

# Minimizing Cable-Induced Measurement Errors in High Current Applications

## Dave Wyban

In my job as an applications engineer, I've been fielding lots of calls about test and measurement problems that engineers encounter with high current applications like characterizing high power LED modules and high brightness light-emitting diodes (HBLEDs). At higher test currents, the appropriate cabling techniques are particularly important in obtaining repeatable and accurate measurements and maximizing performance.

Source measurement unit (SMU) instruments are among the most often-used types of instruments for LED testing. SMU instruments, including Keithley's Model 2651A High Power System SourceMeter® instrument, combine source and measure operations normally performed by two separate instruments into a single simultaneous operation done by a single instrument. They offer two options for cabling connections between the instrument and the LED device: two-wire and four-wire.

Two-wire mode uses a single set of test leads to both source and measure. Although two-wire mode simplifies cabling, it creates measurement errors because voltage measurements will not only include the voltage across the device under test (DUT) but across the test leads as well. In high current applications, even test leads with very little resistance can cause large voltage drops. To compensate for this, SMUs include a four-wire measurement mode. In four-wire mode, one set of leads, known as the source leads, is used to source while a second set of leads, known as the sense leads, is used to measure. Because the measurement circuitry that the sense leads are connected to has very high impedance, very little current will flow through these leads; therefore, the voltage drop across them will be insignificant and the voltage measured will be the same as the voltage across the DUT.

Although four-wire mode is designed to compensate for the voltage drops in the test

leads caused by high currents, excessive lead resistance can still create measurement problems. When testing an LED using pulsed rather than DC currents, fast rise and settle times are critical to obtaining the shortest pulse widths to minimize device self-heating. Minimizing lead resistance makes it possible to obtain the fastest rise times.

Minimizing cable inductance is also crucial when testing LEDs with high test currents. Essentially, inductance resists changes in current by creating a voltage drop when the test current is changing. Although inductance in the test leads will have no effect at the top and bottom of the pulse, where the current is constant, it will cause an additional voltage drop during the rising and falling edges for which the SMU must compensate. As with resistance, minimizing lead inductance is important for obtaining the fastest rise time.

To learn more about how to ensure higher source and measurement accuracy in LED test applications, I encourage you to download and view Keithley's latest webinar on this topic: Meeting the Electrical Measurement Demands of High Power, High Brightness LEDs at [www.keithley.com/events/semconfs/webseminars](http://www.keithley.com/events/semconfs/webseminars). 

## About the Author

David Wyban is an applications engineer with Keithley Instruments, Inc., Cleveland, Ohio, which is part of the Tektronix test and measurement portfolio. He joined the company in 2006, working on the team that developed Keithley's line of System SourceMeter instruments. He holds a bachelor's degree in electrical and computer engineering from The Ohio State University. He can be reached at [dwyban@keithley.com](mailto:dwyban@keithley.com).

Specifications are subject to change without notice.  
All Keithley trademarks and trade names are the property of Keithley Instruments, Inc.  
All other trademarks and trade names are the property of their respective companies.

**KEITHLEY**

A G R E A T E R M E A S U R E O F C O N F I D E N C E

KEITHLEY INSTRUMENTS, INC. ■ 28775 AURORA ROAD ■ CLEVELAND, OHIO 44139-1891 ■ 440-248-0400 ■ Fax: 440-248-6168 ■ 1-888-KEITHLEY ■ www.keithley.com

**BELGIUM**

Sint-Pieters-Leeuw  
Ph: 02-3630040  
Fax: 02-3630064  
info@keithley.nl  
www.keithley.nl

**CHINA**

Beijing  
Ph: 86-10-8447-5556  
Fax: 86-10-8225-5018  
china@keithley.com  
www.keithley.com.cn

**FRANCE**

Saint-Aubin  
Ph: 01-64532020  
Fax: 01-60117726  
info@keithley.fr  
www.keithley.fr

**GERMANY**

Germering  
Ph: 089-84930740  
Fax: 089-84930734  
info@keithley.de  
www.keithley.de

**INDIA**

Bangalore  
Ph: 080-26771071, -72, -73  
Fax: 080-26771076  
support\_india@keithley.com  
www.keithley.com

**ITALY**

Peschiera Borromeo (Mi)  
Ph: 02-5538421  
Fax: 02-55384228  
info@keithley.it  
www.keithley.it

**JAPAN**

Tokyo  
Ph: 81-3-5733-7555  
Fax: 81-3-5733-7556  
info.jp@keithley.com  
www.keithley.jp

**KOREA**

Seoul  
Ph: 82-2-574-7778  
Fax: 82-2-574-7838  
keithley@keithley.co.kr  
www.keithley.co.kr

**MALAYSIA**

Penang  
Ph: 60-4-643-9679  
Fax: 60-4-643-3794  
sea@keithley.com  
www.keithley.com

**NETHERLANDS**

Son  
Ph: 0183-635333  
Fax: 0183-630821  
info@keithley.nl  
www.keithley.nl

**SINGAPORE**

Singapore  
Ph: 65-6747-9077  
Fax: 65-6747-2991  
sea@keithley.com  
www.keithley.com

**SWITZERLAND**

Zürich  
Ph: 044-8219444  
Fax: 044-8203081  
info@keithley.ch  
www.keithley.ch

**TAIWAN**

Hsinchu  
Ph: 886-3-572-9077  
Fax: 886-3-572-9031  
info\_tw@keithley.com  
www.keithley.com.tw

**UNITED KINGDOM**

Theale  
Ph: 0118-9297500  
Fax: 0118-9297519  
info@keithley.co.uk  
www.keithley.co.uk