Teradyne ICT Application Brief	Teradyne, Inc www.teradyne.com	Author: Tim Cunningham Published Date: May 2010

Small Value Capacitor Testing Tips

Test and Debug Guidelines for Accurately and Reliably Testing Low Value Capacitors on GR228X and TestStation Testers

Application Overview

You can accurately and reliably measure low value capacitors on Teradyne GR228X and TestStation systems by following a few simple guidelines. Let's explore the most common issues associated with testing capacitors below 500pF.

Common Problems that prevent testing of low value capacitors

1. The most common problem in testing low value capacitors occurs when the test fixture has twisted pair wiring. If you are attempting to measure a low value capacitor that is connected by twisted pair wiring, **it will not work correctly**. A twisted pair wire is like a bunch of series inductors with a bunch of capacitors hanging from those series connections to ground. Twisted pair wiring adds a complex circuit between your test instrumentation and the capacitor you are attempting to measure.

   Stop wasting time, because it will not work properly. You may eventually obtain the value you want to measure by adding guarding to distort the measurement. If you get lucky with the guarding route, you can be assured that it will not work the same on another tester. The tester is not the problem, it is the implementation. Testing low value capacitors with twisted pair wiring simply will not work correctly!

2. If you are attempting to measure a 100nF capacitor and you have an Alliance power supply connected across it, you will not be able to measure 100nF. You will measure 200nF. Why? Because the Alliance power supplies have a permanent 100nF capacitor connected across the disconnected output of the power supply. This means you cannot remove the 100nF capacitor with the Alliance disconnect relays.

   One user reported a compatibility problem testing a 100nF capacitor that was on the same net as an Alliance power supply. During debug, they added enough guards to distort the measurement so that it measured close to 100nF. But they discovered that it did not measure the same value when it was moved to another tester and it was certainly not stable. When I removed all the guards the instrumentation measured 200nF on multiple test systems reliably.

The user asked why I removed the guards and remarked that the measured value was wrong. I removed the UUT from the test fixture, while stopped at the capacitor test in debug, to show that the instrumentation measured 100nF without the UUT. Thus, if we reconnected the UUT to the test fixture with 100nF on the UUT, we should measure 200nF because the Alliance power supply 100nF capacitor would be connected in parallel with the UUT 100nF capacitor. No guards were required as it was measuring the correct 200nF value in the first place.

3. Generally, adding a guard to a low value capacitance measurement typically adds error to the measurement. Typically, the most effective guarding technique, if required, is accomplished by adding a DC BIAS to pinch off a current path, especially if it is tied to an IC pin. Since it is impossible to guard internal nodes on an IC, the DC Bias often becomes more effective than guarding.

4. When the system reports measuring a negative value for a capacitance measurement, it is an indicator that something is wrong. If you were measuring with 10 KHz and changed the frequency to 1 KHz and find the value turns positive, this usually indicates that inductance in the circuit may not be the problem.

When troubleshooting an issue I generally raise the test fixture off the interface to see what is being measured with nothing connected. Typically, you would expect to see something under 15pF. If you still see a negative value and you change the frequency from 10 Khz to1 KHz and the value turns positive, then you should read the Application Example section below to learn how to correct the problem by modifying the instrument MUX connection for your measurement.

Hardware Requirements

Both Teradyne GR228X and TestStation test systems utilize an ICA (In-Circuit Analog) instrument to perform analog measurements. The ICA instrument is standard on these test systems.

Software Requirements

The GR228X version 5.8.0 software (for GR228X test systems) or latest TestStation software versions 6.4.0 and greater (for TestStation systems) should be installed on your Teradyne tester.

Application Example

How to Eliminate Negative Value Capacitor Measurements

Generally, if you see a negative value measured for capacitance the problem is either inductance in the measurement or a problem in the instrumentation setup. If you change the frequency from 10 KHz to 1 KHz and the negative number turns positive, you can rule out an inductance problem as this would indicate an instrumentation setup issue.

The typical MUX setup for a capacitor test follows:

```
SET MUX AT(
     CHA=ACZVSRC,ACZVSNS:
     CHB=ACZIMEAS,ACZISNS:
     CHC=ACZGRDSNS:
     CHD=REFCONN:
     REF=ACZGND,ACZGND2,ACZGND3,ANAGND);
```

If this is the MUX setup you are using for a low value capacitor test and you are having trouble or you are measuring a negative value, you will need to modify the MUX setup. If you have twisted pair wiring connected to the capacitor you are attempting to measure, you must remove it and replace it with single untwisted wiring.

In order to modify the MUX statement, it is suggested that you create a new label for another test section for testing low value capacitors. Let's create a new label and call it SETLOCAP with a new MUX setup for testing low value capacitors more effectively and reliably. Here is an example.

```
SETLOCAP:
SET MUX AT(
      CHA=ACZVSRC,ACZVSNS:
      CHB=ACZIMEAS,ACZISNS:
      CHC=0:
      CHD=0:
      REF=ACZGND,ACZGND2,ACZGND3,ANAGND);
```

Now you can copy and paste your low value capacitor tests after this new SET MUX statement in your test program. If you had experienced negative value measurements at 10 KHz, but not at 1 KHz, you should be able to change the frequency beyond 10 KHz without experiencing a negative value measurement.

Tests that utilize the automated capacitor calibration variable should continue to work. When using the capacitor calibration variable make absolutely sure you are using the same MEAS CS or MEAS CP statement in the calibration subroutine as you are in the main test. This is very important.

One final note, make sure you remove the guard connections in CHC and CHD in your SET SCAN, MEAS CS, or MEAS CP statements as they are not needed and may cause additional measurement error with this new MUX setup.

Additional Information

For more information on Analog Testing techniques, please refer to the Test Library Programming manual. For programming syntax and commands refer to the Test Language Reference manual. These manuals are part of the documentation package that is shipped with the GR228X and TestStation software.