



# **2018** **Benchtop Test Solutions**

*Programmable Attenuators   Signal Measurement   Switch Matrices  
Signal Generators   Control Products*

**[www.mcdi-ltd.com](http://www.mcdi-ltd.com)**

## Develop Affordable, Flexible Test Setups with Benchtop Test and Measurement Modules

Test and measurement instrumentation has traditionally been one of the largest investments for companies producing RF products, and for good reason. The capability to test many devices quickly can greatly reduce overall production cost and time to market. However, developing a fast, efficient test setup needn't require prohibitive expense. Mini-Circuits' has innovated a line of products for these functions that are smaller, faster, easier to control, and much more affordable than other options typically available in the industry. Our benchtop test and measurement modules offer the ease of control via USB or Ethernet and include programmable attenuators, power sensors, frequency counters, switch modules, signal generators and control products. Depending on the application, these units may be used as standalone solutions or easily integrated as building blocks to build scalable testing platforms customized to each user's individual needs.

Mini-Circuits' line of benchtop test modules is set up to allow customers to build solutions around their exact needs without investing extra money in equipment they don't need. Leveraging a wealth of standard building blocks and detailed customer input, we have helped many customers realize highly functional, affordable solutions to improve test throughput and efficiency. Popular applications have included setups for testing of RF noise characterization, LTE networks, remote radio heads, up-converters, as well as mobile handset interference, interoperability, and certification, and these are just a few. Customers are finding new uses for these products almost daily, and

the ultimate range of their applications will be defined as it has been all along: by each customer's requirements.

This product guide gives you an overview of Mini-Circuits' standard portfolio of benchtop test products. We hope this information gives you some ideas about how we can help you reduce cost and improve efficiency in your test lab, and we invite you to reach out to us at [testsolutions@minicircuits.com](mailto:testsolutions@minicircuits.com) with any questions, custom requirements or other needs you may have. We're here to support you!

Regards,

*Chi Man Shum*

Chi Man Shum

Vice President, Test and Measurement  
Mini-Circuits



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### Programmable Attenuators — Pages 4-7

USB & RS232 Controlled	USB & Ethernet Controlled	4-Channel USB & Ethernet Controlled
RUDAT-13G-60	RCDAT-3000-63W2	RC4DAT-6G-95
RUDAT-13G-90	RCDAT-4000-120	RC4DAT-6G-60
RUDAT-4000-120	RCDAT-6000-30	
RUDAT-6000-30	RCDAT-6000-60	
RUDAT-6000-60	RCDAT-6000-90	
RUDAT-6000-90	RCDAT-6000-110	
RUDAT-6000-110	RCDAT-8000-30	
	RCDAT-8000-60	
	RCDAT-8000-90	



### Solid State Switches — Pages 8-9

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USB-2SP2T-DCH		
USB-4SP2T-63H		



### Compact Modular Systems — Pages 10-11

Multi-Channel Programmable Attenuators	Switching Systems
RCM-100 Series	RCM-200 Series
4 to 6 attenuator channels	Flexible SPDT, SP4T, SP6T, SP8T & Transfer switch combinations



### Mechanical Switches — Pages 12-13

USB Controlled	USB & Ethernet Controlled
USB-1SP4T-A18	RC-1SP4T-A18
USB-1SPDT-A18	RC-1SP6T-A12
USB-2SPDT-A18	RC-4SPDT-A18
USB-3SPDT-A18	RC-1SPDT-A18
USB-4SPDT-A18	RC-8SPDT-A18
USB-8SPDT-A18	RC-2SP4T-A18
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### Signal Measurement — Pages 14-18

Peak Power Sensor	CW Power Sensors	Frequency Counters
PWR-8P-RC	PWR-2.5 GHS-75	UFC-6000
	PWR-4GHS	
RMS Power Sensors	PWR-6GHS	
PWR-4RMS	PWR-6LGHS	
PWR-6RMS-RC	PWR-8GHS	
PWR-6LRMS-RC	PWR-8FS	
Integrated Frequency & Power Sensors	PWR-8GHS-RC	
FCPM-6000RC		



### Signal Generators — Pages 19

USB & Ethernet Controlled
SSG-6000RC
SSG-6001RC



### Control Products — Pages 20-23

USB/RS232 to SPI Converters	Input/Output Control Boxes
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RS232/USB-SPI-N	USB-I/O-4D2R
	USB-I/O-8DRV

### Appendix — Pages 24-27

.NET Example Program in LabVIEW for RCM/ZTM Modular Test Systems	Multiple Programmable Attenuator Control via Mini-Circuits GUI
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# Programmable Attenuators

0 to 120 dB 1 MHz to 13 GHz

Mini-Circuits' programmable attenuators provide precise level control with accurate, repeatable performance for a wide range of test applications from 1 to 13 GHz. Available in models with attenuation ranges spanning 0 to 120 dB in step sizes as small as 0.25 dB, 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.



Mini-Circuits' 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 specific test applications, reducing test time and increasing throughput. DLLs and programming instructions are also included, so you can program your attenuators through your native test software

## Features

- Models with attenuation range up to 120 dB
- Choose from USB, Ethernet, RS232 and SPI control options
- Use our software or yours! User-friendly GUI and DLLs included
- Sweep or hop attenuation levels
- Save and recall customized attenuation patterns
- Pocket-sized package, as small as 3.0 x 2.0 x 0.6"

## Perfect for...

- Fading simulators
- Handover system evaluation
- Automated test equipment
- And MORE!

Multiple attenuators can also be controlled through Mini-Circuits GUI software. Please see application note on page 26 for instructions.

## Model Specifications

Model Number	Control Interface	Frequency Range (MHz)	Input Power (dBm)	Attenuation Range (dB)	Step Size (dB)
RCDAT-3000-63W2	USB & Ethernet	50-3000	+33	0-63	1
RUDAT-13G-60	USB, SPI & RS232	10-13000	+23	0-60	0.5
RUDAT-13G-90	USB, SPI & RS232	10-13000	+23	0-90	0.5
RCDAT-8000-30	USB & Ethernet	1-8000	+28	0-30	0.25
RCDAT-8000-60	USB & Ethernet	1-8000	+28	0-60	0.25
RCDAT-8000-90	USB & Ethernet	1-8000	+28	0-90	0.25
RCDAT-6000-30	USB & Ethernet	1-6000	+20	0-30	0.25
RCDAT-6000-60	USB & Ethernet	1-6000	+20	0-60	0.25
RCDAT-6000-90	USB & Ethernet	1-6000	+20	0-90	0.25
RCDAT-6000-110	USB & Ethernet	1-6000	+20	0-110	0.25
RCDAT-4000-120	USB & Ethernet	1-4000	+20	0-120	0.25
RUDAT-6000-30	USB & RS232	1-6000	+20	0-30	0.25
RUDAT-6000-60	USB & RS232	1-6000	+20	0-60	0.25
RUDAT-6000-90	USB & RS232	1-6000	+20	0-90	0.25
RUDAT-6000-110	USB & RS232	1-6000	+20	0-110	0.25
RUDAT-4000-120	USB & RS232	1-4000	+20	0-120	0.25

## GUI Main Control



# 4-Channel Programmable Attenuators

0 to 95 dB 1 to 6000 MHz

Mini-Circuits' RC4DAT Series of compact multi-channel attenuators provide four independently programmable channels in one device, supporting a wide range of test applications such as 4x4 MIMO testing, handover system evaluation and more. Two models support applications from 1 to 6000 MHz with your choice of attenuation ranges from 0 to 63 dB or 0 to 95 dB in 0.25\* dB steps. The user friendly GUI and fully featured API provide support for a wide range of software environments with control via USB or Ethernet.

\*0.25 dB step from 0 to 90 dB, 0.5 dB step from 90 to 95dB

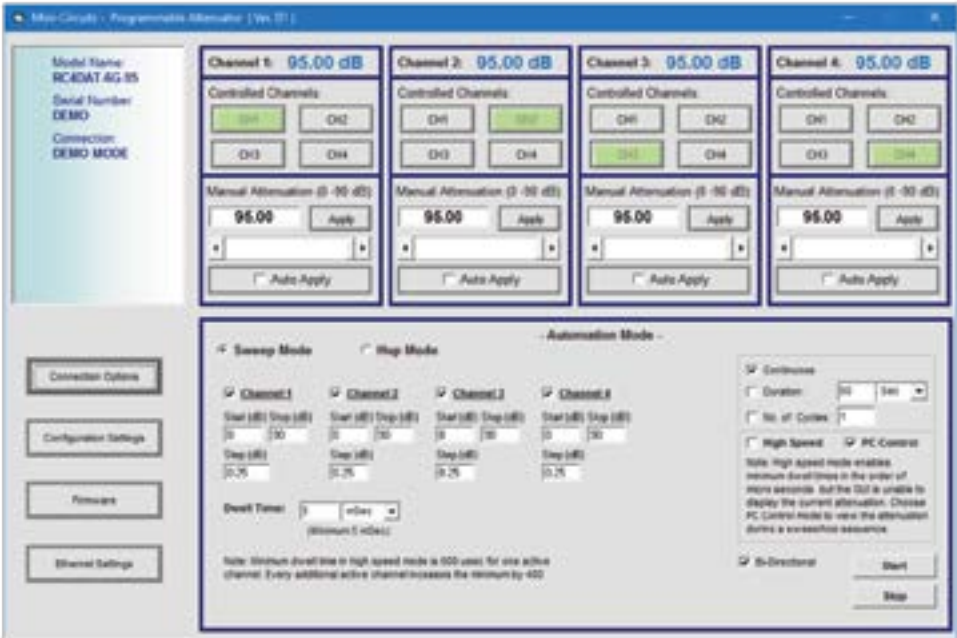


### Model Specs

Model	Control Interface	Number of Channels	Frequency (MHz)	Attenuation Range (dB)	Step Size (dB)
RC4DAT-6G-95	USB & Ethernet	4	1-6000	0-95	0.25
RC4DAT-6G-60	USB & Ethernet	4	1-6000	0-63	0.25

### GUI-Main Control Screen

Quickly set, sweep or hop attenuation any combination of the 4 attenuator channels via USB or Ethernet:



Multiple attenuators can also be controlled through Mini-Circuits GUI software. Please see application note on page 26 for instructions.

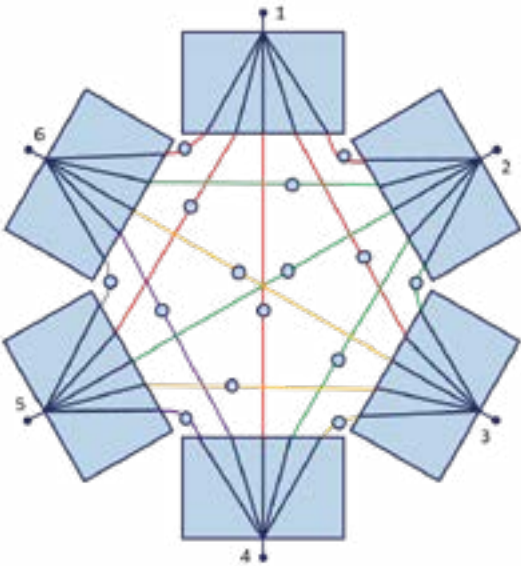
### Also Available: ZTDAT Series

Rack-mounted multi-channel attenuator systems with 8 to 48 channels controlled through a single USB / Ethernet interface. Even larger attenuator matrices can be quickly assembled by cascading multiple units together allowing control over hundreds of attenuator channels, through a single USB or Ethernet interface.



### Application: Mesh Network Test System

6 port network constructed from six 5-way splitter / combiners and four RC4DAT-6G-95 4-channel programmable attenuators. Path loss can be independently varied between any pair of ports, without affecting any other pair of ports, for testing of wireless networked devices (Bluetooth, Zigbee, WiFi).



Schematic diagram of 6-port mesh network

### Also Available: ZTMN Series



Rack-mounted mesh network test systems from 4 to 32 ports; bandwidths up to 6 GHz; 0 to 95 dB attenuation range per path.



**USB/SPI/I²C  
Solid State Switches**

SPDT, SP4T, SP8T, SP10T DC to 8000 MHz

To respond to the growing demand for extremely fast switching capability in test systems for next generation applications like 5G and Massive MIMO, Mini-Circuits has developed a new family of high-speed, solid-state switch modules with control via USB or SPI interfaces. With frequency ranges spanning 1 to 8000 MHz, these switches cover all the key telecom application bands and provide very high isolation and fast switching speed. USB control allows easy connection from almost any PC and automation from most common programming environments. Alternatively, SPI-SP10T-63 supports a simple 3-wire SPI interface that allows connection of many switches along the same control line, cascaded in a “daisy-chain” configuration.



These solid-state switches can be readily integrated into a self-contained switching system with Mini-Circuits proprietary firmware and user-friendly control software, allowing many possible configurations for your signal routing needs.

**Features**

- Low insertion loss
- Up to 90 dB isolation
- Extremely fast switching time, down to 250 ns
- Up to +35 dBm input power handling
- User-friendly GUI and API included

**Perfect for...**

- Production test
- R&D
- Signal routing in systems with high signal traffic
- And MORE!

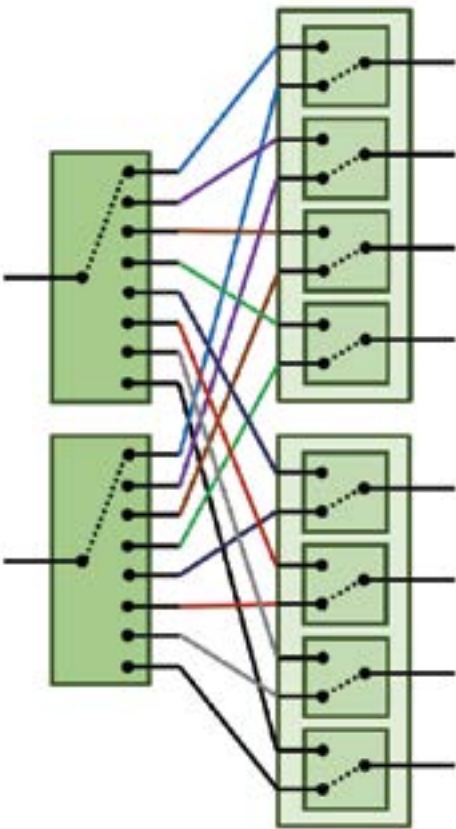
**Model Specs**

Model Number	Switch Type	Control	Frequency (MHz)	Input Power (dBm)	Insertion Loss (dB)	Isolation (dB)	Switching Time
SPI-SP10T-63	SP10T	SPI	1 – 6000	27	4	80	6 µs
USB-1SP8T-63H	SP8T	USB	10 – 6000	30	4	80	250 ns
U2C-1SP4T-63H	SP4T	USB & I²C	10 – 6000	30	3.5	80	250 ns
USB-SP4T-63	SP4T	USB	1– 6000	27	1.3	50	3 µs
USB-4SP2T-63H	4 x SPDT	USB	10 – 6000	30	2.3	80	250 ns
USB-2SP2T-DCH	2 x SPDT	USB	DC – 8000	35	1.4	50	14 µs

**Application Example: 2 x 8 Switch Matrix**

Taking advantage of multiple switches in the same module helps to reduce complexity when constructing larger switch systems. For example, a 2 x 8 switch matrix can quickly be assembled by interconnecting just 4 of Mini-Circuits’ high performance solid-state switch modules as shown. Two USB-1SP8T-63H SP8T modules can be used to “fan-out” from the 2 input ports, with two USB-4SP2T-63H quad SPDT modules used to “fan-in” to the 8 output ports.

Such a system lends itself to automated component testing for example, by enabling a 2-port measurement device to be switched between multiple 2-port DUT (devices under test).



**Also Available: ZTS Series**

Rack-mounted assemblies of solid-state SPDT, SP4T and SP8T switches, configured per your requirements and integrated for control through a single Ethernet or USB interface.



# Compact Modular Multi-Channel Programmable Attenuator Systems

## RCM-100 Series

Mini-Circuits RCM-100 series of compact modular multi-channel attenuator systems let you choose and configure the hardware you need without the high cost and slow turnaround of other customizable test systems on the market. 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.

The system can be controlled via USB or Ethernet (supporting both HTTP and Telnet network protocols). Full software support is provided, including our user-friendly GUI application for Windows systems and full API for both Windows & Linux 32-bit and 64-bit systems.

### Features

- 4 or 6 programmable attenuator channels
- 0 – 30, 60, 90, or 110 dB attenuation range per channel (1-6000 MHz)
- 0 – 120 dB attenuation range per channel (1-4000 MHz)
- Models up to 8 GHz also available on request

### Standard Configurations

Model Name	Channels	Performance per Channel		
		Frequency	Attenuation	Step Size
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 - 95 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
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 - 95 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



RCM 100 Series  
Multi-Channel Programmable  
Attenuator Systems

# Compact Modular Multi-Function Switching Systems

## RCM-200 Series

Mini-Circuits' RCM-200 series compact modular multi-function switching systems give you the same flexibility as the RCM-100 system to customize a hardware configuration for your specific needs with reliable performance and fast turnaround. Choose from one of our standard switch configurations or specify a custom configuration in seconds on our website for a fast response.

The switching system can be controlled via USB or Ethernet (supporting both HTTP and Telnet network protocols). Full software support is provided, including our user-friendly GUI application for Windows systems and full API for both Windows & Linux 32-bit and 64-bit systems.

### Features

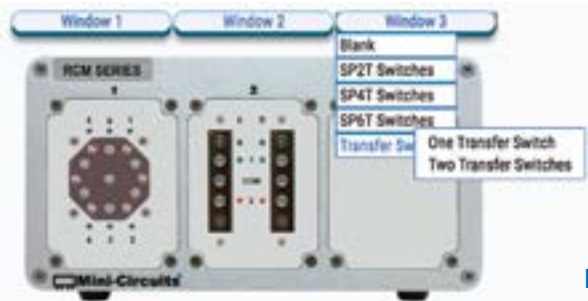
- 6 mechanical SPDT or transfer switches (DC to 18 GHz)
- 3 mechanical SP4T (DC to 18 GHz) or SP6T (DC to 12 GHz) switches
- 2 mechanical SP8T switches (DC – 12 GHz)
- Custom combinations of SPDT, SP4T, SP6T and transfer switches.
- Extra-long switch life, up to 10 million cycles guaranteed\*
- Switch cycle counting feature

\*5 million cycles guaranteed for SP8T models

### Standard Configurations

Model Name	Switch Type	Number of Switches	Frequency
RCM-6SPDT-18	SPDT	6	DC - 18 GHz
RCM-3SP4T-18	SP4T	3	DC - 18 GHz
RCM-3SP6T-12	SP6T	3	DC - 12 GHz
RCM-2SP8T-12	SP8T	2	DC - 12 GHz
RCM-1SP8T-12	SP8T	1	DC - 12 GHz

### Define a Custom Configuration on [minicircuits.com](https://www.minicircuits.com)



RCM-Series systems may also be programmed with LabVIEW.  
Please see application note on page 24 for programming example.



RCM 200 Series  
Multi-Function Switching Systems



<https://www.minicircuits.com/WebStore/rcm.html>



## USB/Ethernet Mechanical Switch Boxes

Mini-Circuits' USB/Ethernet controlled mechanical switch modules give a flexible, cost-effective solution for routing signal in almost any test setup. Now with a wide selection of models in various configurations of SPDT, SP4T, and SP6T switches, the possibilities are practically unlimited.

Our benchtop switch modules incorporate our patented electromechanical absorptive switches with ultra-high reliability and extra-long lifetime (typically 10 million switching cycles). USB and Ethernet control options allow easy connection with most PCs and over a network, whether using our user friendly GUI control software or the intuitive API for automating switch sequences. 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.

### Features

- 0.25 dB insertion loss
- 85 – 90 dB isolation
- 1.2:1 VSWR
- Up to 20W RF input power
- Extra-long switch life, up to 10 million cycles guaranteed
- Switch cycle counting feature

### Perfect for...

- Production test
- R&D
- Automated test equipment
- And MORE!

### Model Specs

Model Number	Switch Configuration	Control Interfaces	Frequency Range (GHz)
RC-1SP4T-A18	1 SP4T	USB & Ethernet	DC-18
RC-1SPDT-A18	1 SPDT	USB & Ethernet	DC-18
RC-2SP4T-A18	2 SP4T	USB & Ethernet	DC-18
RC-1SP6T-A12	1 SP6T	USB & Ethernet	DC-12
RC-2SP6T-A12	2 SP6T	USB & Ethernet	DC-12
RC-2SPDT-A18	2 SPDT	USB & Ethernet	DC-18
RC-3SPDT-A18	3 SPDT	USB & Ethernet	DC-18
RC-4SPDT-A18	4 SPDT	USB & Ethernet	DC-18
RC-8SPDT-A18	8 SPDT	USB & Ethernet	DC-18
USB-1SP4T-A18	1 SP4T	USB	DC-18
USB-1SPDT-A18	1 SPDT	USB	DC-18
USB-2SPDT-A18	2 SPDT	USB	DC-18
USB-3SPDT-A18	3 SPDT	USB	DC-18
USB-4SPDT-A18	4 SPDT	USB	DC-18
USB-8SPDT-A18	8 SPDT	USB	DC-18

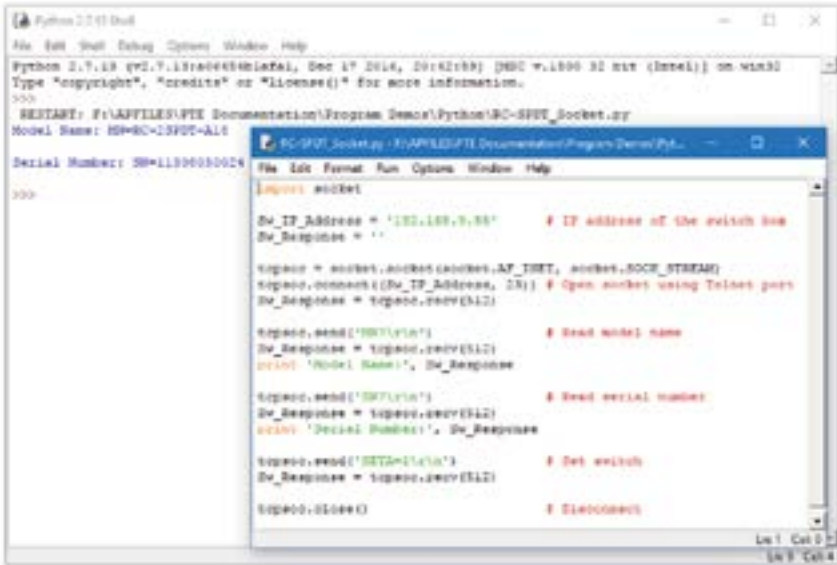


### Ethernet Control of Mechanical Switches

The flexible API (Application Programming Interface) and software package that ships with all of our test equipment supports a huge range of control options.

The examples pictured on this page demonstrate 4 techniques for controlling the RC Series of mechanical switch boxes over a network. With:

1. Internet browser used as a simple console for HTTP communication (top-right)
2. Telnet client used as a simple console for Telnet communication (bottom-left)
3. Custom Python program for flexible automation and control (bottom-right); a wide range of other programming environments and languages are also supported



### Also Available: ZT Series

Rack-mounted assemblies configured to meet your requirements, comprising our mechanical SPDT, SP4T, SP6T, SP8T and transfer switches with Ethernet and USB control interfaces. Custom configurations can be created on request to integrate our full range of RF components and modules.

**NEW!**

## USB/Ethernet **Peak** Power Sensor

10 MHz to 8 GHz, -60 to +20 dBm

Mini-Circuits' PWR-8P-RC is a low cost, compact sensor-head, capable of turning any PC into a high performance power meter. Analyze and graphically plot the peak & average power, duty cycle, pulse width, crest factor, rise & fall times of pulsed, modulated and CW signals. With the 80 dB dynamic range allowing power measurements as low as -60 dBm and as high as +20 dBm, and a fast sampling rate of 2  $\mu$ s, a single power sensor can be used to cover a diverse range of measurement applications.



The dual control interface means the sensor isn't just a traditional USB device, but can also be used for remote power measurements across a network without requiring a direct PC connection. The user-friendly GUI application software for Windows provides a simple means for analyzing the full signal characteristics, plotting the signal traces and exporting the data. Alternatively, the included API allows the full measurement capability to be automated and integrated within your own test software, supported by most common programming environments.

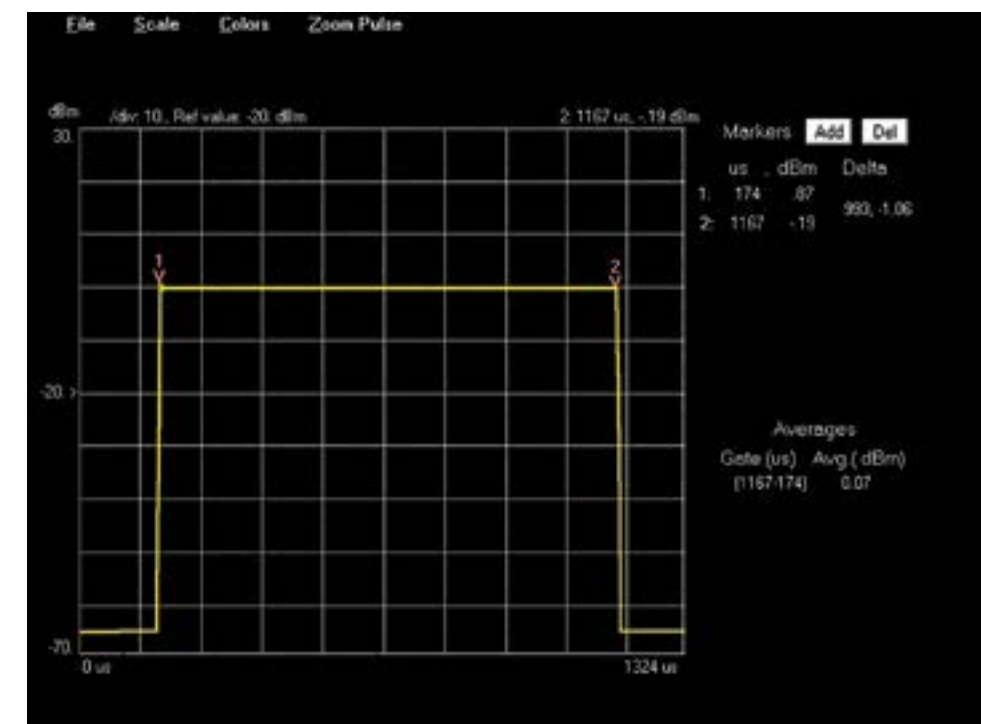
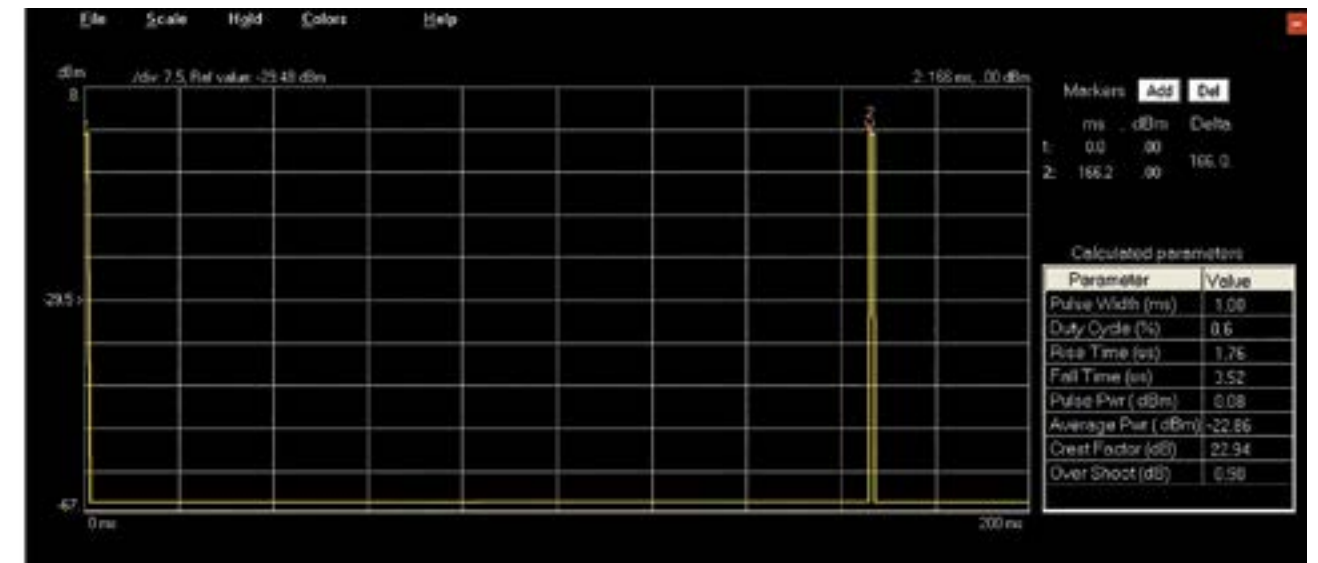
### Features

- Peak & average power of pulsed, CW & modulated waveforms
- Measure power levels down to -60 dBm
- High speed sampling: 2  $\mu$ s
- USB & Ethernet control

### Perfect for...

- Pulse profiling & statistical signal analysis
- Radar characterization (VHF / UHF / L / S / C bands)
- Particle accelerator experimentation
- Telecoms testing (Bluetooth / Wi-Fi / 2G-4G bands)

### Pulse Profiling and Statistical Signal Analysis





# USB/Ethernet Smart Power Sensors

9 kHz to 8 GHz, -45 to +20 dBm

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!



### Features

- CW and True RMS measurement
- Measure signals as low as -45 dBm
- Measurement speed as fast as 10ms
- GUI software supports up to 24 sensors at once
- Measurement averaging and time-scheduled measurement capability
- Small enough to fit in your pocket

### Perfect for...

- Turns almost any Windows or Linux PC into a low-cost Power Meter
- Remote location monitoring
- Automatic, scheduled data collection
- Evaluate high-power, multi-port devices with built-in virtual couplers, attenuators, and other software tools
- Wide range of test applications including 3G, 4G and Wi-Fi products

### Model Specs

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

# Integrated Frequency Counter/Power Sensor

1 to 6000 MHz, -30 to +20 dBm

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 PC via USB or Ethernet.



### Features

- USB & Ethernet control
- Automatically synchronized power & frequency measurements
- Operates with internal or external reference signal
- Automatic frequency calibration & temperature compensation
- Fast measurement speed, 30ms (power), 100ms (frequency)

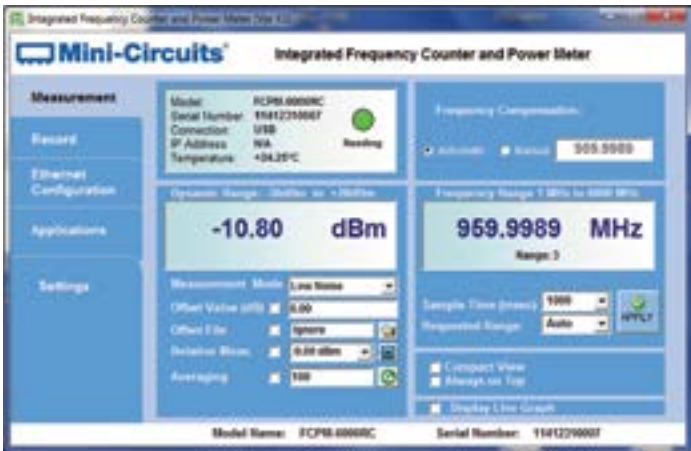
### Perfect for...

- Production test
- Field testing
- Remote location monitoring

### Typical Performance

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

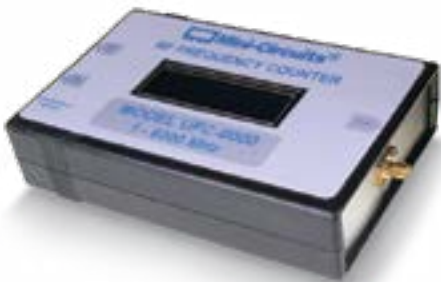
### GUI Main Control



**Frequency Counter**

1-6000 MHz, -28 to +13 dBm

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



**Synthesized Signal Generators**

1 to 6000 MHz, -70 to +15 dBm

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 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.

Features

- USB & Ethernet Control
- Harmonics as low as -66 dBc
- Sweeping and hopping capabilities over frequency and power

Perfect for...

- Production test
- Field testing
- General lab use

Typical Performance

Model	Frequency Range (MHz)	Frequency Resolution (Hz)	Output Power Range (dBm)	Output Power Resolution (dBm)	Modulation	Control Interface
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



## USB I/O Control Boxes

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.



### Features

- 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

### Perfect for...

- Automatic relay control for test equipment
- Control systems

### Models and Key Features

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

### GUI Main Control



## USB/RS232 – SPI Converter

Mini-Circuits' USB/RS232 – SPI converters allow two-way communication with SPI slave devices using either a USB or RS232 port. They operate at 330 kbps 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 female port for RS232 signals.



### Features

- Bi-directional communication:
  - USB <-> SPI
  - RS232 <-> SPI
- Software GUI & API included

### Perfect for...

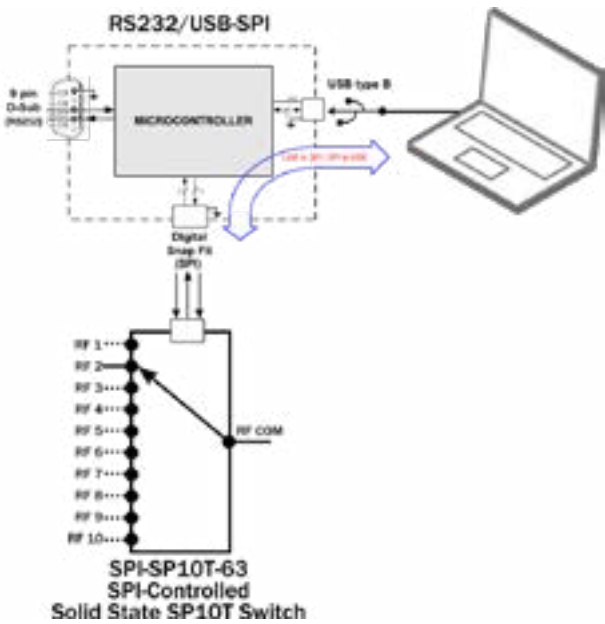
- Interface to SPI test boards / devices
- Control of Mini-Circuits' SPI-SP10T-63 switches

### Models and Key Features

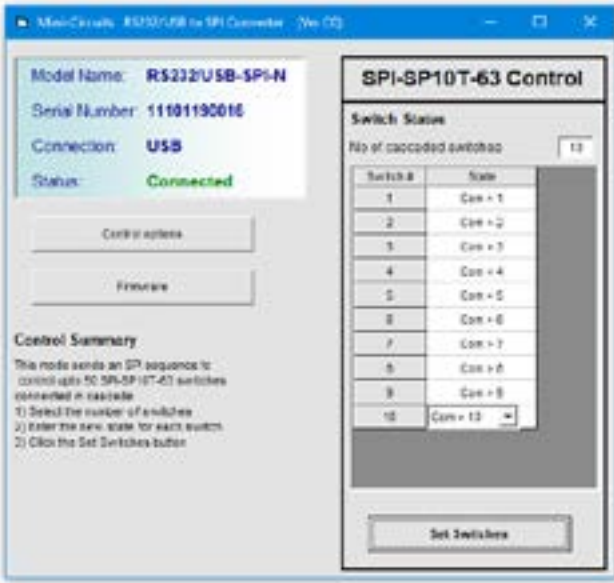
Model	Control	SPI Port	SPI Transmission Rate (kbit/s)	Communication	RS232 Baud Rate (bps)
RS232/USB-SPI	USB / RS232	RJ45	330	Bi-Directional	9600
RS232/USB-SPI-N	USB / RS232	Digital Snap-Fit	330	Bi-Directional	9600

### Application: Communicating with SPI-Controlled Devices using USB-SPI Converter

#### Simplified Schematic



### SPI-SP10T-63 Switch Control GUI



See datasheet for SPI-SP10T-63 for more information:  
<https://www.minicircuits.com/WebStore/dashboard.html?model=SPI-SP10T-63>

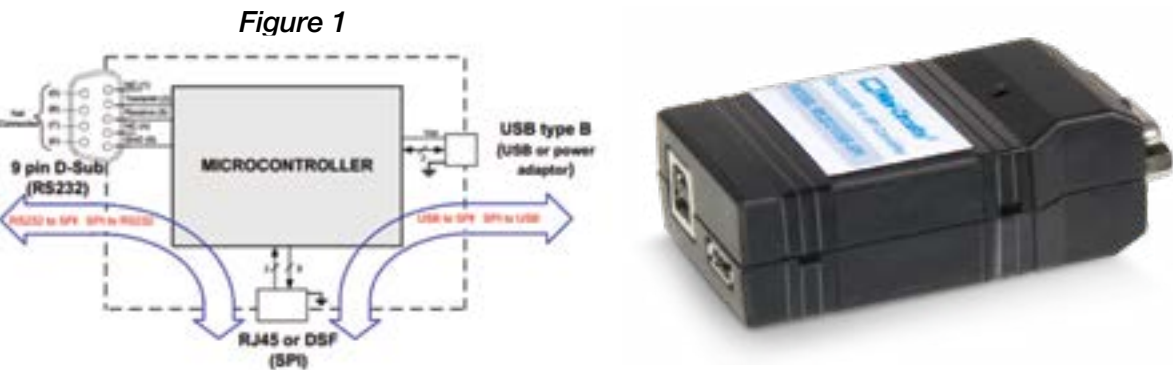
# Application: Bi-Directional USB to SPI Communication Using Mini-Circuits' USB/RS232 – SPI Converter

## 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.



Functional Block Diagram for RS232/USB -SPI Converters

## 2. Application Example - USB Voltage Meter

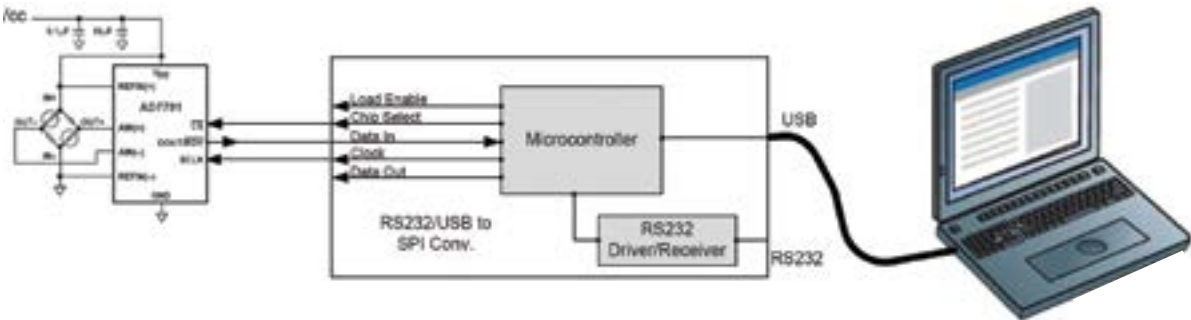
### 2.a Summary

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.



### 2b. 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 department. 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.



# .NET Example Program in LabVIEW for RCM/ZTM Modular Test Systems

The below VI was created to provide an example of how to communicate with an RCM/ZTM modular test unit via USB using the .NET DLL provided by Mini-Circuits

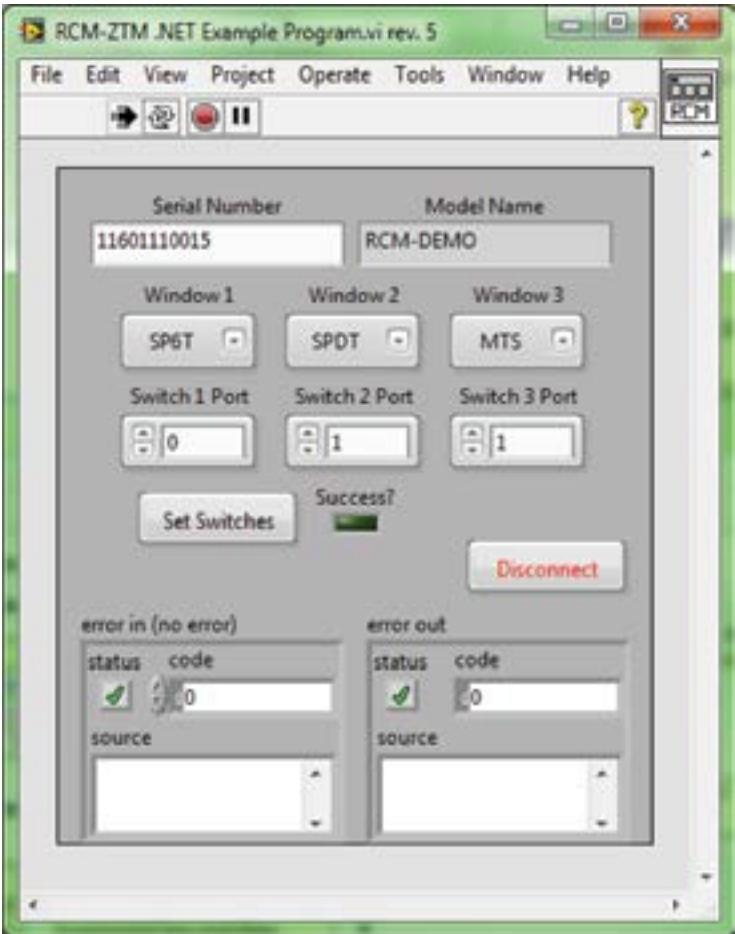
## How to Use the VI (Front Panel)

You'll first need to enter the Serial Number of the unit you wish to connect to before pressing the **Run** button. If only one unit is connected to the PC via USB, then the program will automatically connect to it without a *Serial Number* Input.

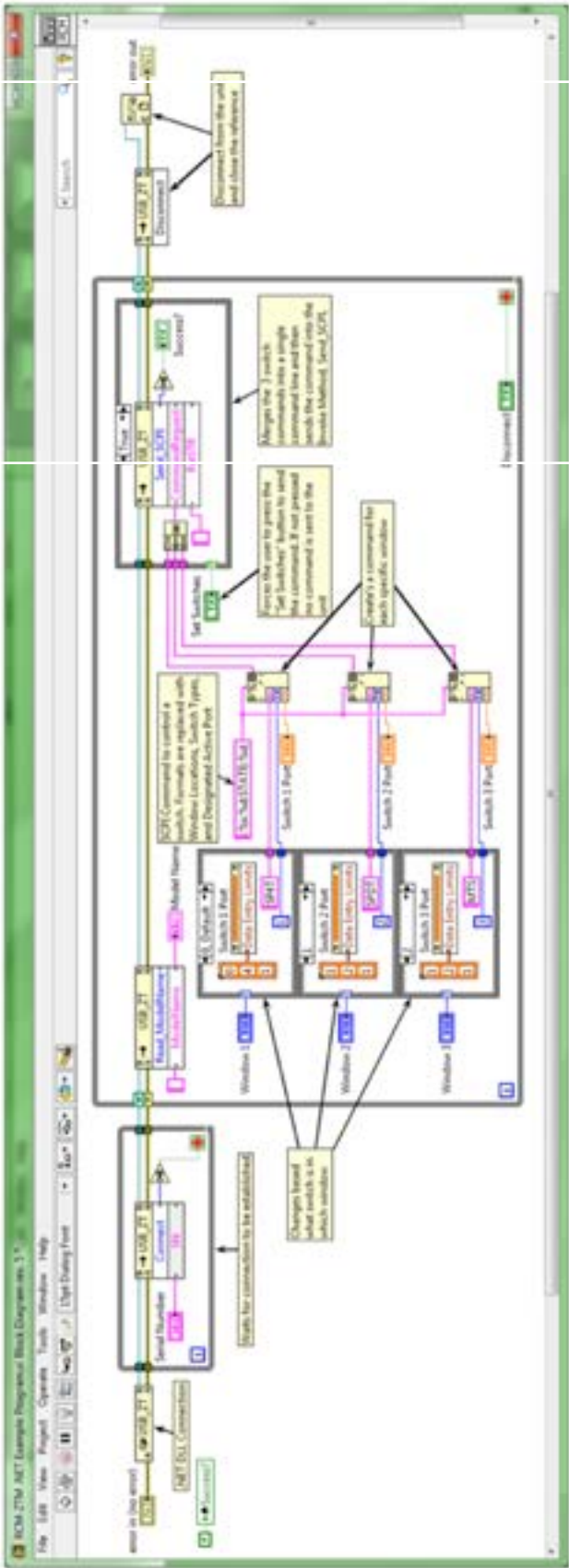
Once connected, you can configure the VI to match the hardware in your unit, either a single SP4T, SPDT, MTS, or SP6T.

Use the Numerical Controls to choose which port you want each switch to be assigned to and then press the **Set Switches** button. If the command was successful, the **Success** LED will light up.

Once you're done using the VI, simply press on the **Disconnect** button to disconnect from the unit and stop the VI.



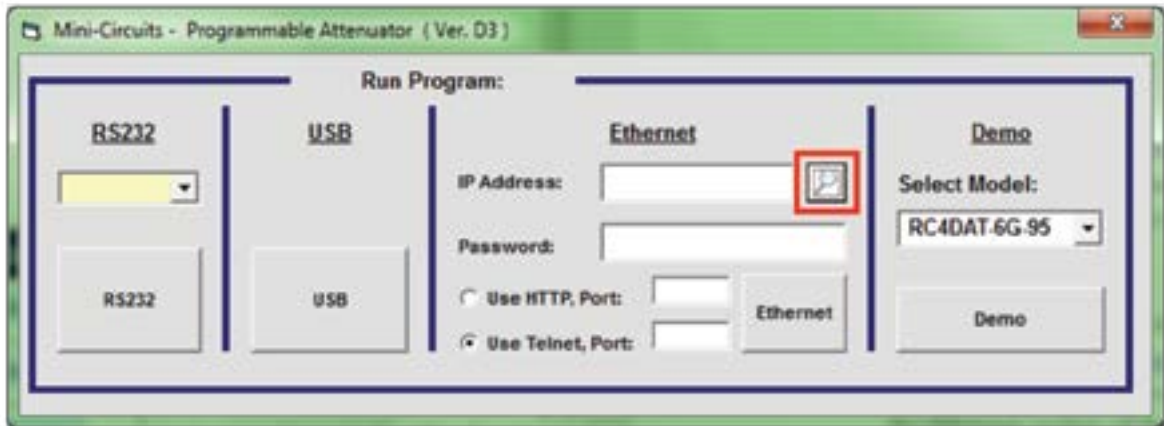
**Block Diagram:**  
Please note all the comments in the Block Diagram to the right. Each comment will explain the function and purpose of the component it points to.



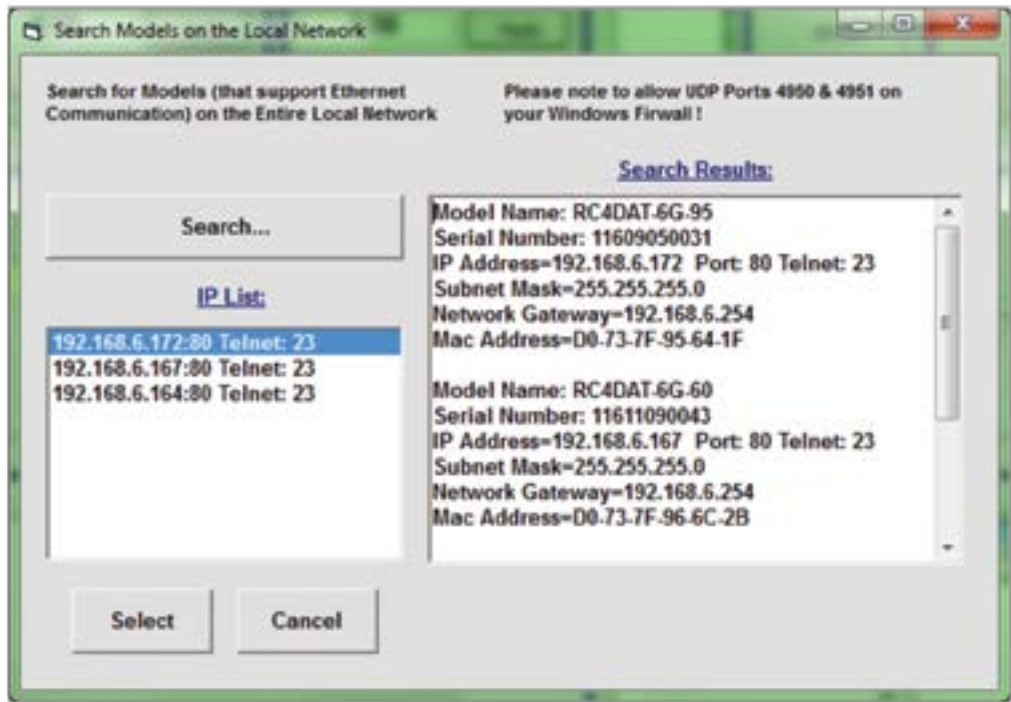
# Multiple Programmable Attenuator Control via Mini-Circuits GUI

The below instructions provide you with insight on how to control multiple RCDAT programmable attenuators using only one computer via the Mini-Circuits GUI. Each of these components are connected to the same network, allowing connection via HTTP or Telnet.

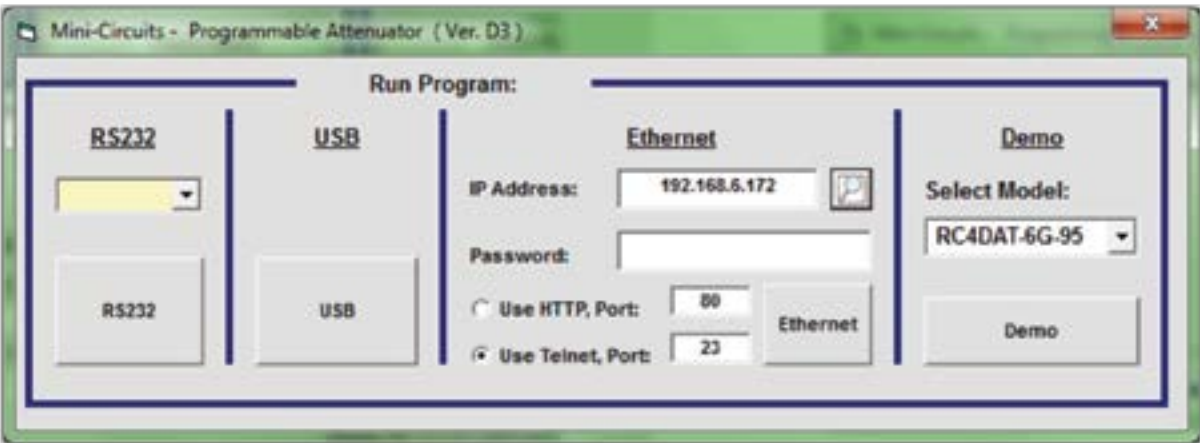
- 1. Open the Programmable Attenuator GUI (the latest version can be found on the Mini-Circuits website here: <https://www.minicircuits.com/softwaredownload/patt.html>)
- 2. Since you'll be using your network to control the attenuators, click on the magnifying glass in the **Ethernet** section of the GUI:



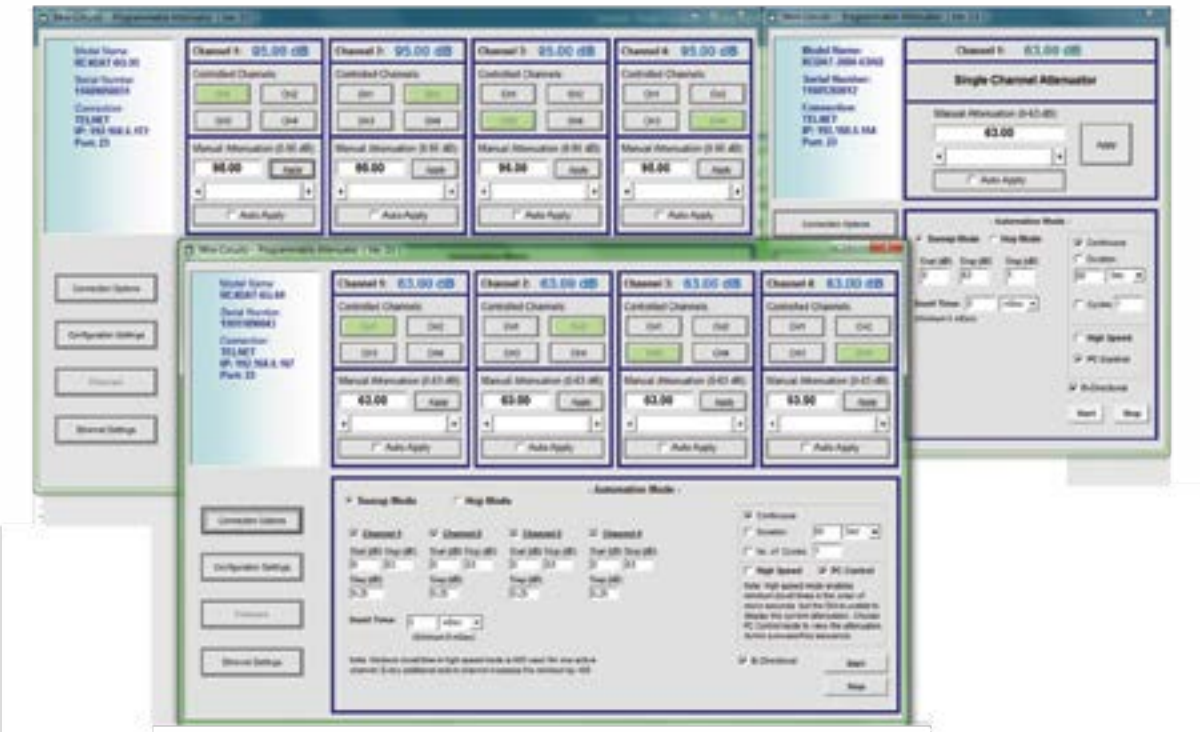
- 3. After clicking the magnifying glass, you should see all units on the network in the IP List, if not simply press the **Search...** button.



- 4. Select the IP address of the first device that you wish to connect to. The IP Address for that unit should now appear in the IP Address slot. Next type in the password for the unit if you've set one and then choose either HTTP or Telnet. Lastly press the Ethernet button.



- 5. The GUI should open based on the unit you selected. To connect to another unit at the same time, simply open the GUI again and connect to another one.
  - a. Please note you cannot use the Connection Options button in the GUI to do this because that creates a new connection using the same instance of the program.
- 6. In the end, you should have a somewhat similar screen to the one below, where multiple instances of the GUI program are running at the same time.





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