

Programmable Attenuator

RUDAT-6000-60

50Ω 0 – 60 dB, 0.25 dB step 1 to 6000 MHz

The Big Deal

- Attenuation range, 60 dB
- Fine attenuation resolution, 0.25 dB
- Short attenuation transition time (650 ns)
- Compact size, 2.0 x 3.0 x 0.6"
- **USB and RS232** control

Applications

- Automated Test Equipment (ATE)
- WiMAX, 3G, 4G, LTE, DVB Fading Simulators
- Laboratory Instrumentation
- Handover system Evaluation
- Power level cycling

Product Overview

Mini-Circuits' RUDAT-6000-60 is a general purpose, single channel programmable attenuator suitable for a wide range of signal level control applications from 1 MHz to 6 GHz. The Attenuator provides 0 to 60 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 and a USB type Mini-B power and control ports.

The attenuator can be controlled via USB or RS232 (via D-Sub connector). Full software support is provided and can be downloaded from our website any time at <http://www.minicircuits.com/softwaredownload/patt.html>. The package includes 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
USB control	The RUDAT-6000-60 can be controlled from any Windows® or Linux® computer with a USB connection. Power may be supplied via either USB or the D-sub connector
RS232 control	The user may also control the RUDAT-6000-60 via RS232 connection, allowing serial communication with the device. Power may be supplied via either USB or the D-sub connector
Programmable attenuation sweep and Hop sequences	The RUDAT-6000-60 can be programmed with a timed sequence of attenuation settings, to run without any additional external control
60 dB attenuation range.	The RUDAT-6000-60 provides high-accuracy attenuation up to 60 dB in 0.25 dB steps, allowing the user precise level control over a broad attenuation and frequency.
High linearity	Typical input IP3 of +50 dBm up to 6000 MHz

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Package Software

Case Style: MS1813

Included Accessories

Model No.	Description	Qty.
MUSB-CBL-3+	2.6 ft. USB cable	1

RoHS Compliant

See our web site for RoHS Compliance methodologies and qualifications

Electrical Specifications ¹ at 0°C to 50°C

Parameter	Frequency range	Conditions	Min.	Typ.	Max.	Units
Attenuation range	1 - 6000 MHz	0.25 dB step	0	-	60	dB
Attenuation accuracy ²	1 - 6000 MHz	@ 0.25 - 10 dB	-	±0.15	±(0.20+9.5% of nominal value)	dB
		@ 10.25 - 20 dB	-	±0.40	±(0.80+4% of nominal value)	
		@ 20.25 - 40 dB	-	±0.25	±1.60	
		@ 40.25 - 60 dB	-	±0.25	±(1.45+1% of nominal value)	
Insertion Loss	1 - 3000 MHz	@ 0 dB	-	3.4	5.5	dB
	3000 - 6000 MHz		-	5.0	7.0	
Input operating power ³ (RF In and RF Out ports)	1 - 10 MHz	@ 0 - 60 dB	-	-	+10	dBm
	10 - 6000 MHz		-	-	+20	
Isolation In-Out	1 - 6000 MHz	Note 4	-	68	-	dB
IP3 Input ⁵	1 - 6000 MHz	@ 0 dB setting (P _{IN} =+10 dBm)	-	+50	-	dBm
VSWR	1 - 500 MHz	@ 0 - 20 dB	-	1.35	-	:1
		@ 20.25 - 60 dB	-	1.2	-	
	500 - 4000 MHz	@ 0 - 20 dB	-	1.3	-	
		@ 20.25 - 60 dB	-	1.2	-	
	4000 - 6000 MHz	@ 0 - 20 dB	-	1.45	-	
		@ 20.25 - 60 dB	-	1.45	-	
Min Dwell Time ⁶	1 - 6000 MHz	High speed mode	-	600	-	µsec
Attenuation Transition Time ⁷	1 - 6000 MHz	-	-	650	-	nsec
Supply Voltage ^{8,9}	-	via USB port or D-Sub Pin#1	4.75	5	5.25	V
DC current draw	-	-	-	60	80	mA
RS232 logic levels	Meets RS232 standard at all voltages with RS232 communications set to 9600 bps; 8 bit word; no parity; stop bit = '1'.					

¹ Attenuator RF ports are interchangeable, and support simultaneous, bidirectional signal transmission, 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 when setting the attenuator to 18 dB attenuation the maximum error will be: ±(0.95+0.02x18)= ±(0.95+0.36)= ± 1.31 dB.

³ Total operating input power from both RF In and RF Out out ports. Compression level not noted as it exceeds max safe operating power level.

⁴ Isolation 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).

⁵ Tested with 1 MHz span between signals.

⁶ Minimum Dwell Time is the time the RUDAT will take to respond to a command to change attenuation states without communication delays. In PC control add communication delays (on the order of msec for USB) to get actual response time.

⁷ Attenuation Transition Time is specified as the time between starting to change the attenuation state and settling on the requested attenuation state.

⁸ Supply voltage +5V at Pin#1 of D-sub connector applies to units with S/N 11407150001 and greater.

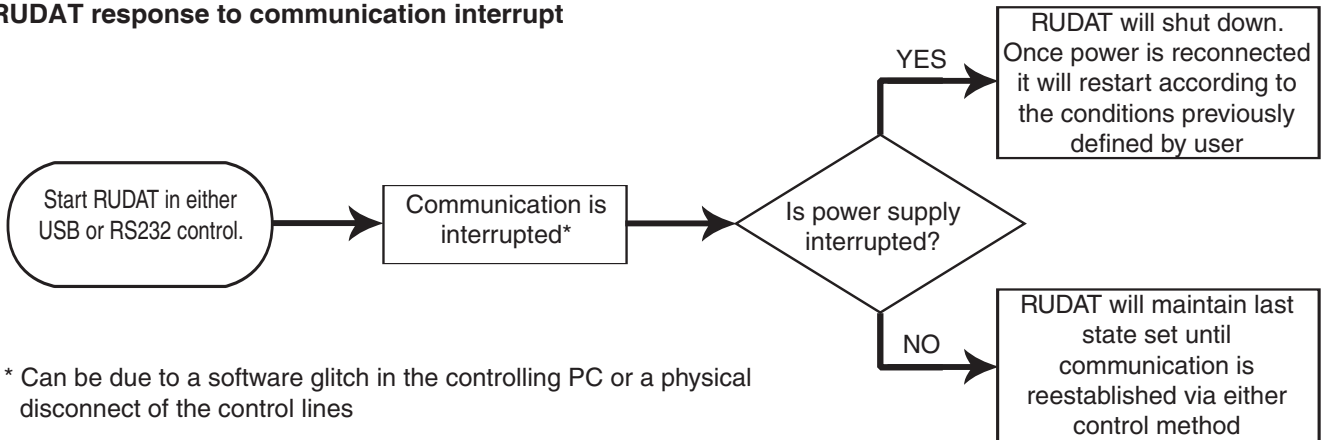
⁹ Power on sequence for RS232 control: Connect 5V power followed by the control lines.

Absolute Maximum Ratings

Operating Temperature	0°C to 50°C	
Storage Temperature	-20°C to 85°C	
Voltage input at RS232 receive pin	-30V to +30V	
Voltage input at RS232 transmit pin	0V to +4V	
Voltage input at RS232 Pin#1	-1V to +6V	
V _{USB} Max.	6V	
DC voltage at RF port	16V	
Total RF power for RF In & RF Out	@ 1 to 10 MHz	+13 dBm
	@ 10 to 6000 MHz	+23 dBm

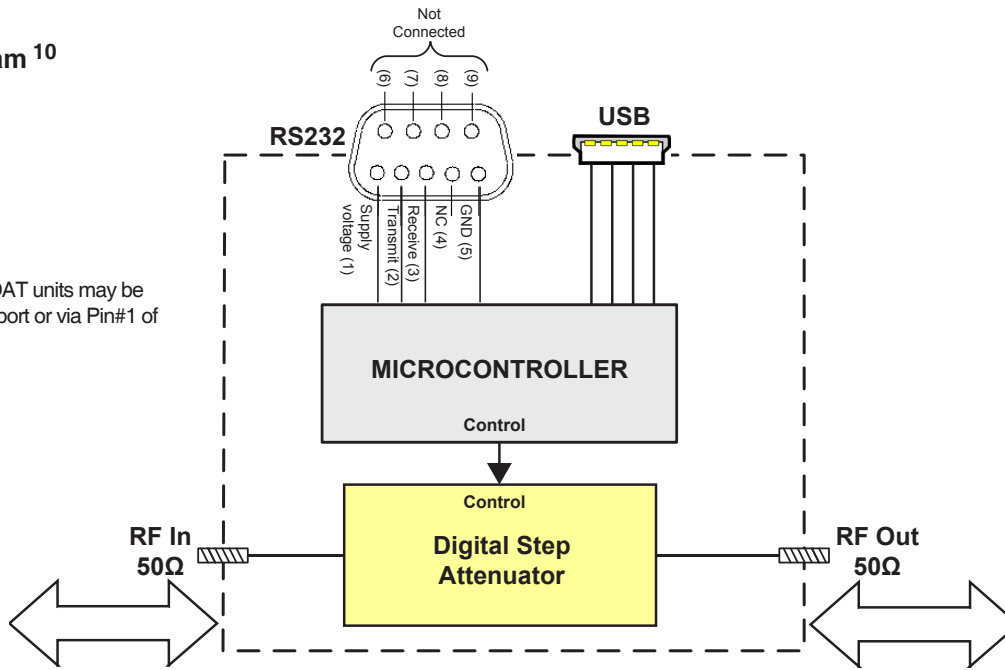
Permanent damage may occur if any of these limits are exceeded. Operation in the range between the max operating power and the absolute maximum rating for extended periods of time may result in reduced life and reliability.

RUDAT response to communication interrupt



Block Diagram ¹⁰

The 5V_{DC} for RUDAT units may be input via the USB port or via Pin#1 of the D-Sub port.



Simultaneous, bidirectional RF signal transmission with symmetrical performance

Connections

RF IN	(SMA female)
RF OUT	(SMA female)
USB	(USB type Mini-B female)
RS232*	(9 Pin D-Sub female)

*9 Pin D-Sub Pin Connections ¹⁰

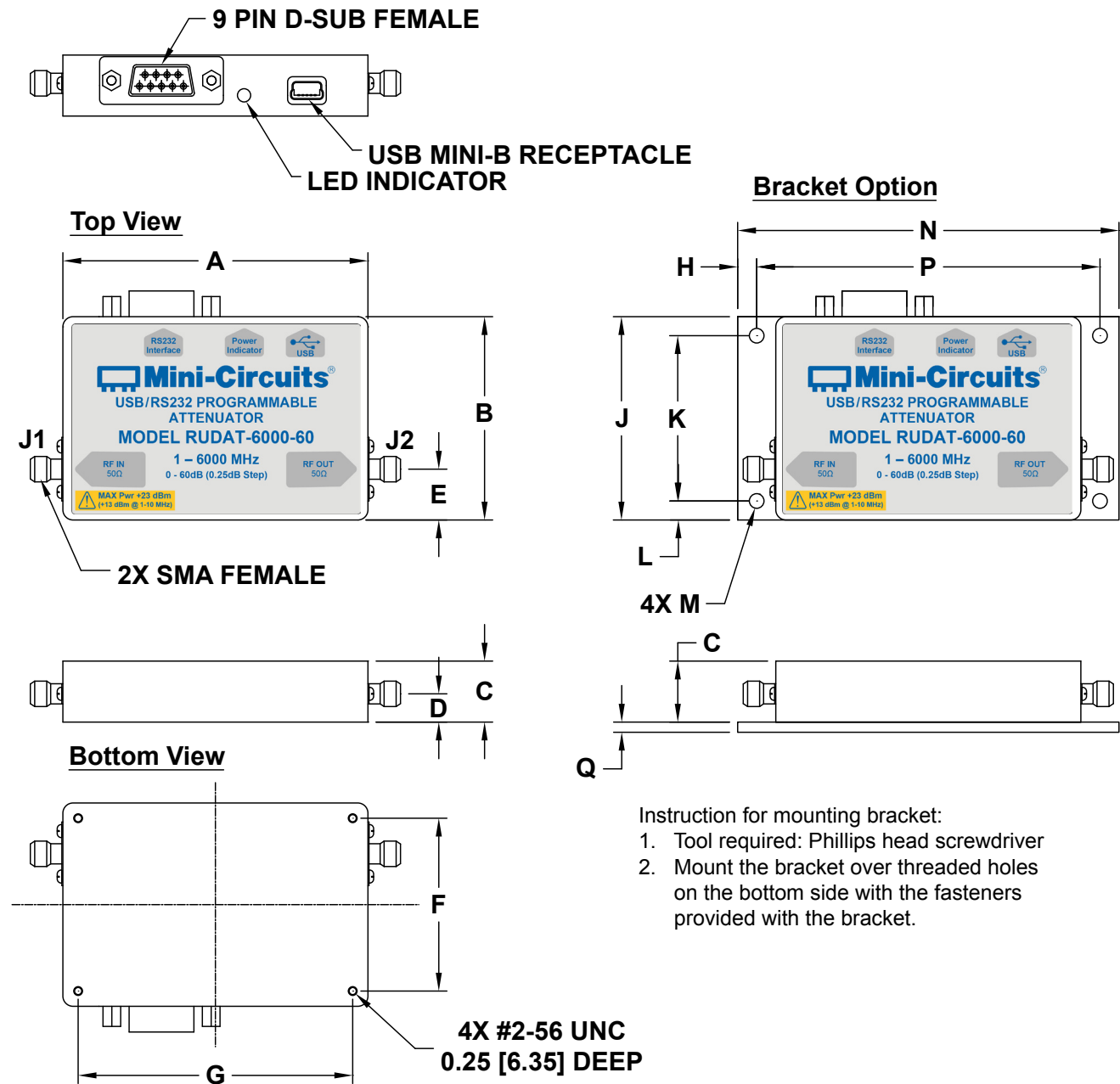
PIN Number	Function
2	Transmit
3	Receive
5	GND
1	+5 V _{DC} ^{11,12}
4,6-9	Not Connected

¹⁰ Block diagram and connection shown apply to units with S/N 11407150001 and greater, for units with lower S/N see archive section on page 9.

¹¹ Pin#1 can be used as supply voltage (+) pin instead of USB connection. When USB power is connected, Pin#1 may be connected to GND or supply voltage (+) or remain disconnected.

¹² Power on sequence for RS232 control: Connect 5V power followed by the control lines.

Outline Drawing (MS1813)

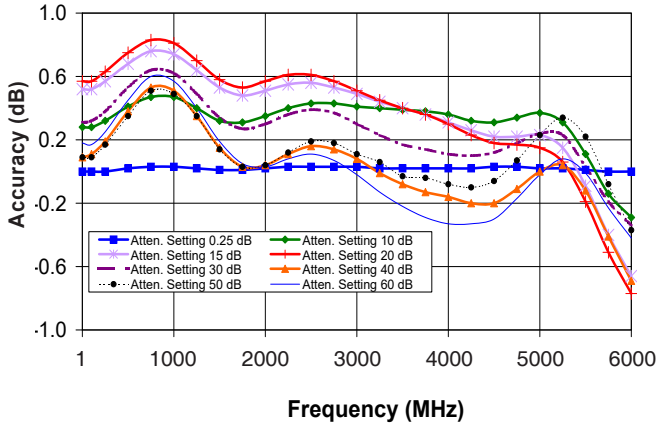


Outline Dimensions (inch/mm)

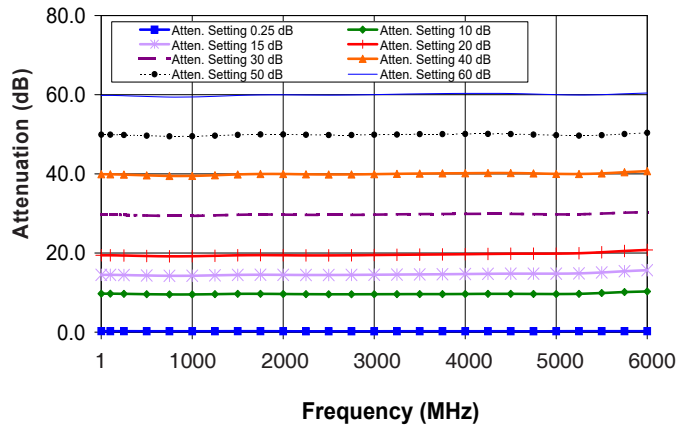
A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	WT. GRAMS
3.00	2.00	0.60	0.28	0.50	1.700	2.700	0.188	2.00	1.625	0.188	0.144	3.75	3.375	0.100	130
76.2	50.8	15.2	7.1	12.7	43.18	68.58	4.76	50.8	41.28	4.76	3.66	95.3	85.72	2.54	

Typical Performance Curves

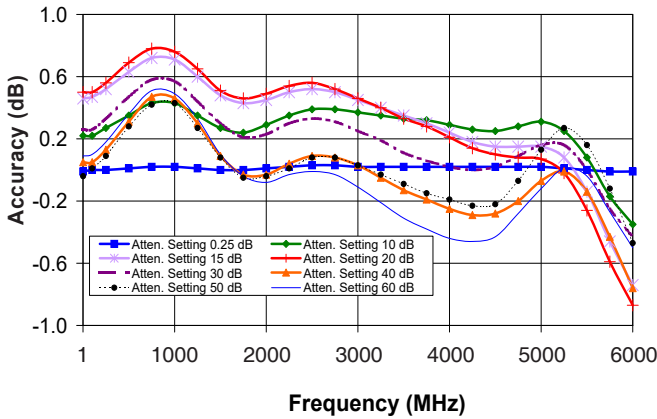
Attenuation Accuracy @ +25°C vs. Frequency over Attenuation settings



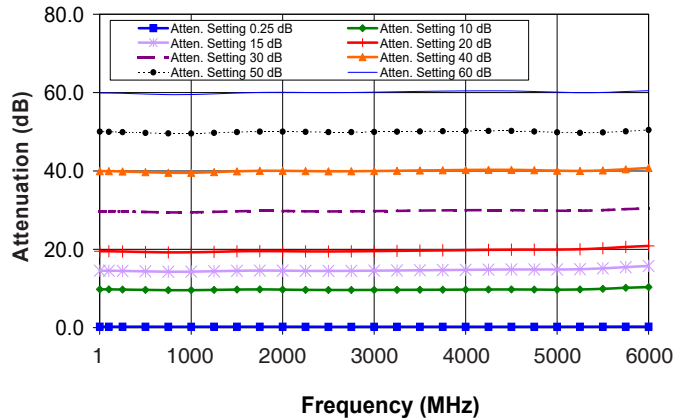
Attenuation relative to Insertion Loss @ +25°C vs. Frequency over Attenuation settings



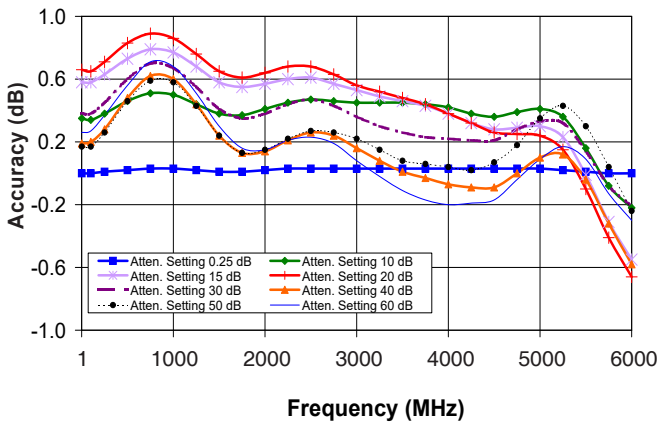
Attenuation Accuracy @ 0°C vs. Frequency over Attenuation settings



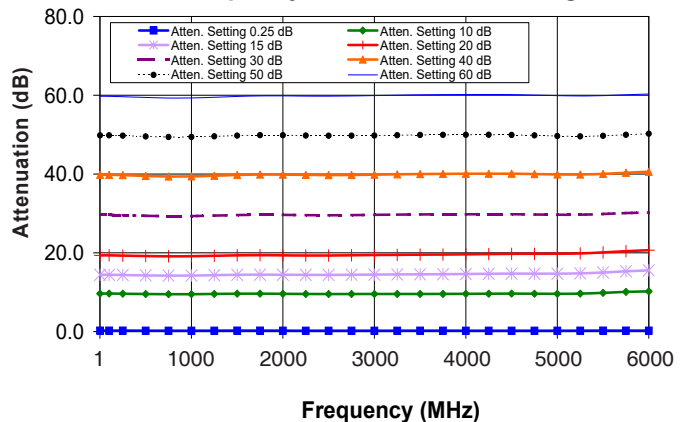
Attenuation relative to Insertion Loss @ 0°C vs. Frequency over Attenuation settings



Attenuation Accuracy @ +50°C vs. Frequency over Attenuation settings

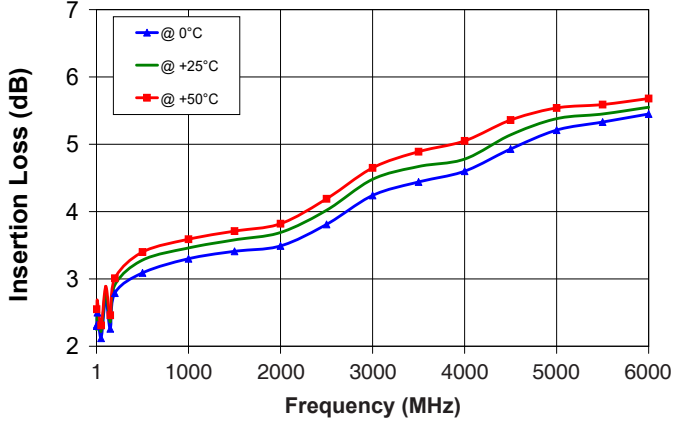


Attenuation relative to Insertion Loss @ +50°C vs. Frequency over Attenuation settings

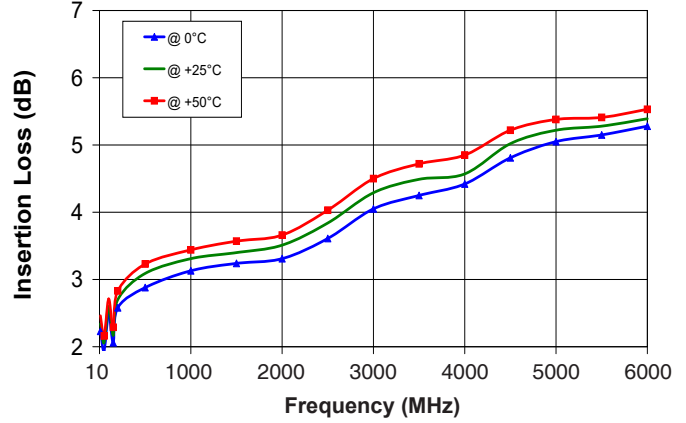


Typical Performance Curves (Continued)

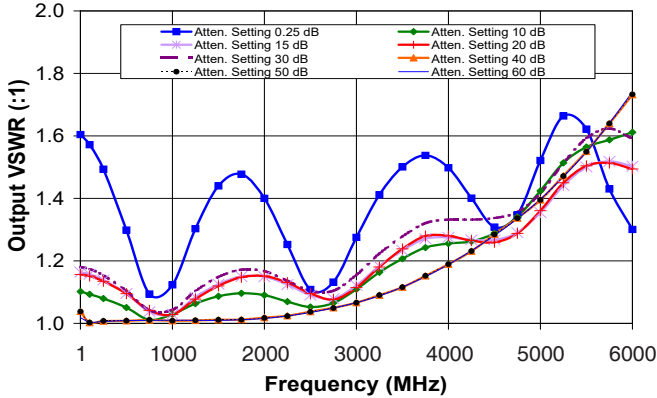
Insertion Loss @ Input Power 0dBm vs. Frequency over Temperatures



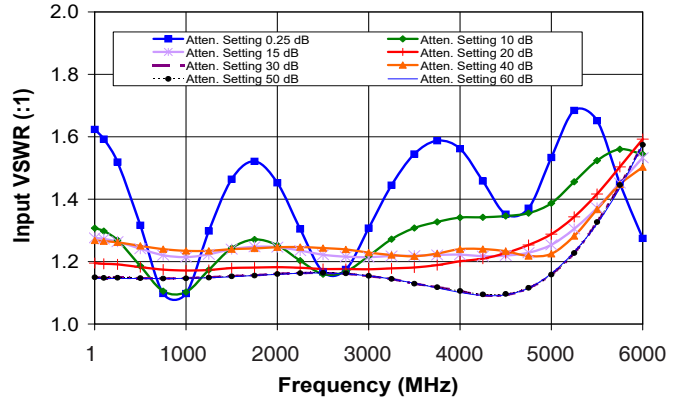
Insertion Loss @ Input Power +20 dBm vs. Frequency over Temperatures



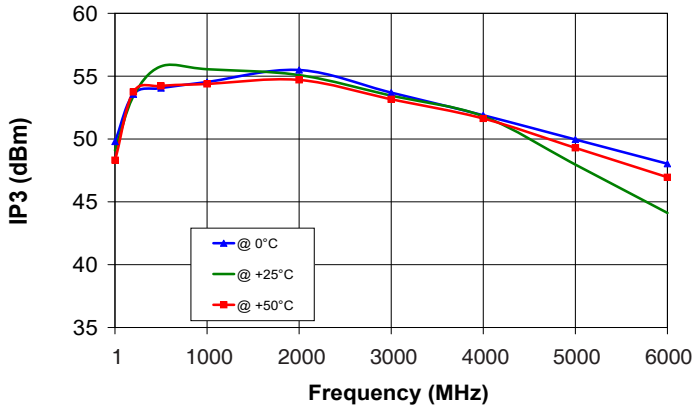
Output VSWR @ +25°C vs. Frequency over Attenuation settings



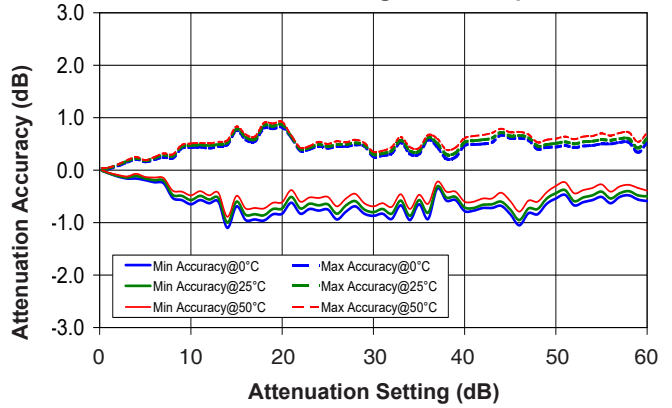
Input VSWR @ +25°C vs. Frequency over Attenuation settings



Input IP3 @ 0dB Attenuation vs. Frequency over Temperatures



Typical Attenuation Accuracy vs. Attenuation settings over Temperature



Software & Documentation Download:

- Mini-Circuits' full software and support package including user guide, Windows GUI, DLL files, programming manual and examples can be downloaded free of charge from <http://www.minicircuits.com/softwaredownload/patt.html>
- Please contact testsolutions@minicircuits.com for support

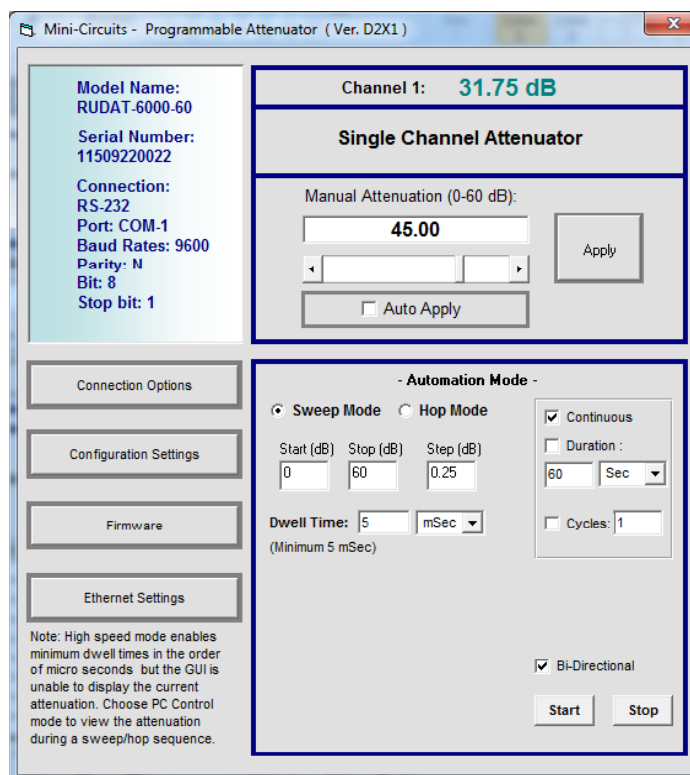
Minimum System Requirements

Parameter	Requirements	
Interface	USB HID or RS232	
System requirements	GUI:	Windows 32 & 64 bit systems from Windows 98 up to Windows 10
	USB API (ActiveX & .Net)	Windows 32 & 64 bit systems with ActiveX or .Net support from Windows 98 up to Windows 10
	USB direct programming support	Linux, Windows systems from Windows 98 up to Windows 10
	RS232	Any computer with a serial port and RS232 support
Hardware	Pentium® II or higher, RAM 256 MB	

Graphical User Interface (GUI) for Windows

Key Features:

- Manual attenuation setting
- Sweep and Hop attenuation sequences directed from the PC, or entire sequence loaded into RUDAT.
- Attenuator address configuration and Firmware upgrade
- Attenuation at power up may be set to selected attenuation level or last attenuation state recorded.
- USB or RS232 control of RUDAT



Application Programming Interface (API)

Windows Support:


- API DLL files exposing the full switch functionality See programming manual at https://www.minicircuits.com/softwaredownload/Prog_Manual-6-Programmable_Attenuator.pdf for details
 - ActiveX COM DLL file for creation of 32-bit programs
 - .Net library DLL file for creation of 32 / 64-bit programs
- Supported by most common programming environments (refer to application note [AN-49-001](#) for summary of tested environments)

Linux Support:

- Full switch control in a Linux environment is achieved by way of USB interrupt commands. See programming manual at https://www.minicircuits.com/softwaredownload/Prog_Manual-6-Programmable_Attenuator.pdf for details

Ordering Information

Model	Description
RUDAT-6000-60	USB/RS232 Programmable Attenuator

Included Accessories	Part No.	Description
	MUSB-CBL-3+	2.6 ft (0.8 m) USB Cable: USB type A(Male) to USB type Mini-B(Male)

Optional Accessories	Description
USB-AC/DC-5 ^{13,14}	AC/DC 5V _{DC} Power Adapter with US, EU, IL, UK, AUS, and China power plugs
MUSB-CBL-3+ (spare)	2.6 ft (0.8 m) USB Cable: USB type A(Male) to USB type Mini-B(Male)
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 ft RS232 Cable: 9 pin D-sub(Male) to 9 pin D-sub(Female)
BKT-3901+	Bracket kit including 3.75" x 2.00" bracket, mounting screws and washers

¹³ Not used in USB control. USB-AC/DC-5 can be used to provide the 5V_{DC} power when control is via RS232; units with S/N 11407150001 and greater can also accept DC supply voltage at Pin#1 of the D-sub connector.

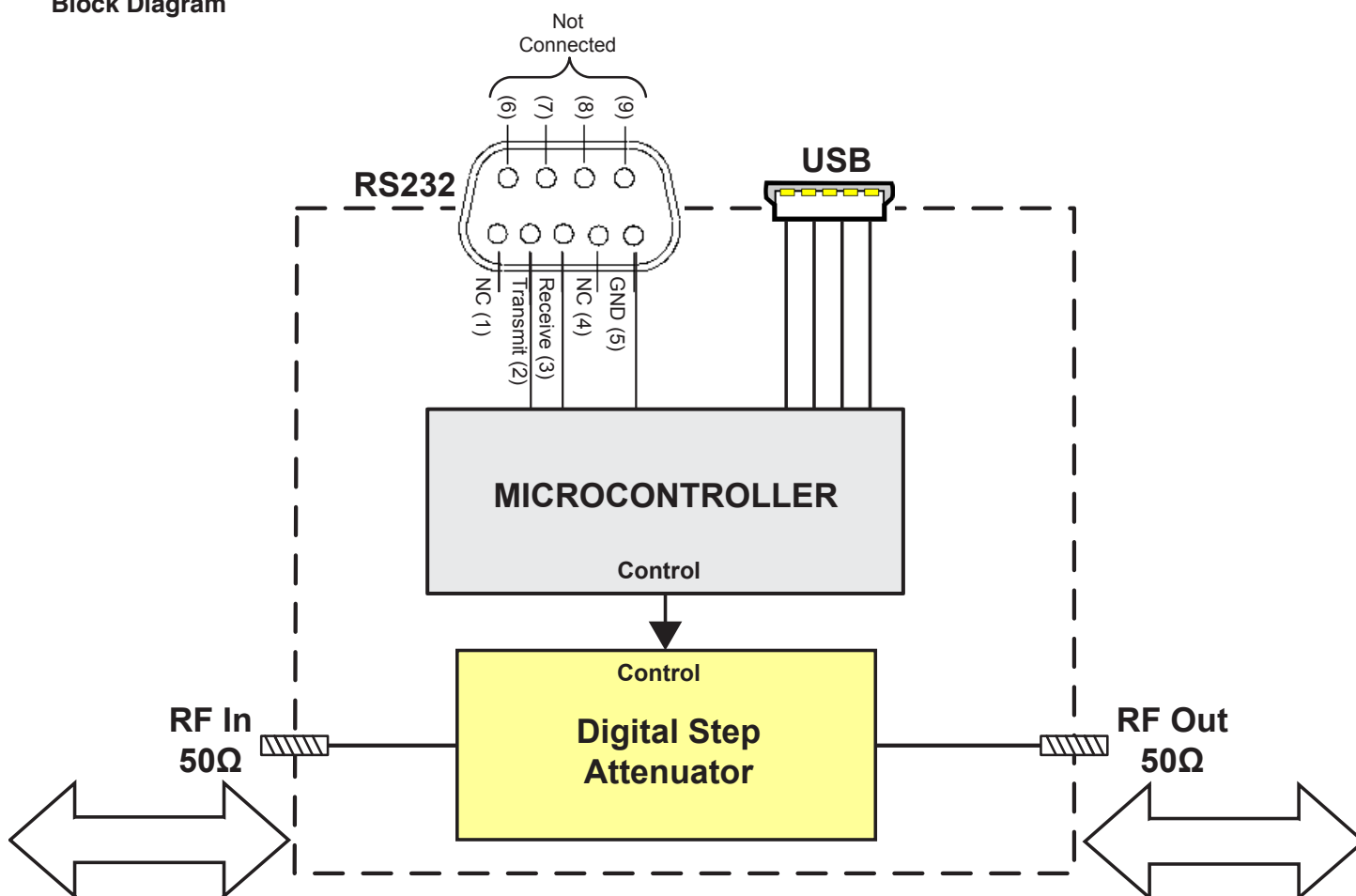
¹⁴ Power plugs for other countries are also available. Plugs for other countries are also available, if you need a power plug for a country not listed please contact testsolutions@minicircuits.com

Additional 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 www.minicircuits.com/MCLStore/terms.jsp

Archive section (applicable to units with S/N lower than 11407150001)

Block Diagram



Simultaneous, bidirectional RF signal transmission with symmetrical performance

Connections

RF IN	(SMA female)
RF OUT	(SMA female)
USB	(USB type Mini-B female)
RS232*	(9 Pin D-Sub female)

*9 Pin D-Sub Pin Connections ¹⁵

Pin Number	Function
2	Transmit
3	Receive
5	GND
1,4,6-9	Not Connected

¹⁵ Supply voltage can be provided via USB port only. When using RS232 control, power must be provided to the USB port via either USB-AC/DC-5 power adaptor or a USB bus.