User Guide

Multi-Channel Programmable Attenuators

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1. General Information

1.1. User-Guide Scope

This user guide provides general introduction, installation instructions and operating information for Mini-Circuits' USB & Ethernet multi-channel programmable attenuators: RC4DAT and RC8DAT series.

For information on Mini-Circuits' single-channel programmable attenuators see:

- https://www.minicircuits.com/app/AN49-005.pdf

1.2. Support Contacts

We are here to support you every step of the way. For technical support and assistance, please contact us at the email address below or refer to our website for your local support:

- testsolutions@minicircuits.com
- https://www.minicircuits.com/contact/worldwide_tech_support.html

1.3. Warranty & RMA Returns

Mini-Circuits provides a limited time warranty with all products. Please contact your account manager or refer to our website for full details: https://www.minicircuits.com/support/ordering.html

If you have any questions or concerns with your product, please contact us in the first instance through testsolutions@minicircuits.com. Our team will work with you promptly to understand and resolve any issues. As a software-controlled instrument, it is usually possible to resolve issues remotely without requiring the unit to be returned to the factory.

In the event that a return to the factory is necessary, Mini-Circuits will provide an RMA number and full return instructions.

1.4. End of Life

Please contact testsolutions@minicircuits.com to review environmentally friendly end of life disposal options.

1.5. 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.
- There is no danger to the user.

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.

2. About Mini-Circuits Programmable Attenuators

2.1. Introduction

Mini-Circuits has developed a series of multi-channel programmable attenuators, the RC4DAT and RC8DAT series, which can be controlled via standard USB or Ethernet-TCP/IP (Telnet, HTTP, and SSH protocols). These programmable attenuators can operate up to 8000 MHz with an attenuation resolution down to 0.05 dB, and attenuation range of up to 120 dB. 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 RC4DAT and RC8DAT models can be controlled from almost any computer, or even a smartphone with a network connection from anywhere in the world.

Refer to *section 2.4* for details of specific models.

2.2. Key Features

- Multiple independent attenuation channels
- Wide attenuation range (model dependent)
- Wide frequency range
- Fine attenuation resolution
- Multiple control options
- USB HID (Human Interface Device) for “plug & play” operation (no driver installation required)
- User-friendly graphical user interface (GUI) for Windows
- API DLL for Windows and direct USB programming support for Linux (see programming manual for details)

For additional details, performance data and graphs, outline drawing, ordering information and environmental specifications, see our catalog at: https://www.minicircuits.com/WebStore/RF-Programmable-Step-Attenuators.html

2.3. Intended Applications

Mini-Circuits multi-channel 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 attenuators can be used by anyone familiar with the basics of electronics measurements or electronic control systems.

2.4. Model Selection Guide

For additional model information – performance graphs and data, outline drawing, environmental specifications, ordering details and more – please click on the model part number to view it on the Mini-Circuits website.

Model name	Num. of Channels	Frequency range (MHz)	Atten. range (dB)	Attenuation resolution (dB)	Max input power (dBm)	Control protocols [1]
RC4DAT-6G-30	4	1 – 6000	30	0.25	+23	USB, HTTP, Telnet, SSH [2]
RC4DAT-6G-60	4	1 – 6000	63	0.25	+23	USB, HTTP, Telnet, SSH [2]
RC4DAT-6G-95	4	1 – 6000	95	0.25	+23	USB, HTTP, Telnet, SSH [2]
RC4DAT-8G-95	4	1 – 8000	95	0.25	+28	USB, HTTP, Telnet, SSH [2]
RC4DAT-8G-95PE [3]	4	1 – 8000	95	0.25	+28	USB, HTTP, Telnet, SSH
RC4DAT-8G-120H	4	200 – 8000	120	0.05	+23	USB, HTTP, Telnet, SSH, Daisy-chain
RC8DAT-8G-95	8	1 – 8000	95	0.25	+28	USB, HTTP, Telnet, SSH
RC8DAT-8G-95PE [2]	8	1 – 8000	95	0.25	+28	USB, HTTP, Telnet, SSH

1. Refer to *chapter 4* for setup and control instructions of the different control protocols.
2. Refer to *section 5.8* for model serial numbers supporting SSH protocol.
3. PE series supports “Power over Ethernet” compliant with IEEE 802.3af mode A and mode B (see datasheet for details).

2.5. Environmental Specifications

Mini-Circuits’ programmable attenuators are intended for operation in office, laboratory, or production test environments. Do not use in any condition which exceeds the published environmental specifications.

Condition	Specification
Operating temperature	0°C to +50°C
Humidity	5% to 85% RH (non-condensing)
Altitude	Up to 2000 m (6560 ft.)
Pollution degree	2 - Normally only non-conductive pollution occurs (per IEC 61010)

2.6. Supported Software Environments

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

- 32-bit systems: Windows 7 or later.
- 64-bit systems: Windows 7 or later (GUI & API); Linux.

Custom automation programs can be created in most modern programming environments, including Python, C#, LabVIEW, MatLab and more.

Refer to the programming manual for more information on attenuator programming.

2.7. Conformity

Mini-Circuits' programmable attenuators conform to the following international standards:

Standard	Meaning
CE	Meets the requirements of the following applicable European directives and carries the CE marking accordingly: • Low Voltage – Directive 2014/35 • Electromagnetic Compatibility – Directive 2014/30/EU • Restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) – Directive 2015/863
UKCA	Meets the requirements of the following applicable UK directives and carries the UKCA marking accordingly: • Electrical Equipment (Safety) Regulations 2016 • Electromagnetic Compatibility Regulations 2016 • The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012
FCC	This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.
USB 2.0	The model meets the specifications of the Universal Serial Bus version 2.0 communication standard as described by USB-IF.
USB HID	The model meets the requirements for Universal Serial Bus Human Interface Devices according to USB-IF's Device Class Definition for Human Interface Devices firmware revision 1.11.
TCP/IP	The model meets the 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 model supports all requirements for communicating with the Hypertext Transfer Protocol (HTTP) as defined in RFC 1945**.**
Telnet	The model supports all requirements for communicating with the Telnet protocol, as defined in RFC 854.
SSH	The models which specify SSH control, support the requirements for SSH protocol as defined by RFCs 4250-4253, 4419, 5647, 5656 and 6668.

2.8. Accessories and Options

The programmable attenuators are supplied with a control cable:

- 3.3 ft (1.0 m) USB cable: USB type A (Male) to USB type Mini-B (Male)
- 3.3 ft (1.0 m) USB cable: USB type A (Male) to USB type C (Male) (model dependent)

The following optional accessories are available (see models' datasheet for details):

- Ethernet cable: RJ45 (Male) to RJ45 (Male) Cat 5E cable
- USB extension cable: USB type A (Male) to USB type A (Female)
- Daisy-chain cable: Digital snap fit (Male-Male) cable assembly connectors (depending on model)
- AC/DC power adapter suitable for a wide selection of wall sockets
- Mounting bracket
- The full software package including GUI, API DLL files and programming instructions, can be downloaded from https://www.minicircuits.com/softwaredownload/patt.html

2.9. Service and Calibration

The programmable attenuators do not require any periodic service or calibration.

The only user-performed service possible for attenuator modules is external cleaning of the case and connectors as needed. Do not use any detergents or spray cleaning solutions. The case can be cleaned with a soft, slightly dampened cloth and the connectors with an alcohol solution. Do not allow any liquid ingress into the case or connectors.

2.10. Safety & Precautions

Mini-Circuits' programmable attenuators contain no user serviceable parts and should not be opened. Discontinue use and contact Mini-Circuits in the event of visible damage to any parts.

Please observe the following safety precautions at all times when using Mini-Circuits' attenuator modules:

Caution:

- Do not input to the device signals of greater power than the attenuator is rated for in its datasheet.
- Safe power input degrades below specified frequency range. Do not input signals below the specified frequency range.

Warning:

- Properly ground all equipment to reduce the risk of accidental electrical shock.

2.11. Functional Block Diagram

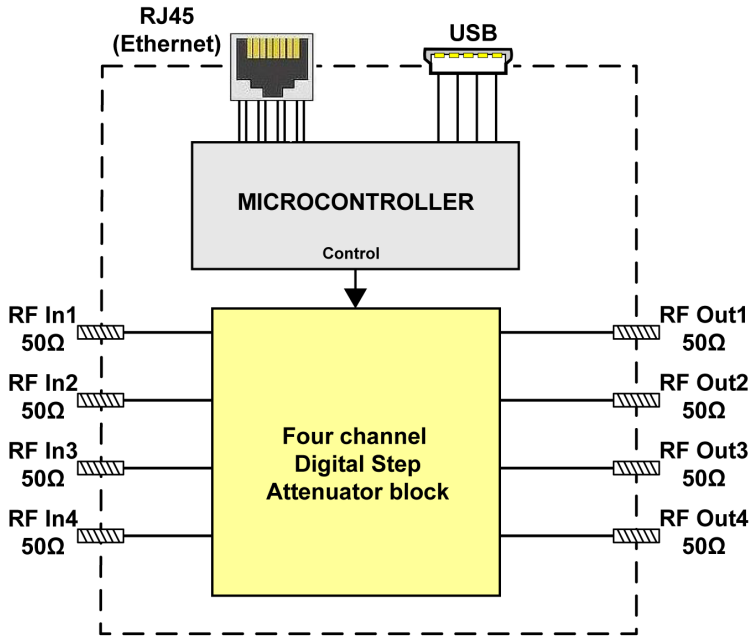


***Figure 2.11a**: RC4DAT-models' functional block diagram*

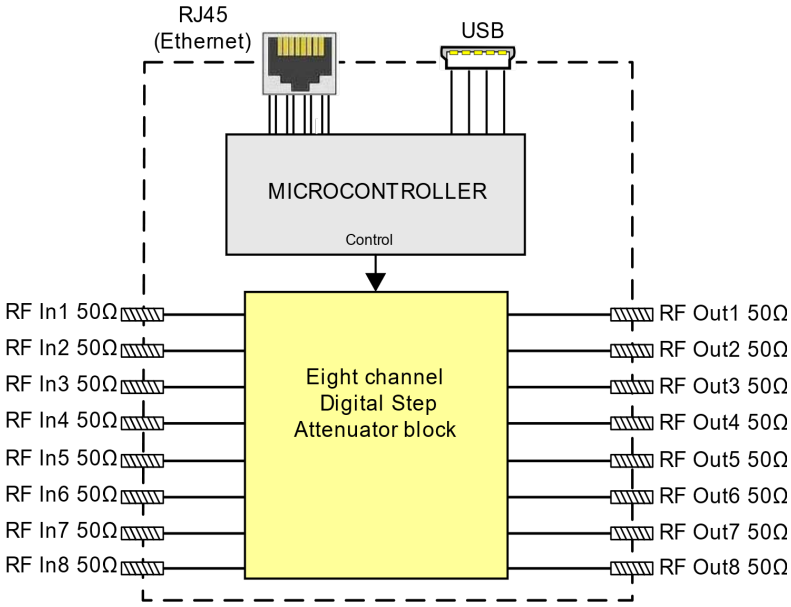


***Figure 2.11b**: RC8DAT-models' functional block diagram*

3. Software Setup

3.1. System Requirements

The minimum requirements for the installation of the Mini-Circuits multi-channel programmable attenuator software package and API on the host PC are:

- Microsoft Windows 7 or later (32- or 64-bit).
- Intel i3 or equivalent (recommended).

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

Control method	Required support
USB control	USB HID
Ethernet control	Network connection

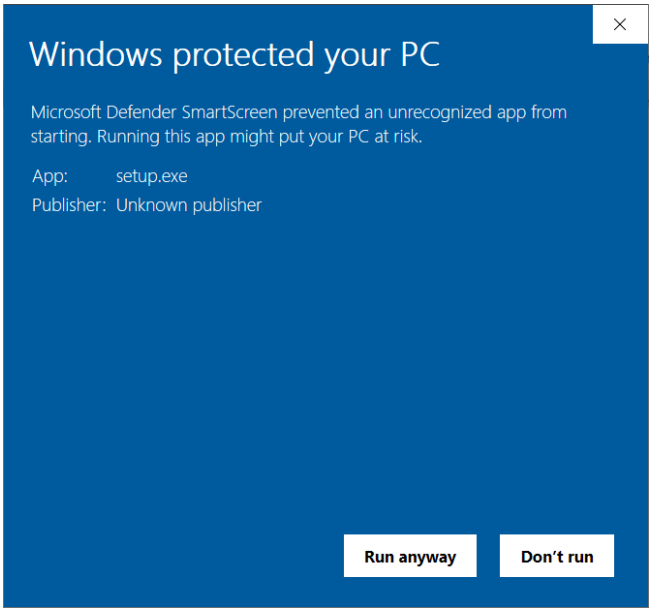
3.2. Software Downloads & Resources

The full programmable attenuator software package (including GUI, API and documentation) is available for download from:

- https://www.minicircuits.com/softwaredownload/patt.html

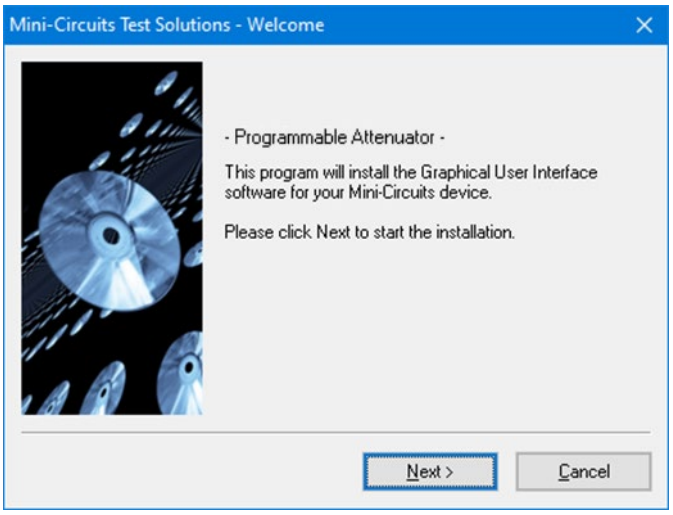
3.3. Software Installation

- Save all work in progress and close any other programs that may be running.
- Download the programmable attenuator software from the Mini-Circuits website.
  Extract the downloaded zip file and begin the installation process and double-click the **Setup.exe** icon.
- If Microsoft Defender SmartScreen provides a warning about an unrecognized app, select **More Info** and then **Run Anyway**.

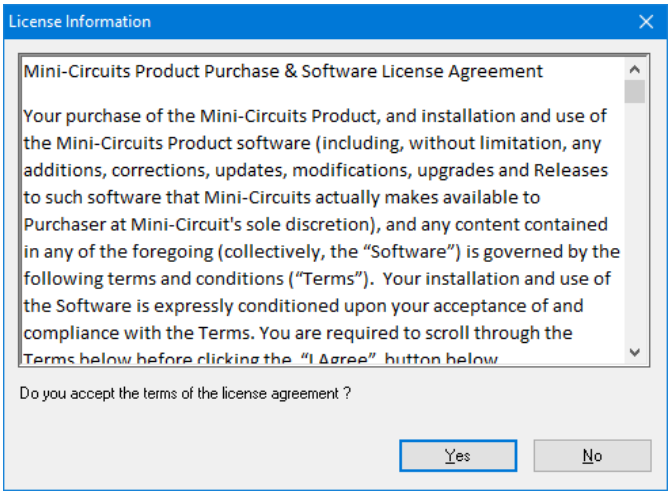


- If prompted by Windows User Account Control, enter user credentials for an account allowing software installation.

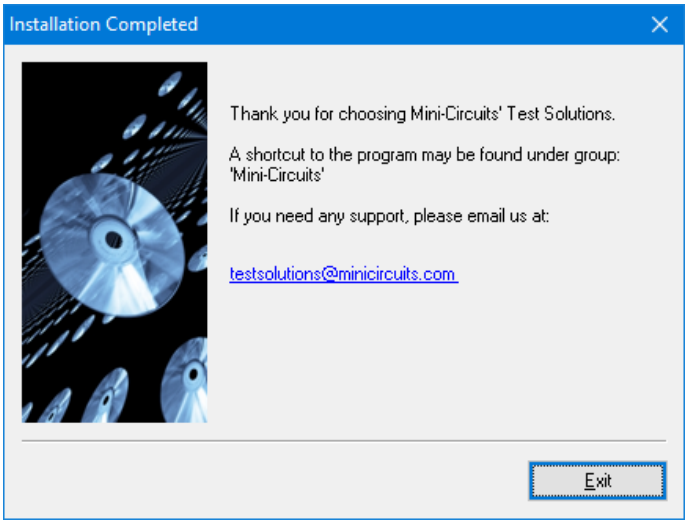
- Click **Next** to begin the installation.



- Click **Yes** to accept the license agreement.



- Click **Exit** on the final window confirming that installation completed successfully.

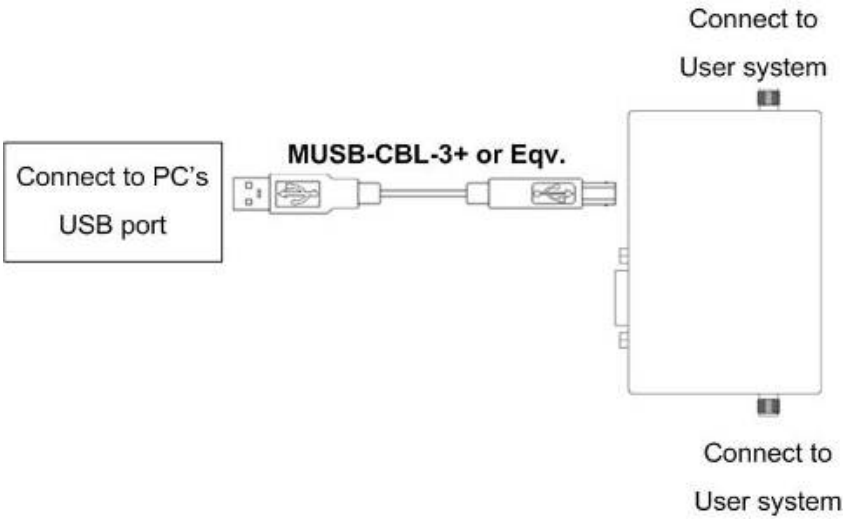


In the event of any issues with installation, please contact testsolutions@minicircuits.com for support.

4. Hardware Setup

4.1. USB Control

Connect the attenuator to the computer using the provided USB cable or equivalent one, and then connect the required RF connections.

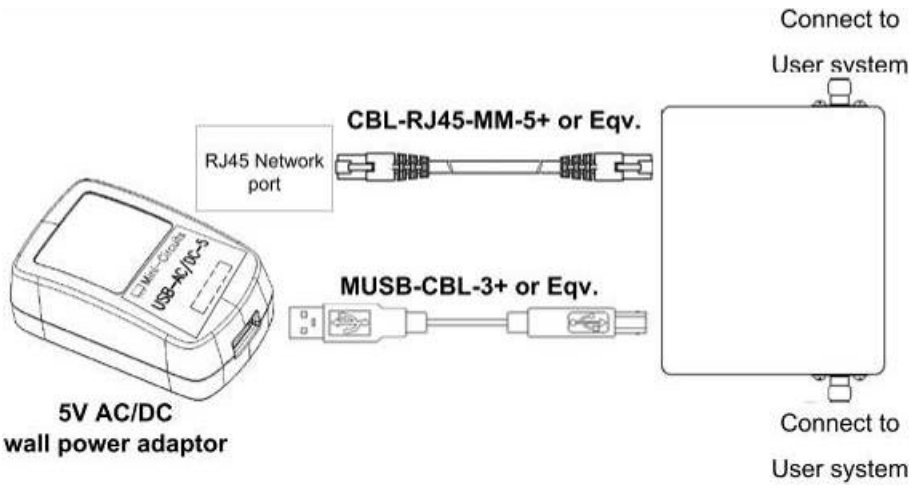


Caution:

- The maximum allowed RF input for programmable attenuator models is reduced at low frequencies.
- Exceeding these values may damage the attenuator. Check the individual model datasheet and do not exceed the specified limits.

4.2. Ethernet Control

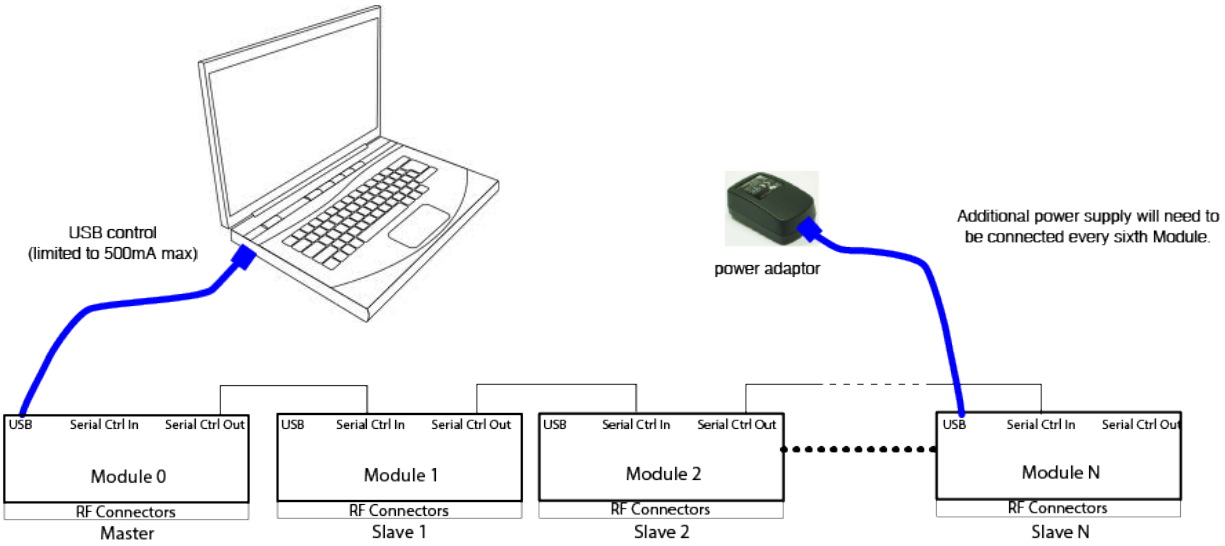
- Connect unit to power source via USB cable or the provided power adaptor.
- Connect a standard network cable between the unit's RJ45 socket and the network port.
- Ensure the network indicators on the unit's RJ45 socket light up after a few seconds.
- Connect the unit's input and output RF ports to your system.



4.3. Daisy-Chain Control

Some models include Mini-Circuits' novel dynamic addressing daisy-chaining interface which allows multiple modules to be connected together into a master/slave chain, with independent control of each module through the single USB connection of the master unit (see *section 2.4* for models supporting this function).

The serial master/slave bus allows connecting modules of different types to the same daisy-chain as long as they all support Mini-Circuits' dynamic addressing setup. To add a new module, simply connect it to the daisy-chain and refresh the address listing -- no need to reset any of the existing modules or assign addresses manually.



Modules will have their addresses assigned automatically when the USB connection from the PC to master is established, or when a refresh address command is issued. The module connected to the computer USB port will be assigned address 0 (master), and subsequent modules connected through it will get incrementing addresses, starting from 1 to N. All control will be through the master module (address 0) which is the only one communicating with the PC.

Note:

- It is possible to connect up to 99 units in a single setup as long as power considerations are taken into account. Refer to model datasheets for number of units tested in series of a given model.
- It is recommended to disable the Ethernet function (see *section 5.3.5*) of the slave units before connecting them in series to reduce power consumption.

4.3.1. Setup Instructions

Digital & DC connections for daisy-chain control can be done in any order so long as addresses are refreshed once all units and power supplies are connected.

1. Arrange the required modules on the work surface in the order they are to be addressed.
2. Use the serial control cables (CBL-1.5FT-MMD+, CBL-5FT-MMD+, or equivalent) to connect the units together in the daisy-chain, from Serial CTRL Out of the first unit, to Serial CTRL In of the second, and so forth.
3. Note the DC current draw of each module in the daisy-chain from the published datasheets.
4. Starting from the first module in the daisy-chain, sum the DC current draw of each module to confirm whether the total exceeds the maximum pass-through current (500 mA), or the maximum available from the USB supply (if lower).
5. If required, connect an additional 5V DC power supply to the USB port of one of the daisy-chained modules, to keep the DC consumption of the previous group beneath the specified limit.
6. Repeat the check from this module forward and add additional power supplies as necessary.
7. Finally, connect the USB cable from the first module to the control PC and the complete chain will power up and automatically assign address (from 00 to nn).
8. To add additional units to the daisy chain, just repeat step 6 from the last unit connected to a power supply, then connect the additional units with serial control cables and click on the address **Refresh** button in the GUI (located below the connected units list).

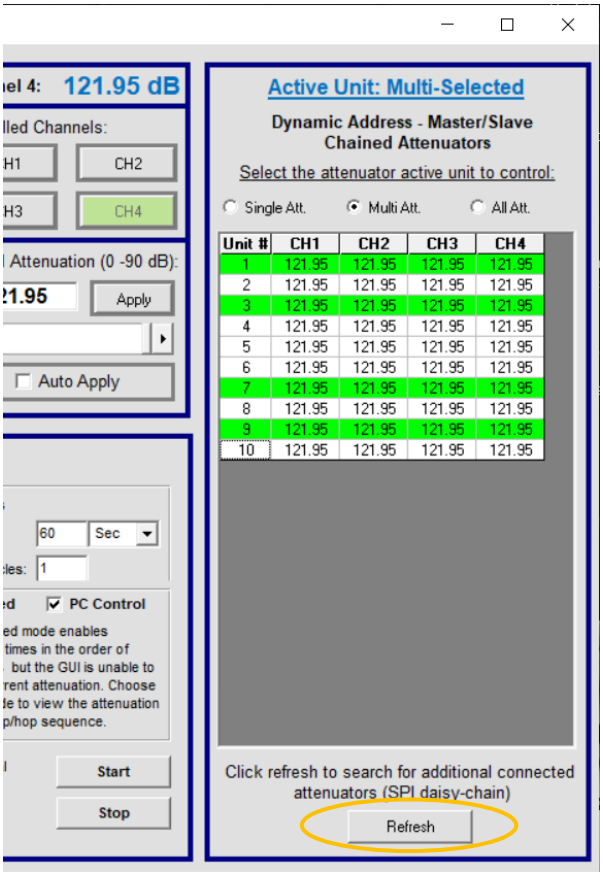


***Figure 4.3.1**: List of connected units on the daisy-chain section of the GUI (appearing for supporting models only)*

5. Using Mini-Circuits' GUI

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

5.1. Getting Started

To start the program, use the Start menu or navigate to the location the Mini-Circuits Programmable Attenuator software was installed in and run the program.

Once running, the user will be required to pick one of the available control modes: RS232, USB, HTTP, Telnet, or SSH control.

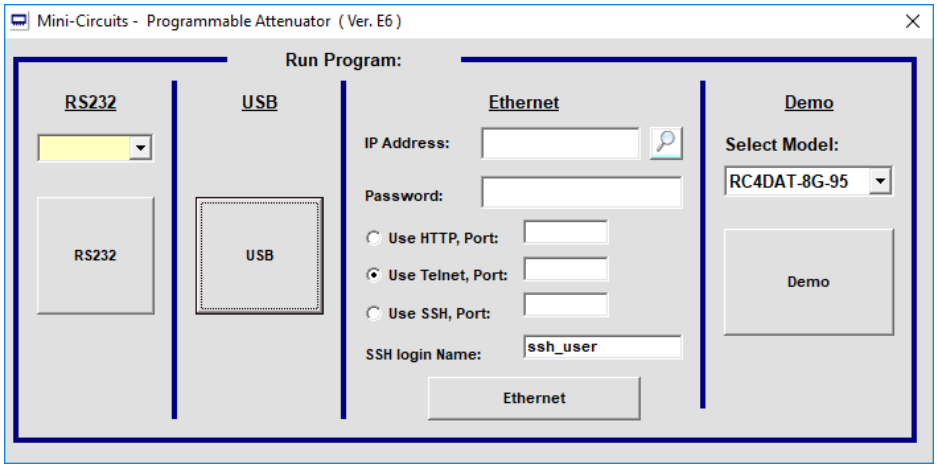


***Figure 5.1**: Startup screen*

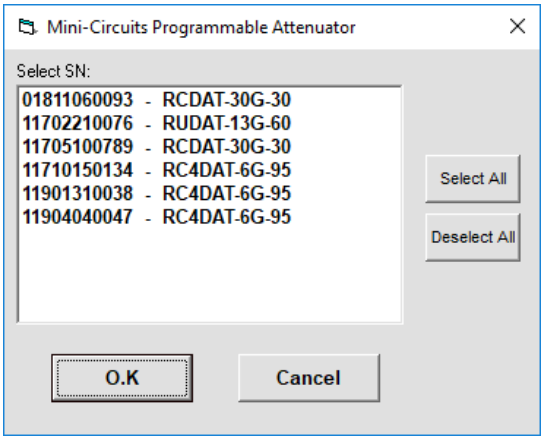
In addition to the control modes, the user can try the demo mode – pick one of the available models from the drop-down menu to learn about the GUI and experiment with the model's operation.

Neither RC4DAT, nor RC8DAT multi-channel programmable attenuators support RS232 control. For RS232 control, see RUDAT models: https://www.minicircuits.com/softwaredownload/AN-49-005.pdf

5.1.1. USB Control

Clicking the **USB** button in the startup screen will start the unit in USB control. In case the program does not detect a unit connected to the PC via USB, or if there are no connected units, an alert will pop-up. If the alert persists even when a unit is connected then check the unit's USB LED indicator or the USB cable's integrity.

If multiple units are connected to the PC via USB (non- daisy-chain link), the unit selection screen will appear with a list of the connected models' serial numbers and model names.



Note:

- The program can handle up to 24 units connected simultaneously.

5.1.2. Ethernet Control

To use Ethernet control with a supporting unit either enter its IP address on the startup screen (ports for HTTP/Telnet/SSH would be also required if using non-default ports) 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 connect using default IP address or change the factory default Ethernet configuration to match your network configuration. See *section 5.3* or the programming manual for details.

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

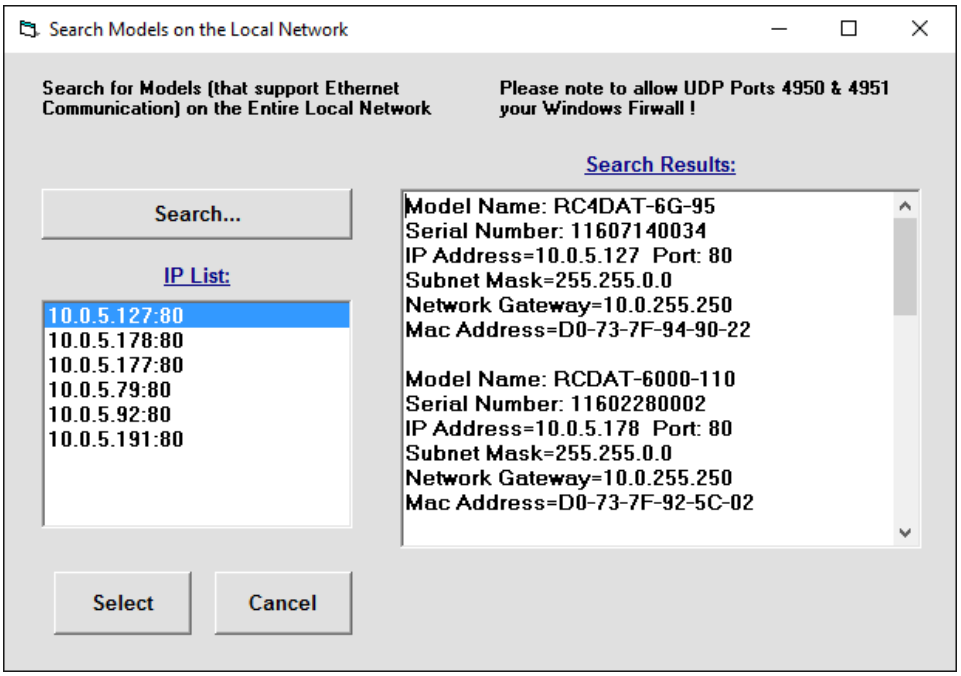


***Figure 5.1.2a**: Ethernet IP search window*

Note:

- To refresh the list of units found click on the **Search…** button.
- The search function uses ports UDP 4950 and UDP 4951 for communication. Ensure your firewall allows access to them.

Once the IP address has been entered, input the password if one has been set (see *section 5.3*). Proceed to select the communication protocol you wish to use (HTTP, Telnet, or SSH) and click on the **Ethernet** button to begin.

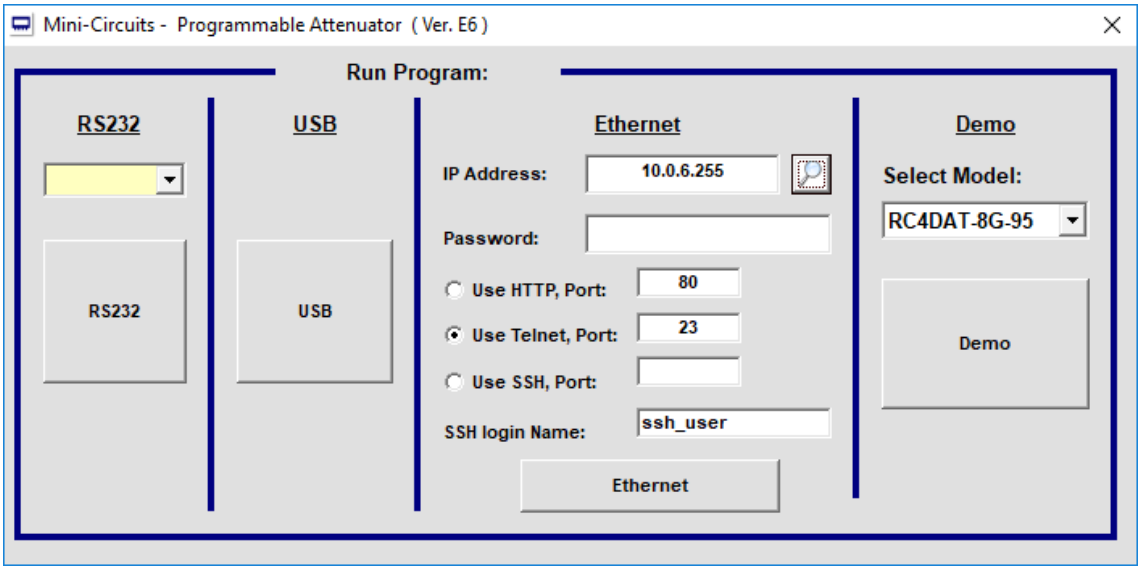


Figure 5.1.2b: *Startup screen with Ethernet fields filled*

Telnet or HTTP text commands can also be used to control the attenuator. This can be achieved in one of the ways below:

- Type the command in the address field of your internet browser.
- Implement a Get/Post HTTP function in your selected application (for HTTP).
- 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 downloaded software (see *section 3.3*), in the Ethernet directory.

5.2. Operating the Attenuator

Once the control method has been selected, the main screen of the GUI program will appear.

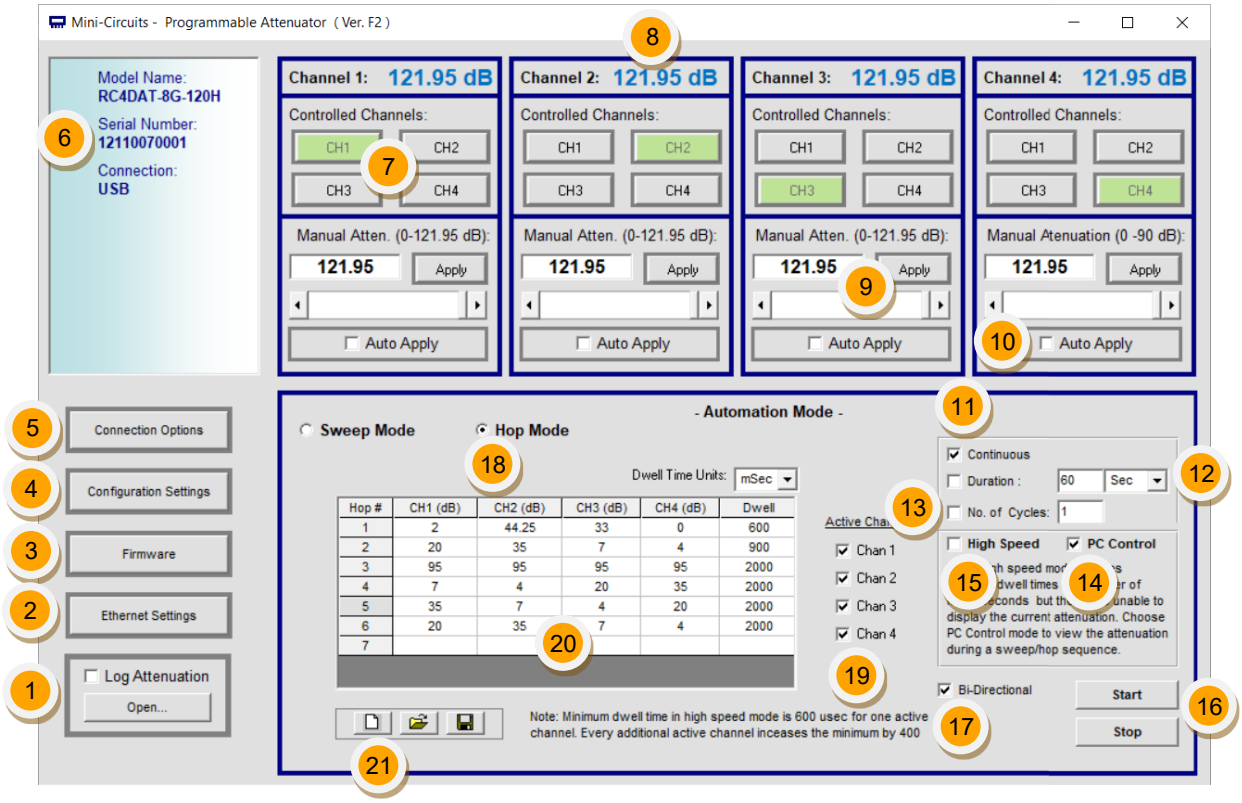


***Figure 5.2a**: Main screen – Hop mode*

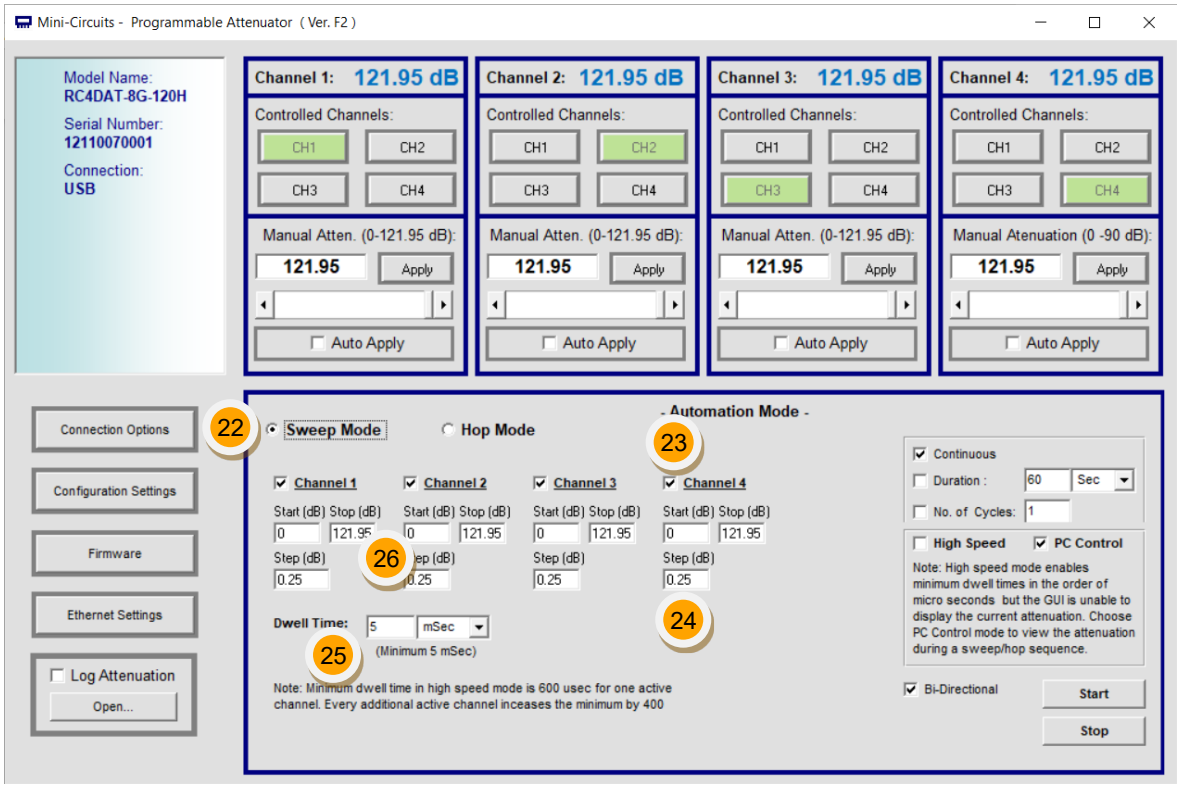


***Figure 5.2b**: Main screen – Sweep mode*

5.2.1. General Functions

#	Name	Descriptions
1	Log attenuation	When checked creates a log of all attenuation states and settings sent to the unit. See *section 5.2.6* for details.
2	Ethernet settings	Opens the Ethernet configuration window. See *section 5.3* for details.
3	Firmware	Opens the Firmware information & update window. See *section 5.7* for details.
4	Configuration settings	Opens a pop-up window allowing the user to specify attenuator state at power up and set the step size used in the manual attenuation setting. See *section 5.2.7* for details.
5	Connection options	Returns to the startup screen.
6	Model description	Field describing the model, this shows model part number, serial number and connection details.

5.2.2. Manual Mode Functions

#	Name	Descriptions
7	Controlled channels	Any attenuation setting specified in the manual control field of the channel will affect all channels selected in the "Controlled Channels" field.
8	Current attenuation	The value each channel of the attenuator is currently set to.
9	Manual attenuation set	Attenuation value to be set. This can be changed by either typing a value, or by using the scroll bar and arrows to change the attenuation then clicking **Apply**.
10	Auto-apply	When this check box is selected every change in attenuation setting will be applied immediately. When it is not selected, the user must click **Apply** to execute the changes.

5.2.3. Automatic Mode Functions

#	Name	Descriptions
11	Continuous	When selected, the attenuator will repeat the user defined sweep or hop until the Stop button is clicked.
12	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).
13	No. of cycles	When selected the attenuator will repeat the user defined sweep or hop sequence for the number of cycles specified.
14	PC control	Default setting. Sweep and Hop instructions are sent individually to the unit. See *section 5.4.3* for details.
15	High-speed	Enables high-speed Sweep and Hop functions. See *section 5.4.4* for details.
16	Start / Stop	**Start** and **Stop** the automatic run (Sweep or Hop) at the current settings.
17	Bi-directional	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).

Note:

- High-speed mode enables minimum dwell times in the order of micro-seconds, as such, the GUI is unable to display the fast attenuation changes to the user. Choose PC Control mode to view to attenuation during a sweep/hop sequence.

5.2.4. Hop Mode Functions

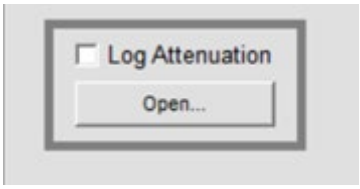
#	Name	Descriptions
18	Hop mode	When selected, allows setting a table of user defined attenuation and dwell time which the attenuator will "hop" through.
19	Channel selection	Enables hop sequence for selected channels.
20	Hop parameters	Define attenuation levels separately for each selected channel & dwell time for all selected channels in hop mode.
21	Save / Recall	(Available in Hop mode only) allows clearing all current settings, opening a file of saved settings or saving current settings.

5.2.5. Sweep Mode Functions

#	Name	Descriptions
22	Sweep mode	When selected, allows setting an attenuation sweep with user defined start, stop, step and dwell time values.
23	Channel selection	Enables sweep for selected channels.
24	Step	Defines the attenuation step in (minimum according to model).
25	Dwell time	Specifies the time the selected channels will hold each attenuation state.
26	Start / Stop	Define attenuation range for a given channel.

5.2.6. Log Attenuation

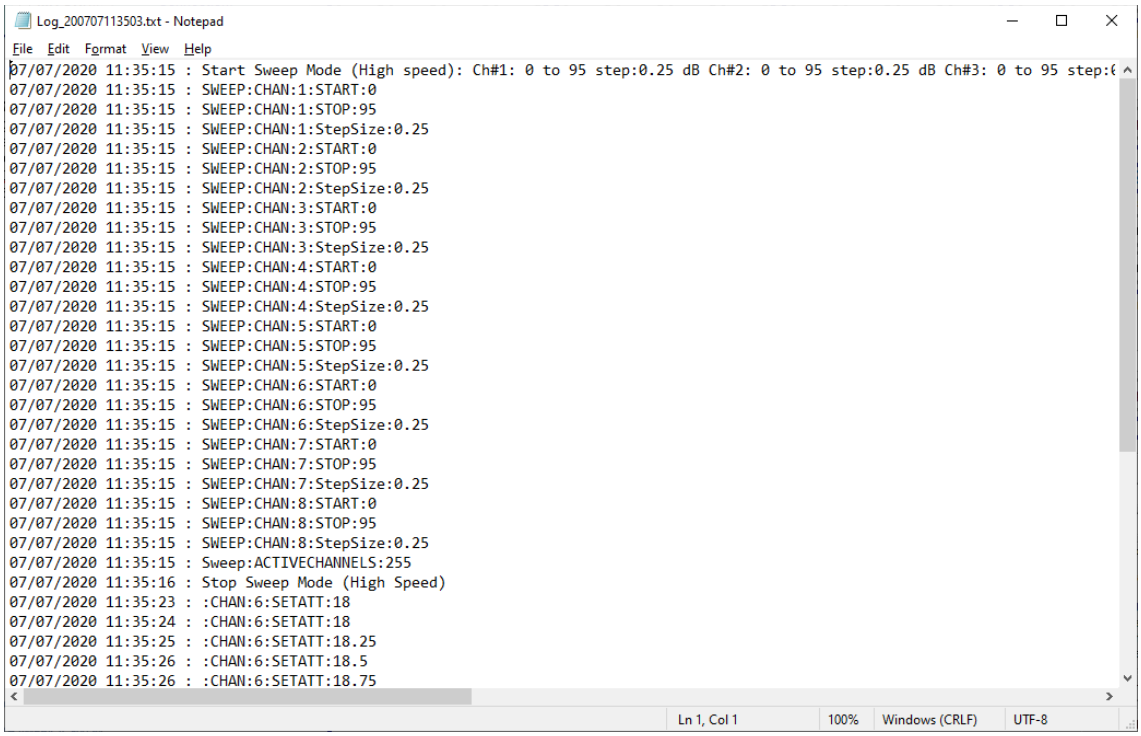
It is possible to record all attenuation changes the unit undergoes by checking the **Log Attenuation** option (located at the lower left corner of the GUI).



Upon checking the option, a pop-up will notify the user of the folder location the *txt* log file will be saved to – which will be in a sub-directory of the Mini-Circuits folder (where the program has been installed to) "…*ProgrammableAttenuator**Log*".

The log file name format will contain the current date and time in the following format *Log_[YYMMDDHHmmss].txt* (Red – Current date in format YYMMDD; Blue – Current time in format HHmmss). For example, a file created on June 24, 2020 at 16:16:55 will be named "**Log_**200624161655.

Once unchecked, the log file will be saved properly with all the attenuation changes in the aforementioned folder.



Note:

- Trying to open the file while a recording is on-going will pop-up a notification alert about the last attenuations possibly not being saved to the file.

5.2.7. Configuration Settings

Clicking on **Configuration Settings** opens a pop-up window which allows the user to set the following parameters:

- On Power Up State – The attenuator can be configured to power up with max attenuation setting (factory default), a user defined attenuation value for each channel separately, or the last attenuation value set for each channel.
- Device Address – Set the device's USB address in the 1 – 255 range (factory default 255).
- Manual Attenuation Scroll Bar – Coarse tune is the step size for each click on scroll bar; Fine Tune is the step size for the arrows.

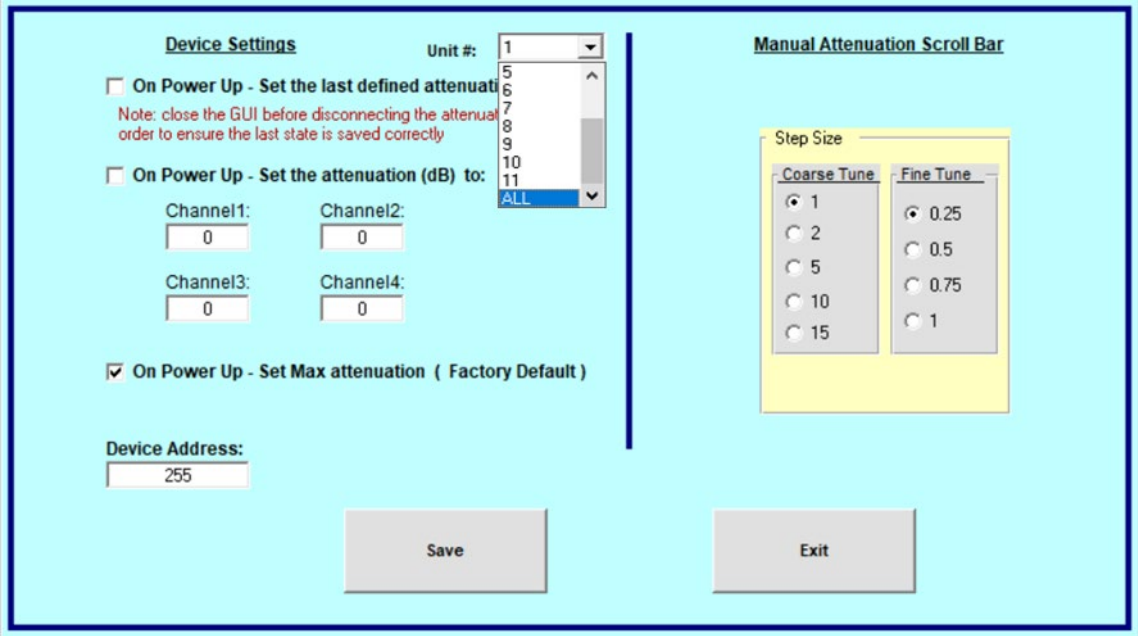


***Figure 5.2.7**: Configuration settings screen showing unit selection option for daisy-chained units*

Units connected in daisy-chain configuration can be configured just as when connected individually to the PC. Simply select the unit you wish to configure from the dropdown menu, or select **ALL** to set the configuration of all units, then proceed to configure it as described above.

Note:

- 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 max attenuation state.
- 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 max attenuation state at power up due to last attenuation state not being recorded correctly.

5.3. Ethernet Configuration

5.3.1. Default IP Configuration

Mini-Circuits' programmable attenuators ship from the factory with DHCP enabled by default so in most cases an IP address will be assigned automatically when the device is connected to the network. Once a valid IP address has been assigned and identified it can be re-configured via the Ethernet connection (for example, to set a static IP configuration) using our GUI, Ethernet configuration tool, or the programming API.

5.3.2. Default Static / "Link-Local" IP Address

A default "link-local" IP address will be assumed when DHCP is enabled if the device does not receive a valid response from a DHCP server. This also applies when an attenuator with DHCP enabled is connected directly via an Ethernet cable to a PC (instead of via a network). The default static / link-local IP address for all Mini-Circuits devices with the relevant firmware is 169.254.10.10.

This can be used as a method to configure a specific static IP address for a new device straight out of the box, without resorting to a USB connection or even Mini-Circuits' GUI. Just connect the attenuator directly to the PC, open the HTML Ethernet configuration tool (see *section 5.3.6*), connect to the attenuator using the *169.254.10.10* default IP and proceed to set the new configuration as needed.

Note:

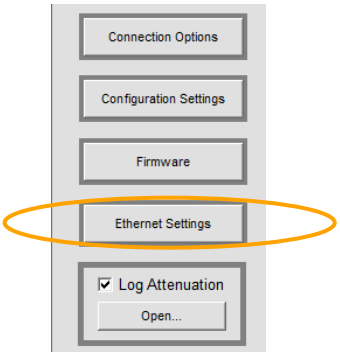
- This feature requires firmware H7 or later for attenuators with the current controller and firmware F1 or later for attenuators with the legacy controller. Refer to *section 5.8* to determine which controller is present in your device by serial number.

5.3.3. Recovery of IP Configuration via USB

If at any time an Ethernet connection cannot be established (for example, if the current IP address is not valid on the network) then the settings can always be reset by connecting to the device using USB and the GUI or programming API.

5.3.4. Default Factory Setting

Default factory settings for RCDAT models are Dynamic IP (DHCP) using port 80 for HTTP or port 23 for Telnet (see *Figure 5.3.5*). To change these settings, click on the **Ethernet Settings** button in the GUI, or use Mini-Circuits' Ethernet configuration tool (see *section 5.3.6*).



5.3.5. Ethernet Settings Screen

The Ethernet Settings screen will open showing the current configuration. *Figure 5.3.5* 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 4.2*.

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

Note:

- For units with older firmware revisions (pre-H7 for current controller or pre-F1 for legacy controller, refer to *section 5.8* for details), user will need to change Ethernet configuration via USB control to match their network setup if no DHCP server is available.
- It is not advised to set the HTTP, Telnet, and SSH ports to use the same port.

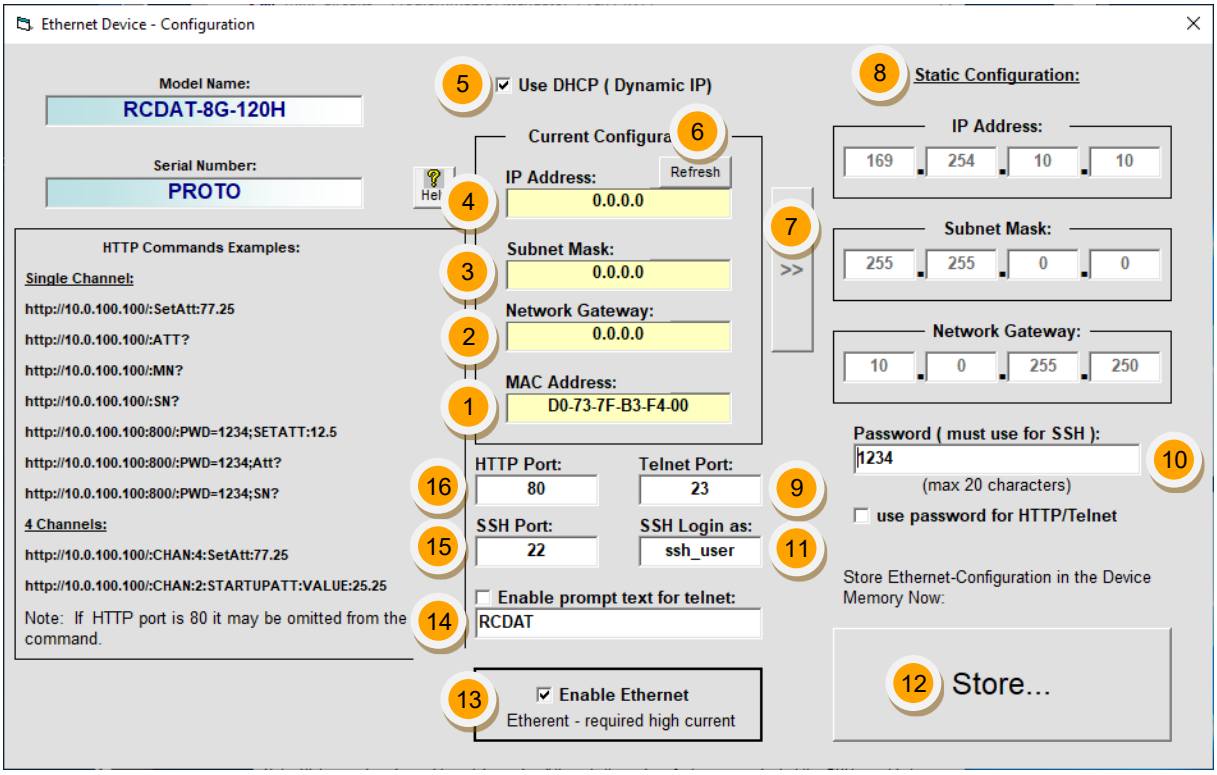


Figure 5.3.5: *Ethernet Settings screen (showing factory default state)*

#	Name	Descriptions
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.
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	Specify the port to use for Telnet communication on the network (default 23).
10	Password	To restrict remote access to the attenuator in HTTP or Telnet mode, select **Use Password** and enter the desired password below (up to 20 characters). In SSH protocol Password is required at all times.
11	SSH Login	Login ID for SSH protocol. Factory default is “ssh_user”.
12	Store	After you've made all changes, click the **Store...** button to save the settings.
13	Ethernet Enable	Allows turning on or off Ethernet circuitry to reduce current consumption while in USB control. Factory default is having Ethernet active.
14	Telnet Prompt	When enabled the prompt will appear in every response from the unit in Telnet protocol. To have the unit return its model number user prompt "MN", and to have it return its serial number use "SN".
15	SSH Port	Specify the port to use for SSH communication on the network (default 22).
16	HTTP Port	Specify the port to use for HTTP communication on the network (default 80). Note that port address does not get assigned by the server when DHCP is selected.

5.3.6. Ethernet Configuration Tool

The Ethernet configuration can also be changed via Ethernet control. To make changing the Ethernet configuration easier for users operating in a non-Windows environment or otherwise can't use the provided GUI, Mini-Circuits created the Ethernet configuration tool.

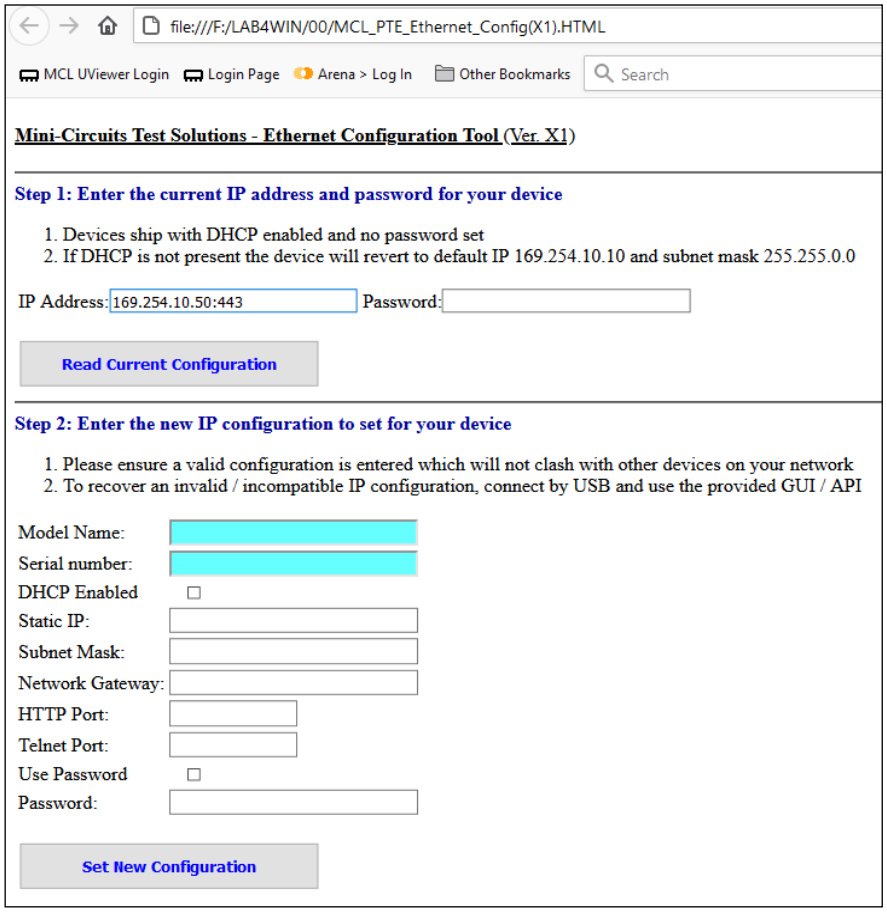
https://www.minicircuits.com/softwaredownload/MCL_PTE_Ethernet_Config.zip

Note:

- Javascript must be enabled in your browser to use the configuration tool.
- This feature requires firmware H7 or later for attenuators with the current controller and firmware F1 or later for attenuators with the legacy controller. Refer to *section 5.8* to determine which controller is present in your device by serial number.

To use the configuration tool:

- Type the IP address in the field in step 1 (if you assigned a password for the unit type it as well).
- If you set the device to some port other than 80, enter the port as well in the same field, then click **Read Current Configuration**.
- The fields in step 2 will be populated with the current state of the device. Enter the updated information in the relevant fields.
- Click **Set New Configuration** to end the process.



5.4. Operation Modes

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.

5.4.1. Sweep Mode

The sweep mode allows each channel to be configured with its own start, stop and step attenuation values for an incrementing or decrementing sequence. Any combination of the 4 or 8 channels can be configured with a sweep sequence but the same dwell time will be applied for each channel and step. All included channels will step through their sweep sequences simultaneously until the channel with the shortest sweep sequence has reached the specified limit, or the attenuator is interrupted.

5.4.2. Hop Mode

The hop mode allows an arbitrary list of attenuation values to be set for any combination of channels; this includes the ability to set each channel to a different value. All included channels will step through their respective hop sequences simultaneously, but a different dwell time can be set at each step.

5.4.3. PC Control Mode

This is the default mode, available on all programmable attenuator models. 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 3 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).

5.4.4. High-Speed Mode

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 µs or 400 µs (model dependent). 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.

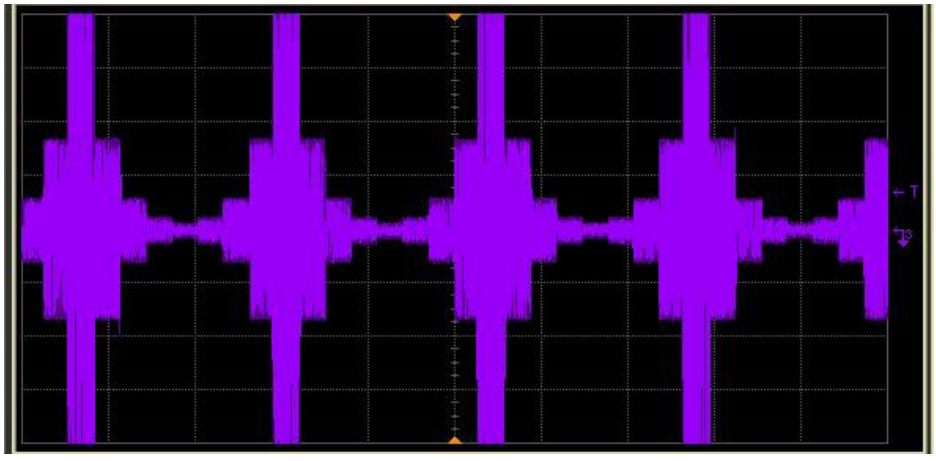


Figure 5.4.4: *Plot of signal when sweeping attenuation 0 - 40dB in 10 dB steps (scale 2ms/div)*

5.4.5. Attenuator Switching Time

Attenuator models are specified with typical switching times of 650 ns, 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:

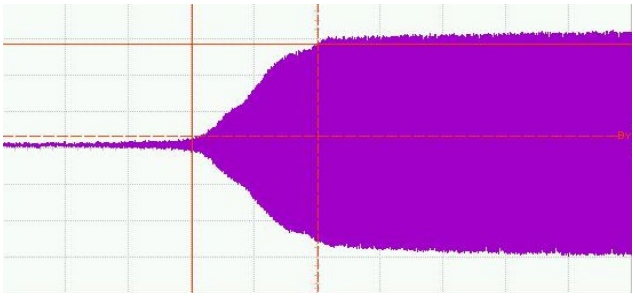


Figure 5.4.5a: *Typ. Switching time from 120 to 0 dB (RCDAT-4000-120); 200 ns switching time achieved*

Δx = 200.00 ns

Δy = 127.00 mV

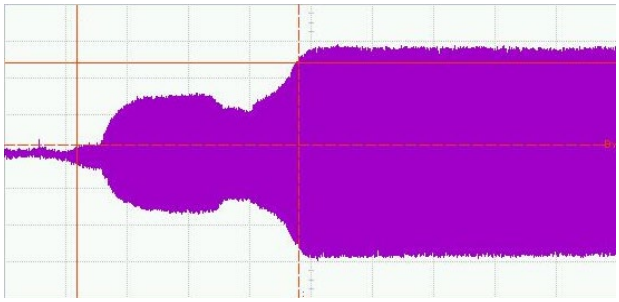


Figure 5.4.5b*: Typ. Switching time from 45 to 15 dB (RCDAT-4000-120); 362 ns switching time achieved*

Δx = 362.00 ns

Δy = 22.44 mV

5.5. Daisy-Chain Control with Dynamic Addressing

5.5.1. Master/Slave Connection with USB Control

In models with dynamic addressing support you can connect a number of units in series, allowing control of multiple attenuators from a single USB or Ethernet port, with each attenuator controlled independently. Dynamic addressing sets the addresses automatically in the order the attenuators are connected (no need to set addresses for each unit) with the master unit (unit connected directly to USB or Ethernet control) as address 0 and the slave units incrementing to the end of the chain.

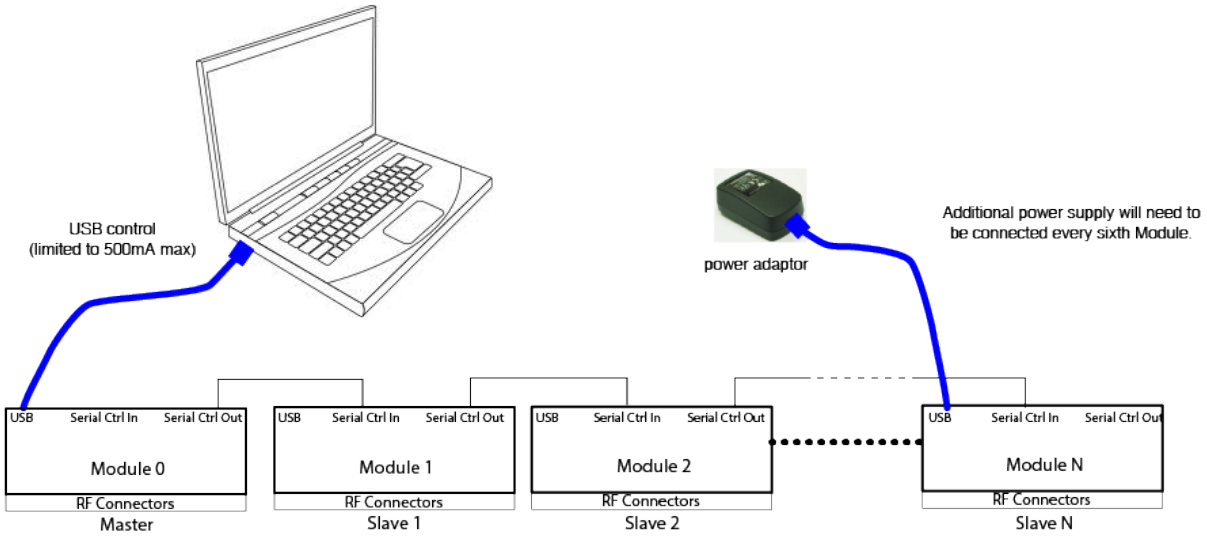


Figure 5.5.1: Master/Slave connection with USB control

The additional "Dynamic Address" panel on the right-hand side of the main control screen will appear if any slave units are detected when the GUI connection (USB or Ethernet) is initiated. This panel shows the number of units connected and their current attenuation settings. If any changes are subsequently made to the daisy-chain interconnections the **Refresh** button can be used to have the addresses checked and re-assign automatically to all units in the chain.

5.5.2. Dynamic Addressing Functions

The center control panel will apply the attenuation settings to whichever combination of attenuators is selected in the “Dynamic Address” panel.

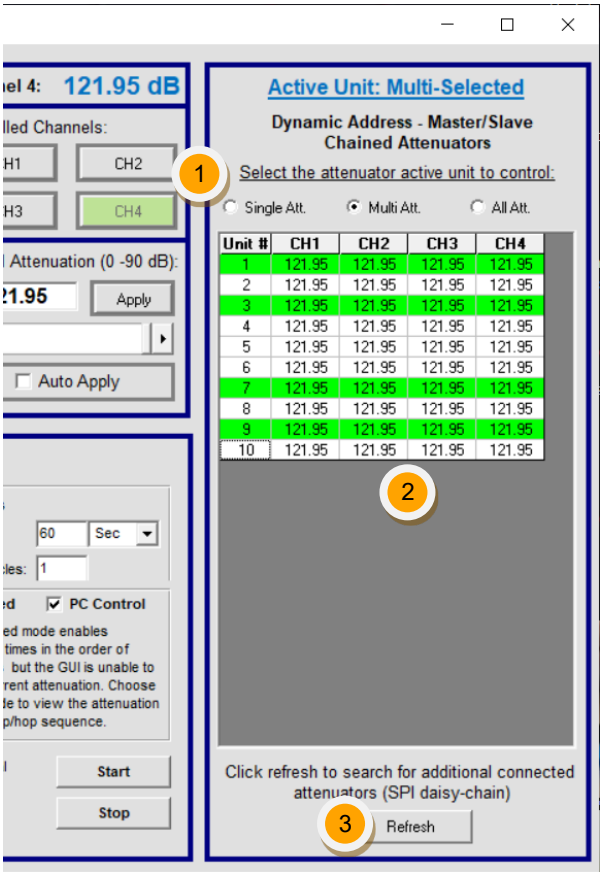


Figure 5.5.2: *List of connected units on the daisy-chain section of the GUI (appearing for supporting models only)*

#	Name	Descriptions
1	Select the attenuator units to control	Select one of three options: • Single attenuator – control one attenuator at a time. • Multi attenuator – select a number of attenuators by clicking on them to send them the same command (selected units appear in green). • All attenuator – all connected attenuators will be selected.
2	Attenuation tables	Table showing current attenuation setting of all connected attenuators
3	Refresh	Refreshes the addresses for the dynamic addressing daisy chain. Click on this after connecting additional units, or changing the units connected.

5.6. Pop-up Alerts

If you type an attenuation value the attenuator cannot meet – either too large a number, or resolution too fine for the attenuator model, an alert will pop up and the attenuation setting will not change. Click **OK** to dismiss the alert and enter a valid attenuation value.

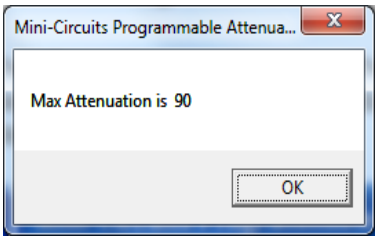


Figure 5.6a: *Value too large for model*

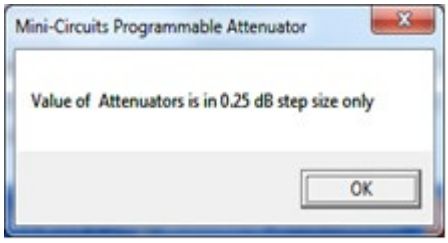


Figure 5.6b: *Resolution too fine for model*

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.

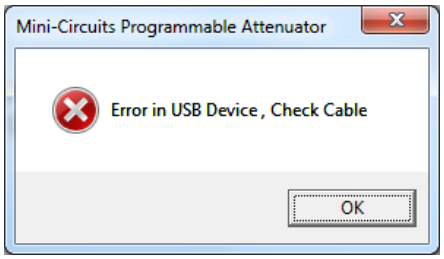


Figure 5.6c: *Data or power disconnected alert*

Checking/Un-checking the **Log Attenuation** option will pop-up an alert notifying the user of the location of the *txt* file log when enabling and disabling the logging operation. An alert will also pop-up if a user tries to open the log file mid recording. Clicking **OK** on either will dismiss the alert.

Figure 5.6d: *Start/end of logging alert*

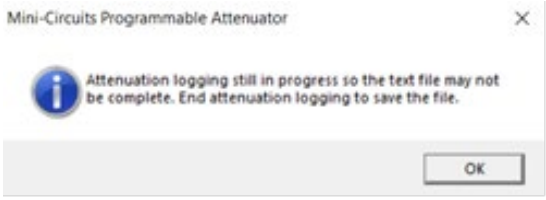


Figure 5.6e: *Mid-recording alert*

The programmable attenuator 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 available for download at https://www.minicircuits.com/softwaredownload/patt.html

5.7. Firmware Update

All units 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.

Caution:

- The firmware update process has the potential to render the device inoperable in the event of communication failure. Updates should only be carried out with a stable PC and USB connection, and in-line with Mini-Circuits' guidelines.
- A recovery option is available to restore units rendered inoperable by an incorrect upgrade process (see *section 5.8* for details).

5.7.1. Requirements

To update a unit's firmware, a Windows computer with an installation of Mini-Circuits' Programmable Attenuator software is required. Additionally, a suitable upgrade file provided by Mini-Circuits' Test Solutions department needs to be available on hand.

5.7.2. Process

The following firmware upgrade instructions apply to both current and legacy controller versions, but with some visual differences (as highlighted below):

- Connect only the unit to be upgraded to the PC via USB (see *section 4.1*) and start Mini-Circuits' Programmable Attenuator GUI program.
- After selecting **USB** connection, click the **Firmware** button on the left side of the program.
- The "Firmware – Info" window will list the currently installed firmware revision. Chose **Update Firmware** to proceed or **Exit** to cancel the process.

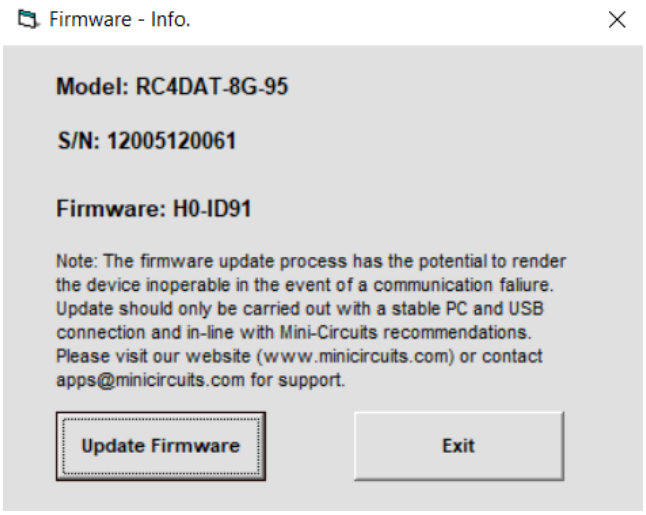


***Figure 5.7.2a**: Firmware - Info window*

- Navigate to the location of the upgrade file you received from Mini-Circuits' Test Solutions and choose it.

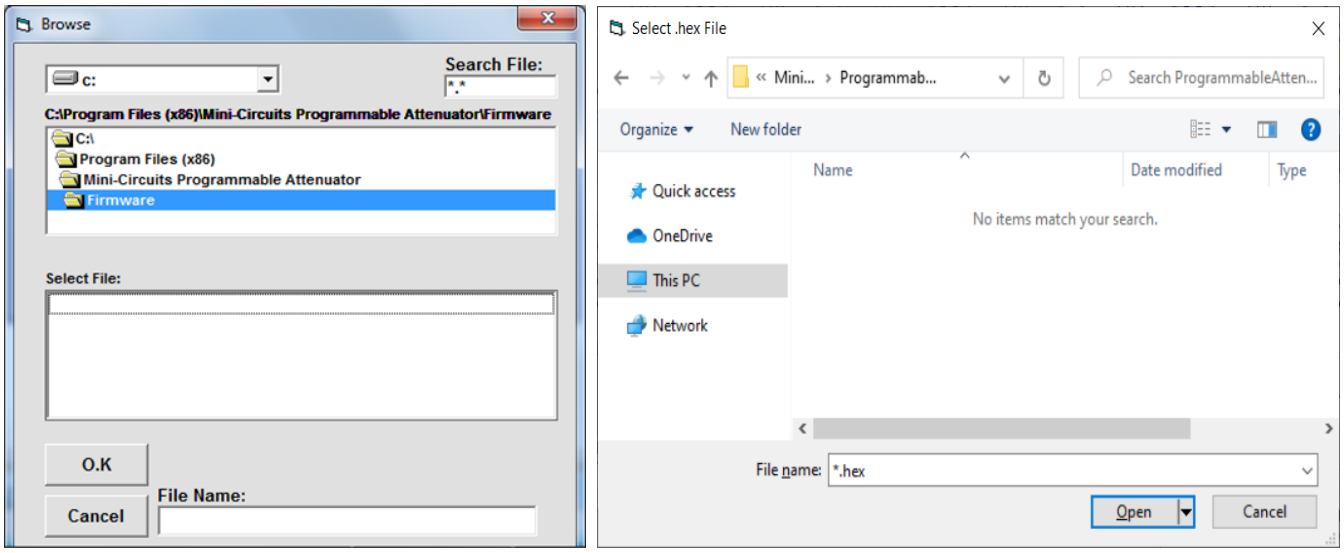


***Figure 5.7.2b**: Firmware - Browse window (Legacy – left, Current – right)*

Note:

- If the file name of the *.hex* file is changed it will not be recognized as a valid firmware file.
- The firmware upgrade file must be in a directory you have read and write access to, otherwise an error message will appear.

- The selected file should now be installed on the attenuator with the process taking up to a minute.

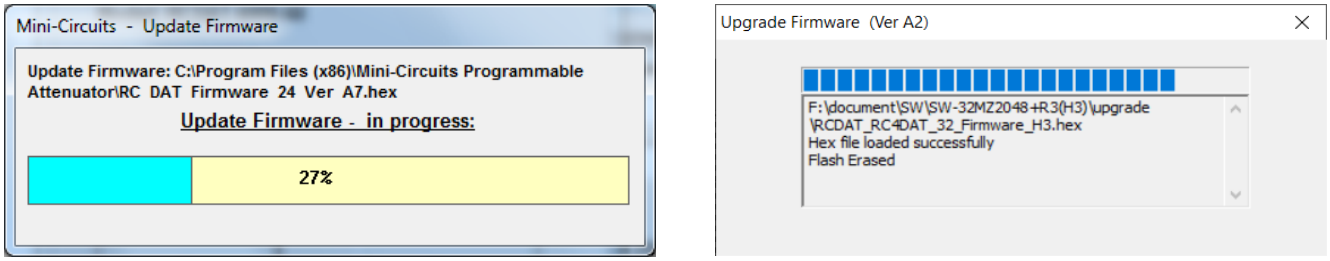


***Figure 5.7.2c**: Firmware - Progress Bar window (Legacy – left, Current – right)*

Caution:

- Do not disconnect the attenuator or shut down the program while the firmware is being updated. Doing so may damage the attenuator.
- 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.

- After the firmware has been updated a confirmation alert will appear. Click **OK** to shut down the program and restart it normally.
- If the firmware upgrade was interrupted, this can result in partial installation rendering the device inoperable. Refer to *section 5.8* to start the firmware recovery process.

5.8. Firmware Recovery

Mini-Circuits models feature a firmware recovery option for cases where the unit's firmware has become corrupted rendering it no longer accessible (for example, due to an interrupted firmware upgrade).

Before starting, consult the table below to determine which recovery process to follow (legacy controller vs. current controller):

Model name	Current Controller (with SSH Support)
RC4DAT-6G-30	From S/N 12009250001 and up
RC4DAT-6G-60	From S/N 12007130001 and up
RC4DAT-6G-95	From S/N 11910300001 and up
RC4DAT-8G-95	From S/N 12004280001 and up
RC4DAT-8G-95PE	All units
RC4DAT-8G-120H	All units
RC8DAT-8G-95	All units
RC8DAT-8G-95PE	All units

Caution:

- Ensure you have the firmware file ready before attempting a recovery process.
- Contact testsolutions@minicircuits.com if you do not have the *.hex* firmware file.

5.8.1. Recovery Steps (Current Controller)

Follow the below recovery steps for models with the current micro-controller (refer to table in *section 5.8* to determine your unit's controller):

- Connect the unit to the PC via USB.
- Navigate to the directory where the Programmable Attenuator GUI has been installed.
- Locate and run the "UpgradeFirmware.exe" utility program.
- Click **Connect** / **Disconnect** and wait for the device to be connected.
- Click **Load Hex File** and navigate to the firmware's (file ending with *.hex*) location on your PC.
- Click **Upgrade Firmware** and wait for the program to finish.

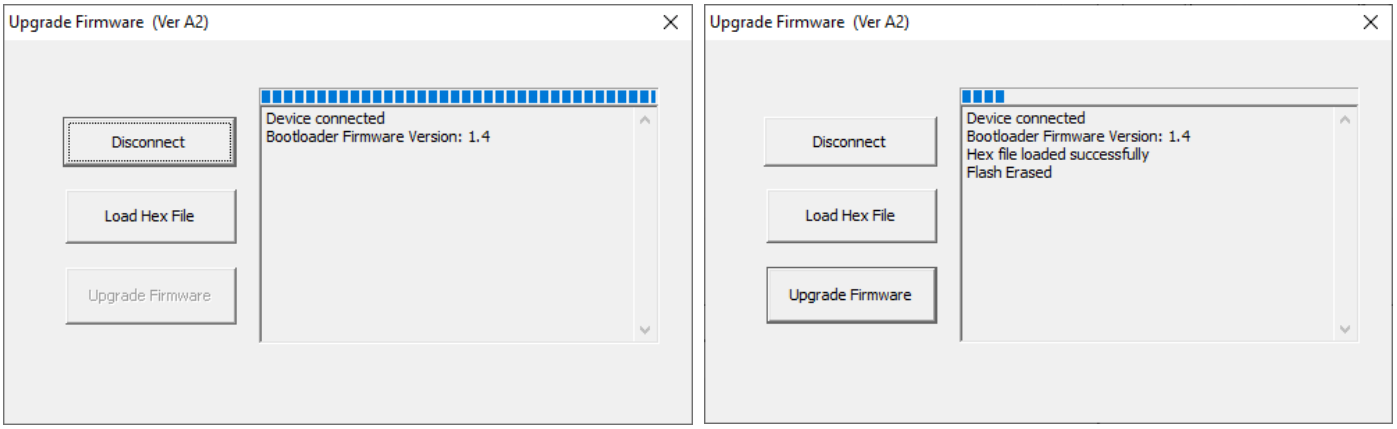


***Figure 5.8.1**: Left – Unit connection step; Right – Firmware upgrade step*

5.8.2. Recovery Steps (Legacy Controller)

Follow the below recovery steps for models with the legacy micro-controller (refer to table in *section 5.8* to determine your unit's controller):

- Connect the unit to the PC via USB.
- Start Mini-Circuits' Programmable Attenuator GUI program and allow it time to attempt and establish a connection with the unit.
- If the connection attempt has failed, an alert would appear advising the user of a corrupt firmware.
- Click **Yes** to proceed with the firmware recovery and refer to *section 5.7.2* on how to proceed.

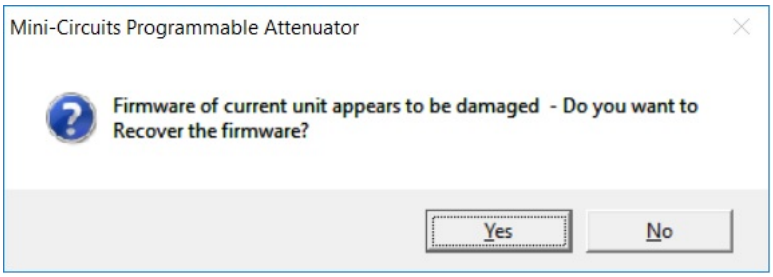


Figure 5.8.2: *A corrupted firmware alert*

6. Revision History

Revision OR (May 08, 2017):

- Initial release of the user guide.

Revision A (Aug 06, 2020):

- Added models: RC4DAT-6G-30, RC4DAT-8G-95, RC8DAT-8G-95.
- Updated “Software Setup and Installation” section.
- Updated “Firmware Update” section (upgrade and recovery).
- Added description of SSH support.
- Added description of “Attenuation log file” option.

Revision B (Sep 30, 2020):

- Updated “Firmware Update” section.
- Separated Firmware Update and Firmware recovery to separate sections.
- Added photo of RC8DAT-8G-95 to front page of user guide.

Revision C (Apr 22, 2021):

- Restructured and expanded Ethernet configuration chapter.
- Added a summary for default IP configuration.
- Added description of Ethernet configuration tool.

Revision D (Jan 25, 2023):

- Updated user-guide format: Re-written and restructured sections to support format update.
- Fixed a typo in URL of Ethernet configuration tool.

Revision E (Jun 26, 2025):

- Added models: RC4DAT-8G-95PE, RC8DAT-8G-95PE.

7. Contact Information

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