

User Guide

USB, RS232, SPI & Ethernet Programable Attenuators



RS232 & USB control,
Input Impedance: 50 Ω



Ethernet & USB control,
Input Impedance: 50 Ω

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Chapter 1 – General Information

1.1 Scope of the User Guide

This User Guide provides general introduction, installation instructions and operating information for Mini-Circuits USB & RS232 programmable attenuators (RUDAT series) and USB & Ethernet programmable attenuators (RCDAT and RC4DAT series)

1.2 Warranty

See Mini-Circuits website <http://www.minicircuits.com/support/ordering.html> for warranty information.

1.3 Definitions

Note: A note advises on important information you may need to ensure proper operation of the equipment. There is no risk to either the equipment or the user.

CAUTION

A caution advises about a condition or procedure which can cause damage to the equipment (no danger to users).

WARNING

A warning alerts to a possible risk to the user and steps to avoid it. **DO NOT** proceed until you are sure you understand the warning.

1.4 General Safety Precautions

There are no general safety precautions for using Mini-Circuits programmable attenuators.

1.5 Introduction

Mini-Circuits has developed two series of programmable attenuators, as shown in **Figure 1.3**. The RUDAT series, which can be controlled via standard USB or RS232 ports (some also support SPI), and the RCDAT series, which can be controlled via standard USB or Ethernet-TCP/IP (Telnet or HTTP protocols). These programmable attenuators can operate up to 8000 MHz with an attenuation resolution 0.25 dB and up to 13,000 MHz with resolution of 0.5 dB. Attenuation ranges from 30 to 120 dB are available. These models are plug & play devices which require no drivers for any of the supported interfaces. With the supplied GUI software, or most common lab test software, you can remotely set any attenuation level in range almost instantly. The attenuators are light, compact and can be powered from the USB bus or external power supply, increasing system flexibility. Using their Ethernet control the RCDAT models can be controlled from almost any computer, or even a smartphone with a network connection from anywhere in the world.



Figure 1.3: Mini-Circuits RUDAT-6000-90



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1.6 Service and Calibration

None of the programmable attenuator models require any periodic service or calibration. The only user service possible for the models is external cleaning of the case and connectors as needed. Do not use any detergents or spray cleaning solutions to clean the attenuators. To clean the connectors use an alcohol solution, and to clean the case a soft, damp cloth.

1.7 Contact Information

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sales@minicircuits.com
For regional offices and tech support see <http://www.minicircuits.com/contact/offices.html>

1.8 Technical Description

1.8.1 Features of Mini-Circuits Programmable Attenuators

- Wide attenuation range (model dependent, see section 1.8.2)
- Wide frequency range (model dependent, see section 1.8.2)
- Fine attenuation resolution (0.25 dB or 0.5 dB)
- Multiple control options
- Easy installation and operation
- Plug & Play devices, no driver installation required
- ActiveX COM object and .Net class library for use with other software: C++, C#, CVI®, Delphi®, LabVIEW® 8 or newer, MATLAB® 7 or newer, Python, Agilent VEE®, Visual Basic®, Visual Studio® 6 or newer, and more (see [AN-49-001](#) for full details)
- User friendly Graphical User Interface for any Windows® 32 or 64 bit computer. Command line support for Linux® computers.
- Mounting bracket (optional)



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1.8.2 Model Selection Guide

Model Name	Num. of Channels	Frequency Range (MHz)	Attenuation Range (dB)	Attenuation Resolution (dB)	Max Input Power (dBm)	Control Protocols
RUDAT-4000-120	1	1 - 4000	120	0.25	20	USB & RS232
RUDAT-6000-110	1	1 - 6000	110	0.25	20	USB & RS232
RUDAT-6000-90	1	1 - 6000	90	0.25	20	USB & RS232
RUDAT-6000-60	1	1 - 6000	60	0.25	20	USB & RS232
RUDAT-6000-30	1	1 - 6000	30	0.25	20	USB & RS232
RUDAT-13G-90	1	10 - 13000	90	0.5	23	USB, RS232 & SPI
RCDAT-4000-120	1	1 - 6000	110	0.25	20	USB, HTTP & Telnet
RCDAT-6000-110	1	1 - 6000	90	0.25	20	USB, HTTP & Telnet
RCDAT-3000-63W2	1	50 - 3000	63	1	33	USB, HTTP & Telnet
RCDAT-6000-90	1	1 - 6000	90	0.25	20	USB, HTTP & Telnet
RCDAT-6000-60	1	1 - 6000	60	0.25	20	USB, HTTP & Telnet
RCDAT-6000-30	1	1 - 6000	30	0.25	20	USB, HTTP & Telnet
RCDAT-8000-30	1	1 - 8000	30	0.25	28	USB, HTTP & Telnet
RCDAT-8000-60	1	1 - 8000	60	0.25	28	USB, HTTP & Telnet
RCDAT-8000-90	1	1 - 8000	30	0.25	28	USB, HTTP & Telnet
RC4DAT-6G-90	4	1 - 6000	90	0.25	23	USB, HTTP & Telnet

For detailed model performance, data and graphs, outline drawing, ordering information and environmental specifications click on the model part number.

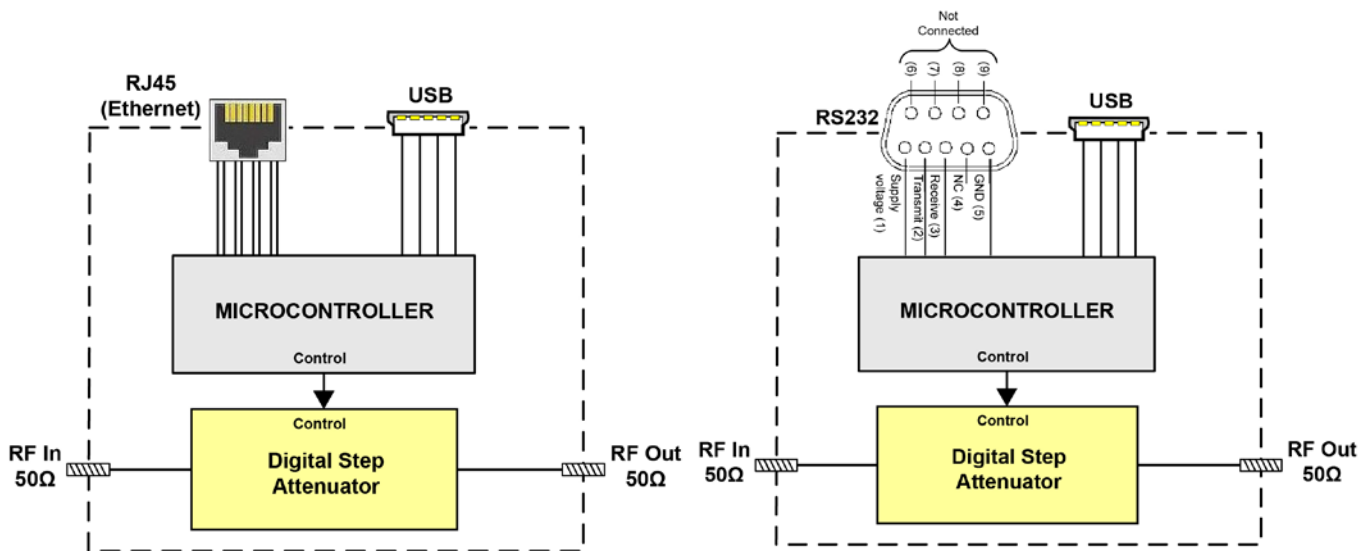


Figure 1.8.2a RUDAT & RCDAT Functional Block Diagrams

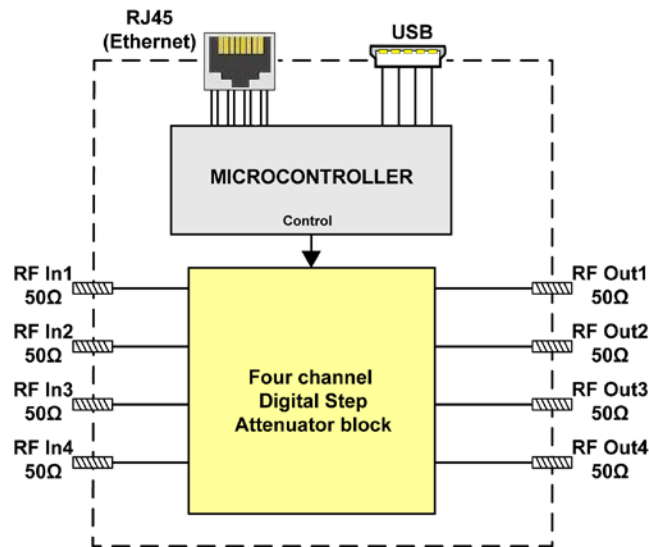


Figure 1.8.2b RC4DAT Functional Block Diagram

1.8.3 Intended Applications

Mini-Circuits programmable attenuators are intended for indoor use in:

- Lab and test equipment setups for both manual and automated measurements.
- Control systems
- Production test equipment

The models can be used by anyone familiar with the basics of electronic measurements or electronic control systems.

1.8.4 Supported Software Environments

Mini-Circuits programmable attenuators have been tested in the following operating systems:

32 bit systems: Windows 10, Windows 8, Windows 7, Windows Vista, Windows XP, Windows 98 and Linux.

64 bit systems: Windows 10, Windows 8, Windows 7, Windows Vista and Linux

The attenuators will work with almost any software environment that supports ActiveX or .Net including: C++, C#, CVI®, Delphi®, LabVIEW® 8 or newer, MATLAB® 7 or newer, Python, Agilent VEE®, Visual Basic®, AutoIT, Visual Studio® 6 or newer, and more (see [AN-49-001](#) for full details)

Additionally the HTTP and Telnet protocols can operate from almost any computer, or even a mobile device/smartphone with a network connection.

For more information see [programming handbook](#) on our website.

1.8.5 Included Accessories and Options

1.8.5.1 RUDAT models are supplied with

- 2.6 ft (0.8m) USB cable (Type A to Type Mini-B)

1.8.5.2 RCDAT and RC4DAT models are supplied with the

- 2.6 ft (0.8m) USB cable (Type A to Type Mini-B)
- AC/DC power adapter suitable for a wide selection of wall sockets

The following additional accessories are also available:

- Mounting bracket
- 6.9 ft (2m) USB cable (Type A to Type Mini-B)
- 6 ft (1.8m) RS232 cable (9 Pin D-Sub Male-Female)
- AC/DC power adapter suitable for a wide selection of wall sockets



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1.8.6 Conformity

Mini-Circuits series of programmable attenuators conform to all requirements for the following international standards:

RoHS – The models comply with EU directive for Restriction of Hazardous Substances for 6 substances.

USB 2.0 – The models meet the specifications of the Universal Serial Bus Ver. 2.0 communication standard as described by USB-IF.

USB HID – The models meet the requirements for Universal Serial Bus Human Interface Devices according to USB-IF's Device Class Definition for Human Interface Devices firmware rev. 1.11

RUDAT series models also comply with:

RS232 – The RUDAT series models meet all requirements for RS232 standard.

RCDAT series models also comply with:

TCP/IP – The RCDAT series models' Ethernet communication complies with the specifications of the Transmission Control Protocol (TCP) and Internet Protocol (IP) as defined in RFC 791 and RFC 793.

HTTP – The RCDAT series models' support all requirements for communicating with the Hypertext Transfer Protocol (HTTP) as defined in RFC 1945.

Telnet – The RCDAT series models' support all requirements for communicating with the Telnet protocol, as defined in RFC 854



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Chapter 2 – Installation and Setup

2.1 Software Setup

System requirements for the RUDAT or RCDAT models are a computer (Pentium II or better) with the following support depending on the control method used:

RS232 control	SPI	USB control	Ethernet control
Serial COM port	3-wire I/O control at LVTTTL	USB HID	Network connection

When using the supplied power adaptor a power source of 110-220V_{AC} (with socket matching one of the two pin plugs provided) is also needed.

To run the GUI program a Windows operating system for either 32 or 64 bits is required as well.



If you have had any problems installing the software, we're here to help.

Try following these complete step-by-step instructions. If you still experience problems, give us a call at Mini-Circuits Worldwide Technical support. It's (718) 934-4500 or e-mail apps@minicircuits.com for North America or go to minicircuits.com/contact/worldwide_tech_support.html for other regional numbers and addresses.

2.1.1 First save all work in progress and close any other programs that may be running.

2.1.2 Next, insert the *Mini-Circuits* CD into the CD-ROM drive, or download the full CD software from minicircuits.com. If installing from files downloaded from the web, unzip the downloaded files to a temporary folder on your local computer, then open the file folder you created, and double-click the "Install" icon.

Note: Saving the directory in an excessively long path may result in problems during installation.

2.1.3 If installation from the CD does not start automatically, run *install.exe* from the <CD drive> root directory.

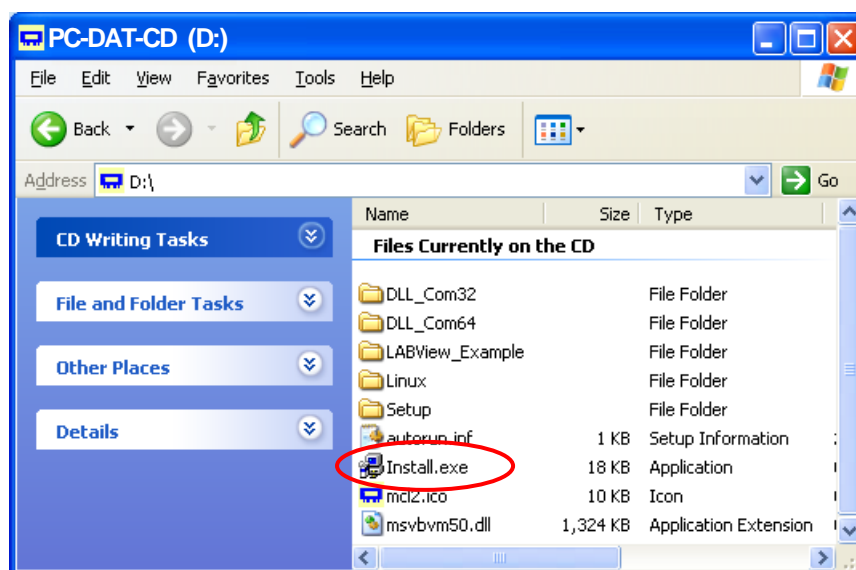


Figure 2.1.3 CD file listing window



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2.2 Installation

2.2.1 **The installer window** should now appear. Click the “Install Now” button.

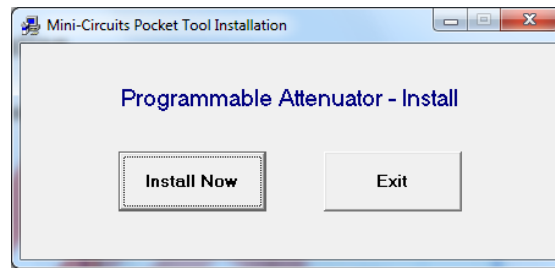


Figure 2.2.1 Installation window

2.2.2 **The license agreement** should now appear. To proceed, click “I Agree” and the “Continue” button.

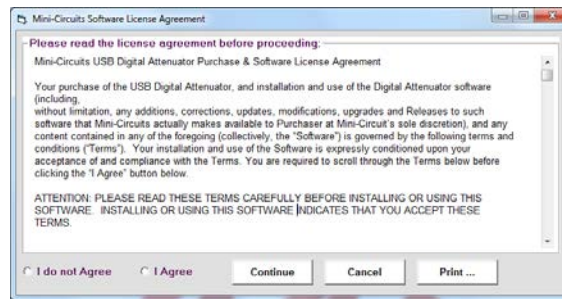


Figure 2.2.2 License agreement

2.2.3 **The installation program will launch.** Click the “OK” button to continue.

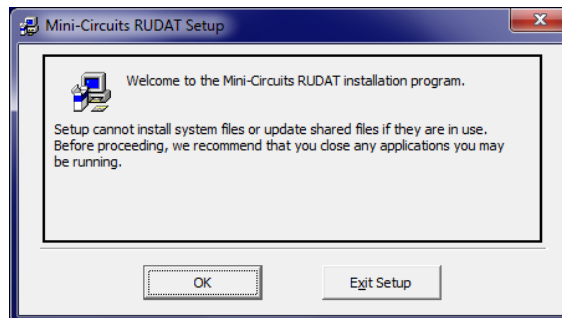


Figure 2.2.3 Installation program window

2.2.4 The destination directory window will appear. In most cases, the default will be your computer's hard drive (C:)\Program Files\Mini-Circuits Programmable Attenuator\. Change it if you prefer. Then click the large button at the top to continue.

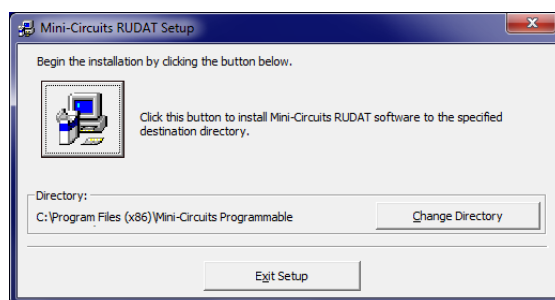


Figure 2.2.4: Destination directory window

2.2.5 The Program Group window will appear. This window allows you to select the program group under which the link for the attenuator control program in the Start Menu will be created. If you change the Program Group for this software, be sure to record that information together with your destination address. Click on "Continue" to proceed.

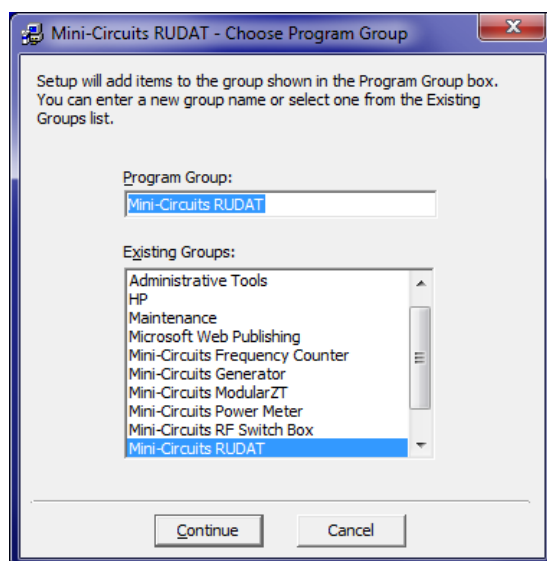


Figure 2.2.5: Program group window

2.2.6 In a second or two, your installation will be complete. Click "OK" to close the installer.

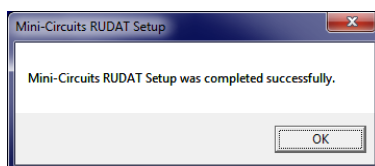


Figure 2.2.6: Installation complete

2.3 Attenuator Physical Setup

CAUTION

The maximum allowed RF input for programmable attenuators models is reduced at low frequencies. Check the individual model datasheet and do not exceed the specified limits.

2.3.1 For USB Control:

- Connect USB cable between the attenuator's USB port and the computer's USB port.
- Note the attenuator's USB indicator lights up.
- Connect attenuator input and output SMA ports to your system.

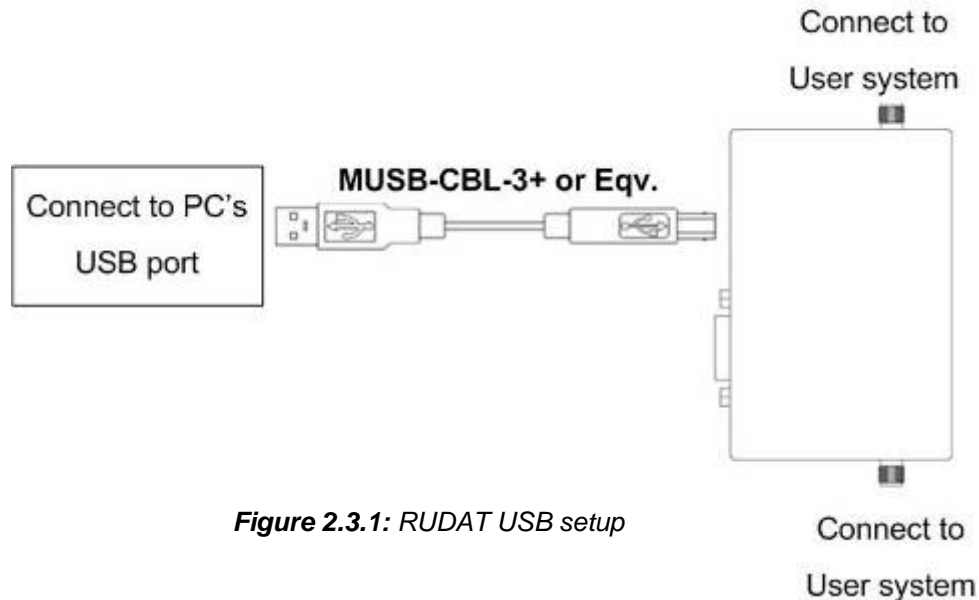


Figure 2.3.1: RUDAT USB setup

2.3.2 For RS232 Control (RUDAT) with power via USB

- Connect D-Sub9 cable between RUDAT unit D-Sub port and computer serial port.
- Connect plug suited for available wall socket to the provided power adaptor and plug in the power adaptor (if a USB bus is available it can be used instead of the power supply).
- Connect USB cable between supplied power adaptor and RUDAT USB port.
- Note the Indicator lights up.
- Connect RUDAT input and output SMA ports to your system.

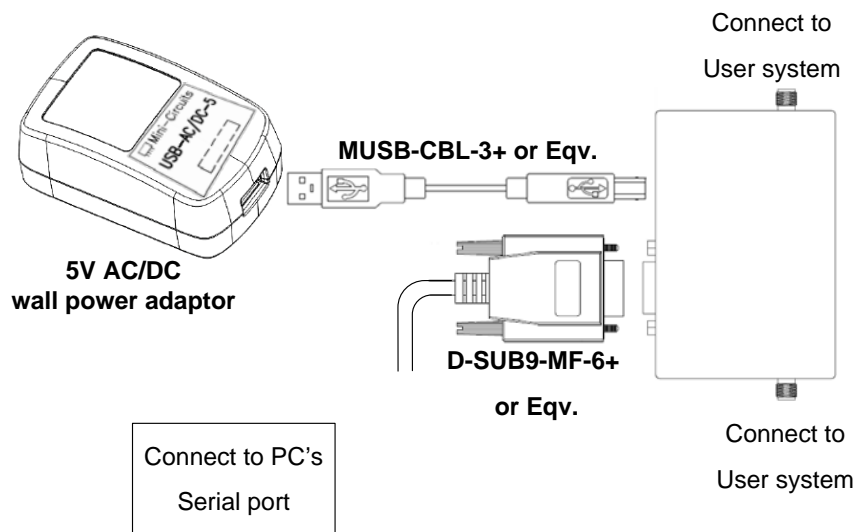


Figure 2.3.2: RUDAT RS232 setup option1

2.3.3 For RS232 Control (RUDAT) with power via D-Sub Pin#1

This option is supported in the following units:

Model P/N	Serial Number
RUDAT-6000-30	11405010010 and greater
RUDAT-6000-60	11407150001 and greater
RUDAT-6000-90	11403230000 and greater
RUDAT-6000-110	All serial Numbers
RUDAT-4000-120	All serial Numbers

This option requires the use of an RS232 port wired to supply +5V_{DC} at Pin#1

-Connect D-Sub9 cable between RUDAT unit D-Sub port and custom RS232 port.

-Note the Indicator lights up.

-Connect RUDAT input and output SMA ports to your system.

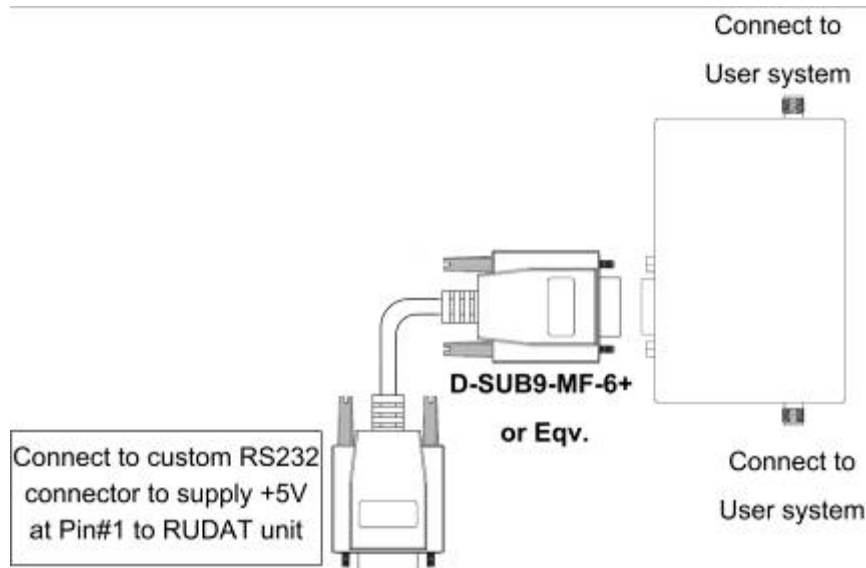


Figure 2.3.3: RUDAT RS232 setup option 2

2.3.4 **For Ethernet Control (RCDAT)**

- Connect plug suited for available wall socket to the provided power adaptor and plug in the power adaptor (if a USB port is available it can be used instead of the AC mains power adapter).
- Connect USB cable between supplied power adaptor and RCDAT USB port.
- Note the USB indicator lights up.
- Connect a standard network cable between RCDAT unit RJ45 socket and network port.
- Note the network indicators on the RJ45 socket of the RCDAT unit light up after a few seconds.
- Connect RCDAT input and output SMA ports to your system.

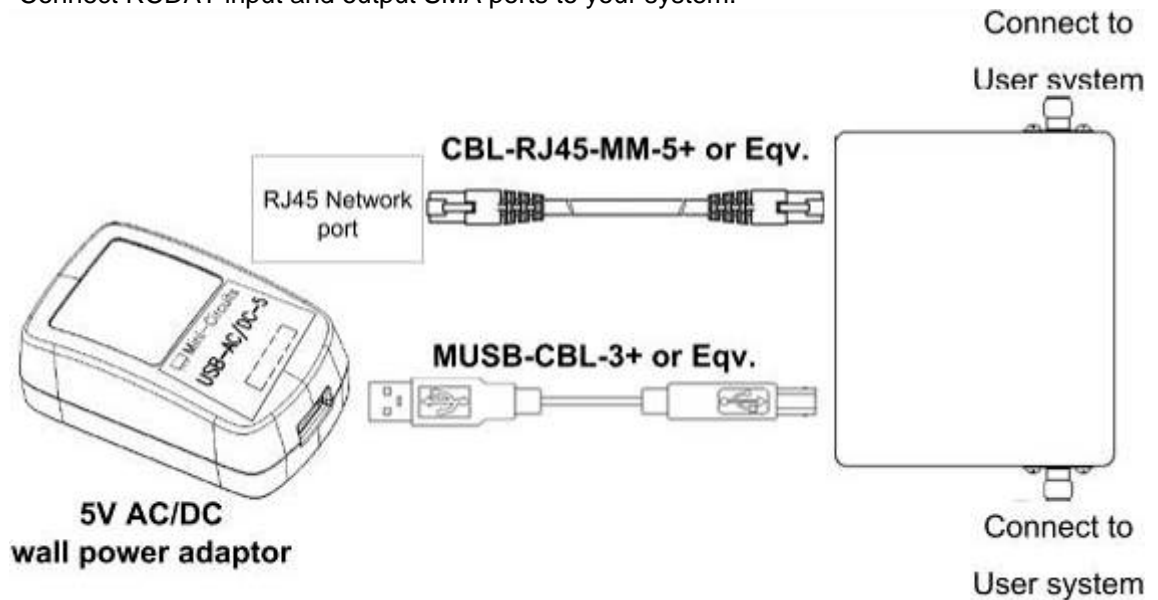


Figure 2.3.4: RCDAT Ethernet setup

2.3.5 **For SPI Control (RUDAT-13G-90)**

- Connect the SPI Clock, Data and Latch Enable pins (identified in the model datasheet) to your I/O control device
- Connect power as for RS232 control
- Note the Indicator lights up.
- Connect RUDAT input and output SMA ports to your system.

Notes:

1. Check model datasheet for SPI voltage and timing instructions for setting the attenuation.
2. In SPI control the attenuation level can be set however there is currently there is no provision for reading unit status via SPI, or any other functions supported for USB and RS232 control.

3.

Chapter 3 – Using the Attenuator Models

The RUDAT, RCDAT and RC4DAT models are supplied along with API programming objects (DLL files) to allow easy control by most common lab test software (See attenuator programming manual for details) and with a Windows GUI program to set the attenuation level manually.

To start the program go to the Start menu and select All Programs>Mini-Circuits RUDAT (default), or go to the other destination address you selected during installation (section 2.2.5). The “Mini-Circuits RUDAT” icon should be waiting there for you. Click on it and get started!

3.1 Starting the GUI Program

3.1.1 **When started the GUI will** show the control selection screen allowing you to choose RS232, USB, HTTP, or Telnet control.

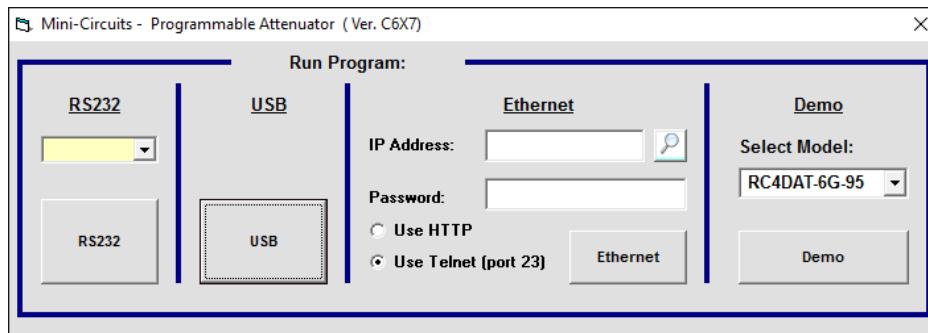


Figure 3.1.1: Startup Screen

3.1.2 **To start a RUDAT unit in RS232 control** select the COM port the unit is connected to from the drop box in the left section and click on the RS232 button. If no unit is found at the COM port selected an alert will pop up advising no unit is connected. Click “Yes” to proceed anyway, or “No” to return to startup screen. If you get this alert when unit is connected check the power and data connections to the attenuator and verify you selected the correct COM port.

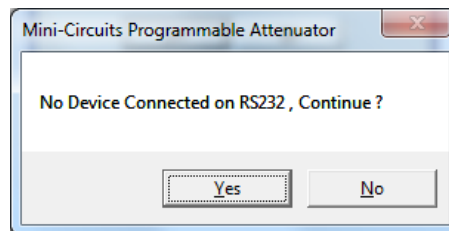


Figure 3.1.2: No unit in RS232 alert

3.1.3 **To start an RUDAT, RCDAT or RC4DAT unit in USB control** click on the USB button in the center. If no unit is connected to USB an alert will pop up. Click “OK” to return to startup screen. If you get this alert with the unit connected to USB check the attenuators USB indicator

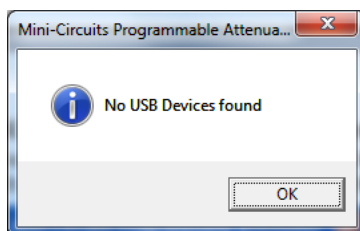


Figure 3.1.3: No USB device alert

3.1.4 **If multiple units are connected via USB**, the unit selection screen will appear with a list of serial numbers and model names for connected units. Select the unit you wish to start with and click “OK”, or click “Cancel” to exit the program. The program can handle up to 24 units connected simultaneously. If only one unit is connected via USB, the program will go directly to the attenuator control screen.

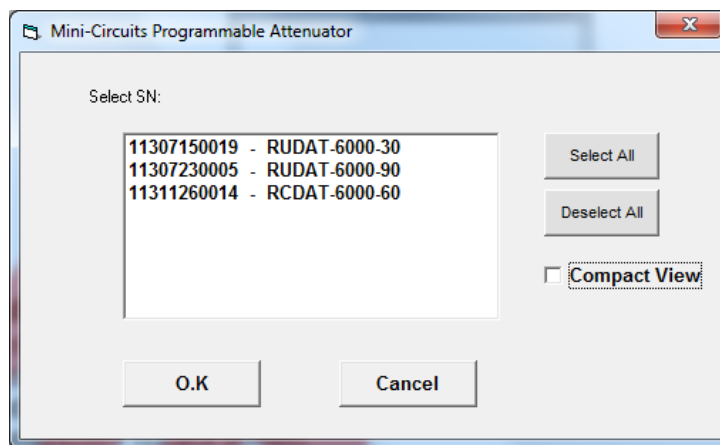


Figure 3.1.4: Unit selection screen

3.1.5 **To start an RCDAT or RC4DAT unit with Ethernet control**, either enter the IP address of the unit (If using HTTP with a port other than 80 port will also be needed) of the unit in the “IP address” field or click on the search icon next to it to find all Mini-Circuits attenuators connected to the network.

Note: When connecting to the unit with Ethernet control for the first time you may need to change the factory default Ethernet configuration to match your network configuration. See **section 3.3** or the [programming manual](#) for details.

3.1.6 **After clicking on the search icon** The IP search will pop up with a list of attenuators IP addresses found and their HTTP ports on the left side of the screen, and full details of each unit on the right. Mark the IP address you wish to use and click select. The search window will close and the IP address will be entered in the IP address field of the startup screen automatically.

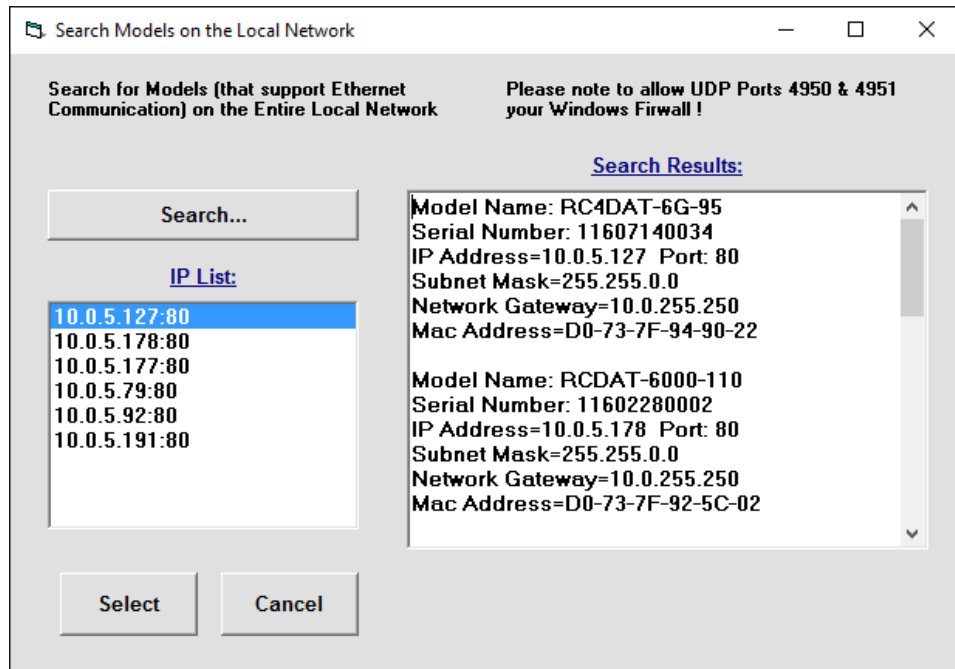


Figure 3.1.6: Ethernet IP search window

Notes:

- 1) To refresh the list of units found click on the Search button.
- 2) The search function uses ports UDP 4950 and UDP 4951 for communication, ensure your firewall allows access to these ports.

3.1.8 After entering the IP address enter your password if you set one (see **section 3.2**), select the communication protocol you wish to use (HTTP or Telnet) and click start, the Attenuation control screen will open.

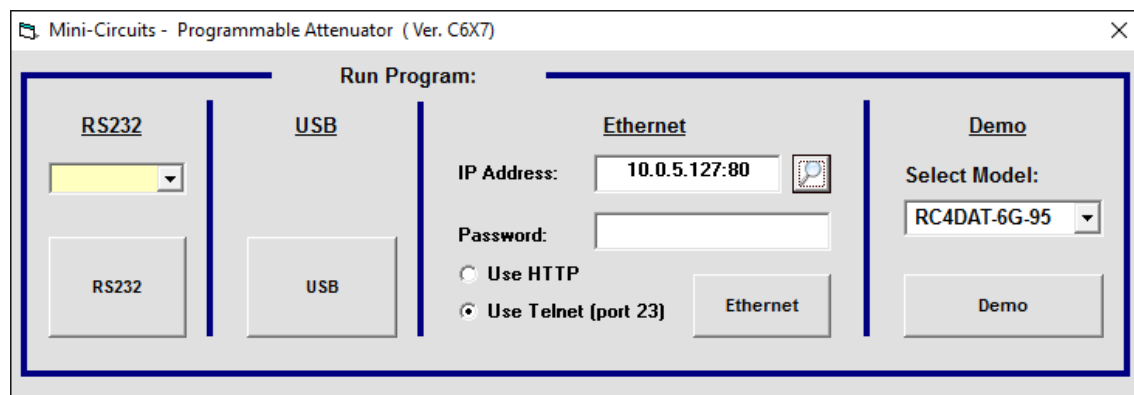


Figure 3.1.8: Ethernet startup screen

Note: changing Ethernet settings is only possible via USB control, see section 3.2 for details.

3.1.9 Telnet or HTTP text commands can also be used to control the attenuator. Just type the command in the address field of your internet browser or implement a Get/Post HTTP function in your selected application (for HTTP), or establish a Telnet connection. A full list of the possible commands and queries is available in Mini-Circuits Programming handbook, and in a text file on the CD provided with the Attenuator, in the Ethernet directory.

3.2 Operating the Attenuator with the GUI Program

3.2.1 **Once you've selected the control method to use**, the main screen of the GUI program will appear.

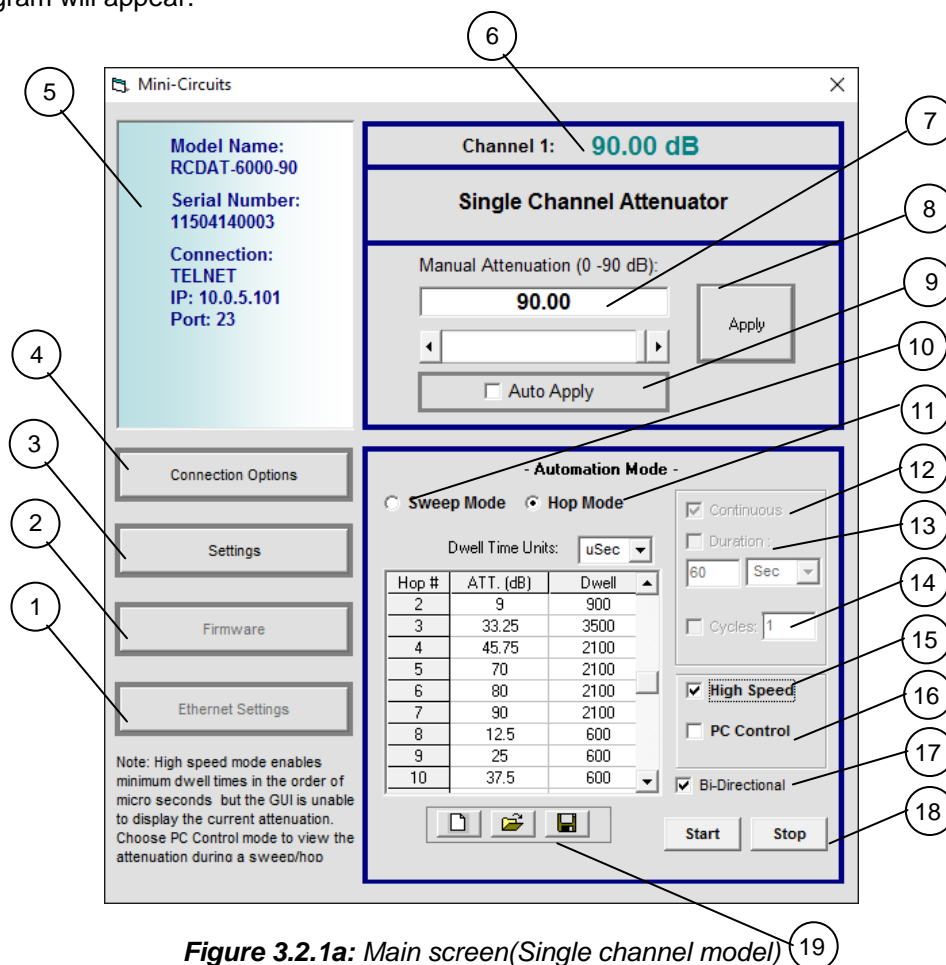


Figure 3.2.1a: Main screen(Single channel model)

3.2.2 Manual Mode functions:

#	Name	Descriptions
1	Ethernet Config	Opens a Ethernet configuration window (See section 3.3 for details)
2	Firmware	Opens the Firmware update window (available only in USB control)
3	Configuration Settings	Opens a pop-up window allowing the user to specify attenuator state at power up (See section 3.2.5 for details) and set the step size used in the manual attenuation setting.
4	Connection Options	Returns to the startup screen
5	Model description	Field describing the model, this shows model part number, serial number and connection details.
6	Current Attenuation	The value the attenuator is currently set to.
7	Manual Attenuator	Attenuation value to be set. This can be changed by either typing a value, or using the scroll bar and arrows to change the attenuation.
8	Apply	Applies the changes made to the attenuation setting.
9	Auto Apply	When this check box is selected every change in attenuation setting will be applied immediately, when it is not selected user must click 'Apply' to execute the changes.

3.2.3 Automatic mode functions:

#	Name	Descriptions
10	Sweep Mode	When selected, allows setting an attenuation sweep with user defined start, stop, step and dwell time values.
11	Hop Mode	When selected, allows setting a table of user defined attenuation and dwell time which the attenuator will "hop" through.
12	Continuous	When selected, the attenuator will repeat the user defined sweep or hop until the Stop button is clicked.
13	Duration	When selected the attenuator will repeat the user defined sweep or hop sequence for the time specified (can be defined in milliseconds, seconds, minutes or hours).
14	No. of Cycles	When selected the attenuator will repeat the user defined sweep or hop sequence for the number of cycles specified.
15	High Speed	(only available with Firmware Rev. B1 or greater) Enables high speed Sweep and Hop functions. See section 3.4.3 for details
16	PC control	Default setting. Sweep and Hop instructions are sent individually to the unit See section 3.4.2 for details.
17	Bidirectional	When selected, the attenuator will sweep or hop through the user defined sequence, then repeat in the reverse direction (sweeping from stop to start or hopping from last to first point in the hop list).
18	Start & Stop	Start and Stop the automatic run (Sweep or Hop) at the current attenuation setting.
19	Icons	In Hop mode allows clearing all current settings, opening a file of saved settings or saving current settings. Not available in Sweep mode.



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3.2.4 Multi-Channel functions(Multi channel models only):

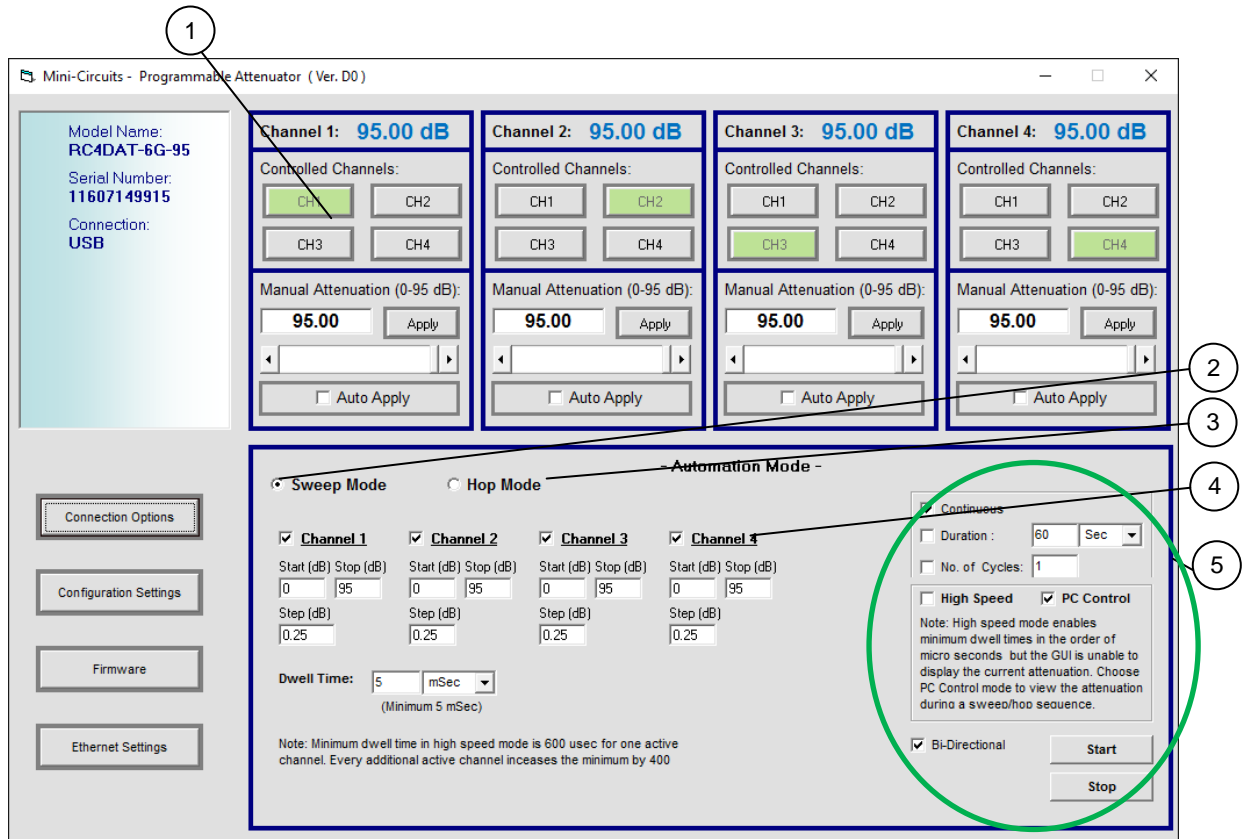


Figure 3.2.4: Main screen(Multi - channel model)

#	Name	Descriptions
1	Controlled channels	Any attenuation setting specified in the manual control field of the channel will affect all channels selected in the 'Controlled Channels' field.
2	Sweep mode	When selected all four channels automation will be in sweep mode
3	Hop mode	When selected all four channels automation will be in hop mode
4	Channel selection	Selects which channels the sweep or hop applies to
5	Automation settings	Same as for single channel model, but apply to all channels.

3.2.5 Configuration Settings

Clicking on 'configuration Settings' opens a popup window which allows the user to set the following parameters:

- Device Address -
 - Set the device's USB address in the 1 – 255 range (factory default 255)
- Power Up State -
 - For 30, 60 or 90 dB models, Firmware A4 or newer required
 - The attenuator can be configured to power up with isolation setting(factory default), a user defined attenuation value, or the last attenuation value set
 - In Multi-channel models – the attenuation state each channel will assume on power up can be set individually.

Notes:

1. If the GUI is not shut down before the attenuator is disconnected the last attenuation state will not be saved and if “set last defined attenuation” was selected the attenuator will start up in high isolation state
 2. Shutting down and then starting up the GUI repeatedly in less than 3 minutes while “set last attenuation” is enabled may result in attenuator resetting to isolation state at power up due to last attenuation state not being recorded correctly.
- Manual attenuation Step size -
 - Gross tune is the step size for each click on scroll bar.
 - Fine Tune is the step size for the arrows

The screenshot shows the 'Configuration Settings' window. On the left, under 'Device Settings', there are three radio button options for 'On Power Up'. The first option is 'Set the last defined attenuation' with a note: 'Note: close the GUI before disconnecting the attenuator in order to ensure the last state is saved correctly'. The second option is 'Set the attenuation (dB) to:' with four input fields for Channel1, Channel2, Channel3, and Channel4, all set to 0. The third option is 'Set Max attenuation (Factory Default)' which is checked. Below these is a 'Device Address' field set to 22. On the right, under 'Manual Attenuation Scroll Bar', there is a 'Step Size' window with 'Coarse Tune' (radio buttons for 1, 2, 5, 10, 15) and 'Fine Tune' (radio buttons for 0.25, 0.5, 0.75, 1). At the bottom of the screen are 'Save' and 'Exit' buttons.

Figure 3.2.5: Configuration Settings screen

3.3 Changing Ethernet Settings Using the GUI Program

3.3.1 Factory default settings for RCDAT and RC4DAT models are Dynamic IP (DHCP) using Port 80 (see Figure 3.3.2). Changing these settings can be done only via USB control. In the USB control GUI (see **section 3.1.3**) click on the Ethernet Settings button.

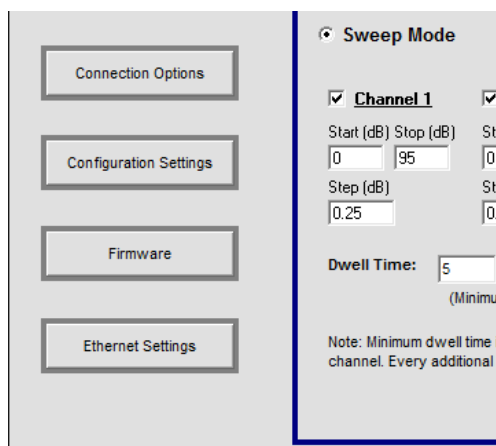


Figure 3.3.1: USB Control

3.3.2 The Ethernet Settings screen will open showing the current configuration. **Figure 3.3.2** shows the factory default of the programmable attenuators. If these settings are appropriate for your local network then you do not need to access the setup before connecting the attenuator to the network and can connect to the attenuator via Ethernet as described in **section 3.1.5**.

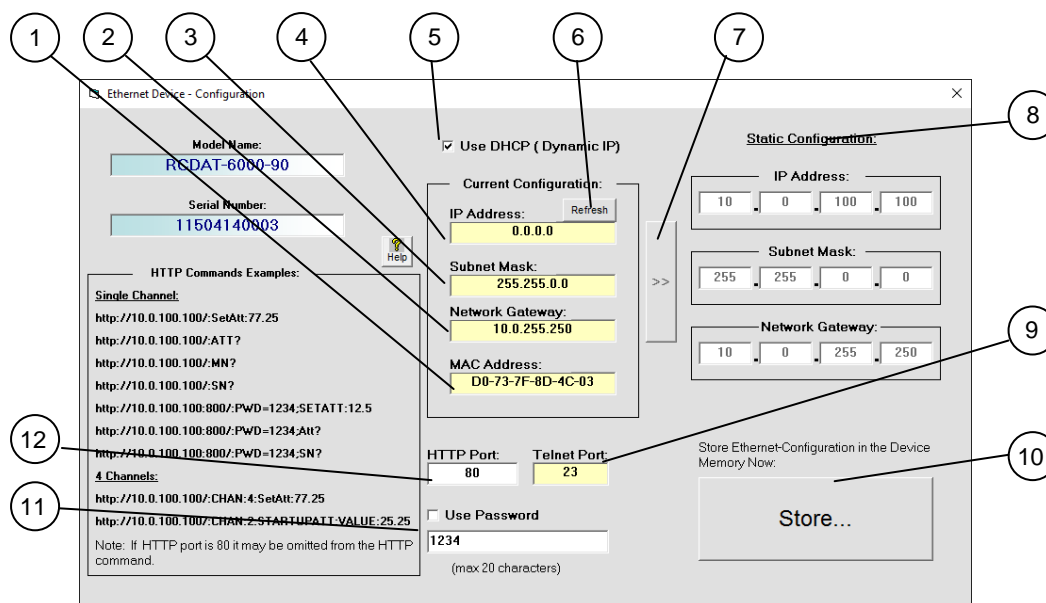


Figure 3.3.2: Ethernet Settings screen (showing factory default state)

3.3.3 *The Ethernet Configuration settings are:*

#	Name	Description
1	MAC Address	Media Access Control address – a unique, unchanging identifier for the attenuator unit.
2	Network gateway	IP address of the network gateway. When DHCP is selected this is assigned by the server and will change according to the server.
3	Subnet Mask	The network's subnet mask. When DHCP is selected this is assigned by the server and will change according to the server.
4	IP Address	The IP address of the unit on the network. When DHCP is selected this is assigned by the server and will change according to the server.
5	Use DHCP	When selected the attenuator will query the server for appropriate parameters with no input from the user. Any manually entered IP address, subnet mask and network gateway will be disregarded.
6	Refresh	Request IP address, gateway and subnet mask from server.
7	Copy state	Copies current state of dynamic IP to static IP, not available when DHCP is selected.
8	Static Configuration	When DHCP is not selected the user must specify the values below which will not be changed by the server.
9	Telnet Port	Port to be used for telnet communication. Cannot be changed by user
10	Store	After you've made all changes you want to click on this button to save the settings.
11	Password	To restrict remote access to the attenuator select "Use Password" and enter the desired password below (up to 20 characters).
12	HTTP Port	Specify the port to use for HTTP communication on the network (default 80). Note port address does not get assigned by the server when DHCP is selected. Port 23 is reserved for Telnet communication and cannot be used.

3.3.4 *After making the changes you want, click on "Store" and the changes will be saved to the attenuator's memory.*



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3.4 Sweep and Hop functions

3.4.1 The GUI provides the ability to carry out an automated sequence of attenuations settings, either a sequential sweep from a start value to a stop value, with a fixed step size (increment or decrement) and dwell time, or an arbitrary "hop" sequence of attenuation and dwell time values.

3.4.2 PC Control Mode (Sweep & Hop Sequences):

This is the default mode, available on all RUDAT, RCDAT and RC4DAT attenuators. In this mode, the attenuation sweep or hop sequence is managed by the GUI so each attenuation value is sent to the attenuator one at a time, as needed. Since the GUI is managing the sequence it is always able to display the current attenuation state but each attenuation setting is subject to communication delays between the PC and attenuator. Communication delays vary by computer but in practice this dictates a minimum dwell time in the order of 5 ms or more for USB 3.0 connections, or longer with USB 1 or 2 connections (10 - 20 ms is not uncommon for older computers or slower connections).

3.4.3 High Speed Mode (Sweep & Hop Sequences):

This mode is only available for units with firmware version B1 or later (see **section 3.6** for the firmware update process). Note: Units with older serial numbers may not support firmware upgrade in the field. See **section 3.6** for supported serial numbers.

In high speed mode, the attenuation sweep parameters or list of attenuation hop values are loaded into the attenuator's internal memory. This initial configuration step, along with the Start and Stop commands from the GUI, are subject to the same communication delays as above but once executed the timing is controlled by the attenuator's internal reference and no further PC communication is required. This enables high speed attenuation sequences with dwell times as low as 600 μ s (400 μ s for RCDAT-3000-63W2). Since the PC communication delays are significantly longer than this minimum dwell time, the GUI will not be able to display the current attenuation state in this mode until the sequence is stopped.

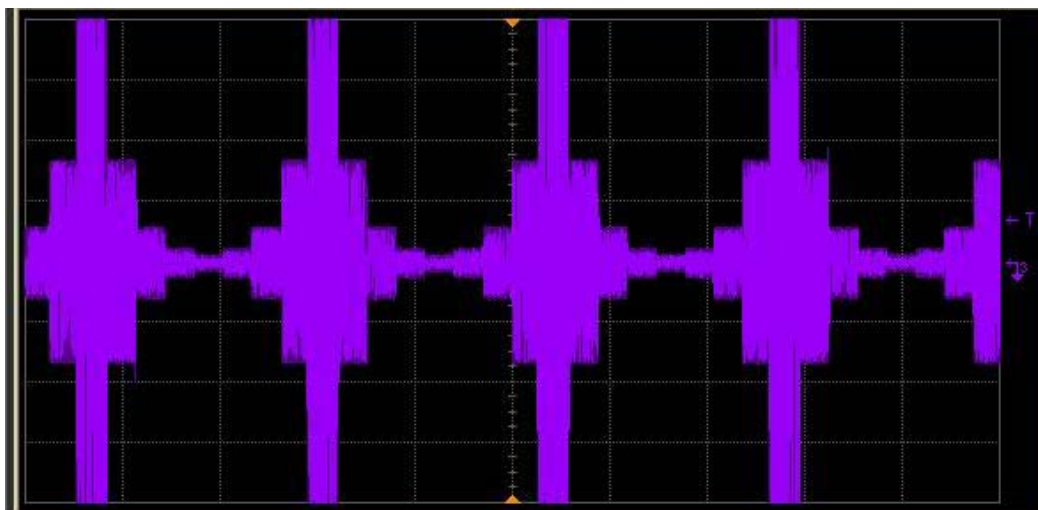


Figure 3.4: Plot of signal when sweeping attenuation 0-40dB in 10 dB steps (scale 2ms/div)

3.4.4 Multi-Channel models:

In models with multiple channels, the user needs to select which channels will be active during a hop or sweep sequence. This is done by checking check box over the channel sweep parameter in sweep mode, or the 'Active Channel' marker to the right of the hop sequence table in hop mode. Each channel can have its own attenuation settings, but the timing must be the same for all channels in a unit. This means that if sweeps of different lengths were set with a set number of cycles, all four channels will sweep only until the channel with the shortest sweep completed the specified number of cycles.

3.4.5 Attenuator Switching Time:

Attenuator models are specified with typical switching times of 650 to 900 ns depending on the model, but even faster transitions can be observed in practice. Switching time in this instance is defined as the time during which the attenuator is transitioning from one attenuation level to the next. This short switching time means the RF signal path has an undefined attenuation state for as short a time as possible during changes in attenuation levels. Switching time is distinct from minimum dwell time during a sweep or hop sequence which is generally dictated by communication and control delays rather than RF switching characteristics.

Some typical switching time measurements applicable to the programmable attenuator series are presented below:

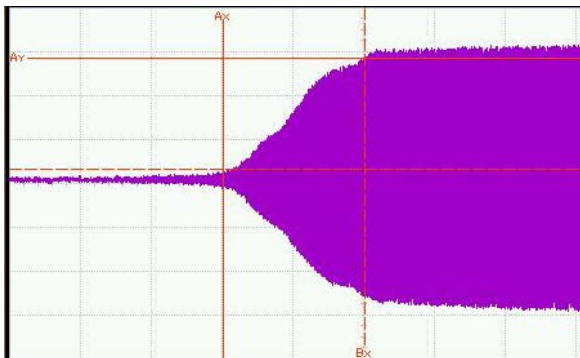


Figure 3.4.5a: Typ. Switching time from 120 to 0 dB(RCDAT-4000-120); 200 ns switching time

Ax = 711.998 μ s	Ay = 143 mV
Bx = 712.198 μ s	By = 16 mV
Δ x = 200.000 ns	Δ y = -127 mV

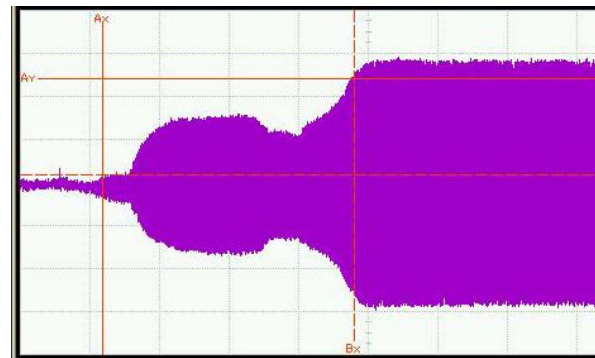


Figure 3.4.5b: Typ. Switching time from 45 to 15 dB(RCDAT-4000-120); 362 ns switching time

Ax = 472.735 μ s	Ay = 25.25 mV
Bx = 473.097 μ s	By = 2.81 mV
Δ x = 362.000 ns	Δ y = -22.44 mV

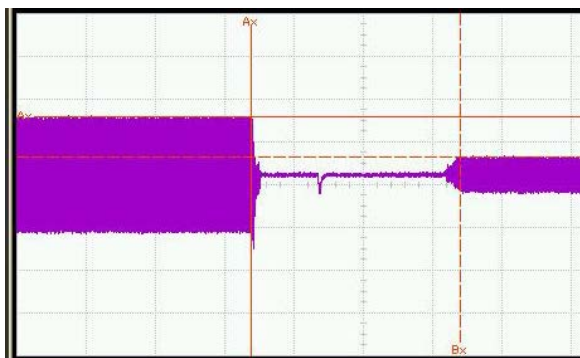


Figure 3.4.5c: Typ. Switching time from 10 to 0 dB(RUDAT-13G-90); 600 ns switching time

Ax = 174.907 μ s	Ay = 140 mV
Bx = 175.510 μ s	By = 46 mV
Δ x = 603.000 ns	Δ y = -100 mV

3.5 Alerts During Operation of the Programmable Attenuator

3.5.1 **If you type** an attenuation value the attenuator cannot meet – either too large a number, or resolution of under 0.25 dB. An alert will pop up and the attenuation setting will not change. Click OK to dismiss the alert and enter a valid attenuation value.

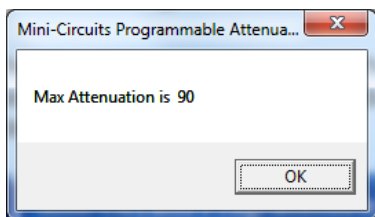


Figure 3.3.1a: Value too large for model

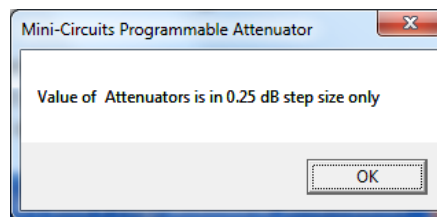


Figure 3.3.1b: Resolution too small for model

3.5.2 **If the attenuator is disconnected** during operation, or experiences a problem with the power supply an alert will pop up. Click OK to close the program and check the power and data connections to the unit before restarting the program.

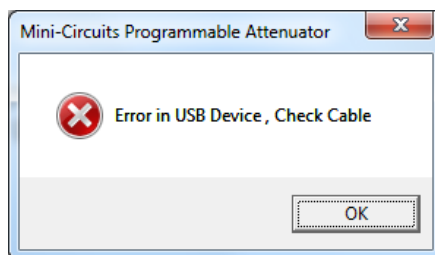


Figure 3.3.2: data or power disconnected alert

3.5.3 **The RUDAT, RCDAT and RC4DAT models can also** be controlled automatically using most common lab test software and the provided DLL files, or your own custom programs. For more information on this see the Programming Guide on the included CD or download it from our website at http://www.minicircuits.com/support/software_download.html

3.6 Firmware Update

The firmware upgrade process requires a computer running a Windows operating system and with the latest Mini-Circuits GUI (Graphical User Interface) program installed for the PTE model to be upgraded.

3.6.1 Model serial numbers which support firmware Upgrade are:

Model P/N	Serial Number
RUDAT-6000-30	11505310041 and greater
RUDAT-6000-60	11506070001 and greater
RUDAT-6000-90	11505310001 and greater
RUDAT-6000-110	11510110020 and greater
RUDAT-4000-120	11510110020 and greater
RUDAT-13G-90	All units
RCDAT-6000-30	All units
RCDAT-8000-30	All units
RCDAT-6000-60	All units
RCDAT-8000-60	All units
RCDAT-3000-63W2	All units
RCDAT-6000-90	All units
RCDAT-8000-90	All units
RCDAT-6000-110	All units
RCDAT-4000-120	All units
RC4DAT-6G-90	All units

3.6.2 All products are shipped with the latest available firmware and an update is usually not required. Mini-Circuits occasionally makes firmware update files available as a courtesy to add additional features or correct known issues. Please contact testsolutions@minicircuits.com for details.

3.6.3 The upgrade is done using a.hex file provided and the programmable attenuator GUI. The GUI must be started in USB control (See **section 3.1**) to allow firmware upgrade. Click on the Firmware button on the left side of the screen.

Note: If the file name of the .Hex file is changed it will not be recognized as a valid firmware file.

CAUTION

A power interrupt, to either the computer or the attenuator while the firmware is being updated may cause the firmware to be corrupted. It is therefore recommended to only update the firmware while both the attenuator and the computer are connected to an Uninterruptable Power Supply (UPS).



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3.6.4 **The Firmware button will open the** firmware - info window to open (See **Fig. 3.6.4**). The 'Firmware' listed is the version of the firmware installed in your attenuator. Click on "Update Firmware" to select a new firmware version to install or click 'Exit' to close the firmware – info window.

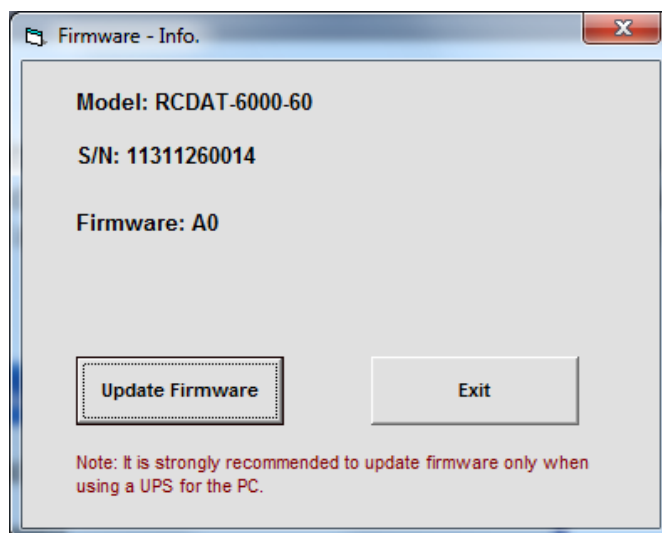


Figure 3.6.4: Firmware Information Window

3.6.5 **A browse window will open to the firmware directory** under the path you selected when installing the GUI program (See **Fig. 3.6.5**). Navigate to where you saved your firmware file, Select the firmware version you wish to install and click ' O.K'.

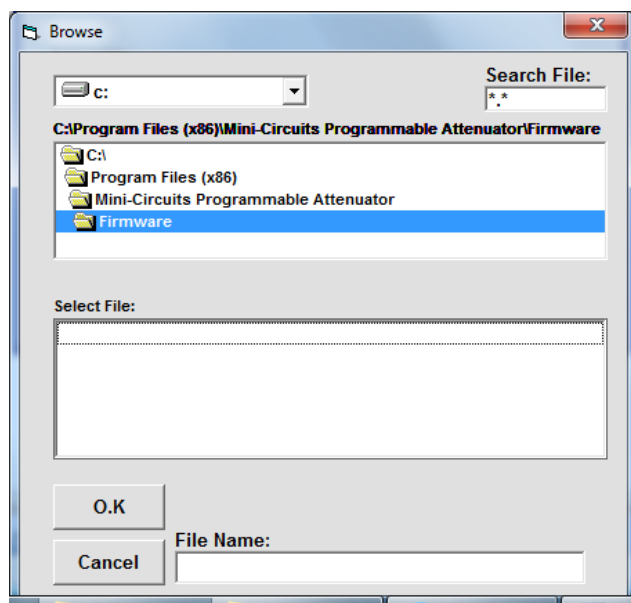


Figure 3.6.5: Firmware - Browse Window

3.6.6 **The selected file will be installed in the attenuator; the process** will take up to a minute.

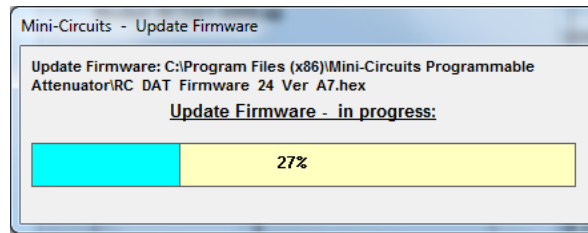


Figure 3.6.6: Firmware - Progress Bar Window

CAUTION

Attempting to start a second GUI session while the firmware is being updated may cause the firmware to be corrupted. It is therefore recommended not to attempt to start any additional GUI sessions until after the firmware upgrade has been completed.

3.6.7 **After the firmware has updated** an alert will appear. Click 'OK' to shut down the Programmable Attenuator program and then restart it normally.

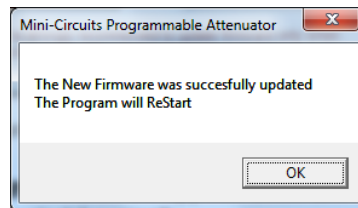


Figure 3.6.7: Firmware - Successful Update

Chapter 4 – Revision History

March 12, 2015: Created user guide Rev OR.

June 26, 2015: Updated user guide per CD Rev. C2 and Firmware Rev. B1, adding high speed Sweep & Hop, showed firmware upgrade support for RUDAT models. Rev A.

August 10, 2015: Rewrote Sweep & Hop section to add more detail to high speed mode and added section on attenuation switching time with plots showing examples. Rev B.

September 16, 2015: Added caution note concerning multiple GUI sessions during firmware upgrade.

October 16, 2015: Added models RCDAT-8000-30 and RCDAT-3000-63W2.

August 07, 2016: Added RC4DAT models and RUDAT-132G-90, Added SPI control, Added multi-channel attenuators to sweep & hop, added third timing diagram, rewrote firmware upgrade to provide contact information for firmware upgrades.



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