

Application Note



Extending test capabilities of the PXI 3000 RF test solution with 3060 Series RF combiner modules



The purpose of this application note is to present the use of the 3060 Series PXI RF combiners under different application scenarios common to RF device testing. The various modules available within the 3060 family enable different applications to be performed with the PXI 3000 system. In some cases the addition of a simple RF combiner to the PXI system will increase system performance and efficiency in a more effective manner than through the addition of external components.

Introduction

In addition to providing summing of signals the 3060 Series modules support various input and output switched path configurations to enable testing of single port and multi-port RF devices and to enable test system internal calibration without the need to disconnect the test subject. The use of High Speed Electronic Switches in 3060 Series RF Combiners provide more reliable and faster switching than products based on mechanical switching. This feature makes the 3060 Series RF Combiners ideally suited for applications where high speed is critical.

APPLICATIONS

The 3060 Series RF Digitizers are designed for use in a multitude of radio test applications, the main applications include:

- Transceiver testing
- Intermodulation testing
- Receiver selectivity and blocking test
- Simultaneous in band/out of band transmitter testing
- Testing transceivers with diversity Rx
- Simultaneous testing of multiple DUTs
- Testing of multiple transceivers in a single DUT
- Testing radios with single port duplex or dual port duplex interfaces
- Dual transceiver device test
- Simultaneous testing of two diversity transceivers
- Testing devices with 2Tx and 3Rx
- Maximum sensitivity and maximum power handling measurement

3060 APPLICATIONS

The 3060 RF Combiner has been designed for a wide variety of applications in the frequency range up to 2.7 GHz.

Transceiver testing

In this configuration, shown in Figure 1, the SUM port acts as a single port duplex connection point with one or two RF sources providing Rx stimulus input(s) and an RF signal analysis instrument connected to the third input port to measure DUT Tx parameters. High port to port isolation of the combiner design makes it ideal for testing FDD transceivers.

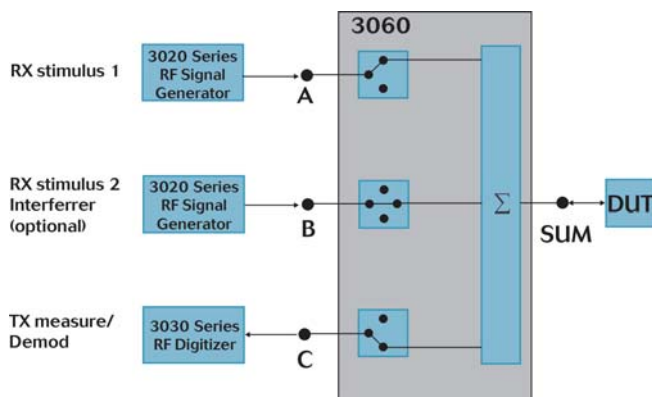


Figure 1. Transceiver testing using 3060 RF Combiner

Receiver selectivity and blocking test

As shown in Figure 1, the 3060 enables two RF Signal Generators to be connected simultaneously to the DUT thus supporting receiver selectivity and blocking tests.

Intermodulation testing

For intermodulation testing, two or three ports can be used to combine RF source inputs to a common DUT test port. In this case the DUT output port would be directly connected to the analysis instrument such as a 3030 Series RF Digitizer. The high isolation between each input port ensures any intermodulation distortion in the output stage of the signal generators is minimized.

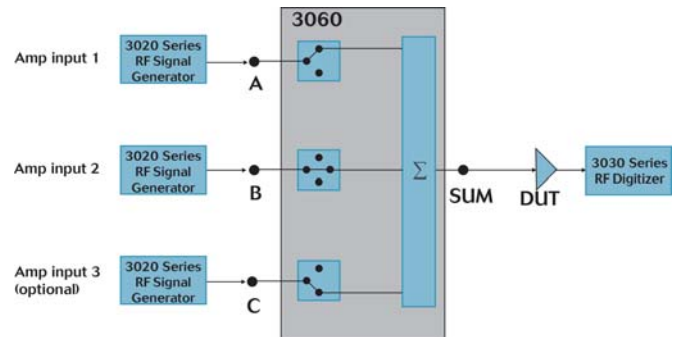


Figure 2. Receiver and amplifier intermod testing using a 3060 RF combiner

Simultaneous in band/out of band transmitter testing

In a similar fashion, simultaneous in band and out of band transmitter measurements can be performed by connecting a pair of RF Digitizers to the DUT. Stimulus being provided by a RF signal generator in the third input port.

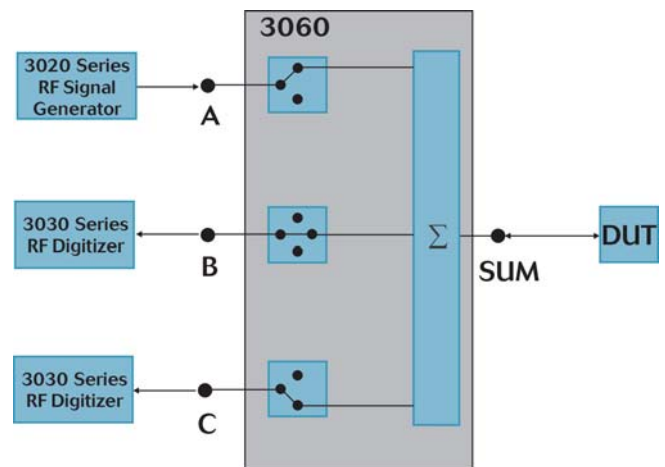


Figure 3. Simultaneous in band/out of band transmitter testing

Dual port duplex with diversity Rx transceiver tests

Testing transceivers with diversity Rx using a 3060 can be performed by using two 3020 Series RF signal generators, one connected to the A port of the 3060 and the other to the Rx port of the DUT. A 3030 Series RF Digitizer connected to Port C can be used to capture the Tx response of the DUT.

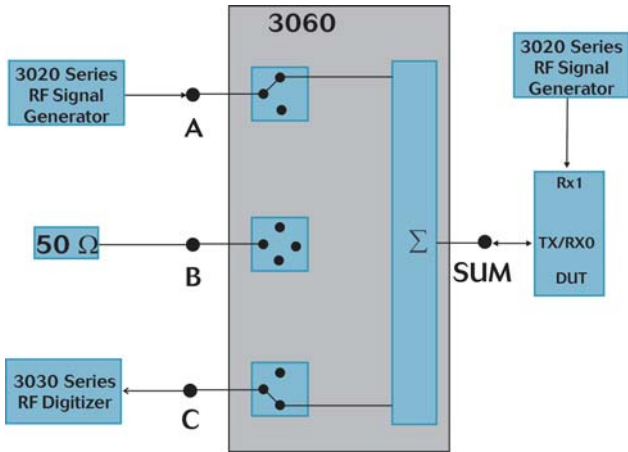


Figure 4. Testing transceivers with diversity Rx using 3060

The same test can be performed with a single 3020 Series signal generator. In this case, the signal from the VSG is routed from port C to B to reach the diversity receiver in the DUT. Port C can be switched back to SUM to test the primary receiver port.

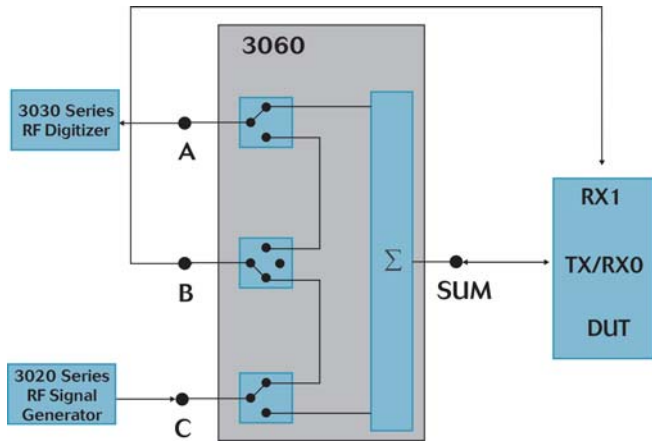


Figure 5. Testing transceivers with diversity Rx from a single signal generator

Maximum sensitivity and maximum power handling for single port duplex transceiver test

Using an external SPDT switch, the following measurements can be performed without the need to disconnect the device under test:

- Maximum sensitivity measurements
- Maximum power handling measurements
- Low level Rx tests
- Tx maximum output test

When the external switch routes the DUT's TRX to port B, a low loss path (only 2 dB) to the digitizer is established using the "A to B and C to SUM" configuration improving sensitivity for measuring low level Tx parameters such as Tx Off Power in TDMA TDD systems. Maintaining the external switch connection and setting the 3060 to the "C to B and A to SUM" configuration, the signal from the 3020 Series VSG can be applied to enable maximum power handling measurements.

Alternatively, when the external switch connects the DUT to the SUM port, and the 3060 is set to "All to SUM", a 15 dB loss exists through the internal path. This setup creates a single duplex port that allows low level Rx tests and maximum Tx output tests with a signal of up to 30 dBm applied at the SUM port

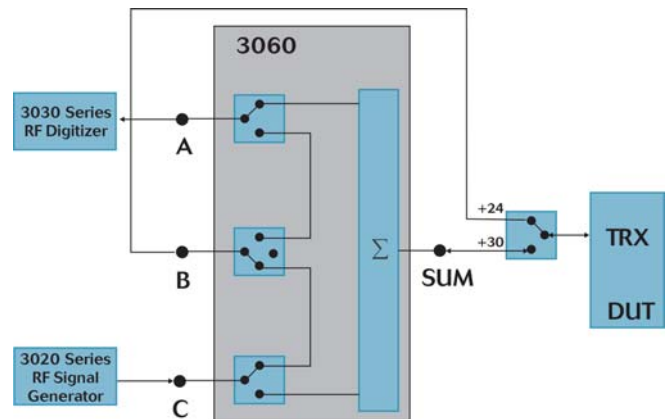


Figure 6. Single port duplex transceiver test showing maximum power handling measurement

Dual transceiver device test using the 3060

By adding 2 SPDT RF switches, the 3060 makes it possible to connect a single VSA/VSG resource to all RF connections in dual transceiver, multi-band devices. Consequently, TX measurements can be performed for each band sequentially and, with the same connection complete main channel Rx measurements. With the 3060 configured to output the VSG to port C the diversity RX branches can be measured. This transceiver configuration is typically found in WLAN products featuring 2.4 GHz and 5.8 GHz transceivers each with diversity receive channel, in which case a 3065 RF Combiner must be used to allow testing at frequencies over 2.7 GHz.

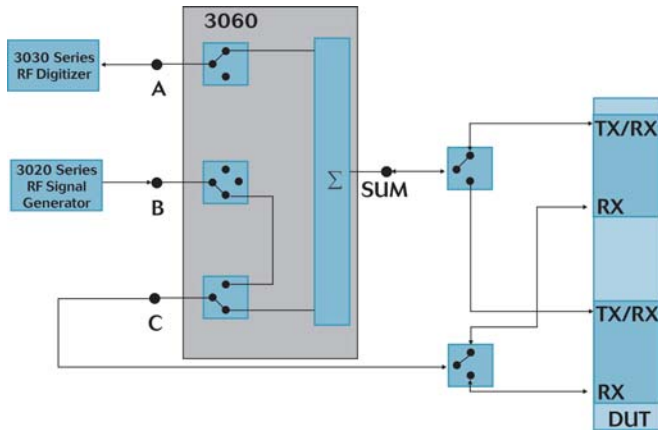


Figure 7. Dual transceiver device test

3061 APPLICATIONS

The 3061 has been carefully designed for cellular mobile phone test applications up to 2.7 GHz.

Unlike the 3060/3065, 3061 is designed to accept input levels up to +33 dBm at SUM 1, 2 and 3 while ensuring that any Aeroflex PXI RF modules connected to the 3061 inputs are not overdriven.

Simultaneous testing of three DUTs

3061 enables connection of a RF signal generator and RF digitizer pair to 3 separate devices simultaneously thus reducing handling time.

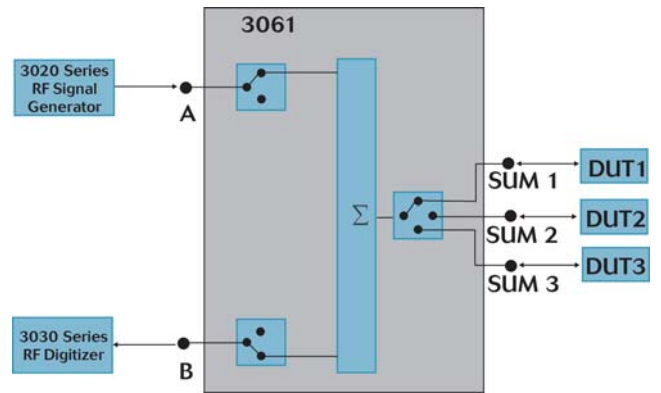


Figure 8. Simultaneous testing of three DUTs

Testing of multiple transceivers in a single DUT

The 3061 can also be used to simultaneously test multiple transceivers in a single device simplifying test set up.

For example, a mobile handset featuring WLAN, Bluetooth and cellular interfaces can be tested under a single set-up. Alternatively the 3061 can be used to support up to 3 x 3 MIMO in Multiple-Input Multiple-Output test applications.

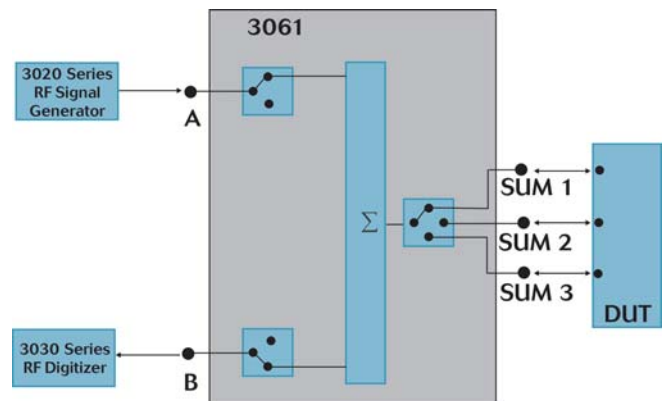


Figure 9. Testing of multiple transceivers in a single DUT

3065 APPLICATIONS

The 3065 is capable of performing all the test scenarios presented for the 3060. The 3065 extends the frequency range to 6 GHz and includes an additional connection port (port D).

The 3065 can be configured to provide a single port full duplex interface between a VSA, VSG connected on ports A, C as well as an additional switched auxiliary port that can be used as an input or an output for two port duplex connection. The auxiliary port also benefits from offering lower loss between PXI modules and the DUT and therefore can be used when improved sensitivity is required or when higher output power is required from the tester.

SIMO (1x2) device testing

The additional switched path of the 3065 allows testing of Single-Input Multiple-Output (SIMO) devices. This setup enables stimulus of both Rx connections simultaneously (with 2nd 302x connected) and testing of the main channel Rx intermod by switch reconfiguration.

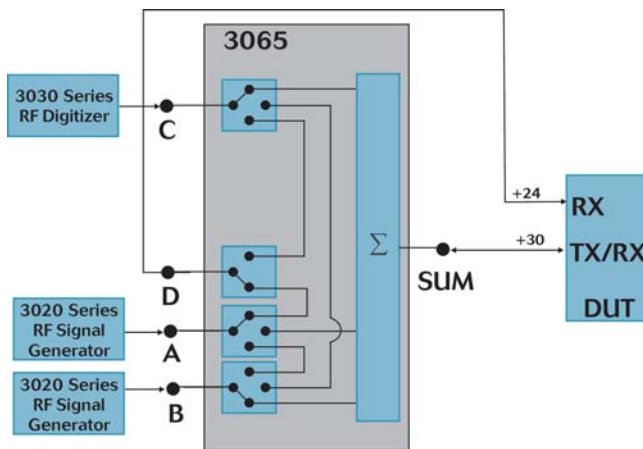


Figure 10. Simultaneous intermod and diversity Rx Test

Dual transceiver device test using 3065

The 3065 enables simultaneous testing of two diversity transceivers with the aid of an external SPDT switch.

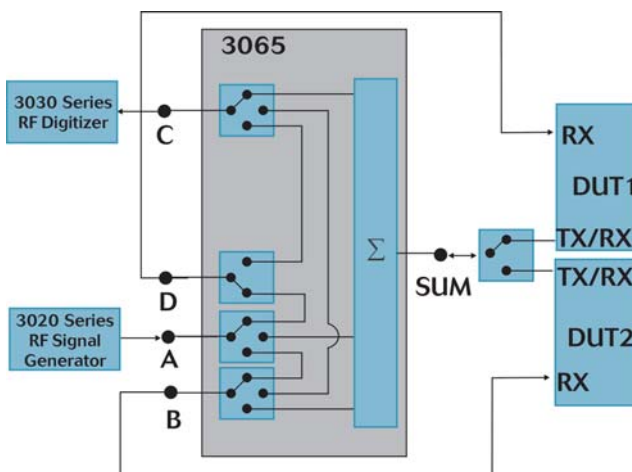


Figure 11. Simultaneous testing of two diversity transceivers

Testing 2x3 MIMO devices

When testing devices equipped with 2Tx and 3Rx, the 3065 can be set up to simultaneously test full port functionality by connecting the 3020 Series RF Signal Generator to the SUM port and the 3030 Series RF Digitizer to Port D.

When the device under test is transmitting in either of its two transceivers, the Tx signal is routed from ports A or C to D through the internal switches for analysis in the 3030 Series RF Digitizer. Meanwhile, the remainder ports continue to receive the signal generated by the 3020 RF signal generator.

This configuration allows uninterrupted stimulus to be applied to the device under test for simultaneous Tx and Rx test thereby enabling multiple input multiple output device testing.

Add pads to A and C to permit >+24 dBm to be generated by the DUT.

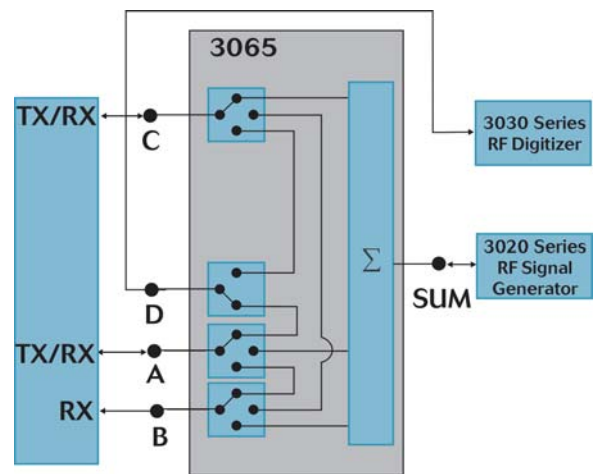


Figure 12: 2Tx/3Rx handset transceiver test

Dual transceiver test using the 3065

As an alternative to the 3061, two 3065 RF combiners are capable of performing dual transceiver tests when connected in the configuration shown in Figure 13. The image shows the two states of the dual transceiver test process.

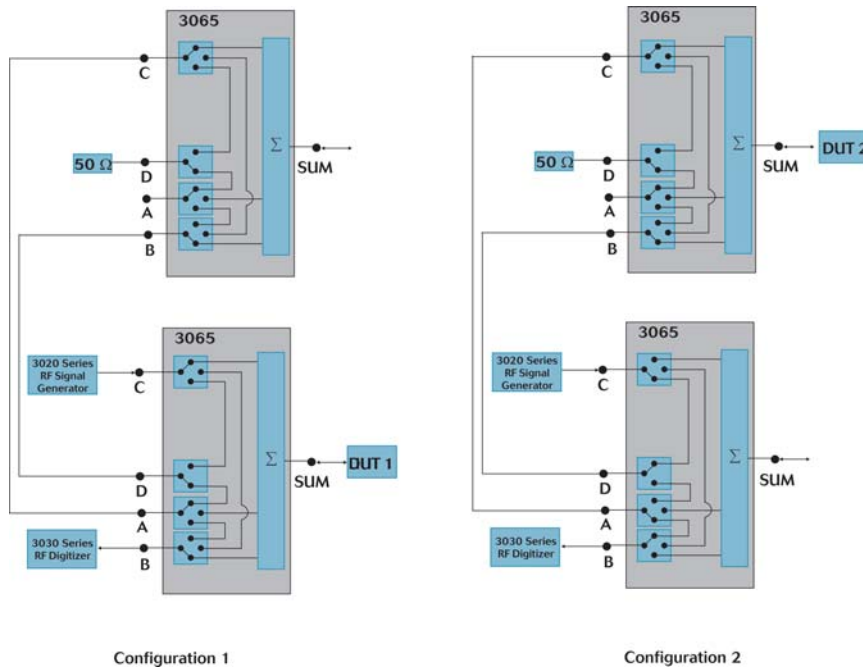


Figure 13. Dual transceiver test

Triple transceiver test using 3065

Triple transceiver tests can also be achieved using two 3065 RF combiners connected through their SUM interfaces. To maximize resource usage and efficiency when testing three DUTs, a 3061 needs to be used (see Figure 8). This is because the 3065 configuration will not allow live DUT changeover and system loss makes it only suitable for conducting DUT Rx low level signal tests.

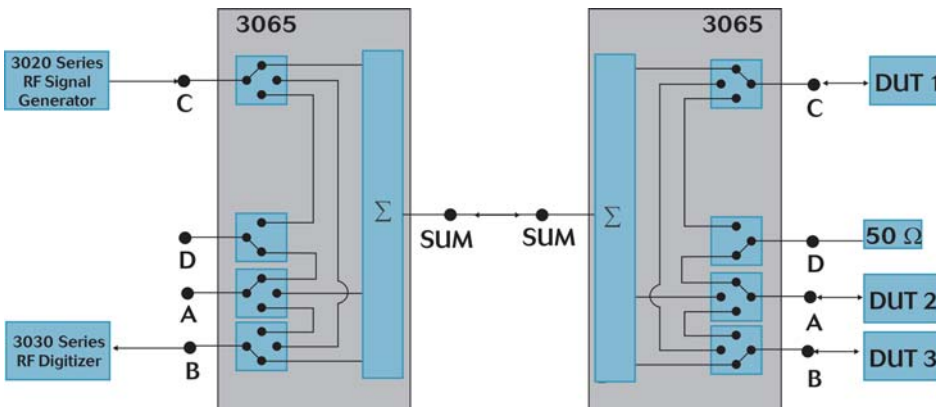


Figure 14. Triple transceiver test

Configurations

Table 1 provides a summary of the possible switched path configurations that are achievable with the 3060 Series RF combiners.

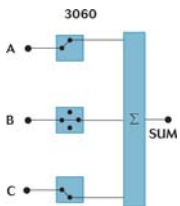
Config	A to	B to	C to	D to	3060	3061	3065
1. All to SUM*	SUM	SUM	SUM		✓	✓	✓
2. A-B	B	A	SUM		✓	✓	✓
3. C-B	SUM	C	B		✓		✓
4. A-D	D	SUM	SUM	A			✓
5. C-D	SUM	SUM	D	C			✓
6. Looped 1	D	C	B	A			✓
7. Looped 2	B	A	D	C			✓

Table 1. Supported port routing

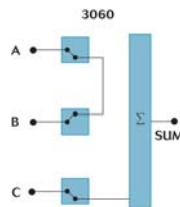
*3061 additionally supports switching to one of 3 summed ports

These configurations are further clarified through the diagrams presented in the following pages for each of the PXI RF conditioning modules that make up the Series.

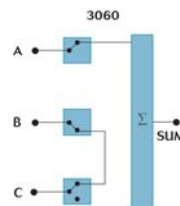
3060 Switched Path Configurations



All to SUM
A to B to C to
SUM SUM SUM

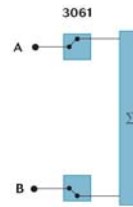


A-B: A to B and C to SUM
A to B to C to
B A SUM

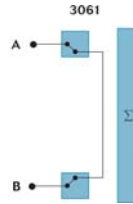


C-B: C to B and A to SUM
A to B to C to
SUM C B

3061 Switched Path Configurations

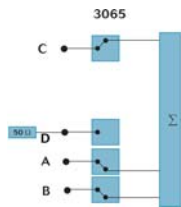


All to SUM
A to B to
SUMx SUMx
SUMx being SUM1, SUM2 or SUM3

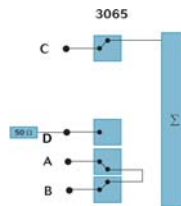


A-B: A to B
A to B to
B A

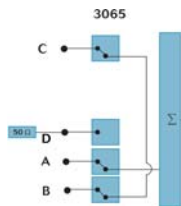
3065 Switched Path Configurations



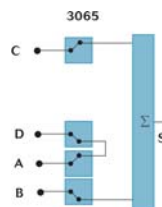
All to SUM
A to B to C to
SUM SUM 50 Ω termination



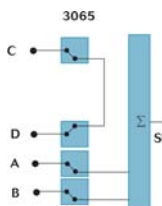
A-B: A to B and C to SUM
A to B to C to D to
B A SUM 50 Ω termination



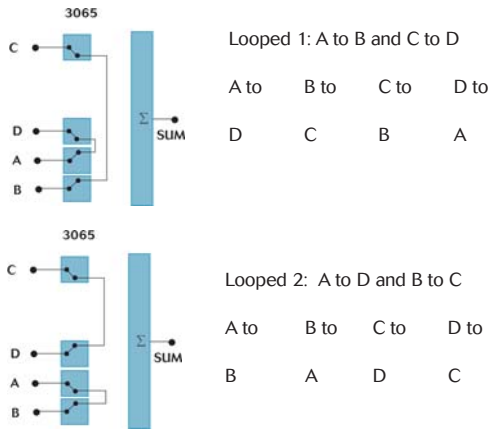
C-B: C to B and A to SUM
A to B to C to D to
SUM C B 50 Ω termination



A-D: A to D with C and B to SUM
A to B to C to D to
D SUM SUM A



C-D: C to D with A and B to SUM
A to B to C to D to
SUM SUM D C



Note that only the D port on the 3065 RF combiner requires the use of a 50 Ω termination to minimize return loss whereas all other ports do not require external termination.

Conclusion

A range of test applications that can be achieved using the 3060 Series PXI RF Combiner modules have been described. The applications presented include a selection of test scenarios that address a variety of wireless technologies and device types. This demonstrates the added flexibility the 3060 Series PXI RF Combiners can provide to the Aeroflex PXI 3000 test system while minimizing complexity and reducing the need for external fixtures.

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