B2200A Femtoamp Low Leakage Switch
B2201A 14-Channel Low Leakage Switch
E5250A Low Leakage Switch

Solving the Parametric Test Conundrum

Parametric instrument integration challenges

Semiconductor parameter analyzer users frequently need to use other instruments such as capacitance meters, precision digital voltmeters, and pulse generators. The integration of all these different instruments, however, presents many measurement challenges. For example, parameter analyzer source/monitor units (SMUs) have triaxial outputs that require adapters for connecting to coaxial-based instruments. In addition, a system is necessary to organize the cables coming from the various instruments. Finally, the need to manually switch between triaxial and coaxial cables makes it impossible to automate measurements on the device under test (DUT).

Solving the most difficult switching challenges

Figure 1. B2200A femtoamp low leakage switch (left) and E5250A low leakage switch (right)

KEYSIGHT TECHNOLOGIES

Switching matrices give rise to performance issues

Switching matrices can solve instrument integration issues, but they can create their own measurement problems. Some switching matrix relays add noise and current leakage paths. This problem typically degrades the current versus voltage (IV) measurement performance relative to that of a standalone parameter analyzer. Capacitance versus voltage (CV) measurements require compensation of the signal path length, but switching matrices create variable path lengths. This makes capacitance measurement compensation much more difficult. Most probe card interfaces also further degrade the IV and CV measurement performance of the overall solution.

Keysight switching matrices meet these measurement challenges

Keysight Technologies, Inc. supplies both Kelvin and non-Kelvin switching solutions to meet all of these challenges. Keysight solutions do not compromise the integrity of your parameter analyzer, and they support accurate CV and low-current IV measurements. Whatever switching needs you have, Keysight offers a solution that both minimizes cost and maximizes the flexibility and integrity of your measurements. Best of all, Keysight's switching solutions easily combine with the B1500A Semiconductor Device Analyzer and EasyEXPERT group+ software to create a complete parametric test environment.
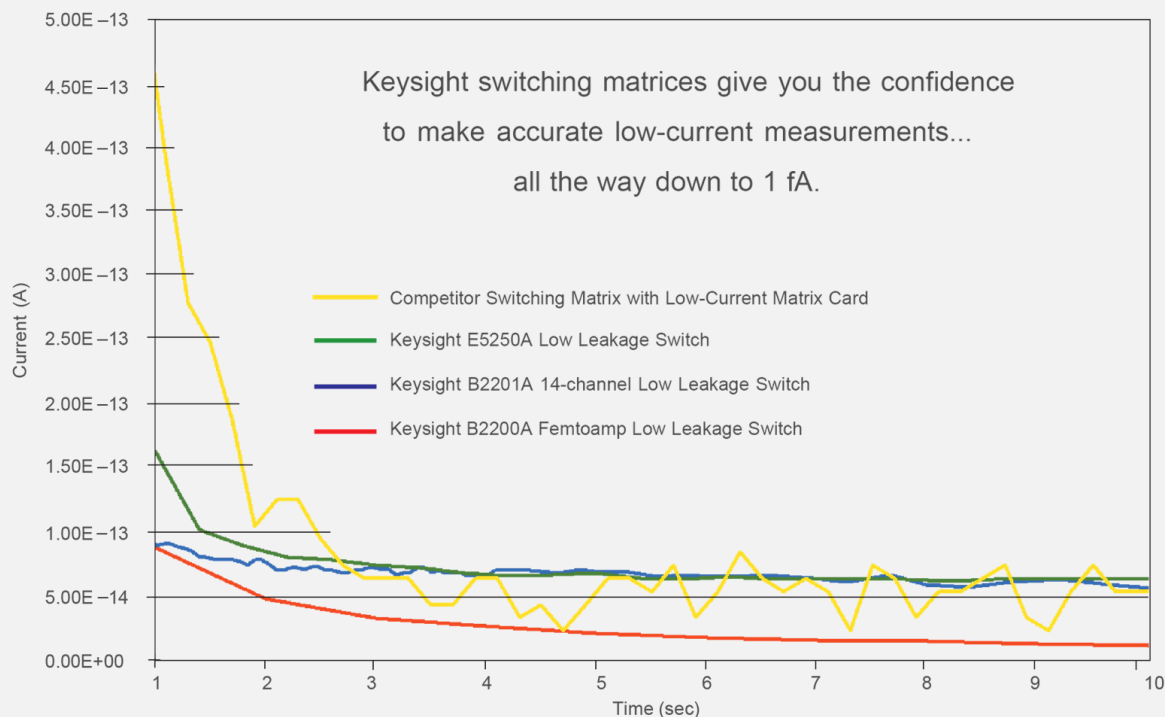

Figure 2. Current settling time at the matrix outputs in response to a 10 V step applied to the matrix inputs.

Switching Solution for Every Need and Budget

Measurement performance without compromise

The Keysight B2200A Femtoamp Low Leakage Switch and Keysight B2201A 14-channel Low Leakage Switch provide exceptional measurement performance. The B2200A and B2201A allow you to achieve current measurement resolutions of 1 fA and 10 fA respectively. Kelvin connections on up to four SMUs are also supported. These features allow you to realize the full measurement potential of your parameter analyzer while benefiting from the measurement flexibility inherent in a switching matrix-based solution.

Easy to use and control

The B2200A and B2201A have identical user interfaces. They can be controlled remotely via GPIB commands or directly from their front panels via the keypad or optional light pen. This makes it easy to perform simple debug operations without using an external controller. In addition, a lighted display provides a convenient visual reference of the relay status. A VXI*plug&play* driver is also available for use with popular programming languages such as VEE and LabView.

Economical switching solutions for non-Kelvin characterization needs

The Keysight E5250A Low Leakage Switch supports non-Kelvin measurement on four SMUs, with six additional multiplexed inputs for other needs. Besides supporting traditional matrix functionality (Keysight E5252A cards), the E5250A also supports long-term reliability stress testing (Keysight E5255A cards). The E5250A can be configured with one to four output cards of either type. Just like the B2200A and B2201A, the E5250A also supports a VXI*plug&play* driver for easy programmatic control.

B2200A and B2201A

- 1 fA and 10 fA resolution respectively
- Kelvin connections on up to 4 SMUs
- Identical user interfaces
- GPIB command control
- Front panel control via keypad or light pen
- Lighted relay status display
- Supports VXI*plug&play* driver

E5250A

- Supports non-Kelvin measurement on 4 SMUs
- Six additional multiplexed inputs
- Traditional matrix functionality
- Supports long-term reliability stress testing
- Supports VXI*plug&play* driver

Versatile Architecture and Features Improve Ease-of-Use

Flexible switching solutions with Kelvin capability

The B2200A and B2201A both support Kelvin measurement on up to four SMUs (eight triaxial inputs). They also provide six additional coaxial inputs for other instruments, such as capacitance meters and digital voltmeters. Each input corresponds to a unique internal path (14 internal paths total), and each triaxial input has the same low-current measurement performance. The B2200A and B2201A mainframes can be configured with one to four Keysight B2210A or Keysight B2211A matrix cards respectively. Each card provides twelve triaxial outputs, which permits x12, x24, x36 and x48 output configurations.

Advanced capabilities simplify common measurement tasks

The B2200A and B2201A have many ingenious features that enhance the utility of the instruments. For example, you can save up to eight setups into nonvolatile memory for fast and easy retrieval at a later time. Another feature lets you use the "couple port" mode to designate pairs of triaxial inputs as Kelvin. This eliminates the possibility of incorrectly connecting the Force and Sense lines when using Kelvin triaxial cables. An auto-detect feature is also available where matrices automatically place the inputs into couple port mode, if a Kelvin cable is connected to the triaxial inputs. A "bias port" mode is also supported, which makes it easy to specify one of the inputs (triaxial or coaxial) as a bias source for use in stress testing applications. Finally, two of the B2200A and B2201A coaxial inputs are optimized for CV measurement for improved accuracy.
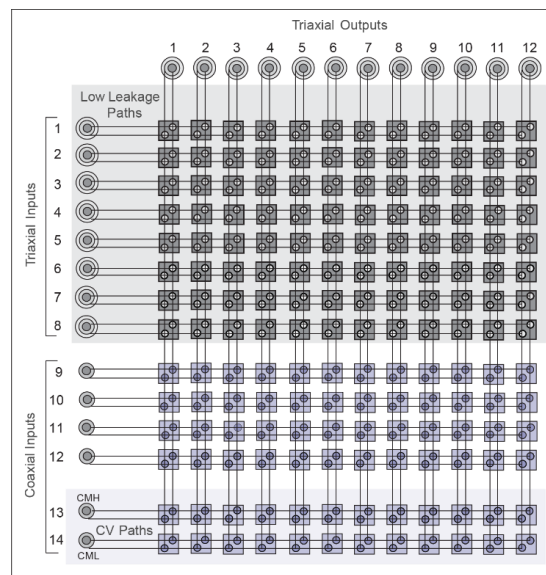

Figure 3. B2200A Switching Matrix (rear view)

Figure 4. 2210A and B2211A Matrix Cards Each input corresponds to a unique internal path (14 total). Each triaxial input is a low-leakage path and has the same low-current measurement performance. Coaxial inputs 13 and 14 are optimized CV paths.

Keysight EasyEXPERT group+ Software Enhances B2200A and B2201A Capabilities

Intuitive GUI switching matrix control

Keysight EasyEXPERT group+ software running on the B1500A and an external PC allow you to create and save B2200A and B2201A switch setups via a Windows-based GUI. You can connect or disconnect any input and output by simply clicking on an intersection point. The intrinsic capacitance compensation ensures accurate CV measurements. Switching matrix capacitance compensation is supported for the B2200A and B2201A in EasyEXPERT group+ when using the B1500A's multifrequency capacitance measurement unit (MFCMU). Cable lengths are automatically compensated up to the output of the switching matrix, and you can create your own compensation file to correct for the additional cables and probes going out to the DUT if desired. Using the two optimized BNC capacitance inputs, you can easily switch between accurate CV measurements and 4-SMU Kelvin IV measurements, with four BNC inputs still available for other instrumentation.

Windows-based, point-and-click GUI Make accurate CV measurements through the B2200A and B2201A. input labels are automatically linked to the active application test, and you can create mnemonic labels for the output ports. Once saved, switching matrix setups can be recalled programmatically and automatically executed in conjunction with parametric measurements and wafer prober moves.

Intrinsic capacitance compensation ensures accurate CV measurements

Switching matrix capacitance compensation is supported for the B2200A and B2201A in EasyEXPERT group+ when using the B1500A's multifrequency capacitance measurement unit (MFCMU). Cable lengths are automatically compensated up to the output of the switching matrix, and you can create your own compensation file to correct for the additional cables and probes going out to the DUT if desired. Using the two optimized BNC capacitance inputs, you can easily switch between accurate CV measurements and 4-SMU Kelvin IV measurements, with four BNC inputs still available for other instrumentation.

Figure 5. Windows-based, point-and-click GUI

Figure 6. Make accurate CV measurements through the B2200A and B2201A.

Switching Solutions that Provide CV-IV Measurement Performance without Compromise

Keysight multipurpose switching matrices
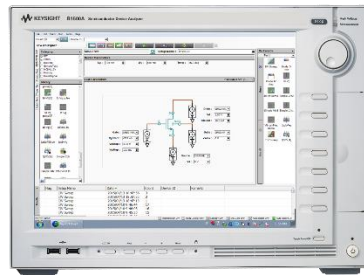

Figure 7. B2200A Femtoamp low leakage switch

Figure 8. B2201A 14-channel low leakage switch

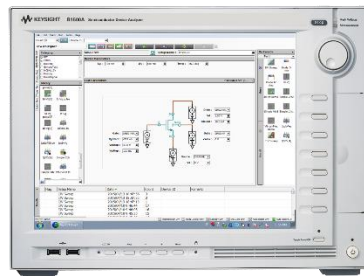**Figure 9. E5250A low leakage switch**

B2200A

B1500A

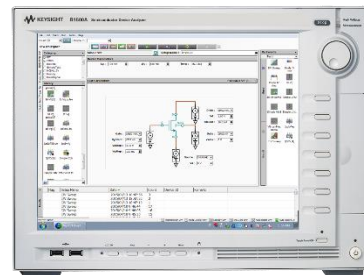**Figure 10. 1 fA Kelvin CV-IV measurement solution**

B2201A

B1500A

Figure 11. 10 fA Kelvin CV-IV measurement solution

E5250A with E5252A Matrix Cards

B1500A

Figure 12. Non-Kelvin CV-IV measurement solution

E5250A with E5255A Multiplexer Cards

Multisite Probe
Card

E5270B

Figure 13. Multisite reliability test solution

B2200A
Probe Card
Interface

B1500A with
B2200A or B2201A

Prober

Figure 14. fA or 10 fA Kelvin CV-IV measurement solutions to the probe tips

Economical Non-Kelvin Switching Matrix Solution

Simple non-Kelvin solution for moderate performance needs

The E5250A and E5252A matrix card combine to form a basic non-Kelvin matrix solution. The E5252A card has 6 triaxial inputs and 4 BNC inputs, with 6 internal paths. The inputs to rows 5 and 6 consist of a 3-to-1 multiplexer. This configuration maintains cost-effectiveness without sacrificing essential CV-IV measurement performance.

Support for low current and CV measurement

The E5250A with E5252A cards is capable of supporting precise CV-IV measurements, although the level of flexibility is less than that provided by the B2200A and B2201A. The E5252A card has two low-current paths available and using these inputs you can achieve measurement resolution of 20 fA to 30 fA. Two multiplexed coaxial inputs are also optimized for use with a capacitance meter to improve the accuracy of CV measurements.

Test automation capability

The B1500A EasyEXPERT group+ software can programmatically control the E5250A with E5252A cards using application tests, which permits test automation. Sample application tests to perform this function are downloadable from the B1500A Web site.

E5250A low leakage switch (rear view)
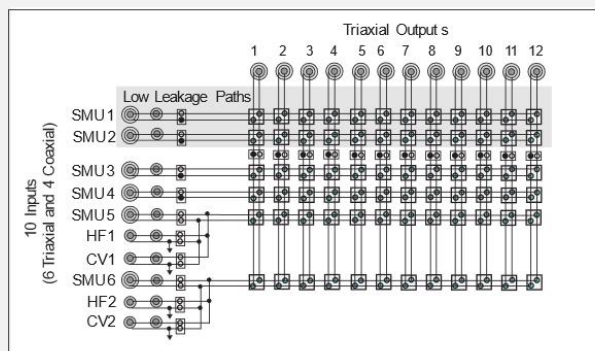
E5252A matrix card

The E5250A supports up to four E5252A matrix cards to provide up to 48 triaxial outputs

Figure 15. E5250A Low Leakage Switch (rear view)

# Multisite Test Solution for Long-Term Stress Testing

Ideal solution for long-term reliability stress tests multisite wafer test support

The E5250A also supports the Keysight E5255A multiplexer card for long-term reliability testing. The multiplexer card has 24 outputs, organized in groups of 8. Each card has one multilevel dc bias input for each set of eight channels, permitting the use of inexpensive power supplies for consistent stress. The E5250A accepts four of these cards, for a total of 96 outputs. Each channel can also have a user-selected protection resistor to limit the current surge after device breakdown or rupture. You can gang up to four E5250A mainframes together using the E5255A cards to create a system with 384-channel capability.

Multisite wafer test support

The E5255A cards are supported by numerous multisite probe card manufacturers. Using the cards, it is easy to stress and measure eight or more sites across a wafer using a single E5250A mainframe. This enables the efficient collection of data for many types of long-term stress testing, such as hot carrier injection (HCI) and time dependent dielectric breakdown (TDDB) tests. In many cases, an E5255A card can save money by eliminating the need to go to a per-pin SMU architecture to achieve multisite wafer test capability.

E5250A Low Leakage Switch (rear view)
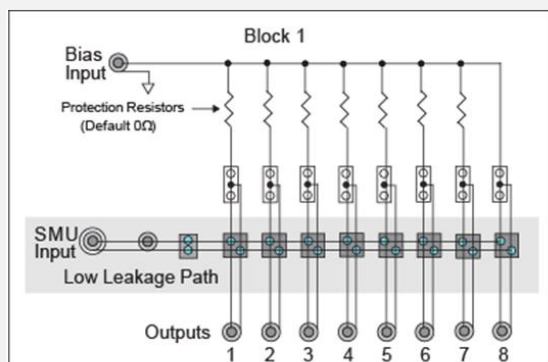
E5255A Multiplexer Card

E5250A with E5255A multiplexer cards allows you to create cost-effective reliability test solutions with up to 96 outputs per mainframe.

Figure 16. The E5255A card is partitioned into three groups of eight (24 outputs per card). Each group of eight can have an independent dc bias supply and a separate SMU connection.

Powerful Test Automation Capabilities and Performance

EasyEXPERT group+ facilitates wafer test automation

EasyEXPERT group+ software makes it simple to automate testing with the B2200A and B2201A and to programmatically call switch patterns in coordination with EasyEXPERT group+ application tests. Because EasyEXPERT group+ also supports all of the popular semiautomatic wafer probers, it is easy to define the wafer, die, and module information to automate probing across an entire wafer. You can automate testing by either using Quick Test mode of EasyEXPERT group+ or by creating an application test sequence. Best of all, you can do this from EasyEXPERT group+ running on the B1500A or from an external PC.

Low leakage probe card solutions

You can use the B2220A probe card interface with both the B2200A and B2201A, which allows you to use 4070 Series-style probe cards for improved measurement performance. You also purchase the B2220A as an option with the 41000 Series integrated parametric analysis and characterization environment (iPACE). With the iPACE solution you can achieve 1 fA and 10 fA current measurement resolution through your probe card (using the B2200A and B2201A respectively) all the way down to your DUT.

Figure 17. The B2200A and B2201A integrate easily with the B1500A Semiconductor Device Analyzer. You can control and automate the entire solution using Keysight EasyEXPERT group+ software running on the B1500A or from an external PC.
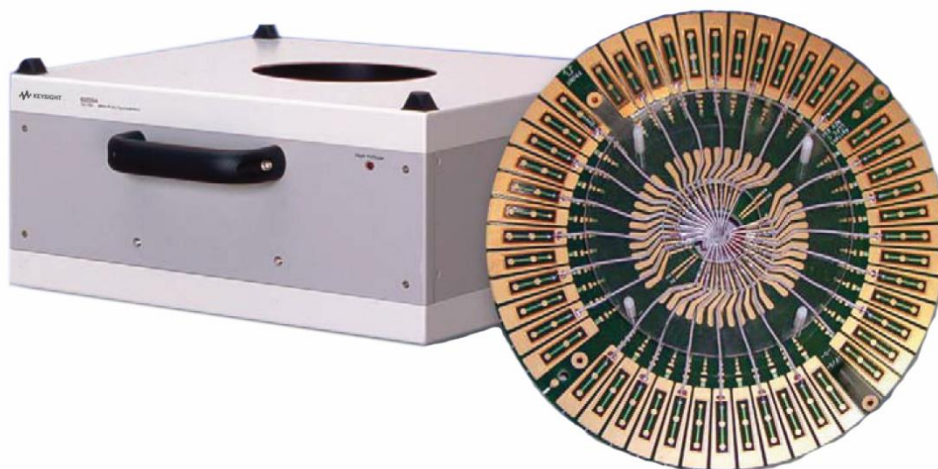
Figure 18. The B2220A probe card interface works with both the B2200A and B2201A and is available in both 24-pin and 48-pin versions. With it you can use the same low-current probe cards that you use in your 4070 Series production test systems.

Features and Specifications

General Features	B2200A[1] (B2210A cards)	B2201A[1] (B2211A cards)	E5250A (E5252A Cards)	E5250A (E5255A Cards)
Front Panel Control	Yes	Yes	No	No
Relay Status Display	Yes	Yes	No	No
Nonvolatile Setup Memory	Yes	Yes	No	No
Bias Port Mode	Yes	Yes	Yes	N/A
Ground Port Mode	Yes	Yes	No	N/A
Couple Port Mode	Yes	Yes	Yes	N/A
Auto Kelvin Cable Detection	Yes	Yes	No	N/A
GPIB Control	Yes	Yes	Yes	Yes
VXI*plug&play* Driver	Yes	Yes	Yes	Yes
Card Type	Matrix	Matrix	Matrix	Multiplexer
Contact Plating Material (Outer Common)	Gold	Nickel	Nickel	Nickel

Technical Specifications	B2200A[1] (B2210A cards)	B2201A[1] (B2211A cards)	E5250A (E5252A Cards)	E5250A (E5255A Cards)
Triaxial (Low Current) Inputs	8	8	6*	6
Coaxial (Auxiliary) Inputs	6	6	4*	3 per card
Internal Paths	14	14	6	6
Low Current Paths	8	8	2	6
Optimized CV Inputs	Yes	Yes	Yes	No
Maximum Output Ports	48	48	48	96**
Channel Isolation (Triaxial Ports)[2]	1 x 1014 Ω	5 x 1013 Ω	1 x 1013 Ω***	1 x 1013 Ω
Channel Isolation (Coaxial Ports)[2]	1 x 109 Ω	1 x 109 Ω	1 x 109 Ω	1 x 109 Ω
Effective Current Measurement Resolution[3]	1 fA	10 fA	20 fA	20 fA
Settling Time[4]	2.0 sec/50 fA	2.0 sec/300 fA	3.5 sec/400 fA	NA
Maximum Current/Voltage (Triaxial Ports)	1 A/200 V	1 A/200 V	1 A/200 V	1 A/200 V
Maximum Current/Voltage (Coaxial Ports)	500 mA/100 V	500 mA/100 V	500 mA/100 V	500 mA/100 V
Bandwidth[5] (3 dB)	30 MHz	30 MHz	10 MHz	NA

1   B2210A cards can only be used with the B2200A. B2211A cards can only be used with the B2201A.
2   At 23 °C ± 5 °C, 5% to 60% relative humidity.
3   Typical performance when used with the 4156C, B1500A or E5270B high-resolution SMU.
4   Time it takes transient current level to settle below the indicated current level in response to a 10 V step applied to the inputs.
5   Using the optimized CV input ports.

*   The first four triaxial inputs have dedicated internal paths. The other two triaxial inputs and four coaxial inputs share two internal paths (3:1 multiplexing).
**   Up to four mainframes can be combined to support up to 384 outputs.
*** Data is for the low-leakage IV ports (1 and 2). The general IV ports have a channel isolation of 1 x 10^{12} Ω

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