USER GUIDE

Mechanical Switch Systems

RC Series

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Contents

1. Overview

1.1. Scope

This user guide is intended for RF engineers of any level of experience who intend to operate Mini-Circuits' RC series of USB & Ethernet controlled mechanical switch systems. It outlines the instructions for software installation, hardware setup and operation. It is recommended that the user familiarize themselves with all aspects of this guide before starting work.

The full software and documentation package including a GUI program, DLL files, user guide and programming examples is available for download from the Mini-Circuits website at:

https://www.minicircuits.com/softwaredownload/rfswitchcontroller.html

For details and specifications on the individual models, please see:

https://www.minicircuits.com/WebStore/RF-Mechanical-Compact-Switch.html

Files made available for download from the Mini-Circuits website are subject to Mini-Circuits' terms of use which are available on the website.

1.2. Programming Manual

This guide focuses on switch control using the supplied Graphical User Interface (GUI). The software support also includes an Application Programming Interface (API) which allows automation of all switch features from most common programming environments, including Python, LabVIEW, C# and many more, via the USB or Ethernet connections.

Full instructions for programming with these models can be found in the programming manual available from our website at:

https://www.minicircuits.com/softwaredownload/rfswitchcontroller.html

1.3. 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

www.minicircuits.com/contact/worldwide_tech_support.html

1.4. Warranty & RMA Returns

Mini-Circuits provides a 1-year 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, please contact Mini-Circuits 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.

1.5. End of Life

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

1.6. Languages

Please contact testsolutions@minicircuits.com if instructions are required in other languages.

2. Introduction to Mini-Circuits' RC Series

Mini-Circuits' RC series is a family of compact mechanical switch boxes with USB and Ethernet control interfaces. Each model houses 1 or more wideband electro-mechanical switch components for a wide range of RF, microwave and millimeter wave switching applications. A software GUI is provided for straightforward "point & click" control straight out of the box and a comprehensive API is included as standard for users wishing to automate switch operations in most modern programming environments.

2.1. Key Features

- High performance mechanical switches for lab & production
- High isolation and low insertion loss
- Compact & rugged benchtop package
- Ethernet & USB with API for simple automation
- Switch configurations including transfer (DPDT), SPDT, SP4T and SP6T
- Frequency options from DC to 50 GHz
- SMA / N-type / 2.92 mm / 2.4 mm connector options
- LED switch state indicators on front panel
- Low insertion loss, high isolation and high-power ratings
- 24V DC input with included AC power adapter

2.2. Supported Model List

For full details and specifications of supported models, please refer to the datasheets published on our website: https://www.minicircuits.com/WebStore/RF-Mechanical-Compact-Switch.html

Model Name	Frequency	Connector	Type	Termination	Switch Count
RC-2MTS-12N	DC - 12 GHz	N-type	DPDT	Transfer	2
RC-1SP6T-A12		SMA	SP6T	Terminated	1
RC-2SP6T-A12					2
RC-2MTS-18	DC - 18 GHz	SMA	DPDT	Transfer	2
RC-3MTS-18					3
RC-1SPDT-A18			SPDT	Terminated	1
RC-2SPDT-A18					2
RC-4SPDT-A18					4
RCM-6SPDT-18					6
RC-8SPDT-A18					8
RC-1SP4T-A18			SP4T	Terminated	1
RC-2SP4T-A18					2
RCM-3SP4T-18					3
RC-1SP6T-A18			SP6T	Terminated	1
RC-2SP6T-A18					2

Model Name	Frequency	Connector	Type	Termination	Switch Count
RC-2MTS-26	DC - 26.5 GHz	SMA	DPDT	Transfer	2
RC-3MTS-26					3
RC-1SPDT-A26			SPDT	Terminated	1
RC-2SPDT-A26					2
RC-4SPDT-A26					4
RC-8SPDT-A26					8
RC-1SP4T-26			SP4T	Terminated	1
RC-2SP4T-26					2
RC-1SP6T-26			SP6T	Terminated	1
RC-2SP6T-26					2
RC-2MTS-40	DC - 40 GHz	2.92 mm	DPDT	Transfer	2
RC-3MTS-40					3
RC-2SPDT-A40			SPDT	Terminated	2
RC-4SPDT-A40					4
RC-8SPDT-A40					8
RC-2SPDT-40				Unterminated	2
RC-4SPDT-40					4
RC-1SP4T-40			SP4T	Terminated	1
RC-2SP4T-40					2
RC-1SP6T-40			SP6T	Terminated	1
RC-2SP6T-40					2
RC-2SP6T-40R				Unterminated	2
RC-2MTS-50	DC - 50 GHz	2.4 mm	DPDT	Transfer	2
RC-3MTS-50					3
RC-2SPDT-50			SPDT	Unterminated	2
RC-4SPDT-50					4
RC-8SPDT-50					8
RC-1SP4T-50			SP4T	Terminated	1
RC-2SP4T-50					2
RC-1SP6T-50			SP6T	Terminated	1
RC-2SP6T-50					2

2.3. Included Accessories

Part Number	Description
AC/DC-24-3W1 	AC/DC 24V DC grounded power adaptor. Operating temperature 0 to +40˚C, max current 2.5A, IEC C4 AC inlet.
CBL-3W1-xx	AC power cord (IEC C5 connector to specified local plug).
USB-CBL-AB-3+	USB cable (2.7ft) type A to type B
CBL-RJ45-MM-5+	Ethernet cable (5 ft)

2.4. Power Cord Options

Part Number		Description
	CBL-3W1-US	USA NEMA 5-15 plug (type B) to IEC C5 connector
	CBL-3W1-EU	Europe CEE 7/7 plug (type E/F) to IEC C5 connector
	CBL-3W1-UK	UK BS-1363 plug (type G) to IEC C5 connector
	CBL-3W1-AU	Australia & China AS/NZS 3112 plug (type I) to IEC C5 connector
	CBL-3W1-IL	Israel SI-32 plug (type H) to IEC C5 connector

2.5. Optional Accessories

Part Number	Description
BKT-xxx	Base mouting bracketg (set of 2). Refer to individual model datasheet for part number.

2.6. Intended Applications

Mini-Circuits RC series switch boxes are intended for indoor use in:

- Lab and test equipment setups for both manual and automated measurements
- Control systems
- Automated switching of signal paths

The models can be used by anyone familiar with the basics of RF electronics and measurements, and interconnection of RF electronic systems.

2.7. Control Interfaces

Interface	Details	
Ethernet Control	Supported Protocols	TCP / IP, HTTP, Telnet, SSH, DHCP, UDP (limited)
	Max Data Rate	10 Mbps (10Base-T Half Duplex)
USB Control	Supported Protocols	HID – Full Speed
	Min Communication Time[1]	3 ms typ

[1] Based on the USB HID protocol polling interval (1 ms with 64 bytes per packet) and no other significant CPU or USB activity

Note: SSH not supported on all models – contact testsolutions@minicircuits.com for support

2.8. Conformity

Standard	Summary
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
USB 2.0	Meets the specifications of the Universal Serial Bus version 2.0 communication standard as described by USB-IF.
USB HID	Meets the requirements for Universal Serial Bus Human Interface Devices according to the USB-IF Device Class Definition for Human Interface Devices firmware revision 1.11.
TCP / IP	Meets the specifications of the Transmission Control Protocol (TCP) and Internet Protocol (IP) as defined in RFC 791 and RFC 793.
HTTP	Meets the requirements for communicating with the Hypertext Transfer Protocol (HTTP) as defined in RFC 1945.
Telnet	Meets the requirements for communicating with the Telnet protocol, as defined in RFC 854.

2.9. Environmental Specifications

These products are intended for operation in office, laboratory, or production test environments. Do not use in any condition which exceeds the published environmental specifications.

Parameter	Specification
Operating Temperature	0 to 40˚C
Storage Temperature	-15 to 85˚C
Relative Humidity	5% to 85% (non-condensing)
Altitude	Up to 2000 m (6560 ft)
Pollution Degree	2 - Normally only non-conductive pollution occurs (per IEC 61010)

2.10. Service & Calibration

These products do not require any periodic service or calibration. The only user service possible is external cleaning of the case and connectors as needed. Do not use any detergents or spray cleaning solutions to clean the switch box; a soft, damp cloth can be used.

3. Hardware Configuration

3.1. Safety & Cautions

3.1.1. ELECTRICAL HAZARD

The AC adapter contains live 110 / 220V contacts and should not be disassembled. Users must exercise caution to avoid touching any parts where live voltage may be present to prevent injury or death due to electrical shock. Discontinue use and contact Mini-Circuits in the event of visible damage to any parts.

3.1.2. HEAVY OBJECT

The unit may be heavy and requires caution to prevent damage to the equipment and ensure user safety. Follow safe lifting protocols and use any necessary lifting aids to prevent muscle strain or back injury. The unit must be securely located to avoid potentially damaging the equipment.

3.1.3. FAN OPERATION

Some units may contain cooling fans with rotating blades that can cause injury if obstructed. Remove any loose articles before working inside the unit case to avoid getting caught in moving parts. Ensure adequate space around the fan vents to allow proper cooling.

3.1.4. SAFE INPUT LEVELS

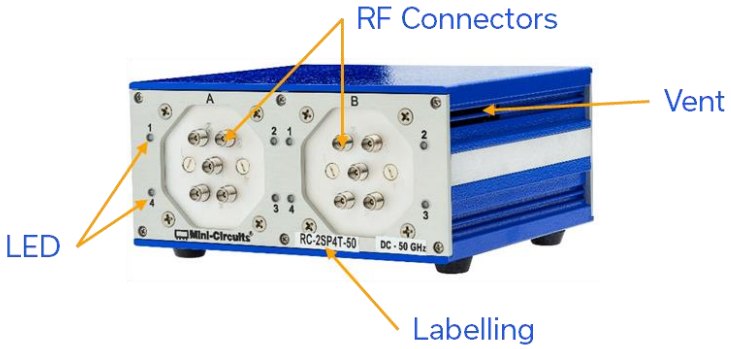
Do not exceed the specified RF input power levels to prevent damage to the product.

3.1.5. USE OF SUPPLIED AC / DC ADAPTER

Use of the supplied AC / DC power adapter is recommended to ensure safe operation. Do not exceed the specified DC voltage input level.

3.2. Front Panel Layout

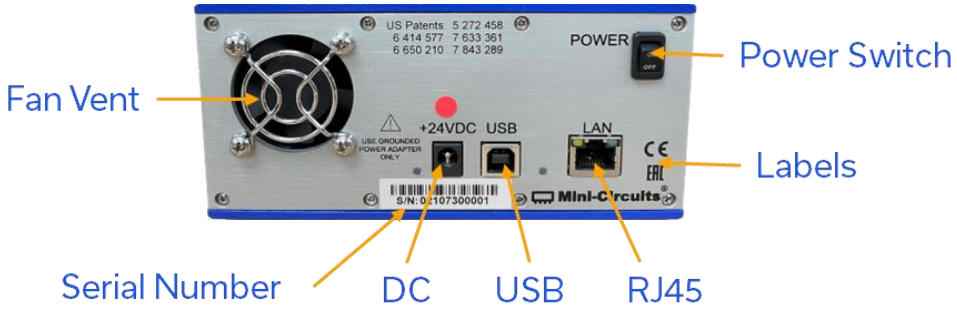
An example front panel layout is shown below. The precise combination of switches, connectors, LED state indicators and labelling varies by model so refer to the model datasheet for full information.



Item	Description
Labelling	Identifying marks for the specific switch box, including model name and frequency.
RF Connectors	The RF connections for each switch component within the switch box. Refer to the datasheet for connector type and quantity.
LEDs	LED state indicators for each switch or port, providing a visual representation of the current switch state(s).
Vents	Ventilation channels to allow air-flow and cooling within the switch box. Do not obstruct.

3.3. Rear Panel Layout

An example rear panel layout is shown below. The precise arrangement varies by model so refer to the model datasheet for full information.



Item	Description
Fan Vent	Ventilation to allow airflow and cooling within the switch box. Do not obstruct.
Serial Number	Serial number which uniquely identifies the unit for traceability
DC	24V DC power supply input
USB	USB type-B control input
RJ45	LAN / Ethernet control input
Labels	Labels for regulatory compliance (varies by model)
Power Switch	Master on / off power switch for the unit

3.4. Connection & Power-On

1. Connect the USB or Ethernet cable between the RC switch box and the host PC or network
2. Connect the supplied AC / DC power adapter between the RC switch box and a suitable AC mains power source
3. Power on the switch box with using the rear panel power switch

Note: Only 1 control method is needed but both can be connected for simultaneous use of USB and Ethernet control

3.5. Default / Fail-Safe Switch States

Mini-Circuits' RC series of switch boxes use a range of high-reliability mechanical switches that revert to a known state when the DC power supply is removed. The default switch states are summarized below:

Switch Type	Default State
SPDT	Com to 1
SP4T	All ports disconnected. Com will be open / reflective for all models. Ports 1-4 will either be internally terminated (for absorptive switches) or open for reflective switches.
SP6T	All ports disconnected. Com will be open / reflective for all models. Ports 1-6 will either be internally terminated (for absorptive switches) or open for reflective switches.
Transfer / DPDT (18 GHz component only)	J1 to J3 and J2 to J4
Transfer / DPDT (all other frequencies)	J1 to J2 and J3 to J4

4. Ethernet Communication

Mini-Circuits' RC series switch boxes support Ethernet communication using HTTP or Telnet protocols. SSH is also available as an option on some models for secure communication (please contact testsolutions@minicircuits.com for details). UDP is supported as a method to broadcast a general query to the network and identify any connected devices.

These protocols are widely supported and straightforward to implement in most programming environments. Any Internet browser can be used as a console / tester for HTTP control by typing the full URL directly into the address bar. Telnet is supported by a number of console applications, including PuTTY.

The Mini-Circuits GUI can be used for full control of the switch box via HTTP, Telnet or SSH (when supported).

4.1. Default Ethernet Configuration

Mini-Circuits' products ship with DHCP enabled by default so in most cases the device should be assigned a dynamic IP address when connected to the network. Once a valid IP address has been assigned and identified it can be re-configured in multiple ways:

1. Using the Windows GUI when connected by USB
2. Using the API when connected by USB or Ethernet (refer to the programming manual for details)
3. Using Mini-Circuits' HTML configuration tool when connected by Ethernet

Note: Firmware F0 or later is required to support configuration of the Ethernet settings when connected by Ethernet

4.2. Link-Local / Auto IP Address

A default "link-local" auto IP address will be assumed when DHCP is enabled but the device does not receive a valid response from a DHCP server. This could be the case on networks with no DHCP server when the device 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.

The default auto-IP features provide a method to implement a static IP configuration, without first relying on DHCP, or resorting to the USB connection. The process would be:

1. Connect the device directly to a PC using the Ethernet cable
2. No DHCP response will be received from the PC so the device will assume the default auto-IP
3. Connect to the device on 169.254.10.10
4. Disable DHCP, set the required static IP configuration and reset the device
5. Reconnect using the updated IP configuration

Note: Firmware F0 or later is required for the default link-local IP address

4.3. Recovering / Resetting the Ethernet Configuration

In the event that an invalid IP configuration is applied and the device can no longer communicate over Ethernet, the configuration can always be read and reset using the USB connection, either using the GUI or the programming API.

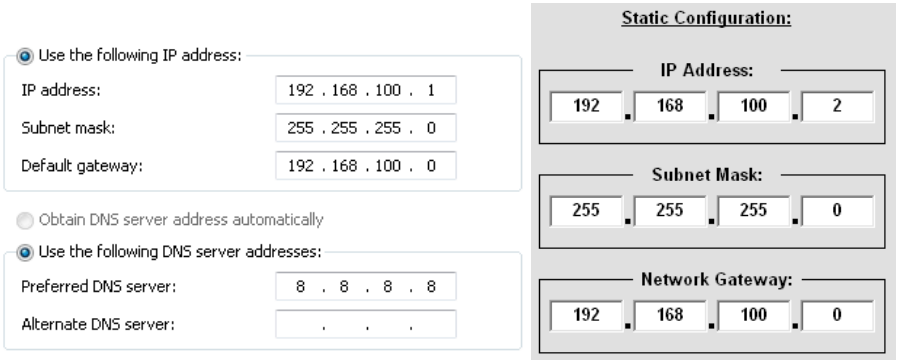
Refer to Configuring Ethernet IP Settings for instructions using the GUI or to the programming manual for details of the API.

4.4. Direct Ethernet Cable Connection to PC

It may be necessary to set a compatible TCP / IP configuration on a PC in order to establish a direct connection by Ethernet cable between the device and PC rather than via a network. The values can be chosen arbitrarily as long as a valid and compatible range is applied to both PC and Mini-Circuits device. The key points are:

1. Set different IP addresses on the same subnet for the PC and device
2. Set another different IP address on the same subnet as the network gateway IP, using the same value on both PC and Mini-Circuits device
3. Set the same subnet mask on PC and device (ensuring the mask allows the above IP range)

An example of a working configuration is shown below, with the PC settings on the left and the static IP settings for the Mini-Circuits device on the right.



4.5. Supported Protocols

4.5.1. HTTP COMMUNICATION

HTTP (HyperText Transfer Protocol) is a widely supported method for communication over a network. Mini-Circuits' devices support HTTP communication through the GUI or API (using Get & Post commands). HTTP also permits using a standard web browser for communication with the device.

A password can be enabled and customized to control access using HTTP. The HTTP port can also be adjusted from the default port 80. Refer to Configuring Ethernet IP Settings for instructions using the GUI or to the programming manual for details of the API.

Note: Since HTTP is an unencrypted protocol the password will be sent in plain-text over the network.

4.5.2. TELNET COMMUNICATION

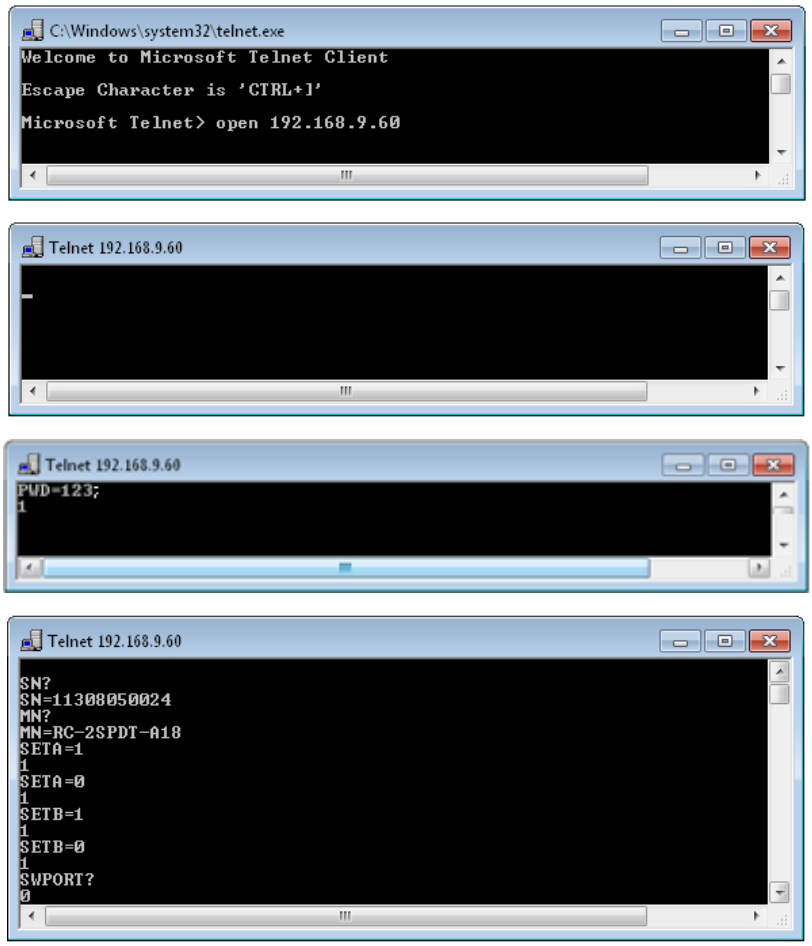
Telnet is a widely supported method for client / server communication over a network. Mini-Circuits supports Telnet communication through the GUI or API.

A password can be enabled and customized to control access using Telnet. The Telnet port can also be adjusted from the default port 23. Refer to Configuring Ethernet IP Settings for instructions using the GUI or to the programming manual for details of the API.

Various third-party clients such as PuTTY can also be used for control. On successful connection, the "line feed" character will be returned. If the system has a password enabled, this must be sent as the first command after connection.

Each Telnet command must be terminated with the carriage return and line-feed characters (\r\n). Responses will be similarly terminated.

Note: Since Telnet is an unencrypted protocol the password will be sent in plain-text over the network.



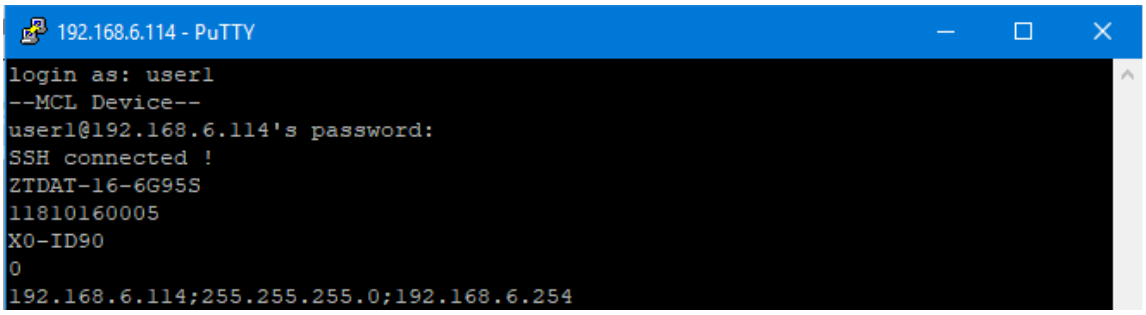
4.5.3. SSH COMMUNICATION

SSH (Secure Shell) is a secure network communication protocol, with all traffic sent in encrypted form.

Note: SSH communication is not supported as standard on all models, please contact testsolutions@minicircuits.com for details.

A username and password is required for communication with Mini-Circuits' devices using SSH with communication on port 22 by default. The default username (`ssh_user`), password and port can be configured as needed, using the GUI or API. Refer to Configuring Ethernet IP Settings for instructions using the GUI or to the programming manual for details of the API.

SSH connections can be initiated using the Mini-Circuits GUI or API, or using a third-part client such as PuTTY.



4.5.4. DISABLING HTTP / TELNET PROTOCOLS

HTTP and Telnet communication can both be enabled or disabled individually as a means for complying with network security policies which prohibit one or other of these protocols. Set the relevant port to 0 or 65535 to disable the protocol, using either the GUI or programming API.

Note: Firmware F1 or later is required to disable HTTP / Telnet communication

Refer to Configuring Ethernet IP Settings for instructions using the GUI or to the programming manual for details of the API.

4.5.5. UDP FOR DEVICE DISCOVERY

Limited support of UDP is provided for the purpose of "device discovery." This allows a user to request the IP address and configuration of all Mini-Circuits' devices within the same family, connected to the network. Full control of those units is then accomplished using SSH, HTTP or Telnet.

Note: UDP is a simple transmission protocol that provides no method for error correction or guarantee of receipt.

Mini-Circuits' Ethernet enabled devices are configured to listen on UDP port 4950 and answer on UDP port 4951. Communication on these ports must be allowed through the computer's firewall in order to use UDP for device discovery. If the switch's IP address is already known, it is not necessary to use UDP.

Mini-Circuits' GUI includes a search function on the initial connection screen which uses UDP. Programmatically, the command `MCLRFSWITCH?` can be broadcast to the local network using UDP on port 4950 to identify devices.

All related Mini-Circuits devices that receive the request will respond with the following information (each field separated by CrLf) on port 4951:

- Model Name
- Serial Number
- IP Address/Port
- Subnet Mask
- Network Gateway
- Mac Address

Example

Sent Data: `MCLRFSWITCH?`

Received Data:

```
Model Name: RC-2SPDT-A18
Serial Number: 11302120001
IP Address=192.168.9.101 Port: 80
Subnet Mask=255.255.0.0
Network Gateway=192.168.9.0
Mac Address=D0-73-7F-82-D8-01

Model Name: RC-2SPDT-A18
Serial Number: 11302120002
IP Address=192.168.9.102 Port: 80
Subnet Mask=255.255.0.0
Network Gateway=192.168.9.0
Mac Address=D0-73-7F-82-D8-02
```

4.6. Ethernet Configuration Tool

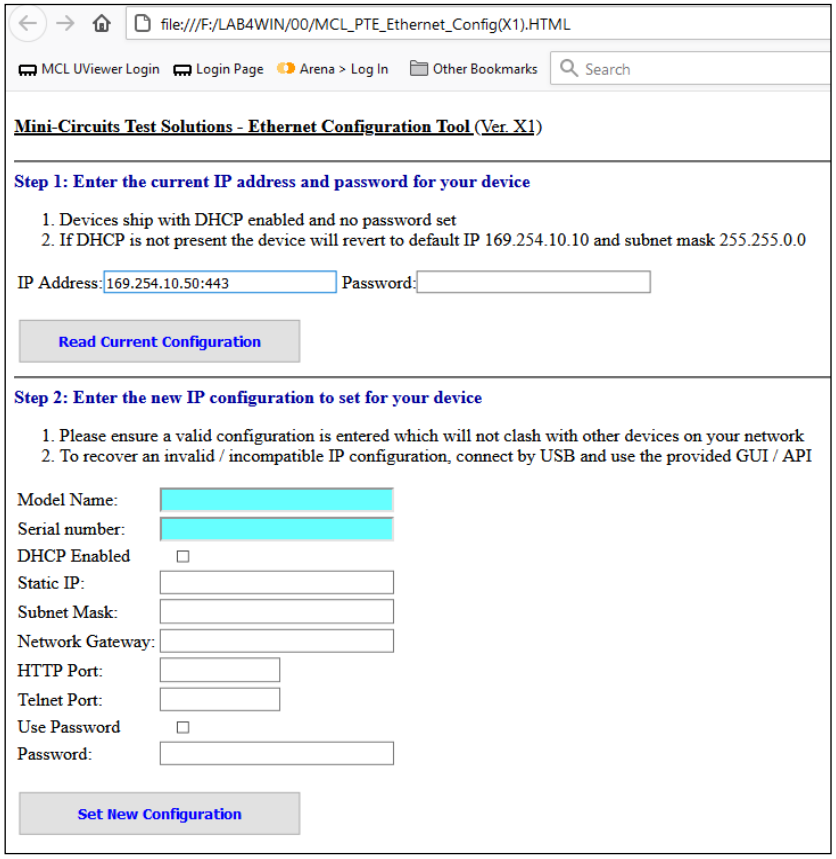
Mini-Circuits provides a simple Ethernet configuration tool which can be downloaded as an HTML file from:

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

The tool provides a method to connect to the device on a known IP address and then set a new IP configuration.

Note:
- Firmware F0 or later is required to support this tool
- Javascript must be enabled in your web browser

To use the tool, download and unzip the package from the link above and open the HTML file in a web browser.



1. Enter the known IP address of the device in the field in Step 1. If the HTTP port is anything other than 80 this must also be entered in the IP address field in the form of ip_address:port
2. Enter the password if one has been enabled for Ethernet control
3. Click Read Current Configuration
4. If the connection is successful, the model name and serial number should be displayed in the Step 2 fields, along with the current IP configuration
5. Overwrite the white Ethernet configuration fields as needed
6. Uncheck the DHCP Enabled field if a static IP configuration is being set
7. Click Set New Configuration to update the device
8. The tool will lose its connection at the old IP address but the device should now be available with the new configuration if valid on the network

5. Windows GUI Control

5.1. Software Downloads & Resources

The full software package including GUI and API is available for download from:

https://www.minicircuits.com/softwaredownload/rfswitchcontroller.html

5.2. Supported Software Environments

These products have been tested in the following operating systems:

Parameter	Specification
Hardware	Intel i3 (or equivalent) or later
GUI (USB or Ethernet Control)	Windows 7 or later
USB API DLL	Windows 7 or later with support for Microsoft .Net Framework or ActiveX
USB Direct Programming	Windows 7 or later; Linux
Ethernet	Windows, Linux or macOS with Ethernet TCP / IP support

A comprehensive set of software control options is provided:

- GUI for Windows – Simple software interface for control via Ethernet and USB
- Programming / automation via Ethernet
  - Complete set of control commands which can be sent via any supported protocol – simple to implement in the majority of modern programming environments
- Programming / automation via USB
  - DLL files provide a full API for Windows with a set of intuitive functions which can be implemented in any programming environment supporting .Net Framework or ActiveX
  - Direct USB programming is possible in any other environment (not supporting .Net or ActiveX)

These products can be controlled from most modern programming environments, including Python, LabVIEW, MatLab, C# and more.

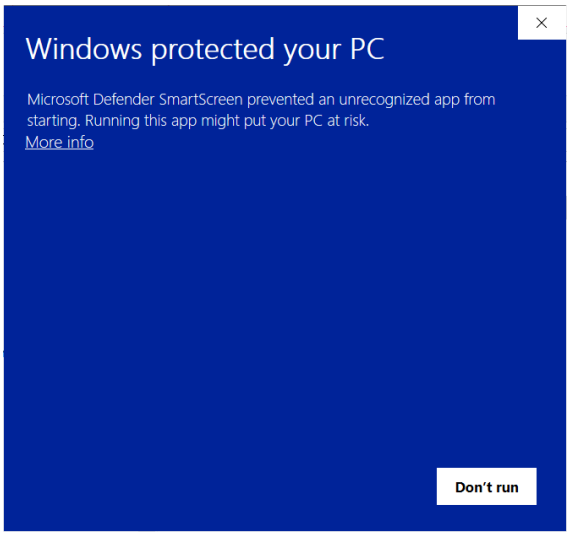
5.3. GUI Installation

1. Download the latest GUI installation package from:

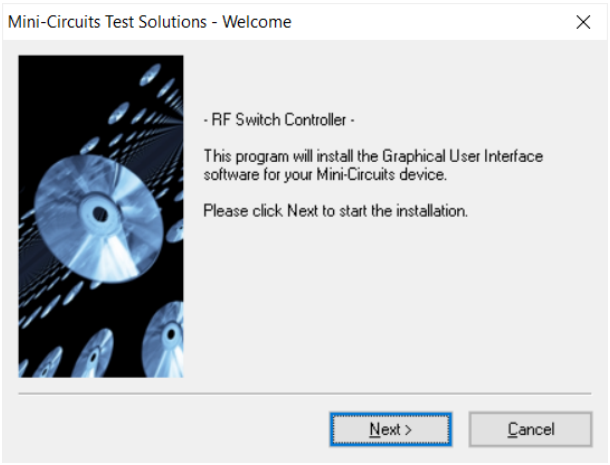
   https://www.minicircuits.com/softwaredownload/RFSwitchController_Setup.zip

2. Open the downloaded RFSwitchController_Setup.zip package
3. Run the setup.exe program to launch the installer

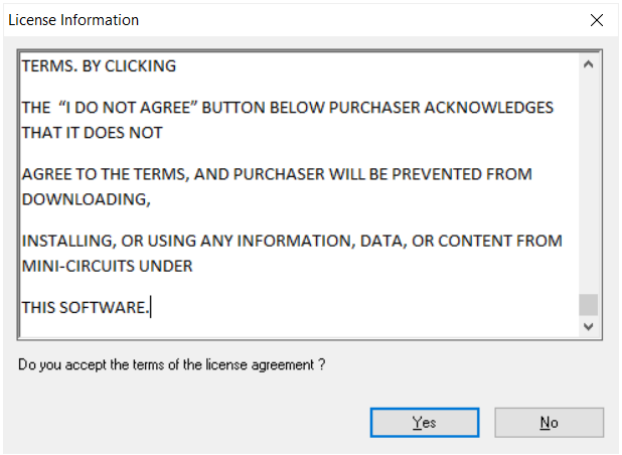
4. If Microsoft Defender SmartScreen provides a warning about an unrecognized app, select More Info and then Run Anyway



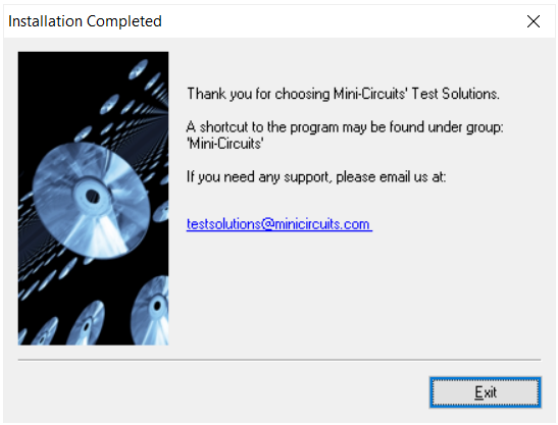
5. You may be prompted to enter credentials for a Windows account with permission to install software
6. Click Next to begin the installation



7. Read and scroll to the bottom of the license agreement and click Yes to accept



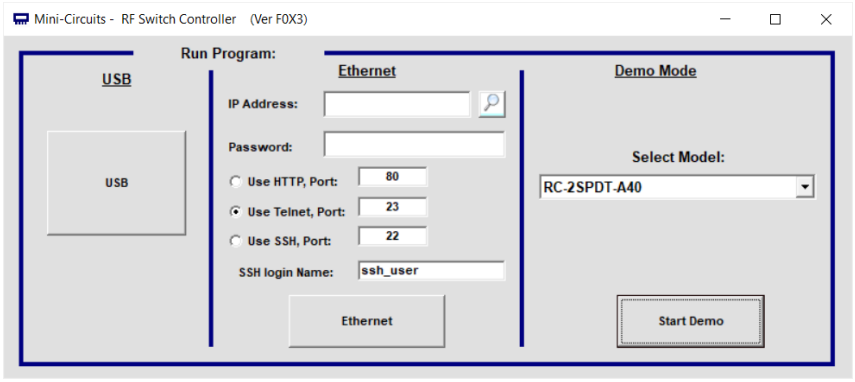
8. After installing all required files, click Exit on the confirmation screen to complete the installation



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

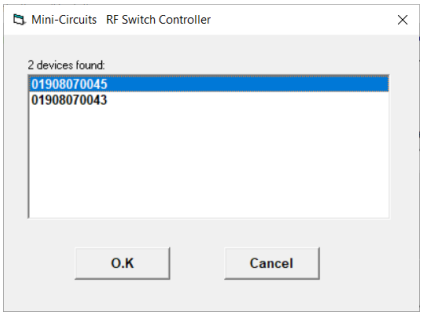
5.4. Connection Screen

The initial connection screen after launching the GUI is divided into 3 main sections; USB control (left), Ethernet control (middle) and demo mode (right). Each GUI instance controls a single switch box; multiple GUI instances can be opened to control multiple switch boxes.

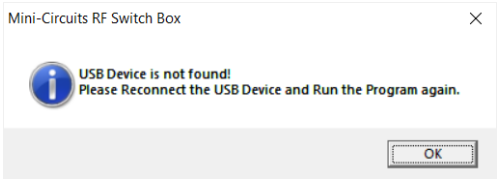


5.4.1. USB CONTROL

Click the USB button to launch the GUI for control of a USB connected switch. If multiple USB connected switch boxes are present, an interim screen will appear to allow the appropriate switch box to be selected by serial number.

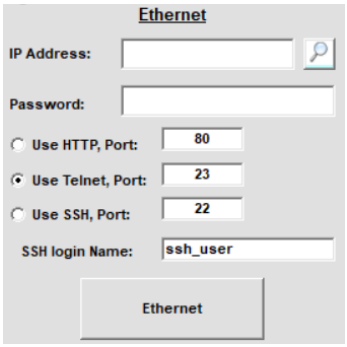


An error will be displayed if no USB connected devices are detected.



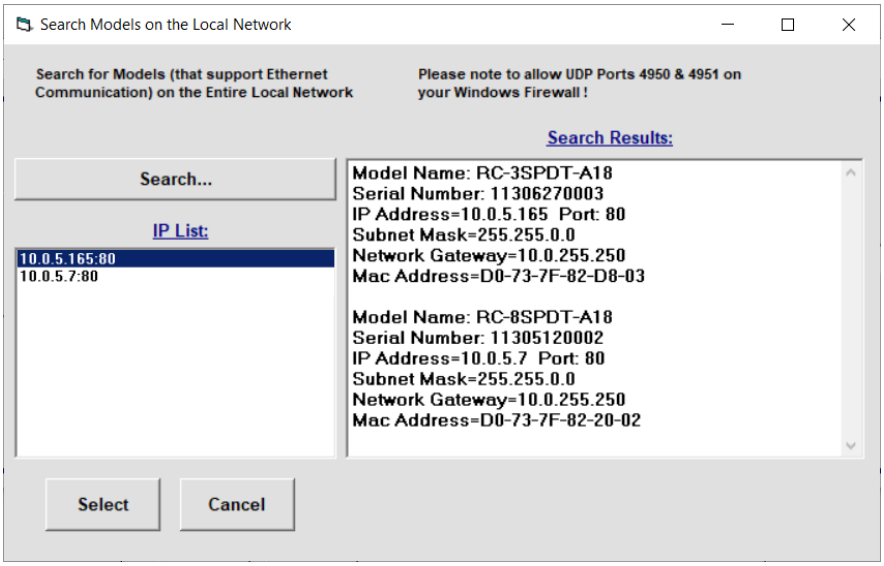
5.4.2. ETHERNET CONTROL

The center section of the connection screen allows the user to specify the IP address of the switch box to control, if known.



Alternatively, clicking the magnifying glass button opens a search window to detect any RC switch boxes on the local network. After clicking "Search...", any devices available on the local network should respond with their identification (including IP address, model name and serial number). Select the IP address for the appropriate switch box to return to the original connection screen with the IP address set.

Note: The network search function requires UDP communication on ports 4950 and 4951 to be allowed on the local PC. Please check the firewall settings if nothing is returned.



To open the GUI for Ethernet control of the specified switch box, select between HTTP, Telnet and SSH communication, enter the port number if different from the default (80 for HTTP, 23 for Telnet, 22 for SSH).

If password control has been enabled that should be entered below the IP address. For SSH connections, the username is also required (ssh_user is the default).

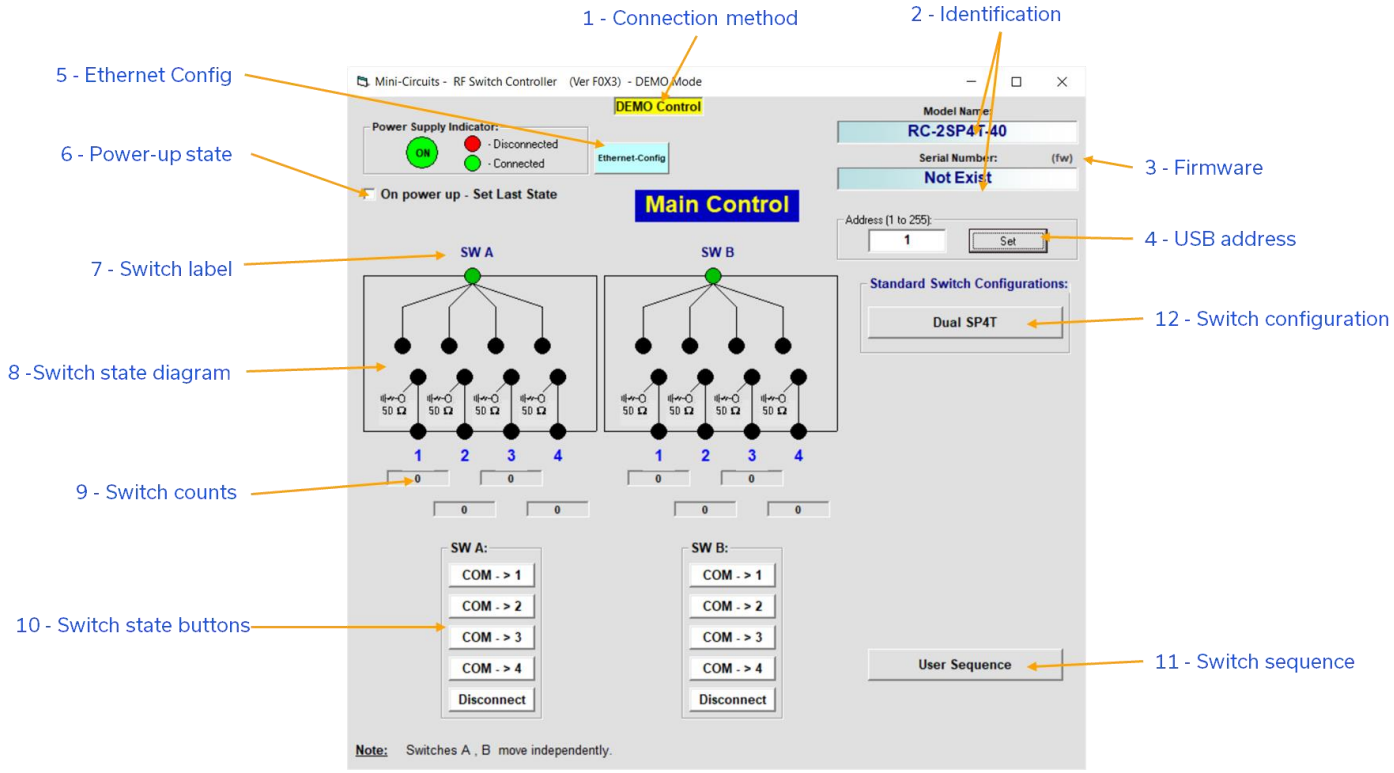
Click the Ethernet button to launch the connection.

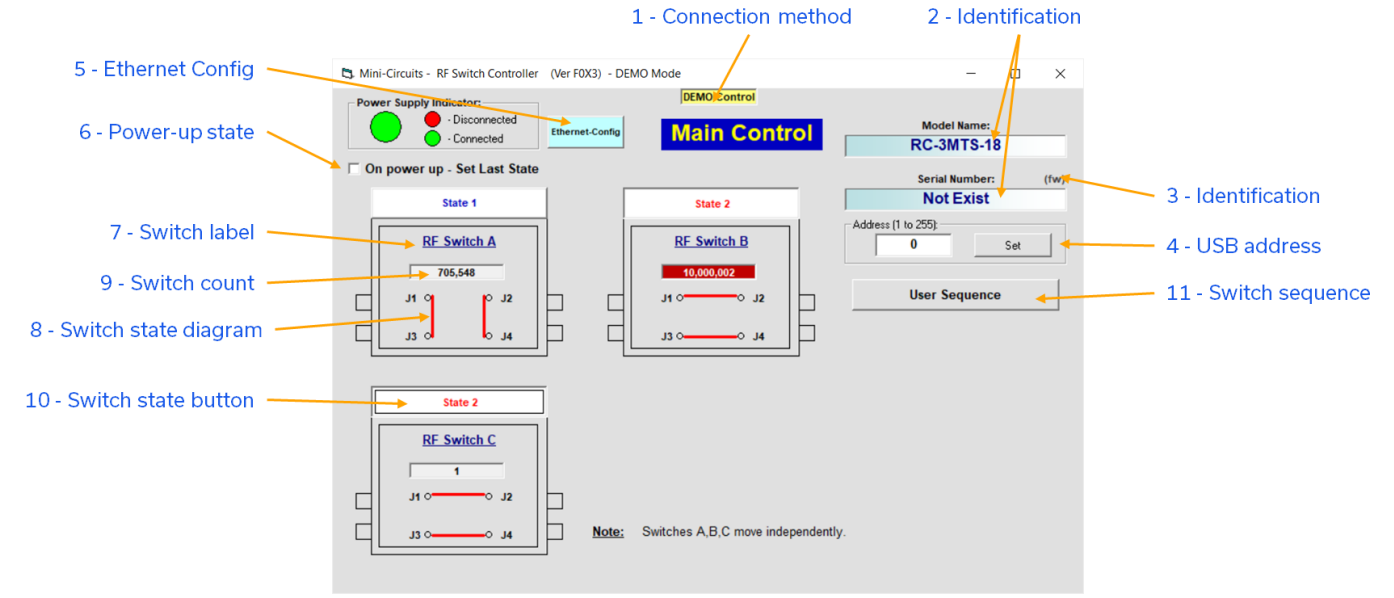
5.4.3. DEMO MODE

To explore the GUI functionality without connecting to a physical switch box, select the model name to demonstrate on the right hand side of the GUI and then click Start Demo.

5.5. Switch Control Screen

The same control screen is loaded for all connection methods (USB, Ethernet or demo mode). The precise layout varies depending on which model of switch box is being controlled and which switches are contained but the features presented are summarized in the examples below for the RC-2SP4T-40 and RC-3MTS-18 switch boxes.





#	Item	Description
1	Connection method	Summarizes the current connection method (USB, Ethernet or demo mode)
2	Identification	Model name and serial number of the connected device
3	Firmware	Link to the installed firmware version with an option to update
4	USB address	Custom address (from 1-255) for identification of multiple switch boxes. The custom address can also be used to identify devices when connecting using the API.
5	Ethernet configuration	Configure the Ethernet IP settings for the switch box.
6	Power-up state	Configure the default states for the mechanical switch components when power is applied.
7	Switch label	Identification for the individual switch within the switch box, matching the front panel labelling.
8	Switch state diagram	Schematic diagram of the mechanical switch component, with an indication of the current switch path.
9	Switch counts	Count of the number of cycles switched over the lifetime of the switch or port.
10	Switch state buttons	Manually set the state of any switch to the desired value. SP4T or SP6T models have separate buttons for each port of a switch; SPDT or transfer switches have a single button per switch which can be set or unset to toggle between the 2 states.
11	Switch sequence	Configure a list of switch states to be executed in a timed sequence.
12	Switch configuration	Model dependent. When present it provides the option to configure multiple switches to change state for a single button click.

5.6. Setting USB Address

The USB address feature is a simple numeric identifier that can be assigned to a switch box. This is not a feature required in the GUI but can be used instead of the serial number as a method to identify and connect a switch box when programming using the API.

Enter an allowed value (1 to 255) in the USB address field and click Set to save.

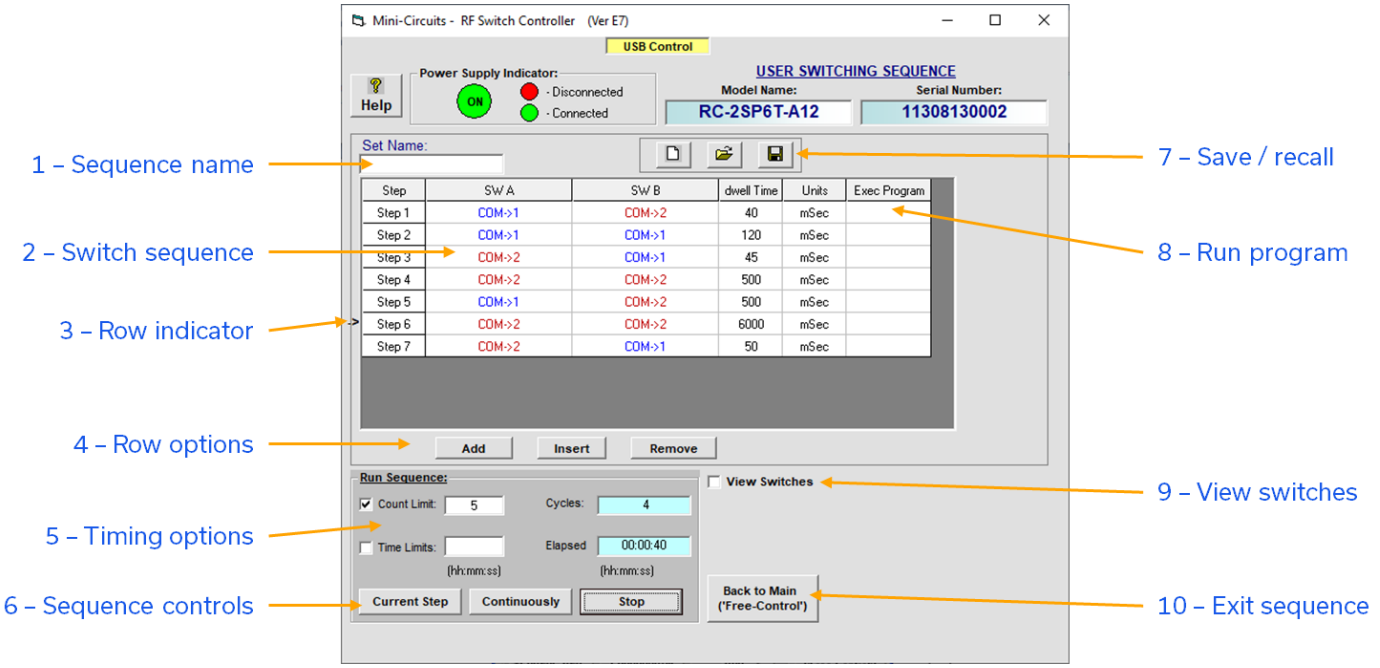
5.7. Power-Up Options

By default, the switch box will power-up will all the switches in their fail-safe states as defined in Default / Fail-Safe Switch States. The switches can alternatively be configured to power-up in their last saved states by checking the "On power up – Set last state" highlighted in position 6 on the switch control screen.

Note: The last saved state only applies when the switch box is powered off in a controlled manner, either by closing the GUI or issuing a programming command through the API before powering off. Alternatively, the last state is saved to permanent memory every 3 minutes while the GUI is running. After a power interruption where the last state was not saved first, the switches will power-up in the default states.

5.8. Switch Sequence Automation

The User Sequence button in position 11 on the switch control screen opens a window where an automated list of switch states can be defined to run unaided. Up to 99 sequences can be defined and saved within the GUI.



#	Item	Description
1	Sequence name	User-friendly name or label for the switch sequence.
2	Switch sequence	Table of switch states to be saved and executed in sequence. The columns are: • Step: Numbered from 1 to N • Switch columns: One column per switch within the switch box. Double-click to cycle through the states available for that switch. • Dwell Time: The time to remain at this step in the sequence after setting the states. • Units: Dwell time units. Click to select between ms, s, min, hour. • Exec Program: Option to run an external program at each step (see below)
3	Row indicator	Cursor to indicate the active row
4	Row options	Select a row and click the buttons to Add, Insert or Remove a step in the sequence
5	Timing options	Set the timing for the sequence. Check Count Limit to repeat the sequence the number of complete cycles specified. Check Time Limits to repeat the sequence for the number of hours, minutes and seconds specified. Uncheck both Count Limit and Time Limits to run the sequence until stopped manually.
6	Sequence control	Start the sequence using the Continuously button and end the sequence using Stop. Alternatively, selecting a row in the table of switch steps and the click Current Step to set the switch states one to those specified in the current step.

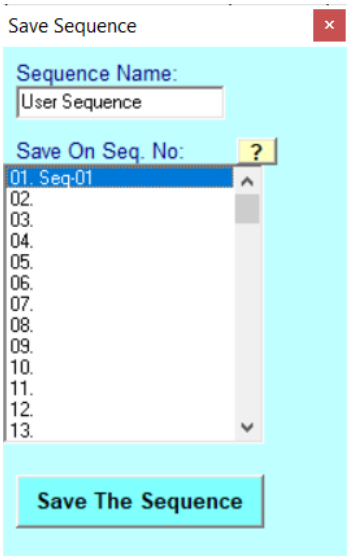
#	Item	Description
7	Save / recall	Save, recall and clear the switch sequence list. Refer to Save / Recall Switch Sequences.
8	Run program	Allows an executable program to be called after setting the switch states at the specified step. Enter the filename of the program (with no path specified) in the table. The program must be saved to C:\MCL_SwitchBox\.
9	View switches	Opens a schematic diagram of the switch components within the switch box, updating their current states as the sequence is executed.
10	Exit sequence	Returns to the main switch control screen

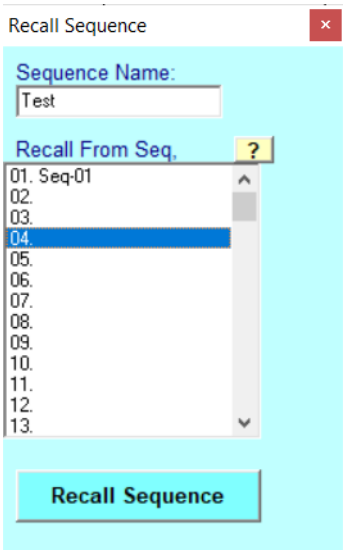
5.8.1. SAVE / RECALL SWITCH SEQUENCES

The user switch sequence automation window defined above provides options to clear, recall and save switch sequences respectively using the 3 buttons shown below.

- Click the blank page button to clear the current sequence.
- Click the file open button to open a list of up to 99 pre-defined sequences. Select the relevant entry and click Recall Sequence to load the sequence into the automation window.
- Click the save button to save a sequence for later recall. Set a Sequence Name, select the location from 01 to 99 in the list and click Save The Sequence to save.

All saved switch sequences are saved as text files with no file extension to C:\MCL_SwitchBox\. These files can be edited in a text editor as long as the formatting conventions are maintained.

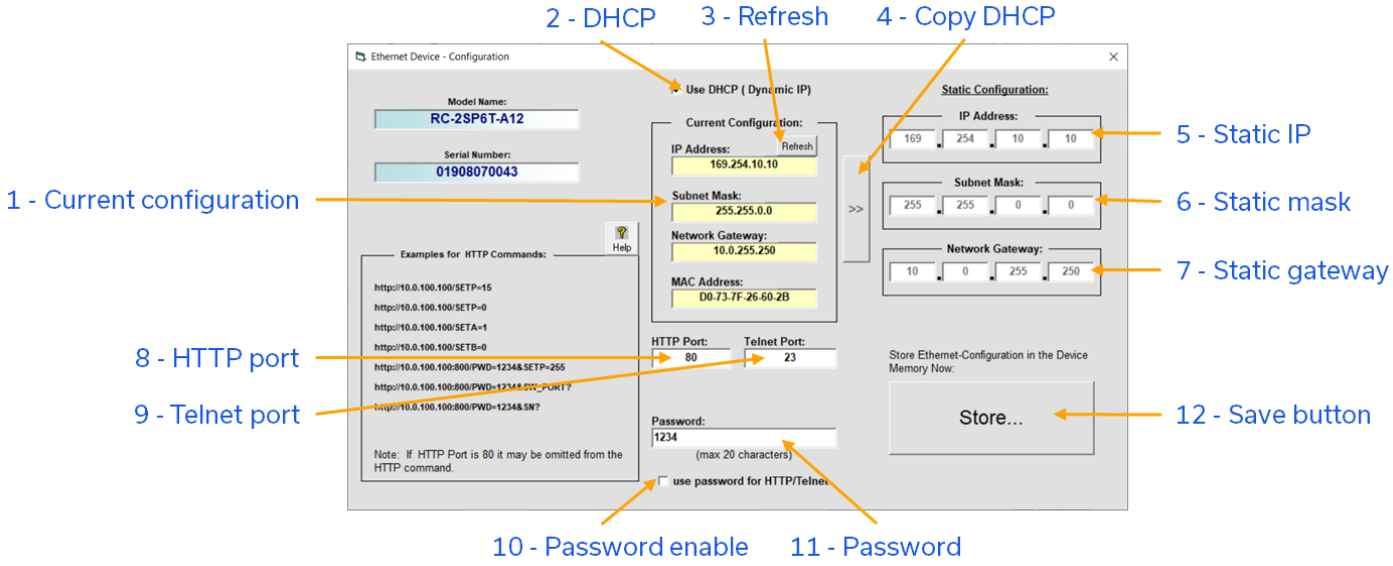




5.9. Configuring Ethernet IP Settings

Clicking the Ethernet Config button in position 5 on the switch control screen opens the Ethernet settings window as shown below.

Note: This feature is only available in the GUI when connected by USB.

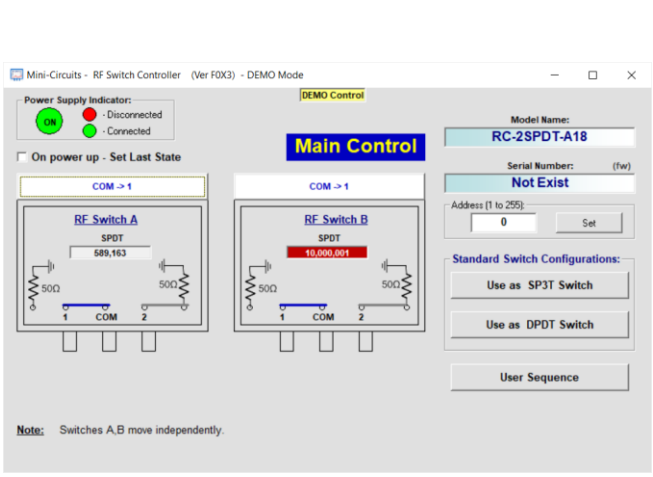


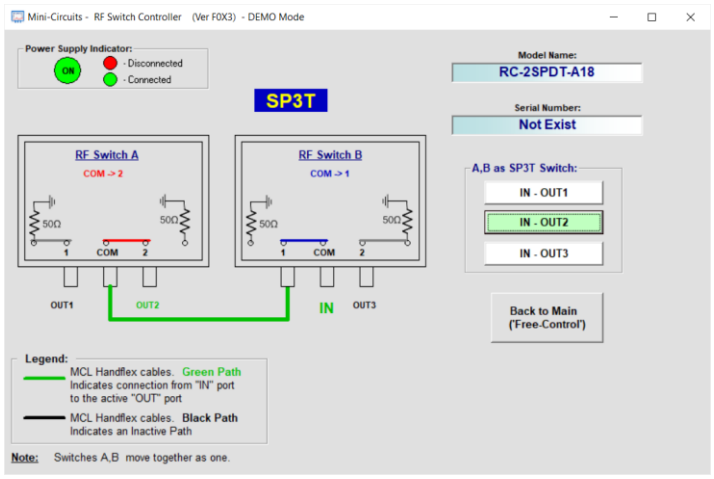
#	Item	Description
1	Current configuration	Summary of the MAC address of the device along with the IP configuration currently enabled (IP address, subnet mask and network gateway)
2	DHCP	Enables or disables DHCP. When unchecked, the user specified static IP configuration is active. Refer to the Default Ethernet Configuration section for details on the default DHCP operation.
3	Refresh	Click to display of the current Ethernet configuration
4	Copy DHCP	Copies the current IP address, subnet mask and network gateway to the static IP configuration section
5	Static IP	The fixed static IP address to be used when DHCP is disabled
6	Static mask	The fixed static subnet mask to be used when DHCP is disabled
7	Static gateway	The fixed static network gateway IP address to be used when DHCP is disabled
8	HTTP port	The TCP / IP port to be used for HTTP communication (default is port 80). Setting the HTTP port to 0 or 65535 will disable HTTP communication.
9	Telnet port	The TCP / IP port to be used for Telnet communication (default is port 23). Setting the Telnet port to 0 or 65535 will disable Telnet communication.
10	Password enable	When checked, a user specified password is required before Ethernet control is permitted. Applies to control from the GUI and the programming API.
11	Password	A user specified password to restrict Ethernet control.
12	Save button	Click to update any changes to the Ethernet configuration

5.10. Grouped Switch Configurations

The switch configuration options highlighted in position 11 on the switch control screen provide options to configure multiple switch components within the switch box into a larger system that can be switched together. A selection of larger switch configuration options will be presented, appropriate to the number and type of switch components present in the connected switch box.

An example with RC-2SPDT-A18 is presented below with the default control screen on the left showing the two SPDT switches within the box which can be controlled independently. Clicking the "Use as SP3T Switch" button will reload the GUI in the format presented on the right below.





The updated GUI shows an external cable connected between Com on switch A and port 1 on switch B. The user should make this physical connection on the front panel between the 2 switches. The remaining 3 ports across the 2 switch components can be used as the In, Out1, Out2 and Out3 ports of an SP3T switch.

The switch control buttons on the right-hand side of the GUI will change the states of both switches together so that they function as a single SP3T switch.

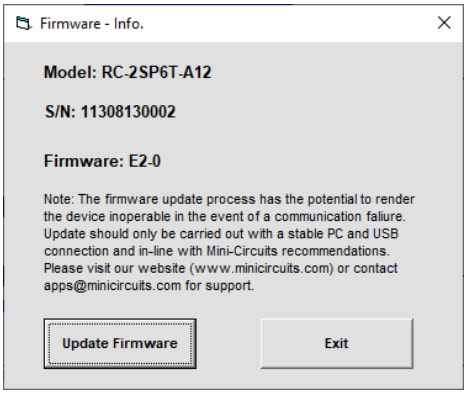
Click the "Back to Main" button to revert to the basic control screen for individual switch control.

5.11. Firmware Update

All Mini-Circuits products are shipped with the latest available firmware installed. Due to the nature of these products and the simple microcontroller structure used, Mini-Circuits does not anticipate a requirement for regular security updates. From time to time, new feature updates can be provided on request. Please contact testsolutions@minicircuits.com for details.

To view the latest firmware version installed on the device click the "(fw)" icon shown in position 3 on the switch control screen.

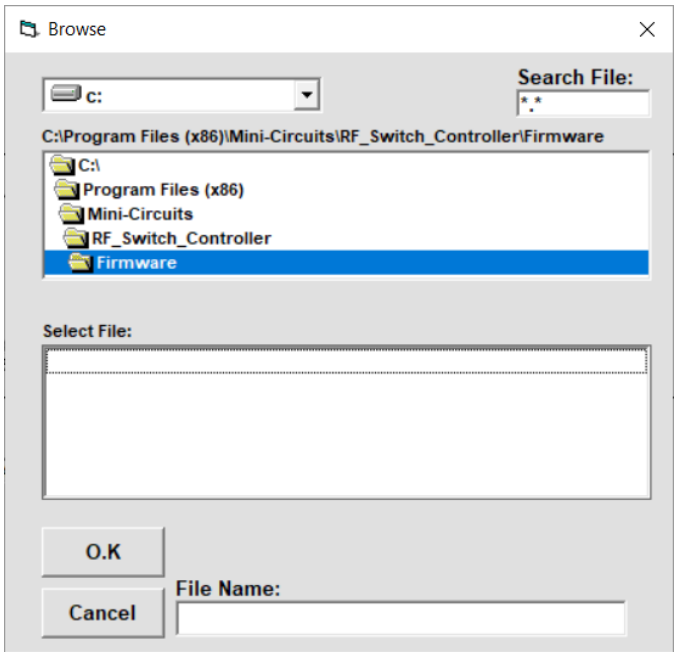
Note: This feature is only available when connected by USB.

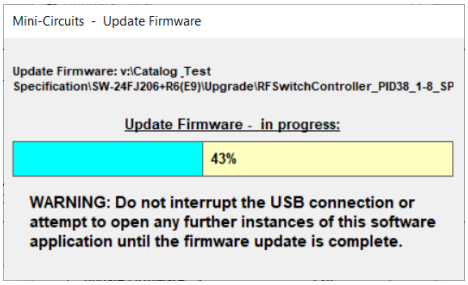


If a new firmware update has been provided by Mini-Circuits, please follow the steps below to install it.

Caution:
- Make sure only 1 Mini-Circuits device is connected to the PC by USB
- Do not interrupt the GUI, USB connection or power supply during the update as it could render the device inoperable

1. Download and unzip the provided firmware hex file to your PC
2. Click Update Firmware
3. Navigate to the downloaded firmware hex file to start the upload





4. The process should complete within 1 minute, at which point the GUI will restart

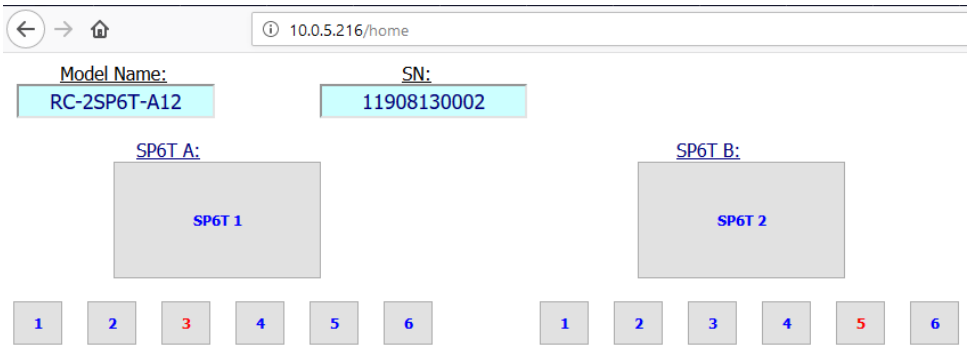
6. Web Browser Control (HTTP)

A limited set of options for control of the device is available using the web browser methods summarized below. For full control of the system, the Windows GUI or programming API are the recommended control methods.

6.1. Web Browser GUI

A basic GUI resides on the switch box's internal controller to provide a simple interface for control through a web browser. Once the switch box is connected to the network and the IP address is known, enter the URL into any web browser as http://ip_address/home, where ip_address is the IP address of your device.

The interface provides a simple control screen with identifications of the connected device and buttons to set and read each switch state.



6.2. Web Browser Programming Commands

The full range of ASCII / SCPI commands supported by the switch box can also be sent using a web browser. Refer to the programming manual for the complete list of commands / queries. To use this method, simply append the command to the IP address in the browser's address bar. The text response from the switch box will be displayed in the browser. Example commands are:

```
http://ip_address/:MN?    // Check model name of the switch box at ip_address
http://ip_address/:SN?    // Check serial number of the switch box at ip_address
```

7. Control Options for MacOS & Linux

Mini-Circuits is not able to provide formal software support (GUI & API) for MacOS & Linux but it is possible to control Mini-Circuits' Ethernet enabled devices without any software installation, from any operating system.

The key steps to get started would be as follows.

7.1. Connect & Identify Initial IP Address

For connection into a network supporting DHCP:

1. DHCP is enabled by default so an IP address should be assigned automatically when the device is connected to the network
2. Identify the assigned IP address by referring to the network administrator or router.
3. Alternatively, a broadcast query can be sent to the network using UDP so that all Mini-Circuits devices respond with their IP (refer to the programming manual)
4. Once identified, the dynamic IP can be used to connect and control the device, including to set a new static IP configuration if required

For a direct connection between the computer and Mini-Circuits device:

1. For devices with the latest firmware, a default "link-local" IP of 169.254.10.10 will be set if no response is received from a DHCP server (which will be the case for a direct computer connection)
2. It may be necessary to configure a complimentary IP address on the computer (see Direct Ethernet Cable Connection to PC)
3. This IP can be used to connect to the device and update the Ethernet configuration as needed

7.2. Updating the Ethernet Configuration

Once the initial IP address has been identified using the above steps, the device can be connected in order to set a new static IP address configuration. This can be achieved using Mini-Circuits' HTML configuration tool, details of which can be seen in Ethernet Configuration Tool.

With a valid IP address, the full list of ASCII / SCPI commands summarized in this programming manual can be used to control the device programmatically, or the web browser options details above can be used.

The fallback in the event of an unknown or invalid IP configuration would be to connect the device by USB in order to overwrite the configuration.

7.3. USB Control

Control of the device using USB control is possible by using the USB interrupt method summarized in the programming manual. No Mini-Circuits API is available for this method so it involves working directly with the USB HID API. This control method is not formerly supported by Mini-Circuits.

8. Contact

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