NEW!
Modular Test Solutions
Delivered within 2 Weeks!

TEST SOLUTIONS
PRODUCT GUIDE

Mini-Circuits®
ISO 9001 ISO 14001 AS 9100 *CERTIFIED*
www.minicircuits.com

TSPG-15
second edition

Mini-Circuits Test Solutions

Rack Mount Test Equipment

Modular Test Systems

ZTM-Series

Custom Test Systems

ZT-Series

Portable Test Equipment

Signal Generators

High Speed DDS Generators
SSG-6400HS

CW & Pulse Generators
SSG-4000HP
SSG-4000LH
SSG-6000RC
SSG-6001RC

Switch Matrices

USB Controlled
USB-xSPDT-A18
USB-xSP4T-A18

USB and Ethernet Controlled
RC-xSPDT-A18
RC-xSP4T-A18
RC-xSP6T-A12

Programmable Attenuators

USB and RS232 Controlled
RUDAT-6000-30
RUDAT-6000-60
RUDAT-6000-90
RUDAT-6000-110
RUDAT-4000-120

USB and Ethernet Controlled
RCDAT-6000-30
RCDAT-6000-60
RCDAT-6000-90
RCDAT-6000-110
RCDAT-4000-120

Control Products

USB/RS232 to SPI converters
RS232/USB-SPI
RS232/USB-SPI-N

Input / Output Control Boxes
USB-I/O-16D8R
USB-I/O-4D2R
USB-I/O-8DRV

Signal Measurement

Integrated Frequency and Power Sensors
FCPM-6000RC

CW Power Sensors
PWR-2.5GHS-75
PWR-4GHS
PWR-6GHS
PWR-8GHS
PWR-8FS
PWR-8GHS-RC

RMS Power Sensors
PWR-4RMS

Frequency Counters
UFC-6000

Contents

Even More!

Test Solutions to Meet Your Needs:
Simple, Reliable, Affordable, and FAST!

Thank you for your interest in Mini-Circuits and our rapidly growing line of solutions for RF and microwave test applications. This expanded second edition of our *Test Solutions Product Guide* showcases even more of our many designs for test environments and the range of capabilities they offer. Inside you'll find a close look at some of the applications these products support as well as useful information on our user-friendly control software, test accessories, and even a new, easy way to configure your test system online for delivery as fast as 2 weeks or less! We hope this guide gives you a helpful reference as you consider the right solution for your testing needs.

What sets Mini-Circuits test solutions apart is our building-block approach to developing custom equipment for each customer's unique requirements. Our wealth and variety of components in stock allows us to create integrated assemblies for a wide range of specifications with exceptionally fast turnaround times – within 2 weeks for simple designs, and no more than 8 – 10 weeks for the most complex systems. Beyond our hundreds of standard components available off the shelf, we can also develop special components in-house to meet your exact needs, avoiding the time and cost of sourcing parts from external suppliers.

USB and Ethernet control interfaces on Mini-Circuits test units give you layout flexibility and freedom to manage your test setup remotely. Our proprietary GUI software makes it easy to control signal sources, routing, attenuation, and measurement with the click of a mouse and comes included with all user-controlled units. We also provide a complete set of DLLs with programming instructions for Windows® and Linux® environments, enabling the same control capabilities through your native test software and allowing easy integration into existing setups. Just give us a call for any custom programming requirements!

With our growing variety of custom and off-the-shelf test and measurement products, we have successfully lowered costs and improved efficiency for many customers in a very wide range of test systems from R&D to high-throughput production testing. This experience has reinforced our customer-centric process for designing and building custom assemblies with a focus on economy, reliability, and fast turnaround.

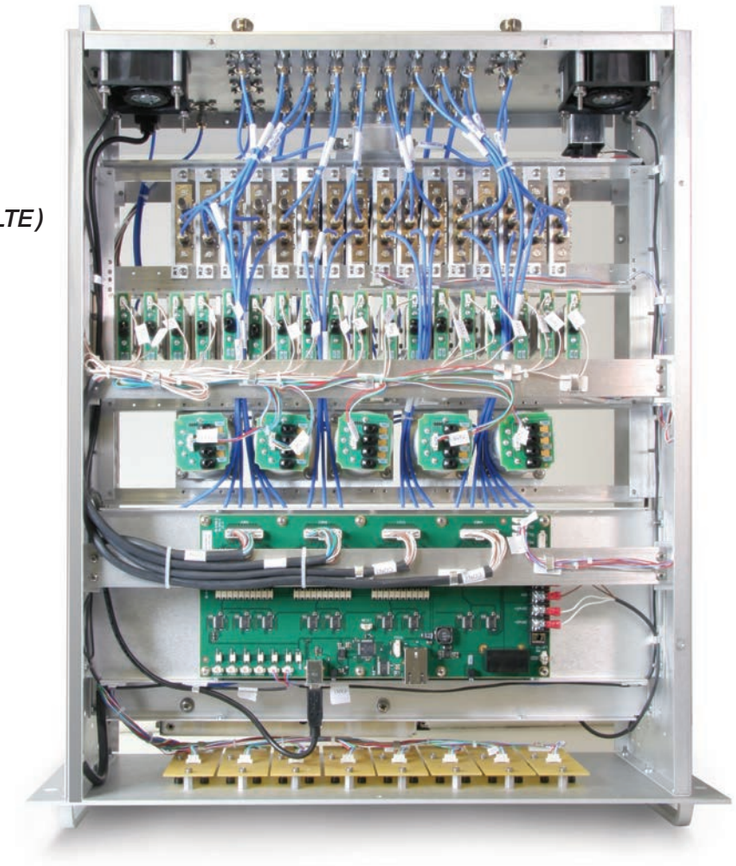
Thanks again for considering how Mini-Circuits can add value to your test setup. We're always here to help, and we invite you to get in touch with us for information about anything you see in this product guide and even more designs to meet your specific needs!

Sincerely,

Chi Man Shum
Vice President, Test & Measurment

Mini-Circuits RF Test Solutions
SELECTED APPLICATIONS

- *Automated Production Test*
- *R&D Bench Test*
- *Telecommunications*
- *Broadband Wireless (3G, 4G, LTE)*
- *Chipset Testing*
- *RF Burn-In*
- *Power Measurement*
- *Antenna Distribution*
- *Mobile Radio*
- *Remote Radio Head (RRH)*
- *Bluetooth, MIMO, WLAN*
- *SatCom*
- *GPS*
- *Laboratory Instrumentation*
- *Handset Certification Testing*
- *RF Noise Characterization*
- *Up/Down-Converter*
- *And More!*



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*

Imagine the Possibilities!

SPDT
DC – 18 GHz

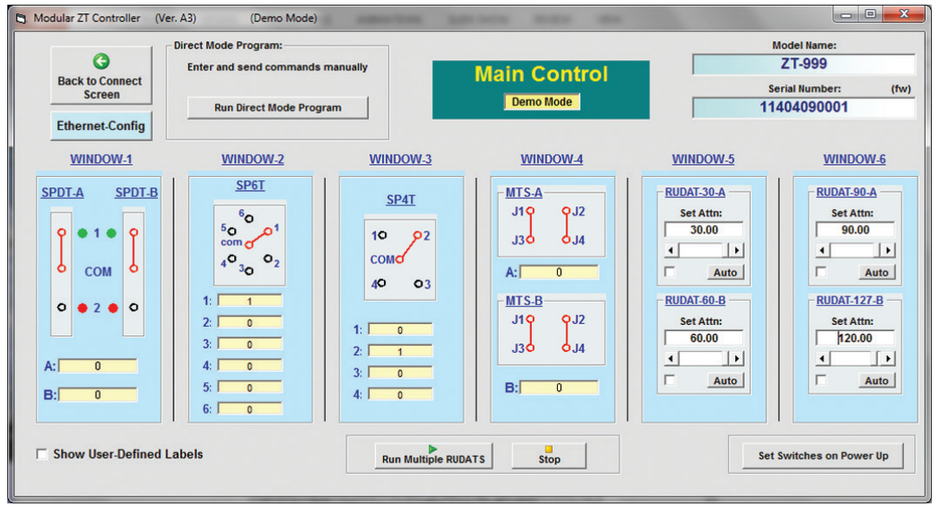
SP4T
DC – 18 GHz

SP6T
DC – 12 GHz

Transfer Switches
DC – 18 GHz

Programmable Attenuators
1 MHz – 6 GHz, 0 – 120 dB

ZTM-Series GUI Main Control



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

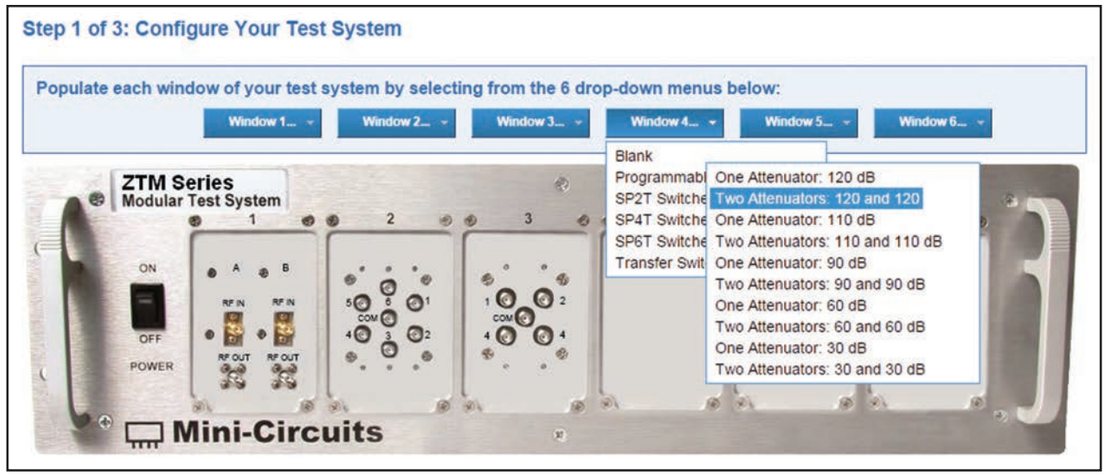
ZTM Series

Configure Your Test System

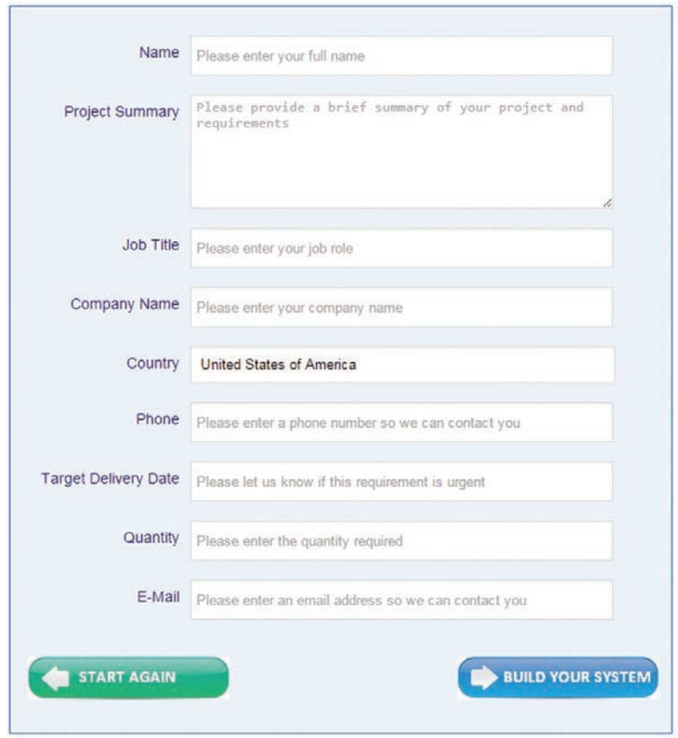
In 3 Easy Steps!

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.

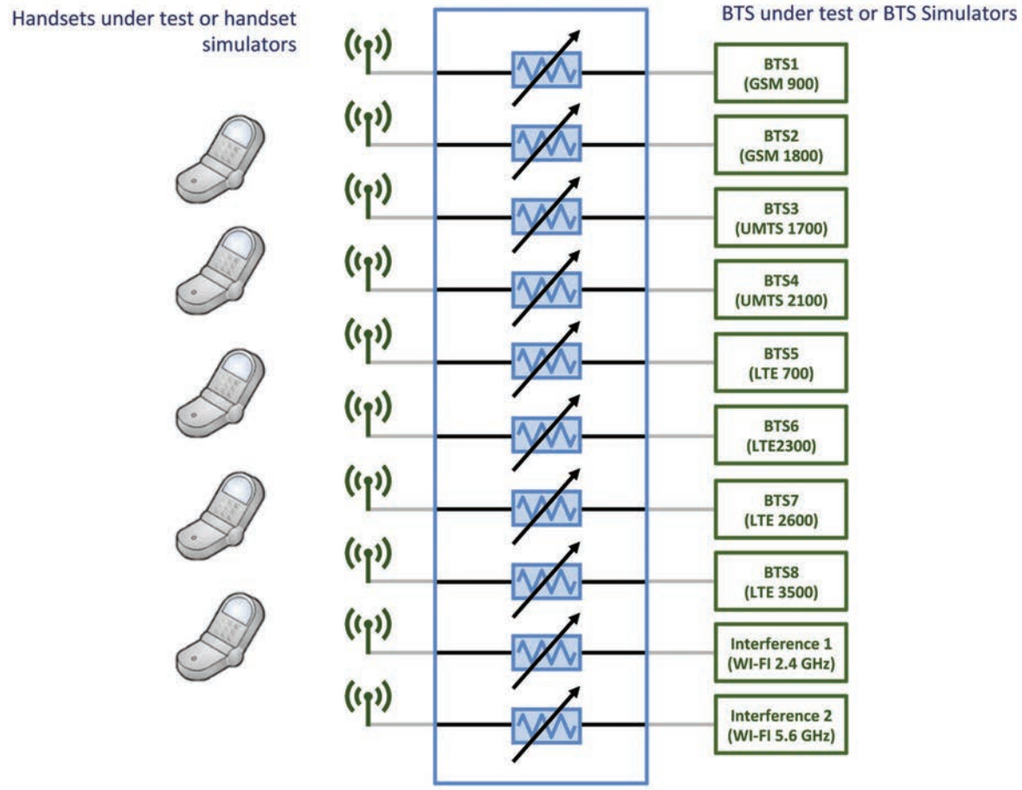
BUILD YOUR SYSTEM

Base-Station (BTS) Testing & Hand-Over Simulation

A common difficulty for manufacturers of wireless handsets and BTS is simulation of real world conditions in a production lab or test facility. In particular, the path loss between the handset and BTS during normal use is highly variable and dependant on a number of factors, including proximity of the handset to the BTS and the presence of obstacles (for example buildings and trees). It is important to be able to replicate these conditions in order to verify the practical sensitivity of the receivers and the ability of the devices to be able to pass from one BTS to the next, without dropping calls.

Mini-Circuits' programmable attenuators offer up to 110 dB attenuation range from 1 to 6000 MHz which makes them ideally suited to simulating the path loss in a wireless communications test system.

The modular ZTM series allows up to 12 programmable attenuators to be integrated into a 19-inch rack chassis with a single power supply and control interface, both USB for local control and Ethernet for remote control over a network.



ZTM Series configured with programmable attenuators

Integrating these programmable attenuators between each BTS and antenna allows the signal strength to be independently varied, opening up many real world test scenarios:

- Simulate the handset and BTS operating in close proximity by setting attenuation to 0 dB.
- Simulate a distance of several kilometers between the handset and BTS by setting maximum attenuation.
- Simulate handset movement between BTS by increasing attenuation to the original BTS or reducing attenuation to the next BTS.
- Simulate performance in the presence of interfering signals by increasing attenuation on the desired BTS paths and reducing loss on the interference paths (a Wi-Fi signal for example).

Shared Test Station for a Multi-User Environment

The ability to communicate over Ethernet and address each component on the front panel independently makes the ZTM Series an extremely flexible test system, well suited to multiple simultaneous users and test requirements.

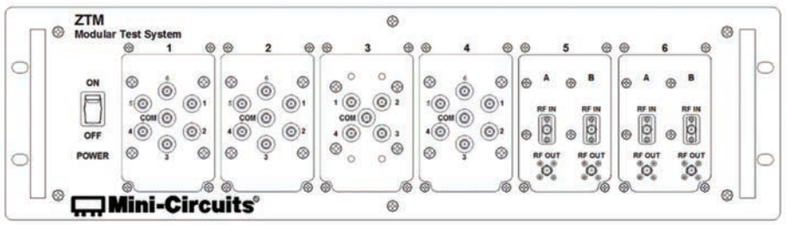
Commands and queries can be sent in the below format over an Ethernet connection using HTTP. In the simplest case the commands can be sent to the ZTM Series by entering them in the address bar of any standard Internet browser (for example Google Chrome® or Internet Explorer®); HTTP is also well supported in most programming environments, allowing custom control applications to be written.

Command/query format:

- *http://[IP_ADDRESS]/:[COMPONENT]:[WINDOW]:[COMMAND]:[VALUE]*
- *http://[IP_ADDRESS]/:[COMPONENT]:[WINDOW]:[QUERY]?*

The user-specified example configuration below was configured with one SP4T, three SP6Ts and four programmable attenuators so the *[COMPONENT]* commands needed are:

- *SP4T* to control an SP4T switch
- *SP6T* to control an SP6T switch
- *RUDAT* to control a programmable attenuator



The *[WINDOW]* parameter refers to the location of the component on the ZTM Series' front panel. The above example has the SP4T switches in window 3; the SP6T switches in windows 1, 2 and 4; and the programmable attenuators in windows 5A, 5B, 6A and 6B.

The *[COMMAND]* or *[QUERY]* parameter is the action to take, for example:

ATT:70.75	sets the attenuation of the specified device to 70.75 dB
ATT?	reads the attenuation of the specified device
STATE:3	sets the specified switch to state 3 (Com port connected to port 3)
STATE?	reads the state of the specified switch

This modular construction and ability to address each component individually allows multiple users to build their test systems around different front panel components in the ZTM Series and use them simultaneously.

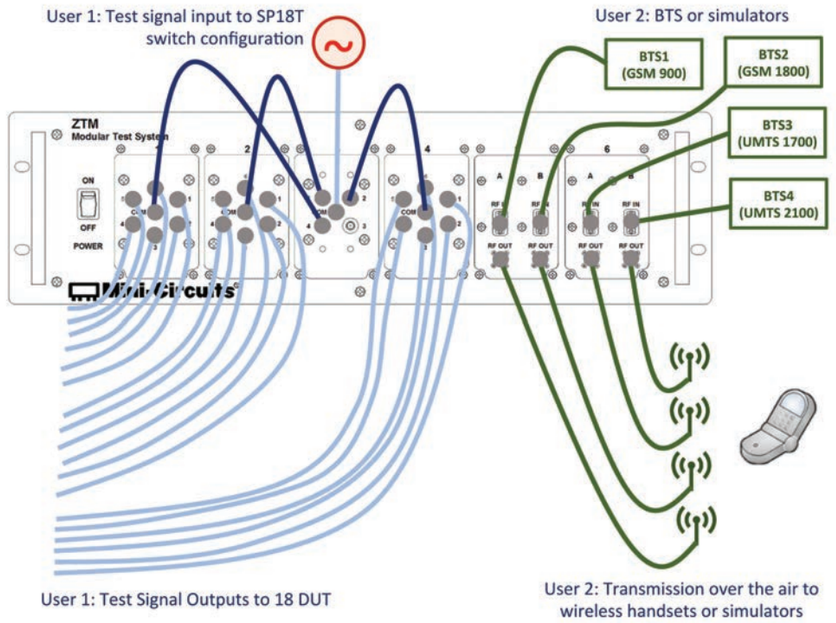
In an example test facility, user 1 may require the switch components in order to switch a test signal to multiple receivers under test. Assuming the ZTM Series has been configured with IP address 192.168.9.100, the commands required to set the switches would be:

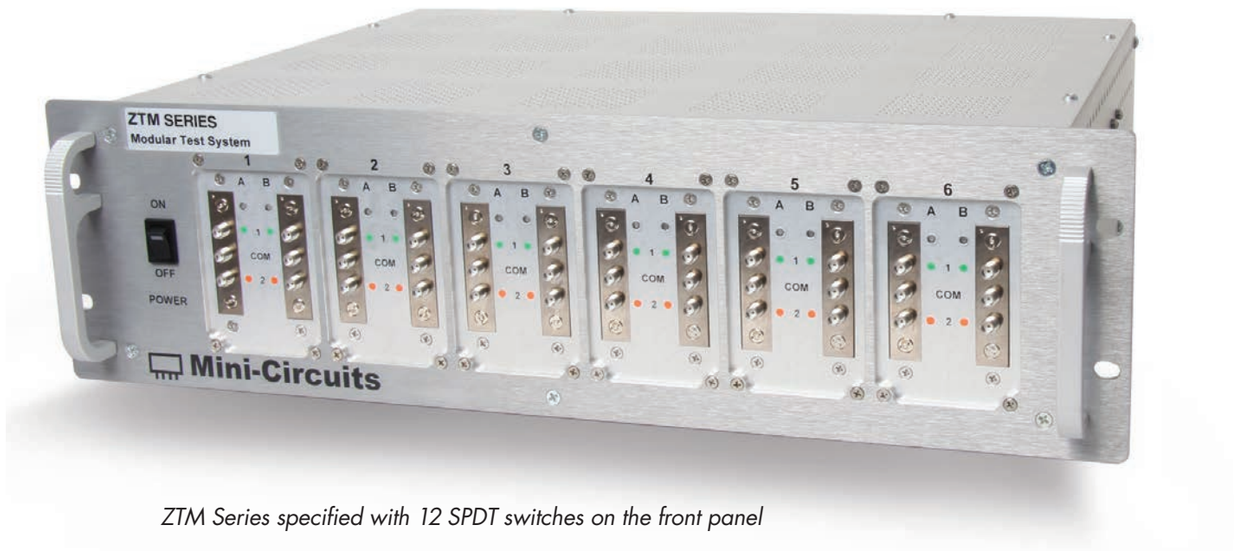
- *http://192.168.9.100/:SP6T:1:STATE:x*
- *http://192.168.9.100/:SP6T:2:STATE:x*
- *http://192.168.9.100/:SP4T:3:STATE:x*
- *http://192.168.9.100/:SP6T:4:STATE:x*

User 2 may require the programmable attenuators in a signal-fading experiment, varying the transmission loss between multiple base-stations and handsets. The commands required for attenuator control would be:

- *http://192.168.9.100/:RUDAT:5A:ATT:x*
- *http://192.168.9.100/:RUDAT:5B:ATT:x*
- *http://192.168.9.100/:RUDAT:6A:ATT:x*
- *http://192.168.9.100/:RUDAT:6B:ATT:x*

The control interface of the ZTM Series will accept both sets of commands simultaneously (processing in the order that they are received) so that both test set-ups can be run side by side. As long as user 1 only addresses commands to windows 1 to 4 and user 2 only addresses commands to windows 5 to 6 there is no danger of interrupting the components located in any other window.





ZTM Series specified with 12 SPDT switches on the front panel

ZTM Series

High Speed Signal Switching

Mini-Circuits' ZTM Series is tailor-made for applications requiring high speed signal switching between a large number of DUTs. The key advantages of the ZTM Series in this respect are:

1. Large number of switch components integrated into a single package:
   1. Up to 12 SPDT switches
   2. Up to 6 SP4T switches
   3. Up to 6 SP6T switches
2. Extended lifetime with regular servicing of high reliability, mechanical switches; up to 100 million cycles per switch.
3. Efficient control interface speeds up switching time by allowing multiple switches to be set simultaneously.

Commands and queries can be sent over an Ethernet connection using HTTP or via a local USB connection. The command required to simultaneously set all twelve SPDTs in the above example is as below:

:SPDT:ALL:STATE:xxxxxxxxxxxx

Each "x" in the above command represents the state of an individual SPDT switch, with the left most character corresponding to switch 1A and the right most to switch 6B. The possible values for "x" are "1" (com connected to port 1) and "2" (com connected to port 2). A test scenario which requires the switches to be alternately set to state 1 and state 2 could therefore use the following switch command:

:SPDT:ALL:STATE:121212121212

In benchmarking tests, the ZTM Series controller connected via USB was able to receive the command and trigger the state of every single switch in as little as 5-10 ms from the point that the software issued the command. This includes the typical delay for communication over a USB connection which can be in the order of 2-3 ms. Since these are mechanical switches, the typical switching time from the control signal being applied to the RF connection being made has been characterized at 10-20 ms typically.

As a result, the ZTM Series is able to set 12 independent SPDT switches, including all software, communication and mechanical delays, within 15-30 ms.

This level of control efficiency, combined with the flexibility of the design and the extended lifetime makes the ZTM Series a highly capable system for all high volume automated test applications.

HPA-272+ 700 - 2700 MHz

High Power (100W) Rack Mount Amplifier

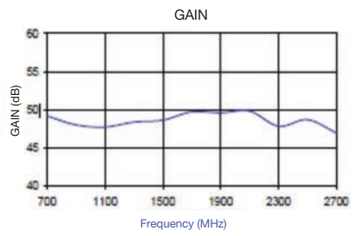
Functional Description

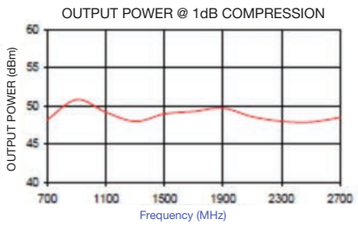
This rugged, high-power amplifier is capable of amplifying signals up to 100W across its entire operating bandwidth of 700 to 2700 MHz. It delivers 48 dB typical gain with ±1.7 dB gain flatness over the full frequency range, supporting a wide variety of high power test applications including EMI, reliability testing, RF stress testing, and more. The amplifier operates on a self-contained 110/220V 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	-	110/220	-
Power Consumption	W	-	531	-

HPA-272+ Curves



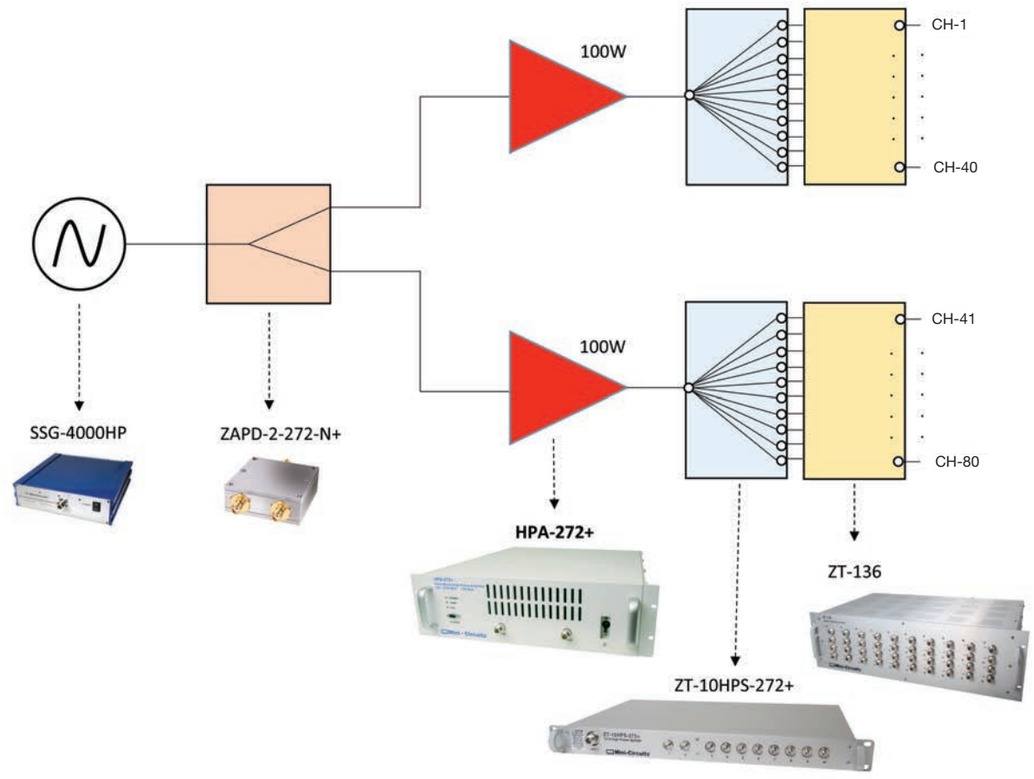


High Temperature Operating Life (HTOL) Testing

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-101 0.7-18 GHz
Amplifier with Switchable Outputs

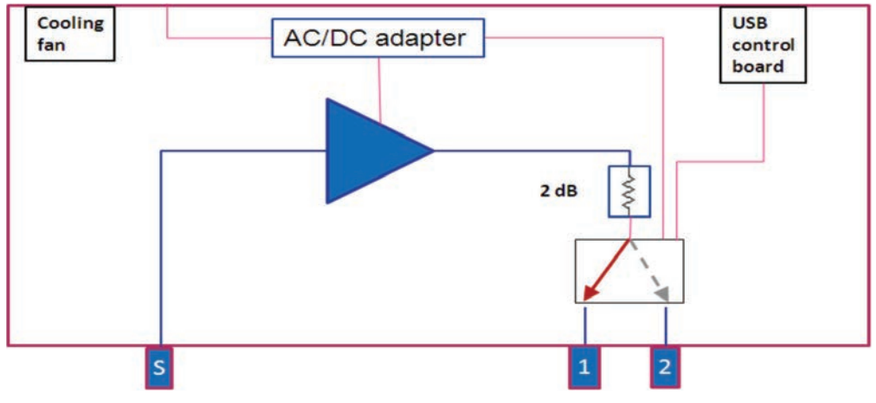
Functional Description

Housed in a space-efficient 1U rack, this design integrates a high performance amplifier operating over 0.7 – 18 GHz and a high-isolation absorptive SPDT switch. The ZT-101 offers a convenient solution to general test lab applications with dual switched outputs controlled via USB connection and user-friendly GUI software.

Electrical Performance

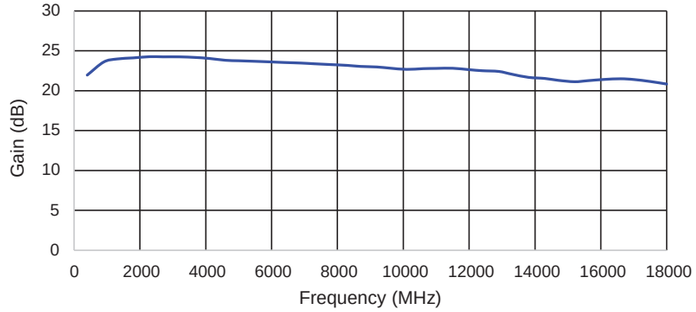
PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	GHz	0.7	-	18
Gain	dB	20	23	-
RF Input Power	dBm	-	-	-5
Output Flatness	dB	-	±2	-
Output P1dB	dBm	+18	+22	-
VSWR	:1	-	1.5	-
Switching Time, Out1 – Out2	ms	-	30	-
RF Isolation, Out1 – Out2	dB	-	65	-
RF Isolation, In – Inactive Output	dB	-	60	-
Supply Voltage	V	-	110/230	-

Functional Schematic

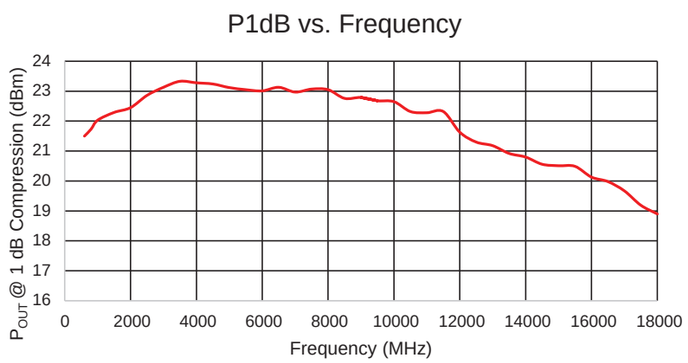


ZT-101 Curves

Gain vs. Frequency



P1dB vs. Frequency



ZT-102 0.8 - 2.5 GHz

High Power Amplifier with RF Sampling Port

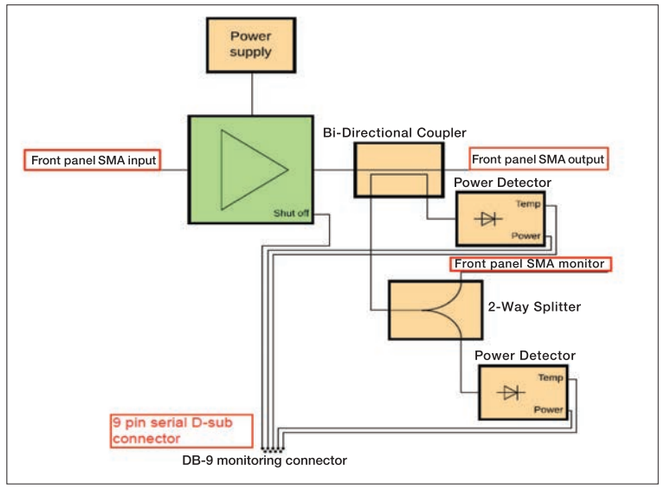
Functional Description

Housed in a compact 2U rack with three cooling fans, this high-power amplifier delivers up to 30W RF output over 0.8 – 2.5 GHz. An RF sampling port is provided for convenient signal monitoring, and the DB-9 panel mount connector allows the user to monitor forward and reverse signals as DC voltage as well as internal temperature.

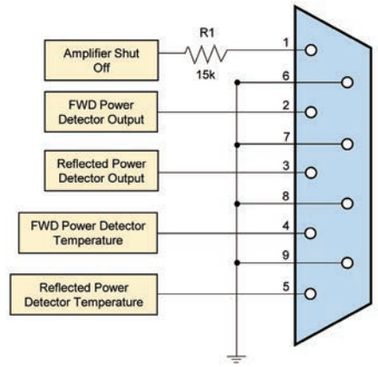
Electrical Performance

PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	MHz	800	-	2500
Output Power at P1dB RF_{OUT}	dBm	+41	+42	-
RF Input Power	dBm	-	-10	-6
Gain at RF_{OUT}	dB	-	48	-
Gain at Sampled RF_{OUT}	dBc	-	25	-
VSWR (IN)	:1	-	1.50	-
VSWR (OUT)	:1	-	1.30	-
Supply Voltage	V	-	110/220	-
AC Power	W	-	260	-

Functional Schematic

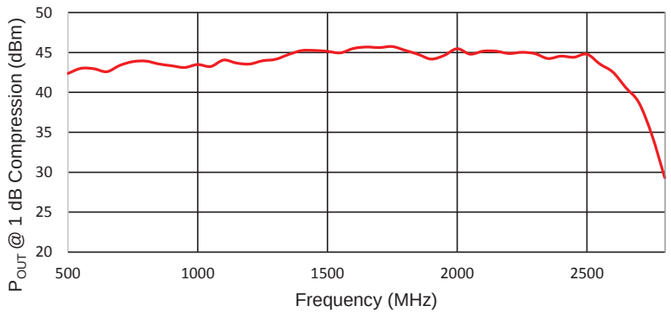


DB-9 Panel Mount Female Connector

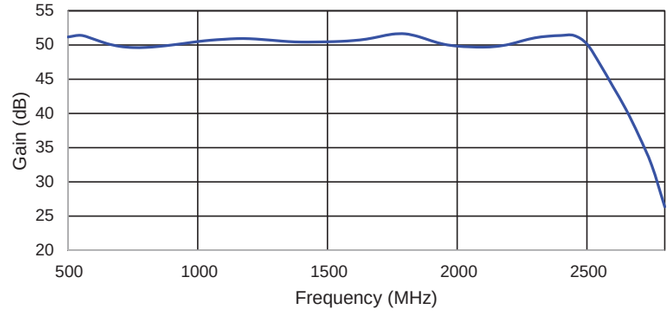


ZT-102 Curves

P1dB vs. Frequency



Gain vs. Frequency



HPG-13

800-1000 MHz

High Power (100W) Synthesized Signal Generator

Functional Description

Combining a synthesized signal generator with a high power amplifier, this 19-inch rack-mount unit is capable of generating continuous wave and pulse signals with adjustable frequency from 800 to 1000 MHz and adjustable output power from -20 to +50 dBm (100W). It provides frequency and power sweeping (up, down, and bi-directional) and hopping over frequencies, power levels, or both. Additional features include a Power Lock function providing automatic level control to within ±0.125 dB and a sampled RF output port with 30 dB attenuation, allowing easy monitoring of output signal level and providing a low power output. Other frequency bands available upon request.

Electrical Performance

PARAMETER	Unit	Min.	Typ.	Max.
Output Frequency Range	MHz	800	-	1000
Output Frequency Resolution (Step Size)	kHz	-	5	-
Output Power Range	dBm	-20	-	+50
Output Power Resolution (Step Size)	dB	-	0.25	-
Pulse Rise Time	ns	-	19.05	-
Pulse Width Resolution	µs	1.0	-	-
2nd Harmonic @ 40 dBm Pout	dBc	-	55	-
3rd Harmonic @ 40 dBm Pout	dBc	-	80	-
Non-Harmonic Spurious @ 40 dBm Pout	dBc	-	70	-
Supply Voltage	V	-	110	-

Daisy Chain up to 256 Output Ports

Popular for burn-in testing, the HPG-13 can be daisy chained with multiple 16-way, 100W splitter modules (ZT-16HPS-23) to provide up to 256 coherent RF channels. Supporting parallel testing of many devices simultaneously, this setup can save significant testing time and cost.

See page 64 for details on the ZT-16HPS-23 100W 16-way splitter matrix.

HTEST-5P 1-6000 MHz

5-Port Test Set for High-Throughput Production Testing

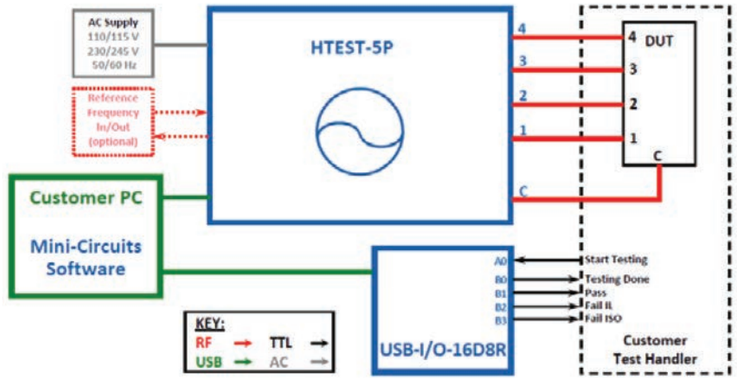
Functional Description

Mini-Circuits developed the HTEST-5P high-speed five-port test set to serve the need for low-cost, high-throughput, focused measurement capability, common in many production testing environments. This unit integrates a synthesized signal generator with switch matrices, power sensors, USB I/O control and special control software to communicate with an external robotic handler. This unit is one example of Mini-Circuits' ability to create a test solution tailored to a specific application within weeks and dramatically reduce test time by employing parallel testing through multiple, simultaneous test paths. This test set can deliver a test throughput of 3,750 units per hour, almost doubling test speed of the system into which it was built. Example shown has 5 ports. Higher port counts and different configurations available on request.

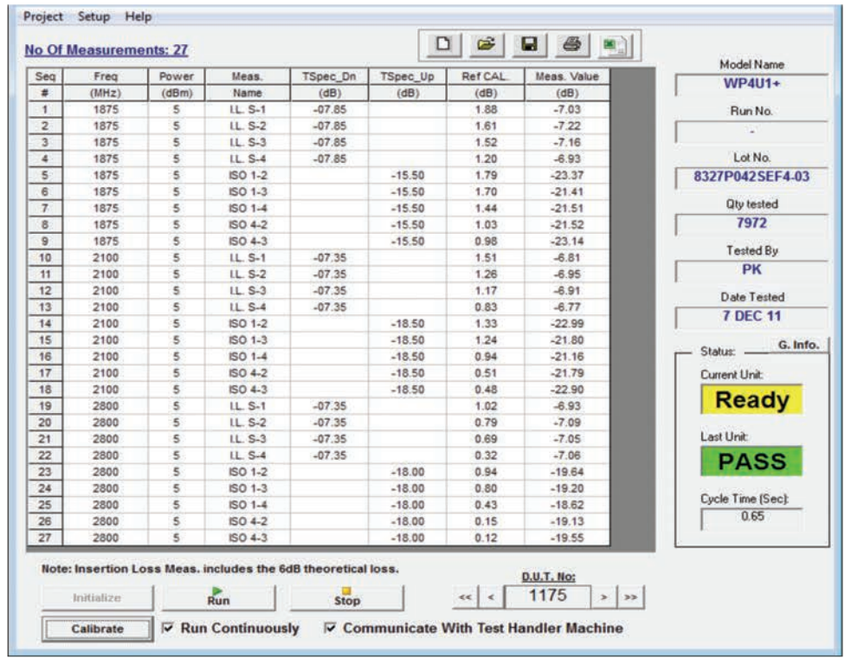
HTEST-5P Test Throughput for a 4-Way Power Splitter

Electrical Test Time (s)	Robotic Handling Time (s)	System Cycle Time (s)	Units Per Hour (#)
0.70	0.26	0.96	3750

Functional Schematic



HTEST-5P GUI Main Screen



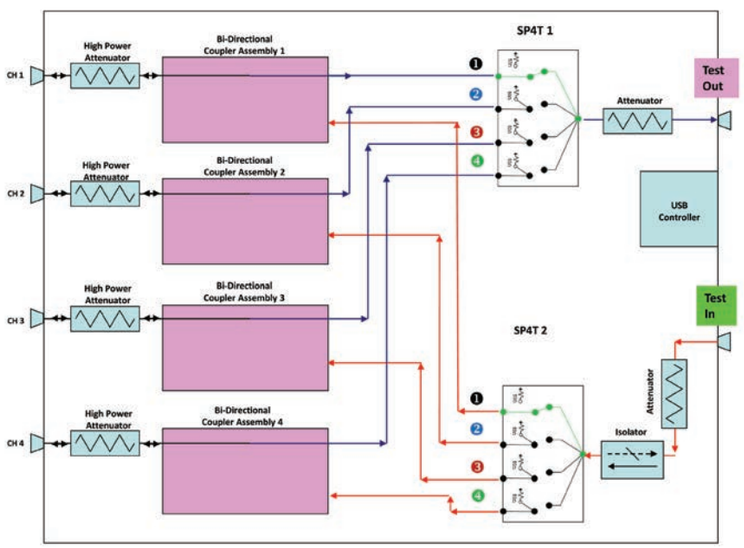
ZT-110 2000 - 3800 MHz

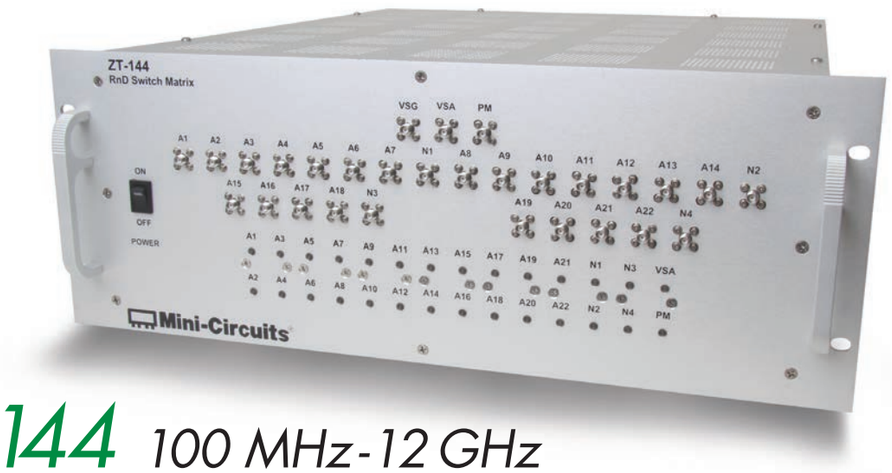
Remote Radio Head Tester

Functional Description

Housed in a 4U, 19-inch standard test rack, this high performance switch matrix is designed to handle 40W of transmit power from an RRH and simultaneously work with the receive path of another channel. This configuration maximizes production testing throughput and eliminates the need to turn off the high Tx path power during channel swapping. A built-in isolator provides additional signal isolation between the Tx and Rx Paths. Thisdesign operates over 2000 – 3800 MHz. Other frequency bands are available upon request.

Functional Schematic





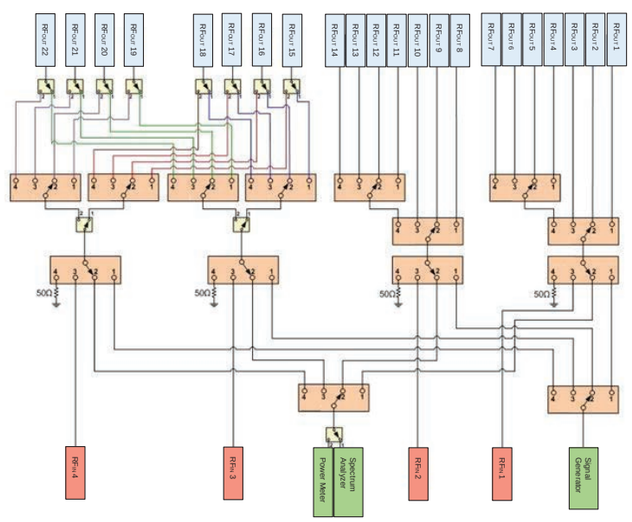
ZT-144 100 MHz - 12 GHz

Bi-Directional RF Test Matrix for R&D

Functional Description

The ZT-144 is a specially designed RF matrix for wireless testing applications requiring high-throughput capability. This smart design integrates a complex configuration of high isolation, extra-long life electromechanical switches to manage signal paths for multiple DUTs. With smart control logic embedded in the firmware, the LED matrix on the front panel automatically detects and displays the chosen active signal path, especially helpful for research and development applications. For the user's convenience, we also provide our custom designed GUI control software, allowing the user to manage testing with the click of a mouse.

Functional Schematic



ZT-169/170/170PS 0.7-6 GHz

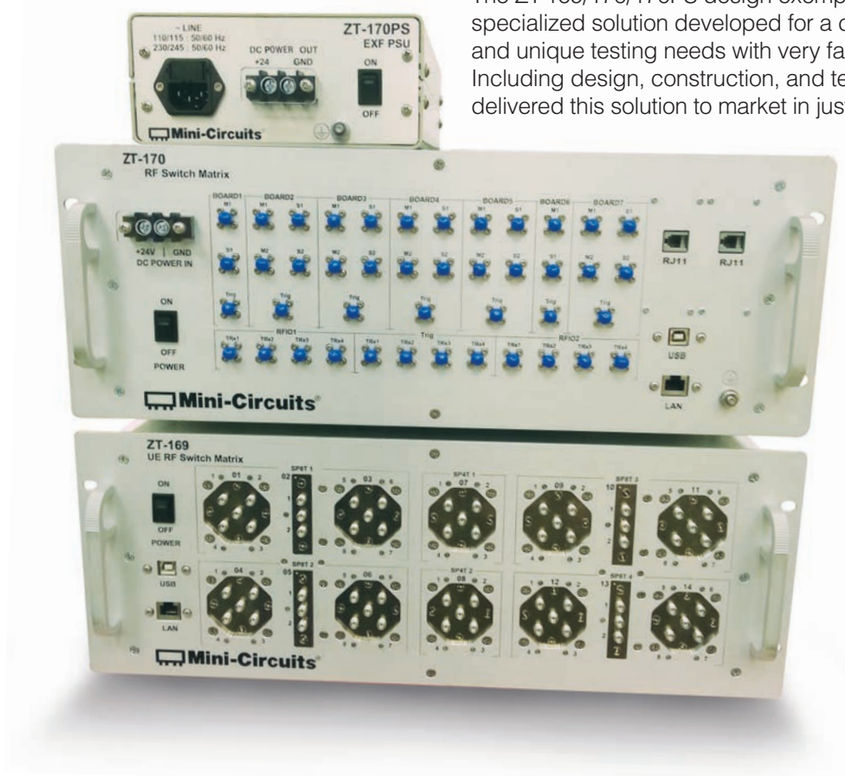
Multi-Module System for Parallel Testing

Functional Description

Specially designed to test multiple unique DUTs in parallel, this advanced test station consists of three interconnected modules, including two complex switch matrices and an external power source. Controlled remotely via USB or Ethernet, this system allows a user to manage multiple test paths using Mini-Circuits' intuitive GUI interface, greatly accelerating test throughput.

This super-compact intergrated system contains over 60 RF discrete components including high-isolation, long-life mechanical switches, low-loss power dividers, and multiple TTL fan-out modules connected with Mini-Circuits' Hand-Flex™ interconnect cables and built into two 4U, 19" wide, 14" deep chassis with a rack mountable tray attachment for the auxiliary power supply.

The ZT-169/170/170PS design exemplifies a highly specialized solution developed for a customer's complex and unique testing needs with very fast turnaround time. Including design, construction, and testing, Mini-Circuits delivered this solution to market in just 5 weeks!



ZT-123 350 MHz-6 GHz

LTE Chipset Tester

Functional Decription

Mini-Circuits' ZT-123 is a complex test laboratory signal distribution system specially designed to increase throughput of chipset testing. It routes multiple stimuli to up to 8 DUTs in parallel while simultaneously sending DUT outputs to signal analyzers for a variety of tests. This system enables tremendous test coverage during complex characterization projects by automating and multiplexing a modern test lab.

The ZT-123 contains over 200 key RF components including high-isolation electromechanical switches, low-loss power dividers, and flat-gain amplifiers all connected with over 200 Mini-Circuits Handflex™ interconnect cables. The system is controlled by a sophisticated control board with firmware allowing easy, intuitive management of complex signal traffic.

This assembly is designed into three interconnected 4U 19-inch rack cases, allowing layout flexibility and easy maintenance.

Model ZT-114

ZT-114 10-1000 MHz

16/32-Way Signal Distribution Assembly

Functional Description

This signal distribution assembly is specially designed for high-throughput telecommunications testing. Housed in a 4U, 19-inch rack-mount case, it is capable of switching 16 Rx and 16 Tx paths simultaneously. All 16 Rx paths are fed simultaneously from a common, customer-supplied input signal source. Any Rx path can be independently (or in any combination) "turned off" from the Rx paths to the DUT via high-isolation mechanical switches. 16 Tx signals are received by the ZT-114 and "switched" to one of two common output paths. Additionally, multiple units can be cascaded in a Daisy-Chain configuration to support up to 12x16 DUTs. All connections are made via the rear panel making the ZT-114 a clean solution for use in complex test labotatories.

Electrical Performance

PARAMETER	SPECIFICATIONS				
	Unit	Min.	Typ.	Max.	Test Conditions
Operating Frequency	MHz	10	-	1000	-
Typical Rx Path Insertion Loss	dB	-	18	-	-
Typical Tx Path Insertion Loss	dB	-	2	-	-
Typical Return Loss	dB	-15	-	-	-
Typical Isolation	dB	130	-	-	All Rx switches OFF (to term)
		85	-	-	Any one Rx switch ON with all other Rx switches OFF
		20	-	-	More than one or ALL Rx switches ON
Supply Voltage	V	-	80/240	-	-
Control Interface	USB Standard. Available with Ethernet-TCP/IP supporting HTTP and Telnet network protocols.				

Model ZT-141

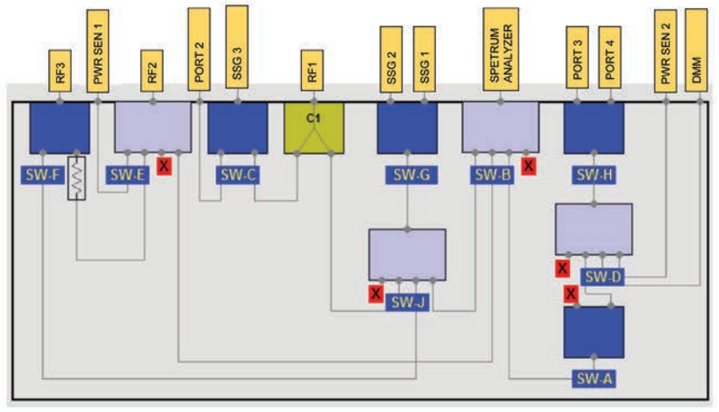
ZT-141 2-8 GHz

Signal Distribution Assembly for RF Noise Characterization

Functional Description

The ZT-141 is specially designed to improve efficiency in RF noise characterization testing. With a sophisticated matrix of Mini-Circuits high-isolation, low-loss mechanical switches, this structure provides a stable and repeatable RF environment, critical for RF noise characterization. Housed in a compact 19-inch, 2U rack, this unit comes standard with both USB and Ethernet (HTTP and Telnet) control interfaces, making remote test management easy and efficient. 2-18 GHz frequency range available on request.

Functional Schematic



ZT-155 100 MHz - 18 GHz

8 Channel Switch Matrix for Amplifier Testing

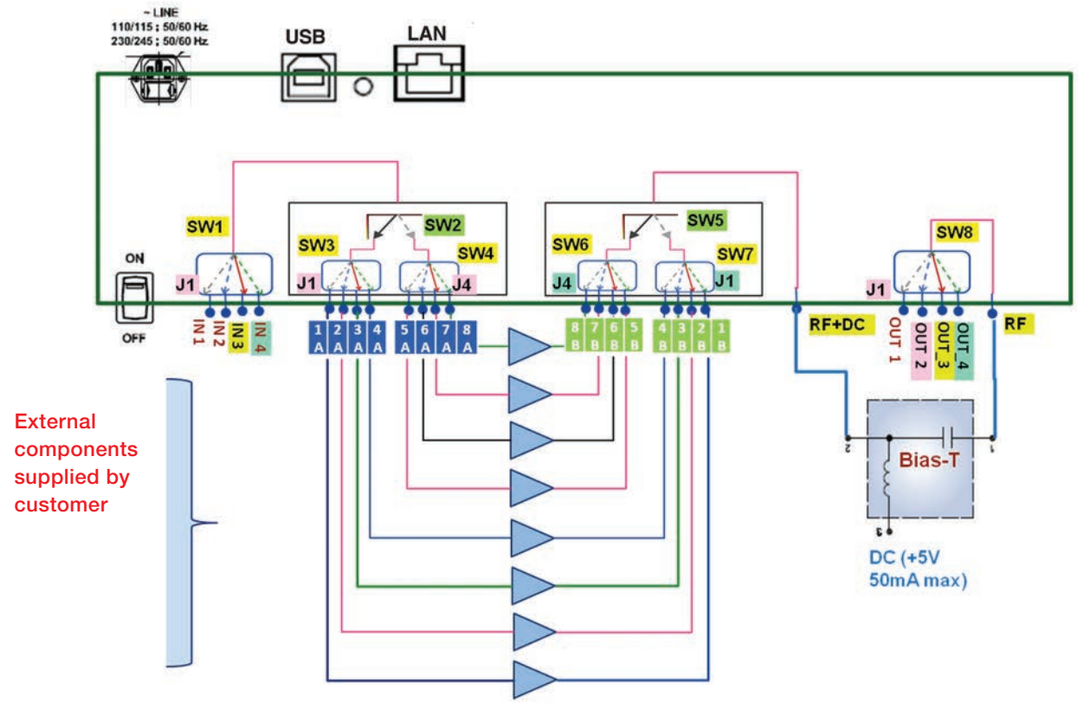
Functional Description

ZT-155 houses a pair of 4 by 8 switch matrices, arranged for the specialized requirements of amplifier production testing. The input 4 to 8 matrix allows multiple test signals to be routed through any of the 8 amplifiers under test, while the output 8 to 4 matrix allows automated switching between multiple test scenarios. Additionally, the output switch matrix includes an external “jumper” connection where a DC bias signal can be inserted through an external bias-tee.

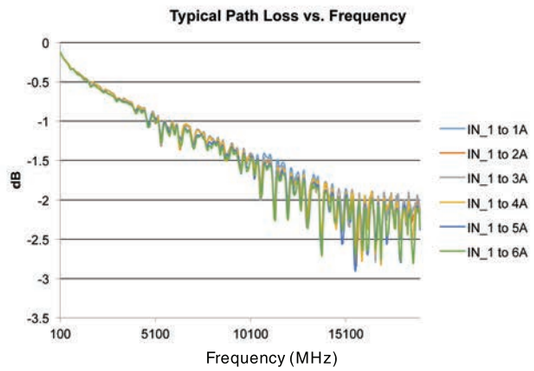
Electrical Performance

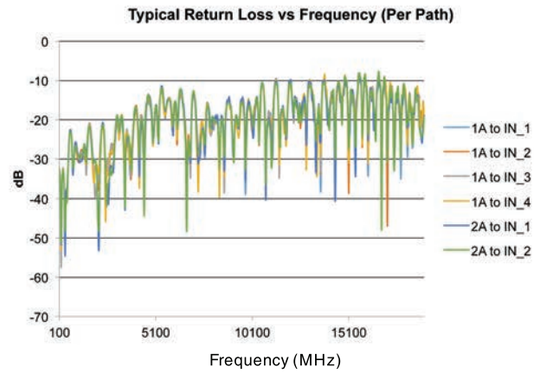
PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	GHz	0.1	-	18
Insertion Loss (per 4 by 8 path)	dB	-	5	-
RF Input Power	dBm	-	-	23
Return Loss	dB	-	20	-
DC Input	-	-	-	5V, 50 mA

Functional Schematic



ZT-155 Curves





Rear Panel

ZT-162

800 MHz - 13 GHz

24 port Bi-directional Switch Matrix for Automated Production Test

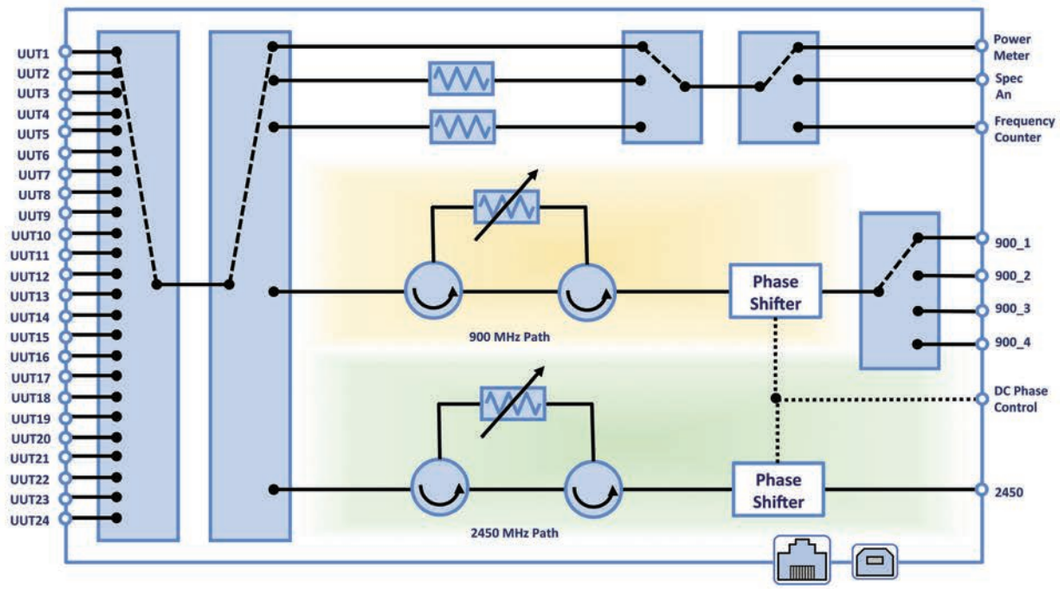
Functional Description

This smart switch matrix allows for a broad spectrum of automated production tests of 24 separate DUTs. In transmit mode, DUTs' signal can be routed to frequency counter, power meter and spectrum analyzer. In receive mode, various standard test signals may be sent through frequency selective paths with variable loss to allow for testing of signal fading and sensitivity. The standard configuration is targeted at RFID transceiver testing with 900 MHz and 2450 MHz paths but alternate frequency plans can be accommodated on request.

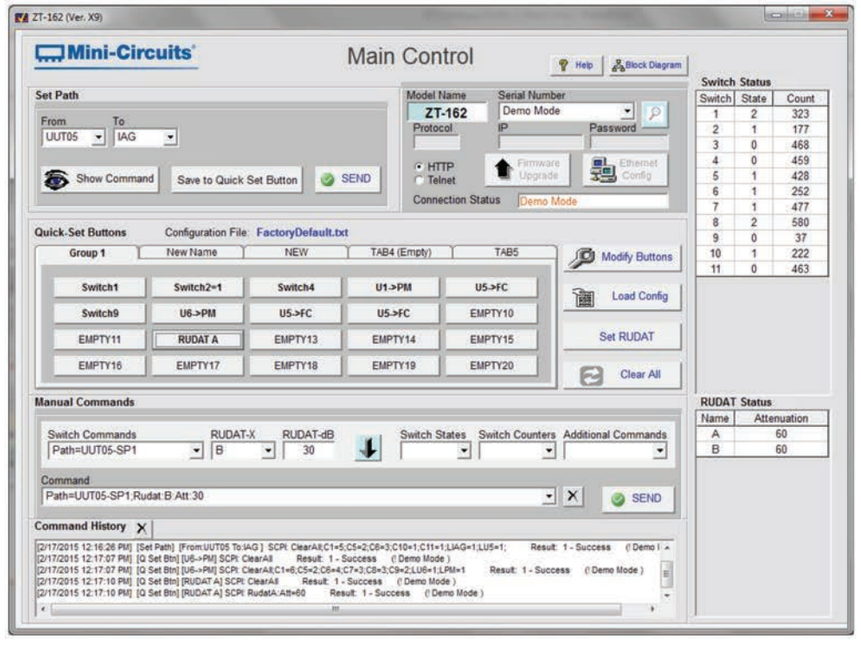
Electrical Performance

PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Broad-band Paths	GHz	0.8	-	13
Low Band Path	MHz	800	915	1000
High Band Path	MHz	2400	2450	2500
Return Loss	dB	-	12	-

Functional Schematic



ZT-162 Graphical User Interface



ZT-100 DC - 8.5 GHz

2 x10 Switch Matrix/VNA Port Extender

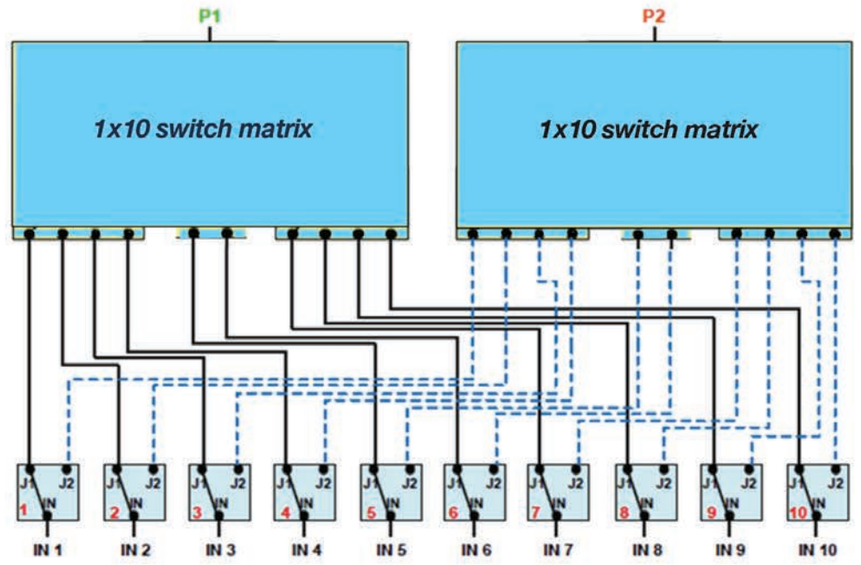
Functional Description

With crossbar configuration, this switch matrix can connect two input ports to any two of the ten output ports with just the push of a button on our intuitive GUI screen. This unit makes it possible to test multiple devices in parallel, improving testing efficiency and throughput.

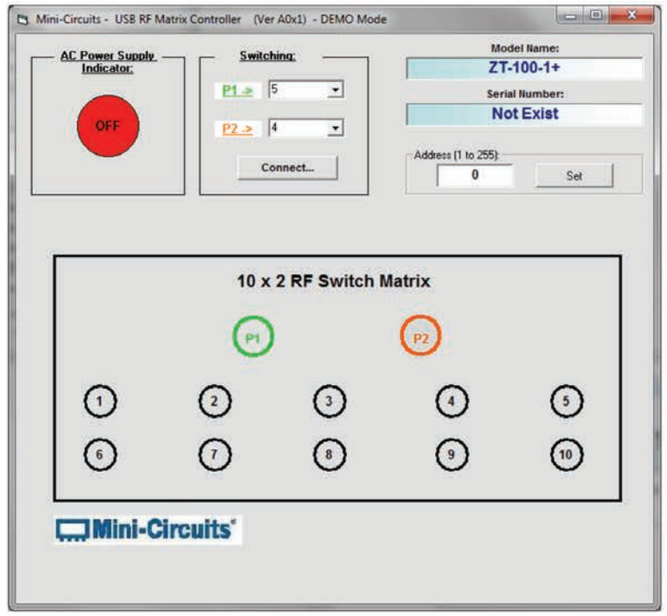
Electrical Performance

PARAMETER	UNIT	TYPICAL PERFORMANCE
Operating Frequency	GHz	DC – 8.5
Insertion Loss	dB	7.5
Return Loss	dB	20
Isolation	dB	95
AC Supply	V	110/220
Supply Current	A	10 (max.)
Control Interface	USB Standard. Available with Ethernet-TCP/IP supporting HTTP and Telnet network protocols.	

Functional Schematic



ZT-100 GUI Main Screen



ZT-106 DC-18 GHz

Dual SPDT Switch Matrix with ±48V$_{DC}$ Input

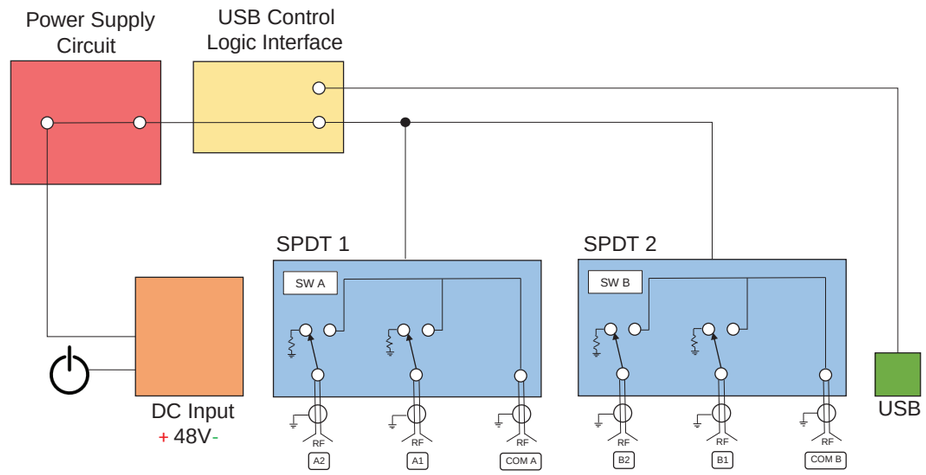
Functional Description

This dual SPDT switch matrix is specially designed for environments where only ±48V supply is available. Mini-Circuits can provide multiple switch configurations in a single 19” test rack to support testing multiple DUTs or multiple input and output structures.

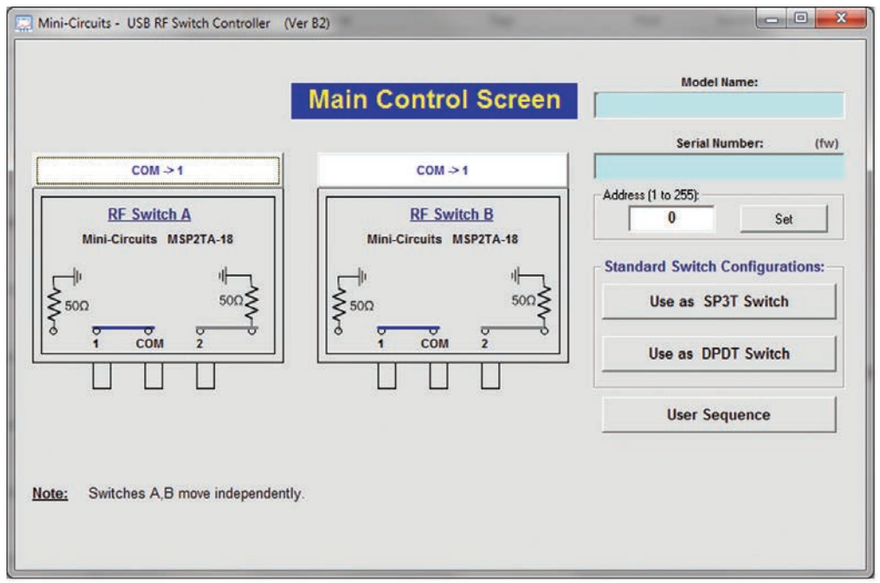
Electrical Performance

PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	GHz	DC	-	18
Insertion Loss	dB	-	0.2	0.3
Isolation	dB	72	89	-
VSWR	:1	-	1.15	1.3
DC Supply	V	-	±48	-
Supply Current	A	-	0.4	-
Control Interface	CONNECTION TYPE USB Standard. Available with Ethernet-TCP/IP supporting HTTP and Telnet network protocols.			

Functional Schematic



ZT-106 GUI Main Screen



ZT-116 600-3000 MHz

Antenna Distribution Matrix with Push Button Control

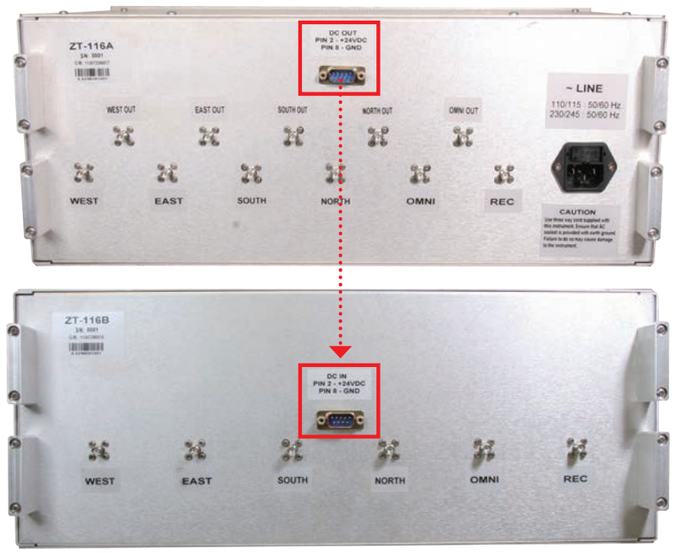
Functional Description

This master antenna box makes engineering evaluation and production testing very efficient by avoiding manual signal routing by cable swapping. Smart push-button control allows the user to switch in signal from various antennas connected through the rear panel to the receivers under test via multiple output channels through the front panel. This design can be used as the master equipment providing +24 VDC power and antenna outputs to a 2nd slave device. Other frequency ranges are available, and remote control via USB and Ethernet can be incorporated upon request.

Electrical Performance

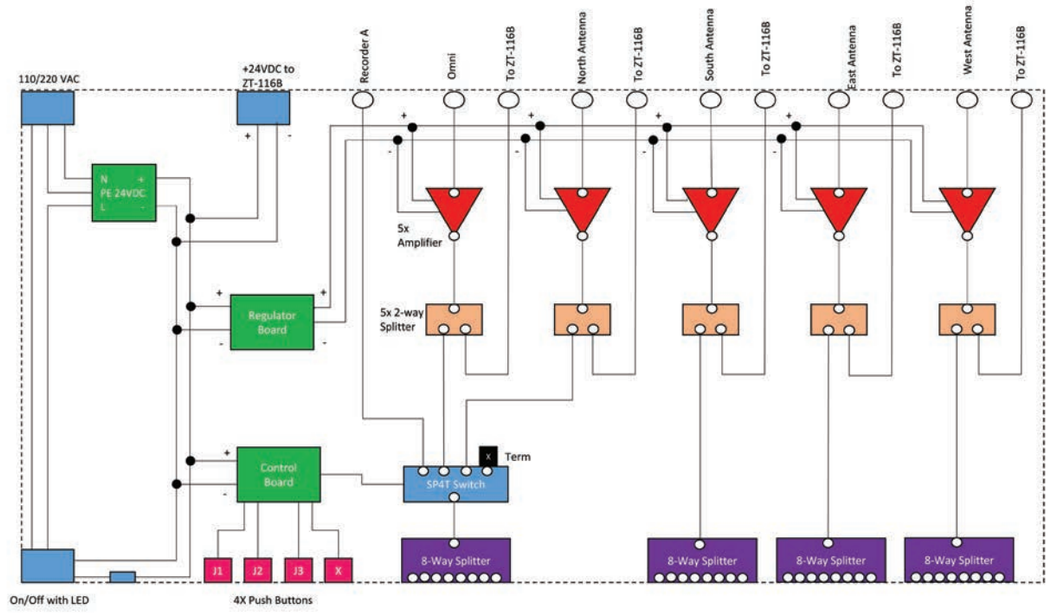
PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	MHz	600	-	3000
Total Path Gain @ 600 MHz	dB	-	7 dB	-
Total Path Gain @ 3000 MHz	dB	-	2 dB	-
Supply Voltage	V	-	110/230	-

***ZT-116A** / Master Box (Rear Panel)*



***ZT-116B** / Slave Box (Rear Panel)*

ZT-116 Functional Schematic



ZT-122 2-18 GHz

6 Channel RF Signal Distribution Matrix with Push-Button Control

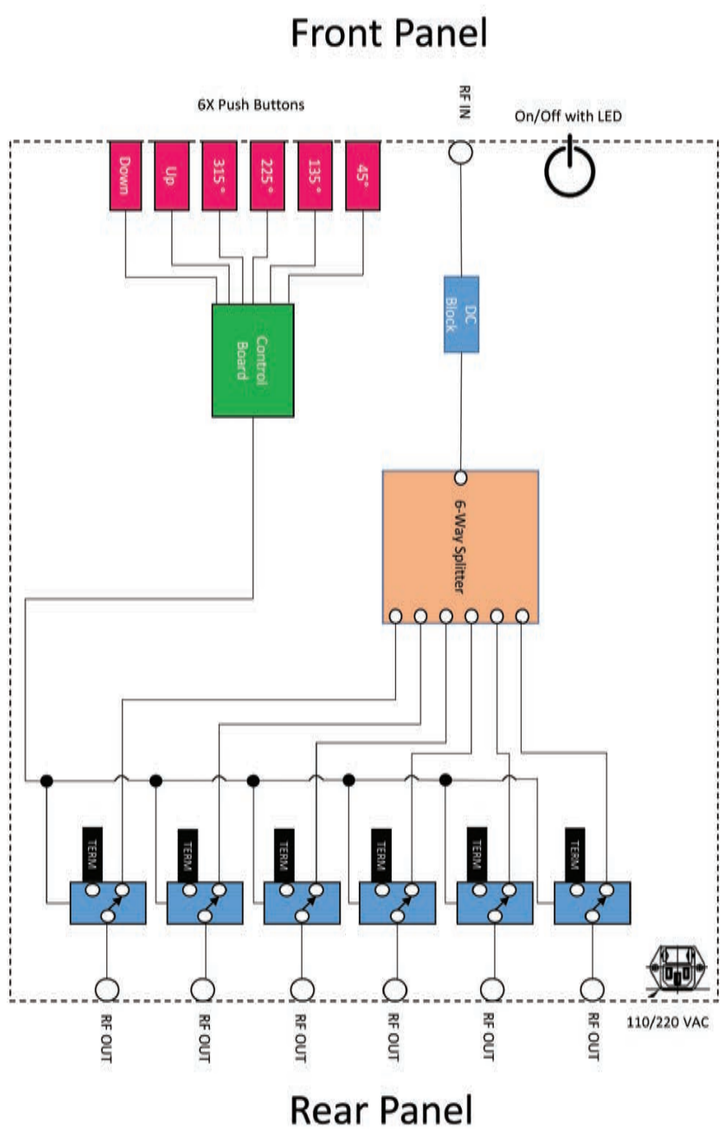
Functional Description

For test requirements where a test tone needs to be directed to one or more outputs simultaneously, the ZT-122 signal distribution matrix provides flexibility with six push-button switch controls on the front panel for change-on-the-fly situations. Operation over 2-18 GHz is standard. Output connector types can be chosen from TNC, SMA, and type N.

Electrical Performance

PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	GHz	2	-	18
Total Path Loss	dB	-	16	-
VSWR	:1	-	2.0	-
RF Input Power	dBm	-	-	+20
Supply Voltage	V	-	110/230	-

ZT-122 Functional Schematic



This design allows the user to send the test signal to up to six phased array antennas in any combination with the push of a button. Each path can be individually controlled by push buttons on the front panel. High-isolation electromechanical switches used in this design (85 dB typical) provide excellent port-to-port isolation preventing signal leakage between channels.

Rear Panel

ZT-151 DC-18 GHz

Bypass Switch Matrix with 3 Transfer Switches

Functional Description

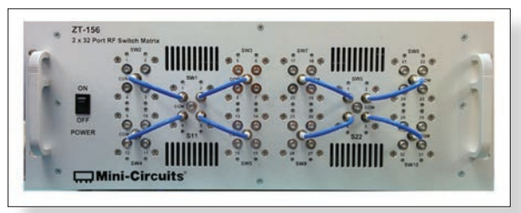
Equipped with 3 Mini-Circuits MTS-18XL+ transfer switches for RF connection through the rear panel, the ZT-151 functions as a bypass switch matrix for a 3x3 non-blocking signal distribution system. Conveniently controlled by USB or Ethernet, this unit operates on 110/240V supply and comes in a rugged 19” 3U aluminum housing.

ZT-156 DC-18 GHz

2 x 32 Port RF Switch Matrix

Functional Description

With 10 high isolation, extra-long life SP4T mechanical switches mounted in a 19" 4U rack, this unit can be used to perform as a dual 1x16 switch matrix with the use of Mini-Circuits handflex cables. When used with a 2-port network analyzer, the ZT-156 is ideal for measuring S-parameters of a 16 port device.



Accessories Required:

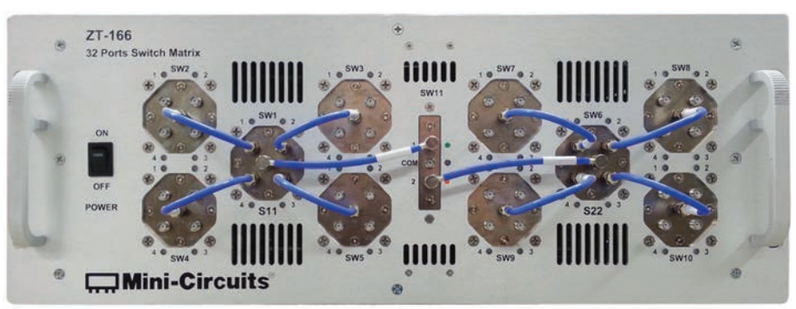
- Mini-Circuits 141-series DC-18 GHz low-loss handflex cables (6 and 7") for switch interconnection
- Mini-Circuits BW-series DC-26 GHz, 2W precision attenuators (3 and 6 dB) for impedance matching

ZT-166 DC-18 GHz

Re-Configurable 1x32 Switch Matrix

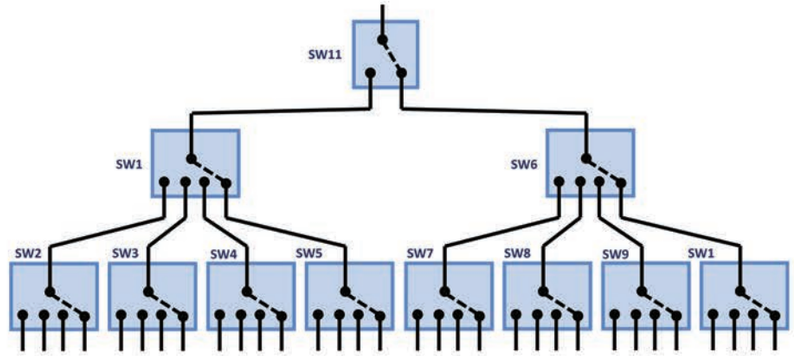
Functional Description

ZT-166 houses 10 independently controlled SP4T switches and a single SPDT switch on the front panel. Using the included software and with external connections made through Mini-Circuits' ***141 Series*** hand-flex cables as shown below, ZT-166 becomes an ultra wideband, 1 by 32 switch matrix. Alternatively, any switch can be controlled independently to accommodate a diverse range of test applications.

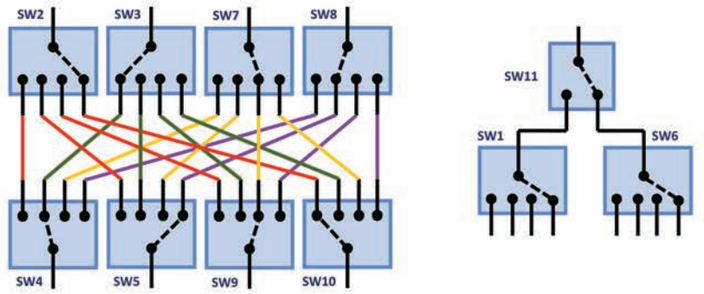


ZT-166 Cable Configuration

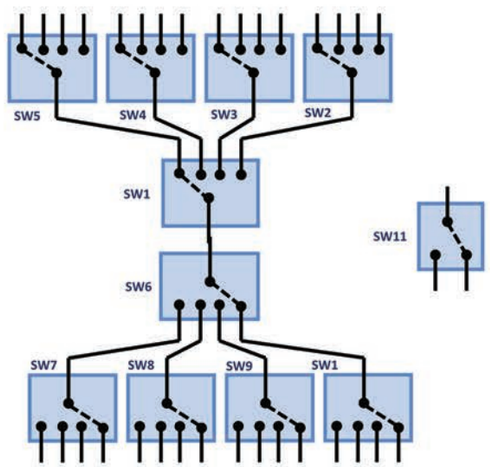
Configuration Options



Single Pole 32 Throw (SP32T) Switch



4 by 4, Non-Blocking Switch Matrix with a Spare SP8T



16 by 16, Blocking Switch Matrix with a Spare SPDT

ZT-169 DC-18 GHz

Front Panel Mounted Switch Matrix

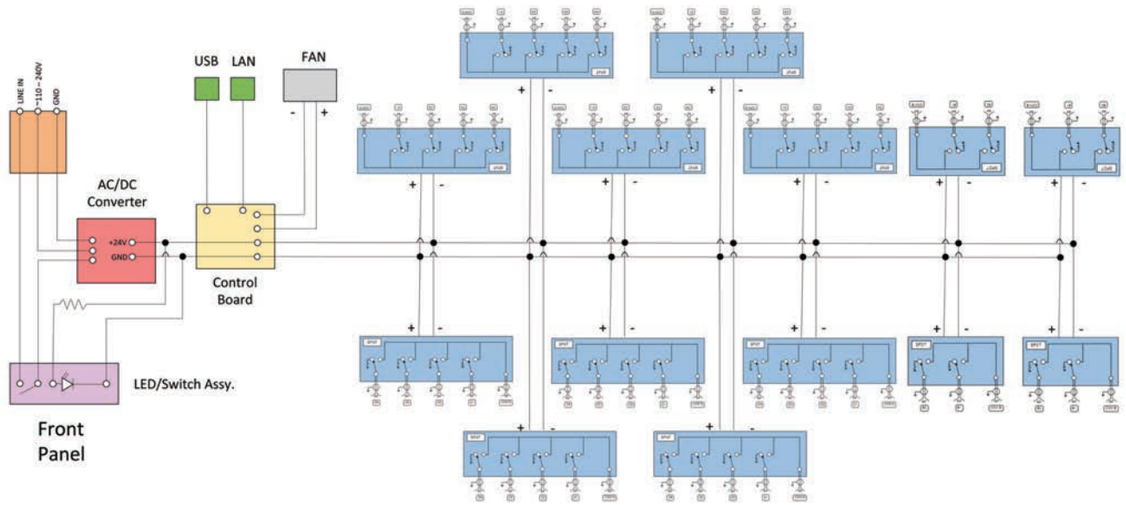
Functional Description

The ZT-169 provides a customized configuration of 4 SPDT switches and 10 SP4T switches mounted on the front panel of a 4U, 19" chassis, conveniently controlled via USB or Ethernet from the user's PC. This particular design was specially developed as part of a complex, three-module test set to manage complex signal routing traffic for automated testing of multiple unique DUTs in parallel.

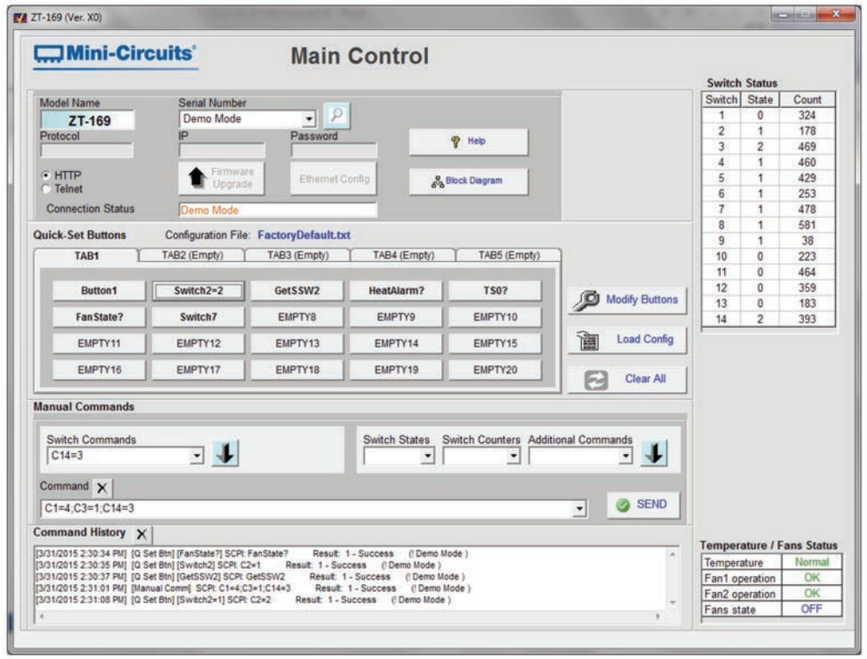
Electrical Performance

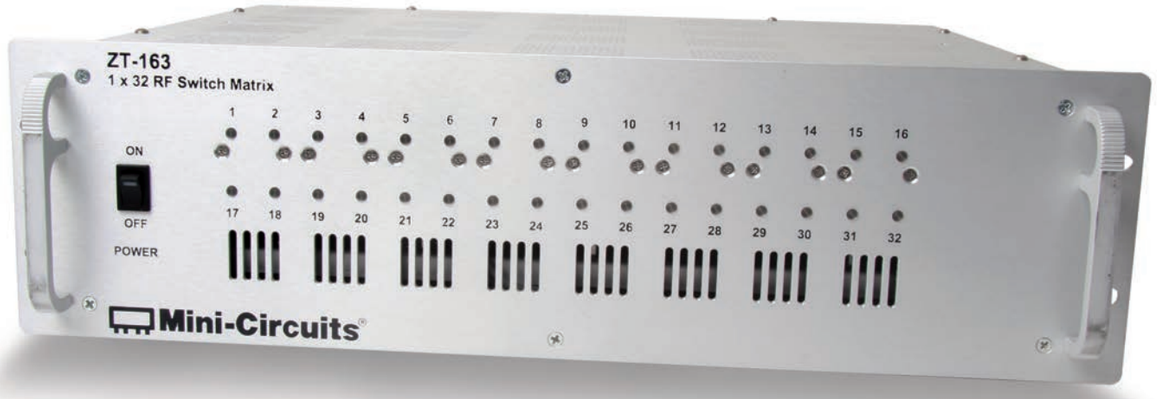
PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Frequency Range	GHz	DC	-	18
RF Power	dBm	-	+10	-
Insertion Loss (for all ports)	dB	-	0.5	-
Isolation between ports	dB	-	80	-

ZT-169 Functional Schematic



ZT-169 Main GUI





ZT-163 500 MHz - 8 GHz

1x32 Bi-Directional Switch Module

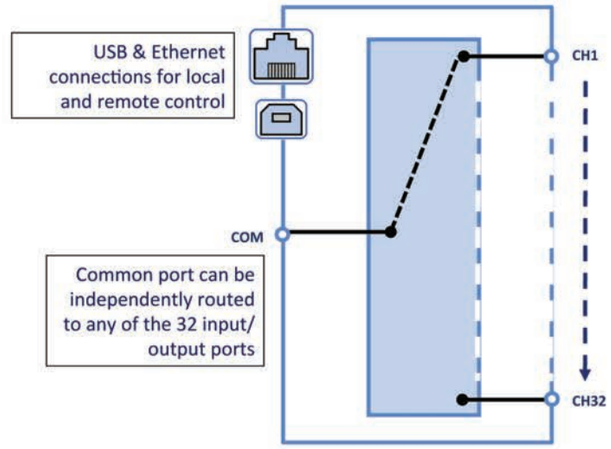
Functional Description

ZT-163 is a highly versatile RF switch, routing signals between a common port and 32 input/output ports. The system is fully self-contained with LED position indicators on the front panel and internal cooling for high-power applications. This switching rack supports a wide variety of automated test applications covering all common telecom frequency bands. 1 MHz to 12 GHz design also available.

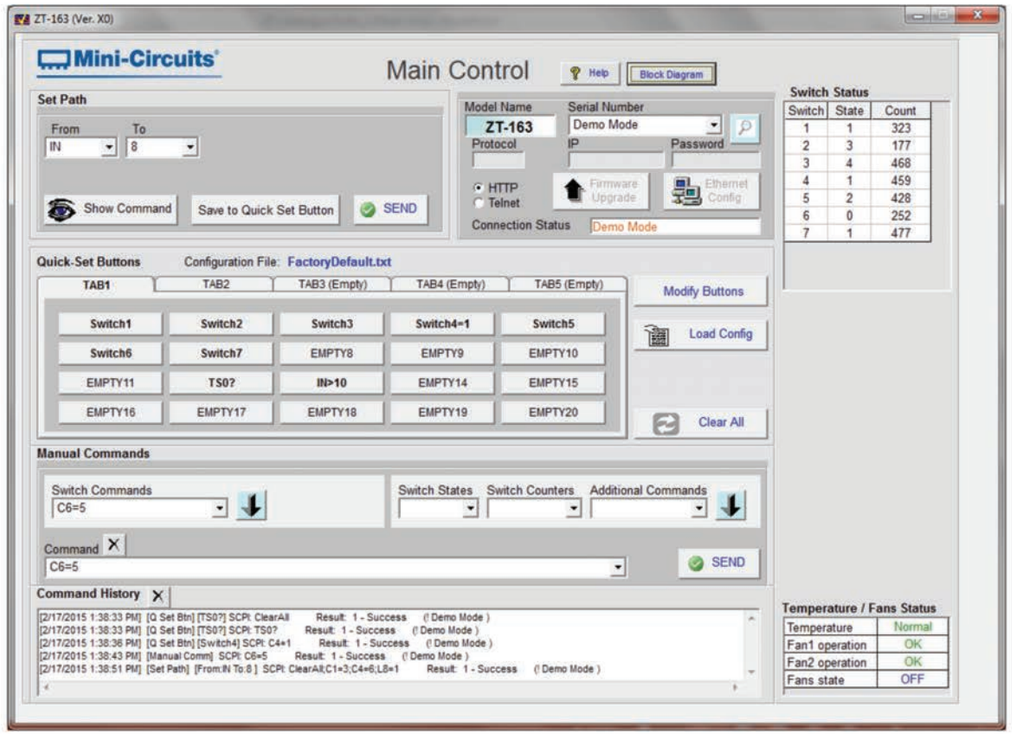
Electrical Performance

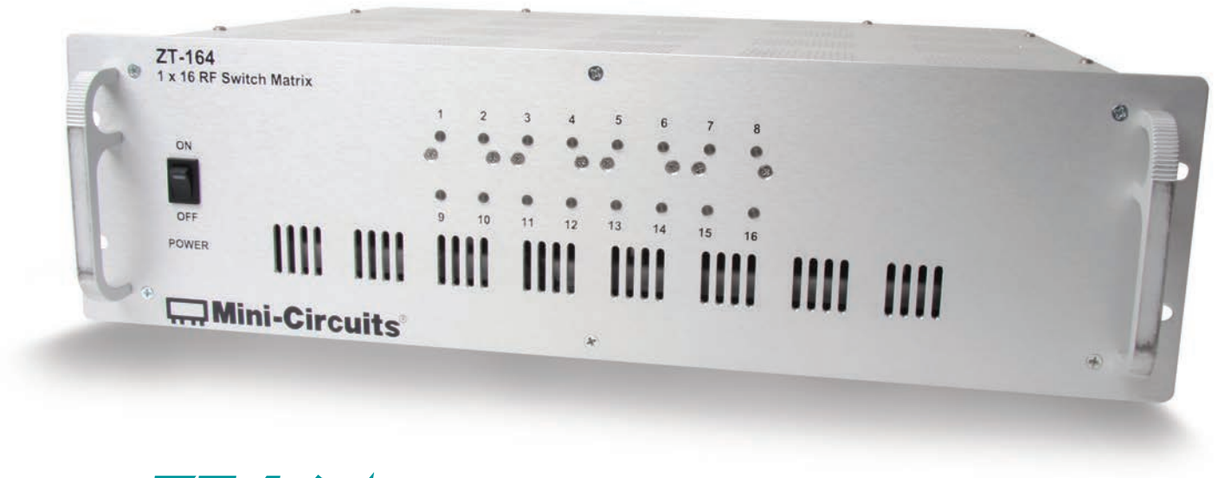
PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	MHz	500	-	8000
Insertion Loss	dB	-	2	-
Isolation	dB	-	80	-
Return Loss	dB	-	15	-

Functional Schematic ZT-163



ZT-163 GUI Main Screen





ZT-164 500 MHz - 8 GHz

1x16 Bi-Directional Switching Module

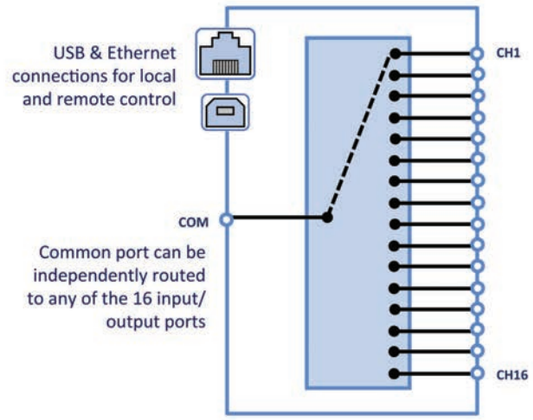
Functional Description

The ZT-164 RF switching module enables signal routing between a common port and 16 input/output ports. The system is fully self-contained with LED position indicators on the front panel and internal cooling for high-power applications. This unit covers all common telecoms frequency bands, lending itself to a wide variety of automated test applications. 1 MHz to 12 GHz design also available.

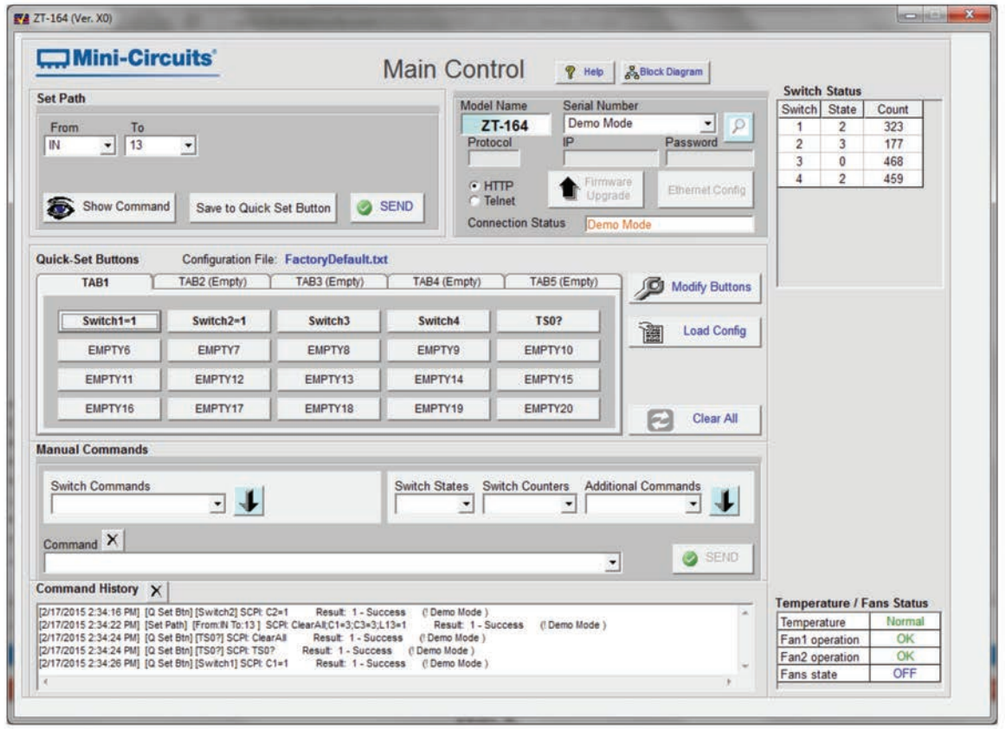
Electrical Performance

PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	MHz	500	-	8000
Insertion Loss	dB	-	2	-
Isolation	dB	-	80	-
Return Loss	dB	-	15	-

Functional Schematic ZT-164



ZT-164 GUI Main Screen

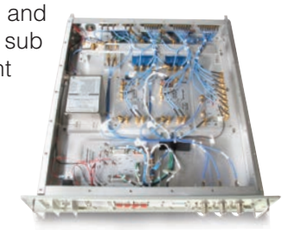


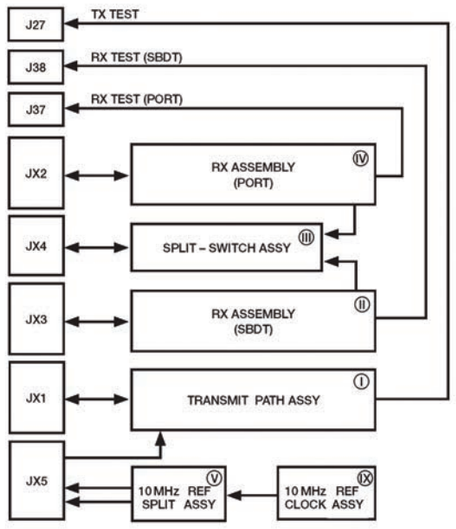
H-Switch 10-4200 MHz

Satellite Antenna Control Module

Functional Description

Designed specifically to control satellite transmit and receive antennas, the Mini-Circuits H-Switch control module is configured with two receive modules and one transmit module. It can also easily be configured for other antenna options. It has a self-contained 10 MHz Rubidium clock with lock detect, operates on a 24VDC supply, and comes contained in a 3.5 x 19 x 20" rack mountable case. All RF connections are PDK style multi-connector, and all control lines are D sub connectors. BNC front panel test ports are available for transmit and receive paths.





Overall Schematic

ZT-167 0.5-18 GHz

Modular Switch Box with Custom Coupler / Splitter Options

Functional Description

ZT-167 is based on Mini-Circuits' modular, user-configured ZTM series switch and programmable attenuator systems. This system has been specified with an additional custom window panel to include the ultra-wideband ZUDC10-183+ directional coupler and ZX10-2-183+ 2-way splitter/combiner. Similar customizations are available on request.

Electrical Performance

PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Per SPDT				
Operating Frequency	GHz	DC	-	18
Insertion Loss	dB	-	0.20	-
Per SP4T				
Operating Frequency	GHz	DC	-	18
Insertion Loss	dB	-	0.30	-
Per 2-Way Splitter				
Operating Frequency	GHz	1.5	-	18
Insertion Loss	dB	-	15	-
Per Directional Coupler				
Operating Frequency	GHz	0.5	-	18
Coupling	dB	-	10.7	-

Rear Panel

2-6 GHz

ZT-149

12 x16 Non-Blocking Matrix with Programmable Attenuators

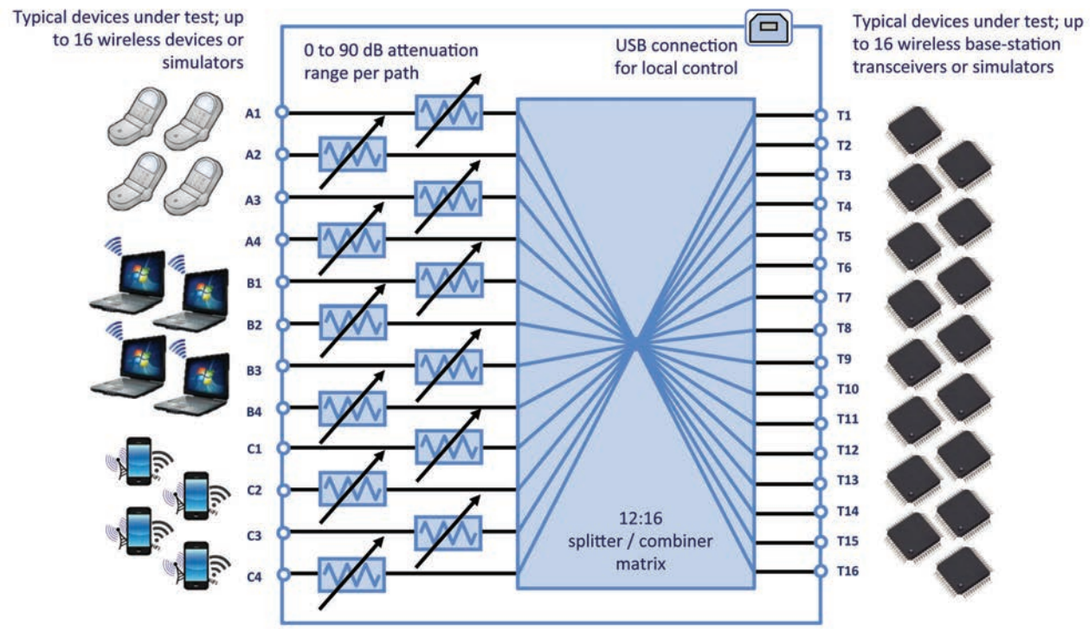
Functional Description

Mini-Circuits ZT-149 allows the user to receive 12 RF input signals and redistribute them into 16 output channels. Each input port is equipped with a Mini-Circuits RUDAT-6000-90 programmable attenuator with adjustable attenuation controlled remotely via USB connection. The ability to control the 12 input signal levels independently over a wide dynamic range (0 – 90 dB) with resolution as fine as 0.25 dB makes the ZT-149 an ideal solution for test applications requiring precise signal fading control such as WLAN routers, Access Points, wireless modules, and more.

Electrical Performance

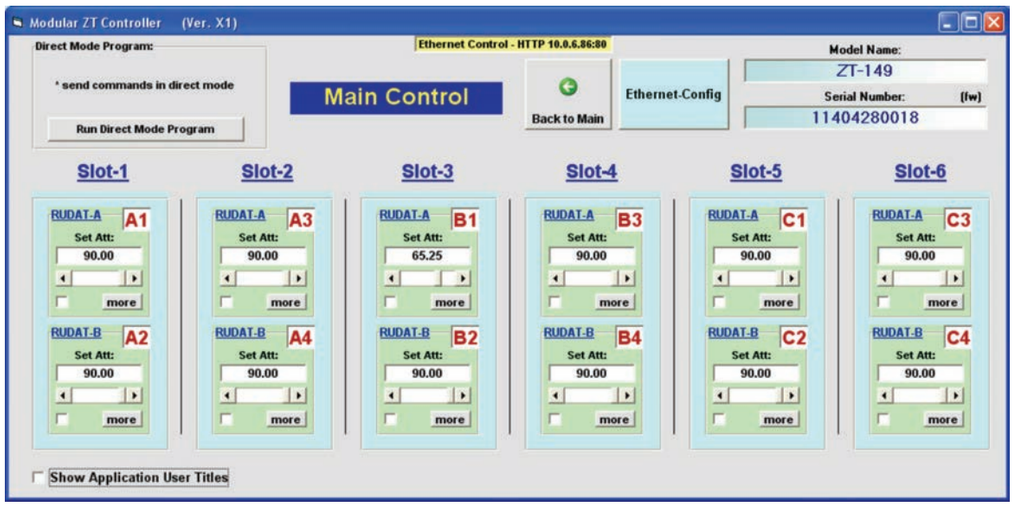
PARAMETER	SPECIFICATIONS				
	Unit	Min.	Typ.	Max.	Conditions
Operating Frequency	GHz	2	-	6	-
Typical Path Loss	dB	-	23	-	2000 MHz, 0 dB attenuation
	dB	-	28	-	6000 MHz, 0 dB attenuation
VSWR	dB	-	1.5	-	-
Isolation	dB	-	>80	-	Between adjacent channels
		-	28	-	A_M to B_N, A_M to C_N, B_M to C_N, 2000 – 6000 MHz, 0 dB attenuation
Supply Voltage	V	-	110/240	-	-
Control Interface	CONNECTION TYPE: USB Standard. Available with Ethernet-TCP/IP supporting HTTP and Telnet network protocols.				

Application Schematic



Functional Schematic & Typical Application Diagram (High Volume Testing of Wi-Fi Transceivers)

ZT-149 GUI Main Screen



ZT-158 1-6000 MHz

Signal Level Control Matrix with 12 Programmable Attenuators

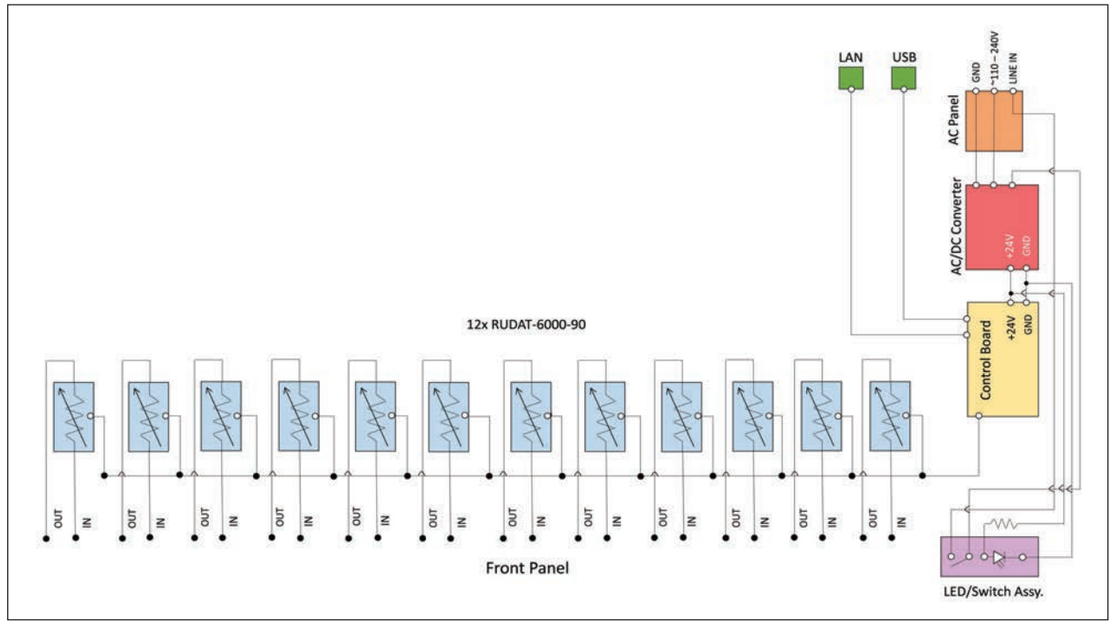
Functional Description

Mini-Circuits ZT-158 level control matrix allows the user to individually control attenuation on up to twelve signal paths from one convenient interface. Equipped with Mini-Circuits' RUDAT-6000-90 programmable attenuators on each of 12 RF inputs fed through the front panel, this unit provides a signal level management hub for multiple stations in your test environment. RUDAT-6000-90 programmable attenuators on RF inputs provide accurate attenuation from 0 – 90 dB in 0.25 dB steps with excellent attenuation flatness over frequency and typical input IP3 of +50 dBm up to 6000 MHz.

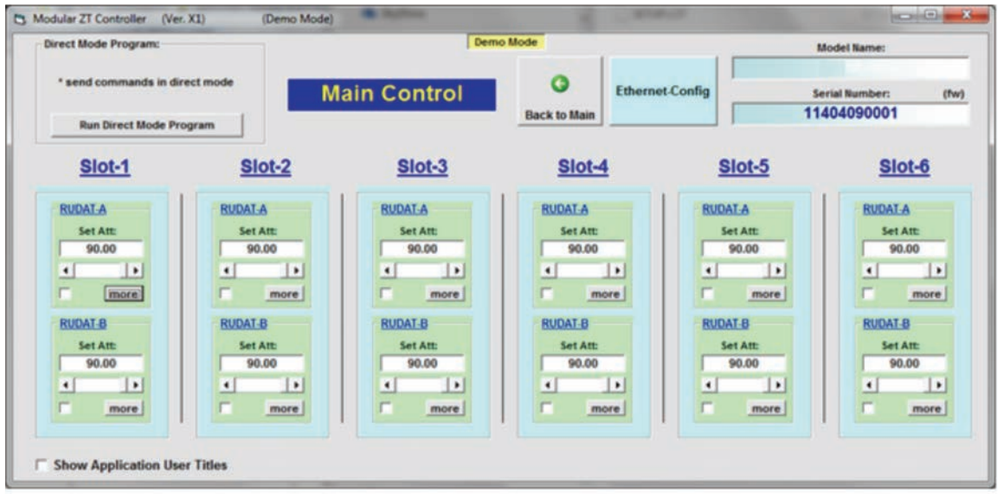
Electrical Performance

PARAMETER	SPECIFICATIONS				
	Unit	Min.	Typ.	Max.	Conditions
Operating Frequency	MHz	1	-	6000	-
Attenuation Accuracy	dB	-	±0.2	-	@ 0.25 – 10 dB attenuation
			±0.7	-	@ 20.25 – 40 dB attenuation
			±1.5	-	@ 60.25 – 90 dB attenuation
Insertion Loss	dB	-	5.0	-	1 – 3000 MHz @ 0 dB attenuation
			8.0	-	3000 – 6000 MHz @ 0 dB attenuation
VSWR	:1	-	1.2	-	500 – 4000 MHz @ 0 – 20 dB attenuation
			1.1	-	500 - 4000 MHz @ 20.25 – 90 dB attenuation
Input IP3	dBm	-	+50	-	@ 0 dB attenuation (PIN=+10 dBm)
Control Interface	CONNECTION TYPE USB Standard. Available with Ethernet-TCP/IP supporting HTTP and Telnet network protocols.				

Functional Schematic



ZT-158 GUI Main Screen



ZT-16HPS-23 600-2300 MHz

High Power (100W) 16-Way Splitter Module

Functional Description

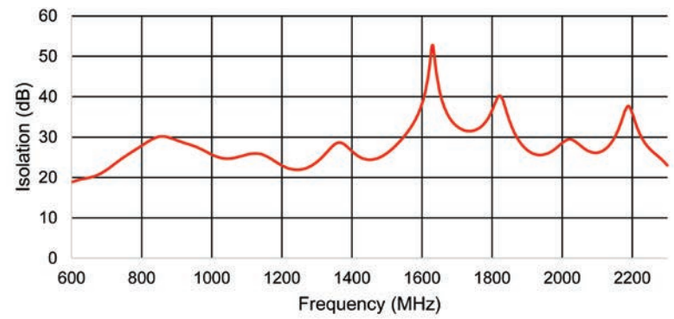
This 16-way, 0° high-power splitter module is capable of dividing input signal levels of up to 100 Watts into 16 coherent RF channels. Multiple units can be configured to provide up to 256 channels if desired. When integrated with the Mini-Circuits HPG-13 100W synthesized signal generator, this setup can be used to build a multi-channel signal source for parallel testing applications such as burn-in, dramatically increasing throughput and reducing testing costs.

Electrical Performance (Per Path)

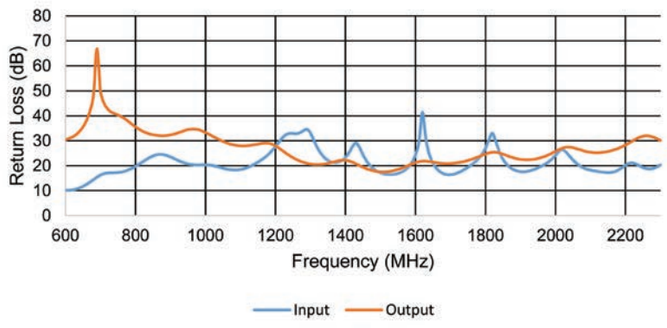
PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Frequency Range	MHz	600	-	2300
Isolation	dB	18.5	28	-
Insertion Loss (above 12 dB)	dB	-	2.0	-
Input Return Loss	dB	-	21	-
Output Return Loss	dB	-	27	-
Input Power	W	-	-	100

ZT-16HPS-23 Curves

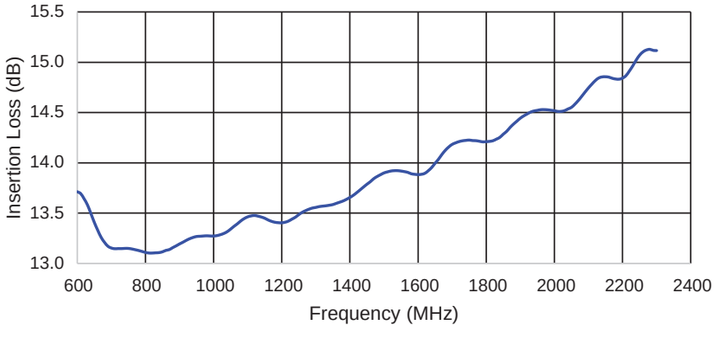
Typical Isolation



Return Loss



Typical Path Insertion Loss



ZT-10HPS-272+ 700 - 2700 MHz

High Power (100W)*

10-Way Splitter Module

Functional Description

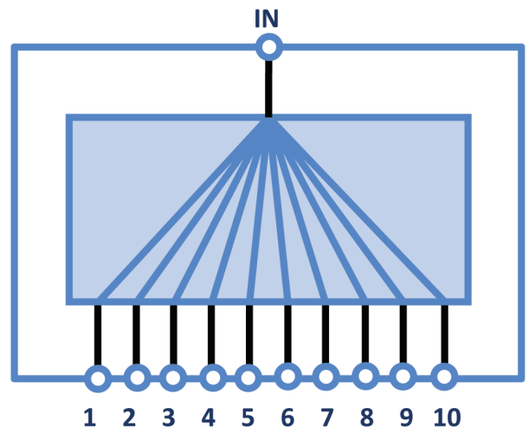
ZT-10HPS-272+ is a passive splitter design enabling high power signal distribution in an RF test environment. The input power rating of 100 W allows the system designer to overcome the inherent splitter losses in a multi-path distribution system and still deliver a test signal to 10 separate outputs at over 5 W per path. The specified operating bandwidth covers all the key telecoms bands up to 2.7 GHz. Mini-Circuits has a range of complimentary power amplifiers capable of delivering up to 100 W into this splitter.

Electrical Performance (Per Path)

PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	MHz	700	-	2700
RF Input Power	W	-	-	100
Insertion Loss	dB	-	11.0	12.5
Amplitude Unbalance	dB	-	0.7	1.0
Isolation	dB	20	-	-
Return Loss (Intput)	dB	18	-	-
Return Loss (Output)	dB	18	-	-

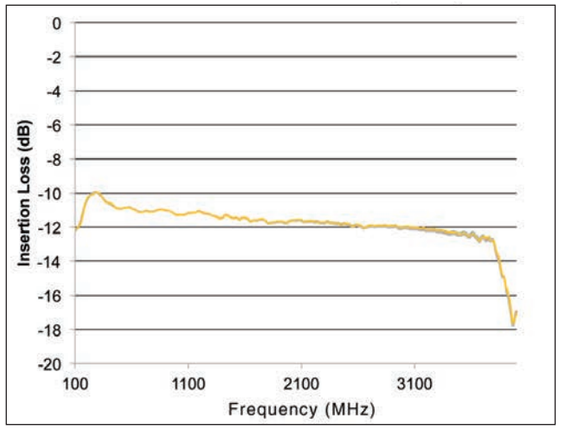
**External heat sinking required*

Functional Schematic

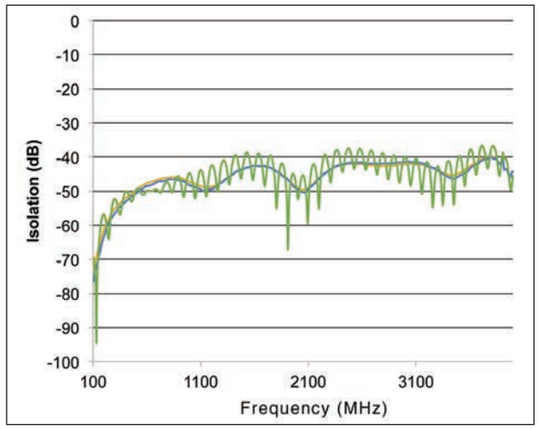


ZT-10HPS-272+ Curves

Insertion Loss Vs. Frequency



Isolation Vs. Frequency



ZT-117 800-2000 MHz

Multi-Channel RF Signal Distribution Rack

Functional Description

Common in all testing environments, multiple splitters are required to distribute test signals to multiple channels and DUTs. RF test cable management for complex configurations is often a challenging task. The ZT-117 is designed with nine six-way splitters to provide 54 RF test channels in a neat arrangement for portable and repeatable configurations. Different splitters can be used to cover the frequency band and configuration of your choice.

Electrical Performance (Per Path)

PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	MHz	800	-	2000
Insertion Loss (above theoretical loss, 7.8 dB)	dB	-	1.0	-
Input Return Loss	dB	-	20	-
Output Return Loss	dB	-	25	-
Isolation	dB	-	27	-
Input Power Handling	W	-	-	10

ZT-136 380-4600 MHz

Multi-Channel RF Signal Distribution Splitter Rack

Functional Description

Equipped with ten 4-way power dividers, this splitter rack is most suited for receiving signals directly from a base station through the rear panel and distributing to various test stations via the front panel. The rear panel is designed to accommodate Mini-Circuits' BW-N30W-50+ 50W fixed precision attenuator for high-power incoming signals.

Electrical Performance (Per Path)

PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	MHz	380	-	4600
Insertion Loss	dB	-	0.9	1.7
Isolation	dB	-	22	-
VSWR (Port S)	:1	-	1.3	1.9
VSWR (Port 1-4)	:1	-	1.2	1.6
Input Power Handling	W	-	-	10

ZT-152 1200-1600 MHz

GPS Distribution Module with 4 Output Channels

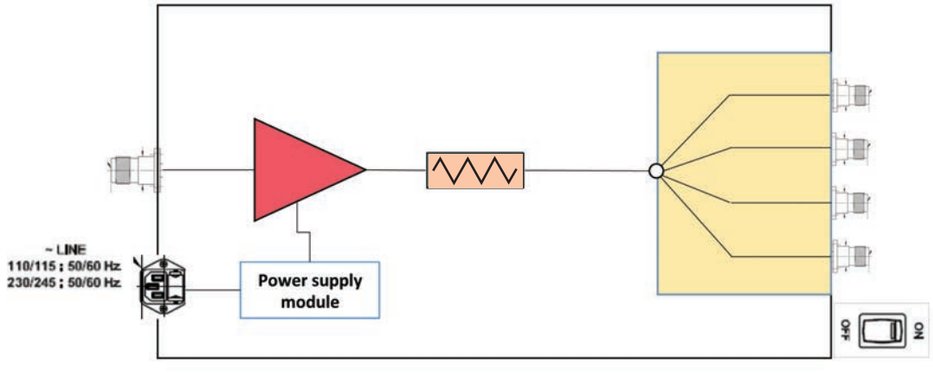
Functional Description

Housed in a compact 19-inch, 1U rack, the ZT-152 distributes a GPS signal into multiple locations in your test environment while maintaining signal strength across multiple outputs. Its ability to provide adequate signal strength to multiple test stations from a single source with consistent performance across channels and easy maintenance make this unit a cost-effective solution improving test efficiency. The example shown displays a four-channel distribution design, but more output channels are available upon request.

Electrical Performance

PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	MHz	1200	-	1600
RF Input Power	dBm	-	-	-25
Total Path Gain (each channel)	dB	-	+26	-
Noise Figure	dB	-	4.0	-
VSWR	:1	-	1.5	-
Supply Voltage	V	-	110/240	-

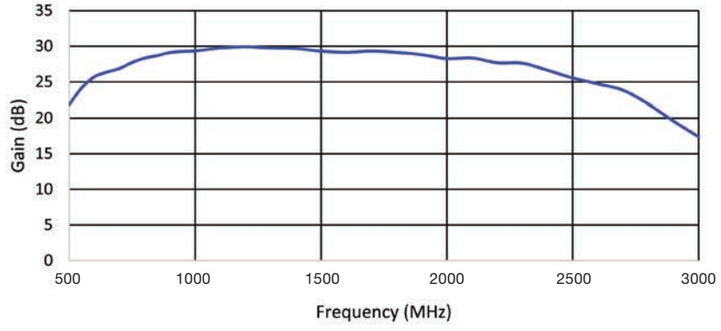
Functional Schematic



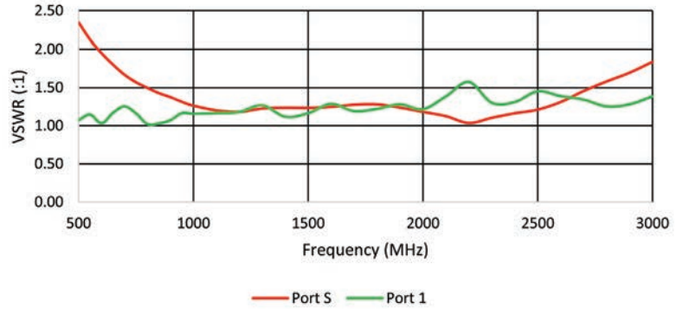
All Connectors Type N Female

ZT-152 Curves

Gain vs. Frequency



VSWR vs. Frequency



Rear Panel

ZT-161RS 1200-1650 MHz

GPS Distribution Module with 16 Output Channels

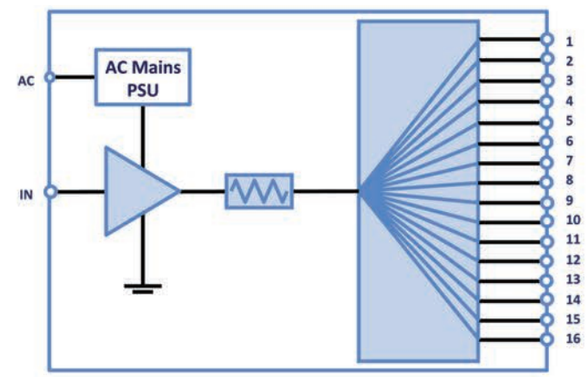
Functional Description

ZT-161RS is an essential component of lab and production test systems for GNSS (global navigation satellite system) applications, allowing a single, low-level test signal to be amplified and distributed among 16 systems under test. The amplifier is housed in a compact 2u package and optimized to cover the key international GNSS bands, including GPS, Galileo and GLONASS.

Electrical Performance

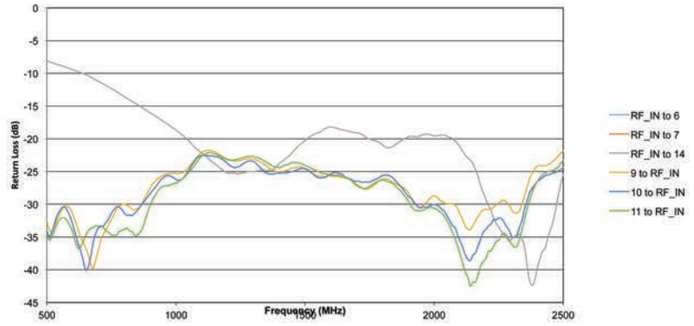
PARAMETER	SPECIFICATIONS			
	Unit	Min.	Typ.	Max.
Operating Frequency	MHz	1200	-	1650
RF Input Power	dBm	-	-	-25
Signal Gain (each path)	dB	20	-	-
Return Loss	dB	-	15	-

Functional Schematic

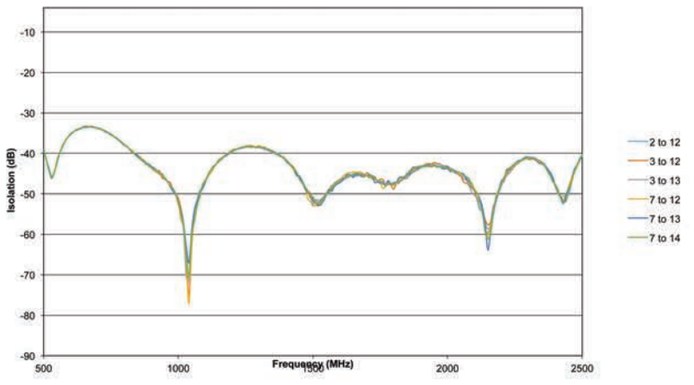


ZT-161RS Curves

Return Loss vs. Frequency



Isolation vs. Frequency



DC-18 GHz
Switch Matrices

Mini-Circuits switch matrices incorporate our patented mechanical switches with ultra-high reliability and extra-long life of 10 years/100 million switch cycles guaranteed performance.* USB and Ethernet control options are available on all models, and our intuitive GUI control screen allows you to set many different switch configurations for step-by-step control or full automation. They even come with a built-in switch cycle counting feature and automatic calibration alerts based on actual usage, improving reliability and saving maintenance cost!

**The mechanical switches within each model are offered with an optional 10 year extended warranty. Agreement required. See data sheets on our website for terms and conditions.*

Electrical Performance

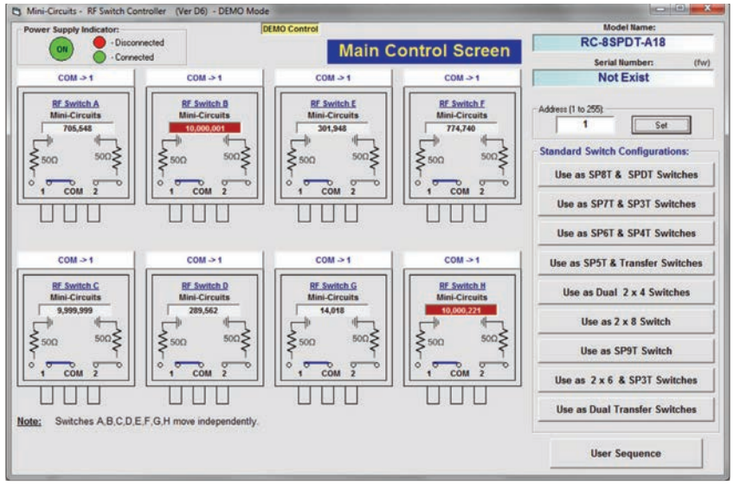
USB Control Switch Matrices

Model	# Switches (SPDT)	IL (dB)	VSWR (:1)	Isolation (dB)	RF P_{MAX} (W)
USB-1SP4T-A18	1(SP4T)	0.25	1.2	85	2
USB-1SPDT-A18	1	0.25	1.2	85	10
USB-2SPDT-A18	2	0.25	1.2	85	10
USB-3SPDT-A18	3	0.25	1.2	85	10
USB-4SPDT-A18	4	0.25	1.2	85	10
USB-8SPDT-A18	8	0.25	1.2	85	10

USB and Ethernet Control Switch Matrices

Model	# Switches (SPDT)	IL (dB)	VSWR (:1)	Isolation (dB)	RF P_{MAX} (W)
RC-1SP4T-A18	1(SP4T)	0.25	1.2	85	2
RC-1SPDT-A18	1	0.25	1.2	85	10
RC-2SPDT-A18	2	0.25	1.2	85	10
RC-2SP4T-A18	2(SP4T)	0.25	1.2	80	10
RC-3SPDT-A18	3	0.25	1.2	85	10
RC-4SPDT-A18	4	0.25	1.2	85	10
RC-8SPDT-A18	8	0.25	1.2	85	10

Switch Matrix GUI Main Screen



1 MHz-6 GHz
Programmable Attenuators

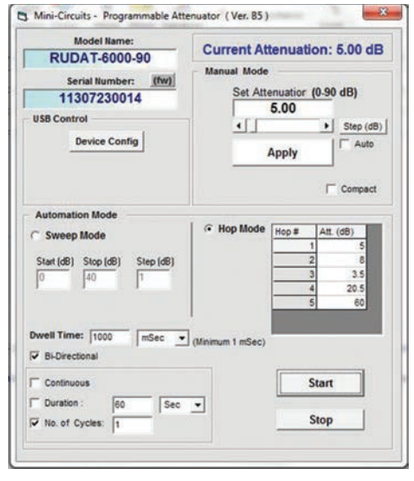
Mini-Circuits' USB and Ethernet controlled programmable attenuators provide precise level control with accurate, repeatable performance for a wide range of test applications from 1 - 6000 MHz. Available in models with attenuation ranges of 0 – 30, 60, 90, 110 and 120 dB in 0.25 dB steps, our unique designs 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	Attenuation Range	Attenuation Accuracy	Step Size	USB Control	Ethernet Control	RS232 Control
RUDAT-6000-30	0 – 30 dB	±0.50 dB	0.25 dB	✓	-	✓
RUDAT-6000-60	0 – 60 dB	±0.80 dB	0.25 dB	✓	-	✓
RUDAT-6000-90	0 – 90 dB	±0.90 dB	0.25 dB	✓	-	✓
RUDAT-6000-110	0 – 110 dB	±0.45 dB	0.25 dB	✓	-	✓
RUDAT-4000-120	0 – 120 dB	±0.50 dB	0.25 dB	✓	-	✓
RCDAT-6000-30	0 – 30 dB	±0.50 dB	0.25 dB	✓	✓	-
RCDAT-6000-60	0 – 60 dB	±0.80 dB	0.25 dB	✓	✓	-
RCDAT-6000-90	0 – 90 dB	±0.90 dB	0.25 dB	✓	✓	-
RCDAT-6000-110	0 – 110 dB	±0.45 dB	0.25 dB	✓	✓	-
RCDAT-4000-120	0 – 120 dB	±0.50 dB	0.25 dB	✓	✓	-

RUDAT GUI Main Screen



0.25 - 6400 MHz
SSG Series
Synthesized Signal Generators

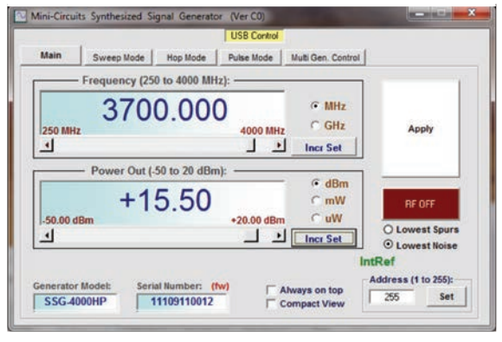
A Variety of Models to Meet Your Needs

Mini-Circuits SSG-series of synthesized signal generators offers a variety of different models to meet your needs and fit your budget. All models feature USB control and selected models provide USB and Ethernet control (HTTP and Telnet protocols) allowing setup flexibility and easy remote test management. All models provide sweeping and hopping capability across frequencies and power levels as well as trigger and reference signal ports for easy integration with other test equipment. They even provide automatic calibration scheduling based on actual usage, improving reliability and saving maintenance costs.

Our user friendly GUI software, DLLs, and programming instructions are all included so you can control your setup easily through our software or yours. SSG-series signal generators are small enough to fit into your laptop case and are available with a rack-mountable front panel option, enabling easy installation into your test rack.

Model	Frequency Range (MHz)	Frequency Resolution (Hz)	Output Power Range (dBm)	Output Power Resolution (dBm)	Modulation	Control Interface
SSG-4000HP	250 to 4000	5000	-50 to +20	0.25	Pulse	USB
SSG-4000LH	250 to 4000	5000	-60 to +10	0.25	Pulse	USB
SSG-6000RC	25 to 6000	3	-65 to +14	0.25	Pulse	USB & Ethernet
SSG-6001RC	1 to 6000	3	-70 to +15	0.25	Pulse	USB & Ethernet
SSG-6400HS	0.25 to 6400	0.01	-75 to +10	0.01	AM, FM, PM, and Pulse	USB & Ethernet

SSG GUI Main Screen



Rack Mount Option Available.

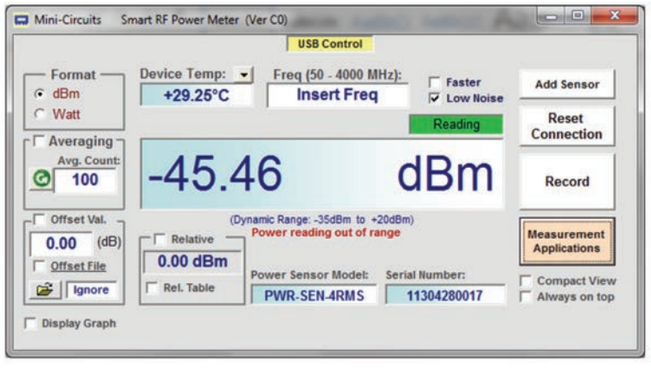
9 kHz - 8 GHz, 50 & 75Ω
PWR Series
USB/Ethernet Smart Power Sensors

4.89 x 1.74 x 0.95"

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-6GHS	1 to 6000, 50Ω	CW	-30 to +20	USB
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	CW	-30 to +20	USB
PWR-4RMS	50 to 4000, 50Ω	True RMS	-35 to +20	USB

Power Sensor GUI Main Screen



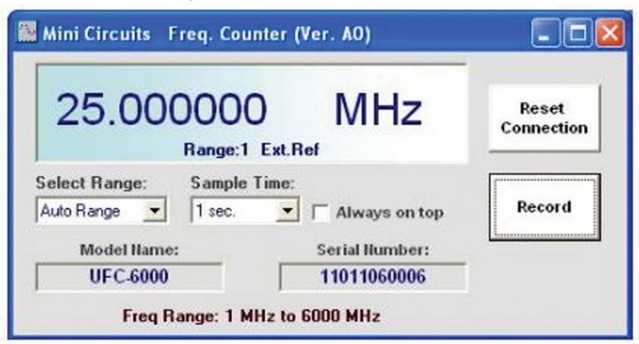
1-6000 MHz, 50Ω
UFC-6000
Frequency Counter

Mini-Circuits UFC-6000 Frequency Counter provides accurate frequency measurement from 1 – 6000 MHz with display directly on a 16x2 character LCD screen or remote display on your PC via USB connection. It can operate either synchronized with an external 10 MHz reference signal or independently using its internal reference. User-friendly GUI monitoring and control software, DLLs and programming instructions are included.

Electrical Performance

Parameter	Unit	Test Conditions	Min.	Typ.	Max.
Frequency Range	MHz	-	1	-	6000
Frequency Resolution	MHz	1 - 40	-	1	-
		40 - 190	-	10	-
		190 - 6000	-	100	-
Frequency Accuracy @ 1 sec. measurement sample time	MHz	1 - 40	-	±2	-
		40 - 190	-	±20	-
		190 - 1400	-	±200	-
		1400 - 6000	-	±800	-

Frequency Counter GUI Main Screen



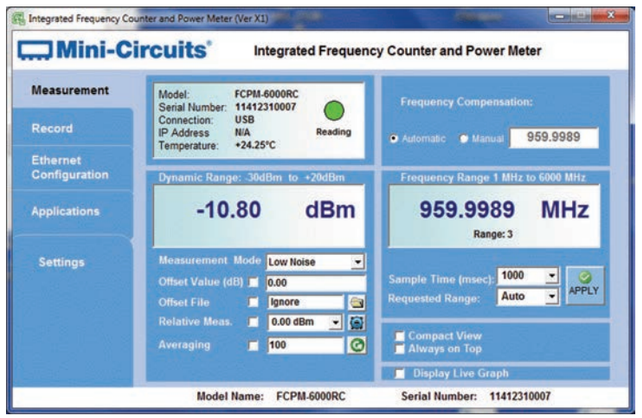
1-6000 MHz, 50Ω
FCPM-6000RC
Integrated Frequency Counter/Power Meter

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



USB I/O Control Boxes

- *Compatible with 32/64 bit systems*
- *4, 8, or 16 channel TTL/LVTTL digital outputs*
- *Noise reduction circuit on digital outputs*
- *All required power drawn from USB bus*
- *GUI, DLLs, and programming instructions included*

Mini-Circuits offers a variety of USB controlled I/O boxes as low-cost solutions for automatic relay control for test equipment, control systems and other applications. Available in models with 4, 8, and 16 TTL/LVTTL digital outputs, they can be used to control and monitor multiple devices simultaneously. The supplied software allows either USB to SPI conversion or direct control of bit states. Other protocols can be programmed by the user using the supplied API DLL com object.

Models and Key Features

USB-I/O Model Series	Input/Output					
	Digital		Analog	Relay	Signal	Power
Model	Input	Output	Outputs	(dry contact)	Type	Source
USB-I/O-4D2R	N/A	4 (TTL/LVTTL)	2	N/A	TTL/LVTTL	USB 24V VCC TTL VCC
USB-I/O-16D8R	0 8 16	16 8 0	N/A	8 (SPDT Form C)	TTL/LVTTL -	USB
USB-I/O-8DRV	0 8 8	8 0 0	N/A	8 (SPDT Form C)	TTL/LVTTL TTL/LVTTL 0 – 32 VDC	USB

GUI Main Control

USB/RS232–SPI Converters

- *USB or RS232 control*
- *Full two-way communication to SPI slave devices*
- *Powered from either the USB bus or power adaptor*
- *Communication rate, 330 kbit/sec*
- *GUI, DLLs and programming instructions included*

Mini-Circuits RS232/USB-SPI converters allow two-way communication with SPI slave devices using either a USB or RS232 port. They operate at 330 kbit per second with 1 to 16 data bits per word (specified by the user). They use 5VDC operating voltage, supplied from either the USB bus or an external power adaptor (included) and come housed in a compact case (2.53 x 1.68 x 0.92") with a USB type B female port, a standard RJ45 network port for SPI signals, and a 9-pin D-Sub 9 female port for RS232 signals.

Models and Key Features

Model	Communication Protocols		RS232 Specifications				Power Supply from USB		
	Source & Control	Output	Baud Rate (bps)	Word) (bits	Parity Bit	Stop Bit	Voltage Min. (V)	Voltage Max (V)	Current Typ. (mA)
RS232/USB-SPI	USB/RS232	SPI	9600	8	Even	1	4.5	5.5	50
RS232/USB-SPI-N	USB/RS232	SPI	9600	8	Even	1	4.5	5.5	50

GUI Main Control

Bi-Directional USB to SPI Communication Using Mini-Circuits' RS232/USB-SPI Converter

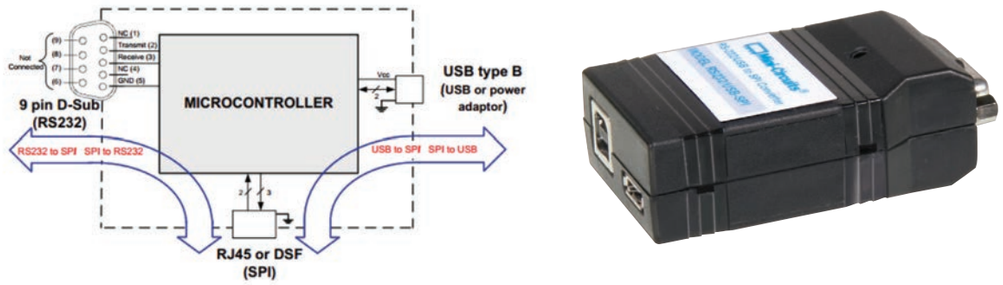
1. Introduction

SPI (Serial Peripheral Interface) is a data-link standard that is widely used for short distance communication with embedded systems, sensors and ICs (integrated circuits). The communication works in a "master/slave" mode, whereby a single master can control multiple slave devices. This structure, along with the low communication overheads from a simple communication protocol, make SPI well suited to high volume production testing.

While SPI is relatively standard for the devices under test (DUT) in these applications, it is not always readily available on the control side of the equation since most computers do not support this connection as standard.

Mini-Circuits' RS232/USB-SPI converters provide a simple solution to this, providing USB and RS232 interfaces for communication with a computer and a serial interface for connection to the DUT. The converters support bi-directional SPI communication between the USB and DUT interfaces and the RS232 and DUT interfaces; allowing the controller to both set and read from the DUT.

Figure 1



Functional Block Diagram for RS232/USB -SPI Converters

2 - Application Example - USB Voltage Meter

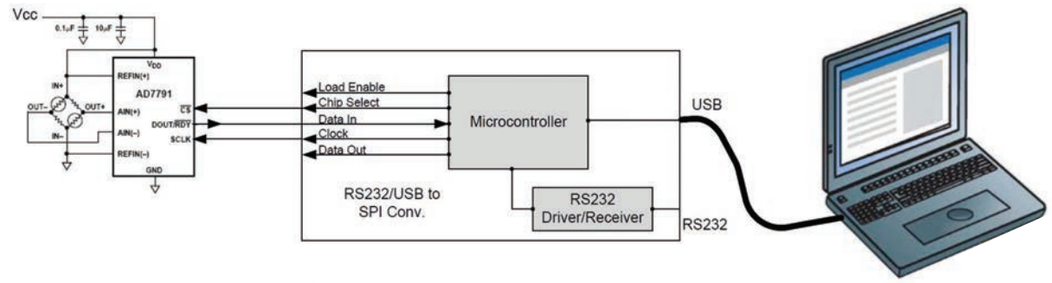
2. A - Summary

To demonstrate this capability, a simple experiment can be set-up where the RS232/USB-SPI converter is used as an interface between a PC (using the USB port in this case) and an ADC (analog to digital converter) mounted on a test board. The ADC has an SPI interface that allows certain properties to be configured before the digital output is read. The RS232/USB-SPI converter operates at 330kb/sec with 1 to 16 data bits (as specified by the user) being sent and received per SPI word.

With configuration of the test board and ADC's external circuitry, the application can be that of a voltmeter:

1. The ADC takes an analog voltage input and provides a digital output over SPI.
2. The RS232/USB-SPI converts between the test board's SPI interface and the computer's USB interface.
3. Mini-Circuits' supporting software interprets the information and allows the original analog voltage to be displayed.
4. The communication needs to be bi-directional in order to configure the ADC with the appropriate settings.

Analog Devices' AD7791 ADC is used for the purposes of this experiment.



2.b - USB-SPI Communication Using the DLL

To automate the SPI communication between PC and DUT via the RS232/USB-SPI converter, Mini-Circuits provides both an ActiveX COM (Common Object Model) and a .NET library as DLL files. Each of these files is a library that provides all the necessary functions to send and read data from the converter and can be utilized within a wide range of programming environments and languages.

The steps required in programming with the converter can be summarized as below and a code example can be provided on request by Mini-Circuits' Applications deparment. For detailed explanation of programming with the RS232/USB to SPI converter please refer to the ***Programming Manual*** on the Mini-Circuits website.

1. Set-up DLL and Converter
   a. A reference needs to be added to the DLL file within the programming environment and then a new converter "object" can be declared and used throughout the code. The converter object contains all the converter functions as defined in the DLL.
   b. The object is associated with a physical RS232/USB-SPI device using the DLL's Connect function. If multiple converters are connected by USB then the serial number should be provided as an argument to specify the correct hardware.
2. Configure the ADC to receive data
   a. Using the DLL's Send_Receive_SPI function, data can be sent to the ADC to configure it for the required application. For further explanation of the parameters set, please consult the Analog Devices datasheet.
3. Read and calculate the voltage from the ADC
   a. Using the same Send_Receive_SPI function as above and this time monitoring the response, the raw data from the ADC can be collected and the corresponding voltage calculated.
   b. This section can be modified into a loop in order to continuously poll the voltage data.
4 Disconnect the converter
   a. When measurements are complete, the DLL's Disconnect function should be called to close the connection, before physically disconnecting the converter from the computer.

Mini-Circuits Test Accessories

Our goal is to make your test applications easier, faster, and more economical. Mini-Circuits offers a wide variety of test accessories to simplify setup, speed up your processes, and save you time and cost. Here's a brief overview of some of our popular products for test environments. Visit minicircuits.com for a full listing of models including performance specs, test data, S-Parameters, and everything you need to find the right solution for your needs!

Attenuators

DC-40 GHz

- *1 – 50 dB attenuation*
- *Up to 100W power handling*
- *VSWR as low as 1.04*
- *Excellent repeatability*
- *SMA, N-Type, BNC, and 2.9mm connectors*

Adapters

DC-34 GHz

- *SMA, BNC, N-type, and 3.5mm connectors*
- *VSWR as low as 1.07*
- *Flat response*
- *Rugged construction*

Terminations

DC-20 GHz

- *Up to 500W*
- *SMA, N-type, DIN, and BNC connectors*
- *Excellent return loss*
- *Rugged construction*
- *SMA, N-Type, BNC, and Din connectors*

Customized Connector Wrenches

- *Easily remove cable connectors from tight spots!*
- *Tighten or remove by hand or in combination with a torque wrench.*

Precision Test Cables

DC-40 GHz

- *All models performance qualified to 20,000 flexures!*
- *SMA, N-Type, and 2.92mm connectors*
- *50 and 75Ω*
- *Low loss*
- *6-month guarantee!*

Couplers

5 kHz-9.7 GHz

- *Directional / Bi-directional / DC pass-through*
- *0.5 – 250W power handling*
- *Coupling ratios from 6 – 39.9 dB*

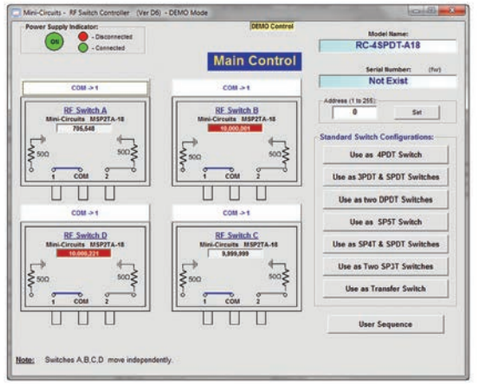
Splitter/Combiners

2 kHz -18 GHz

- *From 2-way to 48-way designs*
- *0°, 90°, and 180° phase configurations*
- *Power handling up to 50W*
- *50 & 75Ω models*

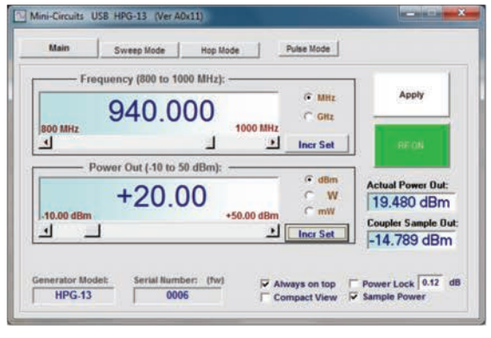
User-Friendly GUI Software and Programming Support

Our Software…

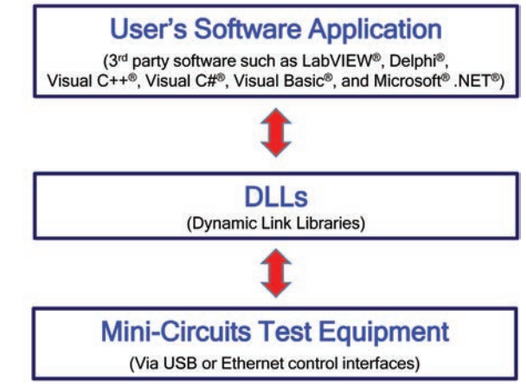


Mini-Circuits test boxes are supplied with easy-to-install, user-friendly GUI software for Windows® systems.

Our control interfaces are intuitively designed to allow automated or step-by-step control of switching, attenuation, signal sources, and test measurements with the click of a mouse!



…or Yours!



A complete set of DLLs for Windows® and Linux® environments with complete programming instructions enables you to control your Mini-Circuits test equipment through your native software, simplifying integration with existing setups. Mini-Circuits test boxes are compatible with most programming environments and third-party applications including:

- Agilent VEE®
- MATLAB®
- LabVIEW®
- CVI®
- Python®
- Visual Basic®
- Visual C#®
- Visual C++®
- Delphi®
- Borland C++®

Need Custom Programming?
Just give our applications team a call. We're here to support you every step of the way!

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)

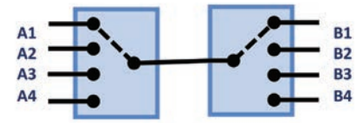
- Mini-Circuits' blanket product family name for the series of USB, Ethernet & RS232 controlled test equipment products, including signal generators, programmable attenuators, switches and power sensors.

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.

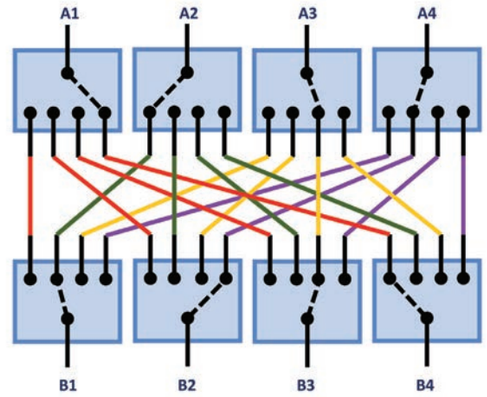
Switch Matrix

- 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.



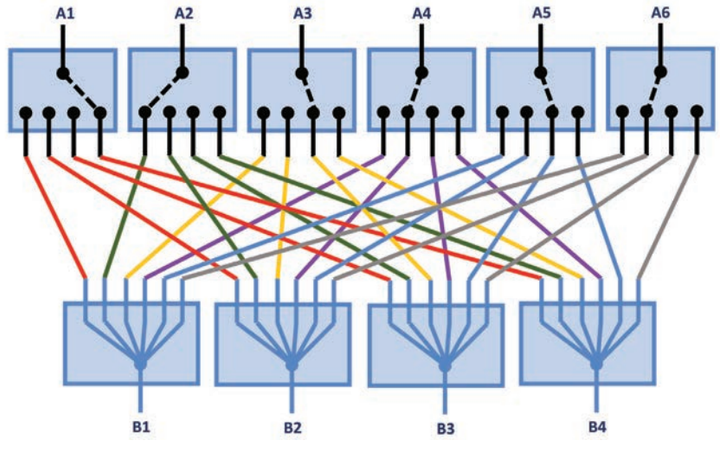
Example of a 4 x 4, blocking switch matrix:

- Setting A1 to B1 prevents any other connection being made.



Example of a 4 x 4, one to one, non-blocking switch matrix:

- Setting A1 to B1 does not prevent any other input being connected to any other output.
- Each input can only be connected to one output and vice versa.



Example of a 6 x 4, many to one, non-blocking switch and splitter matrix:

- Setting A1 to B1 does not prevent any other input being connected to any output.
- All 6 inputs could be routed simultaneously to the same output.

TEST SOLUTIONS
Product Guide

World Class Service

- *On-site integration support*
- *Calibration*
- *Software and programming support*
- *Service and warranty contracts available*
- *Tech support through equipment lifetime*

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