

groov POWER MONITORING MODULE

Features

- Three-phase power monitoring
- Category III wye (up to 400 VAC; higher with potential transformer)
- Category III delta (up to 600 VAC)
- Compatible with 0.333 V, 1 V, or 5 A current transformers
- Measures AC RMS voltage and AC RMS current; provides power measurements and accumulated energy
- 64 channels of voltage, current, power, energy, and frequency data
- Module cover with LED indicates module status
- Touch-sensitive pad triggers display of module information on groov EPIC® processor's display
- Operating temperature: -20 to 70 °C
- UL Hazardous Locations approved and ATEX compliant



GRV-IVAPM-3

DESCRIPTION

groov I/O modules are part of the *groov EPIC*® (Edge Programmable Industrial Controller) system. Wired directly to field devices (sensors and actuators), *groov* I/O translates the electrical signals from those devices into the digital language computers understand—so you can monitor and control devices and use their data wherever you need it, in your local computer network or in cloud services.

The **GRV-IVAPM-3** is an analog input module that provides an efficient way to monitor AC voltage, current, power, and energy usage on Wye or Delta circuits up to UL 61010-3 measurement category III. It can monitor three-phase AC current using 0.333 V, 1 V, or 5 A current transformers (CT). If the module is part of a *groov* EPIC system running a PAC Control™ strategy, strategy logic can automatically perform additional calculations and take action to address any issues detected.

The module measures AC RMS voltage and AC RMS current for up to three phases. From the measured field inputs, the module automatically calculates additional channels of significant data, for a total of 64 data channels. Calculated data includes true, reactive and apparent power, power factor, frequency, net energy, and other values for each phase as well as combined totals for all phases. For more details, see "[Map of Channels to Measurements, Accumulations, and Summation Values](#)" on page 6.

Accumulated energy values are preserved in non-volatile memory every 30 seconds to survive across power interruptions to the *groov* EPIC control system.

This module can be configured to eliminate small signals from power measurement and energy accumulation (see "[Input Signal Filtering](#)" on page 2).

Each module comes with a top-mounted, removable terminal connector, which provides spring-clamp terminals for phase voltage and CT signals. The connector is held in place by a single, captive retention screw. The connector is uniquely keyed, preventing it from being plugged into any other type of module, a safety feature which prevents the connection of high voltage loads to any other module. You can order additional connectors from our website, www.opto22.com (search for part number **GRV-TERMPM13-5**).

With the terminal connector removed from the module:

- Module placement is simplified:
 - Mount the module to the chassis without interference by the wires.
 - Easily move the module from one slot to another.
 - Quickly replace the module with another module.
- Wiring is simplified:
 - Wire your signal wires in advance, saving time.
 - Preserve your wiring if you have to replace your existing GRV-IVAPM-3 with another GRV-IVAPM-3.

Important: If you are using a 5 A CT, **never** remove the terminal connector with power applied to the CT.

The module pivots into place and is held securely by a captive retention screw. *groov* I/O modules are hot swappable (which means

Part Numbers

Part	Description
GRV-IVAPM-3	Input, power monitoring, 3 phase, 600 V with 0.333 V, 1 V, or 5 A CT



they can be installed or removed without turning off power to the *groov* EPIC processor) and self-identifying—as soon as you mount the module to the chassis, it communicates to the processor and identifies itself.

A swinging, two-position cover protects wiring from inadvertent contact, as does the dead-front design. The two positions of the cover offer the option of more space to accommodate larger wire. The module cover provides a touch-sensitive pad; touch the pad and the *groov* EPIC processor displays information about the module, including specifications and a wiring diagram.

Each *groov* I/O module cover provides a large module LED to indicate module health at a glance.

Supported Configurations

The GRV-IVAPM-3 module supports the following configurations:

- 0–600 V_{rms} delta
- 0–520 V_{rms} delta
- 0–260 V_{rms} delta
- 0–400 V_{rms} wye
- 0–300 V_{rms} wye
- 0–150 V_{rms} wye

For wye configurations, higher voltages are supported with the addition of a potential transformer. For more details, see wiring diagram on [page 16](#).

Input Signal Filtering

Each phase can be configured to ignore small signals like leakage current and low voltage noise in power measurement and energy accumulation through the adjustment of three options: Minimum Voltage Threshold Ratio, Minimum Current Threshold Ratio, and Power Creep Adjustment.

Minimum Voltage Threshold Ratio

When the voltage falls below the Minimum Voltage threshold, the module sets all input values for the phase (except energy totals) to 0. Specify the value of the threshold ratio as a fraction (in decimal format) of the full-scale voltage. For example, if the full-scale voltage is set to 0–520 V_{rms} delta and the Minimum Voltage Threshold Ratio is set to 0.05, input values for the phase are set to 0 when the voltage measured on the phase drops below $(520 * 0.05) = 26$ V_{rms}. The default value is 0.0.

When you set the threshold ratio to 1.0, it disables the phase. All input values (except energy totals) for this phase are set to zero regardless of the measured voltage.

To specify the Minimum Voltage Threshold Ratio:

- For PAC Control users: follow the instructions in the "Voltage Type for All Phases" section of the [PAC Control User's Guide](#) (form 1700).

- For *groov* Manage users: follow the instructions in the "Setting Current and Voltage Thresholds" section of the [groov RIO EMU User's Guide](#) (form 2372).

Minimum Current Threshold

The minimum current below which all input values for a phase (except voltage, frequency, and energy totals) are set to 0. This value is specified in units of RMS amps (A_{rms}). The default value is 0.

Power Creep Adjustment

The power threshold below which all measured values for the phase are set to zero (except V_{rms}, I_{rms}, frequency, and energy totals.) This threshold is specified as percent of full-scale apparent power (full-scale V_{rms}) * (full-scale I_{rms}). The default value is 0.0%.

For example, to set all power values for this phase to zero when the power drops below 10%, specify a value of 10.0. If the full-scale voltage is set to 0–300 V_{rms} wye and the full-scale current is set to 50 A_{rms}, all values for this phase are set to zero when apparent power is below $300 \text{ V}_{\text{rms}} * 50 \text{ A}_{\text{rms}} * 0.1 = 1500 \text{ VA}$.

POWER MEASUREMENTS, ENERGY ACCUMULATIONS, AND SUMMATIONS

The GRV-IVAPM-3 module measures & calculates data (power) values and accumulates energy values for each phase that it monitors. It also sums all of those values into totals called summation values. All these values are provided through 64 channels:

- **Measurement values** are provided through channels 0 & 1 for phase A, 18 & 19 for phase B, and 36 & 37 for phase C:
 - Channels 0, 18, & 36 measure V_{rms}.
 - Channels 1, 19, & 37 measure I_{rms}.
- **Data (power) values** are provided through channels 2-12 for phase A, 20-30 for phase B, and 38-48 for phase C. For each phase, the module provides:

– True Power	– Power Factor
– Reactive Power	– Peak Voltage
– Apparent Power	– Peak Current
– Harmonic True Power	– Frequency
– True Power at Fundamental Frequency	
– Average Reactive Power	
– Reactive Power at Fundamental Frequency	
- **Accumulated energy values** for Net, Positive, Negative, Net Reactive, and Apparent energy are provided through channels 13-17 for phase A, 31-35 for phase B, and 49-53 for phase C.

- **Summation values** for True, Reactive, Apparent, Net, Unsigned, Positive, Negative, Net Reactive, and Apparent energy are provided through channels 54-62.
- **Average power factor** is provided through channel 63.

The "Map of Channels to Measurements, Accumulations, and Summation Values" on page 6 outlines which channel provides each of these values and describes the formulas it uses for calculations.

The accumulated and summation values are stored to non-volatile memory every 30 seconds.

Data Types Available to Read or Write Accumulation and Summation Values

The following channels provide accumulation and summation values:

Channels	Phase
13-17	A
31-35	B
49-53	C
57-62	Totals for All Phases

The module provides read, write, and read & clear operations to these channels; each operation supports specific data type(s).

Reading Accumulation and Summation Values

The read operation reads the units as either kWh or mWh, depending on the data type:

- **32-bit IEEE floating-point:** kWh (or kvarh or kVAh).

This value rolls over at 9,223,372,013,568.0 to -9,223,372,013,568.0 due to the characteristics of the signed 64-bit integer from which it is calculated.

Note: *With this data type, you lose precision as the magnitude of the value increases. This is due to the properties of the 32-bit IEEE floating-point data type. (For an explanation of working with 32-bit IEEE floating-point, see Using IEEE Floats in OPTO 22 Products, form 2386.) If your application requires greater precision, use the 64-bit signed integer.*

In a PAC Control strategy, you can read these 32-bit IEEE floating point values with the Move command.

- **32-bit signed integer:** mWh (or mvarh or mVAh).

This value rolls over at 2,147,483,647 to -2,147,483,648.

In a PAC Control strategy, you can read these 32-bit signed integer point values with the Get Counter command.

Note: *Support for 32-bit signed integer with the Get Counter command requires PAC Control R10.5a and the following firmware: groov EPIC firmware version 3.5.0 or SNAP PAC firmware version 10.5a, as appropriate for your application.*

- **64-bit signed integer:** mWh (or mvarh or mVAh).

This value rolls over at 9,223,372,036,854,775,807 to -9,223,372,036,854,775,808.

In a PAC Control strategy, you can read these 64-bit signed integer values with the Get Counter 64 command.

Writing Accumulation and Summation Values

The write operation stores the value to non-volatile memory immediately. The operation requires that the value be specified as a **64-bit signed integer**.

In a PAC Control strategy, you can write these 64-bit signed integer values with the Set Counter 64 command.

Reading and Clearing Accumulation and Summation Values With One Operation

The read-and-clear operation reads the value as units of mWh (or mvarh or mVAh) and sets it to zero in a manner that prevents the loss of summation values during the operation. The operation stores the cleared value into non-volatile memory immediately. The operation requires that the value be specified as a **64-bit signed integer**.

In a PAC Control strategy, you can read and clear the values as 64-bit signed integers with the Get & Clear Counter 64 command.

FEATURES AND SPECIFICATIONS

Specifications are listed on the next page.

Features

Features	GRV-IVAPM-3
Number of Data Channels	64
Channel-to-Channel Isolation	
Analog Totalizing	●
Average Filter Weight	●
Minimum/Maximum Values	●
Offset and Gain	N/A
Quality Indication ^a	●
Scaling	●
Simple Moving Average	N/A

a. The Quality Indication feature enables a channel to provide a numerical code that describes a characteristic of the signal entering or leaving the channel. For a list of numerical codes and what characteristic they describe, see .

Quality Indication

The following table lists the quality codes the indicated signal type(s) may report.

Code	Reportable by
5	Any channel configured for I_{rms} , V_{rms} , or True Power
8	Any channel configured for I_{rms} , V_{rms} , or True Power
15	Any channel configured for I_{rms} or V_{rms}

Analog input above operating limits.

Module failed communication with isolated field circuitry like analog to digital and digital to analog converters.

Analog input is 10% above the highest range. Applicable to unipolar (zero and positive values only) and bipolar (can include negative and positive values) signal ranges.

• A channel on a GRV-IVAPM-3 module is configured for 0–5 A_{rms} and the field signal is actually 5.5 A_{rms} .

To determine the highest range value, see the specification table.

Specifications

Specification	GRV-IVAPM-3
Maximum UL61010-3 Measurement Category	Category III 600 VAC
Delta Voltage Input Ranges, V_{rms}	600, 520, 260 (Line-to-Line)
Wye Voltage Input Ranges, V_{rms}	400, 300, 150 (Line-to-Neutral; higher voltages require use of a potential transformer)
Voltage Accuracy (% of range @ 50-60 Hz, excluding voltage transformer)	Wye: $\pm 0.35\%$, Delta: $\pm 0.5\%$
Current Transformer (CT) Outputs Supported	5.0 A, 1.0 VAC or 0.3333 VAC
Current Accuracy (% of CT range @ 50-60 Hz, excluding current transformer)	$\pm 0.5\%$
Power Accuracy (% of (V_{rms} range) * (CT current rating), @ 50-60Hz)	$\pm 0.5\%$
Data Refresh Time	1 s
Step Response Time	1 s
Quality Indications	V_{rms} out of range, I_{rms} out of range
Isolation (field-to-logic)	3600 VAC working, 5400 VAC transient
Isolation (channel-to-channel)	N/A
Number of Data Channels	64
Chassis Power Consumption	1.1 W
Minimum groov EPIC Firmware Version	3.3.0
Minimum PAC Project Version	10.4000
Minimum Library Package for CODESYS Version	2.0.4.0
Wire Size	28–14 AWG
Wire Strip Length	0.315–0.354 inches (8–9 mm)
Torque, connector screw	2.5 in-lb (0.28 N-m)
Torque, hold-down screw	3.5 in-lb (0.4 N-m)
Temperature (operating)	-20 °C to +70 °C
Temperature (storage)	-40 °C to +85 °C
Relative Humidity (non-condensing)	5–95%
Agency Approvals	UL/cUL (Class 1, Div 2) ^a ; CE: ATEX (Category 3, Zone 2) and RoHS; DFARS; CB Scheme; UKCA
Warranty	Lifetime

a. For use in hazardous locations, equipment must be mounted in an enclosure that meets the requirements of the National Electrical Code, ANSI/NFPA 70, and ANSI/ISA-61010-1 (82.02.01).

MAP OF CHANNELS TO MEASUREMENTS, ACCUMULATIONS, AND SUMMATION VALUES

Ch	Phase	Description	Details
0	A	V_{rms}	Root-mean-square voltage for the phase in units of V_{rms} , measured relative to the neutral terminal, calculated once per second from 4000 samples. (Review equation to the right.) This value is always positive. This channel can be configured with one of the following channel types: <ul style="list-style-type: none"> • 0–600 V_{rms} delta • 0–520 V_{rms} delta • 0–260 V_{rms} delta • 0–400 V_{rms} wye • 0–300 V_{rms} wye • 0–150 V_{rms} wye For wye configurations, higher voltages are supported with the addition of a potential transformer. Review wiring diagram on page 16 on page 109.
1	A	I_{rms}	Root-mean-square current for the phase in units of A_{rms} , calculated once per second from 4000 samples. (Review equation to the right.) This value is always positive. This channel can be configured with one of the following channel types: <ul style="list-style-type: none"> • 0–5 A_{rms} CT • 0–1 V_{rms} CT • 0–0.333 V_{rms} CT.
2	A	True Power	True (or real or active) power for the phase in units of W, calculated once per second from 4000 samples of instant power. (Review equation to the right.) This value can be positive or negative. $P = \frac{\sum_{n=1}^{4000} V_i \times I_i}{4000}$
3	A	Reactive Power	Reactive power for the phase in units of var. This value is calculated once per second from the square root of the apparent power squared minus the true power squared. (Review equation to the right.) This value is always positive. $Q = \sqrt{(S^2 - P^2)}$
4	A	Apparent Power	Apparent power for the phase in units of VA, calculated once per second from V_{rms} times I_{rms} . (Review equation to the right.) This value is always positive. $S = V_{rms} \times I_{rms}$
5	A	Power Factor	Ratio of true power to apparent power for the phase, calculated once per second. (Review equation to the right.) This ratio is always between -1.0 and 1.0. $\text{Power Factor} = \frac{P}{S}$
6	A	Peak Voltage	Instantaneous peak voltage over the last second for the phase in units of V. This value can be positive or negative.
7	A	Peak Current	Instantaneous peak current over the last second for the phase in units of A. This value can be positive or negative.
8	A	Frequency	AC line frequency for the phase in units of Hz. This value is updated once per second and is always positive.
9	A	True Power at Fundamental Frequency	True (or real or active) power at the fundamental frequency for the phase in units of W, calculated once per second from a discrete Fourier transform at the fundamental frequency on the voltage and current and multiplying the result. This value can be positive or negative.

Ch	Phase	Description	Details
10	A	Harmonic True Power	True (or real or active) power in the harmonics for the phase in units of W, calculated once per second by subtracting true power at the fundamental frequency from true power. This value can be positive or negative.
11	A	Reactive Power at Fundamental Frequency	Reactive power at the fundamental frequency for the phase in units of var, calculated once per second from a discrete Fourier transform at the fundamental frequency on the voltage and current and multiplying the result. This value can be positive or negative.
12	A	Average Reactive Power	Reactive power for the phase in units of var. This value is updated once per second from the average of 4000 samples of the product of the voltage, shifted 90 degrees, and the current. (Review equation to the right.) This value can be positive (due to a capacitive load) or negative (due to an inductive load). $Q_{avg} = \frac{\sum_{n=1}^{4000} V_{Q_n} \times I_n}{4000}$
13	A	Net Energy	Net energy for the phase, accumulated by adding true power once per second to a signed 64-bit integer in units of mWh. This value can be positive or negative and is stored to non-volatile memory every 30 seconds. This value can be read in three different formats: 32-bit IEEE float in units of kWh, 64-bit signed integer in units of mWh, and 32-bit signed integer in units of mWh. For more details, review "Data Types Available to Read or Write Accumulation and Summation Values" on page 3 .
14	A	Positive Energy	Positive energy for the phase, accumulated by adding true power, if it is positive, once per second to a signed 64-bit integer in units of mWh. This value can be positive or negative and is stored to non-volatile memory every 30 seconds. This value can be read in three different formats: 32-bit IEEE float in units of kWh, 64-bit signed integer in units of mWh, and 32-bit signed integer in units of mWh. For more details, review "Data Types Available to Read or Write Accumulation and Summation Values" on page 3 .
15	A	Negative Energy	Negative energy for the phase, accumulated by adding true power, if it is negative, once per second to a signed 64-bit integer in units of mWh. This value can be positive or negative and is stored to non-volatile memory every 30 seconds. This value can be read in three different formats: 32-bit IEEE float in units of kWh, 64-bit signed integer in units of mWh, and 32-bit signed integer in units of mWh. For more details, review "Data Types Available to Read or Write Accumulation and Summation Values" on page 3 .
16	A	Net Reactive Energy	Net reactive energy for the phase, accumulated by adding reactive power once per second to a signed 64-bit integer in units of mvarh. This value can be positive or negative and is stored to non-volatile memory every 30 seconds. This value can be read in three different formats: 32-bit IEEE float in units of kvarh, 64-bit signed integer in units of mvarh, and 32-bit signed integer in units of mvarh. For more details, review "Data Types Available to Read or Write Accumulation and Summation Values" on page 3 .
17	A	Apparent Energy	Apparent energy for the phase, accumulated by adding reactive power once per second to a signed 64-bit integer in units of mVAh. This value can be positive or negative and is stored to non-volatile memory every 30 seconds. This value can be read in three different formats: 32-bit IEEE float in units of kVAh, 64-bit signed integer in units of mVAh, and 32-bit signed integer in units of mVAh. For more details, review "Data Types Available to Read or Write Accumulation and Summation Values" on page 3 .
18	B	V_{rms}	For details, see channel 0
19	B	I_{rms}	For details, see channel 1
20	B	True Power	For details, see channel 2
21	B	Reactive Power	For details, see channel 3
22	B	Apparent Power	For details, see channel 4

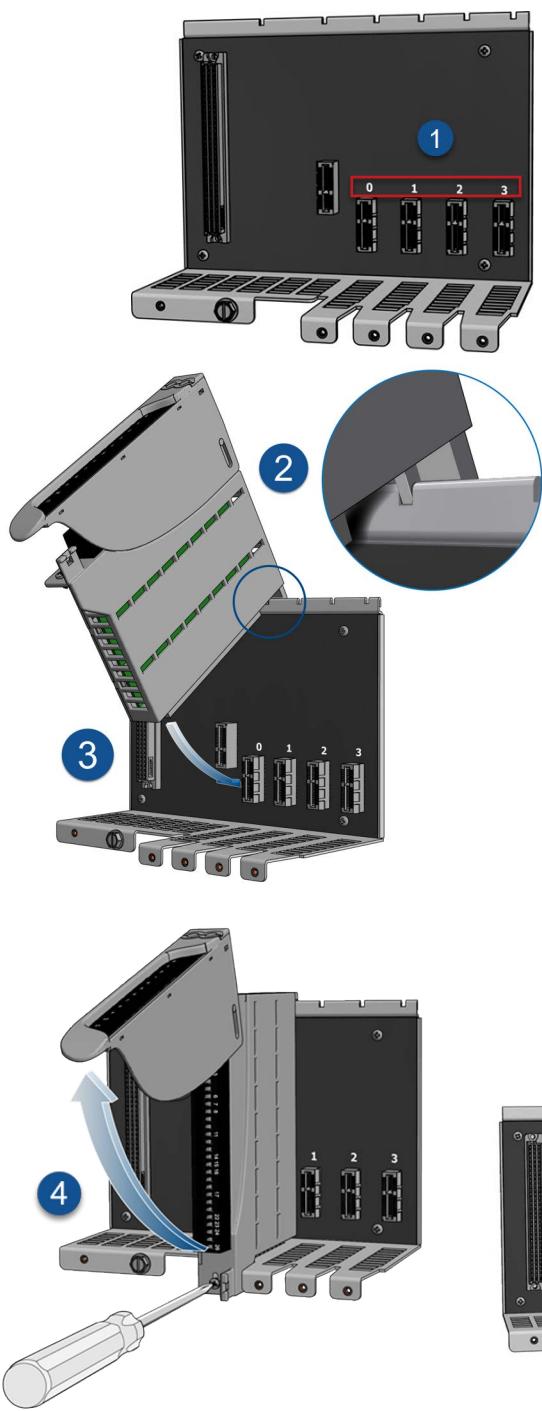
Ch	Phase	Description	Details
23	B	Power Factor	For details, see channel 5
24	B	Peak Voltage	For details, see channel 6
25	B	Peak Current	For details, see channel 7
26	B	Frequency	For details, see channel 8
27	B	True Power at Fundamental Frequency	For details, see channel 9
28	B	Harmonic True Power	For details, see channel 10
29	B	Reactive Power at Fundamental Frequency	For details, see channel 11
30	B	Average Reactive Power	For details, see channel 12
31	B	Net Energy	For details, see channel 13
32	B	Positive Energy	For details, see channel 14
33	B	Negative Energy	For details, see channel 15
34	B	Net Reactive Energy	For details, see channel 16
35	B	Apparent Energy	For details, see channel 17
36	C	V_{rms}	For details, see channel 0
37	C	I_{rms}	For details, see channel 1
38	C	True Power	For details, see channel 2
39	C	Reactive Power	For details, see channel 3
40	C	Apparent Power	For details, see channel 4
41	C	Power Factor	For details, see channel 5
42	C	Peak Voltage	For details, see channel 6
43	C	Peak Current	For details, see channel 7
44	C	Frequency	For details, see channel 8
45	C	True Power At Fundamental Freq	For details, see channel 9
46	C	Harmonic True Power	For details, see channel 10
47	C	Reactive Power At Fundamental Freq	For details, see channel 11
48	C	Average Reactive Power	For details, see channel 12
49	C	Net Energy	For details, see channel 13
50	C	Positive Energy	For details, see channel 14
51	C	Negative Energy	For details, see channel 15
52	C	Net Reactive Energy	For details, see channel 16
53	C	Apparent Energy	For details, see channel 17

Ch	Phase	Description	Details
54	All	Total True Power	True power for all 3 phases in units of W, calculated once per second from the sum of true power for each phase. This value can be positive or negative.
55	All	Total Reactive Power	Reactive power for all 3 phases in units of var, calculated once per second from the sum of reactive power for each phase. This value is always positive.
56	All	Total Apparent Power	Apparent power for all 3 phases in units of VA, calculated once per second from the sum of apparent power for each phase. This value can be positive or negative.
57	All	Total Net Energy	Net energy for all 3 phases, accumulated by adding the sum of true power for all phases once per second to a signed 64-bit integer in units of mWh. This value can be positive or negative and is stored to non-volatile memory every 30 seconds. This value can be read in three different formats: 32-bit IEEE float in units of kWh, 64-bit signed integer in units of mWh, and 32-bit signed integer in units of mWh. For more details, review "Data Types Available to Read or Write Accumulation and Summation Values" on page 3 .
58	All	Total Unsigned Energy	Net energy for all 3 phases, accumulated by adding the sum of the absolute value of true power for each phase once per second to a signed 64-bit integer in units of mWh. This value can be positive or negative (due to rollover) and is stored to non-volatile memory every 30 seconds. This value can be read in three different formats: 32-bit IEEE float in units of kWh, 64-bit signed integer in units of mWh, and 32-bit signed integer in units of mWh. For more details, review "Data Types Available to Read or Write Accumulation and Summation Values" on page 3 .
59	All	Total Positive Energy	Positive energy for all 3 phases, accumulated by adding the sum of true power for all phases if this sum is greater than zero once per second to a signed 64-bit integer in units of mWh. This value can be positive or negative (due to rollover) and is stored to non-volatile memory every 30 seconds. This value can be read in three different formats: 32-bit IEEE float in units of kWh, 64-bit signed integer in units of mWh, and 32-bit signed integer in units of mWh. For more details, review "Data Types Available to Read or Write Accumulation and Summation Values" on page 3 .
60	All	Total Negative Energy	Negative energy for all 3 phases, accumulated by adding the sum of true power for all phases if the sum is less than zero once per second to a signed 64-bit integer in units of mWh. This value can be positive or negative (due to roll-over) and is stored to non-volatile memory every 30 seconds. This value can be read in three different formats: 32-bit IEEE float in units of kWh, 64-bit signed integer in units of mWh, and 32-bit signed integer in units of mWh. For more details, review "Data Types Available to Read or Write Accumulation and Summation Values" on page 3 .
61	All	Total Net Reactive Energy	Net reactive energy for all 3 phases, accumulated by adding the sum of reactive power for all phases once per second to a signed 64-bit integer in units of mvarh. This value can be positive or negative and is stored to non-volatile memory every 30 seconds. This value can be read in three different formats: 32-bit IEEE float in units of kvar, 64-bit signed integer in units of mvarh, and 32-bit signed integer in units of mvarh. For more details, review "Data Types Available to Read or Write Accumulation and Summation Values" on page 3 .
62	All	Total Net Apparent Energy	Positive energy for all 3 phases, accumulated by adding the sum of true power for all phases if this sum is greater than zero once per second to a signed 64-bit integer in units of mVAh. This value can be positive or negative and is stored to non-volatile memory every 30 seconds. This value can be read in three different formats: 32-bit IEEE float in units of kVAh, 64-bit signed integer in units of mVAh, and 32-bit signed integer in units of mVAh. For more details, review "Data Types Available to Read or Write Accumulation and Summation Values" on page 3 .
63	All	Average Power Factor	Average power factor for all 3 phases, calculated once per second from the ratio of Total True Power to Total Apparent Power. This value can be positive or negative.

MOUNTING & REMOVING

Mount groov I/O modules onto a groov EPIC chassis (see the *groov EPIC Chassis Data Sheet* (form 2247) for instructions). To learn the names and physical features of the parts of the module, see "Description of Module Parts" on page 18.

Mounting a Module



The numbers on the diagrams correspond to the numbered steps in these instructions.

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

1. Orient the groov EPIC chassis so that the module connector numbers are right-side up, with **0** on the left as shown in the diagram.
2. Hold the module at a 45° angle, and line up the alignment tab on the back tip of the module with the slot at the back of the chassis.
3. Pivot the front of the module down to the module connector on the chassis, and push to snap the module into the connector.
4. Lift the module cover up to access the module hold-down (retention) screw, and tighten the screw to secure the module into position.

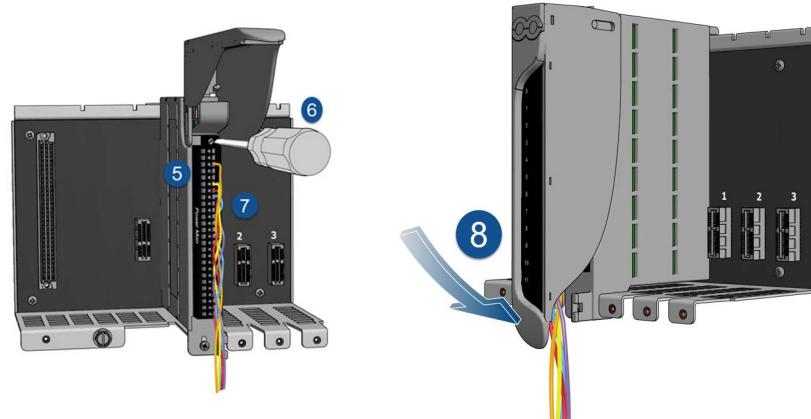
CAUTION: Do not over-tighten. See the torque specs in the "Specifications" table.

5. If the module does not have a terminal connector, install one.
6. Secure the terminal connector by tightening the terminal connector screw.

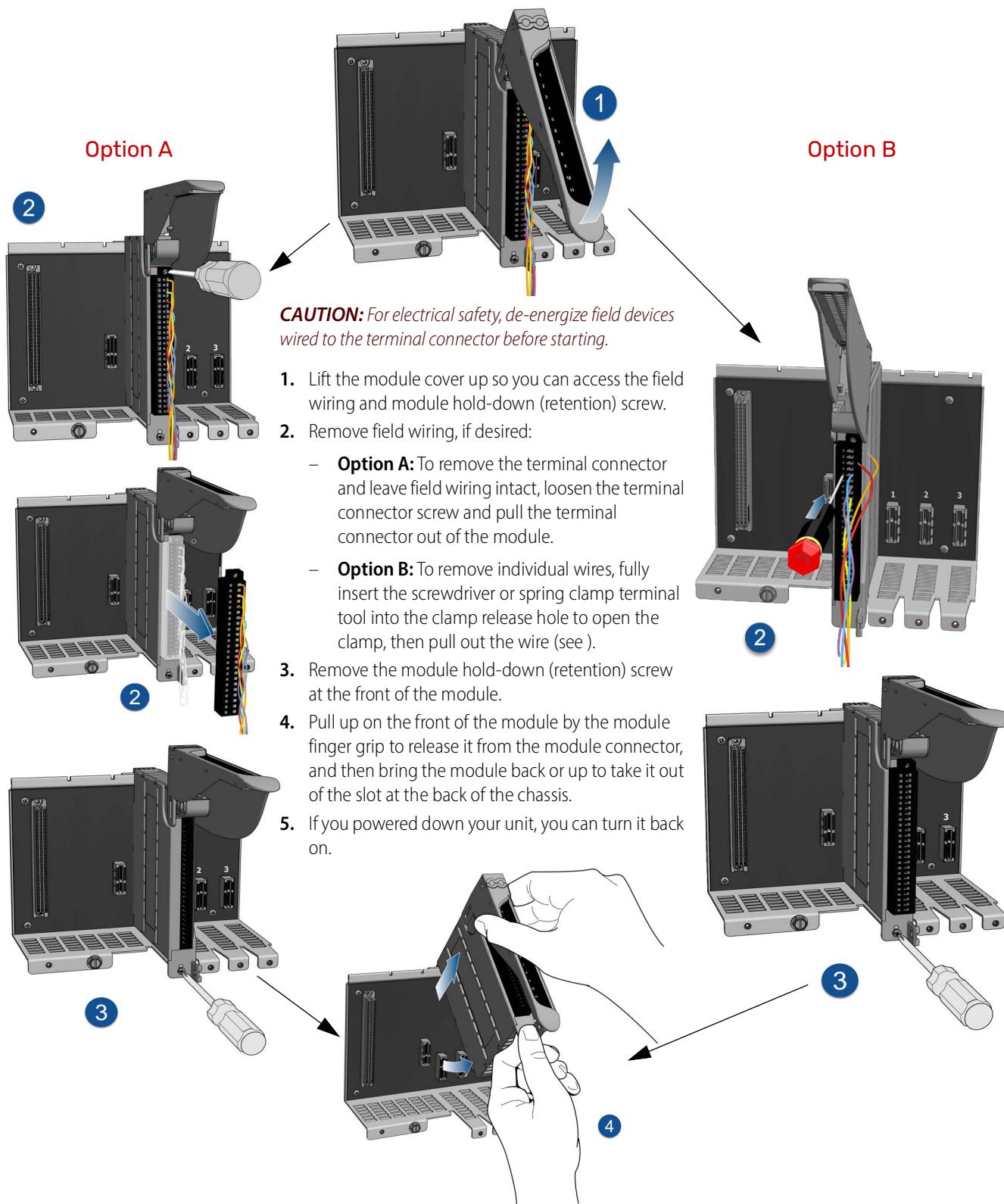
CAUTION: Do not over-tighten. See the torque specs in the "Specifications" table.

7. Follow the wiring instructions in the "Pinout and Wiring" section to wire your field devices to the channels on the terminal connector.
8. When wiring is complete, bring the module cover back down to cover the wires. If the wires are too thick to close the module cover easily, lift the module cover, raise the back of the module cover up to the higher position, and then bring the module cover back down to cover the wires.

If you powered down your unit, you can turn it back on when you are done installing modules and wiring.



Un-mounting a Module



PINOUT AND WIRING

WARNING: DANGER. Hazardous voltage. Direct wiring involves high voltages and must be done by a **qualified** electrician.

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:

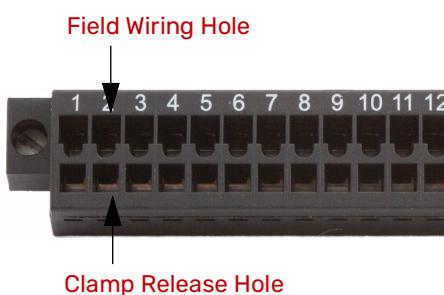
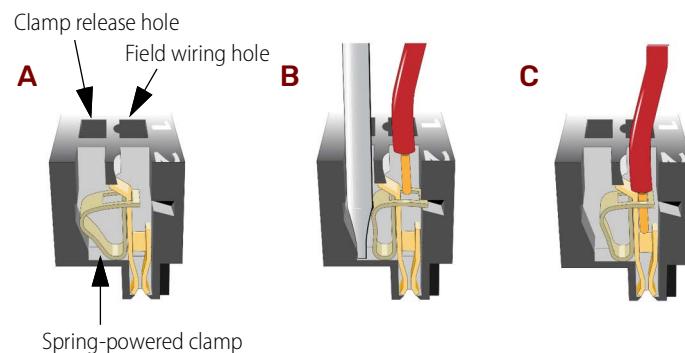
the **Select and prepare the appropriate wire.** The terminal connectors are rated for 28–14 AWG wire. You must use copper wires that are either solid core **or** tinned strands with ferrules

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* EPIC chassis. 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.



Wiring instructions on next page.

Inserting Wires

WARNING: DANGER. Hazardous voltage. Direct wiring involves high voltages and must be done by a **qualified** electrician.

You can monitor one 3-phase electrical panel or piece of equipment, or you can monitor three single-phase panels or pieces of equipment.

Only a qualified electrician should do the wiring described in the following steps:

1. Install CTs and wire electrical loads.

- Determine the maximum current to be measured, then choose a CT with:
 - an appropriate secondary and,
 - a primary current rating that can handle both your selected wire size and maximum current.

For an introduction to selecting CTs, review the [Selecting and sizing a current transformer](#) blog on our website (opto22.com).

UL requires CTs to be CAT III approved. Category III is for measurements performed in a building; for example circuit breakers, wiring, distribution panels, and equipment for industrial use. For more information, review the IEC 61010 standard.

UL also requires that CTs be **UL Listed Current Transformers for Energy Monitoring**.

- Verify that the proper safety fuse is connected to each voltage line of each phase, as close to the source as possible. The fuses should be 1 A or less.
- When the CT is installed, verify that:
 - It is oriented correctly, according to the labeling on the CT.
 - All the CTs are installed in the same direction.
 - Each CT matches its respective voltage tap.
- If loads have a neutral, make sure it's connected.

2. Review the wiring diagram (see "[Wiring: GRV-IVAPM-3](#)" on page 15) to identify which wires from the CT connect to the correct the terminal number on the module.

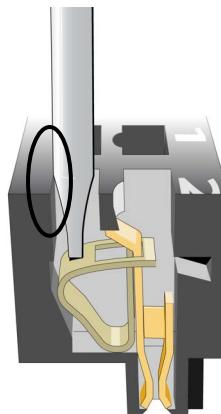
3. Orient the module or terminal connector to match the wiring diagrams on [page 15](#).

4. 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 chassis.
- If you are working only with the terminal connector, secure the terminal connector with a clamp.

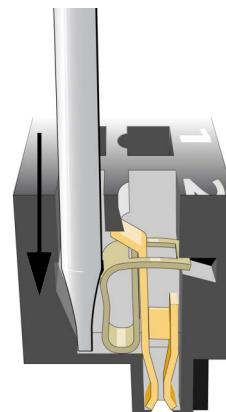
5. Open the spring clamp:

- 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.

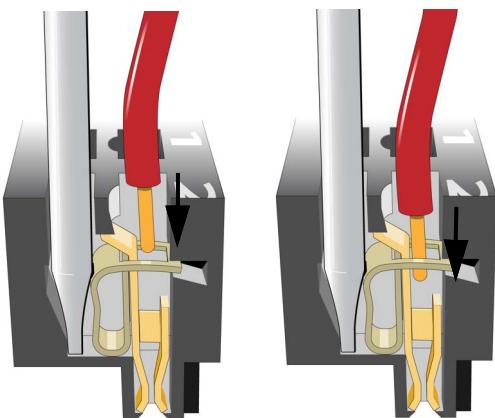


- c. You can confirm that the clamp is open by looking into the field wiring hole.

- 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.

6. Insert the wire into the field wiring hole.

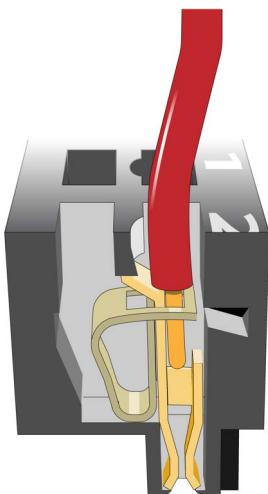


Removing Wires

WARNING: DANGER. Hazardous voltage. Direct wiring involves high voltages and must be done by a **qualified** electrician.

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.

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



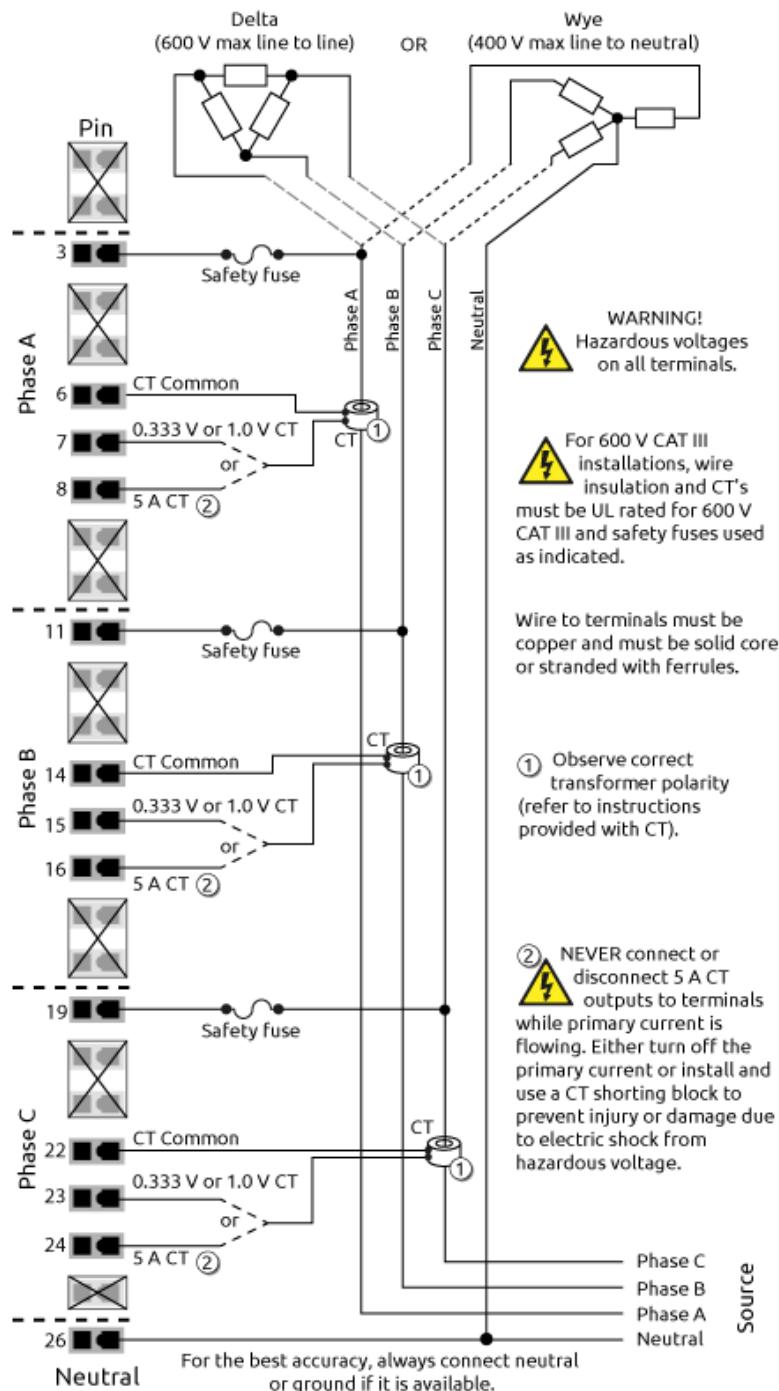
8. Test that the wire is secure by gently pulling on it. If the wire pulls out, repeat steps 5 and 6.

WIRING: GRV-IVAPM-3

The following diagram shows how to correctly wire delta-configured and wye-configured loads without potential transformers. Wye-configured loads above 400 V require the use of potential transformers; see wiring diagram on next page.



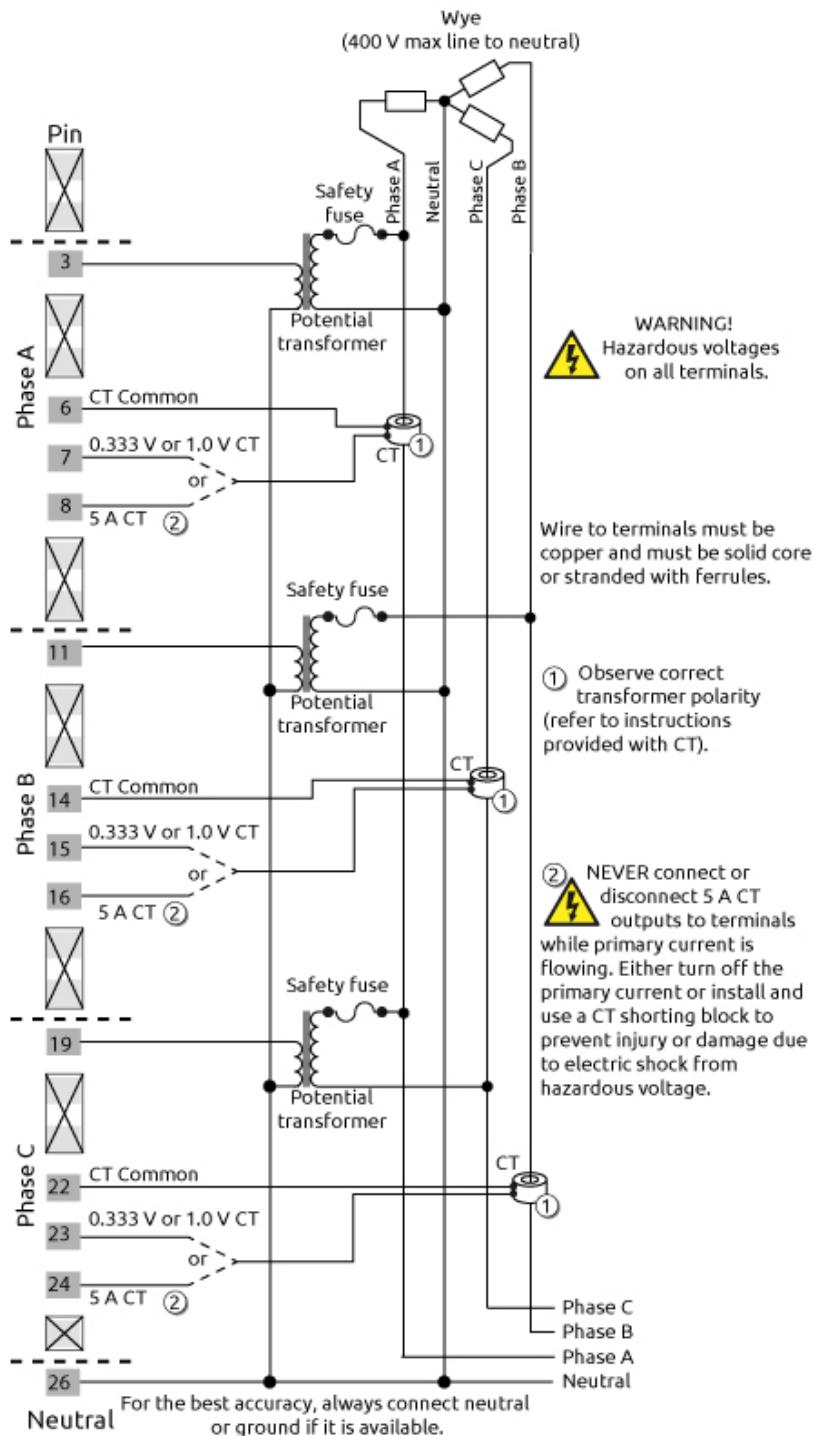
WARNING: DANGER. Hazardous voltage. Direct wiring involves high voltages and must be done by a **qualified technician**.



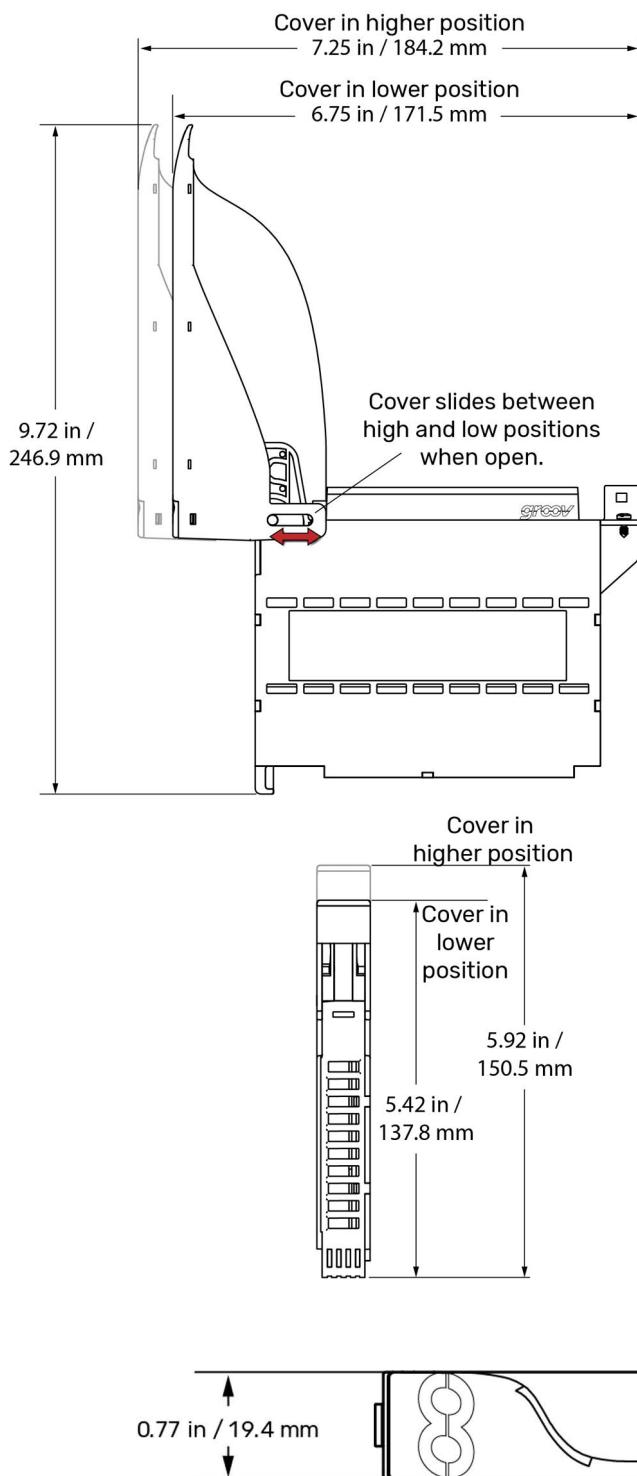
The following diagram illustrates how to correctly wire wye-configured loads when using potential transformers. Wye-configured loads over 400 V require potential transformers.



WARNING: DANGER. Hazardous voltage. Direct wiring involves high voltages and must be done by a **qualified technician**.



DIMENSIONS: GRV-IVAPM-3



The module cover pivots and can be adjusted to two different heights (positions). The higher position provides more space to accommodate thicker wires.

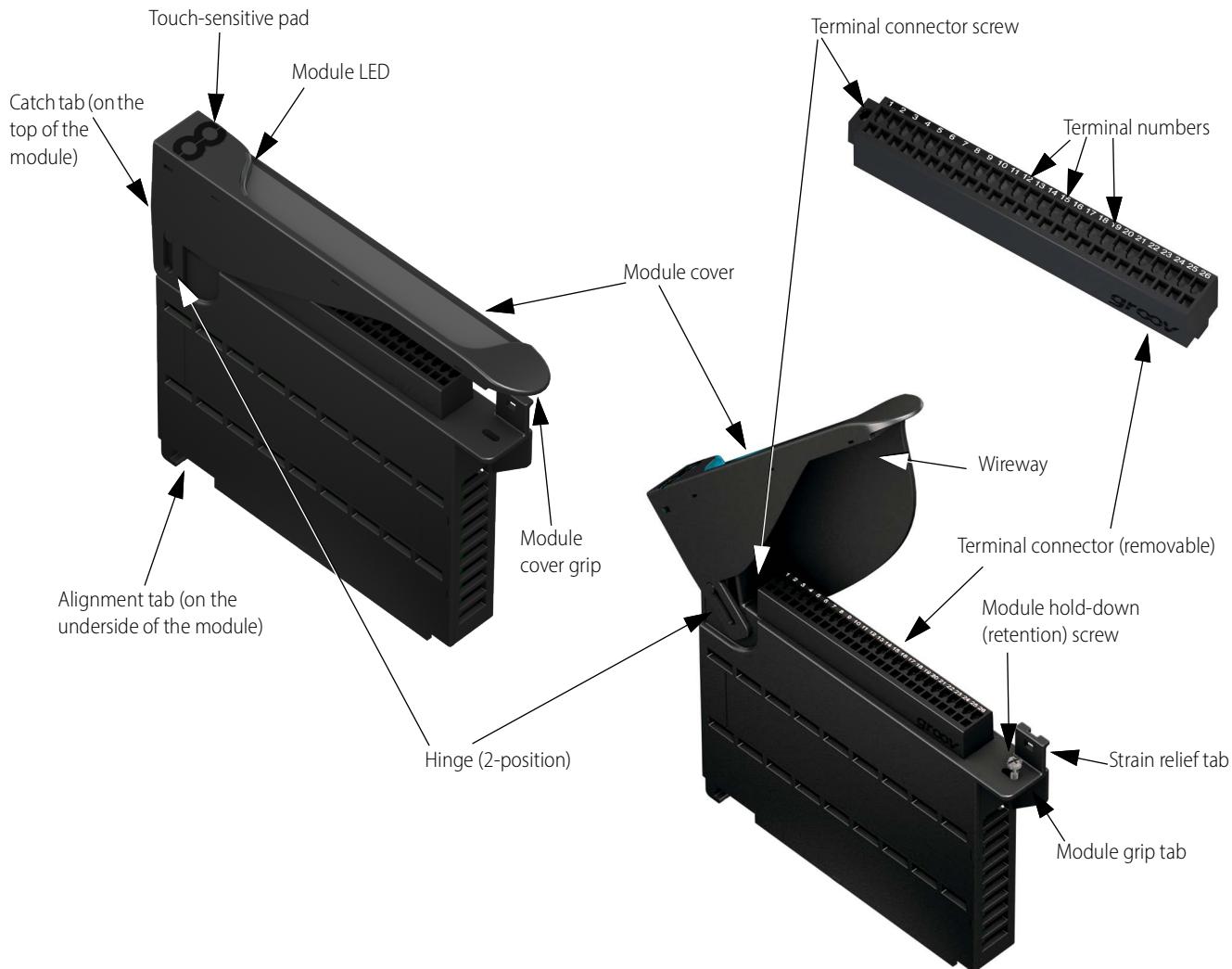
To switch between higher and lower position, lift the cover to at least a 45° angle. Grasp the hinged end of the module cover and do one of the following:

- Pull up on the back hinge to slide it to the higher position.
- Push down on the back hinge to slide it to the lower position.

You cannot switch between the higher and lower positions while the cover is closed.

DESCRIPTION OF MODULE PARTS

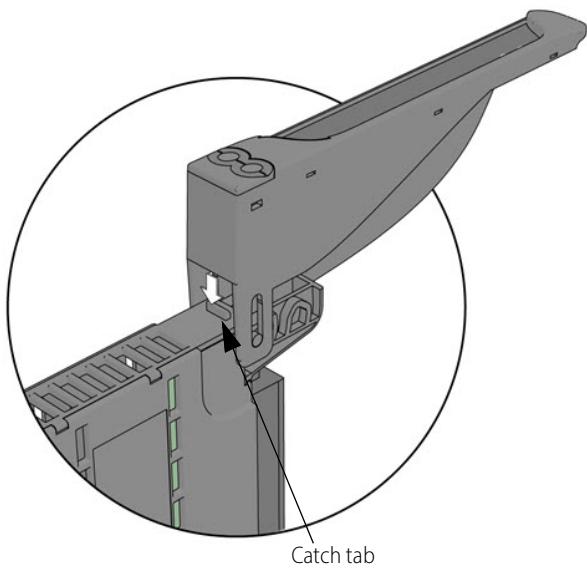
The following diagram identifies the parts of the modules. The installation instructions in the documentation rely on these terms to describe how to handle the module.



Some parts offer unique features:

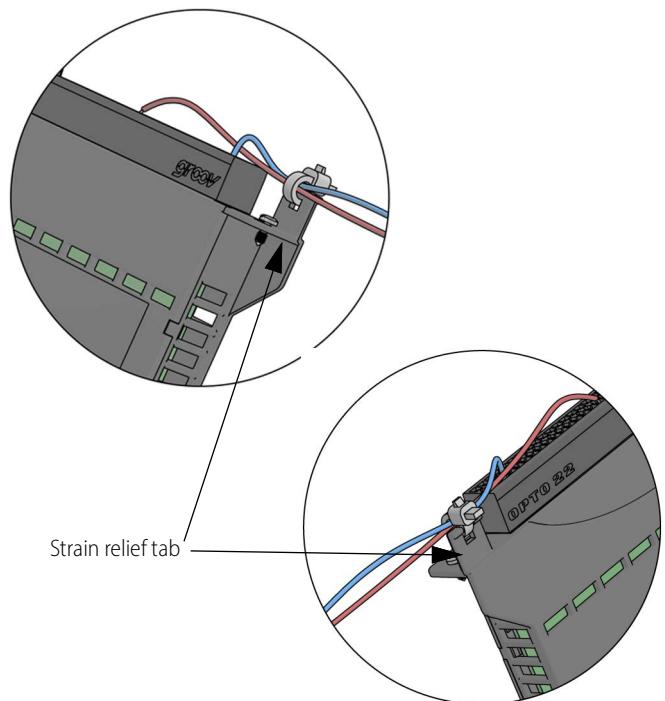
- **Module LED:** Provides a visual indication of the health of the module. For example, if it is blue, the module is operating normally. If it is blinking blue, the module's information is being displayed on the *groov EPIC* processor's screen. For a complete list of the various colors that this LED might display, see the [groov EPIC User's Guide](#) (form 2267).
- **Hinge and Wireway:** These two features work together to provide more space for wires. The hinge can be adjusted between a lower position and a higher position. The wireway is the space underneath the module cover. To increase this space, you can raise the hinge to the higher position.
- **Touch-sensitive pad:** Offers a convenient way to display the module's information on the *groov EPIC* processor. Press on the pad for approximately two seconds and the processor displays that module's information on the screen, as well as changing the module LED to a blinking blue light.
- **Catch tab:** Located at the top of the module, the catch tab provides a place for the cover to "catch" or stop. This prevents the

cover from closing so that you can work on attaching or detaching wires to the terminal connector.



- **Strain relief tab:** This tab offers a way to collect wires into a bundle and secure them to the module. Attaching the wires to the strain relief tab can help hold the wires in a semi-fixed position, preventing them from interfering while you work on a nearby module. It also prevents strain on the part of the wire attached to the terminal connector.

Collect the wires into a bundle, pull a zip tie through the hole in the tab, wrap the zip tie around the bundle and tab, and then clip the excess zip tie.



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](#).

PURCHASING OPTO 22 PRODUCTS

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.