groov RIO® UNIVERSAL EDGE I/O

Features

- Powered by either Power over Ethernet (PoE) ***or*** 10-32 VDC power supply
- 10 channels of software-configurable inputs and outputs
- Analog I/O, temperature, discrete I/O, and mechanical relays
- Two switched Gigabit Ethernet network interfaces for wired networks; supports star or daisy-chain topologies
- CODESYS runtime engine to run control programs in any IEC 61131-3 compliant language (license required)
- Embedded web-based applications: *groov*® Manage, Node-RED, and MQTT; GRV-R7-MM2001-10 includes Ignition Edge®
- USB port for adding devices like Wi-Fi adapter or USB memory drive (user supplied)
- Built-in security with encryption and authentication

GRV-R7-MM1001-10, GRV-R7-MM2001-10

DESCRIPTION

Opto 22's *groov* RIO—remote Ethernet I/O for industrial internet of things (IIoT) and automation applications—solves two main problems with most remote I/O today:

- First, specifying all the required components (rack, power supply, bus coupler, module types, and more) is time-consuming, difficult, and requires significant domain expertise.
- Second, communicating data among field devices, control systems, company software, and cloud services is complex and costly, requiring PLCs, programming, and middleware.

groov RIO revolutionizes remote I/O by solving both problems.

- **One module.** A single module includes built-in, software-configurable I/O; an I/O processor; power over Ethernet; robust cybersecurity features; and mounting without the need for a rack or chassis—in a compact industrial package.
- **Built-in data and control processing.** Web-based configuration, Node-RED software, CODESYS runtime engine for IEC 61131-3 applications, and available SSH access for developing your own custom applications that run on the module.
- **Multiple communication options.** Data communication methods and protocols, including MQTT, Sparkplug, OPC UA, REST API, and Modbus to address any IIoT or automation application.

This data sheet covers *groov* RIO universal I/O modules. For a *groov* RIO module designed specifically for energy monitoring (*groov* RIO EMU), see the *groov RIO Energy Monitoring Unit Data Sheet*.

groov RIO is Edge I/O—and More

These features make *groov* RIO an advanced kind of I/O product: *edge I/O*. Edge I/O does not require an external PLC, PAC, or industrial PC, but is designed as an intelligent, distributed I/O device to meet the needs of IIoT projects, especially those that require data acquisition or communications.

If you need control capability, the on-board CODESYS runtime engine fully supports IEC 61131-3 application programs written in the programming language of your choice: structured text, ladder logic diagram, functional block diagram, and continuous or sequential function chart. Licensing for the CODESYS runtime engine is available separately (see GROOV-LIC-CRE-RIO or below).

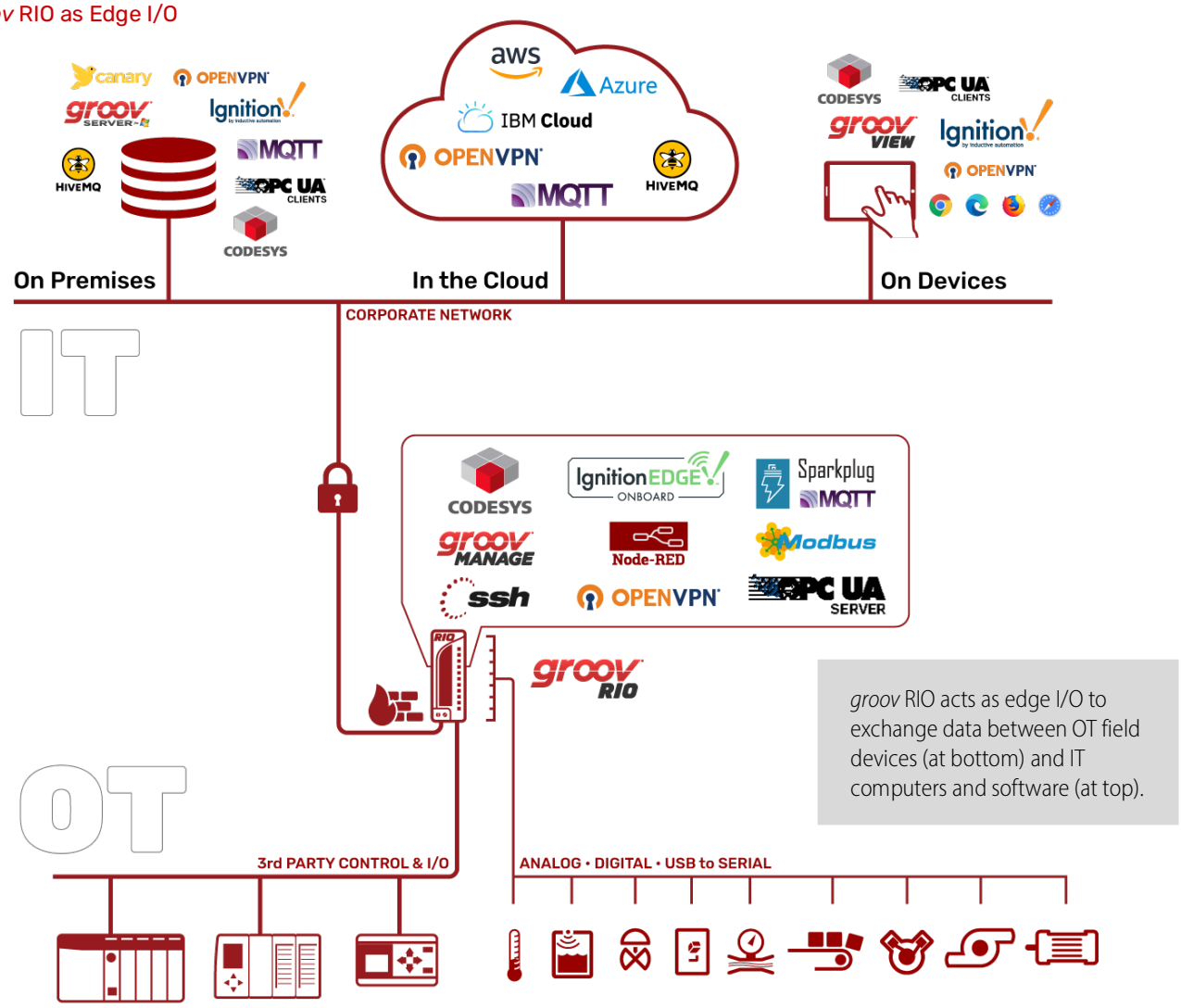
Part Number

Part	Description
GRV-R7-MM1001-10	*groov* RIO universal edge I/O; 8 multifunction, 2 form C electromechanical relay output channels
GRV-R7-MM2001-10	*groov* RIO universal edge I/O; 8 multifunction, 2 form C electromechanical relay output channels; Ignition Edge
GROOV-LIC-EDGE8	Activation key for Ignition Edge software, version 8.1 (only for GRV-R7-MM2001-10)
GROOV-LIC-SHELL	Activation key for secure shell access to Linux operating system
GROOV-LIC-CRE-RIO	Activation key for CODESYS Runtime Engine software on *groov* RIO modules

With *groov* RIO, you can:

- Place the module almost anywhere for remote I/O and data communications. *groov* RIO operates through a wide range of operating temperatures (-20 to 70 °C), is UL/cUL listed, and complies with the ATEX, Low Voltage, and EMC CE directives and UKCA directives.
- Supply power to *groov* RIO through one of the following:
  - The ETH1 network interface connected to a Power over Ethernet Switch and cable (802.3af PoE Class 0), ***or***
  - the power supply terminals connected to a 10–32 V DC power supply.
- Connect the two switched Gigabit Ethernet network interfaces in a daisy-chain configuration or in a standard star configuration. Both interfaces use a single IP address.
- Connect additional devices like a WiFi adapter, a USB memory stick (up to 32 GB), or a USB-to-serial adapter via the *groov* RIO's USB port (additional devices are user supplied).
- Simplify field connections using the 26-pin removable field I/O termination connector with spring clamp wire retention.
- Easily see the status of power, network, and I/O activity on the module's LEDs.
- Use embedded software to quickly set up data communications between field devices and on-premises or cloud-based systems and software.
- Run a control program you build using the CODESYS Development System—right there on your remote I/O.

groov RIO as Edge I/O



groov RIO acts as edge I/O to exchange data between OT field devices (at bottom) and IT computers and software (at top).

Get Up and Running Faster

groov RIO's single part number gives you everything you need for edge I/O, plus options. With Power over Ethernet, you can avoid the extra time and expense of routing power or adding a power supply dedicated to *groov* RIO. Just run a Category 5e or 6 Ethernet cable from a PoE-supplying network switch to ETH1—bringing power and networking over a single cable.

After you turn on your *groov* RIO, open a web browser on a computer or mobile device to connect to your RIO's IP address or hostname. *groov* Manage—a web app that gives you command center-like access to your *groov* RIO—opens so you can configure, troubleshoot, and commission built-in I/O, networking, and security.

Configure a Mix of I/O Channels

The GRV-R7-MM1001-10 and GRV-R7-MM2001-10 are 10-channel universal edge I/O modules supporting thousands of unique field I/O combinations. (How is this possible? Take a look at the wiring diagram on page 20 to see all the available features and input/output configurations or visit info.opto22.com/thousands.)

Through *groov* Manage, you can select a channel, configure its I/O signal, select any feature—such as counting, latching, clamping, and more—supported by the selected channel, and then save your configuration.

Exchange/Send Data Wherever You Like

groov RIO supports both OT and IT protocols and tools, making it easier to safely move data among field devices and computer networks, in some cases without requiring a PLC or middleware. Choose the method that works best for you:

Modbus TCP/IP master—*groov* RIO is a Modbus TCP slave out of the box. Use your favorite Modbus TCP master device or software to poll RIO's I/O channels. A Modbus TCP calculator is built into *groov* RIO's *groov* Manage application, helping you quickly find the Modbus Unit ID and register for a memory map area.

C++ or .NET and free SDKs—With your favorite development tool and our free SDKs, you can programmatically access I/O values on a *groov* RIO by accessing the OptoMMP memory map locations of each channel. An OptoMMP calculator is built into *groov* RIO's *groov* Manage, making it simple to identify the MMP addresses of I/O channels and their features.

HTTP/S, JSON, and REST APIs—The developer community has embraced REST APIs as a method of accessing I/O with HTTP/S and JSON. Opto 22 provides REST APIs for *groov* Manage, which you use to access the I/O values on a *groov* RIO module. A Swagger API document is built into *groov* RIO to quickly access REST API calls and evaluate responses.

MQTT broker/server—An efficient and robust publish/subscribe protocol, MQTT is an ideal method of exchanging data for industrial internet of things (IIoT) applications. *groov* RIO has support for MQTT built in, requiring only a simple configuration to publish I/O data and subscribe to commands as Sparkplug B or string payloads.

Node-RED—Create a data flow with the built-in Node-RED editor and runtime to send data to cloud services, databases, other I/O channels, and APIs through pre-built nodes. Even develop simple user interfaces (UIs) with Node-RED UI nodes and serve them directly from *groov* RIO to any mobile or web-based device.

groov RIO in a Control Program or SCADA

In addition to its use as autonomous edge I/O, *groov* RIO can also be used to expand the scope of existing control programs or industrial applications. You can add *groov* RIO modules to monitor, control, and collect data from field devices:

- **In a PAC Control™ strategy**—With PAC Project™ Basic or Professional Software Suite, add a *groov* RIO as an I/O unit, configure your I/O points, then download your strategy to a:
  - *groov* EPIC® processor running firmware version 2.0.0 or higher
  - SNAP PAC controller or SoftPAC running PAC Controller firmware 10.3 or higher (also requires PAC Project 10.3 or higher)
- **In a CODESYS® application**—Download and install the Opto 22 Library Package for CODESYS Development System, version 2.0.0.0 or later. If you plan to use *groov* RIO as a PLC, see below. Update your application and you'll be ready to add a *groov* RIO and configure I/O points.
- **In an Ignition SCADA**— Ignition Edge in GRV-R7-MM2001-10 connects to Allen-Bradley®, Siemens®, and Modbus®/TCP devices via OPC UA and offers efficient IIoT communications using MQTT with Sparkplug B payload (requires purchase of license GROOV-LIC-EDGE8).
- **In a custom control program**—You can access *groov* RIO I/O programmatically through OptoMMP or REST APIs.

groov RIO as a PLC

Automation control programming and configurable I/O in one box? It's possible with the on-board CODESYS runtime engine (requires purchase of GROOV-LIC-CRE-RIO). Download and install version 3.1.0.0 or later of the Opto 22 Library Package for CODESYS Development System to create applications that you can then download to your *groov* RIO. Running a control program, your *groov* RIO becomes a compact PLC, great when the local I/O monitoring footprint is small but your application requires access to remote I/O.

Independent PID Loop Control

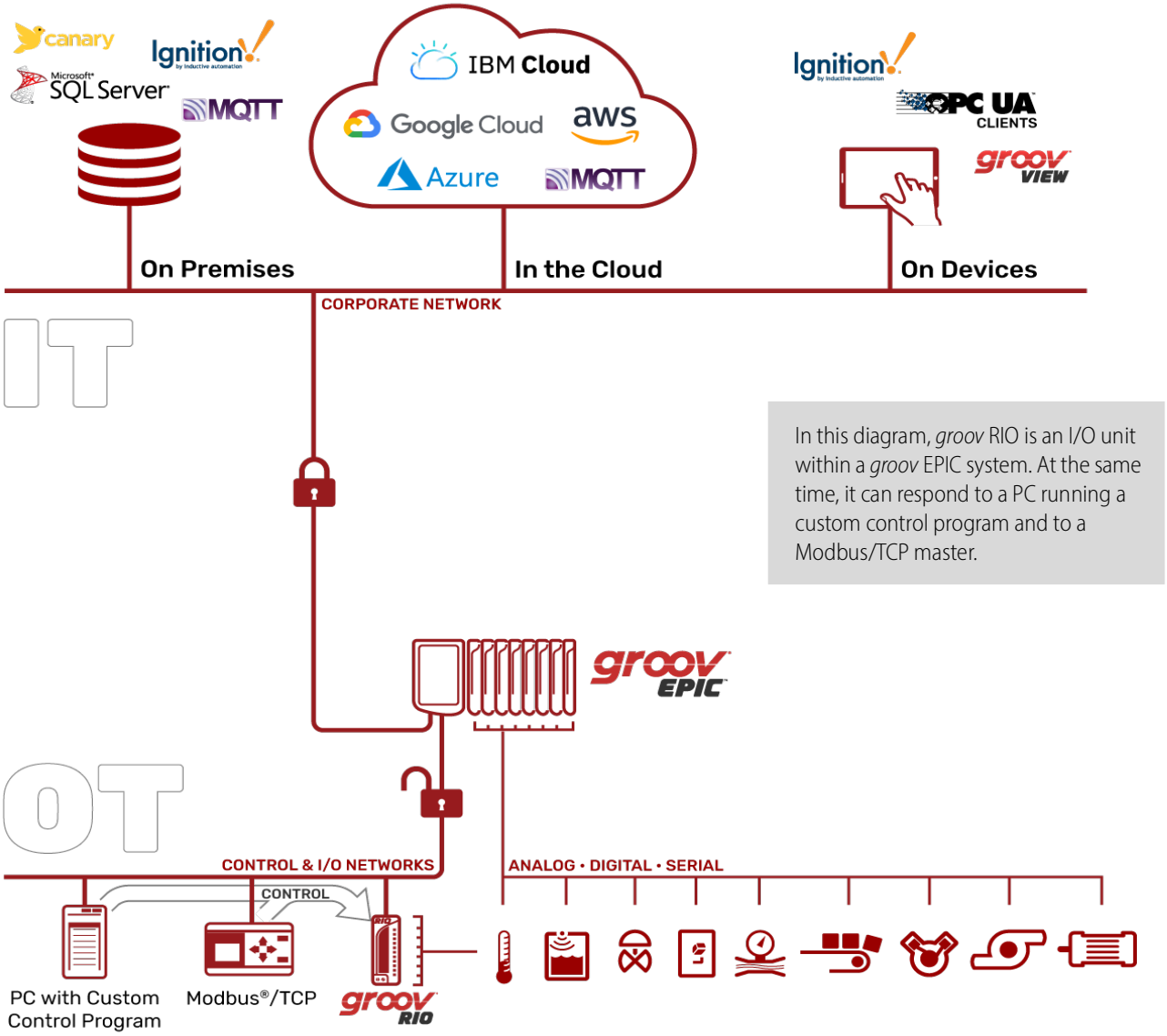
A *groov* RIO universal I/O module can independently solve PID loops when any analog output is configured as the Control Output (CO) of the loop. Up to four independent loops are supported, with configurable loop times.

Leverage Existing *groov* and SNAP PAC Knowledge

If you already have *groov* EPIC or SNAP PAC control systems, you can expand your I/O footprint with the addition of *groov* RIOs. *groov* RIO works as remote I/O with *groov* EPIC and SNAP PACs, and it uses many of the same principles and technologies found in your existing *groov* EPIC or SNAP PAC control system:

- *groov* Manage for I/O configuration and other tools to help manage your *groov* RIO
- MQTT to transmit Sparkplug or string payloads
- Node-RED for simple data flows
- OpenVPN client to connect to an OpenVPN server running a virtual private network
- PAC Control for programming and I/O configuration
- Distributed control—I/O features like counting, latching, totalization, and minimum & maximum values continue to run independently on *groov* RIO, even if communication to the controller is lost.

groov RIO in an Opto 22 Control System, also Responding to a Modbus/TCP Master and Custom Program



In this diagram, *groov* RIO is an I/O unit within a *groov* EPIC system. At the same time, it can respond to a PC running a custom control program and to a Modbus/TCP master.

Security

groov RIO provides several features to help keep your data secure.

User account management—*groov* RIO has no default username or password. You must set up the first Admin user account and remember its username and password, as these user credentials are secure and cannot be recovered. You can also locally create more users, set their passwords and permissions, and set global and individual user session timeouts.

Centralized user management—*groov* RIO can help you scale your control system by supporting user management through LDAP. Configure your *groov* RIOs to connect to your LDAP-compatible directory service, then your IT staff can manage users/groups from one spot. LDAP support can also help satisfy data integrity requirements in regulated industries.

VPN client—You can securely connect to *groov* RIO using a VPN. Support is provided for OpenVPN servers.

Configurable firewall—Configure the device (or host) firewall in *groov* RIO for greater security. You can control which ports, protocols, and interfaces are open for incoming connections to the services listening on each port number. For example, you should disable the ports of unused protocols.

Security certificate management—You have control over the Client and Server Security Certificates used with your *groov* RIO, from a self-signed certificate you can create on the module to a signed certificate from an internet-based Certificate Authority (CA). See the *groov* RIO EMU User's Guide (form 2372) for details.

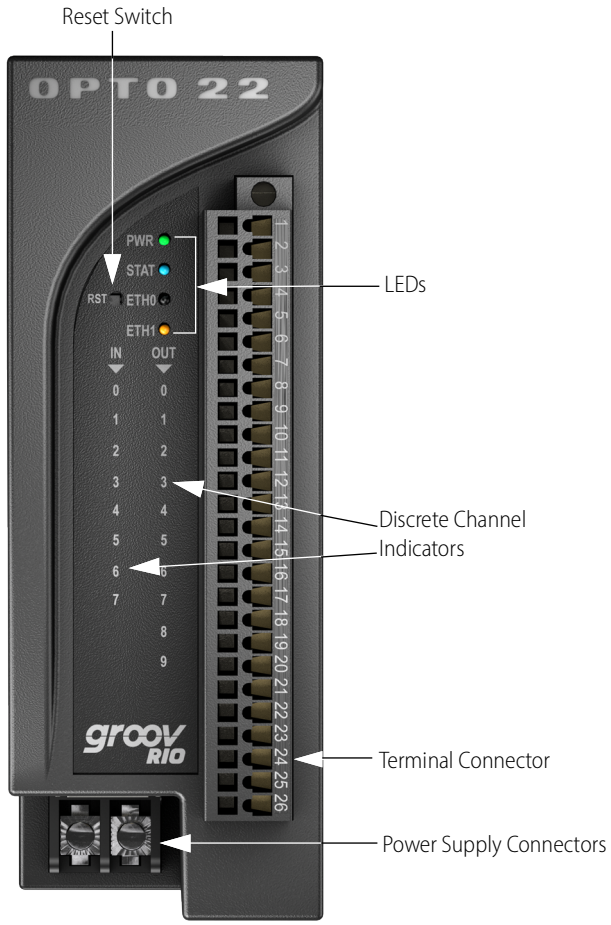
Need help? Try the *groov* RIO Explorer

It can sound overwhelming sifting through thousands of unique field I/O combinations, so we created an online app to help you select the right combination and correctly wire your field devices to your *groov* RIO: ***the groov RIO Explorer***.

With this web app, you can select which function you want on each channel, and then the app displays the corresponding wiring diagram. You can print out the wiring diagram or save it as an image for reference.

LEDs, NETWORK INTERFACES, PORTS, AND CONNECTORS

The LEDs, network interfaces, USB port, and connectors (terminal and power supply) on the *groov* RIO offer features to help you review the status and health of your *groov* RIO, as well as connect it to a power supply, a network, and field devices. For more information about these features and how to utilize them, see *groov* RIO Universal I/O User's Guide (form 2324).



Reset Switch

This switch reboots your *groov* RIO or can reset it to factory defaults, erasing all the changes you made to your module and setting the firmware to the version installed when it was shipped.

Discrete Channel Indicators

There are two columns of indicators on the face of *groov* RIO to indicate state for discrete channels:

- Input on the left.
- Output on the right.

When a channel is configured for discrete input or output, its corresponding indicator lights up when the channel is on.

LEDs

<table>
<tr><th>LED</th><th>Indicates</th></tr>
<tr><td>PWR</td><td>The status of power.
• Solid green—groov RIO is powered on.
• Solid red—groov RIO is restarting.</td></tr>
<tr><td>STAT</td><td>Indicates whether groov RIO is running or resetting.
• Solid green—groov RIO is running normally.
• Blinking green—groov RIO is starting (power on) or restarting (initiated by Reset button).
• Blinking between green and red—groov RIO is resetting to factory defaults.</td></tr>
<tr><td>ETH0, ETH1</td><td>Network connection speed and whether there is any transmission activity:
<table>
<tr><th>Color</th><th>Connection Speed</th><th>Transmission Activity</th></tr>
<tr><td>Solid green</td><td>1 Gbps</td><td>No</td></tr>
<tr><td>Blinking green</td><td>1 Gbps</td><td>Yes</td></tr>
<tr><td>Solid orange</td><td>10 or 100 Mbps</td><td>No</td></tr>
<tr><td>Blinking orange</td><td>10 or 100 Mbps</td><td>Yes</td></tr>
</table></td></tr>
</table>

Terminal Connector

The terminal connector provides a spring-clamp wiring system to securely connect the wires from your field deviceselectrical systems to *groov* RIO. To learn how to use the spring-clamp wiring system, see "Pinout and Wiring" on page 16.

The terminal connector for GRV-R7-MM1001-10 and GRV-R7-MM2001-10 is gray in color. This terminal connector is designed to accurately read thermocouple inputs. and energy If a terminal connector is black, all the pin numbers are labeled, and there are no other labels, then you can use that terminal connector on most *groov* I/O modules. For a list of which terminal connectors work with which *groov* I/O or *groov* RIO modules, see *groov* Accessories Data Sheet (form 2314).

Power Supply Connector

To supply power with an external power supply, Opto 22 recommends you follow these wiring guidelines:

- Use a 10 to 32 V DC power source or supply.
- Use wire size 22 to 14 AWG. Keep the wires as short as possible.

Note: *If you are using an external power supply, do* ***NOT*** *connect PoE; PoE cannot be used as an alternate power source.*

Power Supply Wiring Diagram

Before wiring the *groov* RIO to an external power supply, verify that your wiring cables conform to the requirements described above.

Network Ports

The Ethernet ports are part of an internal Ethernet switch, which means you can network *groov* RIOs in a daisy-chain configuration or in a standard star configuration using either Ethernet port. Both ports share the same IP address.

The network ports support speeds of up to 1 Gbps. Check that your Ethernet cable is rated for the speed of your network.

The **ETH1** port, when connected to Power Sourcing Equipment (PSE)—for example, a PoE switch—through a PoE-rated Ethernet cable, can power the *groov* RIO module. Opto 22 recommends you select a PSE that supports IEEE 802.3af and has sufficient power available for all the powered devices (PDs) connected to it.

Do not *supply power through PoE as an alternative or backup to powering through a separate external power supply. Supply power through an external power supply or PoE, but not both.*

USB Port

The USB port acts as a USB host device that can help you extend the capabilities of the *groov* RIO. You can connect a:

- WiFi adapter to add wireless connectivity.
- USB-to-serial adapter to read and write data to serial devices.
- USB memory stick to expand the storage space; for example, to increase data logging capacity.

The wireless interface WLAN0 (which becomes available when you plug in a WiFi adapter) does not provide access to other *groov* RIOs in a daisy-chain configuration because this interface has a separate IP address on a separate subnet.

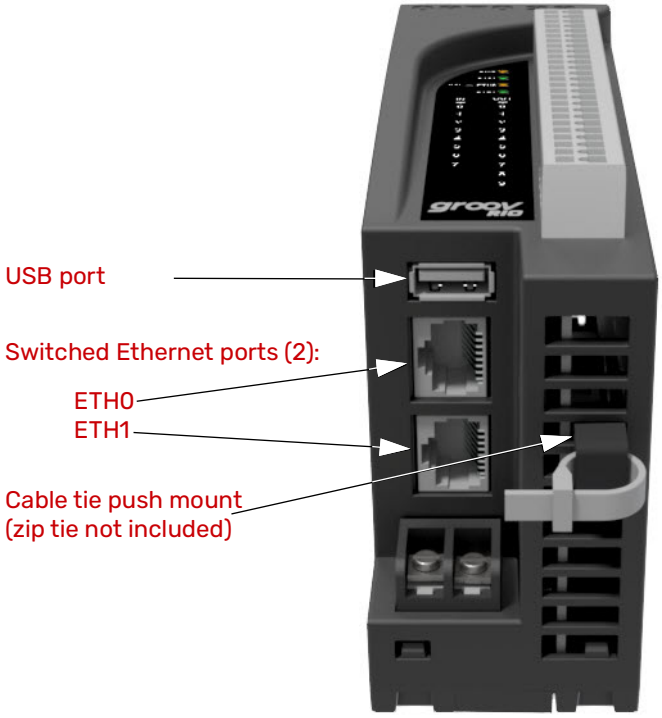
Wireless Connectivity

The following WiFi USB adapters have been tested and proven to be compatible with *groov* RIO:

Device Manufacturer	Model
ALFA	AWUS036ACS
Netgear	AC1200 (A6150)
Netis	WF2180 WF2190
Panda Wireless	PAU0A AC600 PAU0D AC1200
Linksys	AE6000
TP-Link	Archer T1U
Sabrent	AC600

Cable Tie Push Mounts (Optional Use)

Cable tie push-mounts can help you manage wires. Each *groov* RIO includes two user-installable cable tie push mounts that snap into a vent, providing a sturdy loop through which you can thread a zip tie (not included), and then bundle the wires together with the zip tie.



FEATURES AND SPECIFICATIONS

Features

The following table lists the features available for each signal type. Note that some signal types are available only on specific channels, as listed in the "Channels" row.

GRV-R7-MM1001-10 GRV-R7-MM2001-10	Signal Type						
	DI: • Discrete • Switch Input, Powered	**DI:** • Discrete • Switch Input, Powered	**DO:** • DC Sinking	**DO:** • Form C Mech. Relay	**AI:** • Voltage • ICTD • Thermistor • Resistor	**AI:** • Current • Thermocouple • Millivolt	**AO:** • Voltage • Current
Channels	**0-1**	**2-7**	**0-7**	**8-9**	**0-7**	**0-3**	**4-7**
Features							
On/off State	●	●	●	●			
On/off Latching	●						
Counting	●						
On/off Totalization	●						
Frequency Measurement	●						
Period Measurement	●						
Pulse Measurement	●						
Scaling					●	●	●
Offset and Gain					●	●	
Minimum/Maximum Values					●	●	
Average Filter Weight					●	●	
Simple Moving Average							
Analog Totalizing					●	●	
Output Pulsing / TPO			●				
Ramping							●
Clamping							●
Watchdog Timeout Value			●	●			●
Quality Indication					●	●	●

Specifications

The specifications are divided into two categories: common and by signal type. The common category (located at the bottom of the following table, page 14) lists the specifications that apply to all channels, regardless of the signal type you select. The by signal type category applies when the channel is configured for that particular signal type.

Specification	GRV-R7-MM1001-10 GRV-R7-MM2001-10
Voltage Input	
Available Channels	0–7
Input Range	0–10 V DC
Over-range Limit	0–11 V DC
Resolution	0.5 mV
Accuracy	±0.05% of range (±5 mV)
Gain Temperature Coefficient	30 ppm/°C
Offset Temperature Coefficient	15 ppm/°C
Input Impedance	> 425 kOhms
Data Refresh Time	550 ms
50 / 60 Hz rejection	> 90 dB
Current Input	
Available Channels	0–3
Input Range	0–20 mA, 4–20 mA
Over-range Limit	0.0–20.8 mA, 2.0–20.8 mA
Recommended Fuse	32–40 mA, Fast Acting (for example, Eaton S500-32-R)
Resolution	1.0 µA
Accuracy	±0.05% (±10 µA)
Gain Temperature Coefficient	30 ppm/°C
Offset Temperature Coefficient	15 ppm/°C
Input Voltage Drop (±10%)	0.9 V @ 4 mA, 2.0 V @ 20 mA, 25 °C
Equivalent Input Impedance (±10%)	225 Ohms @ 4 mA, 100 Ohms @ 20 mA, 25 °C
Data Refresh Time	550 ms
50 / 60 Hz rejection	> 90 dB

Specifications continued on next page.

Specification	GRV-R7-MM1001-10 GRV-R7-MM2001-10
ICTD Input	
Available Channels	0–7
Input Range with ICTD Probe	-40 to +100 °C
Resolution	0.04 °C
Accuracy with ICTD Probe	±1.0 °C (1.8 °F)
Gain Temperature Coefficient	30 ppm/°C
Offset Temperature Coefficient	60 ppm/°C
Data Refresh Time	550 ms
50 / 60 Hz rejection	> 90 dB
Thermocouple Input	
Available Channels	0–3 (see Note)
Nominal Input Range	-75 to +75 mV
Full Scale Range	-78 to +78 mV
Input Resolution	3 microvolts
Input Impedance	> 1 megohm
Data Refresh Time	550 ms
50 / 60 Hz rejection	> 90 dB
Thermocouple ITS90 Types	**± Accuracy / Resolution**
B: 90 °C to 1,820 °C	7 °C / 0.4 °C
E: -80 °C to 1,000 °C	2 °C / 0.1 °C
J: -100 °C to 1,200 °C	2 °C / 0.1 °C
K: -80 °C to 1,372 °C	2 °C / 0.1 °C
N: -100 °C to 1,300 °C	3 °C / 0.1 °C
R: 100 °C to 1,768 °C	7 °C / 0.3 °C
S: 100 °C to 1,768 °C	7 °C / 0.3 °C
T: -60 °C to 400 °C	3 °C / 0.1 °C
Note: To achieve the best thermocouple accuracy when also using current outputs or discrete outputs, always configure thermocouples on the lowest channel numbers and outputs on the highest channel numbers.	
Millivolt Input	
Available Channels	0–3
Input Ranges	±150 mV, ±75 mV, ±25 mV
Over-range Limits	±165.0 mV, ±78.0 mV, ±27.5 mV
Resolution	10 µV, 3 µV, 2 µV
Accuracy	±0.1% of Full Scale (±150 µV) ±0.1% of Full Scale (±75 µV) ±0.2% of Full Scale (±50 µV)
Input Impedance	> 1 MOhms
Data Refresh Time	550 ms
50 / 60 Hz rejection	> 90 dB

Specification	GRV-R7-MM1001-10 GRV-R7-MM2001-10
Thermistor Input (Requires firmware version 3.0.0 or later)	
Available Channels	0–7 (see Note)
Input Range (Ohm)	0-400 k
Accuracy (Ohm @ Range)	greater of 3 Ohm or 0.5%@0-25k, 400@25k–50k, 900@50k–75k, 1.5k@75k–100k, 5k@100k–200k, 20k@200k–400k
Gain Temperature Coefficient	500 ppm/°C
Resolution (Ohm @ Range)	0.5@0–1k, 1@1k–5k, 2@5k–10k, 5@10k–25k, 50@25k–100k, 200@100k–200k, 700@200k–400k
Power Dissipation @ Resistance (µW @ Ohm)	375@1k, 950@5k, 1075@10k, 875@25k, 600@50k, 450@75k, 350@100k, 200@200k, 100@400k
Predefined Thermistor Curves	**Accuracy (°C) @ Range (°C)**
2252	0.2 °C @ -40 °C to 70 °C 2.5 °C @ 70 °C to 150 °C
3K	0.2 °C @ -40 °C to 70 °C 2.5 °C @ 70 °C to 150 °C
10K type 2	0.75 °C @ -40 °C to -20 °C 0.2 °C @ -20 °C to 120 °C 0.6 °C @ 120 °C to 150 °C
10k type 3	0.5 °C @ -40 °C to -20 °C 0.3 °C @ -20 °C to 120 °C 0.6 °C @ 120 °C to 150 °C
Custom	depends on curve
Data Refresh Time	550 ms
Note: To achieve the best thermistor accuracy when also using current outputs, always configure thermistors on the lowest channel numbers and current outputs on the highest channel numbers.	
0–400 kOhm Input (Requires firmware version 3.0.0 or later)	
Available Channels	0–7 (see Note)
Input Range (Ohm)	0–400k
Accuracy (Ohm @ Range)	greater of 3 Ohm or 0.5%@0-25k, 400@25k–50k, 900@50k–75k, 1.5k@75k–100k, 5k@100k–200K, 20k@200k–400k
Gain Temperature Coefficient	500 ppm/°C
Resolution (Ohm @ Range)	0.5@0–1k, 1@1k–5k, 2@5k–10k, 5@10k–25k, 50@25k–100k, 200@100k–200k, 700@200k–400k
Power Dissipation @ Resistance (µW@Ohm)	375@1k, 950@5k, 1075@10k, 875@25k, 600@50k, 450@75k, 350@100k, 200@200k, 100@400k
Data Refresh Time	550 ms
Note: To achieve the best resistance accuracy when also using current outputs, always configure the 0-400 kOhm channel type on the lowest channel numbers and current outputs on the highest channel numbers.	

Specifications continued on next page.

Specification	GRV-R7-MM1001-10 GRV-R7-MM2001-10
Discrete DC Input	
Available Channels	0–7
Input Voltage Range	5–30 V DC
Minimum ON Voltage	5.0 V
Maximum OFF Voltage	1.5 V
Input Impedance	> 425 KOhms
Max. Input Frequency (50% square wave)	10000 Hz
Switch Input, Powered	
Available Channels	0–7
Open Circuit Voltage (Switch Open)	10.5 V (minimum)
Channel Current Limit	1.1 mA max.
Channel Operating Current	0.63 mA typical
Minimum Off Resistance	3300 Ohms
Maximum On Resistance	1200 Ohms
Minimum ON Voltage	5 V
Maximum OFF Voltage	1.5 V
Maximum Continuous Survivable Input Voltage	32 V
Input Impedance	> 425 KOhms
Max. Freq. (50% square wave)	10000 Hz
Discrete Counter Input	
Available Channels	0–1
Input Voltage Range	5–30 V DC
ON Threshold	5 V
OFF Threshold	1.5 V
Input Impedance	> 425 KOhms
Max. Frequency (50% square wave): State, Latches, Counter	10000 Hz
Max. Frequency (50% square wave): On/Off pulse width, Period, Frequency	2000 Hz
Max. Frequency (50% square wave): On/Off totalization	750 Hz
Pulse Width Measurement Resolution	100 microseconds
Pulse Width Measurement Error (50% square wave)	0.1% 0 to 20 Hz 1% 21 to 200 Hz 5% 201 to 2000 Hz
Period/Frequency Error (50% square wave)	0.05% 0 to 20 Hz 0.1% 21 to 200 Hz 1% 201 to 2000 Hz

Specification	GRV-R7-MM1001-10 GRV-R7-MM2001-10
Discrete DC Sinking Output	
Available Channels	0–7 (4-7 if using any thermocouple inputs)
Line Voltage Range	5–30 V DC
Maximum Continuous Current	1.0 A
Peak Current (< 10 ms)	4.0 A
Recommended Fuse / Circuit Breaker	1 A at 30 V DC
Output Voltage Drop	175 mV at 1 A
Off-State Leakage (per channel)	< 80 µA at 24 V, -20 to +70 °C
Peak Blocking Voltage	32 V
TPO Period (min, max, resolution)	0.004, 4294967, 0.001
Turn On / Off Time	20 ms nominal
Form C Relay Output	
Available Channels	8, 9
Line Voltage Range	0–250 V AC or 5–30 V DC
Clamp Voltage	440 V nominal
Current Rating	5 A per channel
Surge Current	6 A peak for 1 second
Recommended Fuse / Circuit Breaker	5 A at 250 V AC / > 30 V DC per channel
Initial Contact Resistance	< 100 milliohms
Turn On Time	8 ms
Turn Off Time	4 ms
Operating Life (to specification)	Min. 30,000 cycles at max. ratings
Mechanical Life	Min. 10,000,000 cycles
Voltage Output	
Available Channels	4–7
Range	0–10 V
Resolution	2.5 mV
Accuracy	±0.3% of range (±30 mV)
Gain Temperature Coefficient	50 ppm/°C
Offset Temperature Coefficient	20 ppm/°C
Output Slew Rate	> 15 V/ms
Minimum Load Resistance	7.5 kOhms
Output Impedance	< 10 Ohms
Short-circuit Current	20 mA
Data Refresh Time	Nominal 20 ms. Proportional to I/O scan time.

Specification	GRV-R7-MM1001-10 GRV-R7-MM2001-10
Current Output	
Available Channels	4–7
Output Range	0–20 mA
Resolution	5 µA
Accuracy	±0.325% of range (±65 µA)
Gain Temperature Coefficient	60 ppm/°C
Output Slew Rate	> 10 mA/ms
Maximum Loop Resistance	700 Ohms
Data Refresh Time	Nominal 20 ms. Proportional to I/O scan time.
Common Specifications	
Ethernet	Two switched Gigabit ports; Ethernet communication daisy-chainable. Supports Auto MDI-X (crossover cable not needed)
USB	One Port, USB 2.0 HS
Memory	**GRV-R7-MM1001-10:** 1 GB RAM, 4.0 GB disk space **GRV-R7-MM2001-10:** 2 GB RAM, 7.0 GB disk space
Power Supply	10–32 V DC***or***802.3af PoE Class 0 (ETH1)
Power Consumption	10 W
Max. Survivable Input (channels 0 - 7)	32 V DC
Isolation (between channels 0 - 7)	None
Isolation (between channel 8 or 9 and all others)	3000 V AC_{rms} 1 min.
Isolation (field to Ethernet / power input)	1500 V AC_{rms} 1 min.
Minimum *groov* RIO Firmware Version	**GRV-R7-MM1001-10:** N/A **GRV-R7-MM2001-10:** 3.0.0

Specifications continued on next page.

Specification	GRV-R7-MM1001-10 GRV-R7-MM2001-10
Minimum *groov* EPIC Firmware Version	**GRV-R7-MM1001-10:** 2.0.0 (3.0.0 for Thermistors) **GRV-R7-MM2001-10:** 3.0.0
Minimum PAC Project Version	**GRV-R7-MM1001-10:** 10.3000 (10.3003 for Thermistors) **GRV-R7-MM2001-10:** 10.3003
Minimum Library Package for CODESYS Version	**GRV-R7-MM1001-10:** 2.0.0.0 (2.0.1.0 for Thermistors) **GRV-R7-MM2001-10:** 2.0.1.0
Field Connector Wire Size	28–14 AWG
Torque, field connector screw	2.5 in-lb (0.28 N-m)
Power Connector Wire Size	22–14 AWG
Torque, DC power connector screws	7.0 in-lb (0.79 N-m)
Torque, panel mount tab screw	2.0 in-lb (0.23 N-m)
Temperature (operating)	-20 °C to +70 °C
Temperature (storage)	-40 °C to +85 °C
Relative Humidity (non-condensing)	5–95%
MTBF (minimum, 25 °C)	1.2 Mhrs
Agency Approvals	UL/cUL(Class 1 Div. 2); CE, ATEX(Category 3, Zone 2), RoHS; DFARS; CB Scheme; UKCA
Warranty	30 months

Wire Assignments

The following wire assignments apply to the thermocouple signal type:

Type	-	+	Range
B	Red	Gray	+90 °C to +1,820 °C
E	Red	Purple	-80 °C to +1,000 °C
J	Red	White	-100 °C to +1,200 °C
K	Red	Yellow	-80 °C to +1,372 °C
N	Red	Orange	-100 °C to +1,300 °C
R,S	Red	Black	100 °C to +1,768 °C
T	Red	Blue	-60 °C to +400 °C

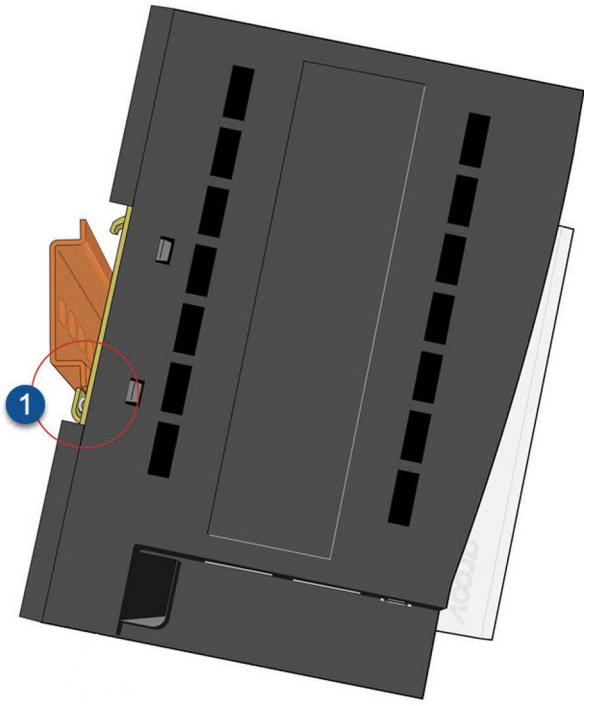
MOUNTING ON DIN RAIL

Before mounting your *groov* RIO:

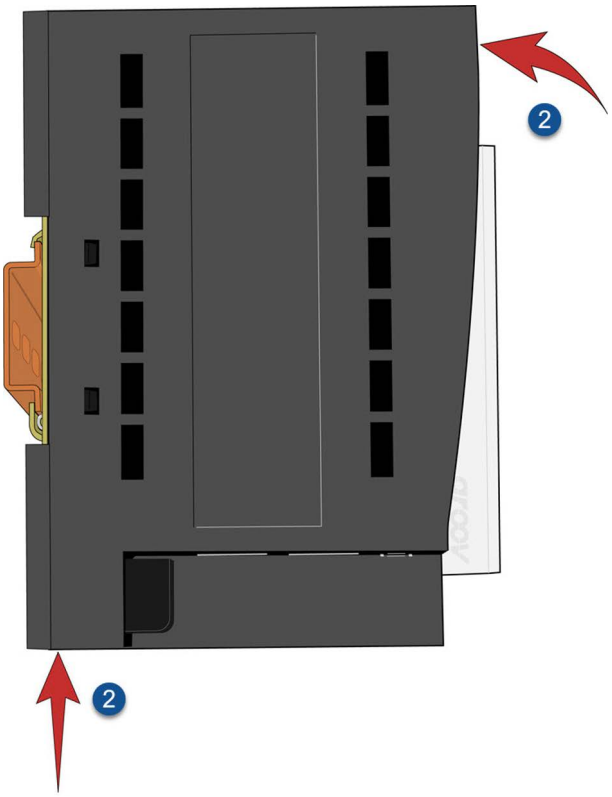
- Ensure that the vents around the module are not obstructed.
- Ensure that the mounting location meets the clearances described in "Orientation and Clearances".

The module is built with a DIN rail adapter for use on 35 mm DIN rail. No additional assembly is required.

1. Hold your module so that the Opto 22 logo is at the top and at an angle such that the top of the DIN rail adapter is away from the DIN rail and the bottom of the DIN rail adapter can slide behind the bottom lip of the DIN rail. See the circled area in the image below.

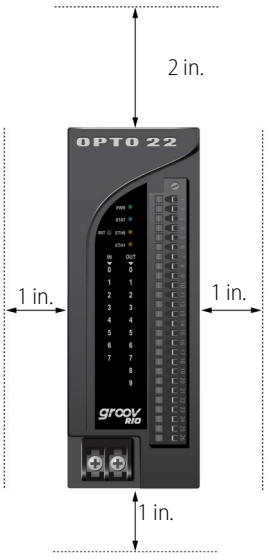


2. Push the bottom part of the module upward, making sure that you feel the clip catch on to the rail, and simultaneously push the top half of the module toward the DIN rail until the top of the DIN rail adapter engages the top lip of the DIN rail.



Before you release the module, verify that the top and bottom of the DIN rail adapters have engaged the DIN rail.

ORIENTATION AND CLEARANCES



Make sure that there is a minimum of 2 inches clearance on the top, and 1 inch clearance on the bottom, each side, and in front of RIO, after it is mounted. Mount RIO as shown in the diagram: with the Opto 22 logo at the top. Compliance with these guidelines helps ensure that *groov* RIO performs as described in the specifications.

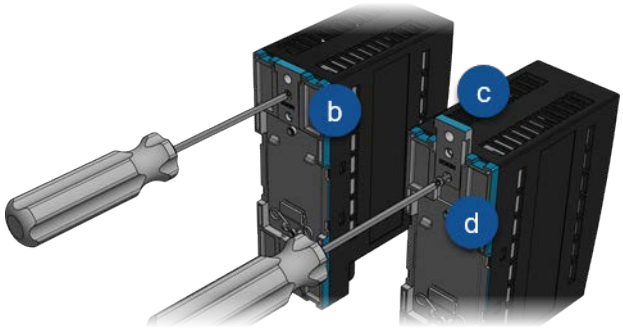
MOUNTING ON A PANEL

Before mounting your *groov* RIO on a panel:

- Ensure that the vents around the module are not obstructed.
- Review the clearance requirements described in "Orientation and Clearances" on page 16.

After checking these items, you can attach the module to a panel:

1. Extend and secure the tabs to expose the mounting holes on each tab:
   a. Turn the module so you can see the backside.



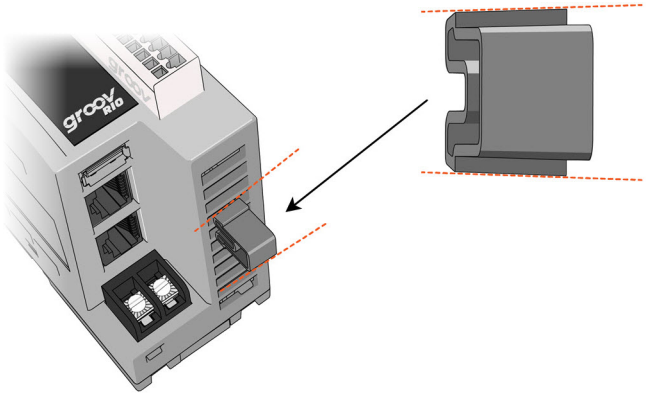
   b. With a small Phillips screwdriver, remove the tab-locking screw on one tab.
   c. Slide the tab out so the middle hole on the tab aligns with the screw hole on the module.
   d. Reinsert the tab-locking screw to the torque indicated for the panel mount tab screw in the specifications table on .
   e. Repeat steps b through d with the other tab.
2. Use the module as a template to mark where the holes should be drilled and tapped on the panel and verify placement before attaching the module.
3. Attach the module to the panel with screws (not provided):
   a. Tighten a screw into one tab *close* to the torque indicated for the panel mount tab screw in the specifications table on .
   b. Tighten another screw into the second tab *up to* the torque indicated for the panel mount tab screw.
   c. Return to the first screw and re-tighten the screw up to the torque indicated.

INSERTING A CABLE TIE PUSH MOUNT

Each *groov* RIO comes with two user-installable cable tie push mounts. You only need to insert one mount.

1. Identify the thin side of the mount, then position it over a vent so that the thin side faces the ports and is away from the PCB, which is visible through the vents (see image on page 7).
2. With one hand, hold the *groov* RIO down on a sturdy surface. With the other hand, push the mount in, beginning with the thin side. Push until you hear a loud click. Verify that the mount is securely inserted by gently pulling on it; it should not come out.

Thread a zip tie (not included) through the mount. Collect the wires into a bundle, wrap the zip tie around the bundle, then clip the excess zip tie.



PINOUT AND WIRING

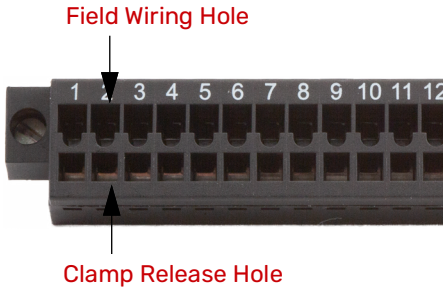
Before you begin wiring your field devices to your *groov* I/O module, make sure you select and prepare the appropriate wires and review how to use the spring clamps on terminal connectors:

Select and prepare the appropriate wire. The terminal connectors are rated for 28–14 AWG wire. Strip the wire according to the Wire Strip Length listed in the Common Specifications section of the Specifications table on page 9. If you're using stranded wire, twist or tin the strands or add ferrules to make it easier to insert the wire and create a stronger connection.

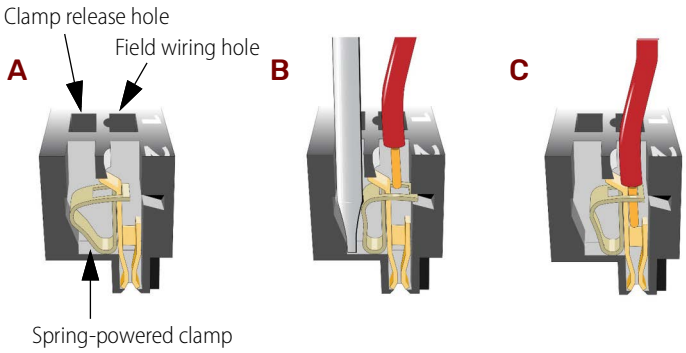
Use the right tool. To open the spring clamps, make sure to use either:

- a flathead screwdriver with a tip dimension of 2.5 mm x 0.4 mm, ***or***
- the *groov* spring-clamp terminal tool, typically supplied with a *groov* RIO module. You can order a replacement spring-clamp terminal tool on our website www.opto22.com. Search for GRV-TEX-SCTOOL.

Familiarize yourself with the spring clamps. On the terminal connector, each terminal number has a corresponding **clamp release hole** and **field wiring hole**.



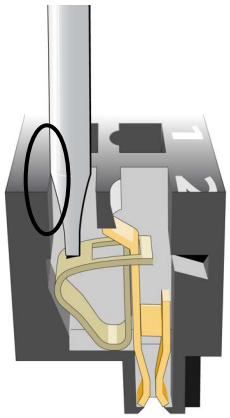
A spring-powered clamp sits between the clamp release hole and the field wiring hole (**A**). When you push the correct screwdriver (see above for dimensions) or the *groov* spring-clamp tool straight down into the clamp release hole, the diameter of the screwdriver or tool displaces the spring laterally, which exposes the hole through which you can insert the wire (**B**). When you pull the screwdriver or spring-clamp tool straight up, the spring returns to its original position, which causes the clamp to hold the wire. (**C**). You can view a video that explains how to wire your field devices and demonstrates how the spring clamp works on our website, www.opto22.com.



Inserting Wires

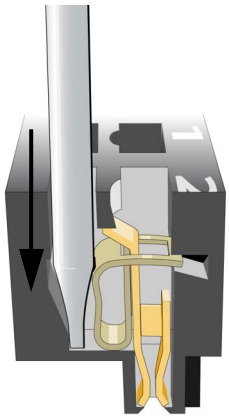
CAUTION: *For electrical safety, before starting, de-energize field devices wired to the terminal connector.*

1. Orient the module or terminal connector to match the wiring diagrams on .
2. To make it easier to handle the screwdriver or the spring-clamp terminal tool and the field wires, secure the module or terminal connector:
   - If you are working with the terminal connector while it is attached to the module, make sure the module is screwed securely to the DIN rail or panel.
   - If you are working only with the terminal connector, secure the terminal connector with a clamp.
3. Open the spring clamp:
   a. Insert the screwdriver or spring-clamp terminal tool into the clamp release hole, pressing the tool against the side of the hole furthest from the terminal numbers.



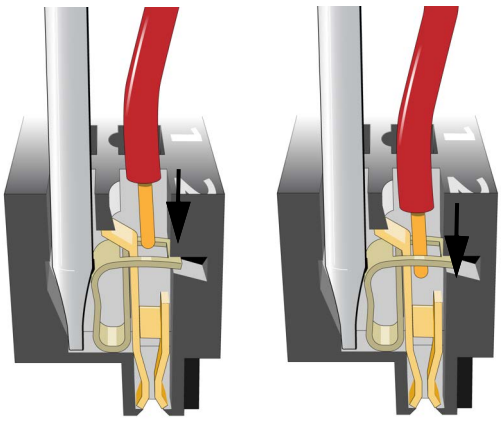
b. Press straight down firmly until you feel the screwdriver or tool reach the bottom.

Important: Let the shape of the tool, as it is pressed straight down, open the clamp. Do not rock or wiggle the tool because it may damage the clamp.

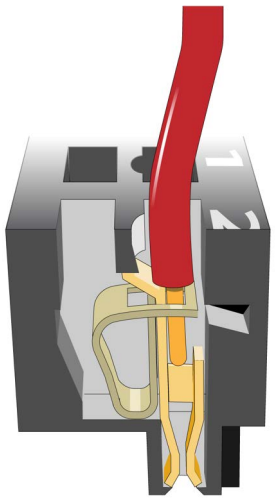


c. You can confirm that the clamp is open by looking into the field wiring hole.
   - If the hole is dark, the clamp is open. You can go to the next step.
   - If you see a shiny surface, repeat steps a through c. **Important:** Do not rock or wiggle the tool to try to open the clamp because it may damage the clamp.

4. Insert the wire into the field wiring hole.



5. Pull out the screwdriver or spring-clamp terminal tool. The spring returns to its original position and clamps down on the wire.

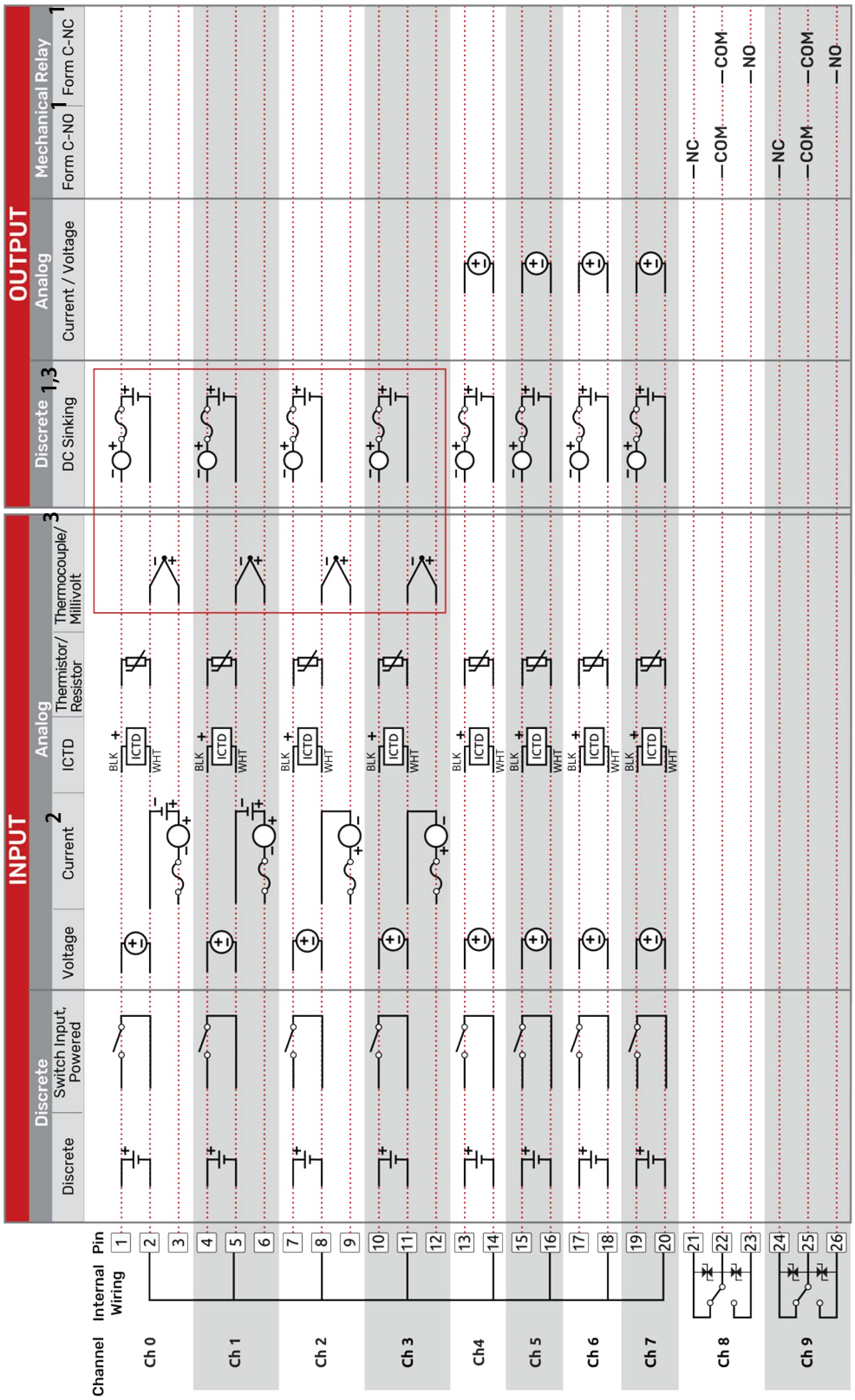


6. Test that the wire is secure by gently pulling on it. If the wire pulls out, repeat steps 3 and 4.

Removing Wires

1. Insert the screwdriver or spring-clamp terminal tool into the clamp release hole, pressing the tool against the side of the hole furthest from the terminal numbers.
2. Press straight down firmly until you feel the screwdriver or tool reach the bottom.
3. Pull the wire out.
4. Pull out the screwdriver or spring-clamp terminal tool. The spring returns to its original position.

WIRING DIAGRAM

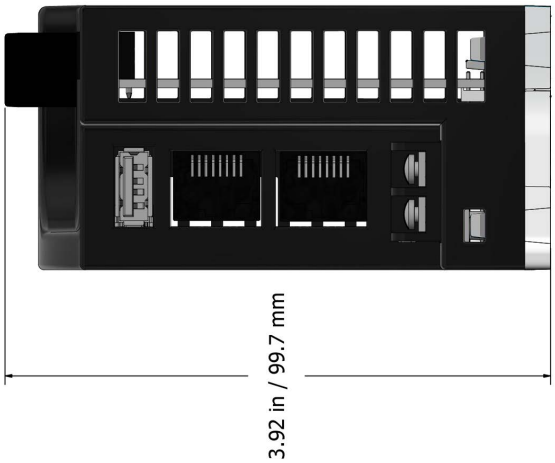


Notes:

1. You must supply external fusing.
2. Opto 22 recommends adding external fusing. Review the specification table for specific ratings. Compatible with an externally powered or self powered transmitter. Wiring for externally powered transmitter is shown on channels 0 and 1. Wiring for a self powered transmitter is shown on channels 2 and 3.
3. Thermocouple inputs and discrete sinking outputs cannot be mixed on channels 0-3.

DIMENSIONS: *groov* RIO

Depth

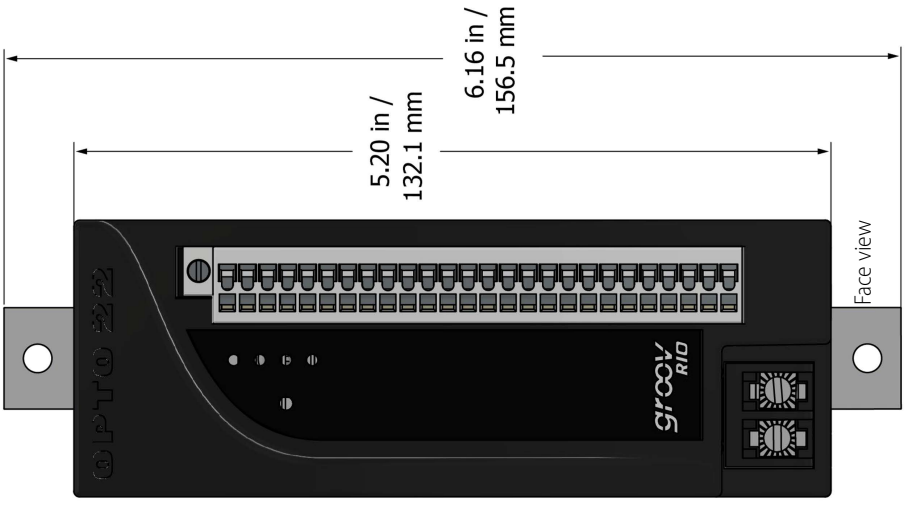


Width

Height

The image below shows the height in two settings:

- With the panel mounting tabs extended (the larger dimension).
- With the panel mounting tabs tucked in (the smaller dimension).



Note: *If you attach a cable tie mount, the bundle of wires you attach to the mount may exceed the height of the module with the panel mounting tabs extended.*

More about Opto 22

OPTO 22

PRODUCTS

Opto 22 develops and manufactures reliable, easy-to-use, open standards-based hardware and software products. Industrial automation, process control, remote monitoring, data acquisition, and industrial internet of things (IIoT) applications worldwide all rely on Opto 22.

groov RIO®

groov RIO edge I/O offers a single, compact, PoE-powered industrial package with web-based configuration and IIoT software built in, support for multiple OT and IT protocols, and security features like a device firewall, data encryption, and user account control.

Standing alone, *groov* RIO connects to sensors, equipment, and legacy systems, collecting and securely publishing data from field to cloud. Choose a universal I/O model with thousands of possible field I/O configurations, with or without Ignition from Inductive Automation®, or a RIO EMU energy monitoring unit that reports 64 energy data values from 3-phase loads up to 600 VAC, Delta or Wye.

You can even write an IEC 61131-3 compliant control program to run on *groov* RIO, using CODESYS. You can also use *groov* RIO with a Modbus/TCP master or as remote I/O for a *groov* EPIC system.

groov EPIC® System

Opto 22's *groov* Edge Programmable Industrial Controller (EPIC) system gives you industrially hardened control with a flexible Linux®-based processor with gateway functions, guaranteed-for-life I/O, and software for your automation and IIoT applications.

groov EPIC Processor

The heart of the system is the *groov* EPIC processor. It handles a wide range of digital, analog, and serial functions for data collection, remote monitoring, process control, and discrete and hybrid manufacturing.

In addition, the EPIC provides secure data communications among physical assets, control systems, software applications, and online services, both on premises and in the cloud. No industrial PC needed.

Configuring and troubleshooting I/O and networking is easier with the EPIC's integrated high-resolution color touchscreen. Authorized users can manage the system locally on the touchscreen, on a monitor connected via the HDMI or USB ports, or on a PC or mobile device with a web browser.

groov EPIC I/O

groov I/O connects locally to sensors and equipment. Modules have a spring-clamp terminal strip, integrated wireway, swing-away cover, and LEDs indicating module health and discrete channel status. *groov* I/O is hot swappable, UL Hazardous Locations approved, and ATEX compliant.

groov EPIC Software

The *groov* EPIC processor comes ready to run the software you need:

- Programming: Choose flowchart-based PAC Control, CODESYS Development System for IEC61131-3 compliant programs, or secure shell access (SSH) to the Linux OS for custom applications
- Node-RED for creating simple IIoT logic flows from pre-built nodes
- Efficient MQTT data communications with string or Sparkplug data formats
- Multiple OPC UA server options
- HMI: *groov* View to build your own HMI viewable on touchscreen, PCs, and mobile devices; PAC Display for a Windows HMI; Node-RED dashboard UI
- Ignition or Ignition Edge® from Inductive Automation (requires license purchase) with OPC-UA drivers to Allen-Bradley®, Siemens®, and other control systems, and MQTT communications

Older products

From solid state relays, to world-famous G4 and SNAP I/O, to SNAP PAC controllers, older Opto 22 products are still supported and working hard at thousands of installations worldwide. You can count on us for the reliability and service you expect, now and in the future.

QUALITY

Founded in 1974, Opto 22 has established a worldwide reputation for high-quality products. All are made in the U.S.A. at our manufacturing facility in Temecula, California.

Because we test each product twice before it leaves our factory rather than testing a sample of each batch, we can afford to guarantee most solid-state relays and optically isolated I/O modules for life.

FREE PRODUCT SUPPORT

Opto 22's California-based Product Support Group offers free technical support for Opto 22 products from engineers with decades of training and experience. Support is available in English and Spanish by phone or email, Monday–Friday, 7 a.m. to 5 p.m. PST.

Support is always available on our website, including free online training at OptoU, how-to videos, user's guides, the Opto 22 KnowledgeBase, and OptoForums.

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Opto 22 products are sold directly and through a worldwide network of distributors, partners, and system integrators. For more information, contact Opto 22 headquarters at **800-321-6786** (toll-free in the U.S. and Canada) or **+1-951-695-3000**, or visit our website at www.opto22.com.

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