

## Open and Short Correction

Before measurement, zero the Digibridge as described herein. In this process, the instrument automatically measures stray parameters and retains that data, which it then uses to correct measurements so that results represent parameters of the DUT alone, without (for example) test-fixture or adaptor capacitance.



Standards are measured using different connection methods. The 1689M Digibridge makes a 4-terminal measurement using BNC connectors. Calibration must be valid for all connections even though the cabling and connectors used may have different series resistance and inductance and shunt capacitance. To make sure the measured value is corrected for these series and shunt parameters, open circuit and short circuit measurements are made. These 'zero corrections' must be made each time the connection configuration (hardware) is changed.

The actual open and short are corrected in the 1689M using the formula in Equation 1.

$$Z_x = \left[ \frac{(Z_{MEAS} - Z_{SC})}{1 - (Y_{OC} \times Z_{MEAS})} \right]$$

$Z_{OC}$  = Open Circuit Impedance Value  
 $Z_{SC}$  = Short Circuit Impedance Value  
 $Z_{MEAS}$  = Uncorrected Measured Impedance Value  
 $Z_x$  = DUT Impedance Value  
 $Y_{OC}$  = Parallel Admittance =  $\frac{1}{Z_{OC}}$

### Equation 1: DUT Impedance Calculation

$Y_{OC}$  is the parallel admittance and is mathematically equal to  $1/Z_{OC}$ , the open circuit impedance.

If we have an impedance in series with the DUT and an admittance in parallel with it, we can measure  $Z_x$  itself very accurately by:

- 1.) Replacing  $Z_x$  with a short circuit and measuring  $Z_{sc}$
- 2.) Replacing  $Z_x$  with an open circuit and measuring  $Y_{oc}$
- 3.) Applying the formula in Equation 1 (where  $Z_{meas}$  is the uncorrected measurement data)

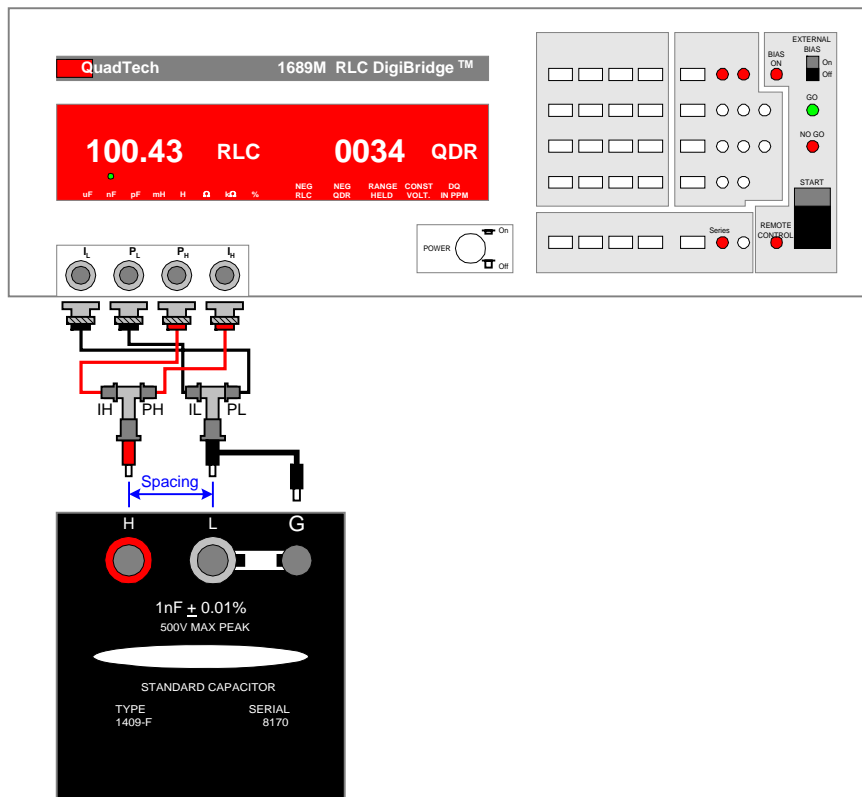
## Precautions on Cabling and Cable Movement

Cabling and adapters can cause an additional error in measurements. This additional error is primarily due to connection geometry and can be a large in comparison to the DUT impedance as listed in Table 1. This additional error can be minimized by using the same connection geometry for open/short compensation as for connection to the device under test.

**Table 1: Cable Error**

Parameter		Error
Capacitance	C	$\pm 1.0 \text{ pF}$
Resistance	R	$\pm (10\text{m}\Omega + R/[5 \times 10^6])$
Quality Factor	Q	$\pm 50 \text{ ppm}$

As an example, when measuring 1409 Standard Capacitor it is important to maintain the spacing between the banana plugs during the open compensation at exactly the same distance as the spacing is when the banana plugs are connected to the 1409. If the spacing is not exactly the same the measured value will be higher than the actual value. This is due to the fact that the four terminal Kelvin connection stops at the BNC T. The banana plugs are two-terminal so the capacitance between the parallel spaced banana plugs will be measured as part of the overall measurement unless open compensation is performed to eliminate this additional capacitance.



**Figure 1: 1689M DigiBridge connected to 1409 Capacitor Standard**

## Performing an open and short on the 1689M Digibridge

The method for performing an open and short compensation on a 1689M Digibridge is listed herein.

a. Test Conditions:

- SLOW measure rate
- 1 V test voltages (default)
- RANGE HELD indicator NOT lit.

b. Open Circuit.

- Press [FUNCTION] key (if necessary) to select MEASURE function
- Press [MEASURE MODE] key (if necessary) to select TRIGGERED mode.
- Connect and position cables and adapters being used with the 1689M for the appropriate standard to be tested.
- Be sure that the cables and adapters are open circuited.
- If you want this “zero” process to echo a display of 00000, press the [Cs/D] key. However doing so will disable automatic parameter selection.
- Press these keys deliberately: [1] [6] [8] [9] [=] [SHIFT] [OPEN].
- Note: the GO indicator being lit and two zeros confirm the previous step. Watch the GO indicator on the keyboard; not one on any remote test fixture.
- Keep hands and objects at least 10 cm (4 in.) from cables and adapters.
- Press the START button. The GO indication disappears.
- Wait for the GO indicator to be lit again.

c. Short Circuit

- Short the cables and adapters together
- Press these keys: [1] [6] [8] [9] [=] [SHIFT] [SHORT].
- Note: the GO indicator being lit and two fives confirm the previous step.
- Press the START button. The GO indication disappears.
- Wait for the GO indicator to be lit again.
- Remove the short circuit.

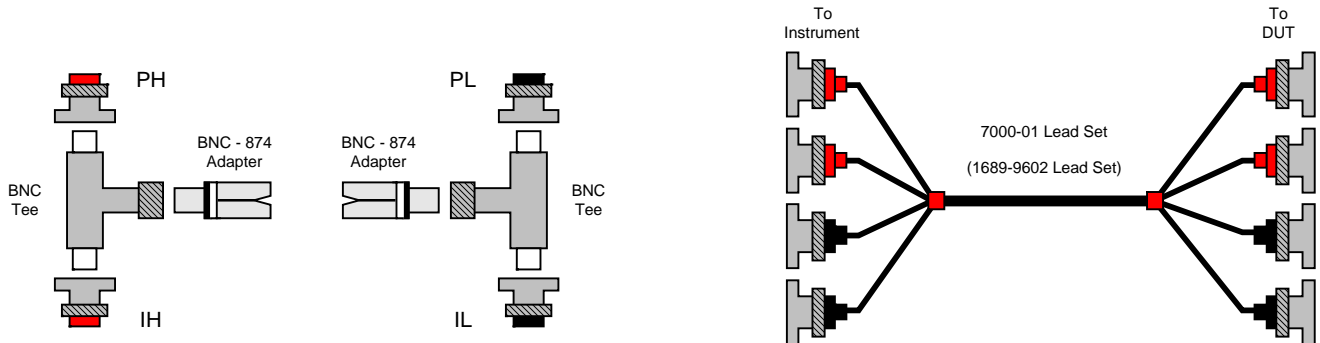
**NOTE:**

For best accuracy:

Repeat this procedure daily and after changing test-fixture adaptors or frequency.

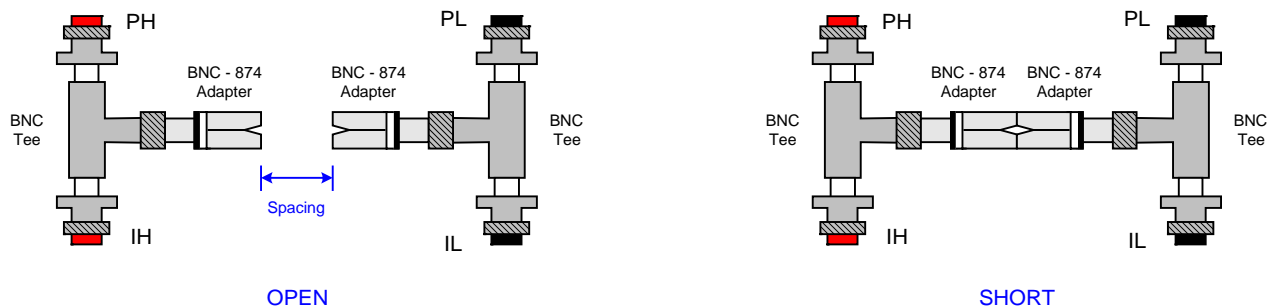
## Connection to 1689 using 874 Coaxial Connectors

When connecting to some standards the use of 874 coaxial connectors may be necessary. This connection can be made using either the 1689-9602 or 7000-01 BNC to BNC Cable, two BNC Tees and two BNC to 874 adapters\* (Figure 2).



**Figure 2: BNC-Tee to 874 Coaxial Connector Setup**

Figure 3 illustrates the Open Circuit Compensation Configuration and the Short Circuit Compensation Configuration for this 874 example. Remember the spacing between the leads for the open configuration should be the same placement as when the DUT is tested.



**Figure 3: Open Circuit and Short Circuit Configurations**

For complete product specifications on the Digibridge Line of LCR meters or any of IET's products, visit us at <http://www.ietlabs.com/digibridges.html> Do you have an application specific testing need? Call us at 1800-899-8436 or email engineering at [sales@ietlabs.com](mailto:sales@ietlabs.com) and we'll work with you on a custom solution. Put IET to the test because we're committed to solving your testing requirements.