

Applying DC Bias to Inductors with the 1910 Inductance Analyzer & 1320 Bias Current Source

The 1910 Inductance Analyzer can be connected to the QuadTech 1320 Bias Current Source to provide external DC bias current ranging from 0.0A – 20.0A, programmable in 5mA steps. Refer to Application Note 035087 for information on the 1910's internal DC bias capability. The subject of this application note shall be the connection and programming of the 1320 Source and 1910 Analyzer for external DC bias current tests.

Get Real: Bias that Inductor

In order to get an accurate inductance measurement the inductor must be tested under actual conditions for current flowing through the coil. This cannot always be done with the typical AC source and a standard LCR meter as the typical source in an LCR meter is normally only capable of supplying small amounts of current. This level of current is not satisfactory for testing most inductors used in power supplies. DC bias current provides a way of biasing the inductor to normal operating conditions where the inductance can then be measured under actual conditions.

The 1320 Bias Current Source can generate 20A DC to the device under test. Connect the 1320 to the 1910 for external DC sourcing then connect the DUT to the 1910 output terminals. With this connection you achieve real time operating conditions of up to 20A DC and gain the measurement capabilities of the 1910 Inductance Analyzer. Have an inductor that needs to withstand 15A DC? How do you test it under this condition? How do you accurately analyze all its parameters? And can you test a whole production lot of these inductors? This is what the 1910 Inductance Analyzer combined with the 1320 Bias Current Source is designed to do. A highly accurate Inductance tester and a DC current work horse combined.



Figure 1: 1910 Inductance Analyzer & 1320 Bias Current Source

Safety Precautions

The voltage across an inductor is proportional to its inductance and the **rate of change** of the current through it. $E = L \, di/dt$. If the current could be instantly switched off, then the voltage would in theory become infinite. This does not occur because the high voltage develops an arc across the switch as contact is broken, keeping di/dt from becoming infinite. This does not however prevent the voltage from increasing to potentially **dangerous** levels. If a person breaks the contact without the proper protection, the inductor induces a high voltage, forcing the current through the person (arm to arm across the heart). Refer to Figure 2.

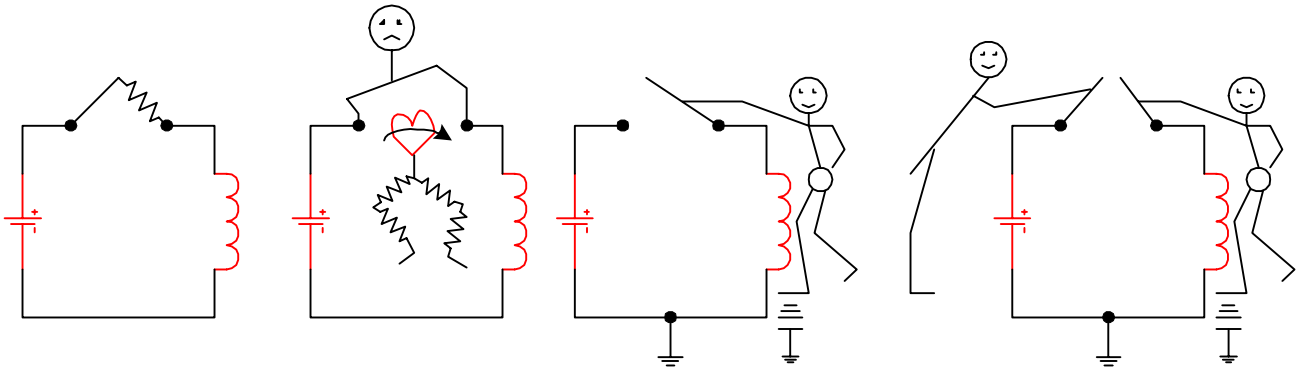


Figure 2: Breaking the Contact across an Inductor

WARNING

Inductors carrying current may contain lethal energy.
Dangerous voltages are generated if connections are broken while the current is flowing.
Set all power sources to zero before making or breaking connections. Limit Supply Voltages to 200V or less.
Use multiple safety measures to reduce shock hazards to personnel and test equipment.

A person does not have to be **across** the broken connection to receive a dangerous shock because the current can flow through ground. So breaking the circuit with one hand is **not** necessarily safe. If the switching is done remotely by another person even at some distance, the person touching the inductor could still get a **dangerous** shock. A disconnection of the circuit could also be the result of a component or wiring failure that could occur at any time.

Even armed with all these safety considerations, QuadTech suggests the following safety precautions be used when measuring biased inductors to avoid shock hazard.

1. Instruct the operator on all possible dangers.
2. Enclose the inductor in an insulated box with an interlock switch so that the current cannot flow when the box is open.
3. Use a double-throw switch and rectifiers.
4. Connect the inductor in a method that prevents the operator from directly touching the conducting connectors.
5. Use a power supply to indicate the current is ZERO and instruct the operator to NOT touch the box if the current is not zero.
6. Make sure the floor and the work surface are non-conductive.
7. Inspect the test setup regularly to ensure the safety mechanisms are functioning correctly.

Programming the 1910 & 1320

Connect the (4) 1910 output terminals to the (4) 1320 'From L Meter' BNC terminals using the 1320-03 4-BNC to 4-BNC Cable Lead Set.

Connect the 1910 rear panel REMOTE I/O (37-PIN) to the 1320 HANDLER INTERFACE (24-PIN) using the 1320-07 (37-PIN to 24-PIN) interconnect cable.

Turn the 1910 and 1320 instrument [POWER] ON.

Program the 1910:

Press [PROGRAM] to enter programming mode.

Press [▲] to select the Primary Parameter = Automatic.

Press [▶] to select the Bias Current Screen.

Press [▲] to select the Bias Current Value = OFF.

Press [PROGRAM] to exit programming mode.

Press [UTILITY] to select trigger mode.

Press [▶] to select the Trigger Source Screen.

Press [▲] to select the Trigger Source = EXTERNAL.

Press [UTILITY] to exit system utilities mode.

Program the 1320:

Press [PROG/ESC] to enter programming mode.

Press [SHIFT] [I/F] [=] [1] [ENTER] to set the 1320 to HANDLER mode.

Press [SHIFT] [MODE] [=] [2] [ENTER] to select MULTIPLE AUTO mode.

EXAMPLE: Apply 10A in 5 step interval.

Press [5] [ENTER] to select STEP NUMBER = 5.

Press [1] [ENTER] to select UNIT INTERVAL? = YES.

Press [1] [.] [0] [ENTER] to select I1 = 1.0A

Press [1] [0] [.] [0] [ENTER] to select I5 = 10.0A

Press [3] [.] [0] [ENTER] to select DELAY TIME = 3.0sec.

Press [PROG/ESC] to exit programming mode.

Connect DUT to 1320 Unknown terminals as illustrated in Figure 3.

Press red [START] button on 1320 to trigger the 1910 measurement of DUT.

Connection to DUT

Figure 3 illustrates the connection of the 1910 Inductance Analyzer to the 1320 Bias Current Source for the purpose of applying DC bias ($>1A$) to an inductor. The 1910 instrument is capable of providing 1A internal DC bias to the DUT. The 1320 BCS instrument can provide 20A DC bias in FWD or REV configuration. Adding a 1320S Slave unit provides another 20A DC bias current. Up to 4 slave units can be connected in parallel with the 1320 Master to provide a maximum of 100A DC bias. This combination of 100A DC bias current and an inductor is potentially **lethal if** the current were instantaneously cut off.

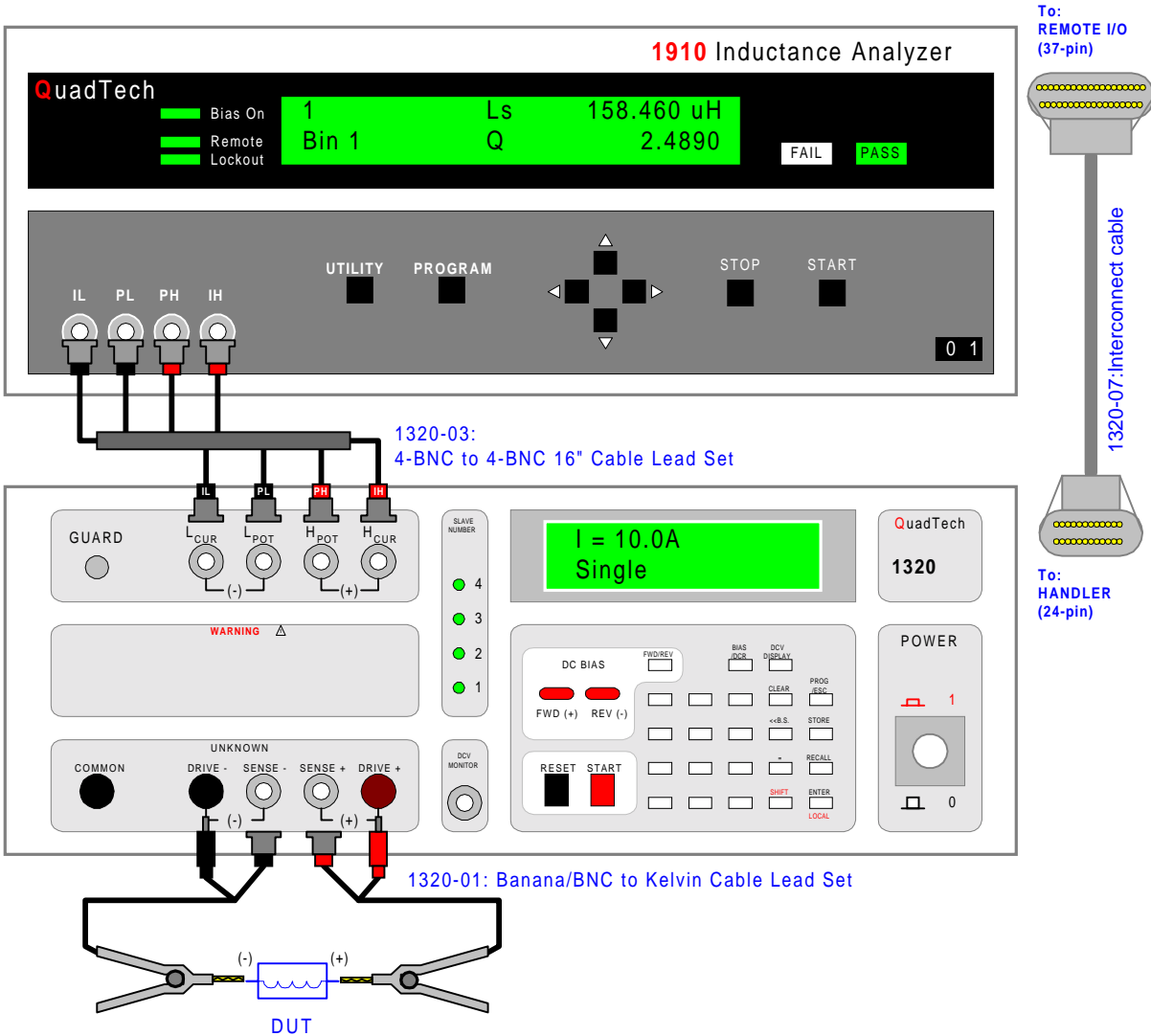


Figure 3: Connection of 1910 Inductance Analyzer to 1320 Bias Current Source

Condensed Product Specifications

1320 Bias Current Source

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

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

DC Resistance:	Range	Measure Range	Measure Current	Accuracy
	20mΩ	0.00-19.99mΩ	2A	±(2% + 0.07mΩ)
	200mΩ	0.0-199.9mΩ	2A	±(2% + 0.2mΩ)
	2Ω	0.000-1.999Ω	20mA	±(3% + 0.002Ω)
	20Ω	0.00-19.99Ω	20mA	±(3% + 0.02Ω)
	200Ω	0.0-199.9Ω	20mA	±(3% + 0.2Ω)

Interface: • IEEE-488 • LCR Link/Handler • Slave

1910 Inductance Analyzer

Measurement Parameter	Measurement Range	Measurement Accuracy		
		Fast	Medium	Slow
Ls, Lp	0.001nH – 99.999H	± (0.5%)	± (0.25%)	± (0.1%)
Cs, Cp	1pF – 9.9999pF	± (0.5%)	± (0.25%)	± (0.1%)
D _F	0.00001 – 99.999	± (0.005)	± (0.0025)	± (0.001)
Q	0.00000 – 9999.9	± (0.005)	± (0.0025)	± (0.001)
Y, Gp, Bp	10nS – 9999.9S	± (0.005)	± (0.0025)	± (0.001)
Z, Rs, Rp, Xs, ESR	0.0001mΩ – 99.999MΩ	± (0.5%)	± (0.25%)	± (0.1%)
Phase Angle (θ)	-180.00° – +179.99°	± (1.8°)	± (0.9°)	± (0.18°)
DCR	0.1mΩ – 100kΩ	± (0.5%)	± (0.25%)	± (0.1%)
DUT AC Voltage	20mV – 1.0V	± (2% + 5mV), at 1kHz		
DUT AC Current	1μA – 150mA	± (2% + 5μA), at 1kHz		
DUT DC Voltage	20mV – 1.0V	± (2% + 5mV)		
DUT DC Current	1μA – 150mA	± (2% + 5μA)		

Test Frequency: • 20Hz – 1MHz, ± (0.01% + 0.02Hz) (27,000 user programmable frequencies)

Source Impedance: • 5Ω • 25Ω • 50Ω • 100Ω

Interface: • RS232 • IEEE-488 • Handler

DC Bias Current: • Internal (1A) • External (20A, 1320) • External (100A, QT 1320 & 1320S)

Voltage Leveling: • ON • OFF

For complete product specifications on the 1910 and 1320 instruments or any of QuadTech's products, please visit us at <http://www.quadtech.com/products>. Call 1-800-253-1230 or email your questions to info@quadtech.com.

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