

# Programmable Attenuator

RUDAT-6000-60

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

## The Big Deal

- Attenuation range, 30 dB
- Fine attenuation resolution, 0.25 dB
- High speed attenuation switching (650 ns)
- Compact size, 2.0 x 3.0 x 0.6"
- **USB and RS232** control



Installation CD

Case Style: MS1813



## Product Overview

Mini-Circuits' RUDAT-6000-60 is a general purpose programmable RF attenuator supporting frequencies from 1 to 6000 MHz with attenuation from 0 to 60 dB in 0.25 dB steps. Its unique design maintains linear attenuation change per dB, even at the highest attenuation settings. The attenuator is controlled via USB or RS232 ports. It comes housed in a rugged, shielded metal case with SMA(F) input/output SMA(F) RF ports (input/output ports are interchangeable), a USB type Mini-B socket, and a 9-pin D-sub(F) RS232 port. Power can be supplied via either USB or the D-sub port.

The RUDAT-6000-60 is supplied with our easy-to-install, user-friendly GUI software, API objects for Windows® environments, and complete programming instructions for 32 and 64 bit Windows® and Linux® operating systems. See p. 8 for a complete list of included accessories.

## 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                                            |
| Plug-and-Play – no additional device drivers required. | Fast and easy setup and installation. The RUDAT-6000-60 interfaces with various third-party software, making it easy to integrate into existing setups.                      |
| 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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50Ω    0 – 60 dB, 0.25 dB step    1 to 6000 MHz

### Features

- USB and RS232 control
- Very good attenuation accuracy,  $\pm 0.3$  dB typ.
- High speed attenuation switching (650 ns)
- Sweep and Hop attenuation sequences
- Extremely low leakage
- Interchangeable Input/Output ports
- Plug & Play device – no drivers required
- User-friendly Windows® Graphical User Interface
- Supports a wide range of programming environments  
(See application note [AN-49-001](#) for details)
- Optional mounting bracket, see page 5

### Applications

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



Installation CD

Case Style: MS1813

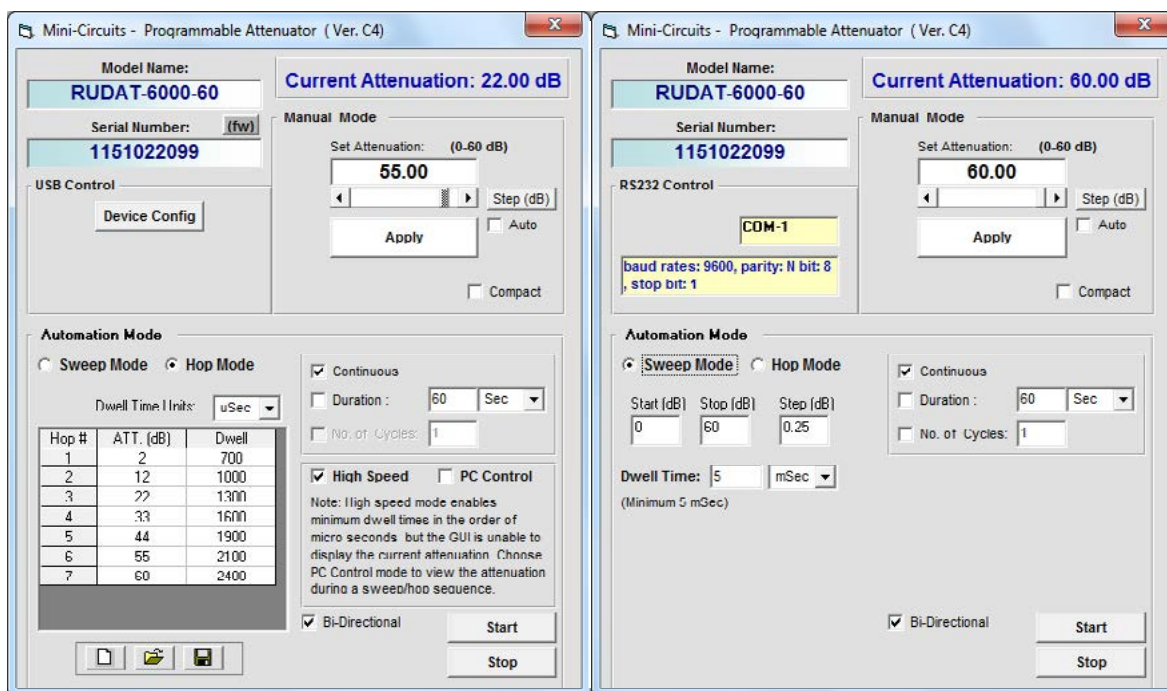
### Included Accessories

| Model No.   | Description              | Qty. |
|-------------|--------------------------|------|
| MUSB-CBL-3+ | 2.6 ft. USB cable        | 1    |
| PC-DAT-CD   | Software Installation CD | 1    |

### RoHS Compliant

See our web site for RoHS Compliance methodologies and qualifications

### Mini-Circuits Graphical User Interface for RUDAT-Series Programmable Attenuator



RUDAT GUI screen (USB control, Hop mode)

RUDAT GUI screen (RS232 control, Sweep mode)

For programming instructions, see [programming guide](#) on Mini-Circuits' website.



## Electrical Specifications <sup>1</sup> 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 <sup>2</sup>                                  | 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 <sup>3</sup><br>(RF In and RF Out 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 <sup>5</sup>                                             | 1 - 6000 MHz                                                                                                           | @ 0 dB setting<br>(P <sub>IN</sub> =+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  | –                             |       |
| Switching Speed                                                    | 1 - 6000 MHz                                                                                                           | Note 6                                       | –    | 650   | –                             | nsec  |
| Min Dwell Time                                                     | 1 - 6000 MHz                                                                                                           | High speed mode                              | –    | 600   | –                             | μsec  |
| Supply Voltage <sup>7,8</sup>                                      | –                                                                                                                      | 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'. |                                              |      |       |                               |       |

<sup>1</sup> 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.

<sup>2</sup> 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.

<sup>3</sup> 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.

<sup>4</sup> 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).

<sup>5</sup> Tested with 1 MHz span between signals.

<sup>6</sup> Switching speed specified without communication delays, USB communication delays (in PC Control mode) on the order of 3.5 msec.

<sup>7</sup> Supply voltage +5V at Pin#1 of D-sub connector applies to units with S/N 11407150001 and greater.

<sup>8</sup> Power on sequence for RS232 control: Connect 5V power followed by the control lines.

## Absolute Maximum Ratings

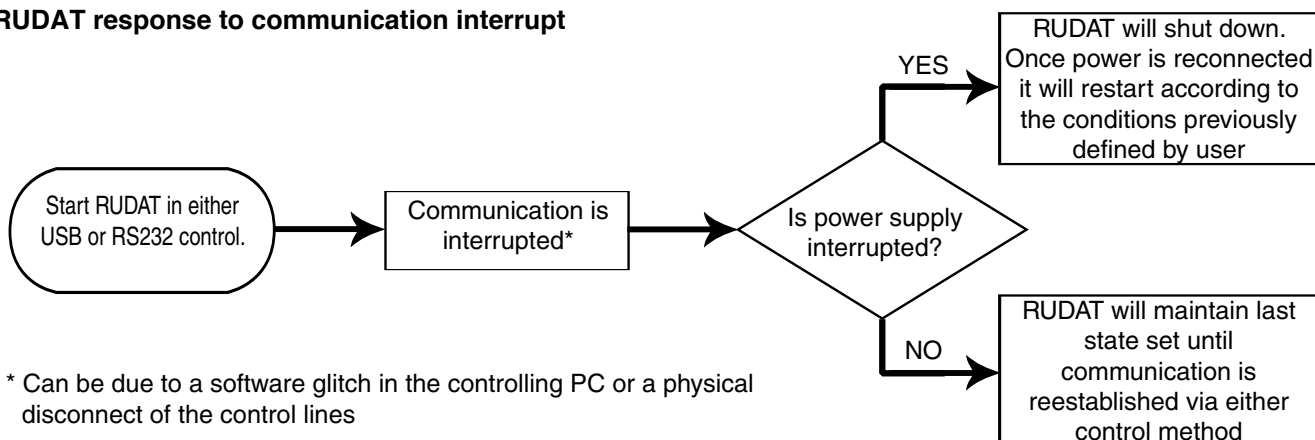
|                                     |                          |
|-------------------------------------|--------------------------|
| Operating Temperature               | 0°C to 50°C              |
| Storage Temperature                 | -20°C to 85°C            |
| Voltage input at RS232 receive pin  | -30V to +30V             |
| Voltage input at RS232 transmit pin | 0V to +4V                |
| Voltage input at RS232 Pin#1        | -1V to +6V               |
| V <sub>USB</sub> Max.               | 6V                       |
| Total RF power for                  | @ 10 to 6000 MHz +23 dBm |
| RF In & RF Out                      | @ 1 to 10 MHz +13 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.

## Minimum System Requirements

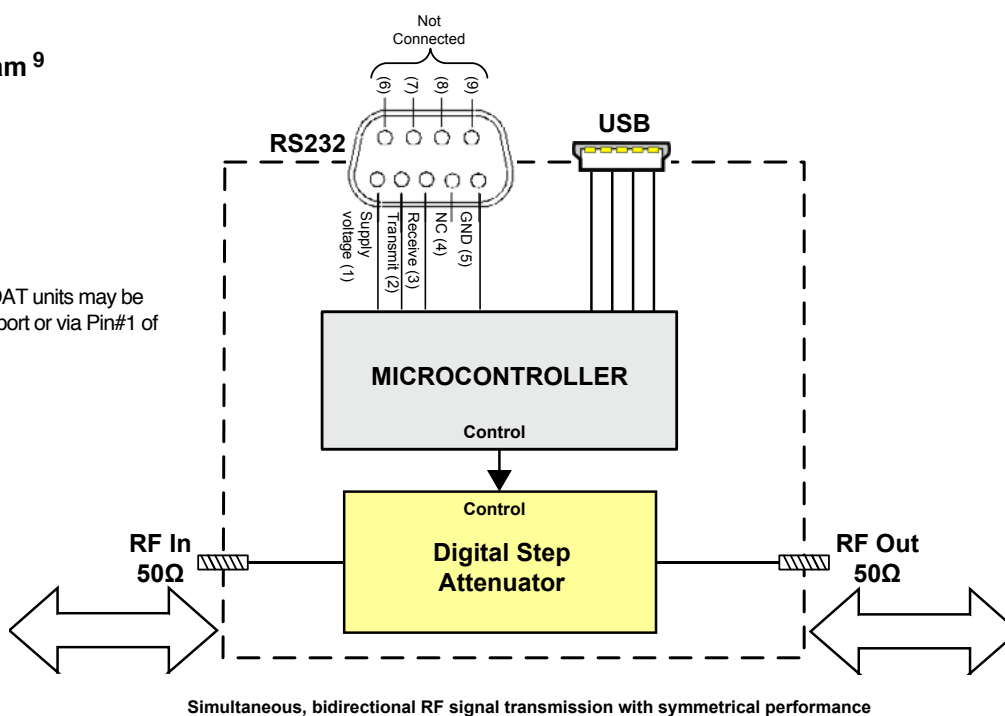
|                                       |                                                                                                                                                                  |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Interface                             | USB HID or RS232 protocols                                                                                                                                       |
| Host operating system - USB Control   | <b>Windows 32/64 Bit operating system:</b> Windows 98®, Windows XP®, Windows Vista®, Windows 7®, Windows 8®<br><b>Linux® support:</b> 32/64 Bit operating system |
| Host operating system - RS232 Control | Any computer with a serial port and RS232 support                                                                                                                |
| Hardware                              | Pentium® II or better                                                                                                                                            |

## RUDAT response to communication interrupt



## Block Diagram <sup>9</sup>

The 5V<sub>DC</sub> for RUDAT units may be input via the USB port or via Pin#1 of the D-Sub port.



### 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 <sup>9</sup>

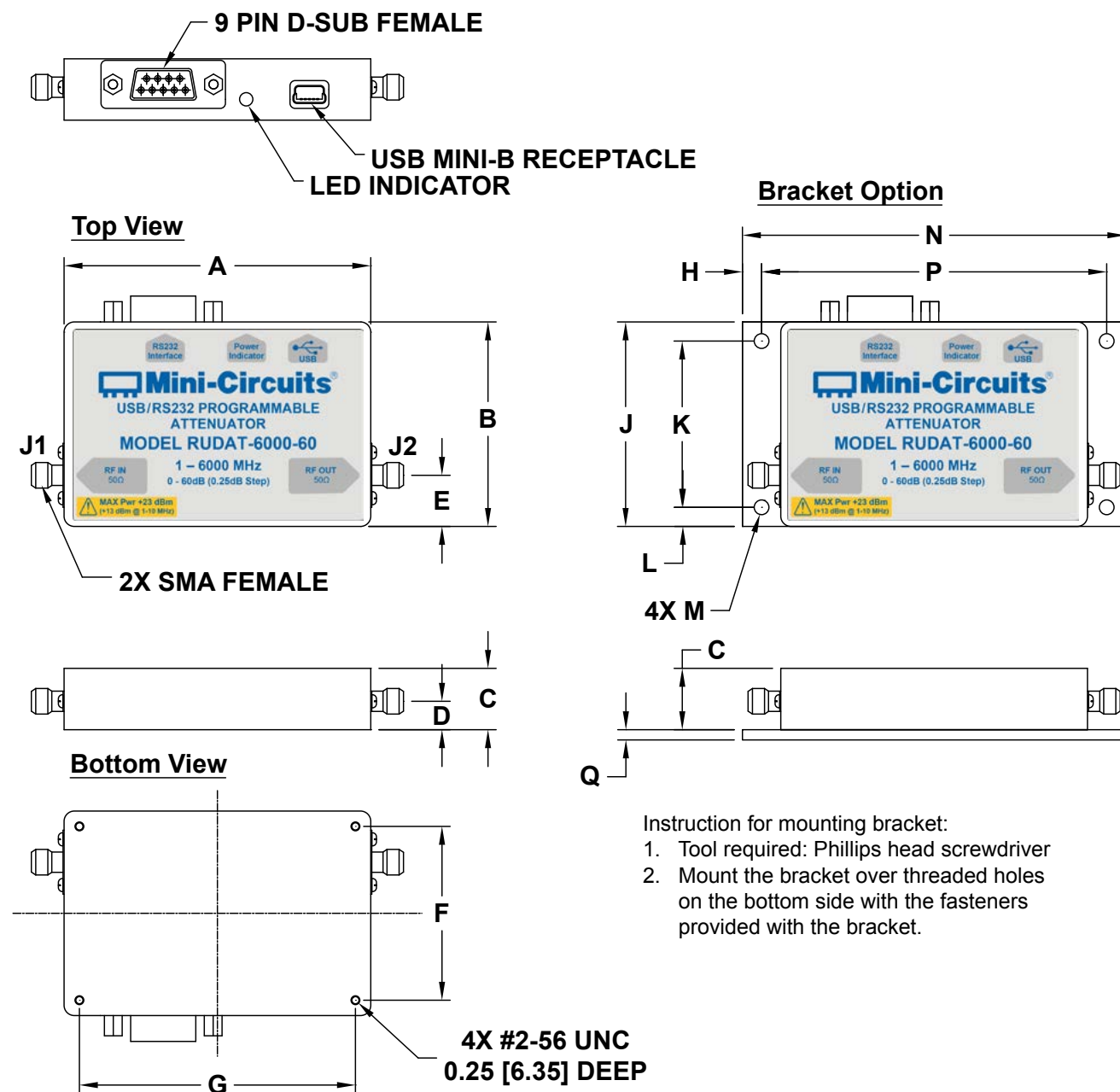
| PIN Number | Function                            |
|------------|-------------------------------------|
| 2          | Transmit                            |
| 3          | Receive                             |
| 5          | GND                                 |
| 1          | +5 V <sub>DC</sub> <sup>10,11</sup> |
| 4,6-9      | Not Connected                       |

<sup>9</sup> 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.

<sup>10</sup> 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.

<sup>11</sup> Power on sequence for RS232 control: Connect 5V power followed by the control lines.

## Outline Drawing (MS1813)

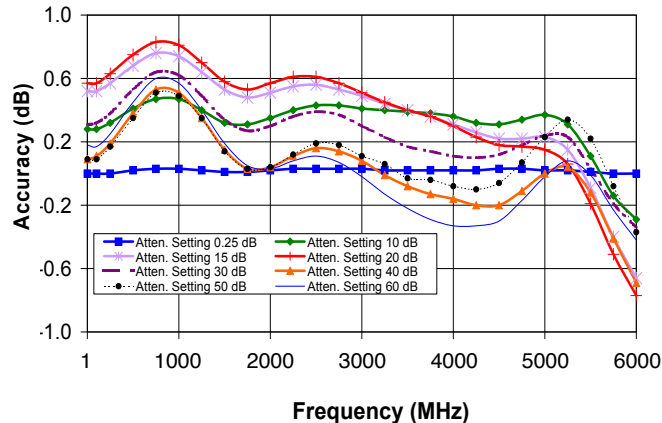


## Outline Dimensions ( $\frac{\text{inch}}{\text{mm}}$ )

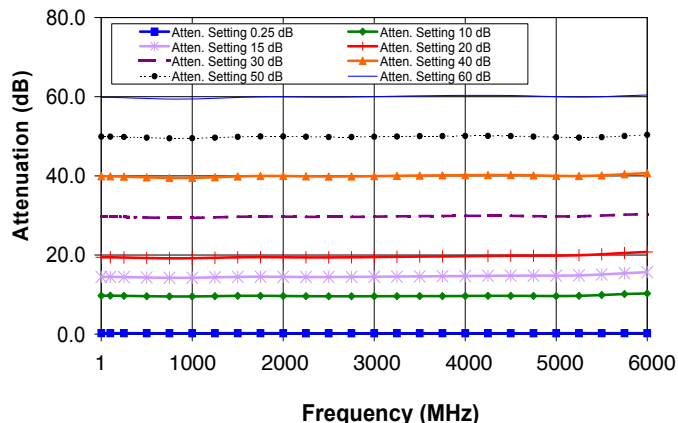
| A    | B    | C    | D    | E    | F     | G     | H     | J    | K     | L     | M     | N    | P     | Q     | WT.<br>GRAMS |
|------|------|------|------|------|-------|-------|-------|------|-------|-------|-------|------|-------|-------|--------------|
| 3.00 | 2.00 | 0.60 | 0.28 | 0.50 | 1.700 | 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

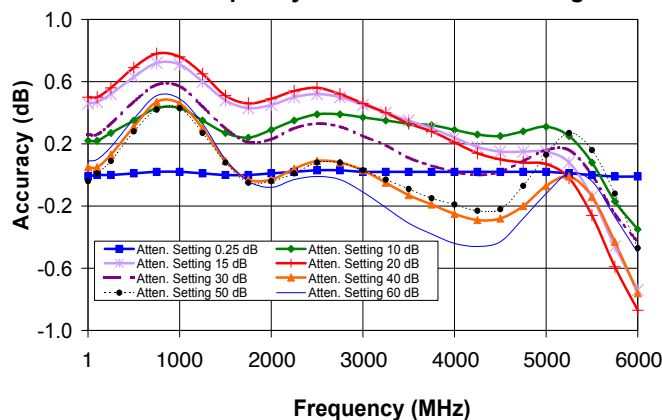
**Attenuation Accuracy @ +25°C  
vs. Frequency over Attenuation settings**



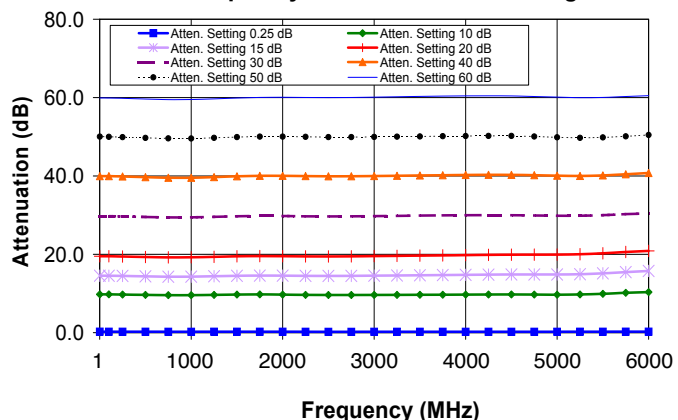
**Attenuation relative to Insertion Loss @ +25°C  
vs. Frequency over Attenuation settings**



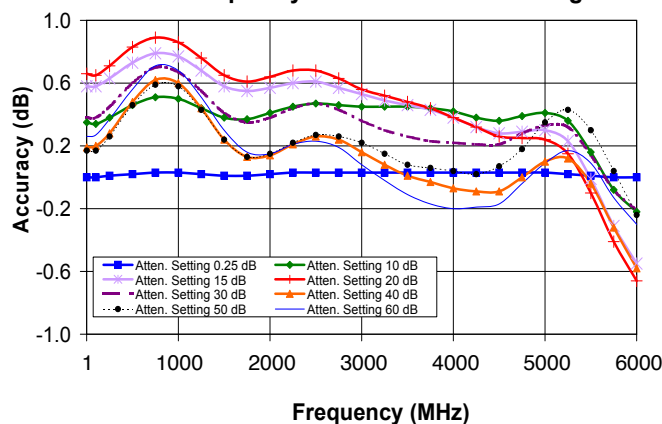
**Attenuation Accuracy @ 0°C  
vs. Frequency over Attenuation settings**



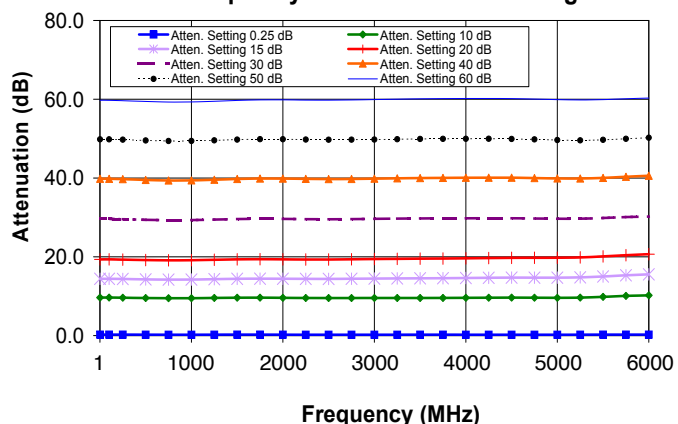
**Attenuation relative to Insertion Loss @ 0°C  
vs. Frequency over Attenuation settings**



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



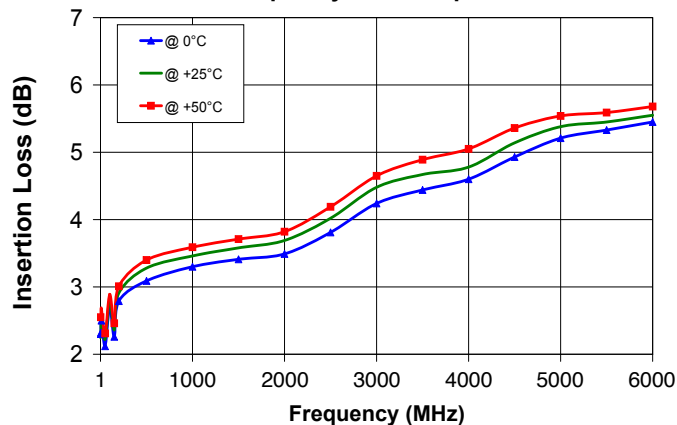
**Attenuation relative to Insertion Loss @ +50°C  
vs. Frequency over Attenuation settings**



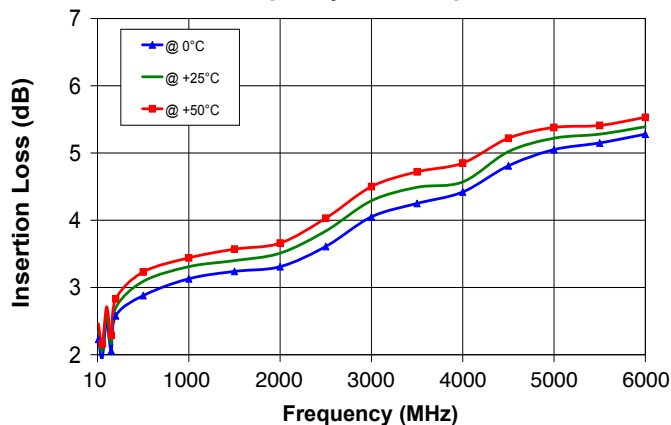


## Typical Performance Curves (Continued)

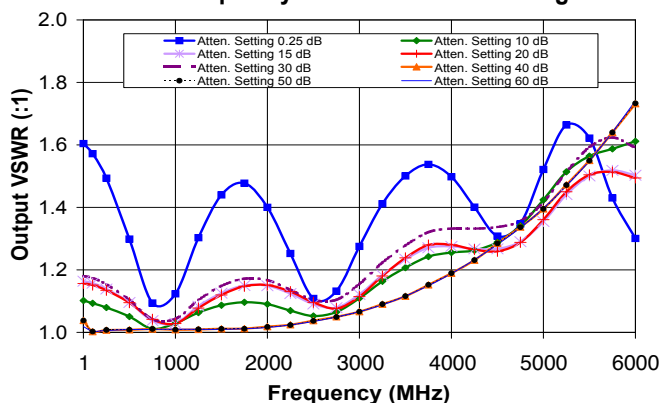
**Insertion Loss @ Input Power 0dBm  
vs. Frequency over Temperatures**



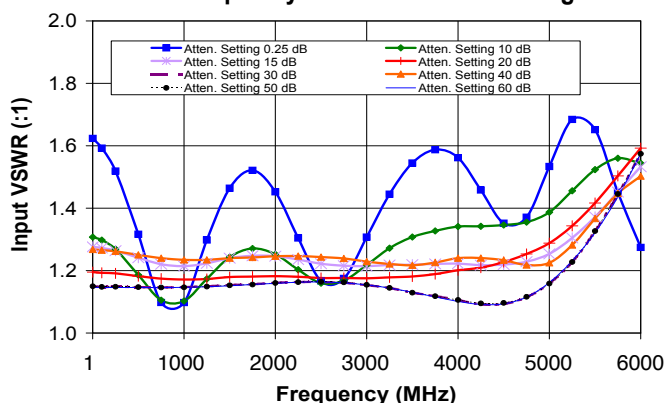
**Insertion Loss @ Input Power +20 dBm  
vs. Frequency over Temperatures**



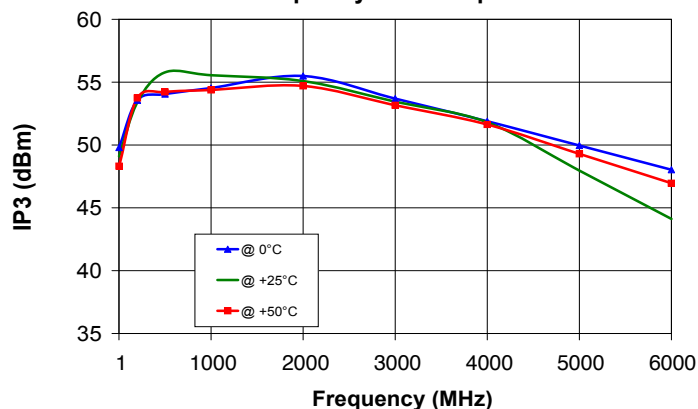
**Output VSWR @ +25°C  
vs. Frequency over Attenuation settings**



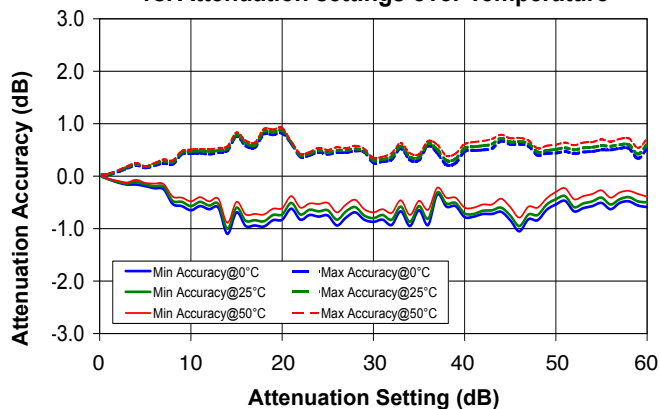
**Input VSWR @ +25°C  
vs. Frequency over Attenuation settings**



**Input IP3 @ 0dB Attenuation  
vs. Frequency over Temperatures**



**Typical Attenuation Accuracy  
vs. Attenuation settings over Temperature**



## Ordering Information

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

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

| Optional Accessories         | Description                                                                          |
|------------------------------|--------------------------------------------------------------------------------------|
| 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)                           |
| USB-AC/DC-5 <sup>12,13</sup> | AC/DC 5V <sub>DC</sub> Power Adapter with US, EU, IL, UK, AUS, and China power plugs |
| BKT-3901+                    | Bracket kit including 3.75" x 2.00" bracket, mounting screws and washers             |

<sup>12</sup> Not used in USB control. USB-AC/DC-5 can be used to provide the 5V<sub>DC</sub> 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.

<sup>13</sup> Power plugs for other countries are also available, if you need a power plug for a country not listed in the table please contact [apps@minicircuits.com](mailto:apps@minicircuits.com) or check <http://www.minicircuits.com/contact/offices.html> for regional offices e-mail and phone numbers.

## Additional Notes

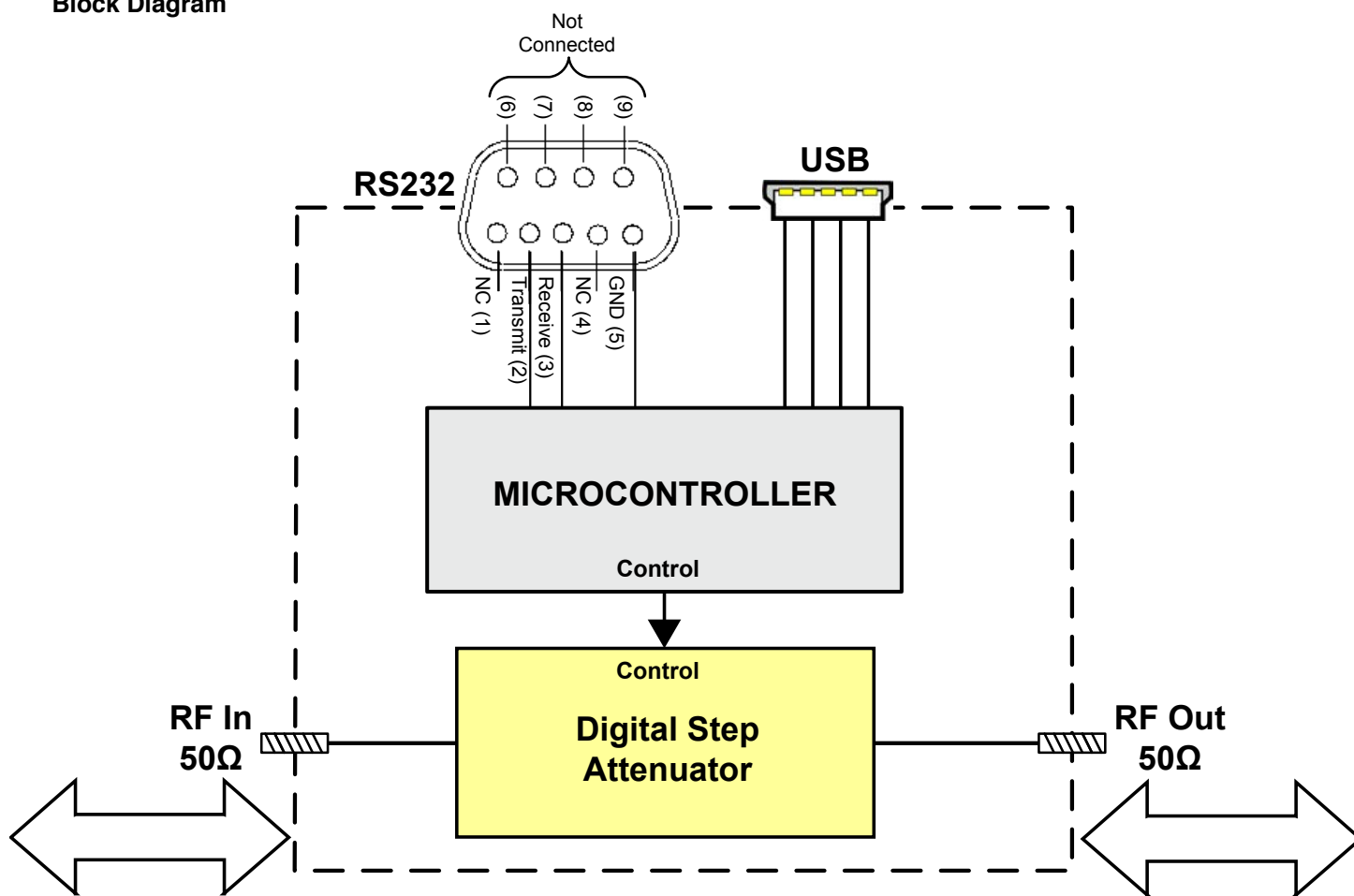
- Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.
- Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.
- 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](http://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 <sup>14</sup>

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

<sup>14</sup> 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.