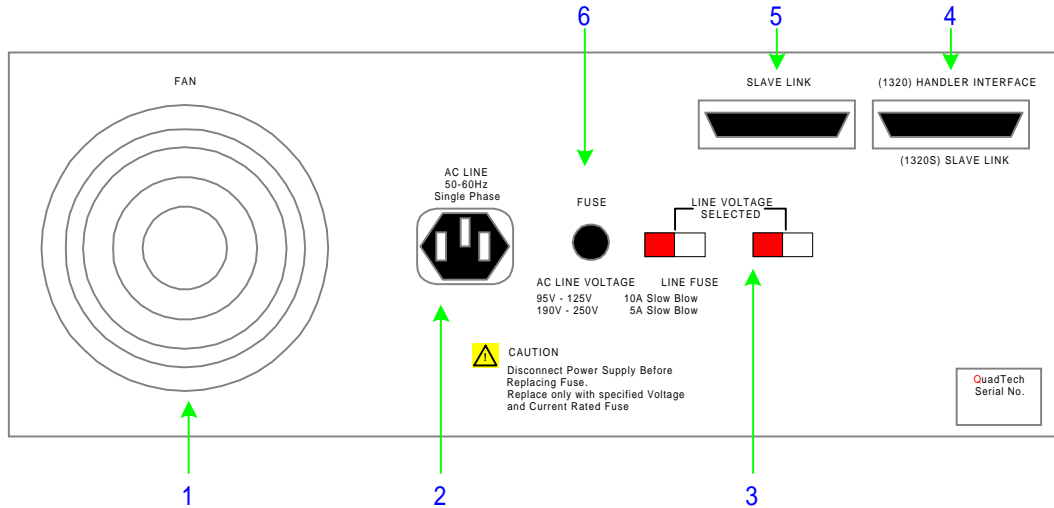
**Figure 3-6: 1320S Slave Front Panel Controls and Indicators**

**Table 3-9: 1320S Front Panel Controls and Indicators**

Reference Number Figure 3-6	Name	Type	Function
1	COMMON	Black Banana Plug/Binding Post	Common Ground Terminal
2	DRIVE-	Black Banana Plug/Binding Post	Current Drive (-) Low terminal
3	DRIVE+	Maroon Banana Plug/Binding Post	Current Drive (+) High terminal
4	REVERSE	Red LED	When lit, output current is in Reverse direction (Negative)
5	FORWARD	Red LED	When lit, output current is in Forward direction (Positive)
6	OVER HEAT	Red LED	When lit, unit has exceeded safe operating temperature. Shut Off.
7	POWER	White 2-position Toggle Switch	Provide power: 1 = ON, 0 = OFF

### 3.3.2 Rear Panel Controls and Connectors

Figure 3-7 illustrates the controls and connectors on the rear panel of the 1320S Slave instrument. Table 3-10 describes them with description and function.



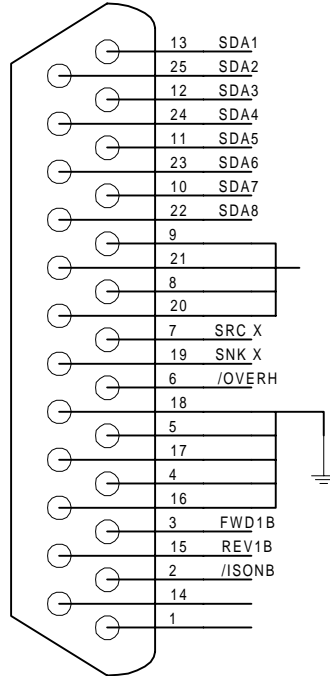
**Figure 3-7: 1320S Slave Rear Panel Controls and Connectors**

**Table 3-10: Rear Panel Controls and Connectors**

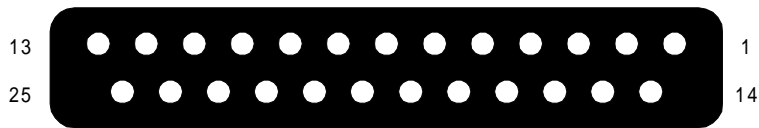
Reference Number Figure 3-7	Name	Type	Function
1	FAN	AC 120V 50/50Hz Fan UF12B12	50°C On/Off Fan
2	AC LINE	Black 3-wire AC receptacle	Input for AC power
3	LINE VOLTAGE SELECTED	Two Red 2-position slide switches	Select AC line operation: 115V or 230V
4	1320S SLAVE LINK	Black 25-pin connector	Connect 1 <sup>st</sup> 1320S (Slave) to 2 <sup>nd</sup> 1320S (Slave)
5	SLAVE LINK	Black 25-pin connector	Connect 1320 Master to 1 <sup>st</sup> 1320S (Slave)
6	FUSE	Black screw cap fuse holder	Short Circuit Protection 10A/250V for 95-125V operation 5A/250V for 190-250V operation

### 3.4.3 Slave Interface Pin Configuration

Figure 3-8 illustrates the pin configuration of the 25-Pin Slave interface on the rear panel of the 1320 instrument.



1320 SLAVE LINK Pin Designation

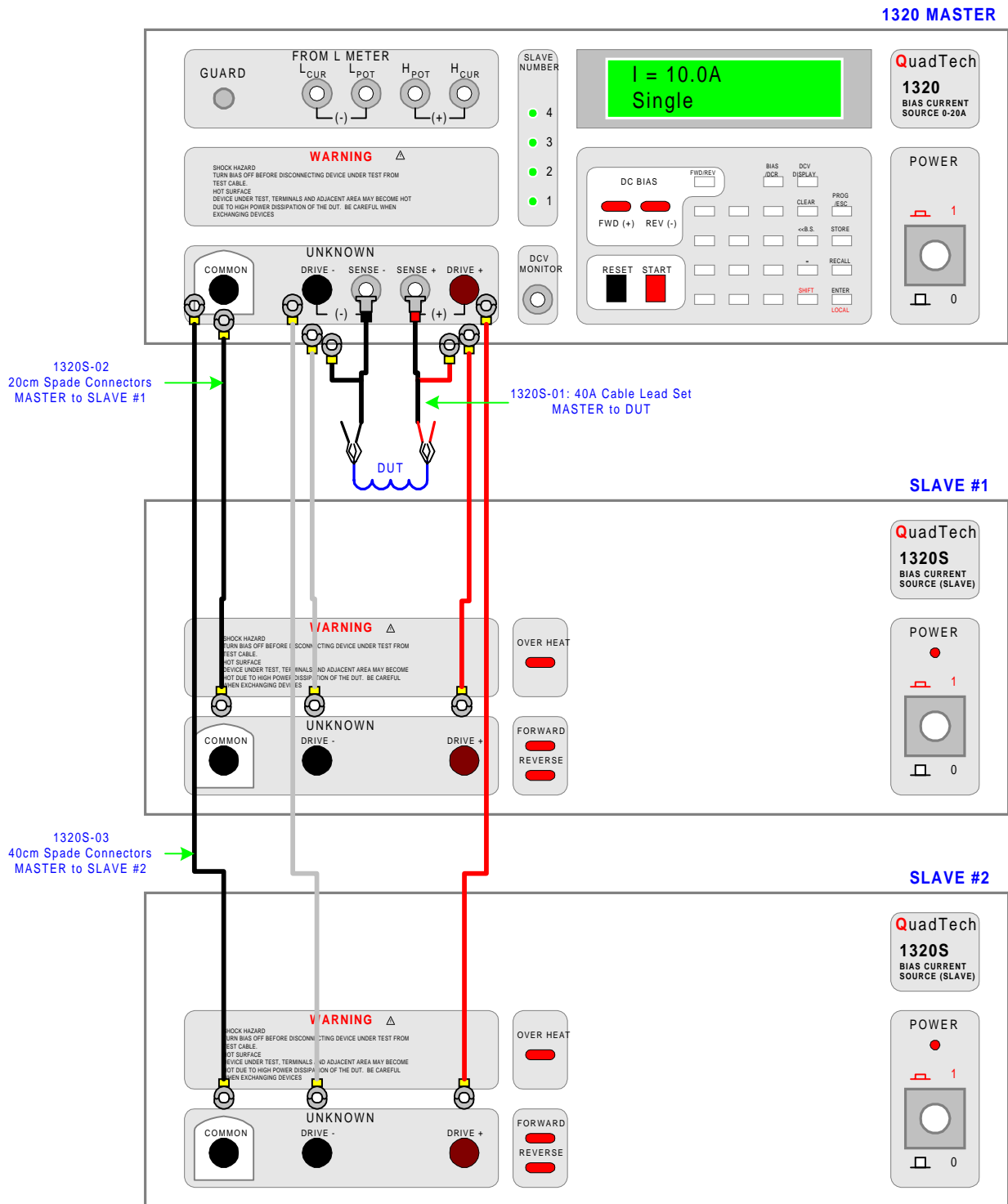


1320 SLAVE LINK Pin Configuration Rear Panel View

**Figure 3-8: 1320 SLAVE LINK Pin Configuration**

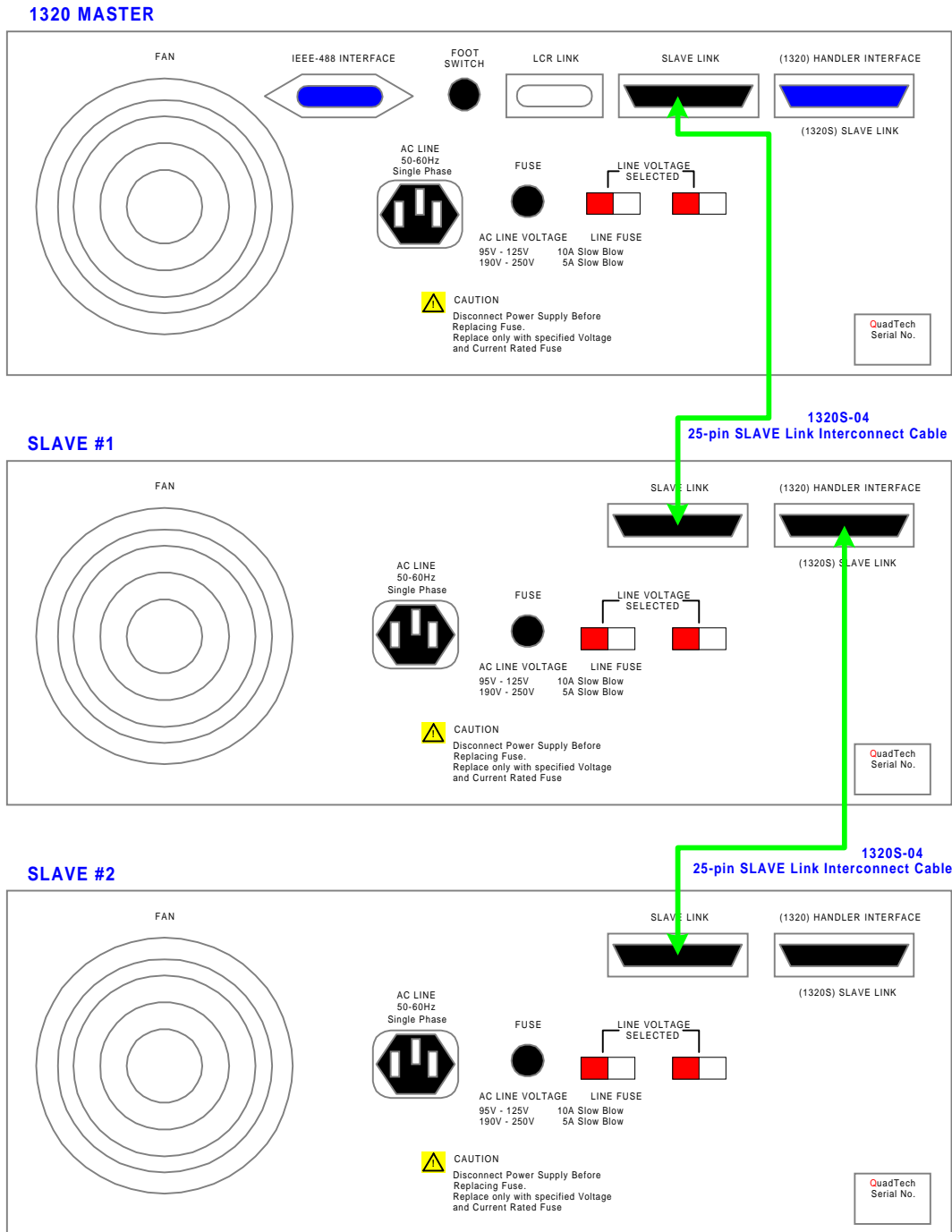
### 3.4.4 Slave Connection to 1320

Bias current extension is obtainable by connecting up to four 1320S (Slave) instruments to the 1320 Master. Connect the DUT to the 1320 UNKNOWN terminals using the 1320S-01 40A Lead Set. Connect the 1320 COMMON, DRIVE- and DRIVE+ terminals to the 1<sup>st</sup> Slave's COMMON, DRIVE- and DRIVE+ terminals with the 1320S-02 (20cm) Spade to Spade Connector cables. If a 2<sup>nd</sup> Slave is added connect to 1320 Master with 1320S-03 (100cm) Connector cables. Refer to Figure 3-9.



**Figure 3-9: 1320S (Slave) Connection for Bias Current Extension**

Connect the rear panel 25-pin SLAVE LINK on the 1320 BCS instrument to the rear panel 1320S (Slave) 25-pin SLAVE INTERFACE with the 1320S-04 25-pin Slave Link interconnect cable. If a second Slave unit is added, a second 25-pin interconnect cable is connected between the “(1320S) SLAVE LINK” of the first Slave unit and the “SLAVE LINK” of the second Slave unit. Refer to Figure 3-10.



**Figure 3-10: 1320 Slave Interface Rear Panel Connection**



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## Section 4: Service & Calibration

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### 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 1320 Bias Current Source instrument is calibrated via a Sink board current adjustment and a DCR board voltage adjustment. Calibration 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%. Allow the 1320 instrument to warm up for 30 minutes minimum prior to calibration.

### 4.3.1 Equipment Required

1. 2.5mΩ, 0.2% Resistor: Current Divider
2. Fluke 8842A (or equivalent): Digital Multimeter
3. Banana to Banana Plug Lead Set
4. BNC/Banana to Kelvin Clip Lead Set

### 4.3.2 1320 Calibration (Master)

#### 4.3.2.1 Sink Board Current Adjustment

Connect the digital multimeter to the 1320 “UNKNOWN” terminals: COM to DRIVE- and HIGH to DRIVE+ as shown in Figure 4-1. Place a 2.5mΩ 0.2% resistor as a current divider between the DRIVE- and DRIVE+ terminals. Press [START].  $I=V/R$ . Enter the current value (in amps) which is equal to the voltmeter reading (in volts) divided by the resistor value (.0025Ω).

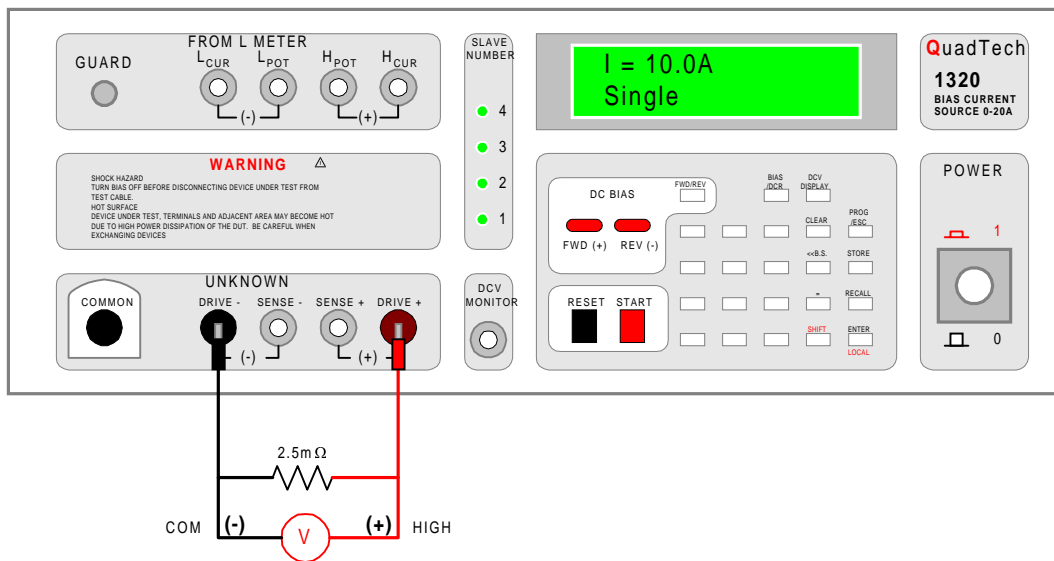


Figure 4-1: Connection of Multimeter to 1320 BCS Instrument

Press [PROG] [SHIFT] [4] to enter current calibration mode. There are 8 Current calibration points for the Sink Board: 0.010A, 0.900A, 1.50A, 4.90A, 6.00A, 19.0A, 0.020A and 2.00A.

When current calibration mode is entered, the display will show the first calibration point (0.010A) and its last calibrated value. Press [START] and enter the multimeter value. Press [RESET] [ENTER] to accept calibration value just entered. The unit automatically changes to the second calibration point (0.900A).

Proceed with the remaining calibration points. Press [START]. Enter the multimeter value. Press [RESET] [ENTER].

Here is the scroll through of the 8 Sink Board Current Calibration Points:

Press:	Display Reads:	
[PROG] [SHIFT] [4]	CAL 0.010 A I = 0.00710 A	1st Cal Point
[START] [0] [.] [0] [0] [9] [9] [9] [Multimeter Value/.0025]	CAL 0.010 A I = 0.00999 A	
[RESET] [ENTER]	CAL 0.900 A I = 0.90600 A	2nd Cal Point
[START] [0] [.] [9] [0] [5] [9] [1] [Multimeter Value/.0025]	CAL 0.900 A I = 0.90591 A	
[RESET] [ENTER]	CAL 1.50 A I = 1.52000 A	3rd Cal Point
[START] [1] [.] [5] [1] [7] [0] [0] [Multimeter Value/.0025]	CAL 1.50 A I = 1.51700 A	
[RESET] [ENTER]	CAL 4.90 A I = 4.98000 A	4th Cal Point
[START] [4] [.] [9] [8] [7] [0] [0] [Multimeter Value/.0025]	CAL 4.90 A I = 4.98700 A	

**Points 5 through 8 are illustrated on the following page.**

Remainder of the Sink Board Current Calibration Points:

**Press:**

**Display Reads:**

[RESET] [ENTER]

CAL 6.00 A  
I = 6.02500 A

5th Cal Point

[START] [6] [.] [0] [0] [1] [2] [3]  
[Multimeter Value/.0025]

CAL 6.00 A  
I = 6.00123 A

[RESET] [ENTER]

CAL 19.0 A  
I = 19.23200 A

6th Cal Point

[START] [1] [9] [.] [1] [0] [2] [7] [5]  
[Multimeter Value/.0025]

CAL 19.0 A  
I = 19.10275 A

[RESET] [ENTER]

CAL 0.020 A  
I = 0.01970 A

7th Cal Point

[START] [0] [.] [0] [1] [9] [8] [5]  
[Multimeter Value/.0025]

CAL 0.020 A  
I = 0.01985 A

[RESET] [ENTER]

CAL 2.00 A  
I = 1.98100 A

8th Cal Point

[START] [1] [.] [9] [9] [7] [1] [1]  
[Multimeter Value/.0025]

CAL 2.00 A  
I = 1.99711 A

[RESET] [ENTER]

CAL 0.010 A  
I = 0.00999 A

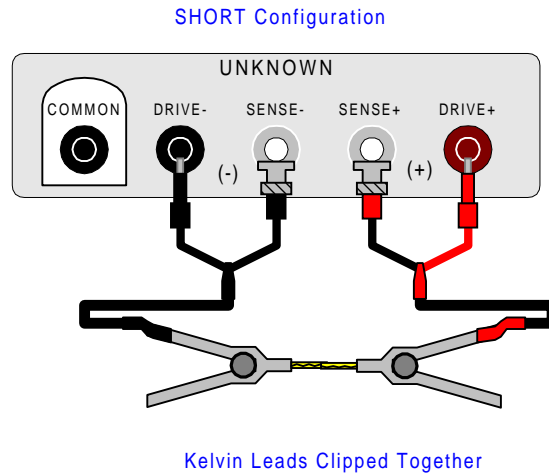
1st Cal Point

Return to 1st Calibration Point. Sink Board Calibration Complete

Sink Board Current Calibration is complete. Press [PROG] to exit the programming mode.

### 4.3.2.2 DCR Board Voltage Adjustment

Open the 1320 BCS unit by removing the top cover. Turn the POWER ON and wait 15 minutes. Connect the BNC/Banana to Kelvin Clip leads to the UNKNOWN terminals on the 1320 front panel. Short the test leads by clipping the Kelvin leads together as shown in Figure 4-2.



**Figure 4-2: Kelvin Clip Leads Shorted**

To adjust VR1 on the DCR Board (DCR & Terminals Board P/N 48-13204-033), ground TP6 and apply +1V to TP5. Adjust VR1 to equal  $1V \pm 1\text{count}$ .

To adjust VR2, short the test cables and measure DCR. To measure DCR, press [BIAS/DCR] so that the display reads "DCR TEST". Short test cables. Press red [START] button. Adjust VR2 so that the display reads  $0.00\text{m}\Omega$ . Press black [RESET] button.

### 4.3.3 1320S Calibration (Slave)

The 1320S Slave instrument requires a Sink Board Current Adjustment to calibrate the unit. A 1320 Master unit is required to calibrate the Slave. Connect the digital multimeter to the 1320S “UNKNOWN” terminals: COM to DRIVE- and HIGH to DRIVE+ as shown in Figure 4-2. Place a 1mΩ 0.2% resistor as a current divider between the 1320S (SLAVE) DRIVE- and DRIVE+ terminals. Press [START].  $I=V/R$ . Enter the current value (in amps) that is equal to the voltmeter reading (in volts) divided by the resistor value (.001Ω).

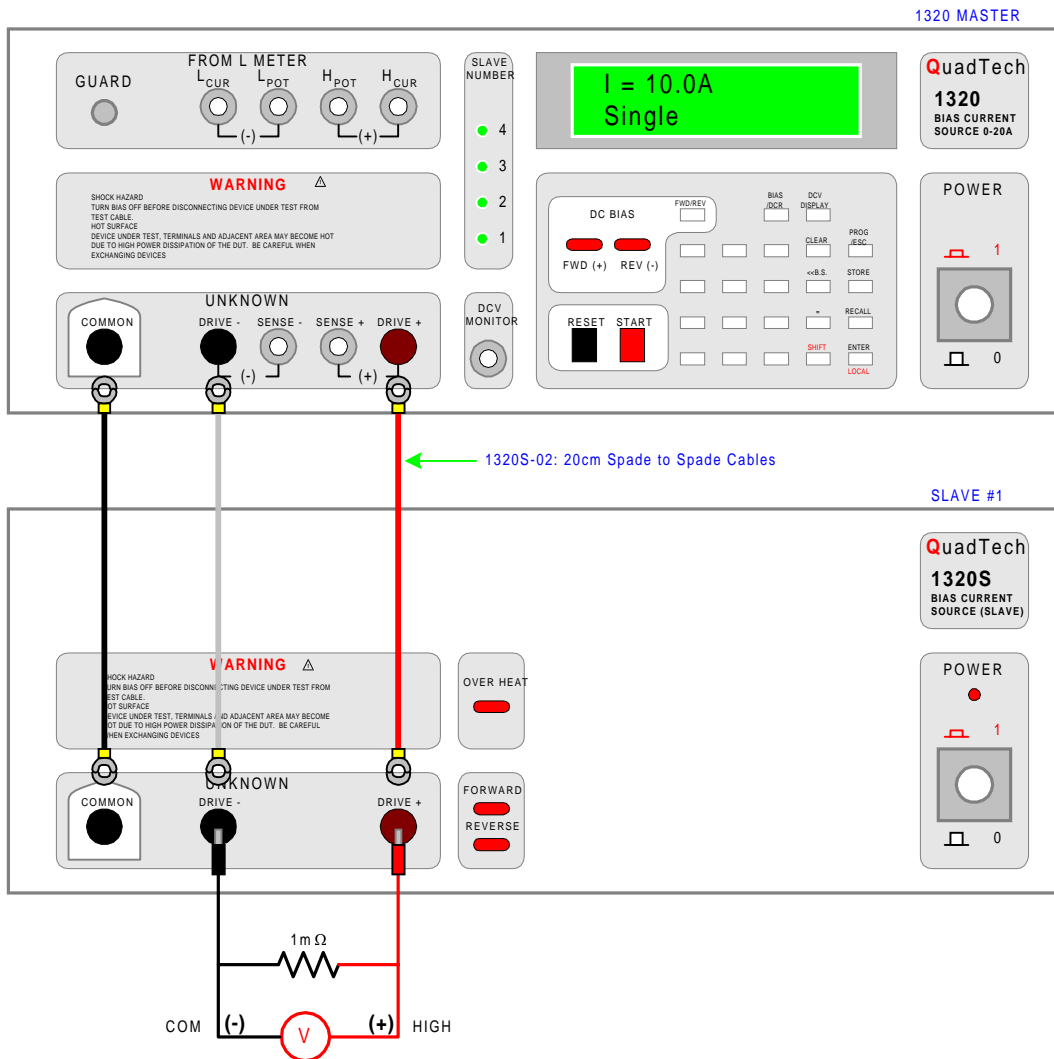
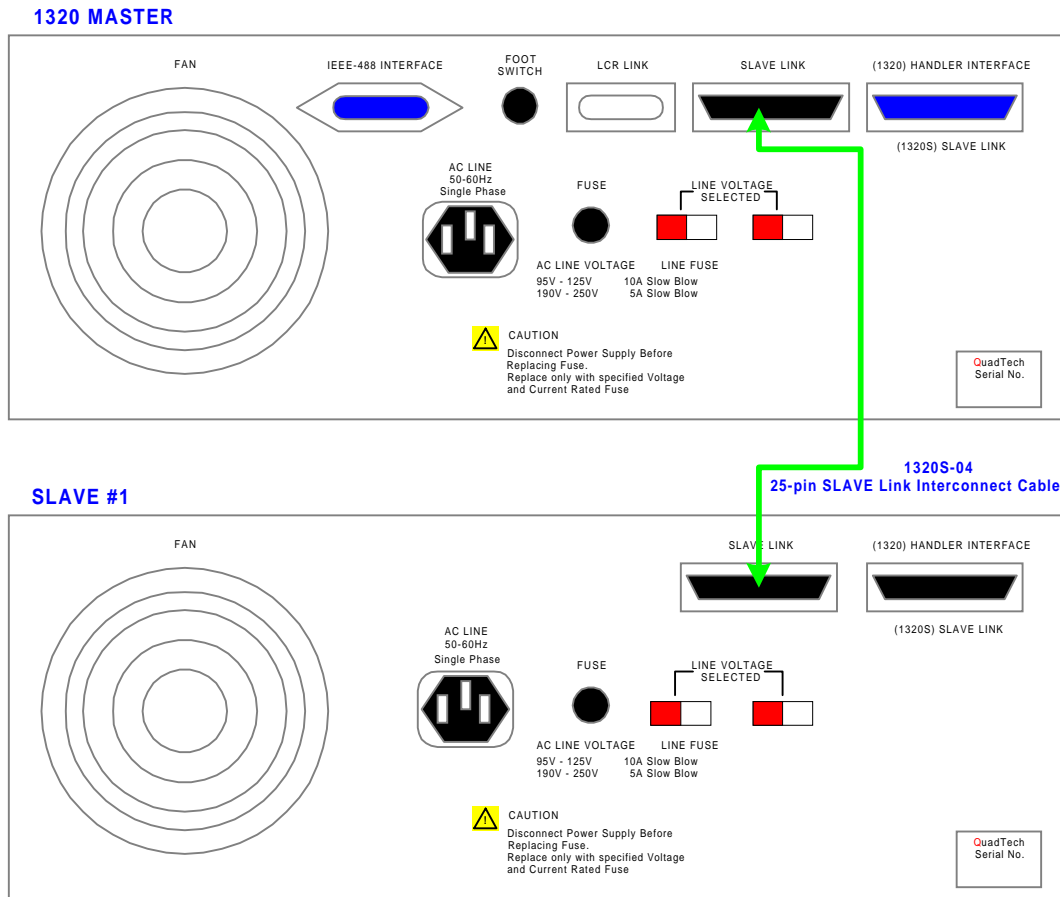


Figure 4-2: Front Panel Connection of 1320S (Slave) to 1320 (Master)

The rear panels of the Master and Slave must be interconnected as shown in Figure 4-3. Connect the 1320S-04 25-pin interconnect cable between the 1320 Master “SLAVE LINK” interface and the 1320S Slave “SLAVE LINK” interface.



**Figure 4-3: Rear Panel Connection of 1320S (Slave) to 1320 (Master)**

Press [PROG] [SHIFT] [4] to enter current calibration mode.  
 There are 8 current calibration points for the Sink Board: 0.010A, 0.900A, 1.50A, 4.90A, 6.00A, 19.0A, 0.020A and 2.00A.

When current calibration mode is entered, the display will show the first calibration point (0.010A) and its last calibrated value.

Press **[START]**. Enter the multimeter value (in V) divided by .001Ω.  
 Press [RESET] [ENTER] to accept calibration value just entered.  
 The unit automatically changes to the second calibration point (0.900A).  
 Proceed with the remaining calibration points.

Press **[START]**. Enter the multimeter value (in V) divided by .001Ω.  
 Press [RESET] [ENTER].

Here is the scroll through of the 8 Sink Board Current Calibration Points:

**Press:**

**Display Reads:**

[PROG] [SHIFT] [4]

CAL 0.010 A  
I = 0.00710 A

1st Cal Point

[START] [0] [.] [0] [0] [9] [9] [9]  
(Multimeter Value/.001)

CAL 0.010 A  
I = 0.00999 A

[RESET] [ENTER]

CAL 0.900 A  
I = 0.90600 A

2nd Cal Point

[START] [0] [.] [9] [0] [5] [9] [1]  
(Multimeter Value/.001)

CAL 0.900 A  
I = 0.90591 A

[RESET] [ENTER]

CAL 1.50 A  
I = 1.52000 A

3rd Cal Point

[START] [1] [.] [5] [1] [7] [0] [0]  
(Multimeter Value/.001)

CAL 1.50 A  
I = 1.51700 A

[RESET] [ENTER]

CAL 4.90 A  
I = 4.98000 A

4th Cal Point

[START] [4] [.] [9] [8] [7] [0] [0]  
(Multimeter Value/.001)

CAL 4.90 A  
I = 4.98700 A

**Points 5 through 8 are illustrated on the following page.**



Remainder of the Sink Board Current Calibration Points:

**Press:**

**Display Reads:**

[RESET] [ENTER]

CAL 6.00 A  
I = 6.02500 A

5th Cal Point

[START] [6] [.] [0] [0] [1] [2] [3]  
(Multimeter Value/.001)

CAL 6.00 A  
I = 6.00123 A

[RESET] [ENTER]

CAL 19.0 A  
I = 19.23200 A

6th Cal Point

[START] [1] [9] [.] [1] [0] [2] [7] [5]  
(Multimeter Value/.001)

CAL 19.0 A  
I = 19.10275 A

[RESET] [ENTER]

CAL 0.020 A  
I = 0.01970 A

7th Cal Point

[START] [0] [.] [0] [1] [9] [8] [5]  
(Multimeter Value/.001)

CAL 0.020 A  
I = 0.01985 A

[RESET] [ENTER]

CAL 2.00 A  
I = 1.98100 A

8th Cal Point

[START] [1] [.] [9] [9] [7] [1] [1]  
(Multimeter Value/.001)

CAL 2.00 A  
I = 1.99711 A

[RESET] [ENTER]

CAL 0.010 A  
I = 0.00999 A

1st Cal Point

Return to 1st Calibration Point. Sink Board Calibration Complete

Sink Board Current Calibration is complete. Press [PROG] to exit programming mode.