Mini-Circuits®

NEW! 2016
TEST SOLUTIONS

THIRD EDITION

www.minicircuits.com

TSPG-16
third edition

NEW! 2016
TEST SOLUTIONS

Introduction

Mini-Circuits' line of custom test solutions has expanded with a new lineup of exciting capabilities to meet your needs. Some of our newest products in 2016 include a compact, half-rack-sized modular test system with 3 customizable hardware windows, reducing cost and space requirements. We're now manufacturing mesh networks allowing simultaneous interconnection of up to 32 DUTs with independent attenuation control on each path to simulate real-world communication networks in your test environment. We've even developed a series of VNA port expansion modules that can turn two ports of your Vector Network Analyzer into 8, 12 or 16 ports to dramatically increase your test throughput. Bottom line – we're continuously developing more solutions and growing our portfolio to meet your needs. We hope this product guide gives you some ideas about how Mini-Circuits can add value to your test setup. We're always here to support you. Reach out to testsolutions@minicircuits.com for information about anything you see in this product guide and even more designs to meet your specific needs!

What's New?

▶ *Compact Modular Test Systems* (See pp. 14-15)

Our new RCM-series of compact modular test systems gives you the flexibility of customizable hardware configuration in a small module with USB and Ethernet control for low cost. This new system consists of a compact chassis (8.25 x 8.25 x 4.25") with three customizable hardware windows on the front panel.

▶ *80 Channel HTOL Test Setup* (See pp. 16-17)

Our popular 100W rack mounted amplifier, HPA-272+ may be combined with a synthesized signal generator and a high-power splitter network to drive up to 80 test channels for high-throughput HTOL testing.

▶ *n-Port Mesh Networks Test Systems* (See pp. 22-27)

Mini-Circuits now offers mesh network modules allowing simultaneous interconnection of multiple devices to simulate real-world communication networks in your test environment. Our first model, ZT-191 is an 8-port mesh-network with independent attenuation control on each path, but mesh networks may be built for interconnection of up to 32 devices.

▶ *2 x N Switch Matrices* (See pp. 34-35)

Our new series of 2xN switch matrices is designed to route signal from each of two input ports to any of 8, 12, 16 or more output ports. These systems are popular for expanding 2 ports of vector network analyzers into multiple, switchable channels to support testing of DUTs with high port counts, and to increase test throughout in production test setups.

▶ *Signal Distribution Panels* (See pp. 46-47)

By providing an organized, space-efficient array of ports mounted in a rack-mountable panel, our panel-mounted signal distribution and cable management racks are a perfect solution for high-traffic lab environments where maintaining orderly cable connections is a constant challenge.

▶ *Programmable Attenuators up to 8 GHz* (See p. 48)

To support even more applications up to C-Band radar and SatCom, Mini-Circuits has expanded our popular line of RCDAT-series USB/Ethernet-controlled programmable attenuators with three new models covering frequencies from 1 to 8000 MHz with attenuation ranges of 0 to 30, 60, 90, 110, or 120 dB in 0.25 dB steps.

▶ *High-Sensitivity Smart Power Sensors* (See p. 49)

Our lineup of USB and Ethernet controlled power sensors now includes two new models adding high-sensitivity measurement capabilities for CW as well as multi-tone and modulated signals from 50 to 6000 MHz with dynamic range from -45 to +10 dBm.

ZTM Series
DC-18 GHz
Modular Test Systems
Built-to-Order

Built Your Way…
Configured and Shipped Within 2 Weeks or Less!

Mini-Circuits' ZTM-Series modular test systems are designed to simplify and accelerate the development of custom test solutions. The modular chassis structure allows a very wide variety of custom hardware configurations to be built and shipped to you within two weeks or less! Each hardware window may be configured with 1 SP4T or SP6T switch or up to 2 SPDT switches, transfer switches, or programmable attenuators.

ZTM units may be controlled via USB or Ethernet (HTTP and Telnet Protocols) connections, allowing setup flexibility and easy remote test management. All units come supplied with Mini-Circuits' user-friendly Graphical User Interface (GUI) program and DLLs for 32- and 64-bit Windows® operating systems. Full programming support is provided for a wide range of programming environments on both Windows and Linux® operating systems, supporting control through your native test software.

Features
- *Rugged 19" Rack-Mountable Chassis*
- *Customizable Front Panel Layout*
- *Light Weight*
- *USB and Ethernet Control*
- *GUI and DLLs Included*
- *Affordable Cost*

Hundreds of Combinations…
Imagine the Possibilities!

SPDT
DC – 18 GHz

SP4T
DC – 18 GHz

SP6T
DC – 12 GHz

Transfer Switches
DC – 18 GHz

Programmable Attenuators
1 MHz – 8 GHz, 0 – 120 dB

ZTM-Series GUI Main Control

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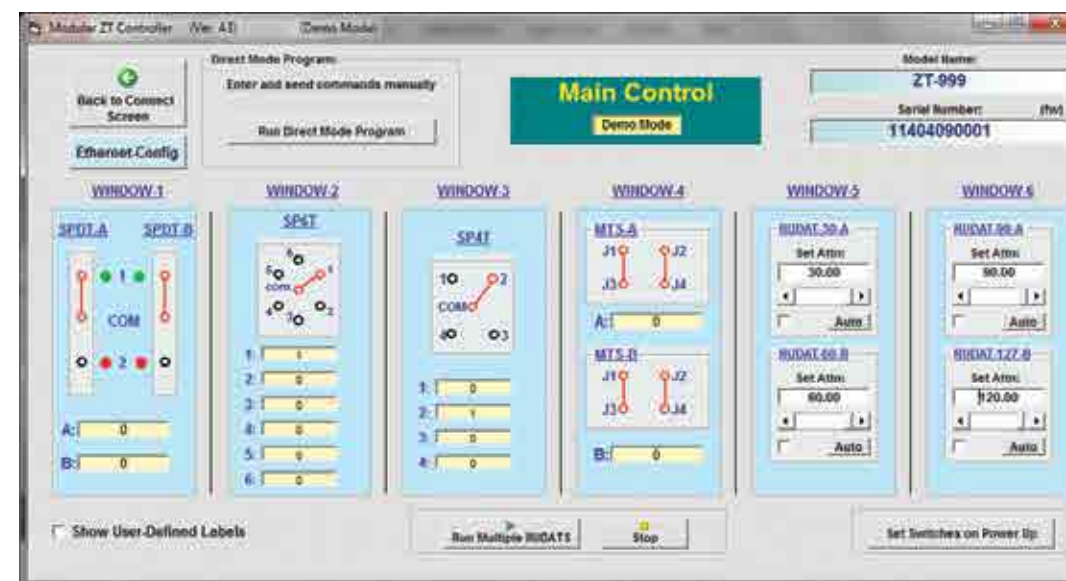
ZTM Series
Hundreds of Possible Configurations
Here are Just a Few!

Window	Window Contents
1	2 SPDT
2	2 SPDT
3	2 SPDT
4	2 SPDT
5	Blank Panel
6	Blank Panel

Window	Window Contents
1	1 SP4T
2	1 SPDT
3	1 SP4T
4	2 SPDT
5	2 Transfer Switches
6	2 Attenuators

Window	Window Contents
1	1 SP4T
2	1 SP4T
3	1 SP4T
4	1 SP4T
5	Blank Panel
6	Blank Panel

Window	Window Contents
1	2 SPDT
2	1 SP4T
3	1 SP4T
4	2 SPDT
5	2 Transfer Switches
6	2 SPDT

Window	Window Contents
1	1 SP4T
2	2 SPDT
3	1 SP4T
4	1 SP4T
5	2 SPDT
6	1 SP4T

Window	Window Contents
1	1 SP4T
2	1 SP4T
3	1 SP4T
4	1 SP4T
5	1 SP4T
6	1 Attenuator

Window	Window Contents
1	1 SP4T
2	1 SPDT
3	1 SP4T
4	1 SP4T
5	1 SPDT
6	1 SP4T

Window	Window Contents
1	1 SP4T
2	1 Attenuator
3	2 SPDT
4	2 Transfer Switches
5	2 Attenuators
6	Blank Panel

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ZTM Series

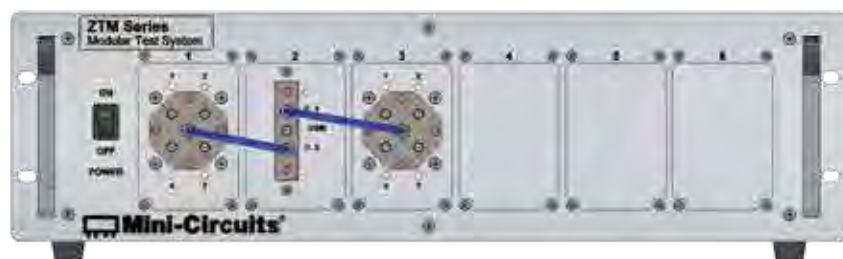## Add Flexibility to your System with HandFlex™ Interconnect Cables

1 x 8 Switch Matrix

Hardware Configuration

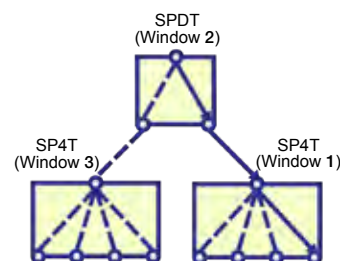| Hardware Window	1	2	3	4	5	6
Component	1 SP4T	1 SPDT	1 SP4T	-	-	-

Functional Schematic

SPDT
(Window **2**)

SP4T
(Window **3**)

SP4T
(Window **1**)

External Connections

Connect J1 of SPDT in Window 2 to COM of SP4T in Window 3

Connect J2 of SPDT in Window 2 to COM of SP4T in Window 1

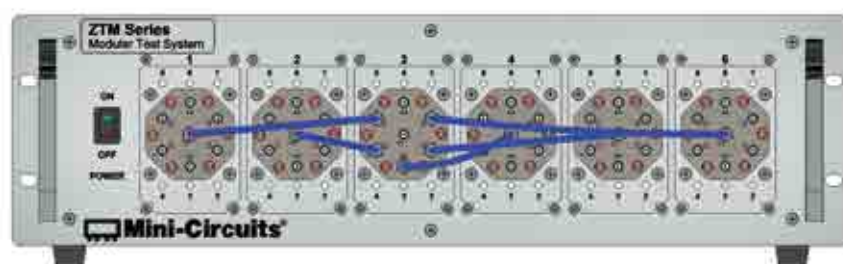## 1 x 31 Switch Matrix

Hardware Configuration

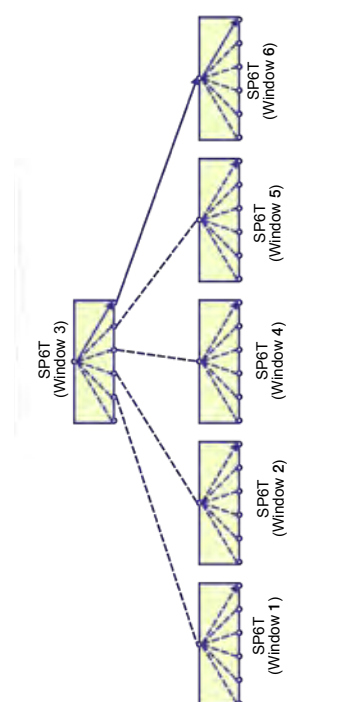| Hardware Window	1	2	3	4	5	6
Component	1 SP6T	1 SP6T	1 SP6T	1 SP6T	1 SP6T	1 SP6T

External Connections

Connect J1 of SP6T in Window 3 to COM of SP6T in Window 6

Connect J2 of SP6T in Window 3 to COM of SP6T in Window 5

Connect J3 of SP6T in Window 3 to COM of SP6T in Window 4

Connect J4 of SP6T in Window 3 to COM of SP6T in Window 2

Connect J5 of SP6T in Window 3 to COM of SP6T in Window 1

Functional Schematic

SP6T (Window 6)
SP6T (Window 5)
SP6T (Window 4)
SP6T (Window 3)
SP6T (Window 2)
SP6T (Window 1)

4 x 4 One-to-One Blocking Switch Matrix

Hardware Configuration

Hardware Window	1	2	3	4	5	6
Component	2 SPDT	2 SPDT	2 SPDT	2 SPDT	-	-
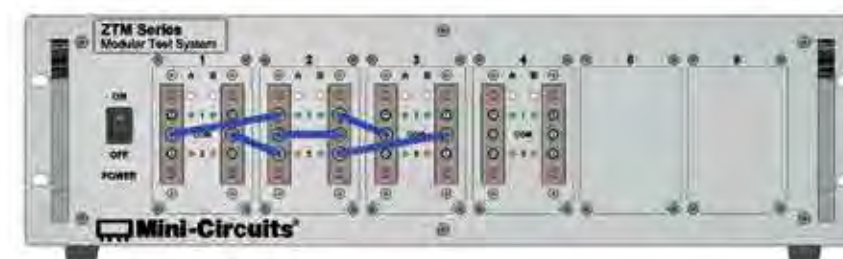
External Connections

Connect J1 of SPDT A in Window 2 to COM of SPDT A in Window 1

Connect J2 of SPDT A in Window 2 to COM of SPDT B in Window 1

Connect J1 of SPDT B in Window 2 to COM of SPDT A in Window 3

Connect J2 of SPDT B in Window 2 to COM of SPDT B in Window 3

Connect COM of SPDT A in Window 2 to COM of SPDT B in Window 2

Functional Schematic

SPDT **B** (Window 1)
SPDT **A** (Window 1)
SPDT A (Window 2)
SPDT B (Window 2)
SPDT A (Window 3)
SPDT B (Window 3)
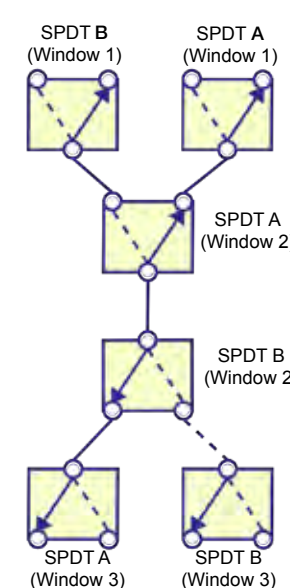
2 x 2 One-to-One Blocking Switch Matrix

Hardware Configuration

Hardware Window	1	2	3	4	5	6
Component	2 SPDT	-	-	-	-	-

External Connections

Connect COM of SPDT A in Window 2 to COM of SPDT B in Window 2

Functional Schematic

SPDT A (Window 1)

SPDT B (Window 1)

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4 SP4T / 4 SPDT Setup
for 8 DUT Characterization

Hardware Configuration

Hardware Window	1	2	3	4	5	6
Component	1 SP4T	2 SPDT	1 SP4T	1 SP4T	2 SPDT	1 SP4T
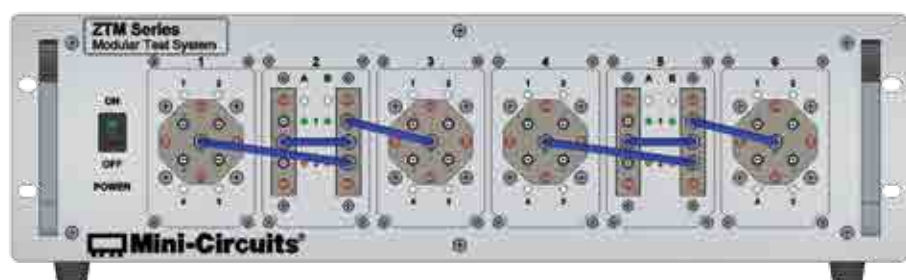
Functional Description

This 4 SP4T / 4 SPDT system allows the user to configure a setup connecting up to 8 2-port DUTs with a vector generator, spectrum analyzer, and network analyzer to perform modulation analysis and S-parameter analysis from the same test station without the need to disconnect and reconnect the DUTs to different instruments. By using a switch network to multiplex 1- and 2-port test instruments and minimize repetitive connections between test fixtures, this setup dramatically increases test throughput, saves time, and reduces overall production cost.
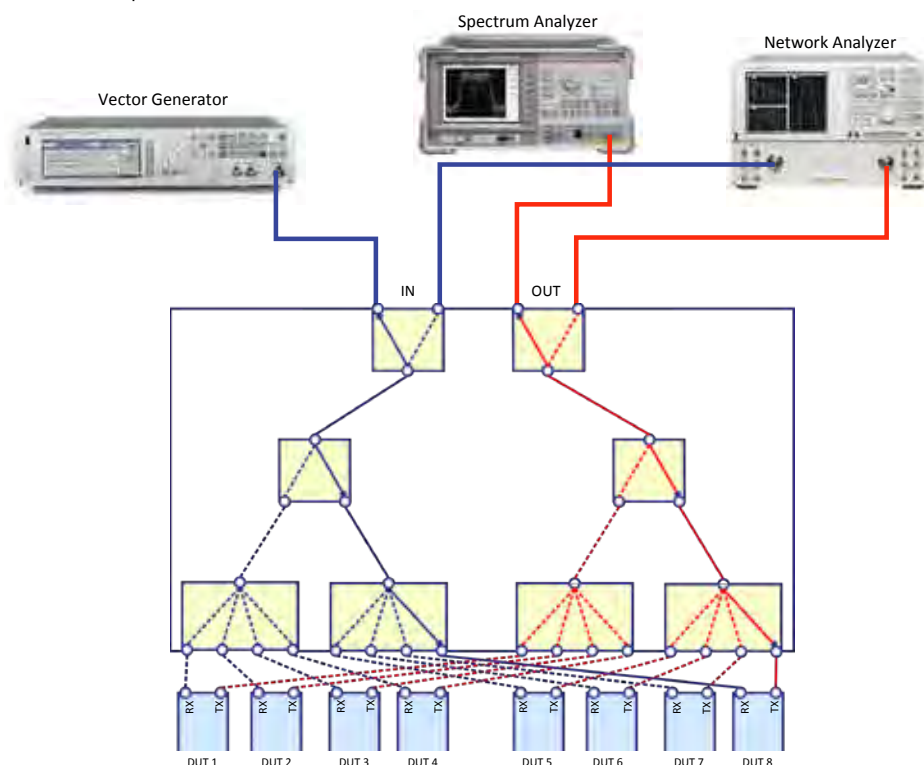
Additional Examples
of ZTM Front Panel Configurations

| Matrix Configuration	Front Panel Layout						External Connections
	1	2	3	4	5	6	
1 x 5	SPDT	SP4T					Connect J2 of SPDT 1 to COM of SP4T 2
1 x 6	SPDT	SP4T	SPDT				Connect J4 of SP4T 2 to COM of SPDT 1 Connect J3 of SP4T 2 to COM of SPDT 3
1 x 7	SP4T	SP4T					Connect J3 of SP4T 1 to COM of SP4T 2
1 x 8	SP4T	SPDT	SP4T				Connect J1 of SPDT 2 to COM of SP4T 1 Connect J2 of SPDT 2 to COM of SP4T 3
1 x 9	SP6T	SP4T					Connect J2 of SP6T to COM of SP4T
1 x 10	SP4T	SP4T	SP4T				Connect J1 of SP4T 2 to COM of SP4T 1 Connect J2 of SP4T 2 to COM of SP4T 3
1 x 11	SP4T	SP4T	SPDT	SP4T			Connect J1 of SP4T 2 to COM of SP4T 1 Connect J2 of SP4T 2 to COM of SPDT 3 Connect J3 of SP4T 2 to COM of SP4T 4
1 x 13	SP4T	SP4T	SP4T	SP4T			Connect J1 of SP4T 2 to COM of SP4T 1 Connect J2 of SP4T 2 to COM of SP4T 3 Connect J3 of SP4T 2 to COM of SP4T 4
1 x 16	SP6T	2 SPDT	2 SPDT	SPDT	SP6T		Connect J1 of SPDT 3A to COM of SPDT 2B Connect J1 of SPDT 2B to COM of SPDT 2A Connect J2 of SPDT 2B to COM of SP6T 1 Connect J2 of SPDT 3A to COM of SPDT 3B Connect J1 of SPDT 3B to COM of SPDT 4 Connect J2 of SPDT 3B to COM of SP6T 5
1 x 19	SP4T	SP4T	SP4T	SP4T	SP4T	SP4T	Connect J1 of SP4T 3 to COM of SP4T 2 Connect J4 of SP4T 3 to COM of SP4T 1 Connect J2 of SP4T 3 to COM of SP4T 4 Connect J3 of SP4T 3 to COM of SP4T 5 Connect J2 of SP4T 5 to COM of SP4T 6
1 x 20	SP6T	SP6T	SP4T	SP6T	SPDT		Connect J1 of SP4T 3 to COM of SP6T 1 Connect J4 of SP4T 3 to COM of SP6T 2 Connect J2 of SP4T 3 to COM of SP6T 4 Connect J3 of SP4T 3 to COM of SPDT 5
1 x 24	SP6T	SP6T	SP4T	SP6T	SP6T		Connect J1 of SP4T 3 to COM of SP6T 1 Connect J2 of SP4T 3 to COM of SP6T 4 Connect J3 of SP4T 3 to COM of SP6T 5 Connect J4 of SP4T 3 to COM of SP6T 2
1 x 28	SP6T	SP6T	SP6T	SP6T	SP6T	2 SPDT	Connect J1 of SP6T 4 to COM of SPDT 6A Connect J2 of SP6T 4 to COM of SPDT 6B Connect J3 of SP6T 4 to COM of SP6T 5 Connect J4 of SP6T 4 to COM of SP6T 1 Connect J5 of SP6T 4 to COM of SP6T 2 Connect J6 of SP6T 4 to COM of SP6T 3
1 x 29	SP6T	SP6T	SP6T	SP6T	SP6T	SP4T	Connect J1 of SP6T 4 to COM of SP4T 6 Connect J2 of SP6T 4 to COM of SP6T 5 Connect J4 of SP6T 4 to COM of SP6T 1 Connect J5 of SP6T 4 to COM of SP6T 2 Connect J6 of SP6T 4 to COM of SP6T 3
1 x 31	SP6T	SP6T	SP6T	SP6T	SP6T	SP6T	Connect J1 of SP6T 3 to COM of SP6T 6 Connect J2 of SP6T 3 to COM of SP6T 5 Connect J3 of SP6T 3 to COM of SP6T 4 Connect J4 of SP6T 3 to COM of SP6T 2 Connect J5 of SP6T 3 to COM of SP6T 1
2 x 2 (blocking)	2 SPDT						Connect COM of SPDT 1A to COM of SPDT 1B
4 x 4 (blocking)	SP4T	SP4T					Connect COM of SP4T 1 to COM of SP4T 2

ZTM Series

Configure Your Test System
In 3 Easy Steps!

To make it easy for customers to request quotes and proposals for modular test systems, we've developed a new online dashboard where you can configure a system to your specifications virtually and submit a request for pricing and a complete design proposal. It's easy:

Step 1. Go to www.minicircuits.com/ztm/ztm.html and use the dashboard to configure your desired hardware layout.
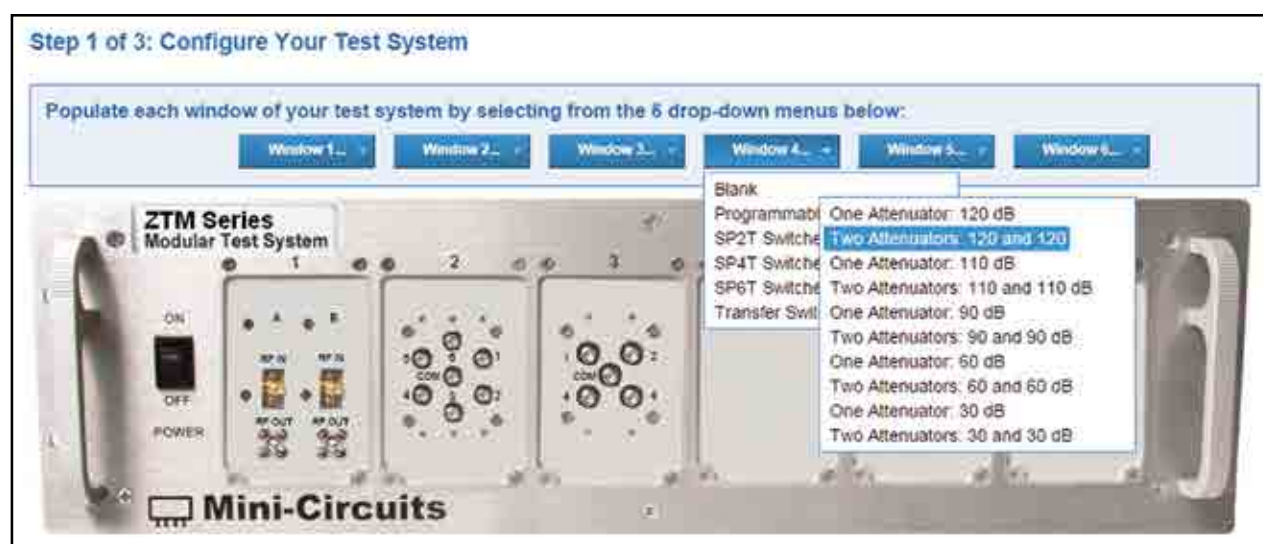
Step 2. Enter your contact info, target delivery date, and any relevant details about your project.

Step 3. Click "Build Your System" to submit your request. Our applications engineers will contact you within 1 business day with a design proposal and a quote.

BUILD YOUR SYSTEM

RCM 100 Series Programmable Attenuator Module

4 Programmable Attenuator Channels

Model Name	Channels	Performance per Channel		
		Frequency	Attenuation	Step
RCM-30	4	1- 6000 MHz	0 - 30 dB	0.25 dB
RCM-60	4	1- 6000 MHz	0 - 60 dB	0.25 dB
RCM-100	4	1- 6000 MHz	0 - 90 dB	0.25 dB
RCM-110	4	1- 6000 MHz	0 - 110 dB	0.25 dB
RCM-120	4	1- 4000 MHz	0 - 120 dB	0.25 dB

6 Programmable Attenuator Channels

Model Name	Channels	Performance per Channel		
		Frequency	Attenuation	Step Size
RCM-30-6	6	1- 6000 MHz	0 - 30 dB	0.25 dB
RCM-60-6	6	1- 6000 MHz	0 - 60 dB	0.25 dB
RCM-100-6	6	1- 6000 MHz	0 - 90 dB	0.25 dB
RCM-110-6	6	1- 6000 MHz	0 - 110 dB	0.25 dB
RCM-120-6	6	1- 4000 MHz	0 - 120 dB	0.25 dB

8 GHz systems available upon request

RCM 200 Series Multi-Function Switching Systems

Choose any combination of SP6T, SP4T, SPDT and transfer switches – hundreds of possibilities!
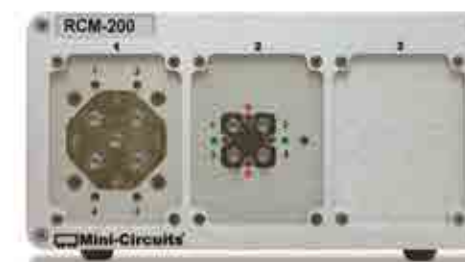
1 SP4T, 1 Transfer (DPDT)   *1 SP6T, 2 SPDT, 2 Transfer (DPDT)*

RCM Series
Compact Modular Test Systems

Save Space and Reduce Cost!

Mini-Circuits' RCM series compact modular test systems offer the same flexibility and fast turnaround of our ZTM-series modular test racks for setups requiring smaller size. The design consists of a small, light-weight chassis with three open hardware slots, each of which may be outfitted with your choice of programmable attenuators with 0 – 30, 60, 90, 110 and 120 dB attenuation range (RCM-100 series) and any combination of SPDT, SP4T, SP6T and transfer switches (RCM-200 series).

All models come with USB and Ethernet-TCP/IP (HTTP and Telnet protocols) control options, allowing setup flexibility and easy remote test management. The units may be controlled with our easy-to-install, easy-to-use GUI or through your native test software using the supplied API objects for Windows® environments. The hardware is supplied with a complete set of DLLs for 32- and 64-bit Windows operating systems, programming instructions for both Windows® and Linux® operating systems, and all the accessories you need for immediate use right out of the box!

Features:
- *Compact Chassis, Ideal for Benchtop Use*
- *Customizable Hardware Layout*
- *Light Weight*
- *USB & Ethernet Control*
- *GUI and DLLs Included*
- *Low-Cost*

Configure your system online for a fast quote!

BUILD YOUR SYSTEM

RCM 100 Series
Multi-Channel Programmable Attenuator Systems

RCM 200 Series
Multi-Function Switching Systems

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HPA-272+ 700-2700 MHz

High Power (100W)
## Rack Mount Amplifier

Functional Description
This rugged, high-power amplifier is capable of amplifying signals up to 100W across its entire operating bandwidth of 700 to 2700 MHz. It delivers 48 dB typical gain with ±1.7 dB gain flatness over the full frequency range, supporting a wide variety of high power test applications including EMI, reliability testing, RF stress testing, and more. The amplifier operates on a self-contained 90/260V AC power supply, making setup quick and easy in lab environments. Extensive safety features include over-temperature protection with automatic shut-off and the ability to handle open/short loads up to 3 dB compression point.

Electrical Performance

PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Frequency Range	MHz	700	-	2700
Gain	dB	45	48	-
Gain Flatness	dB		±1.7	-
Output P1dB	dBm	-	+49	-
Noise Figure	dB	-	8.2	-
Input VSWR	:1	-	1.3	-
Output VSWR	:1	-	1.3	-
AC Supply	V	-	90/260	-
Power Consumption	W	-	531	-

Refer to datasheet for complete model info

### HPA-272+ Curves

GAIN

OUTPUT POWER @ 1dB COMPRESSION
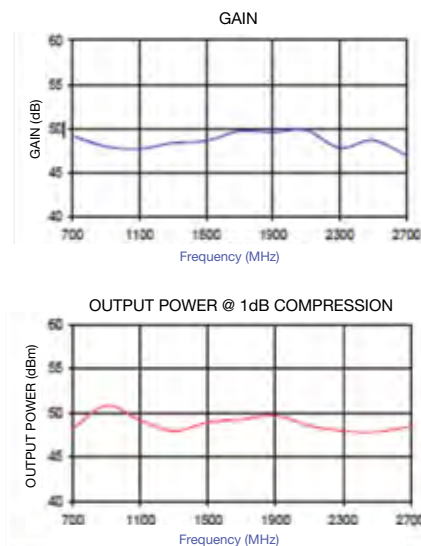
High Temperature Operating Life (HTOL) Testing

For cost-effective HTOL testing it's desirable to test large numbers of units simultaneously. This requires a system capable of distributing a test signal over a large number of channels with a high power signal source used in order to overcome the inevitable splitter losses.
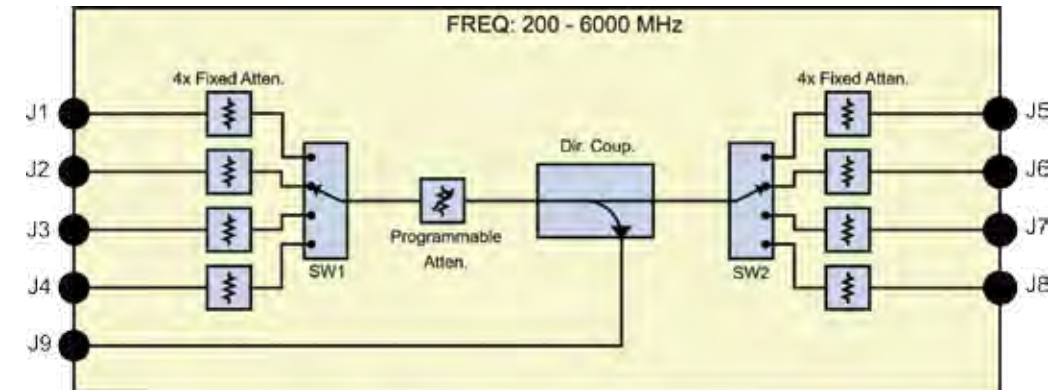
The HPA-272+ 100W amplifier can be used to drive 80 test channels in a configuration similar to that shown here. This setup is popular for use in high-throughput production testing applications such as HTOL where parallel processing of many DUTs is a requirement.

HPA-272+ in RF Burn-In System
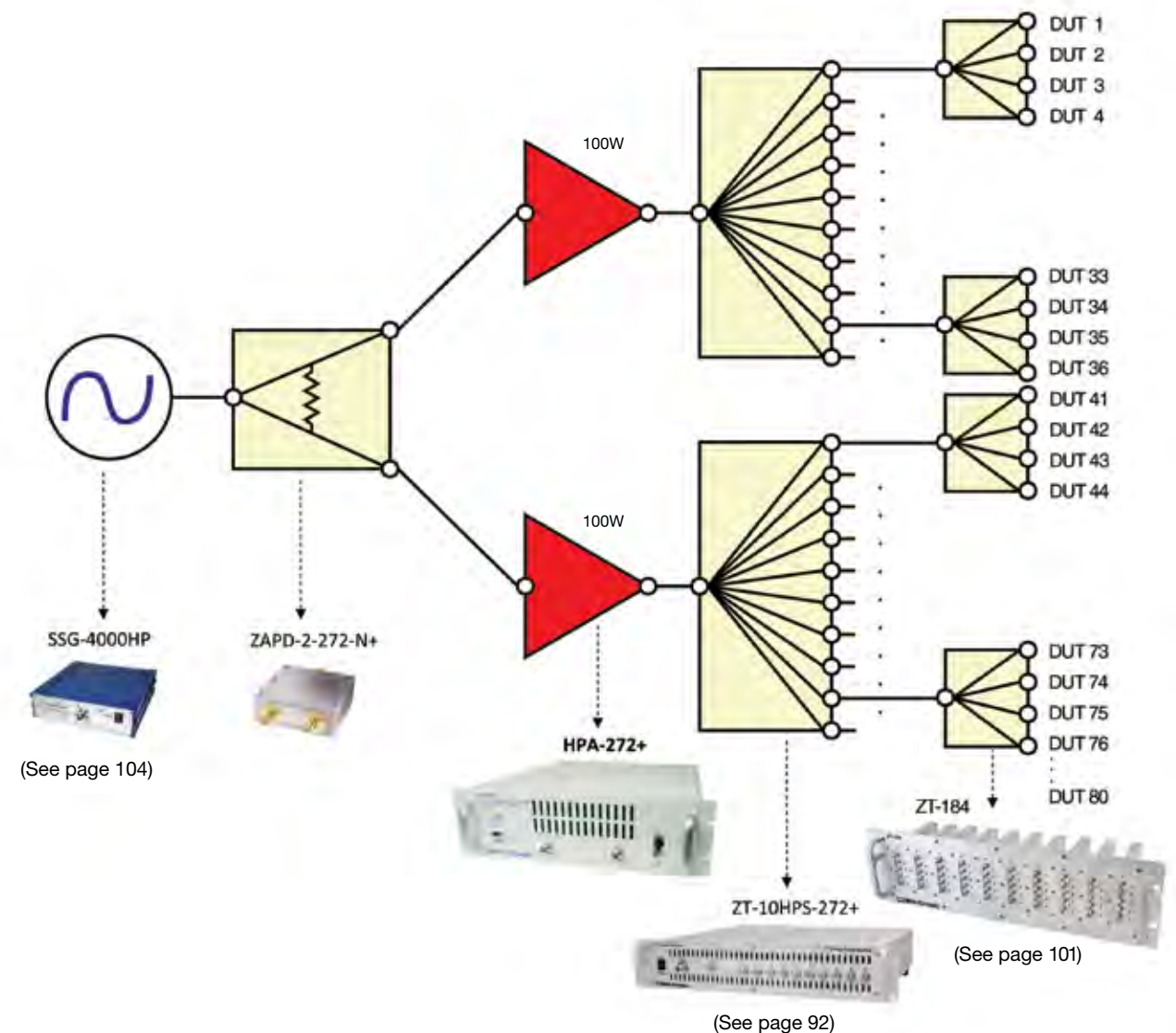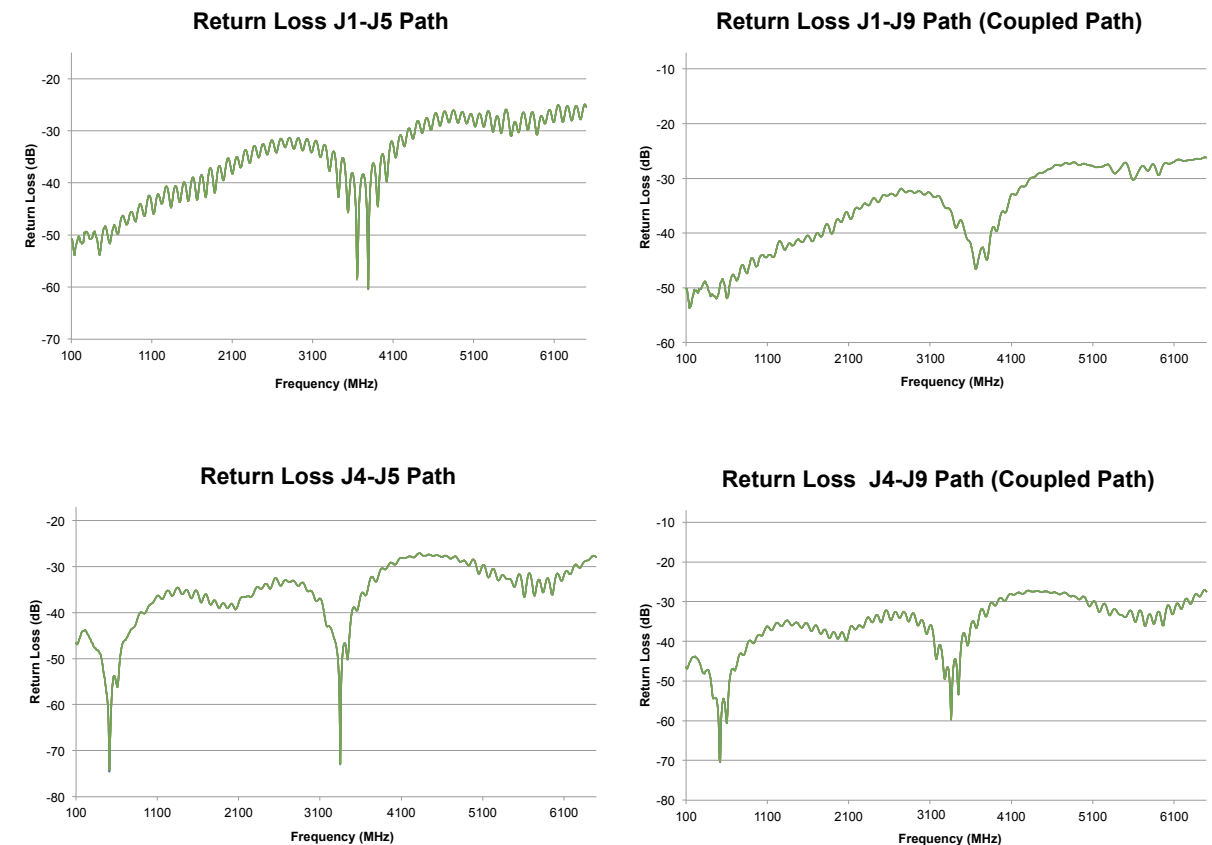
ZT-187 Functional Schematic

ZT-187 Curves

ZT-187 *200 - 6000 MHz*

Datalink RF Test Tool

Functional Description

ZT-187 is a 4 x 4 switch matrix with a "one to one" path configuration and an additional signal sampling port. The matrix is designed with high path loss and an additional 0 to 90 dB programmable attenuation range for simulation of transmission loss in a production test environment. The sampling port allows the active signal to be monitored at an external spectrum analyzer, with minimal impact on the through path and regardless of which switch path configuration is selected. Designed to support signals from 200 to 6000 MHz, this system is capable of handling high RF input power from 5W to 20W per port depending on the choice of front end attenuators. It provides greater than 90 dB typical isolation, and excellent return loss per path up to 23 dB. Depending on the user's need, programmable attenuation ranges from 0 to 30, 60, 90, or 110 dB are available.

Return Loss J1-J5 Path

Return Loss J1-J9 Path (Coupled Path)

Return Loss J4-J5 Path

Return Loss J4-J9 Path (Coupled Path)

ZT-190A/B Functional Schematic
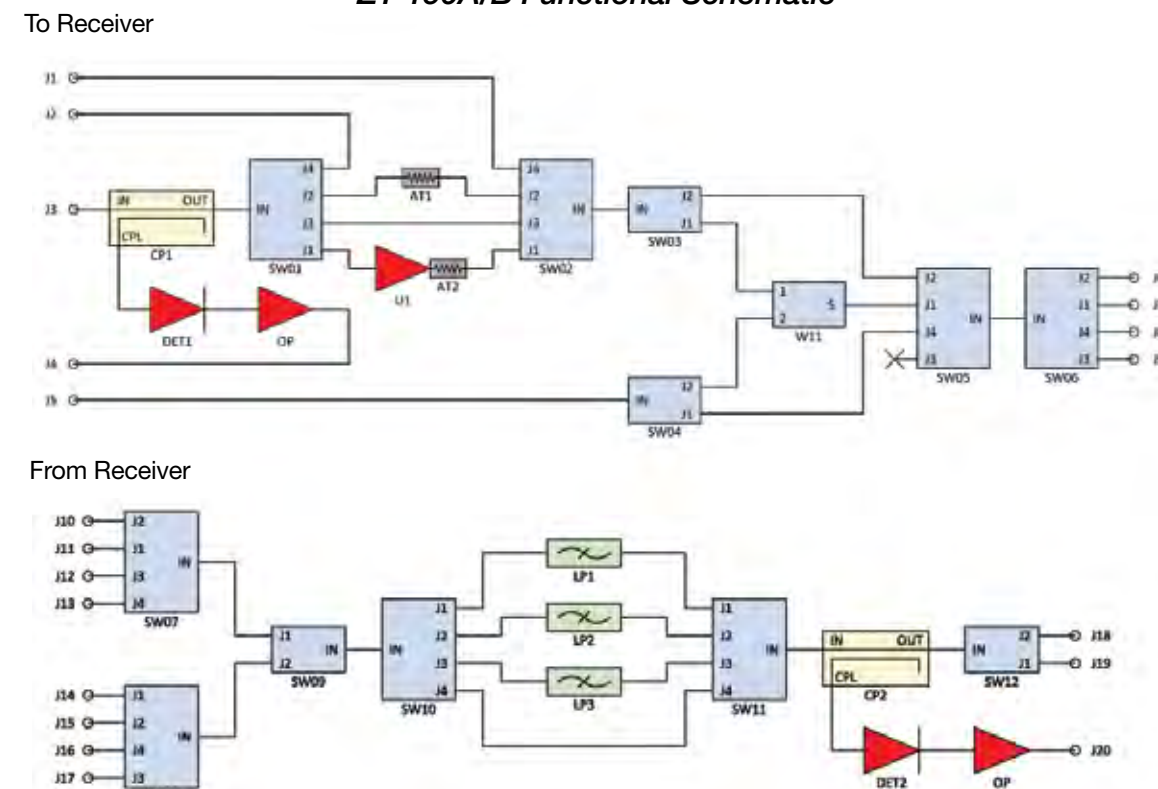
To Receiver

From Receiver

ZT-190 A/B 0.5 - 18 GHz

RF Test Shelf

Functional Description

The ZT-190A&B form an integrated production test system for wideband receiver testing. ZT-190A routes inputs from 2 external signal sources to any of 4 DUT channels. Each DUT can be switched to either signal generator or the combination of both for 2 tone testing with selectable path loss. ZT-190B provides an 8 by 2 switch matrix for re-combining DUT outputs into external measurement equipment; the integrated switched filter bank further removes unwanted harmonics from the measurements. The ZT-190A/B system is an example of multiple modules cascaded to build larger system supporting a complex test application.

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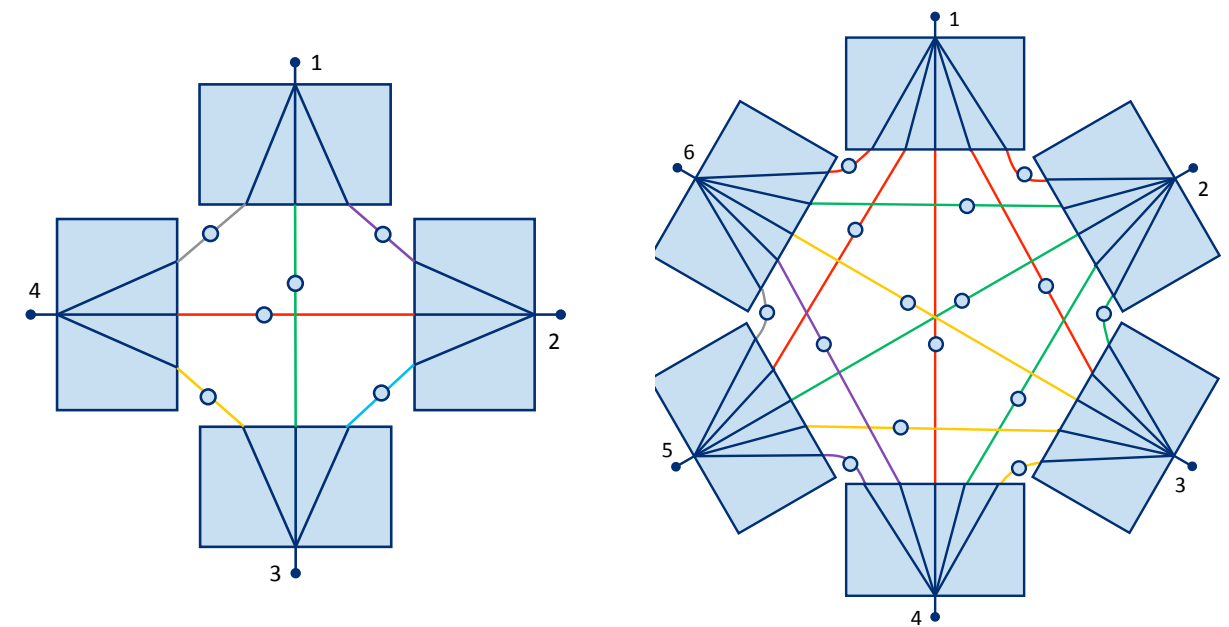
n-Port Mesh Networks

Multi-Port Networks for Interconnecting 3 to *n* Devices

Mesh networks allow simultaneous interconnection of 3 to *n* devices or test systems. Common applications include testing of Bluetooth and Zigbee devices, wireless handsets and Wi-Fi systems.

Mini-Circuits has developed a range of mesh networks with independently variable attenuation on every path. This concept allows simulation of a "real-world" mesh communication network in the confined space of a production environment. Path loss can be varied independently between any pair of devices, simulating the effects of distance and interference, without affecting any other paths.
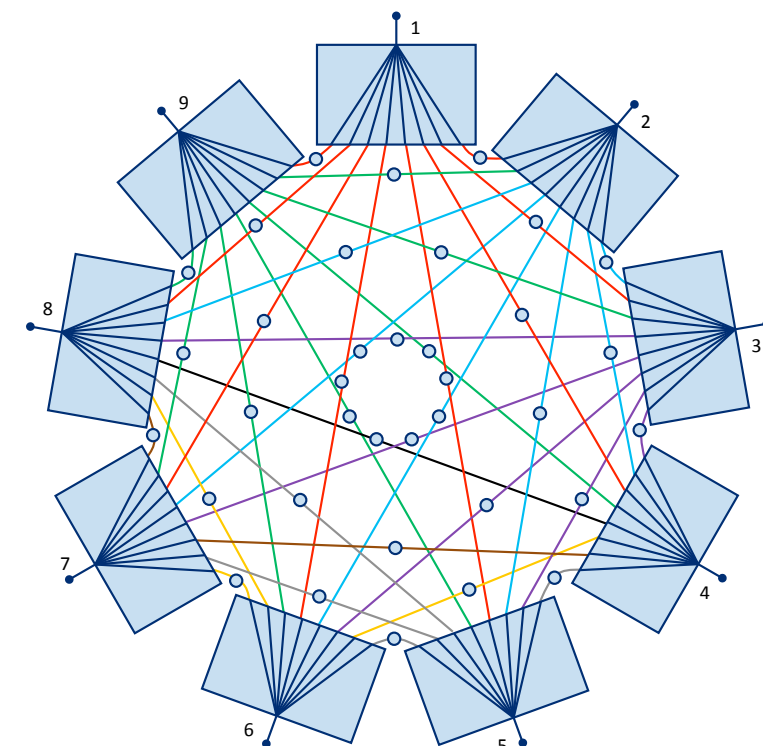
Number of paths, operating frequency and path attenuation range (up to 120 dB) can be tailored to the specific test requirement.

Schematic drawings for 5-port mesh network; conceptual diagram below and assembly diagram to the right.
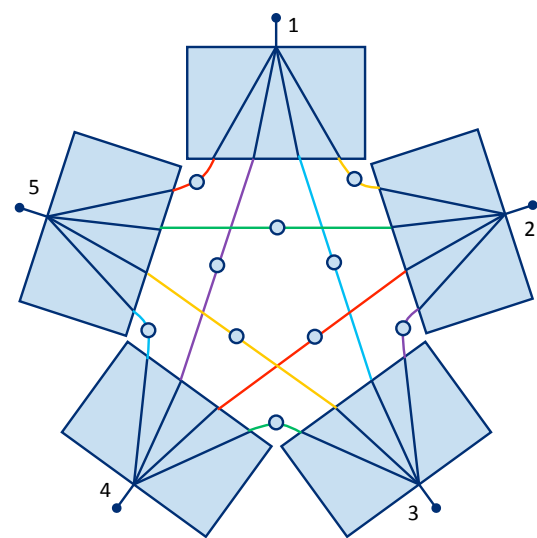

◉ = *programmable attenuator*

Common mesh network requirement, clockwise from top right: 4-port mesh; 6-port mesh; 9-port mesh

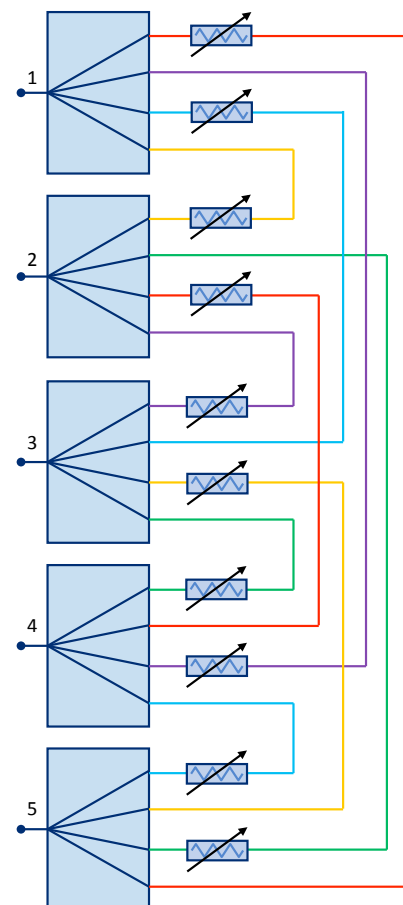**Even larger mesh network configurations available on request!**

◉ = *programmable attenuator*

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ZT-191 *2.4 - 6.0 GHz*

8-DUT Mesh Network Test Drawer

Functional Description

The ZT-191 is a multi-use mesh network for WiFi device and base station testing. The system provides multiple, simultaneous interconnect options between up to 8 devices or test sets with variable path loss, ideal for simulating distance and interference in a production test environment.

ZT-191 Functional Schematic
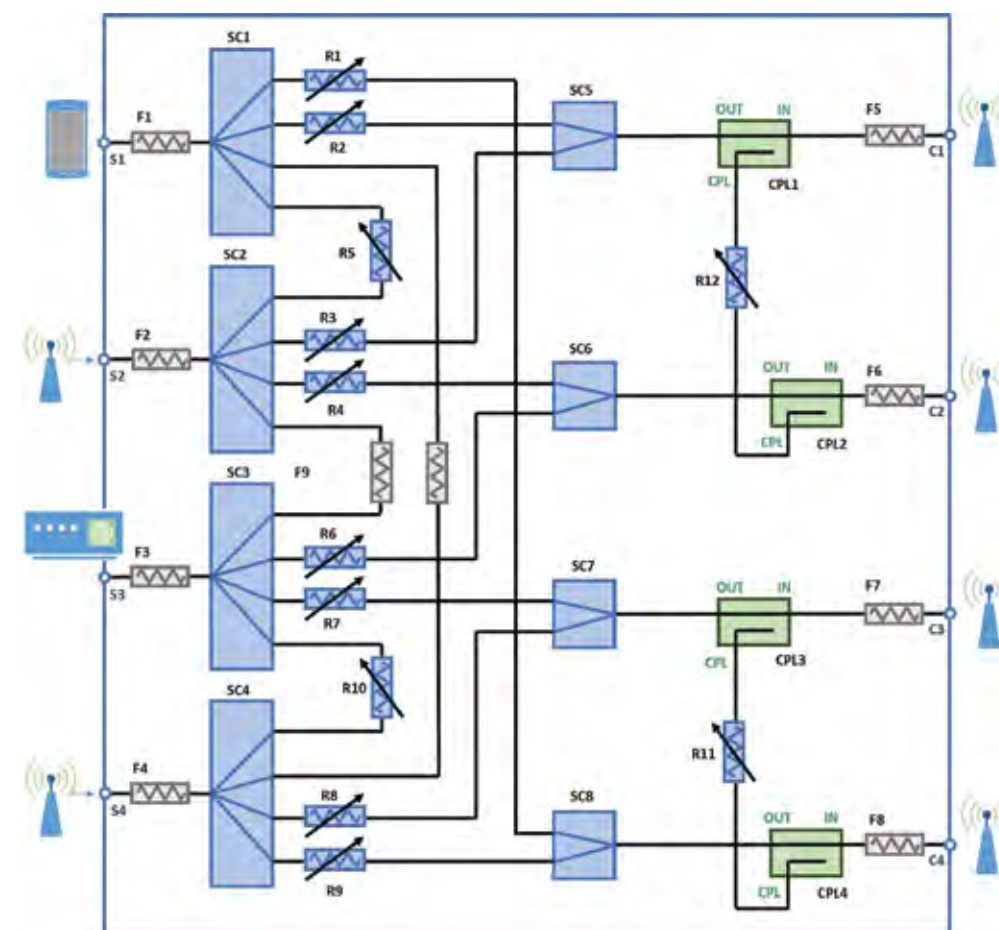
Electrical Performance

PARAMETER	TYPICAL PERFORMANCE	CONDITION	UNITS
Path Loss (typ.)	33	Port-A $\to$ N$_{3,6}$	dB
	33	N$_1$ $\to$ N$_{3,4}$	
	33	Port-B $\to$ N$_{4,5}$	
	33	N$_2$ $\to$ N$_{5,6}$	
Port-to-Port Isolation (typ.)	44	Port-A $\to$ N$_1$; Port-B $\to$ N$_2$	dB
	46	N$_3$ $\to$ N$_4$; N$_5$ $\to$ N$_6$	
	76	N$_3$ $\to$ N$_6$; N$_4$ $\to$ N$_5$	
Return Loss (typ.)	16	All Ports	dB

ZT-191 Curves

Return Loss, Full-Path

Isolation, No-Direct-Path
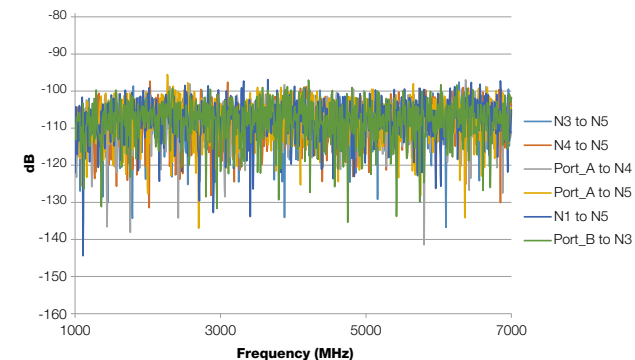
ZT-211   2.4 to 6.0 GHz
Custom Mesh Network Test Drawers

ZT-211 is an example of the custom telecoms test systems that can be developed with Mini-Circuits' expert support. This particular example provides a multi-use mesh network for WiFi device and base station testing, with the following key features:

- Multiple, simultaneous interconnect options between up to 8 devices or test sets
- Variable path loss, ideal for simulating distance and interference in a production test environment
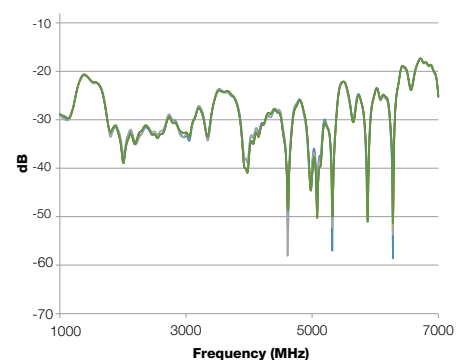- Full software API for automation in a wide range of programming environments
- USB and Ethernet control interface for local or remote control

Variations of this system can be developed on request to cover alternative frequency bands or provide specific interconnection options between systems and devices under test. Mini-Circuits' Application Engineers can work with you from a simple outline spec or a full block diagram, to create your custom system.

Please contact testsolutions@minicircuits.com for support.

ZT-211 Functional Schematic
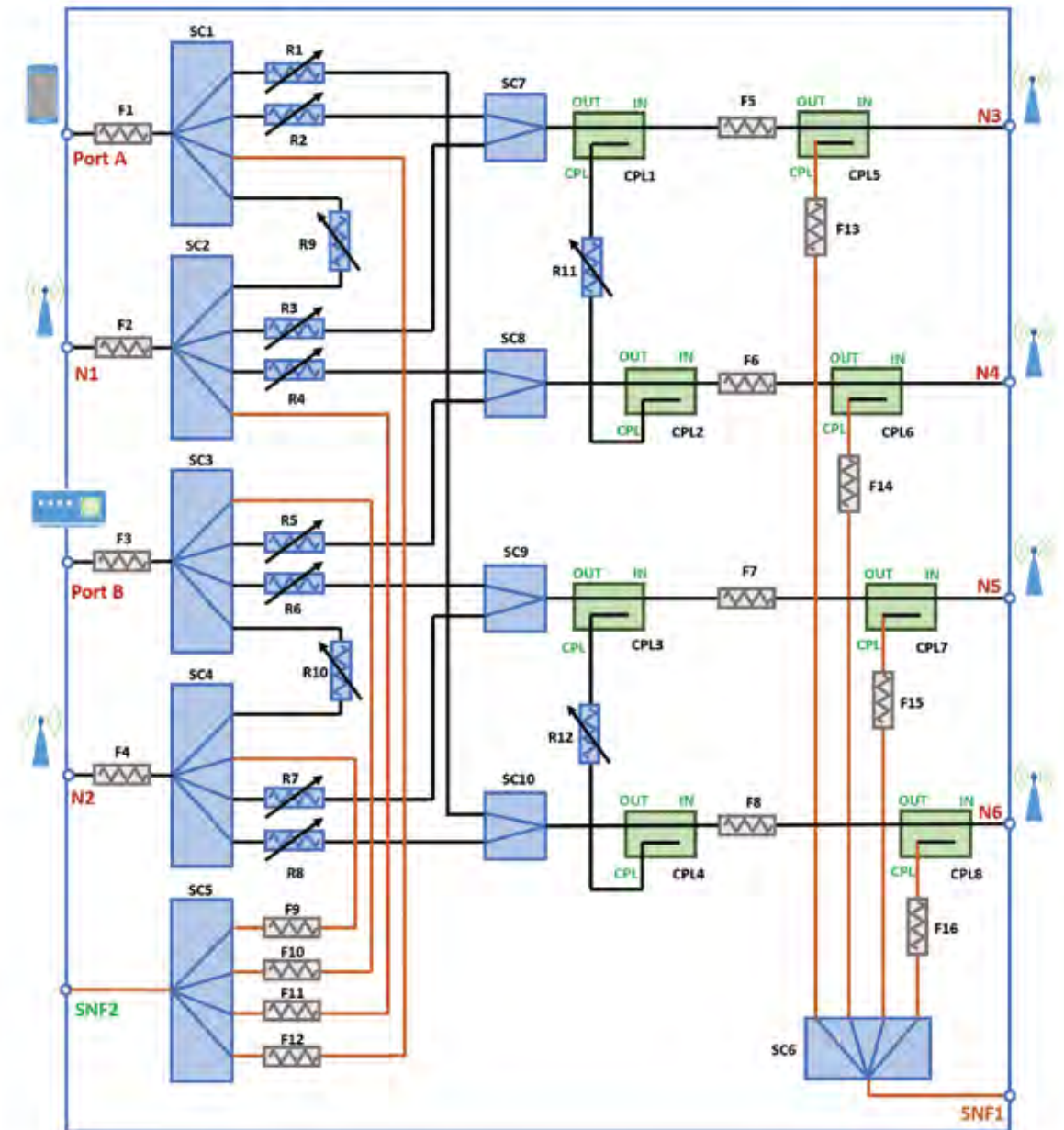
Functional Schematic of 6 x 8 Port RF Switch Matrix
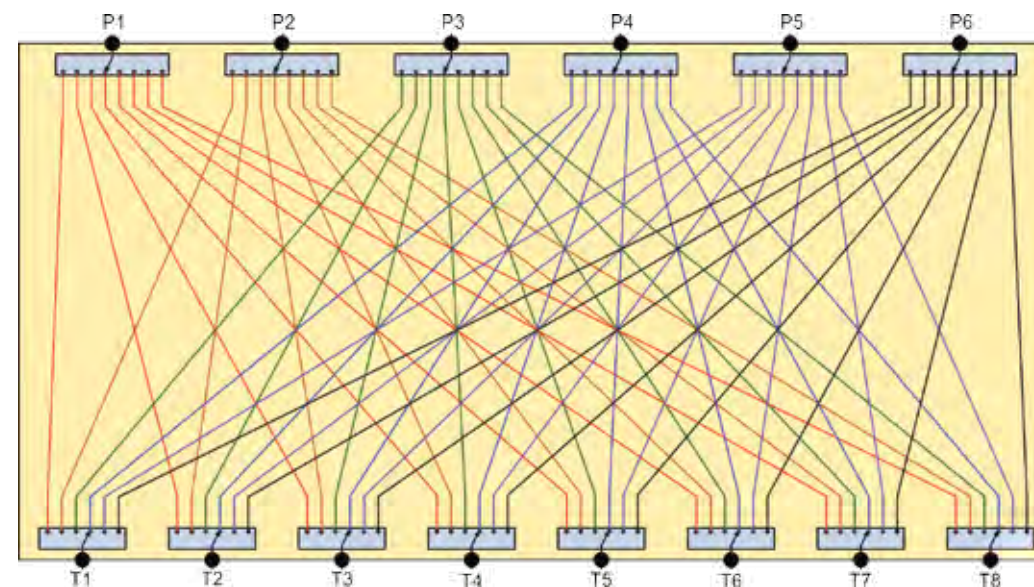
Rear Panel

ZT-175 2-8 GHz

6x8 RF Switch Matrix

Functional Description

This flexible switch matrix employs a sophisticated switching network to allow signal from any of the 6 RF inputs on the rear panel to be routed to any of the 8 RF outputs on the front panel. Controlled via USB or Ethernet, the assembly features Mini-Circuits' patented electromechanical SP6T switches with low loss, high isolation and extra long switching life. This design gives operators full control over up to 48 unique signal paths, ideal for many situations where routing complex signal traffic for various setups is needed.

ZT-175 Curves

Electrical Performance

PARAMETER	SPECIFICATIONS			
	Units	Min.	Typ.	Max.
Frequency Range	GHz	2	-	8
Typical Path Insertion Loss	dB	-	4.0	-
Typical Path VSWR	dB	-	1.4:1	-
Typical Isolation	dB	-	85	-

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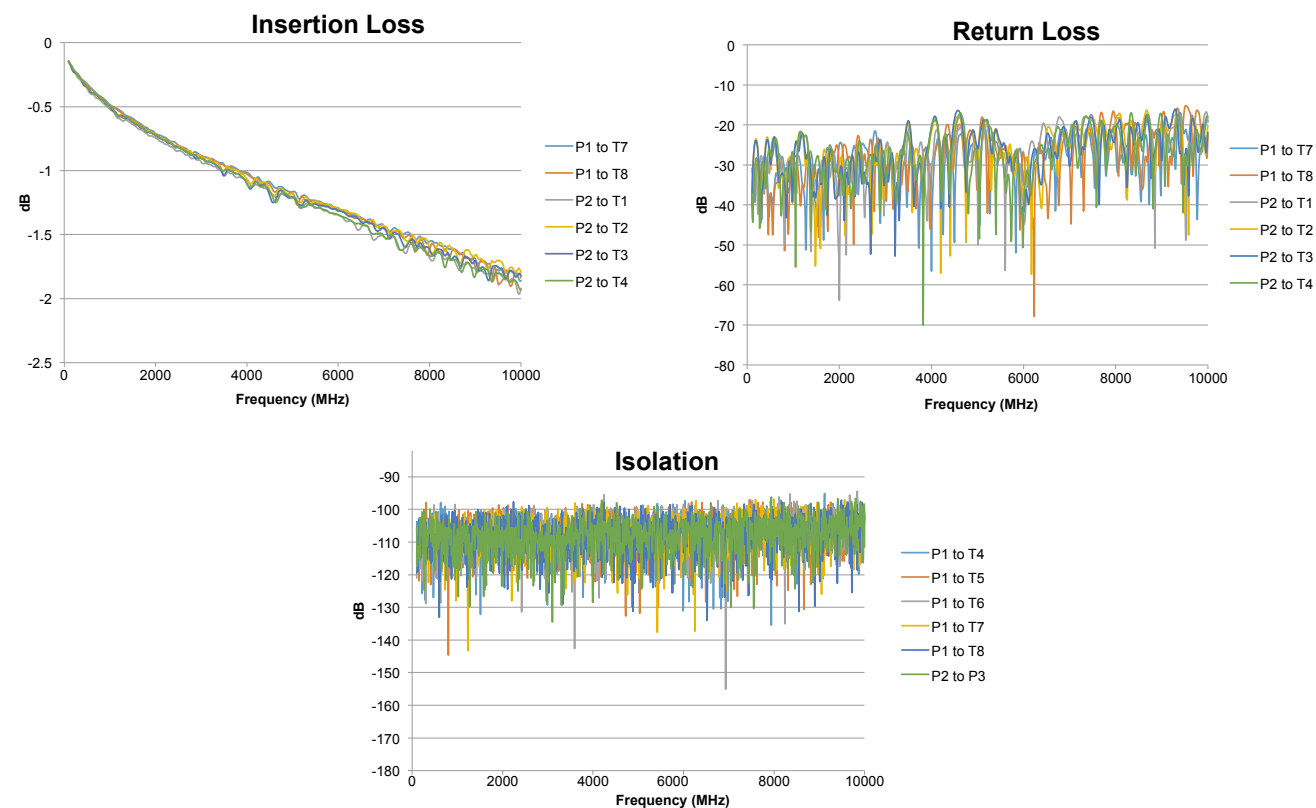
ZT-177 *350 - 6000 MHz*

4 x 4 Full Fan Out Matrix

Functional Description

The ZT-177 full fan out matrix distributes each of 4 input signals into 4 switchable channels controlled via electromechanical absorptive SP4T switches at each of the output ports. This configuration allows easy switching between test channels through multiple ports wi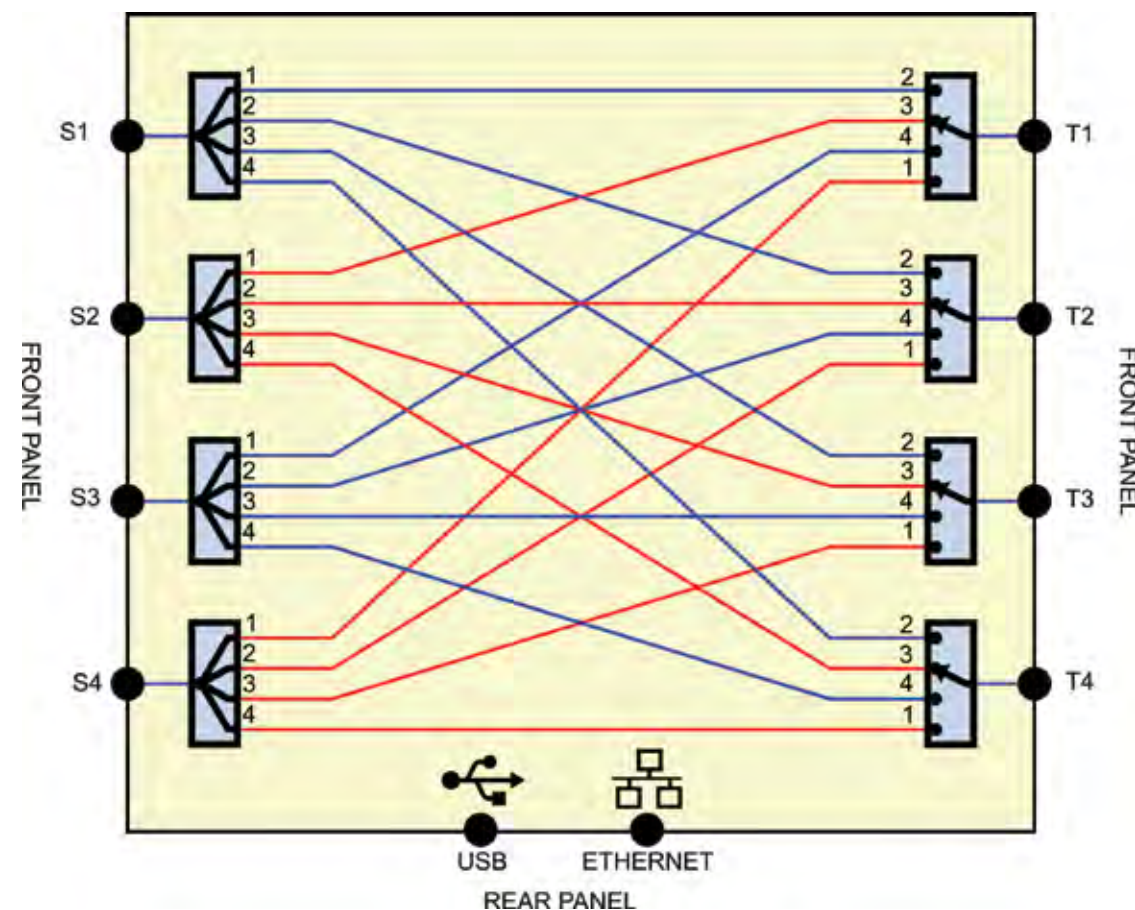thout the need for re-cabling, affording the operator flexibility where routing of multiple test signals to various DUT ports is needed, and reducing test time.

Functional Schematic

Electrical Performance

PARAMETER		PERFORMANCE		CONDITION
	Units	350 to 2000 MHz	2000 to 6000	MHz Max. RF input = +20 dBm
Path Loss, S_N port to T_M Port	dB	8.0	9.5	
Return Loss @ S_N Port	dB	14	12	When S_N and T_M connected
Return Loss @ T_N Port	dB	12	15	and terminated in 50Ω load
Isolation S_N to S_M	dB	90	90	S_N and S_M connected to the same T port
Isolation T_N to T_M	dB	20	20	T_N and T_M connected to the same S port
Leakage T_N to T_M	dB	90	90	T_N and T_M connected to different S ports
Amplitude Unbalance, S_1 to T_1 and S_1 to T_4	dB	1	1	

Typical Path Loss
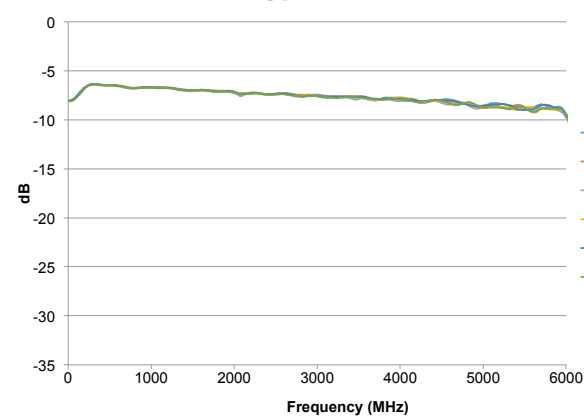
Typical Return Loss
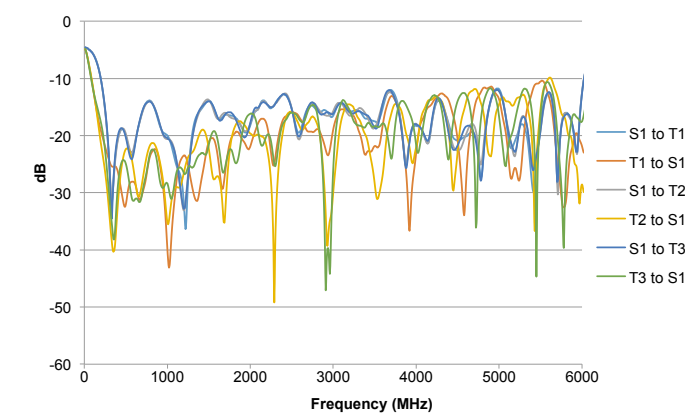
2 x N Port Switch Matrices

Expansion systems for multi-port/parallel test applications

Mini-Circuits' ZTVX Series is a family of 2 by N switch matrices, each packaged in a compact, 2U height, 19-inch rackmountable chassis with all RF connections (SMA) on the front panel. Models are available covering DC to 12 GHz or DC to 18 GHz using Mini-Circuits' patented high reliability fail-safe mechanical switches. Switch matrix combinations to 2 by 16 ports are available as standard products.

These systems are ideal as a VNA extender, opening up a standard 2 port VNA to a wide range of multi-port or multidevice test scenarios, including:

- Parallel testing of up to multiple 2 port devices (eg: filter and amplifier production testing)
- Production testing of splitter/combiner or switch components with higher port counts (eg: splitter/combiners)
- Testing of multi-channel MIMO systems

The systems are supplied with Mini-Circuits standard software support, including programming API, with USB and Ethernet connections.

N-type connectors are available as an option (3u height package) and custom port combinations can be created on request.
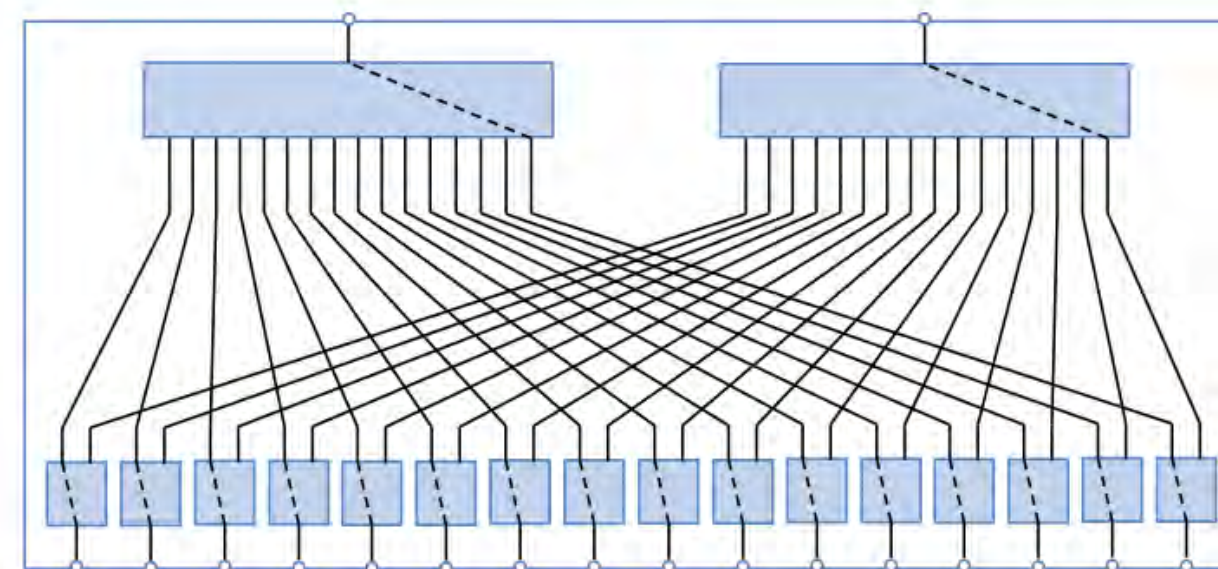
Functional schematic for ZTVX-16-18-S, DC-18 GHz 2 x 16 switch matrix

ZTVX Series Model Selection Guide

| Model Name	Configuration	Frequency Range (GHz)	Insertion Loss (typ., dB)	Return Loss (typ., dB)	Isolation (typ., dB)
ZTVX-8-12-S	2 x 8 port	DC to 12	1	20	90
ZTVX-8-18-S	2 x 8 port	DC to 18	1.5	12	90
ZTVX-10-12-S	2 x 10 port	DC to 12	1	20	90
ZTVX-10-18-S	2 x 10 port	DC to 18	2.5	12	90
ZTVX-12-12-S	2 x 12 port	DC to 12	1	20	90
ZTVX-12-18-S	2 x 12 port	DC to 18	2.5	12	90
ZTVX-16-12-S	2 x 16 port	DC to 12	2	15	90
ZTVX-16-18-S	2 x 16 port	DC to 18	2.5	12	90

ZT-180 *DC -18 GHz*

2 x 16 VNA Expansion Module

Functional Description

The ZT-180 VNA Expansion Module is an RF switch matrix specially designed to pair with vector network analyzers in RF test environments. The unit consists of a network of high-isolation, low-loss electromechanical absorptive RF switches which allows any 2 ports of a network analyzer to be routed through any of the 16 ports on the front panel. This capability allows users to test devices with higher port counts without repeatedly disconnecting and reconnecting cables. It can also be used to enable parallel processing of multiple DUTs from the same network analyzer, improving test efficiency and throughput. LED lights on the front panel conveniently indicate the active port(s), so the user can easily determine the signal path without referring to the GUI.

ZT-180 Functional Schematic

Vector Network Analyzer
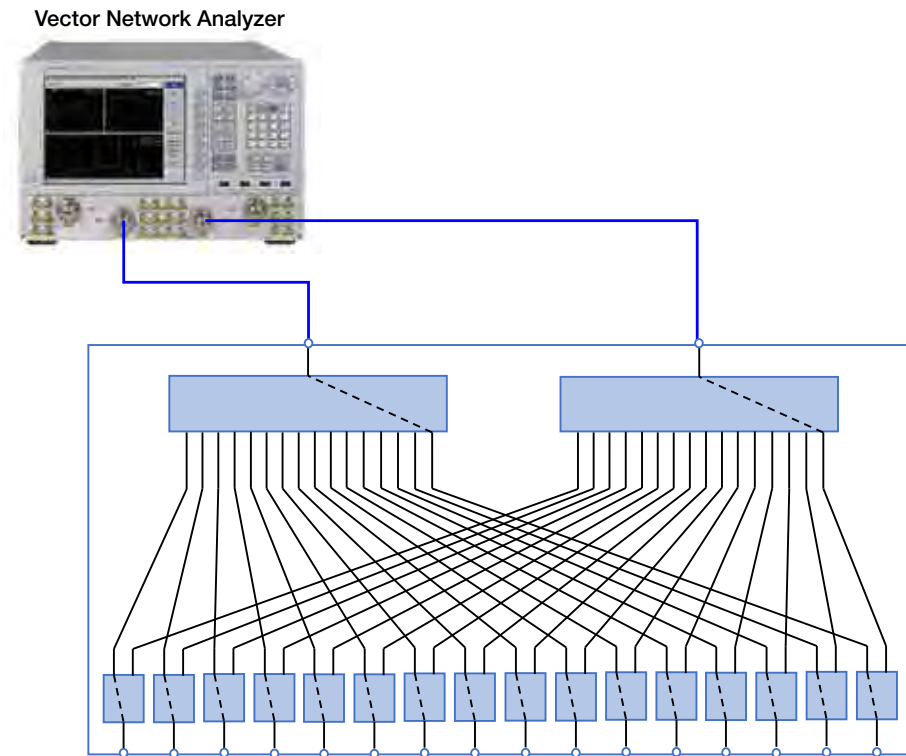
Note: the functional schematic is indicative of the switch matrix operation but is not a wiring diagram; the exact topology used may differ.

ZT-180 Paired with Vector Network Analyzer

ZT-180 Curves

Insertion Loss

Legend: RF_IN1 to 1, RF_IN1 to 3, RF_IN1 to 2, RF_IN2 to 1, RF_IN2 to 3, RF_IN2 to 2

Isolation

Legend: 1 to 2, 2 to 3, 1 to 9, 9 to 10, 2 to 10, 7 to 8

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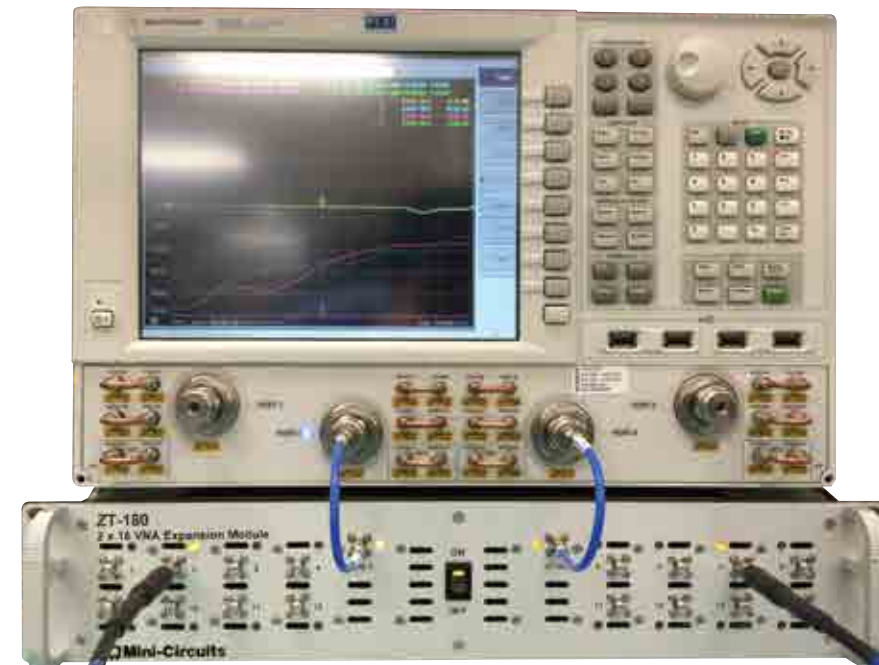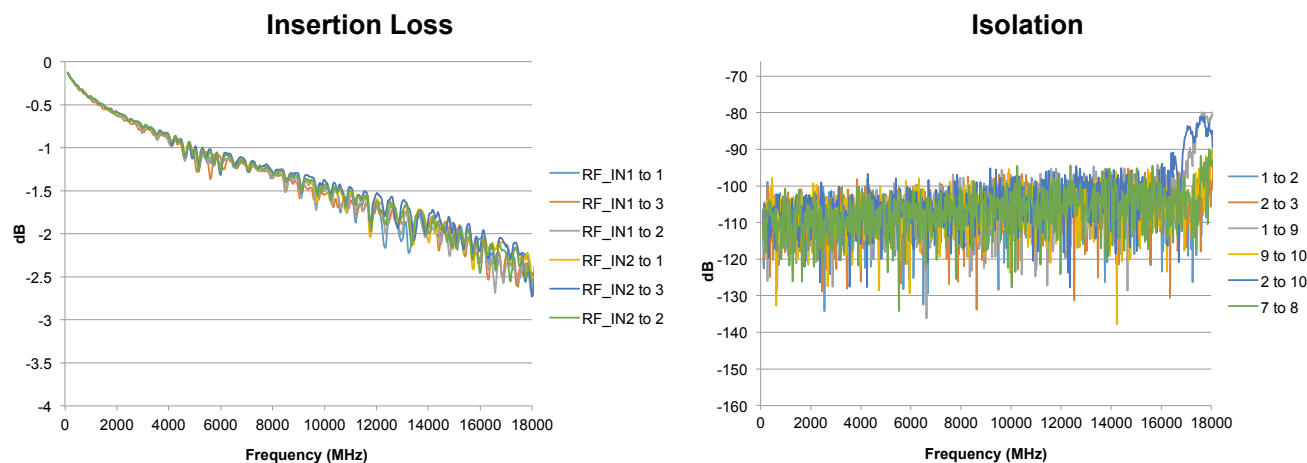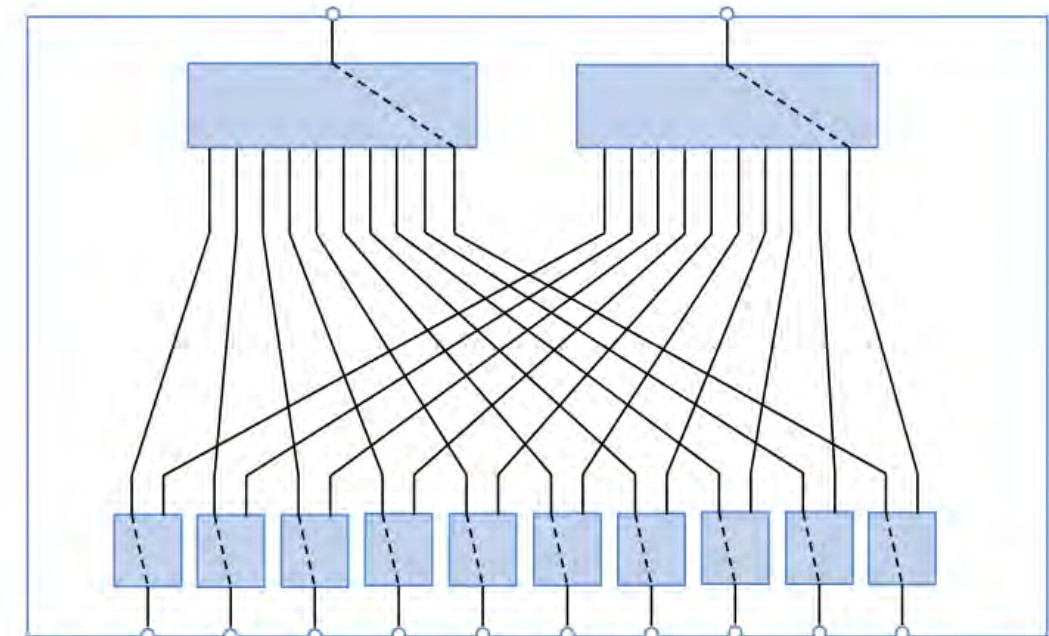
Functional schematic for ZT-209

ZT-209 *5 to 1800 MHz* 75Ω
2 x 10 Port 75Ω Switch Matrix

ZT-209 is a 2 by 10 port switch matrix with 75Ω characteristic impedance and wide band frequency coverage, ideal for characterization of DOCSIS 3.1 components and systems. The non-blocking configuration allows the 2 ports to be connected to any pair of the 10 opposite ports.

All RF ports have 75Ω N-type connectors with excellent impedance match, making the system ideal for extension of a 2 port VNA to allow simultaneous testing of multiple devices or multi-port systems.

Electrical Performance

PARAMETER	SPECIFICATIONS			
	Units	Min.	Typ.	Max.
Operating Frequency	MHz	5	-	1800
Characteristic Impedance	Ω	-	75	-
Input Return Loss	dB	-	20	-
Output Return Loss	dB	-	25	-
Insertion Loss	dB		7	-
Isolation	dB	-	80	-

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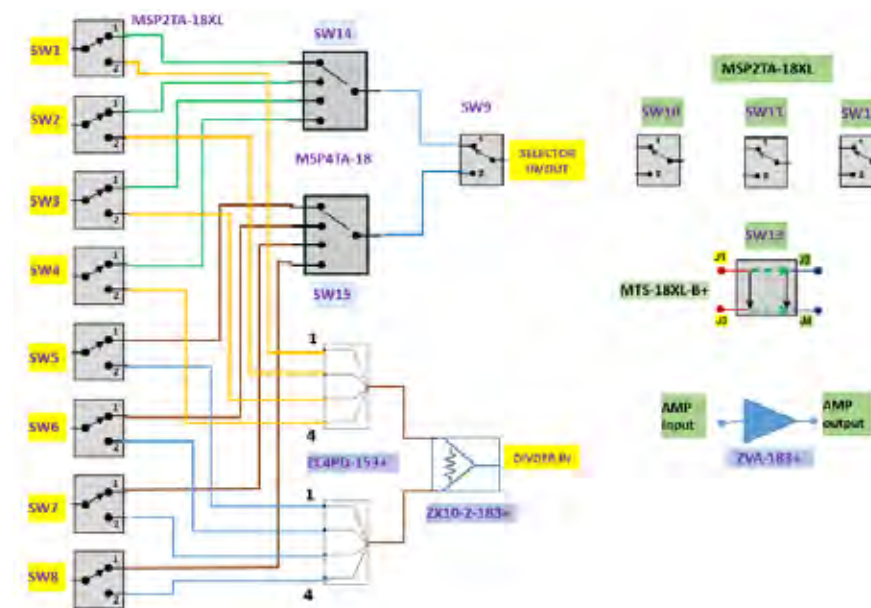
ZT-185 6-15 GHz

ATE Switch Matrix

Functional Description

The ZT-185 is a high frequency, 2 by 8 complex switch matrix which allows any of the 8 input/output ports to be routed through a low-loss "one-to-one" matrix (Selector port) or through a "many-to-one" combination matrix (Divider port). The matrix also includes three separate SPDT switches, one transfer switch, and a wideband (0.7-18 GHz) amplifier, with all RF connections accessible on the front panel, allowing the system to be easily expanded across a diverse range of test applications.

Electrical Performance

PARAMETER	UNIT	PERFORMANCE			CONDITION
		Min.	Typ.	Max.	
Frequency Range	GHz	6	-	15	-
Insertion Loss	dB	-	14	-	Divider In → SW1 thru SW8
	dB	-	3	-	Selector In/Out → SW1 thru SW8
Return Loss	dB	-	10	-	@ 15 GHz

ZT-185 Functional Schematic

ZT-185 Curves

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ZT-188 Functional Block Diagram
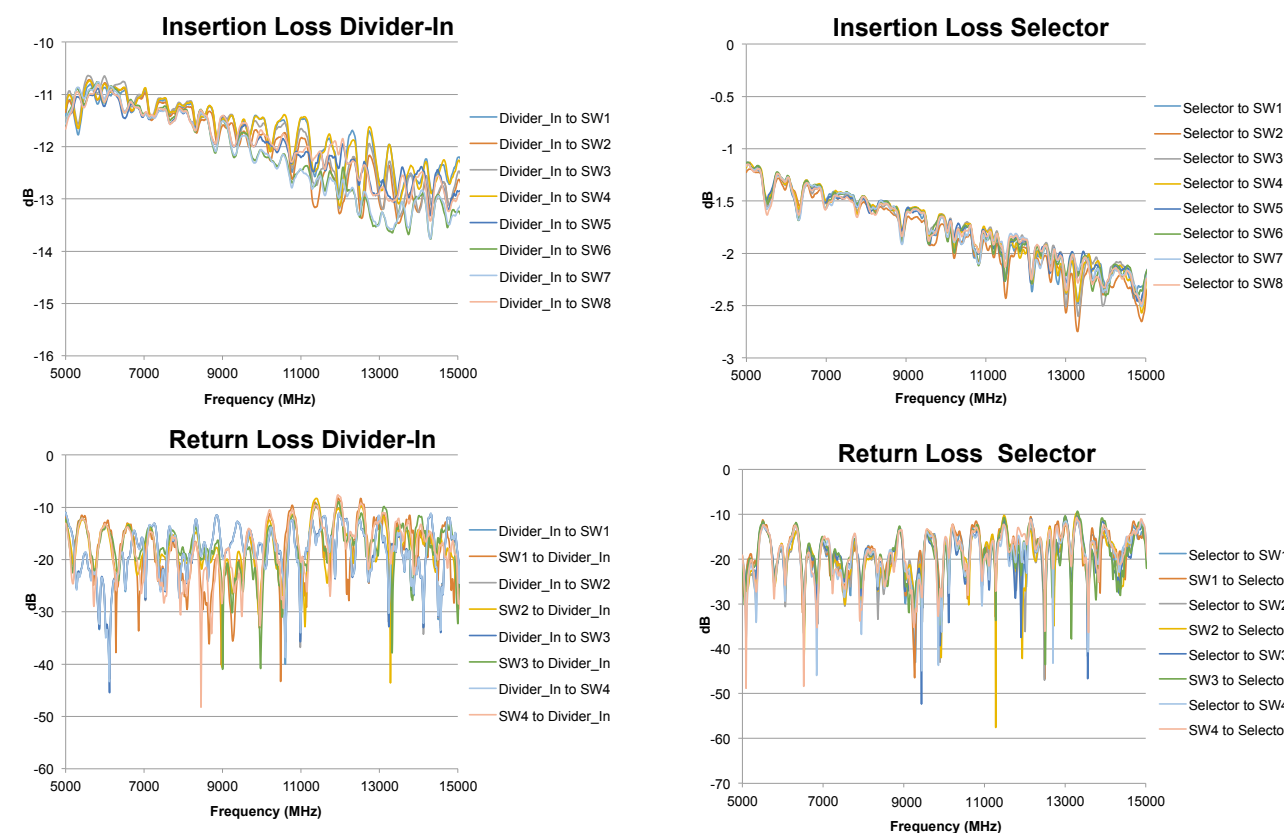
ZT-188 1.6 - 2.3 GHz

Wireless Base Station (BTS) / Handset Testing Station

Functional Description

ZT-188 was developed as a multi-function test set for Low Capacity Trunk Radio and other wireless BTS/handset test environments. The core of the system is a 4 x 8 non-blocking switch matrix, allowing up to 8 handsets / terminals to be simultaneously routed to any combination of 4 BTS, with input powers of up to 20 W per port in either direction. The system also provides auxiliary test ports which allow an external test signal to be injected to any BTS or the output to be monitored with an external spectrum analyzer.

ZT-188 GUI

Return Loss

— C2 to P1
— P1 to SG INPUT
— P1 to C2
— SG INPUT to P1

Isolation

— S1 to S2
— S2 to S3
— S3 to S4

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Rear Panel

Functional Schematic

ZT-10HPS-272 700-2700 MHz

High Power (100W)
Rack Mountable 10-Way Splitter

Functional Description

ZT-10HPS-272 is a passive splitter design enabling high power signal distribution in an RF test environment. With 100W input, this splitter is capable of deli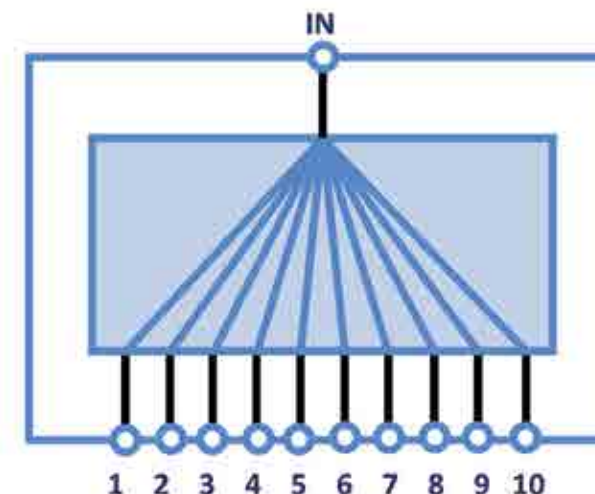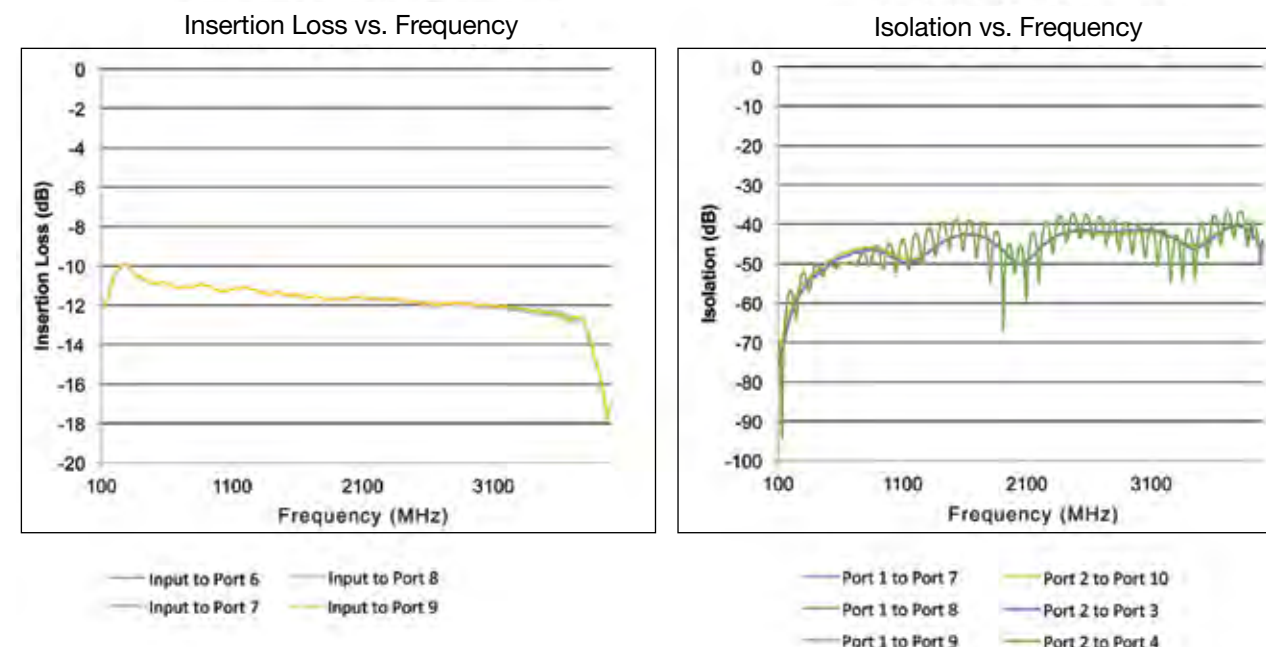vering about 6W each to all 10 output channels. The unit is specifically designed for applications requiring tight amplitude unbalance where phase unbalance is non-critical. The specified operating bandwidth covers all the key telecoms bands up to 2.7 GHz. This splitter is recommended to be used together with Mini-Circuits HPA-272+ 100W high power amplifier in HTOL tests. Mini-Circuits offers a range of power amplifiers capable of delivering up to 100W into this splitter.

Electrical Performance (Per Path)

PARAMETER	SPECIFICATIONS			
	Min.	Typ.	Max.	Units
Operating Frequency	700		2700	MHz
Input Power[12]			100	W
Insertion Loss		11.5	12.5	dB
Amplitude Unbalance		0.6	1.0	dB
Isolation		25	16	dB
VSWR (Intput)		1.3:1		
VSWR (Output)		1.25:1		
AC Supply		90/260		V

ZT-10HPS-272 Curves

Insertion Loss vs. Frequency

Isolation vs. Frequency

— Input to Port 6   — Input to Port 8
— Input to Port 7   — Input to Port 9

— Port 1 to Port 7   — Port 2 to Port 10
— Port 1 to Port 8   — Port 2 to Port 3
— Port 1 to Port 9   — Port 2 to Port 4

ZT-207 *350 to 6000 MHz*
6 x 2-Way Splitter/Combiner Box

To simplify the interconnection of RF signal distribution components within rack-mounted test configurations, Mini-Circuits has created ZT-207 and ZT-208. ZT-207 is a 3u rack shelf which integrates 6 individual RF splitter/combiners (2-way each) on the front panel, providing a convenient platform for connection into the wider test system.

Each splitter covers 350 to 6000 MHz, incorporating most common telecoms applications such as GCM/CDMA/LTE/Bluetooth/Wi-Fi.

Each splitter/combiner has low insertion loss and a high power rating of up to 25 W when splitting an input signal.

Electrical Performance

PARAMETER	SPECIFICATIONS			
	Units	Min.	Typ.	Max.
Operating Frequency	MHz	350	-	6000
Insertion Loss (above 3 dB)	dB	-	0.7	-
Isolation	dB	-	20	-
VSWR	1	-	1.4	-
Power Handling (as a splitter)				
350-3600 MHz	W	-	-	25
3600-6000 MHz	W	-	-	15
Power Handling (as a combiner)	W	-	-	1

ZT-208 *380 to 4600 MHz*
4 x 4-Way Splitter/Combiner Box

ZT-208 integrates 4 individual RF splitter/combiners (4-way each) on the front panel of a 3u rack shelf, providing a convenient platform for connection into the wider test system.

Each splitter covers the 380 to 4600 MHz band, incorporating all of the common 2G/3G/4G applications, with low insertion loss and high power rating (30 W when splitting an input signal).

Electrical Performance

PARAMETER	SPECIFICATIONS			
	Units	Min.	Typ.	Max.
Operating Frequency	MHz	350	-	4600
Insertion Loss (above 6 dB)	dB	-	1	-
Isolation	dB	-	22	-
VSWR	1	-	1.3	-
Power Handling (as a splitter)	W			30
Power Handling (as a combiner)	W	-	-	1

Panel-Mounted Structures

ZT-165

Rear View

24 N-Type to N-Type Cable Management Panel

Functional Description
To provide clean, organized management of cable connections in high-traffic lab environments, the ZT-165 provides 24 N-type female to N-type female adapters neatly configured in a 19" rack-mount panel.
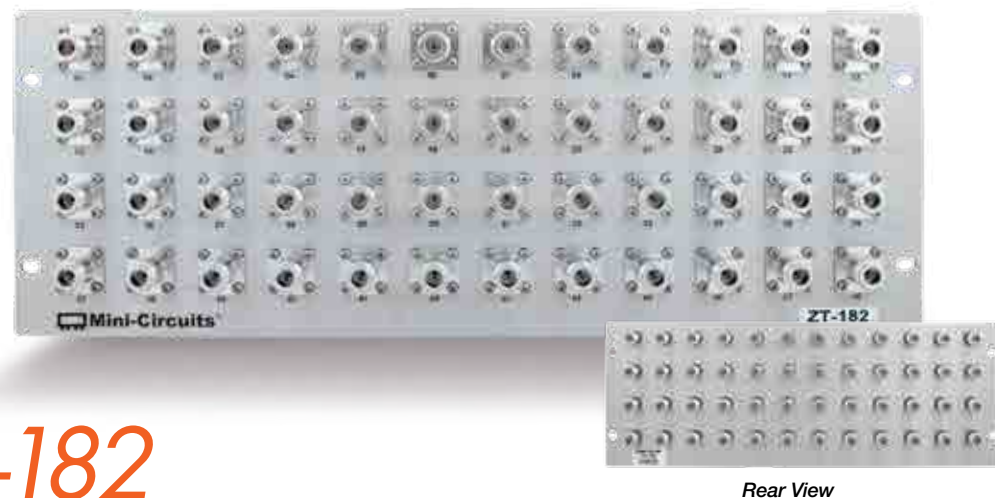
ZT-182

Rear View

48 N-Type to N-Type Cable Management Panel

Functional Description
The ZT-182 cable management panel provides 48 N-Type female to N-Type female adapters in a neat 4 x 12" arrangement on a standard 19" rack-mount panel, allowing easy organization of cables in setups with many simultaneous connections.

ZT-183

Rear View

48 SMA to N-Type Cable Management Panel

Functional Description
The ZT-183 cable management panel provides 48 SMA to N-Type female low-loss adapters in a standard 19" rack-mount panel, allowing easy interconnection between cables with different connector types in multi-channel test setups.
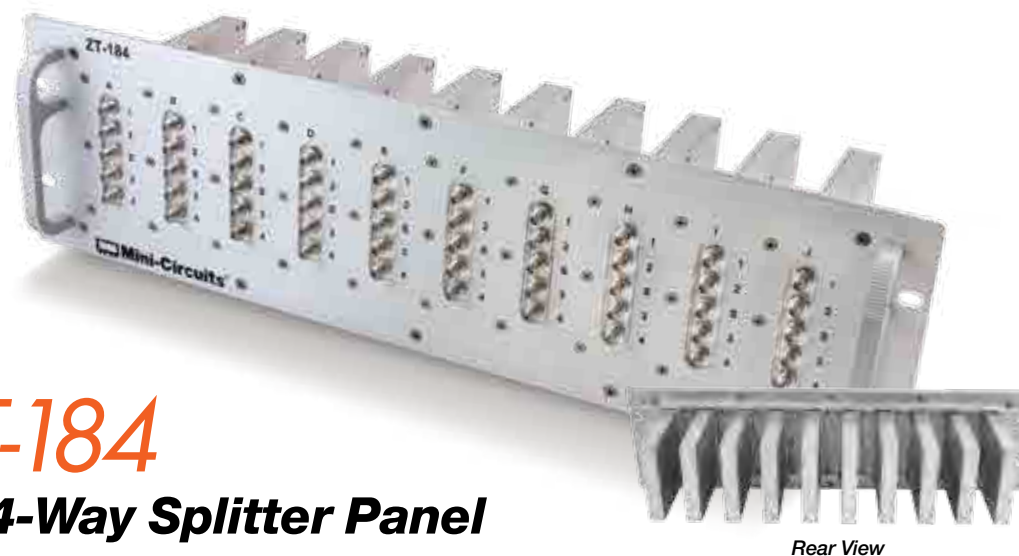
ZT-184

Rear View

10 4-Way Splitter Panel

Functional Description
The ZT-184 splitter incorporates 10 wideband 4-way 0° splitters, each with 10W RF input power handling, 1 dB insertion loss, 0.2 dB amplitude unbalance, and 2° phase unbalance. This design enables the user to distribute up to 10 input test channels into 40 output channels, ideal for setups where multiple DUTs are tested in parallel.

1 MHz - 8 GHz
Programmable Attenuators

Mini-Circuits' USB and Ethernet controlled programmable attenuators provide precise level control with accurate, repeatable performance for a wide range of test applications from 1 - 8000 MHz. Available in models with attenuation ranges of 0 – 30, 60, 90, 110 and 120 dB in 0.25 dB steps, our unique designs maintain linear attenuation change per dB over the entire range of attenuation settings. Small enough to fit in your pocket, they're perfect for use in the lab or in the field.

Our smart GUI software supplied with all models allows you to sweep or hop attenuation levels, and even save and recall your own test profiles with specific attenuation patterns for R&D and production test, reducing test time and increasing throughput. DLLs and programming instructions are also included, so you can program your attenuators through your native test software.

Electrical Performance

Model	Frequency Range	Attenuation Accuracy	Step Size	USB Control	Ethernet Control	RS232 Control
RUDAT-6000-30	1– 6000 MHz	0-30 dB	0.25 dB	✓	-	✓
RUDAT-6000-60	1– 6000 MHz	0-60 dB	0.25 dB	✓	-	✓
RUDAT-6000-90	1– 6000 MHz	0-90 dB	0.25 dB	✓	-	✓
RUDAT-6000-110	1– 6000 MHz	0-110 dB	0.25 dB	✓	-	✓
RUDAT-4000-120	1– 4000 MHz	**0-120 dB**	0.25 dB	✓	-	✓
RCDAT-6000-30	1– 6000 MHz	0-30 dB	0.25 dB	✓	✓	-
RCDAT-6000-60	1– 6000 MHz	0-60 dB	0.25 dB	✓	✓	-
RCDAT-6000-90	1– 6000 MHz	0-90 dB	0.25 dB	✓	✓	-
RCDAT-6000-110	1– 6000 MHz	0-110 dB	0.25 dB	✓	✓	-
RCDAT-4000-120	1– 4000 MHz	**0-120 dB**	0.25 dB	✓	✓	-
New RCDAT-8000-30	**1– 8000 MHz**	0-30 dB	0.25 dB	✓	✓	-
New RCDAT-8000-60	**1– 8000 MHz**	0-60 dB	0.25 dB	✓	✓	-
New RCDAT-8000-90	**1– 8000 MHz**	0-90 dB	0.25 dB	✓	✓	-
New RCDAT-3000-63W2 **2W Power Handling!**	1– 3000 MHz	0-63 dB	1.00 dB	✓	✓	-

RUDAT GUI Main Screen

9 kHz - 8 GHz, 50 & *75Ω*
PWR Series
USB/Ethernet Smart Power Sensors

Mini-Circuits PWR-series smart power sensors are pocket-sized, precision measurement devices that provide highly accurate measurements of continuous wave (CW) as well as modulated and multi-tone signals. USB and Ethernet control options give you the freedom to manage your test setup from your PC remotely, and our user-friendly GUI software provides comprehensive control capability including data acquisition tools for reporting and data analysis. It even includes built-in measurement applications for measurement of RF components such as couplers, filters, amplifiers and more!

Model	Frequency (MHz) and Impedance	Measurement Type	Dynamic Range (dBm)	Control Interface
PWR-2.5GHS-75	0.1 to 2500, *75Ω*	CW	-30 to +20	USB
PWR-4GHS	0.009 to 4000, 50Ω	CW	-30 to +20	USB
PWR-4RMS	50 to 4000, 50Ω	True RMS	-35 to +20	USB
PWR-6GHS	1 to 6000, 50Ω	CW	-30 to +20	USB
New PWR-6LGHS	50–6000 MHz, 50Ω **High Sensitivity**	CW	-45 to +10 dBm	USB
New PWR-6RMS-RC	1– 6000 MHz, 50Ω	True RMS	-35 to +20 dBm	USB & Ethernet
New PWR-6LRMS-RC	50–6000 MHz, 50Ω **High Sensitivity**	True RMS	-45 to +10 dBm	USB & Ethernet
PWR-8GHS	1 to 8000, 50Ω	CW	-30 to +20	USB
PWR-8GHS-RC	1 to 8000, 50Ω	CW	-30 to +20	USB & Ethernet
PWR-8FS	1 to 8000, 50Ω **Fast Measurement Speed, 10ms**	CW	-30 to +20	USB

Power Sensor GUI Main Screen

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1-6000 MHz, 50Ω
# FCPM-6000RC
Integrated Frequency Counter/Power Sensor

Mini-Circuits' FCPM-6000RC integrated frequency counter and power meter is a pocket sized (5.00 x 2.66 x 1.36") precision test device controlled via USB or Ethernet (supporting HTTP and Telnet protocols) or operated as a standalone test instrument. It simplifies test applications by enabling synchronized frequency and power measurements from a single device. The unit features an LCD display, allowing convenient readings directly off the measurement head, while our user-friendly GUI software lets you perform measurements remotely from your Windows® or Linux® PC via USB or Ethernet.

Typical Performance

Frequency Range	1 to 6000 MHz
Dynamic Range	-30 to +20 dBm
Power Resolution	0.01 dB
Frequency Resolution	1 Hz (across 1 to 40 MHz)
	10 Hz (across 40 to 190 MHz)
	100 Hz (across 190 to 6000 MHz)
Measurement Speed	30ms

FCPM-6000RC GUI Main Screen
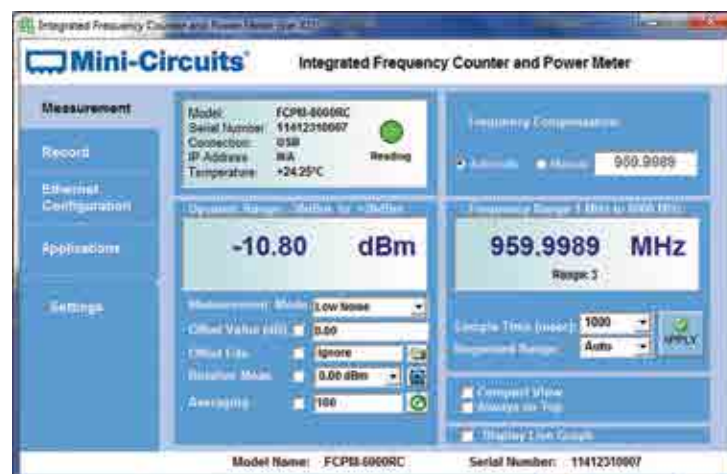
Glossary

API (Application Programming Interface)
- A software interface defining a set of inputs, outputs and processes that allow software building blocks to be easily implemented and re-used as part of a larger program.
- Mini-Circuits provides APIs in the form of DLL files which give the user simple access to the full functionality of our test products/systems on computers running a Windows operating system.

Blocking Matrix
- A matrix where connecting a given input to a given output will prevent certain other input/output combinations from being set simultaneously.

Combination Matrix
- A matrix for routing between multiple inputs and outputs, constructed from a combination of splitter/combiners and switches.
- Typically reduces the through loss compared to a splitter/combiner only matrix while allowing one to many/many to one combinations that aren't possible with a switch only matrix.

DLL (Dynamic Linked Library)
- A shared library format designed by Microsoft for Windows operating systems.
- Mini-Circuits provides APIs in a choice of two DLL files for each test equipment family, an ActiveX COM object and a .Net library, which are supported in a wide range of programming environments.
- The DLL file/API provides the interface between the programming environment and the physical hardware over a USB connection, defining all the functions needed for control of the equipment.

DUT (Device Under Test)
- Sometimes referred to as SUT (System Under Test) or UUT (Unit Under Test).
- The subject of the test system, ie: the device/component/system that requires testing.

GUI (Graphical User Interface)
- The software interface that the user can view and interact with on a computer screen in order to control the connected system.

Many to Many Matrix
- A matrix where multiple inputs can be simultaneously connected to multiple outputs.

Non-Blocking Matrix
- A matrix constructed in such a way that any input can be connected to any output without preventing any other input from being connected to any other output.

One to Many/Many to One Matrix
- A matrix where a single input can be simultaneously connected to multiple outputs, or a single output to multiple inputs.

One to One Matrix
- A matrix where any single input can only be connected to a single output at a time.

PTE (Portable Test Equipment)
- Mini-Circuits' blanket product family name for the series of USB, Ethernet & RS232 controlled test equipment products, including signal generators, programmable attenuators, switches and power sensors.

Splitter/Combiner Matrix
- A matrix for routing between multiple inputs and outputs, constructed from individual power splitter/combiners.
- Mini-Circuits' splitter/combiner matrices allow many to many configurations where all inputs are simultaneously routed to all outputs; the trade-off is significantly higher loss compared to a switch matrix.

Switch Matrix
- A matrix for routing between multiple inputs and outputs, constructed from individual switches.
- Mini-Circuits' switch matrices typically offer lower loss than other matrix constructions but can only be one to one.

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