USB & RS232

Programmable Attenuator RUDAT-6000-110

50Ω 1 to 6000 MHz 0 to 110 dB 0.25 dB Step SMA Female

THE BIG DEAL

- Wide attenuation range, 110 dB
- Fine attenuation resolution, 0.25 dB
- Short attenuation transition time (650 ns)
- Compact size, 2.50 x 3.00 x 0.60"
- USB and RS232 control

Generic photo used for illustration purposes only

APPLICATIONS

- LTE, 5G FR1, DVB fading simulators
- Wi-Fi device testing
- Signal level calibration
- Automated gain control
- Laboratory instrumentation

PRODUCT OVERVIEW

Mini-Circuits' RUDAT-6000-110 is a general purpose, single channel programmable attenuator suitable for a wide range of signal level control applications from 1 to 6000 MHz. The attenuator provides 0 to 110 dB attenuation in 0.25 dB steps. Its unique design maintains linear attenuation change per dB, even at the highest attenuation settings.

The attenuator is housed in a compact and rugged package with SMA female connectors on the bi-directional input and output RF ports, a standard 9 pin D-Sub port and a USB type Mini-B power and control port.

Full software support is provided, including our user-friendly GUI application for Windows and a full API with programming instructions for Windows and Linux environments (both 32-bit and 64-bit systems).

KEY FEATURES

Feature	Advantages
Programmable attenuation sequences	Configure timed sweep and hop sequences to run unaided without additional user interaction.
110 dB attenuation range	The module provides high-accuracy attenuation up to 110 dB in 0.25 dB steps, allowing the user precise level control over a broad attenuation and frequency range.
High linearity	Typical input IP3 of +52 dBm up to 6000 MHz.
USB and RS232 control	USB HID and RS232 (for serial communication) interfaces provide easy compatibility with a wide range of software setups and programming environments.

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ELECTRICAL SPECIFICATIONS [1], 0 TO +50°C

Parameter	Conditions	Frequency (MHz)	Min.	Typ.	Max.	Unit
Attenuation Range	0.25 dB step	1 - 6000	0	–	110	dB
Attenuation Accuracy [2]	0.25 - 10 dB	1 - 2000	–	±0.15	±(0.25+8.0% of setting)	dB
		2000 - 4000	–	±0.15	±(0.20+6.0% of setting)	
		4000 - 6000	–	±0.10	±(0.30+7.0% of setting)	
	10.25 - 40 dB	1 - 2000	–	±0.55	±(0.40+5.0% of setting)	
		2000 - 4000	–	±0.50	±(0.80+3.0% of setting)	
		4000 - 6000	–	±0.40	±(0.55+5.0% of setting)	
	40.25 - 90 dB	1 - 2000	–	±0.50	±(0.80+2.0% of setting)	
		2000 - 4000	–	±0.25	±(1.00+1.5% of setting)	
		4000 - 6000	–	±0.60	±(1.70+1.0% of setting)	
	90.25 - 110 dB	1 - 2000	–	±0.70	±(-1.30+4.0% of setting)	
		2000 - 4000	–	±0.35	±(1.00+1.5% of setting)	
		4000 - 6000	–	±0.80	±(-1.10+4.0% of setting)	
Insertion Loss	0 dB	1 - 2000	–	6.5	8.5	dB
		2000 - 4000	–	9.0	10.5	
		4000 - 6000	–	9.5	11.5	
Isolation	In-Out [3]	1 - 4000	–	134	–	dB
Return Loss In	0 - 10 dB	1 - 500	–	15	–	dB
		500 - 6000	–	23	–	
	10.25 - 110 dB	1 - 6000	–	23	–	
Return Loss Out	0 - 10 dB	1 - 500	–	15	–	dB
		500 - 3500	–	23	–	
		3500 - 6000	–	15	–	
	10.25 - 110 dB	1 - 6000	–	17	–	
IP3 Input [4]	0 dB setting (P_{IN}= +10 dBm)	1 - 3000	–	+53	–	dBm
		3000 - 6000	–	+51	–	
Attenuation Transition Time [5]	–	1 - 6000	–	650	–	ns
Minimum Dwell Time [6]	High-speed mode	1 - 6000	–	600	–	µs

1. Attenuator RF ports support simultaneous, bi-directional signal transmission, within the specified power limits. However the specifications are guaranteed for the RF In and RF Out as noted on the label. There may be minor changes in performance when injecting signals to the RF Out port.
2. Max accuracy defined as ±[absolute error+% of attenuation setting]. For example, if a 20 dB attenuation at a given frequency is defined as max accuracy of "±(0.5 + 3.0%)" then the maximum error at those settings will be: ±(0.5+0.03x20)= ±(0.5+0.6)= ± 1.1 dB.
3. Isolation within a channel is defined as max attenuation plus insertion loss; this is the path loss through the attenuator when initially powered up. After a brief delay (~0.5 sec typically) the attenuator will revert to a user defined "power-up" state (either max attenuation or a pre-set value).
4. Tested with 1 MHz span between signals.
5. Attenuation Transition Time is specified as the time between starting to change the attenuation state and settling on the requested attenuation state.
6. Minimum Dwell Time is the minimum time from settling on one attenuation level to settling to a new one in response to command (without communication protocol delays).

ELECTRICAL SPECIFICATIONS, 0 TO +50°C (CONTINUED)

Parameter	Conditions	Frequency (MHz)	Min.	Typ.	Max.	Unit
Supply Voltage (V_{DC})	USB port / D-Sub pin #1 [7]	–	4.75	5.00	5.25	V
Supply Current (I_{DC})		–	–	190	250	mA
Operating Input Power [8]	0 - 110 dB	1 - 50	–	–	Note 9	dBm
		50 - 6000	–	–	+23	

7. Supply voltage of +5V at pin #1 of D-Sub connector applies to units with S/N 11403230000 and greater.
8. Total Operating Input Power from both RF In and RF Out ports. Compression level not noted as it exceeds max safe operating power level.
9. Derates linearly from +23 dBm at 50 MHz to +9 dBm at 1 MHz.

ABSOLUTE MAXIMUM RATINGS [10, 11]

Operating Temperature		0°C to +50°C
Storage Temperature		-20°C to +85°C
DC Voltage @ RF Ports		16 V
V_{USB} MAX		6 V
D-Sub pins' Voltage input	**Pin #1**	-1 V to +6 V
	Pin #2	0 V to +4 V
	Pin #3	-30 V to +30 V
Max RF Power	**1 - 50 MHz**	Derates linearly from +26 dBm at 50 MHz to +12 dBm at 1 MHz
	50 - 6000 MHz	+26 dBm

10. Permanent damage may occur if any of these limits are exceeded.
11. Operating in the range between operating power limits and absolute maximum ratings for extended periods of time may result in reduced life and reliability.

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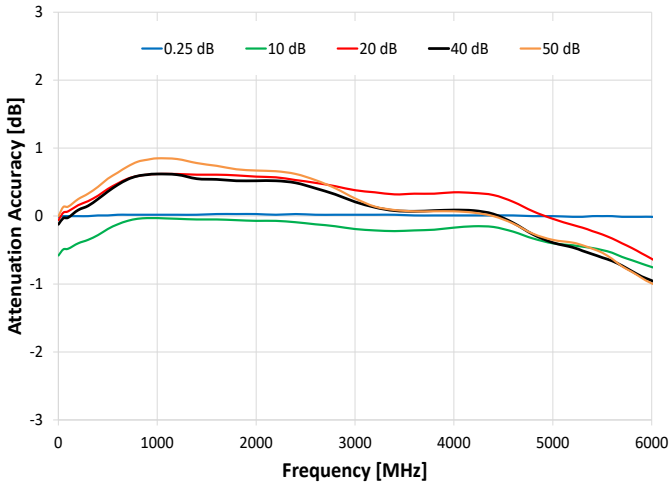
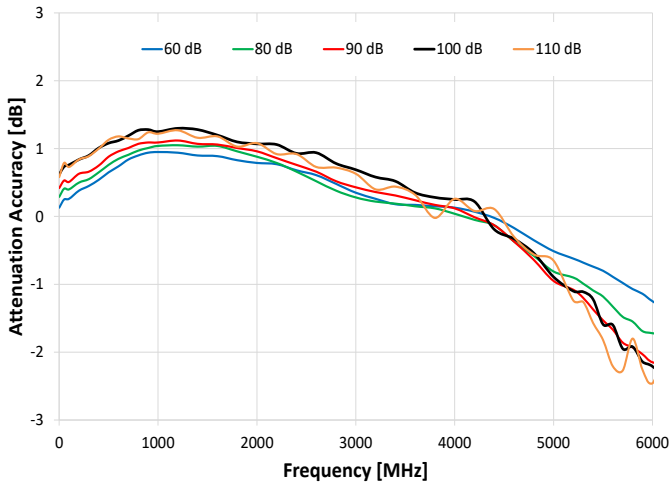
TYPICAL PERFORMANCE GRAPHS

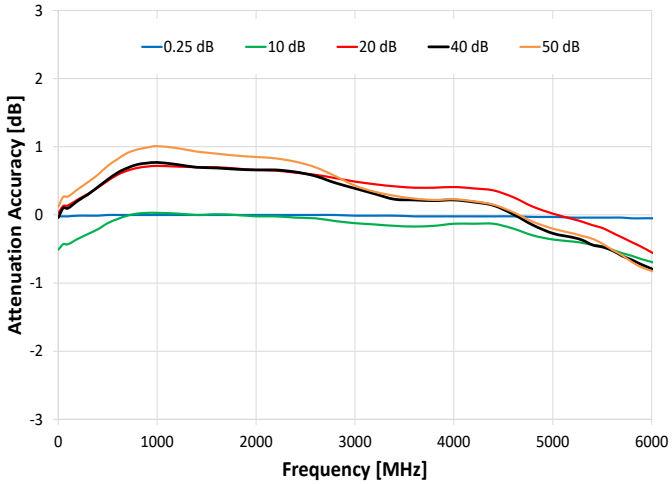
Attenuation Accuracy @ 0°C vs. Frequency



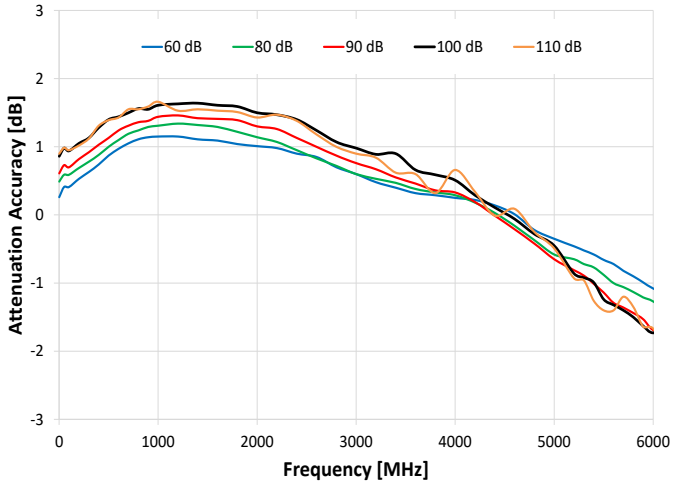
Attenuation Accuracy @ 0°C vs. Frequency



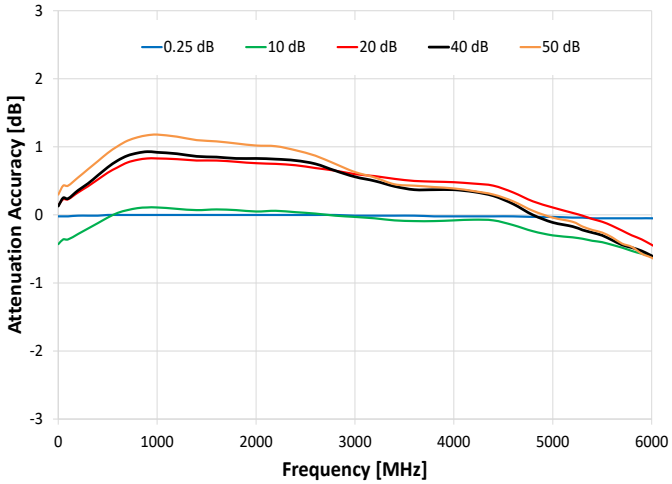
Attenuation Accuracy @ 25°C vs. Frequency



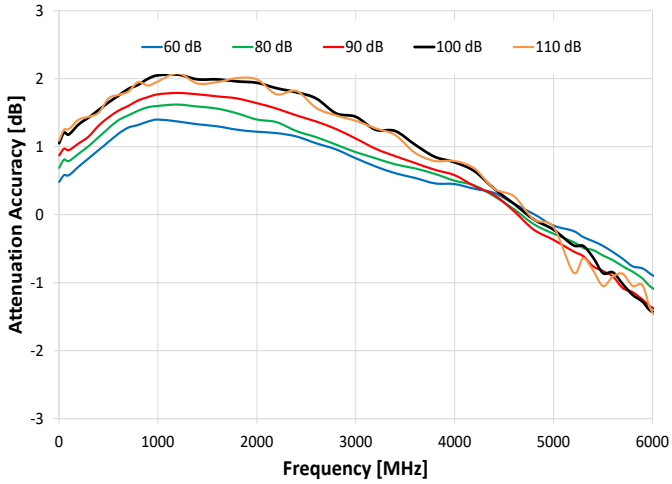
Attenuation Accuracy @ 25°C vs. Frequency



Attenuation Accuracy @ 50°C vs. Frequency



Attenuation Accuracy @ 50°C vs. Frequency



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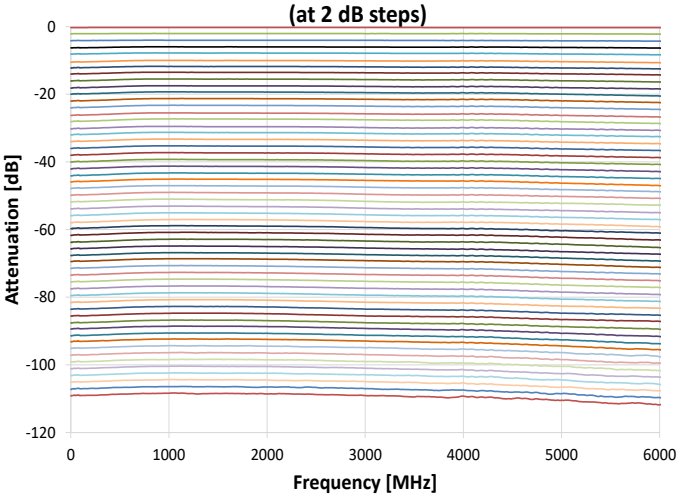
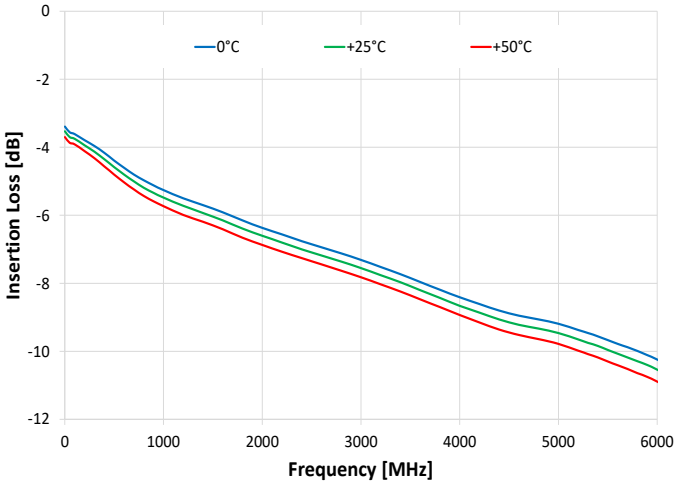
TYPICAL PERFORMANCE GRAPHS (CONTINUED)

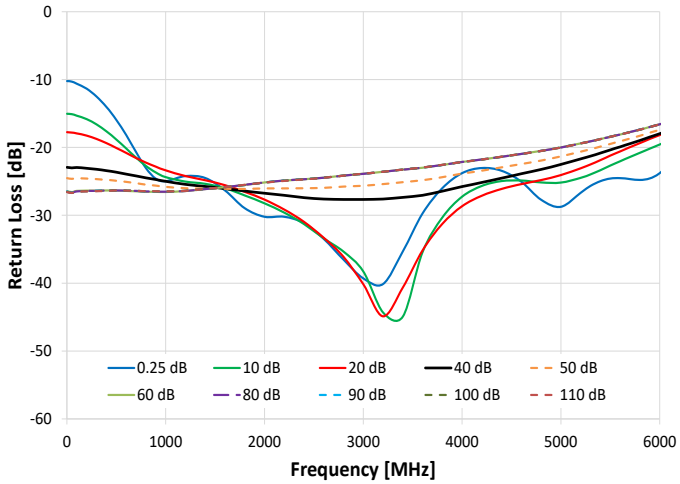
Attenuation relative to Insertion Loss vs. Frequency (at 2 dB steps)



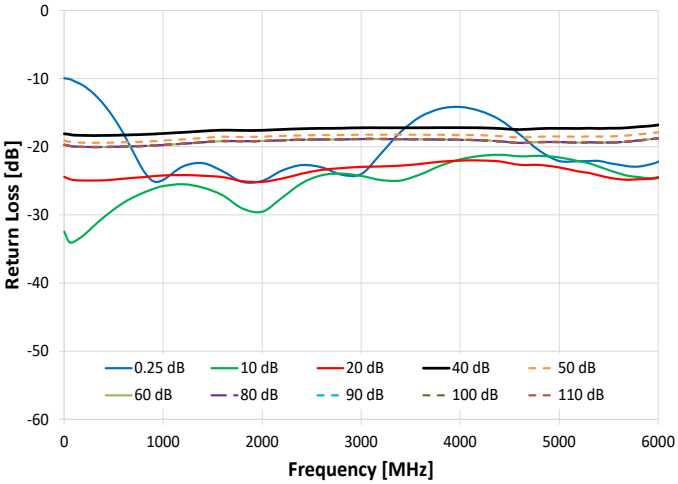
Insertion Loss vs. Frequency



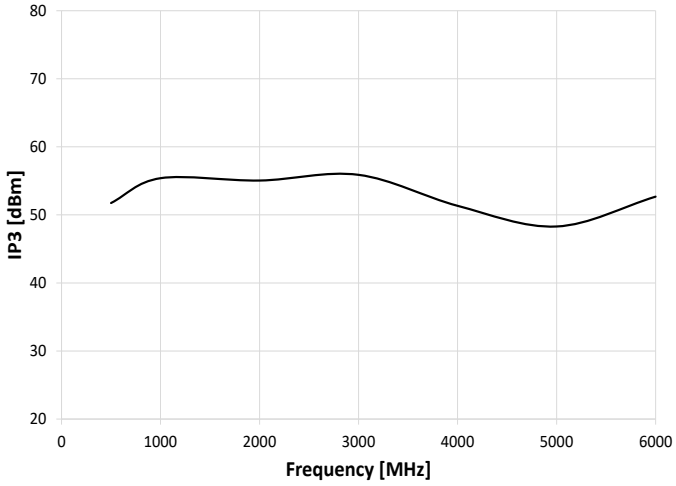
Return Loss In vs. Frequency



Return Loss Out vs. Frequency



IP3 @ 0 dB Attenuation vs. Frequency



CONTROL INTERFACES

USB Control	Protocol	HID (Human Interface Device) - Full-speed
	Min Communication Time [12]	3 ms typical (full transmit/receive cycle)
RS232 Control	Protocol	Meets RS232 standard at all voltages with RS232 communications set to 9600 bps; 8 bit word; no parity; stop bit = '1'.

12. USB Min Communication Time is based on the polling interval of the USB HID protocol (1 ms polling interval, 64 bytes per packet), medium CPU load and no other high-speed USB devices using the USB bus.

SOFTWARE & DOCUMENTATION

Mini-Circuits' full software and support package including user guide, Windows GUI, API, programming manual and examples can be downloaded free of charge (refer to the last page for the download path).

A comprehensive set of software control options is provided:

- GUI for Windows – Simple software interface for control via Ethernet and USB.
- Programming / automation via USB:
  - DLL files provide a full API for Windows with a set of intuitive functions which can be implemented in any programming environment supporting .Net Framework or ActiveX.
  - Direct USB programming is possible in any other environment (not supporting .Net or ActiveX).

Please contact testsolutions@minicircuits.com for support.

MINIMUM SYSTEM REQUIREMENTS

GUI	Windows 7 or later
USB API DLL	Windows 7 or later and programming environment with ActiveX or .NET support
USB Direct Programming	Linux, Windows 7 or later
Hardware	Intel i3 (or equivalent) or later

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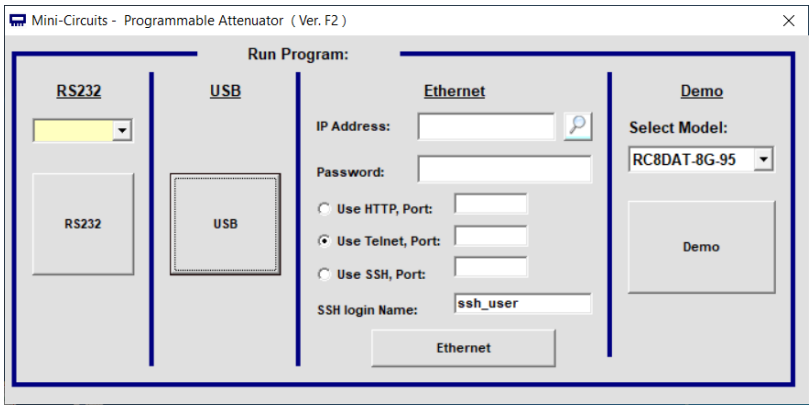
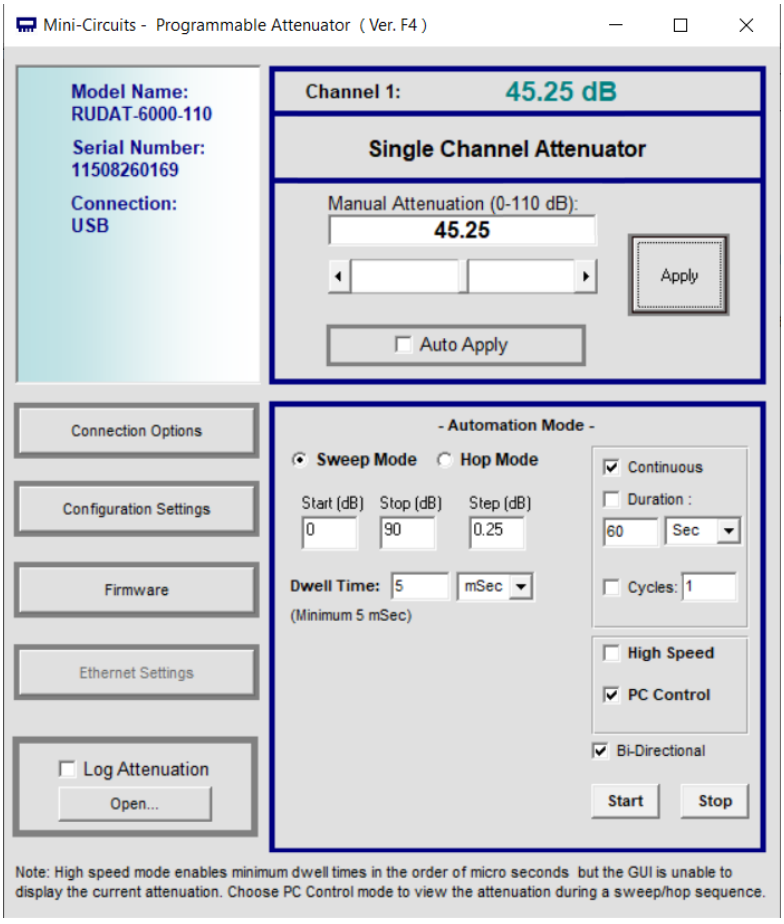
GRAPHICAL USER INTERFACE (GUI) FOR WINDOWS - KEY FEATURES

- Connect via USB or Ethernet to control the module.
- Run GUI in "demo mode" to evaluate software without a hardware connection.



- Manual attenuation setting.
- Sweep and Hop attenuation sequences directed from the PC, or entire sequence loaded into the module.
- Attenuator address configuration and firmware upgrade.
- Attenuation at power up may be set to selected attenuation level or last attenuation state recorded.



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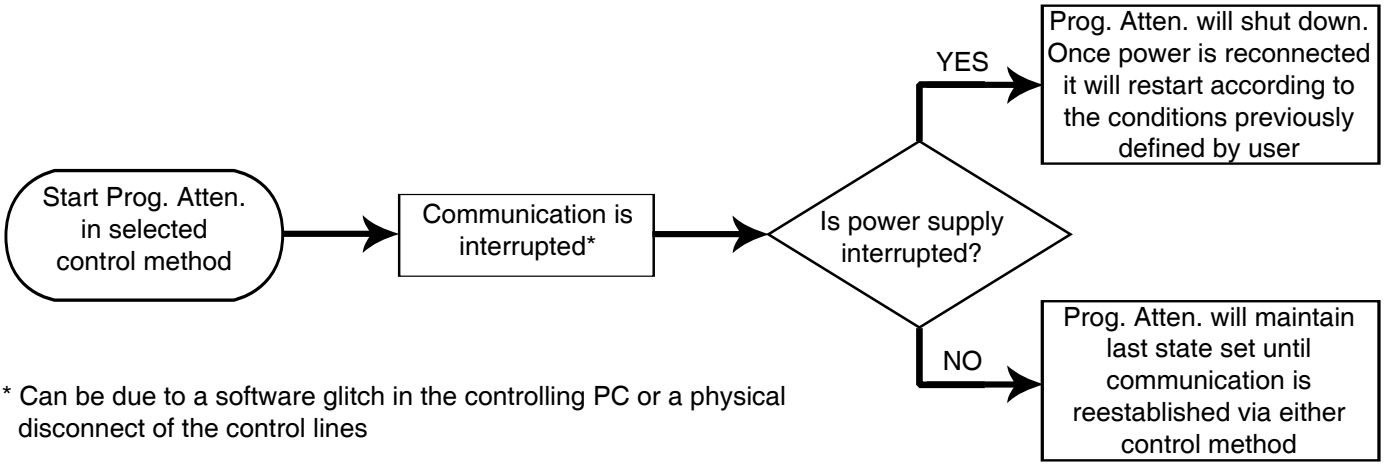
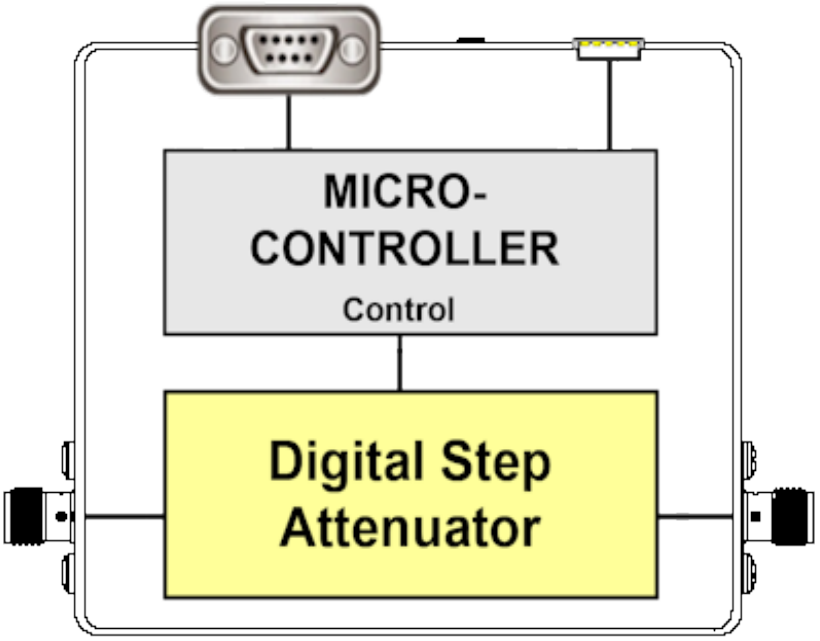
PROGRAMMABLE ATTENUATOR RESPONSE TO COMMUNICATION INTERRUPT



* Can be due to a software glitch in the controlling PC or a physical disconnect of the control lines

BLOCK DIAGRAM



Simultaneous, bidirectional RF signal transmission with symmetrical performance

CONNECTIONS

Port Name	Connector Type
RF In & Out (50Ω)	SMA female
USB	USB type Mini-B female
RS232	9-pin D-Sub female

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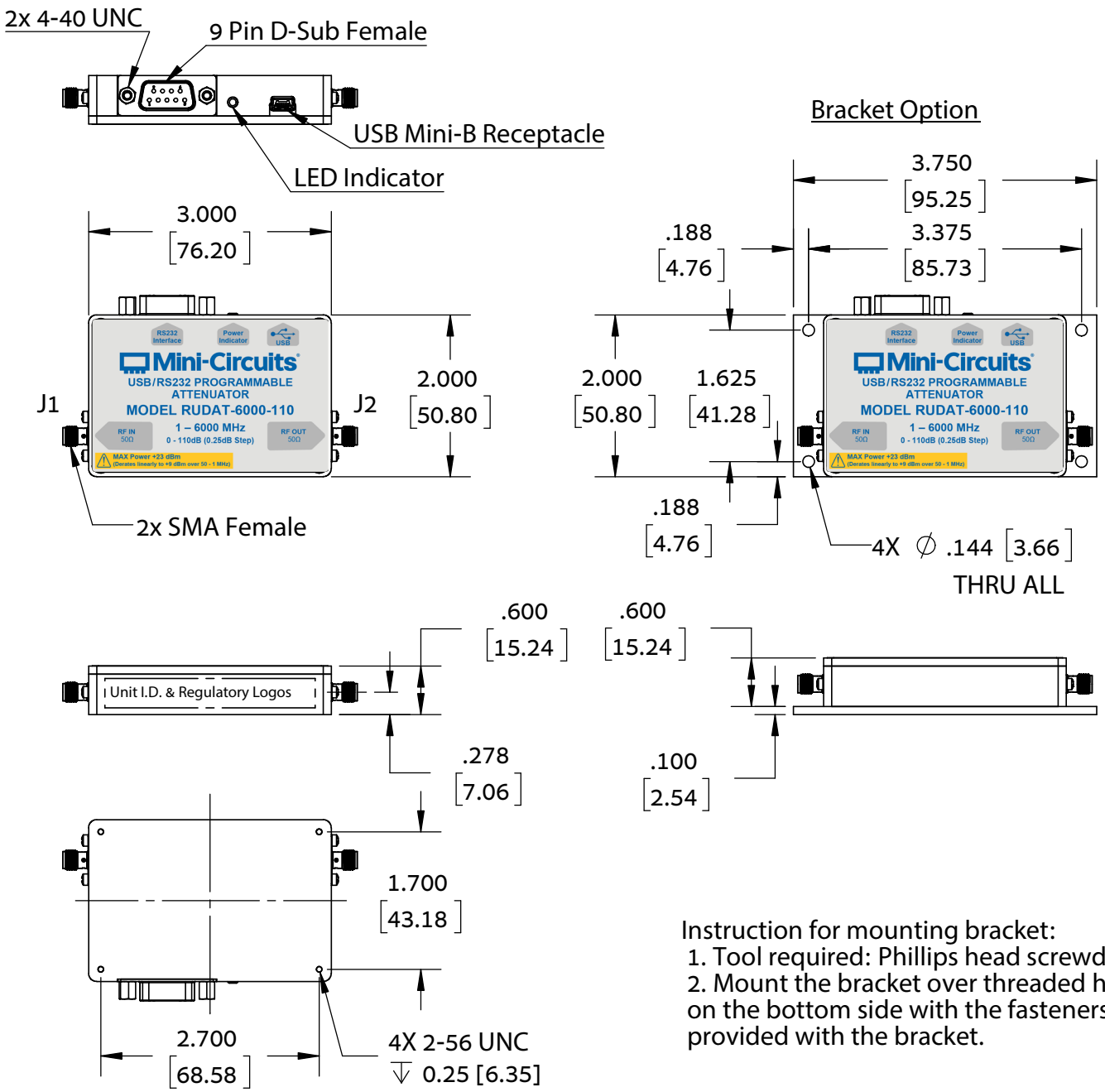
CASE STYLE DRAWING (MS1813)



Instruction for mounting bracket:
1. Tool required: Phillips head screwdriver
2. Mount the bracket over threaded holes on the bottom side with the fasteners provided with the bracket.

NOTES:
1. Case material: Aluminum alloy.
2. Case Finish: Nickel Plate.
3. Dimensions: Inches [mm]. Tolerances 2 Pl. ±.03 inch; 3 Pl. ±.015 inch.
4. Weight: 130 grams
5. Marking may contain other features or characters for internal lot control.

D-SUB PIN CONNECTIONS

The RS232 uses the D-Sub 9-pin connector so special attention must be paid to the standards requirements when designing a control cable.

Note in particular that RUDAT modules do not use the RS232 RTS (Ready to Send) function which is commonly implemented on pin #7 so it is important to disconnect this pin for RS232 control.

Pin #	RS232 control
1	Optional +5 V_{DC}
2	RS232 transmit (Tx)
3	RS232 recieve (Rx)
4	Do not connect
5	Ground (GND)
6	Do not connect
7	Do not connect
8	Do not connect
9	Do not connect

RS232 CONTROL PINS

- Only pins #2 and #3 should be used for control.
- Pin #5 should be grounded.
- Pin #1 can be used to provide the +5 V_{DC} supply voltage instead of the USB port.
  When USB power is connected, pin #1 may be connected to GND or supply voltage (+) or remain disconnected.
- All other pins must be disconnected in the control cable.

Note: Pin connections marked in red (in the pin connection table) should not be connected to allow proper device operation.

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DETAILED MODEL INFORMATION IS AVAILABLE ON OUR WEBSITE CLICK HERE

Performance Data & Graphs	**Data** **Graphs**
Case Style	**MS1813**
Environmental Rating	**ENV55T1**
Software, User Guide & Programming Manual	https://www.minicircuits.com/softwaredownload/patt.html
Regulatory Compliance	Refer to user guide for compliance information CE FC UK CA https://www.minicircuits.com/app/AN49-011.pdf
Support	testsolutions@minicircuits.com

INCLUDED ACCESSORIES [13]

	Part No.	Description	Qty.
	MUSB-CBL-3+	3.3 ft (1.0 m) USB cable: USB type A (Male) to USB type Mini-B (Male)	1

13. Additional quantities are available for purchase as optional accessories.

OPTIONAL ACCESSORIES

	Part No.	Description
	MUSB-CBL-7+	6.6 ft (2.0 m) USB cable: USB type A (Male) to USB type Mini-B (Male)
	D-SUB9-MF-6+	6.0 ft (1.8 M) RS232 Cable: 9 pin D-Sub (Male) to 9 pin D-Sub (Female)
	USB-AC/DC-5+	AC/DC +5V power adaptor with USB connector [14, 15]
(N/A)	BKT-3901+	Bracket kit including 3.75" x 2.50" bracket, mounting screws and washers

14. The power adaptor may be used to provide additional power via USB port when connecting several units in daisy chain control.
15. Includes power plugs for US, UK, EU, IL, AU & China. Plugs for other countries are also available. If you need a power cord for a country not listed, please contact testsolutions@minicircuits.com

NOTES:

A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
C. The parts covered by this specification document are subject to Mini-Circuits standard limited warranty and terms and conditions (collectively, "Standard Terms"); Purchasers of this part are entitled to the rights and benefits contained therein. For a full statement of the Standard Terms and the exclusive rights and remedies thereunder, please visit Mini-Circuits' website at https://www.minicircuits.com/terms/viewterm.html