Chroma Turnkey Test & Automation Solution Provider

APPLICATION NOTE

Guarding

Guard Shield used for Low Current (nano-Amp) Measurement

Key Words: Guarding, Guard Shield, SMU, Settling Time, Force, Low Current Measurement, nano-Amp range, Triaxial Cable, Leakage Current

Product Family: Model 52400 series SMU (Source Measure Unit)

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Chroma ATE Inc.

Scope

Guarding- A technique that reduces leakage current error and decreases settling time. It keeps the potential of the guard connector at the same potential as the force conductor, so current does not flow between the force and guard conductors. It also eliminates the cable capacitance between source measure unit (SMU) and DUT for faster and accurate measurements. This document describes how to prevent leakage current error for very-low current measurement. For more information about charging delay (settling time), please refer to the related document: AN-52400-02V1.00.

A guard is a low-impedance point in the circuit that's at the same potential as the high-impedance lead in the circuit. In a guarded measurement, because the shield is driven to the same potential as the force high terminal of the **SMU** (Source Measure Unit), no current flows through the insulation medium; therefore, eliminates leakage current effects.

Low-Current Measurement can be affected by Cable Leakage

Leakage currents are currents flowing through paths other than the intended signal path, for example, current flowing through the interconnect insulator. This leakage current can be a problem when the device under test (DUT) impedance is similar to that of various insulators in the circuit.

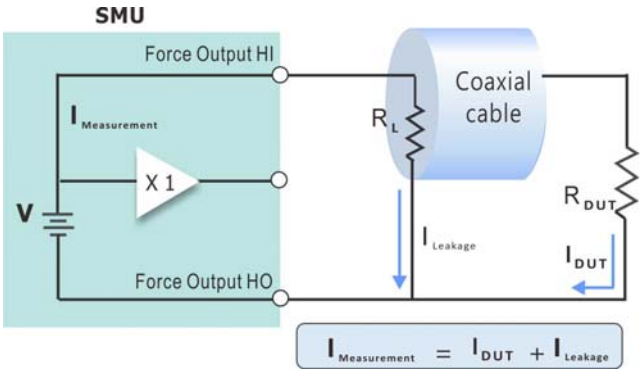


Figure-1. Leakage current flows through the cable's insulation resistance

When the SMU (Source Measure Unit) is connected to the DUT using coaxial cable (see Figure-1.), a leakage current flow through the cable insulation resistor. This causes the SMU to measure the sum of the current flowing through the DUT and the leakage current, rather than just the current flowing through the device.

Triaxial cable prevents the Current Leakage by keeping Guard same potential as Force

A technique called "**Guarding**" can eliminate the effects of leakage currents flowing through the insulator. A guard is a low-impedance point in the circuit that's at the same potential as the high-impedance lead in the circuit. In a guarded measurement, the shield is driven to the same potential as the Force Hi output terminal of the SMU using a unity-gain, low-impedance amplifier (guard). Therefore, no leakage current flows through the insulation resistor.

Guarding is a very effective way to reduce leakage currents. The Guard shield of a triaxial cable can solve the current leakage problem. As it is shown in Figure-2, the core (known as the **Force**) and the inner shield (known as the **Guard**) are kept at the same electrical potential, thus the leakage current between them is zero for all practical purposes, despite the imperfections of the insulation. This eliminates the current leakage that would otherwise limit low current measurements.

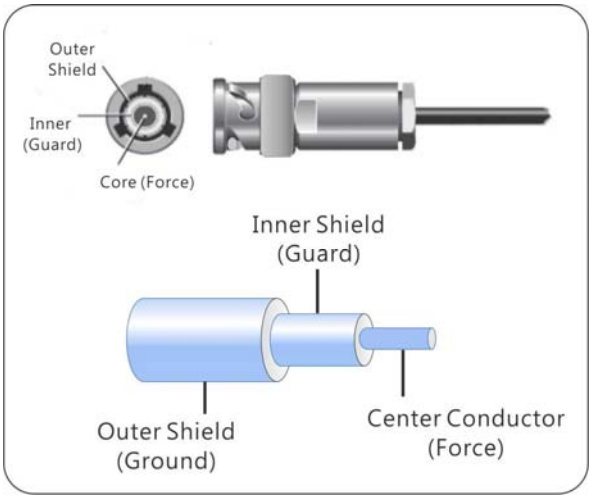


Figure-2. Triaxial Cable with Outer and Inner Shield

Connection for Guarding

The SMU port at the back of instrument has two pair of independent output for both Source (Force) and Sense.

One should also note that each output is a Triaxial cable (not BNC). In a Triaxial cable center conductor is surrounded by circular cable (called guard) which has the same voltage as center conductor thus avoiding any leakage current between center conductor and outermost ground.

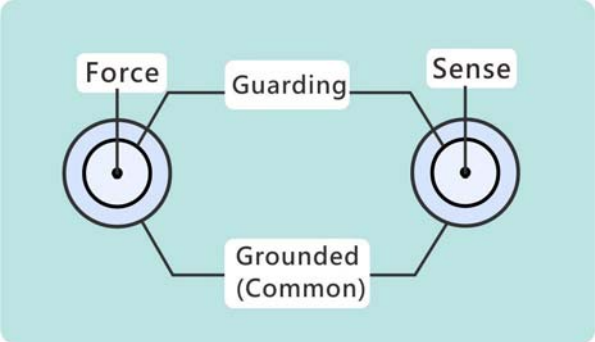


Figure-3. Two pairs of Force/Sense

This is called guarding and used for very high impedance devices or for ultra low current measurement. If you are not doing ultra low current measurement, you can simply ignore the sense output.

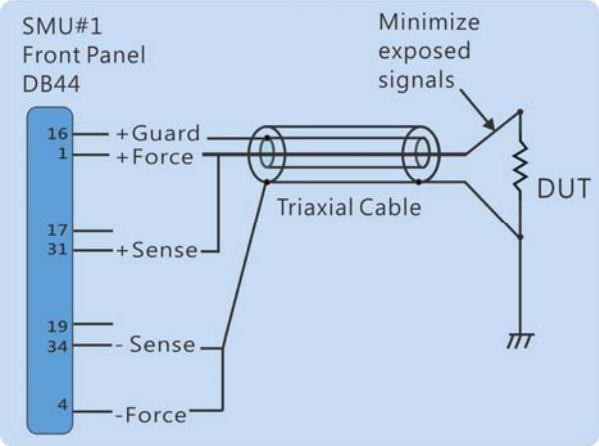
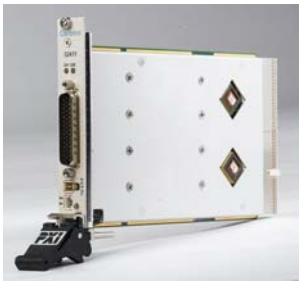


Figure-4. Connection Suggestion for Low current- Local Sense, Guarded

Chroma 52400 Series SMU

The Chroma 52400 family has two fully isolated SMUs allowing testing or measure; such as, FET or BJT IV sweeping. No additional piece of equipment is necessary. Kelvin remote sense connections for precise voltage/sense at the DUT as well as +/-Guard signal to suppress unwanted leakage current are available.

Other features, such as hardware sequencer for precise output profile control, two isolated channels in one compact PXI slot are capable to meet most demanding test requirements



Model 52400 series SMU

For more detailed information about Chroma 52400 series SMU & other Chroma solutions, please visit Chroma's website at: www.chromaate.com

PXI Systems Alliance

www.pxisa.org

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