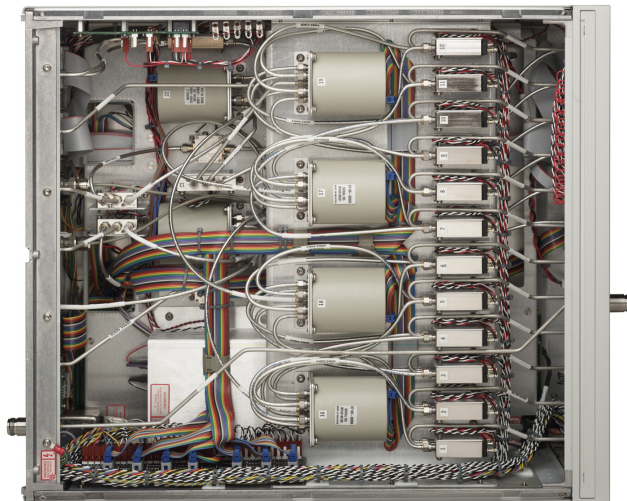


# Keysight Technologies

## Simplifying Complex Benchtop Measurements with USB Switches

Application Note



## Introduction

Switches and switch matrices are widely used for the routing of RF and microwave signals in high-speed ATE systems. As today's devices and products become more complex, there is an increasing need for the speed and flexibility of switching systems capable of connecting multiple signals or instruments to multiple devices under test (DUTs).

On a smaller scale, the same is true in R&D and design validation when developing such products or when creating test routines that will be used later in manufacturing. Even on the bench or in a small system, dependable switching can improve efficiency and save time.

For day-to-day testing, the Keysight Technologies, Inc. U1810B USB coaxial switch combines excellent RF performance with the convenience of USB connectivity. Operating from DC to 18 GHz, this single-pole/double-throw (SPDT) unit connects directly to the inputs of instruments such as network analyzers and spectrum analyzers using a rugged Type-N connector. The plug-and-play USB connection provides power and the control interface. A simple push button provides manual control, a soft front panel enables more advanced control from the screen of a PC, and programmatic control is supported using C++, LabVIEW, Keysight VEE, and more.

This application note provides a brief overview of switching topologies before outlining three measurement scenarios that include the U1810B USB switch. The end of the note provides pointers to related information about the U1810B and the instruments used in the scenarios.

## Comparing Switch Topologies

Several factors are important in the selection of an appropriate switch for a specific application: frequency range, switching speed, settling time, power handling and operating life are near the top of the list. Additional considerations include electrical characteristics such as insertion loss, return loss, repeatability, isolation, voltage standing-wave ratio (VSWR) and termination.

Less obvious is the effect of switch topology. In the simplest terms, two types may be used: the switch ports are either on the same electrical plane or on different electrical planes. Each has pluses and minuses.

In conventional switch designs, all connector ports are on the same plane. This type of topology is commonly found in the large, front-mounted switch matrices used in complex ATE systems. Placing all the ports on the same plane saves space and thereby reduces the size of the resulting switch matrices.

Figure 1 shows two typical connections between a conventional switch and an instrument: both methods require the use of one or more RF cables between the switch, the instrument and the DUT. If a rigid cable is used, its length and bend angle must be taken into consideration. If a semi-rigid or flexible cable is used, it has to remain stationary during the measurement because even the slightest movement will change the mismatch and affect the measurement accuracy. If cable pairs are used, as shown on the right in Figure 1, they must be equal in length to ensure phase accuracy.

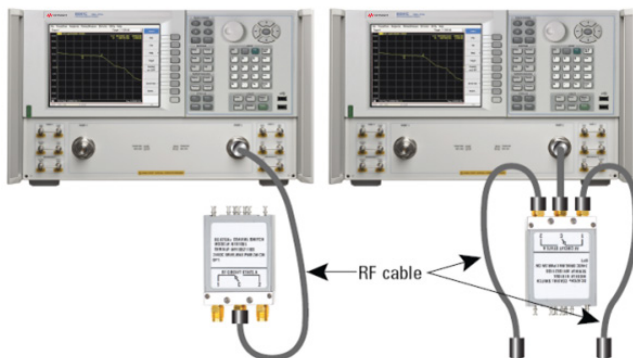


Figure 1. The use of extra RF cables adds complexity and may affect the accuracy or repeatability of measurement results.

For some applications, good measurement results can be obtained when the switch ports are on different planes. This topology makes it possible to add switching to the test instrument or system without requiring additional RF cables. While this may simplify setups and eliminate the issues described above, it puts practical limits on the breadth and complexity of the switching solution. For example, creating multi-tier switching or a switch matrix would take up considerable space and require use of long interconnect cables.

## Utilizing a Convenient Alternative

The Keysight U1810B USB coaxial switch provides a unique combination of excellent RF performance and the convenience of USB connectivity in a small package. Operating from DC to 18 GHz, this SPDT device is configured to route signals between one common port and a pair of switched ports. The unit connects directly to instruments such as network analyzers and spectrum analyzers using a rugged Type-N connector; the switched ports use female SMA connectors (Figure 2).

Because the U1810B contains unique electro-mechanical switch technology, it offers exceptionally long operating life. With a specified life of five million cycles (10 million cycles typical), the U1810B reduces the cost of test and enhances system reliability. Its insertion-loss repeatability is guaranteed to be 0.03 dB, ensuring measurement accuracy and extending calibration intervals. Isolation of greater than 70 dB enhances signal integrity by minimizing crosstalk between channels.

The plug-and-play USB connection is used to provide power and the control interface. This eliminates the need for external power supplies or switch drivers and simplifies measurement setups, especially when using current-generation Keysight network and spectrum analyzers that have at least one USB port.

Under manual control, the U1810B provides push-button switching between ports 1 and 2. A soft front panel enables more advanced control from the screen of a PC, and in fully automated testing it can be controlled programmatically using C++, LabVIEW, Keysight VEE, and more.



Figure 2. The U1810B USB coaxial switch simplifies test setups while adding versatility.

## Illustrating Example Applications

Three simple measurement scenarios demonstrate what can be done with the U1810B USB switch: network analysis, cable-and-antenna testing and spectrum analysis.

### Simplifying network analysis

Adding a pair of U1810B switches to a two-port network analyzer can be used to enable comparisons between two devices or simplify calibration or compensation (Figure 3). In this configuration, one connection can be used to measure two devices in either the frequency or time domain.

During calibration or compensation, the process typically requires a series of connections and disconnections involving the reference unit and the DUT. With a pair of U1810Bs, the reference can remain connected and be measured as needed while a series of DUTs is connected and measured.

To increase throughput with a four-port network analyzer, the addition of four USB switches enables connection of up to eight devices—DUTs, cal units, references, etc.—to the analyzer (Figure 4).

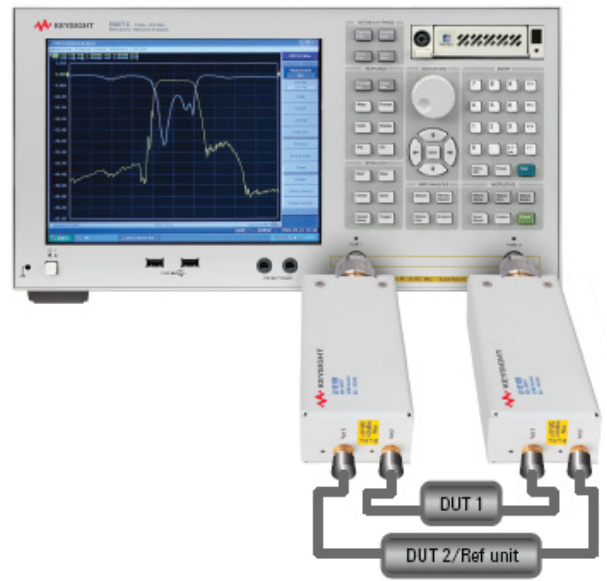


Figure 3. Switching saves time in network analysis when comparing DUTs or when performing calibration or compensation.



Figure 4. A quartet of U1810B switches doubles the number of devices that can be connected to a four-port network analyzer.

## Enhancing cable-and-antenna testing

Installation and maintenance of specialized systems—radio networks, satellite ground stations, radars—often requires field verification or adjustment of cables, antennas, filters, diplexers and duplexers. When engineers and technicians venture out to remote locations in potentially harsh conditions, they want to carry a minimum of equipment and complete their measurement tasks as quickly as possible.

With capabilities such as cable-and-antenna testing (CAT) and network analysis, the Keysight FieldFox handheld analyzers deliver bench-caliber RF and microwave measurement results in the field. Adding a U1810B USB switch to FieldFox can reduce the time spent connecting, disconnecting and reconnecting cables or devices. As shown in Figure 5, two cables can be connected through the U1810B to the FieldFox analyzer. This could be used to quickly compare a known-good cable to one or more potentially damaged cables, and this scenario can include distance-to-fault measurements with a suitably configured FieldFox. Measurements such as return loss and cable loss also can be performed.

## Extending spectrum analysis

A variety of systems use multiple transmitters and receivers. Examples include multi-channel radar systems and wireless LAN or mobile communications systems that use multiple-input/multiple-output (MIMO) technology.

Even though the addition of a USB switch to a Keysight X-Series signal analyzer won't enable correlated measurements between signals, it will accelerate back-and-forth comparisons between a pair of connected transmitters, antennas or other DUTs up to 18 GHz (Figure 6).



Figure 5. A single USB switch unit is a useful and time-saving addition to a field measurement kit.

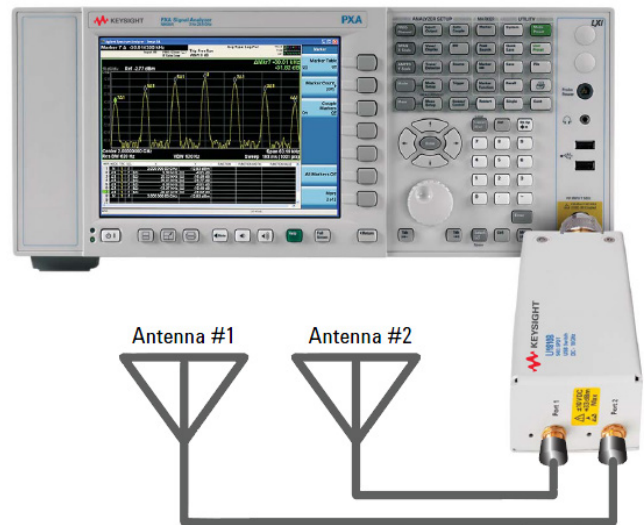


Figure 6. In spectrum analysis applications, the U1810A coaxial switch enables quick comparisons between different signals or antennas.

## Conclusion

Even in small-scale configurations, high-quality switching offers convenience and efficiency by reducing the number of connects, disconnects and reconnects needed to accomplish common day-to-day measurements. Because the U1810B utilizes advanced electro-mechanical switching technology, it can be expected to provide long life and excellent electrical performance in a variety of applications.

## Related Literature

- Technical overview: *Keysight U1810B USB Coaxial Switch SPDT, DC to 18 GHz*, publication 5991-1454EN
- Flyer: *Keysight U1810B USB Coaxial Switch*, publication 5991-0466EN
- Brochure: *Keysight E5071C ENA Network Analyzer*, publication 5989-5478EN
- Brochure: *Keysight FieldFox Handheld Analyzers: Carry precision with you*, publication 5990-9779EN
- Brochure: *X-Series Signal Analysis*, publication 5990-7998EN

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