USB & RS232 & SPI

Programmable Attenuator RUDAT-13G-90

50Ω 0.01 to 13 GHz 0 to 90 dB 0.5 dB step SMA female

THE BIG DEAL

- Wide bandwidth, 10 MHz to 13 GHz
- Wide attenuation range, 90 dB
- USB control and automation
- RS232 and SPI for serial control compatibility

APPLICATIONS

- Test & measurement equipment / systems
- Transmission loss / fading simulators
- Communications, radar, EW, and ECM defense systems
- 5G FR1, WiFi 6E, UWB testing

Generic photo used for illustration purposes only.

PRODUCT OVERVIEW

Mini-Circuits' RUDAT-13G-90 is a general purpose, single channel programmable attenuator suitable for a wide range of signal level control applications from 10 MHz to 13 GHz. The attenuator provides 0 to 90 dB attenuation in 0.5 dB steps. Its unique design maintains linear attenuation change per dB, even at the highest attenuation settings.

The attenuator is housed in a compact, rugged metal case (3.75" x 2.00" x 0.68") with SMA (F) connectors on the bi-directional input and output RF ports, a 9-pin D-Sub connector and a USB type Mini-B receptacle for control and power.

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
USB control	USB HID interface provides easy compatibility with a wide range of software setups and programming environments.
RS232 and SPI control	Support for a wide range of straightforward serial control interfaces, without the overhead of a PC and operating system.
Programmable attenuation sweep and hop sequences	Configure automated signal fading and attenuation sequences to run without any external control.
Wide attenuation range	The module provides high-accuracy attenuation allowing the user precise level control over a broad attenuation range.

Mini-Circuits
www.minicircuits.com P.O. Box 350166, Brooklyn, NY 11235-0003 (718) 934-4500 sales@minicircuits.com

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

Parameter	Conditions	Frequency (GHz)	Min.	Typ.	Max.	Unit
Attenuation range	0.5 dB step	0.01 - 13	0	–	90	dB
Attenuation accuracy [2]	0.5 - 3.5 dB	0.01 - 0.5	–	±0.90	±(1.0+15% of setting)	dB
		0.5 - 5	–	±0.35	±(1.0+10% of setting)	
		5 - 11	–	±0.35	±(1.0+10% of setting)	
		11 - 13	–	±0.35	±(1.0+10% of setting)	
	4 - 45 dB	0.01 - 0.5	–	±1.30	±(1.9+2.0% of setting)	
		0.5 - 5	–	±0.60	±(1.6+2.5% of setting)	
		5 - 11	–	±0.65	±(1.5+3.5% of setting)	
		11 - 13	–	±0.90	±(1.9+4.0% of setting)	
	45.5 - 90 dB	0.01 - 0.5	–	±0.90	±(0.3+4.5% of setting)	
		0.5 - 5	–	±1.55	±(1.4+4.0% of setting)	
		5 - 11	–	±1.10	±(0.7+4.0% of setting)	
		11 - 13	–	±0.80	±(2.3+3.0% of setting)	
Insertion loss	0 dB	0.01 - 0.5	–	7.0	8.0	dB
		0.5 - 5	–	9.5	12.0	
		5 - 11	–	12.5	15.5	
		11 - 13	–	14.5	17.5	
Isolation in-out [3]	–	0.01 - 13	–	100	–	dB
Return loss	0 - 3.5 dB	0.01 - 0.5	–	9.5	–	dB
		0.5 - 11	–	14.0	–	
		11 - 13	9.5	16.5	–	
	4 - 45 dB	0.01 - 0.5	8.5	14.5	–	
		0.5 - 11	9.5	16.5	–	
		11 - 13	9.5	16.5	–	
	45.5 - 90 dB	0.01 - 0.5	11.5	17.5	–	
		0.5 - 11	10.5	16.5	–	
		11 - 13	9.5	16.5	–	

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 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).

ELECTRICAL SPECIFICATIONS[1] AT 0 TO +50°C (CONTINUED)

Parameter	Conditions		Frequency (GHz)	Min.	Typ.	Max.	Unit
IP3 input [4]	0 dB setting (P_{IN}= +5 dBm)		0.1 - 13	–	+41	–	dBm
Input operating power [1, 5]	0 - 90 dB		0.01 - 0.4 0.4 - 13	– –	– –	Note 6 +23	dBm
Attenuation transition time [7]	–		0.01 - 13	–	900	–	ns
Minimum dwell time [8]	High-speed mode		0.01 - 13	–	600	–	µs
Supply voltage (Vcc)	USB or D-Sub port	–	–	4.75	5	5.25	V_{DC}
Supply current (Icc)	USB or D-Sub port	0 dB	–	-	200	300	mA
		90 dB	–	-	120	180	

4. Tested with 1 MHz span between signals. IP3 degrades below 100 MHz.
5. Total operating input power from both RF in and RF out ports. Compression level not noted as it exceeds max safe operating power level.
6. Derates linearly from +23 dBm at 400 MHz to +10 dBm at 10 MHz.
7. Attenuation transition time is specified as the time between starting to change the attenuation state and settling on the requested attenuation state.
8. Minimum dwell time is the minimum time the module will take between two attenuation changes.

ABSOLUTE MAXIMUM RATINGS [9]

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
Voltage input at D-Sub	**Pin #1**	-1 V to +6 V
	Pin #2	0 V to +4 V
	Pin #3	-30 V to +30 V
	Pin #6 - #9	0 V to +3.6 V
Max RF Power	**0.01 - 0.4 GHz**	Derates linearly from +25 dBm at 400 MHz to +13 dBm at 10 MHz
	0.4 - 13 GHz	+25 dBm

9. Permanent damage may occur if any of these limits are exceeded. 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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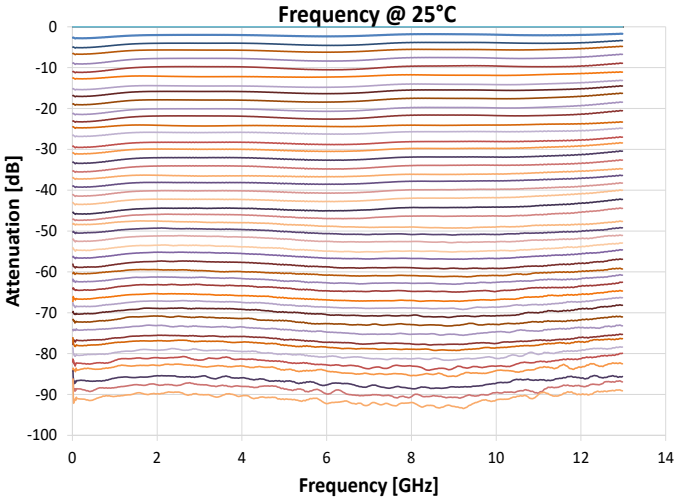
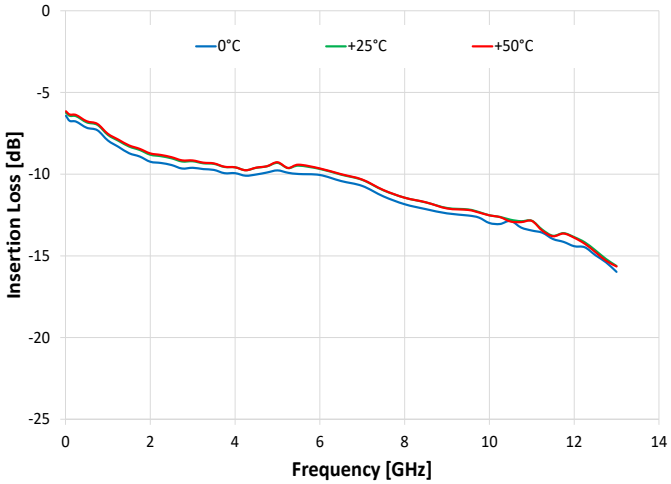
TYPICAL PERFORMANCE GRAPHS

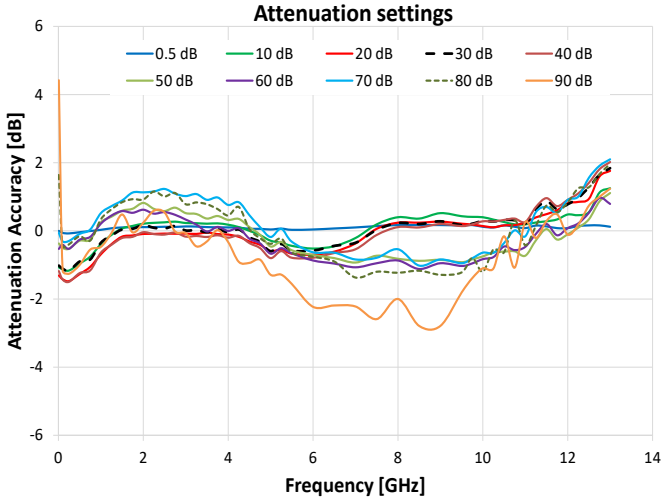
Attenuation relative to Insertion Loss vs. Frequency @ 25°C



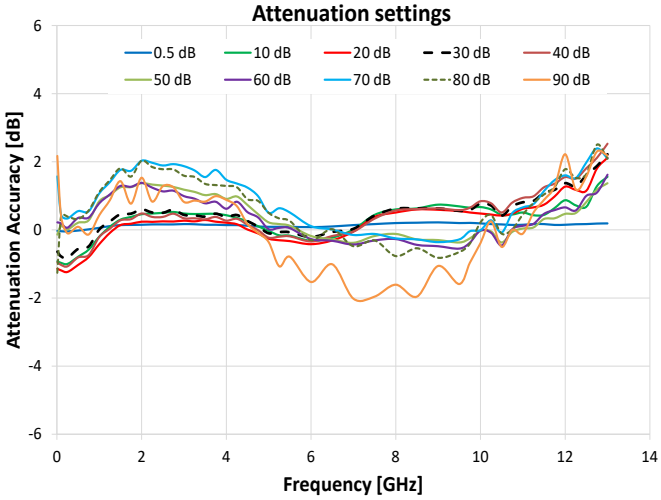
Insertion Loss vs. Frequency over Temperature



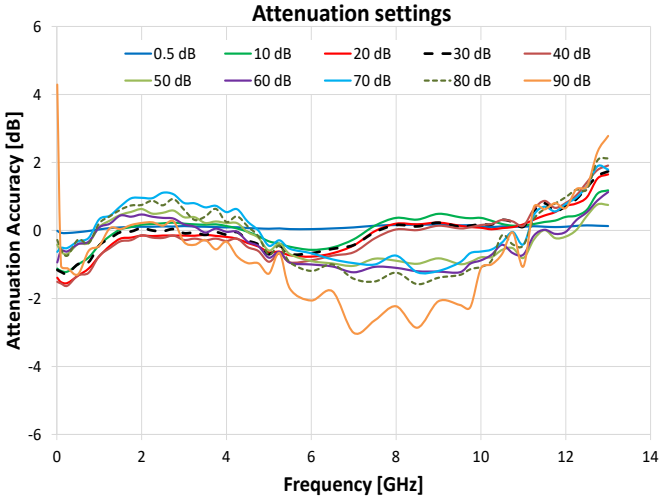
Attenuation Accuracy @ 25°C vs. Frequency over Attenuation settings



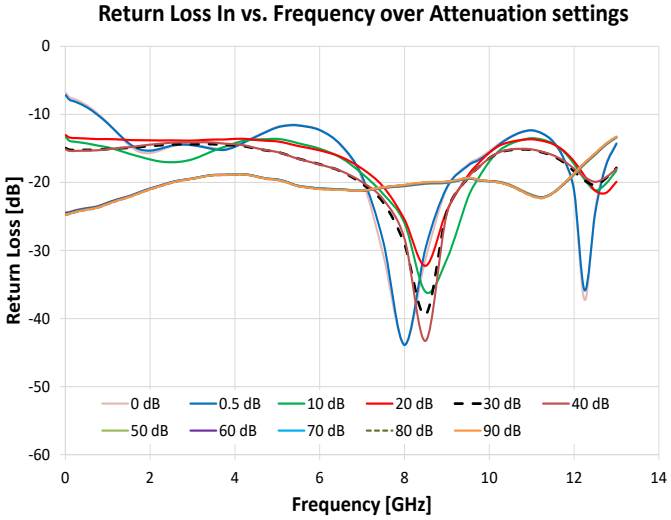
Attenuation Accuracy @ 0°C vs. Frequency over Attenuation settings

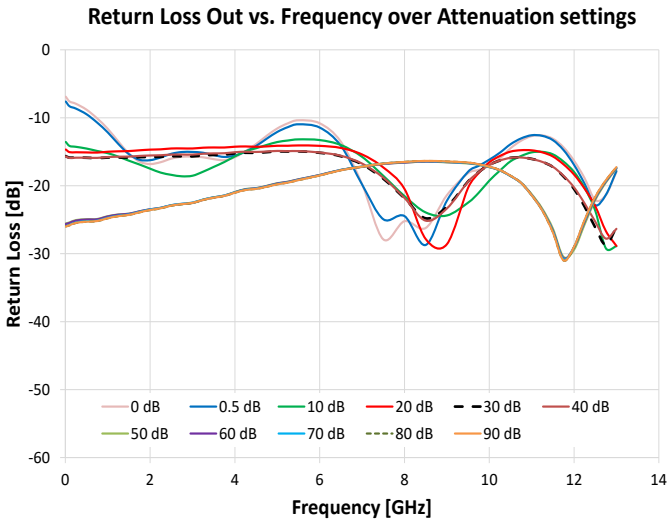


Attenuation Accuracy @ 50°C vs. Frequency over Attenuation settings



TYPICAL PERFORMANCE GRAPHS (CONTINUED)





CONTROL INTERFACES

USB control	Protocol	HID (Human Interface Device) - Full-speed
	Min communication time [10]	3 ms typ (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'.
SPI control	Protocol	See "SPI Communication Parameters" section

10. 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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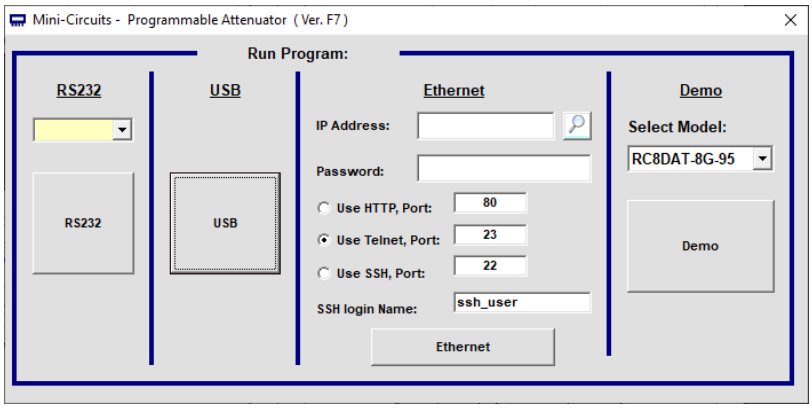
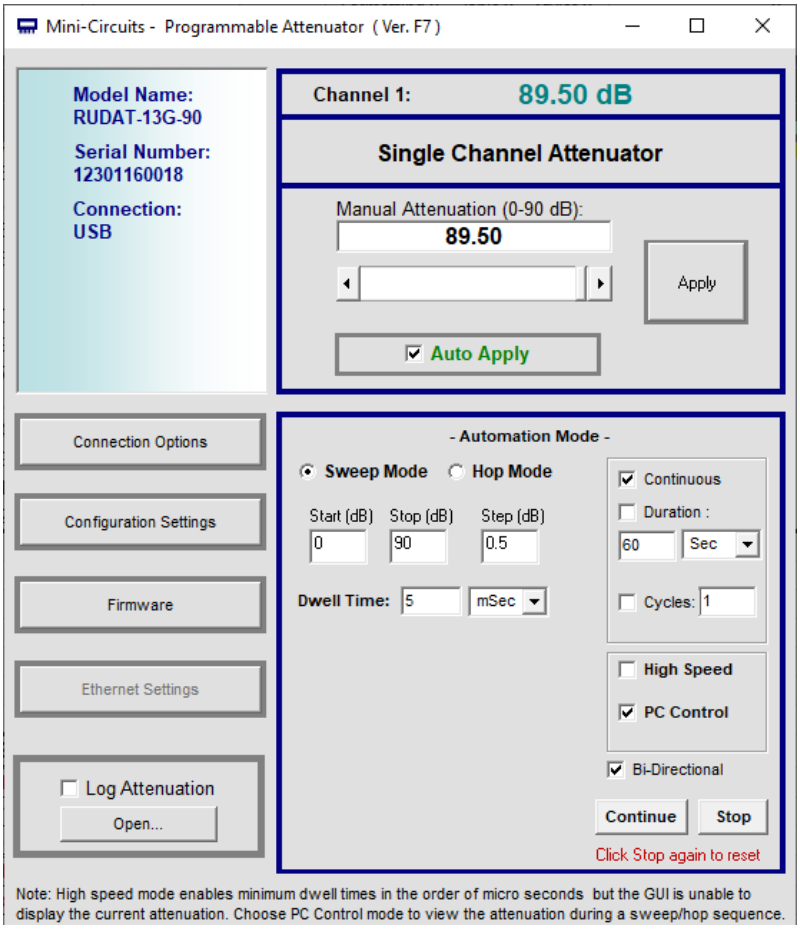
GRAPHICAL USER INTERFACE (GUI) FOR WINDOWS - KEY FEATURES

- Connect via USB 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.



D-SUB PIN CONNECTIONS

The RS232 and SPI control options share the same D-Sub 9-pin connector so special attention must be paid to the requirements of both standards when designing a control cable.

Note in particular that RUDAT-13G models 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	SPI control
1	Optional +5 V_{DC} [11]	Optional +5 V_{DC} [11]
2	RS232 transmit (Tx)	Do not connect
3	RS232 recieve (Rx)	Do not connect
4	Do not connect	Do not connect
5	Ground (GND)	Ground (GND)
6	Do not connect	Do not connect
7	Do not connect	SPI latch enable (LE)
8	Do not connect	SPI clock
9	Do not connect	SPI data in

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.

RS232 CONTROL PINS

- Only pins #2 and #3 should be used for control.
- Pin #5 should be grounded.
- Pin #1 can optionally be used to provide the +5 V_{DC} supply (this could alternatively be provided via the USB port).
- All other pins must be disconnected in the control cable.

SPI CONTROL PINS

- Only pins #7, #8 and #9 should be used for control.
- Pin #5 should be grounded.
- Pin #1 can optionally be used to provide the +5 V_{DC} supply (this could alternatively be provided via the USB port).
- 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.

SPI COMMUNICATIONS PARAMETERS

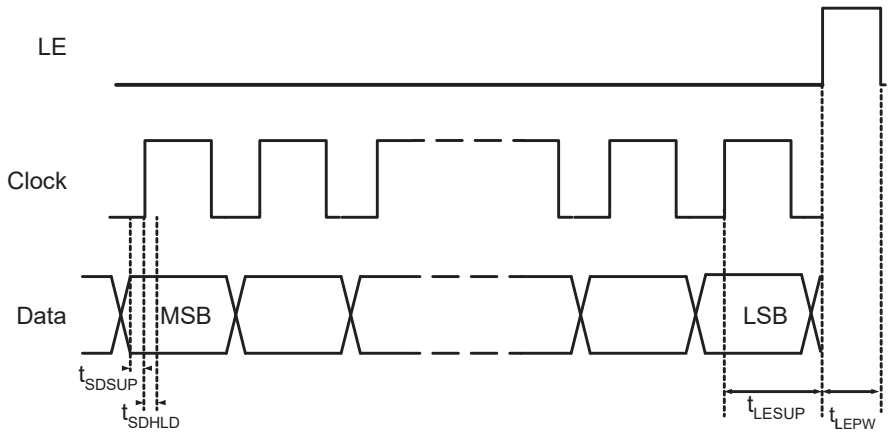
Parameter	Conditions		Min.	Typ.	Max.	Units
Voltage levels	Logic low voltage	Input	0	-	0.8	V
	Logic high voltage	Input	2.1	-	3.3	
Control current	Per pin		-	-	1.0	mA
Clock frequency	-		-	-	20	MHz

The SPI control used a 8-bit serial in, parallel-out shift register buffered by a transparent latch with Data, Clock, and Latch Enable (LE) voltages compatible with LVTTL. The Data and Clock inputs allow data to be serially entered into the shift register, a process that is independent of the state of the LE input. The Value entered should be desired attenuation x 2, so for example to set attenuation level of 45.5 dB you will enter 91 decimal which is 0101 1011 in Binary.

The LE input controls the latch. When LE is HIGH, the latch is transparent and the contents of the serial shift register control the attenuator. When LE is brought LOW, data in the shift register is latched.

The shift register should be loaded while LE is held LOW to prevent the attenuation state from changing as data is entered. The LE input should then be toggled HIGH and brought LOW again, latching the new data. The timing for this operation is defined by the SPI Timing Diagram and SPI Interface AC Characteristics below.

SPI TIMING DIAGRAM



SPI INTERFACE AC CHARACTERISTICS

Symbol	Parameter	Min.	Max.	Units
f_{clk}	Serial data clock frequency	-	20	MHz
t_{clkH}	Serial clock HIGH time	10	-	ns
t_{clkL}	Serial clock LOW time	10	-	ns
t_{LESUP}	LE set-up time after last clock falling edge	30	-	ns
t_{LEPW}	LE minimum pulse width	20	-	ns
t_{SDSUP}	Serial data set-up time before clock rising edge	10	-	ns
t_{SDHLD}	Serial data hold time after clock falling edge	10	-	ns

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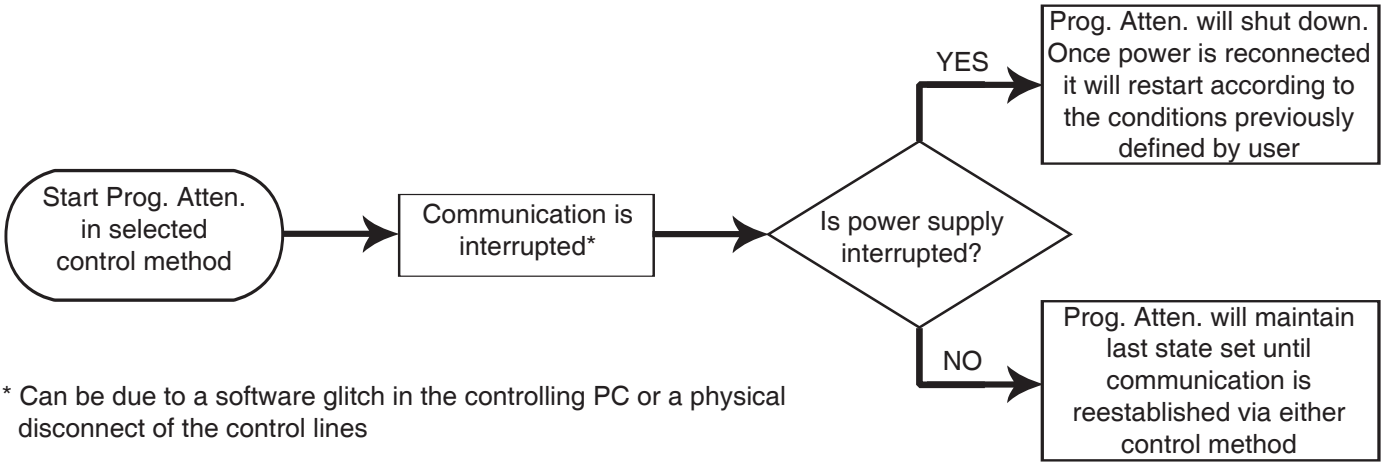
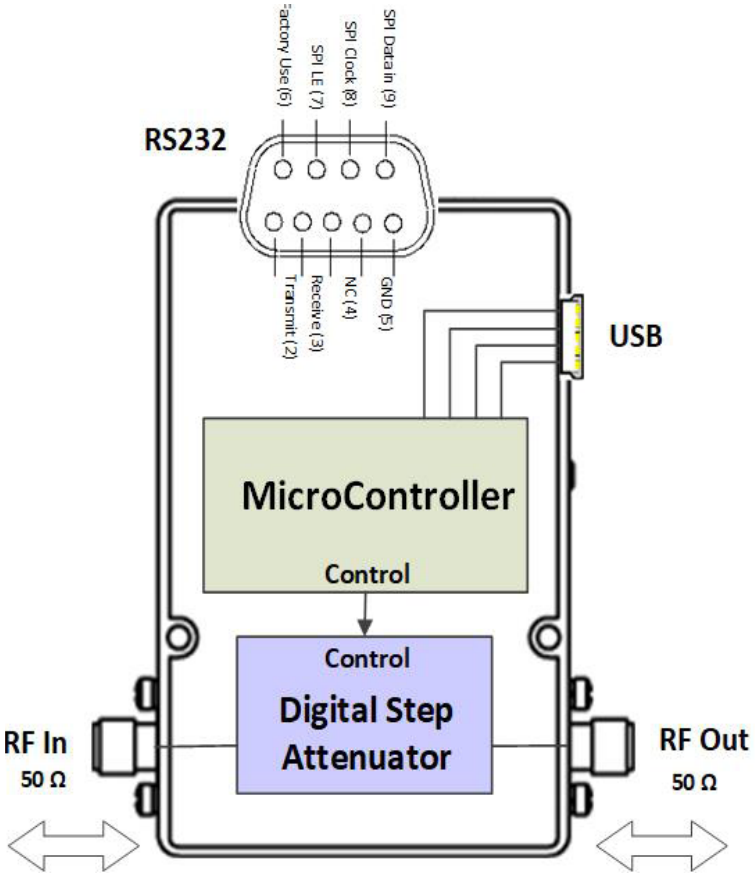
PROGRAMMABLE ATTENUATOR RESPONSE TO COMMUNICATION INTERRUPT



* 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

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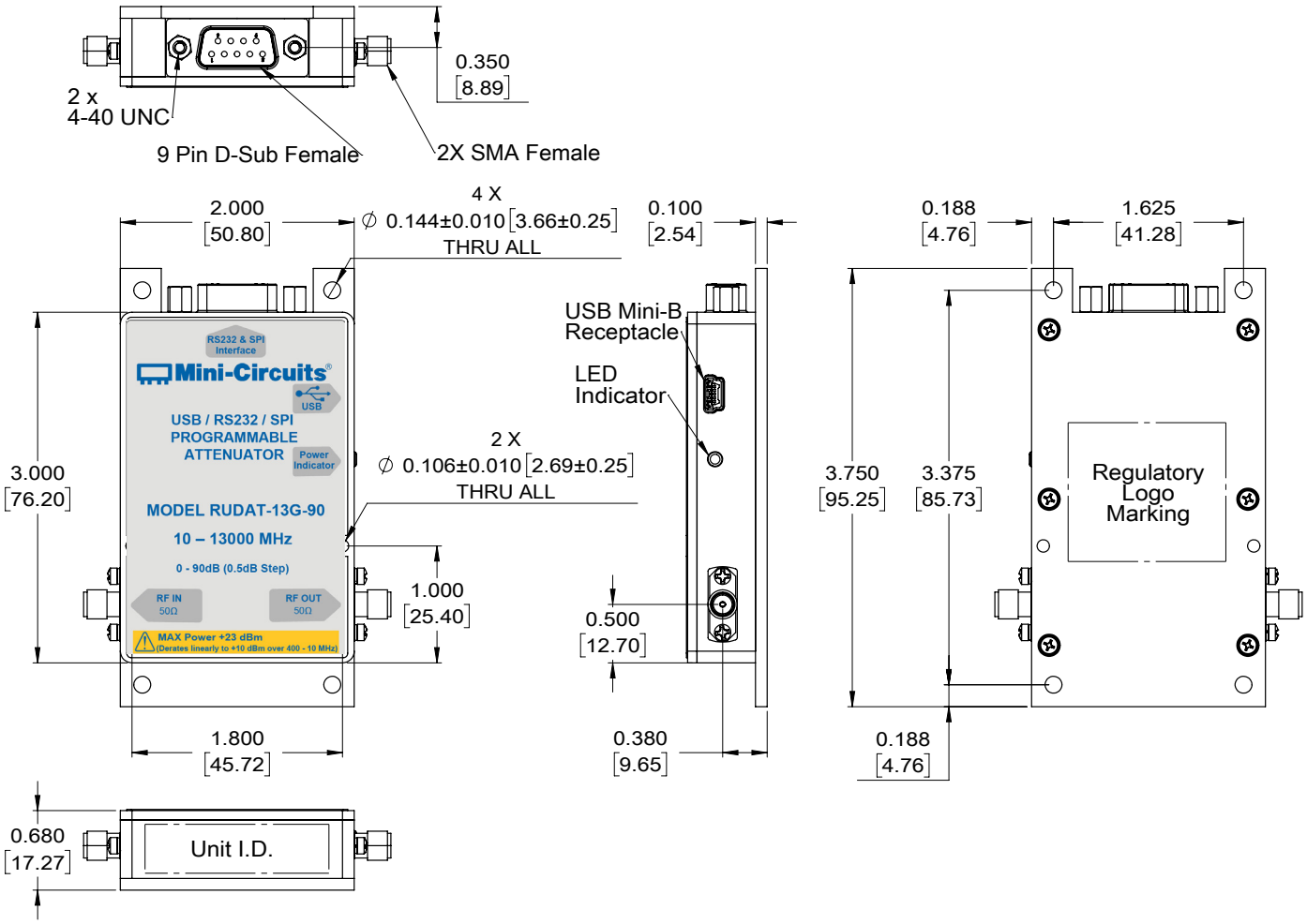
CASE STYLE DRAWING (QF3370)



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: 150 grams
5. Marking may contain other features or characters for internal lot control.

CONNECTIONS

Port Name	Connector Type
RF in & RF out	SMA female
USB	USB type Mini-B receptacle
RS232 & SPI	9-pin D-Sub female

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RECOMMENDED ACESSORIES

D-SUB9-MPT-3+ is an optional accessory cable for RS232 and SPI control. The cable has a D-Sub connector for mating to the module and bare wires (pig tail) on the other end allowing users to assemble their own cable with any connector they need. The cable is 36 inches (0.9 meter) long using 28 AWG wires.

CONTROL CABLE D-SUB9-MPT-3+

Pin number	When used for RS232 control		When used for SPI control		Pigtail wire color
	Function	Description	Function	Description	
1	Vcc	Supply voltage	Vcc	Supply voltage	BLACK
2	Tx	RS232 transmit	N/A	Do not connect	BROWN
3	Rx	RS232 recieve	N/A	Do not connect	RED
4	N/A	Do not connect	N/A	Do not connect	ORANGE
5	GND	Ground connection	GND	Ground connection	YELLOW
6	N/A	Do not connect	N/A	Do not connect	GREEN
7	N/A	Do not connect	LE	SPI latch enable	BLUE
8	N/A	Do not connect	Clock	SPI clock	PURPLE
9	N/A	Do not connect	Data	SPI data in	WHITE

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DETAILED MODEL INFORMATION IS AVAILABLE ON OUR WEBSITE CLICK HERE

Performance Data & Graphs	Data Graphs
Case Style	QF3370
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 UKCA https://www.minicircuits.com/app/AN49-005.pdf
Support	testsolutions@minicircuits.com

INCLUDED ACCESSORIES

	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

OPTIONAL ACCESSORIES

	Part No.	Description
	MUSB-CBL-3+ (Spare)	3.3 ft (1.0 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)
See page 12	D-SUB9-MPT-3+	3.0 ft (1.0 m) I²C Cable: 9 pin D-sub (Male) to Pig-Tail (Bare wires)
	USB-AC/DC-5	AC/DC +5V power adaptor with USB connector [12, 13]

12. Not used in USB control. USB-AC/DC-5 can be used to provide the $5V_{DC}$ power when control is via RS232 or SPI; units can also accept DC supply voltage at Pin#1 of the D-Sub connector.
13. 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