eGauge

MEASURE EVERY MOMENT

Power Relay Module Owner's Manual

Version 1.04

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Download the latest manual at `egauge.net/support`
For an overview of setup process, visit `egauge.net/help/overview`

1   Introduction

The eGauge Power Relay Module is a versatile device intended to control up to three 240V AC/15 A resistive loads or motors up to 15 FLA (80 LRA). The relays can be opened and closed individually or synchronously, enabling the switching of up to three single-phase loads, one split-phase and one single-phase load, or one three-phase load. The relay can be controlled via USB and via Modbus/RTU (RS-485). Multiple relay modules can be used if additional loads need to be controlled.

The first and second sections of this manual describe installation of the product. The third section provides operating instructions and is followed by a section on equipment maintenance. The appendices provide the device specifications and a reference to troubleshooting information.

Please visit the eGauge support site to verify you have the latest version of this manual. There, you can also find additional training materials, tutorial videos, and configuration guides.

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http://egauge.net/support/
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1.1   Features

- Three relays:

    - Contacts rated for up to 240 V AC/15 A resistive (50-60 Hz)

    - Relay state persists across power-outages.

    - Can be switched independently or in arbitrary groups

    - Configurable minimum open/close durations to minimize relay wear.

- DIN-rail enclosure

- USB interface:

    - CDC ACM virtual serial port

    - Easy to use SCPI command set (text commands)

    - Bus powered

- RS-485 interface:

- – Single 5 V DC/500 mA power supply

- – Modbus protocol

- – SunSpec compatible

- Low average power consumption:

  - – <500 mW typical with all relays on

  - – <100 mW with relays off

- Wide operating range: -30. . . 70 °C, up to 4000 m altitude

- Intended Application: Remote control of air conditioners, heaters, refrigerators, office-automation, and similar equipment.

1.2   Glossary

The following table describes various terms and symbols used throughout this manual and as markings on the device:

Term/Symbol:	Description:
Class 2	Class 2 power supplies, as defined by the NEC (National Electric Code for North America), have output power limited to 100 W or less.
LPS	Limited Power Source - A power supply that meets the requirements of IEC 60950-1.
LRA	Locked-rotor Amperage - The current flowing through a motor at its rated voltage when its rotor is kept stationary (motor is not spinning or rotating).
FLA	Full-Load Amperage - The rated current flowing through a motor when it is operating at the rated (full) load and rated voltage.
⚠	Caution, risk of danger. See additional information provided in this manual whereever this symbol occurs.

2 Installation

Installation must be performed by a licensed electrician according to all applicable local, national, and international codes.

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The relay contacts of the Power Relay Module may carry high voltage. For safety, the device must be installed in an enclosure that is rated for the installation environment. The enclosure must have a screw-on or locking cover that prevents accidental touch of the relay contacts.

2.1 What's included in the box

- 1× eGauge Power Relay Module device

- 1× 1.5 m USB Type A to Type B cable

- 1× 4-pin RS-485 and external power-supply terminal block (detachable)

2.2 Materials required for installation

The Power Relay Module is designed for installation inside an enclosure with a DIN rail (35 mm top-hat). The enclosure and DIN rail must be provided by the installer. Additionally, the following materials may be required:

- Power-supply: When using the USB cable, the Power Relay Module is normally powered by the USB bus (5 V). Power may also be supplied by an external 5 V DC Class 2 or LPS power supply. This power supply is required when not using a USB cable.

- Solid or stranded copper wire for relay terminal plugs: AWG 12–24. Length depending on installation location and intended use of relays. Thermal resistance to at least 90 °C. Wire gauge needs to be selected according to the breaker or fuse that protects the wires connected to the terminal plugs. AWG 12 is required when wired to 20 A breakers. Tighten terminal plug screws to 0.56 Nm (5 Lb-in).

- Electrical tape

- Conduit and couplings as needed

- Mounting and wire organization hardware as needed

- Appropriately rated enclosure (e.g., IPX4/NEMA4 for outdoor use).

2.3   Tools required for installation

- #1 slotted screwdriver

2.4   Safety Warnings

Please follow the installation instructions in this manual. To reduce the risk of electric shock:

- Do not connect relay contacts to a circuits operating at voltages greater than 240 V AC.

- Always disconnect circuits from Power Distribution System of building before wiring relay contacts.

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If the equipment is used in a manner not specified by eGauge Systems LLC, the protection provided by the equipment may be impaired.

2.5   Installation Location

The Power Relay Module is usually installed near the load (or loads) that it controls. It is permanently connected equipment.

The Power Relay Module is a listed device and must be installed inside a suitable enclosure. The enclosure must be rated according to the environment it is used in. For example, outdoor installations require an outdoor-rated enclosure such as IPX4/NEMA4.

Select an installation location that is not exposed to direct sunlight or the elements. Otherwise, warranty may be voided.

2.6   Device Overview

The Power Relay Module provides three remotely controllable relays that can be used to power on and off AC-powered equipment. The controlled equipment may be single phase (1 pole), split-phase (2 poles), or three phase (3 poles). Accordingly, the relays can be controlled individually, as an arbitrary group of two, or as a group of three relays.

The minium duration for which a relay stays open or closed is configurable from zero seconds to 4 minutes 15 seconds. If a relay is commanded to switch before the minimum duration has elapsed, the relay remains in the existing state until the duration has expired. By default, the relays are configured for a minimum duration of 10 seconds.

The device can be controlled via USB or RS-485 interface. Both interfaces are always active and may be used simultaneously.

The device can be powered from the USB-bus or via an external 5 V DC power supply. For redundancy, both a USB cable and an external power supply may be connected at the same time. If the voltage of the external power supply is greater than 5 V, it will be the primary supply and USB will be the backup supply.

Figure 1 shows the Power Relay Module as seen from above . The left side shows the low-voltage communication ports and the right side the three high-voltage relay connectors (plugs inserted).

The USB port consists of a standard Type-B connectors.

The RS-485 port consists of a 4-pin 3.5mm pitch terminal block with a removable plug. When using the RS-485 port, the D+, and D-, and ground ($\equiv$) pins must be wired to the RS-485 bus. If the Power Relay Module is the first or the last device on the RS-485 bus, a 120 ohm/0.5 W termination resistor also must be installed on the D+ and D- pins. Figure 2 shows a typical wiring diagram. Unless the device is powered through the USB cable, a 5 V DC power-supply also must be wired to the +5V and $\equiv$ pins.

The relay connectors consist of three 2-pin 7.62mm pitch terminal blocks. The plugs are removable for ease of wiring. The relay contacts are normally open.
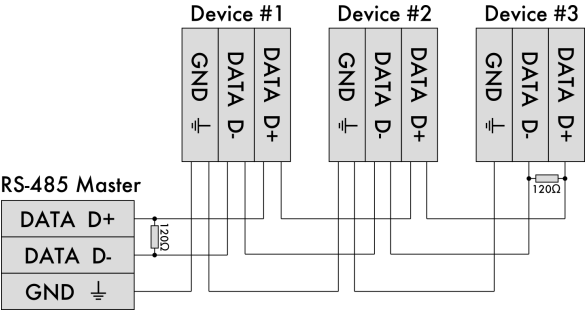
Figure 1: Power Relay Module viewed from above

Figure 2: Typical RS-485 Wiring Example

3   Maintenance

The Power Relay Module is designed to be maintenance free. No preventive maintenance or inspections are required.

Should it become necessary to clean the Power Relay Module, disconnect it from the building supply by turning off the breakers wired to the relay contacts, remove the device, and clean it with a soft cloth. If a cleaning fluid is needed, use 70 % isopropyl alcohol. Wait until all cleaning fluid has evaporated before reinstalling the device and turning the breakers back on.

The device has no replaceable batteries and no replaceable fuses.

4   USB Port

The Power Relay Module identifies itself over USB as a CDC ACM device with vendor id 0x04D8 (Microchip) and product id 0xECA6.

Since CDC ACM presents itself as a virtual serial port, any terminal communication program such as Minicom or PuTTY can be used to issue commands over USB.

4.1   SCPI Command Set

The Power Relay Module can be controlled over USB using the SCPI commands defined in this section. SCPI (pronounced "skippy") stands for "Standard Commands for Programmable Instruments" and uses ASCII-encoded strings. Commands are entered one line at a time. Each line must end with a carriage-return (ASCII code 13) and/or line-feed character (ASCII code 10). Line length (including line terminators) is limited to at most 64 characters. Commands are case-insensitive, so `RELAY` has the same meaning as `relay`, for example. Most SCPI commands may be abbreviated to the first four characters. Required command characters are shown in upper case, optional ones in lower case. For example, `MODBus` indicates that the command may be abbreviated to just `MODB`. SCPI-convention normally would allow specifying multiple commands in a single line by separating the commands with a semicolon. However, the Power Relay Module does not support this convention and always expects a single command per line.

Each SCPI command returns a single response-line which is terminated by a carriage-return line-feed sequence. The response is `INVALID COMMAND` if there was an error processing the command. If the command was processed successfully the response is `OK` or a command-specific response.

Command	Response	Description
`*IDN?`	devid	Return device identifier.
`EEPRom?`	decimal	Return number of times the EE-PROM has been written.
`RELAy:`n`?`	decimal	Query status of relay n, where n is one of 1, 2, or 3. Returns string `0` if relay is open, `1` if it is closed.
`RELAy:`n `cv`	status	Open or close relay n, where n is one of 1, 2, or 3. If cv is `0` or `OFF`, the relay is opened, if `1` or `ON`, the relay is closed.
`RELAy:`n`:COUNt?`	decimal	Return number of times relay n has been switched (opened or closed). The value of n must be one of 1, 2, or 3.
`RELAy:MASK?`	decimal	Query status of all relays. The returned number has bit (n-1) set if relay n is closed, cleared otherwise. For example, return value 6 would indicate that relay 1 is open (bit 0 is cleared) and relays 2 and 3 are closed (bits 1 and 2 are set).
`RELAy:MASK` m	status	Open or close relays as indicated by mask m. If bit (n-1) is set, relay n is closed, otherwise it will be opened.
`RELAy:MASK:SET` m	status	Close relays as indicated by mask m. If bit (n-1) is set, relay n is closed, otherwise relay n will remain in its current state.
`RELAy:MASK:CLR` m	status	Open relays as indicated by mask m. If bit (n-1) is set, relay n is opened, otherwise relay n will remain in its current state.

Command	Response	Description
`RELAy:MIN:OFF?`	decimal	Query the minimum duration for which a relay remains open. The returned number is the duration in seconds.
`RELAy:MIN:OFF d`	status	Set the minimum duration for which a relay remains open to d seconds. The duration must be an integer in the range from $0..255$.
`RELAy:MIN:ON?`	decimal	Query the minimum duration for which a relay remains closed. The returned number is the duration in seconds.
`RELAy:MIN:ON d`	status	Set the minimum duration for which a relay remains closed to d seconds. The duration must be an integer in the range from $0..255$.
`MODBus:BAUD?`	decimal	Returns the baud rate of the RS-485 port.
`MODBus:BAUD n`	status	Sets the RS-485 baud rate to n baud. The value of n may be one of 9600, 19200, 38400, 57600, or 115200.
`MODBus:PARIty?`	parity	Returns the parity used for the RS-485 port.
`MODBus:PARIty p`	status	Sets the RS-485 parity. If p is n, no parity is selected, if e, even parity is selected, and if o, odd parity is selected.
`MODBus:UNIT?`	decimal	Returns the MODBUS unit number of the device.
`MODBus:UNIT n`	status	Sets MODBUS unit number of the device to n. The value of n may be in the range from 1 through 247.

Table 1: SCPI Commands

The SCPI commands supported by the Power Relay Module are shown in Table 1. The first column shows the syntax of the command, the second column the response type, and the third is a description of the command.

For response type devid, the return value consists of a string containing the manufacturer name, model name, product serial-number, and the product version, separated by commas. For example, the returned devid might be:

```
eGauge,PRM3,3N013453,1.00
```

For response type status, the return value consists of either `OK` or `INVALID COMMAND`. For response type decimal, the return value consists of either `INVALID COMMAND` or a decimal integer number string. For response type parity, the return value consists of either `INVALID COMMAND` or a single character, where the character `n` indicates no parity, `e` indicates even parity, and `o` indicates odd parity.

5   RS-485 Port

The RS-485 port supports the standard Modbus/RTU protocol. From the factory, the port is configured with the following parameters:

- 19,200 baud

- 1 start bit

- 8 data bits, least-significant bit sent first

- no parity

- 1 stop bit

Baud rates between 9600 and 115200 bps and other parity settings can be selected via USB or Modbus commands.

5.1   Modbus/RTU Support

The Power Relay Module acts as a Modbus server. As such, it responds to requests sent by a client. It never initiates a request on its own.

By default, the device uses Modbus unit number 1. All registers are holding registers. They can be read with "Read Holding Registers" (function code 0x03) and written with "Write Single Register" (function code 0x06).

Addr.	Size	Name	Type	Description
0	1	RS-485 param	uint16	Baud Rate code (bits 0..7) and parity (bits 8..15).
1	1	Unit number	uint16	Modbus unit number (1–247).
2	1	Relay mask	uint16	Relay status. On write, if bit $(n-1)$ is set, relay n is closed, opened otherwise. On read, if bit $(n-1)$ is set, relay n is closed, open otherwise.
3	1	Relay set	uint16	Close relays. On write, if bit $(n-1)$ is set, relay n will be closed, unchanged otherwise. On read, if bit $(n-1)$ is set, relay n is closed, open otherwise.
4	1	Relay clear	uint16	Open relays. On write, if bit $(n-1)$ is set, relay n will be opened, unchanged otherwise. On read, if bit $(n-1)$ is set, relay n is closed, open otherwise.
100	2	EEPROM writes	uint32	Number of times EEPROM has been written.
102	2	Relay 1 count	uint32	Relay 1 switch count.
104	2	Relay 2 count	uint32	Relay 2 switch count.
106	2	Relay 3 count	uint32	Relay 3 switch count.
108	1	Min. open duration	uint16	Minimum duration (in seconds) for which a relay stays open.
109	1	Min. close duration	uint16	Minimum duration (in seconds) for which a relay stays closed.

Table 2: Modbus Register Mappings

Table 2 shows the available Modbus registers (base-0 addressing). The "RS-485 param" register provides access to the RS-485 baud rate and parity. The upper eight bits define the parity as shown below:

Value	Parity Mode
110 (ASCII code of "n")	no parity
101 (ASCII code of "e")	even parity
111 (ASCII code of "o")	odd parity

The lower eight bits define the baud rate as shown below:

Value	Baud Rate
1	9600 bps
2	19200 bps
4	38400 bps
6	57600 bps
12	115200 bps

For example, a value of 0x6506 would indicate 57600 bps and even parity.

The "Unit number" register defines the Modbus unit number under which the device responds. By default, this value is 1 but it can be set to any number in the range from 1 to 247.

The "Relay mask", "Relay set", and "Relay clear" registers provide access to the relays. They all return the same value when read: in the returned value, if bit $(n-1)$ is set, it means that relay n is closed and if it is cleared, it means that the relay is open. When written, the three registers have different behavior: "Relay mask" sets all the relays as indicated by the written value. That is, if bit $(n-1)$ is set, relay n will be closed and otherwise it will be opened. In contrast, writing "Relay set" will only close the relays for which the corresponding bit is set. Similarly, writing "Relay clear" will only open the relays for which the corresponding bit is set.

Addr.	Size	Name	Type	Description
40000	2	SunSpec_ID	uint32	Value = 0x53756e53 ("SunS").
40002	1	SunSpec_DID	uint16	Value = 0x0001 (Common Model Block).
40003	1	SunSpec_Length	uint16	Value = 65 (Length of block).
40004	16	Manufacturer	str32	Manufacturer "eGauge".
40020	16	Model	str32	Model name (e.g., "PRM3").
40036	8	Options	str16	Installed options.
40044	8	Version	str16	Product version (e.g., "1.00").

Addr.	Size	Name	Type	Description
40052	16	SerialNumber	str32	Serial number (e.g., "3N013453").
40068	1	DeviceAddress	uint16	Modbus unit number.
40069	1	SunSpec_DID	uint16	Value = 0xffff (End Marker).
40070	1	SunSpec_Length	uint16	Value = 0x0000.

Table 3: SunSpec Register Mappings

The Power Relay Module also provides an address block to enable device identification according to the SunSpec standard. Since SunSpec does not have a standardized model for relay controllers, the only model block provided is the Common Model (SunSpec_DID 0x0001) as shown in Table 3. This block allows identifying the device by manufacturer and model name.

A   EMI Compliance

A.1   FCC Compliance Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.

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Changes or modifications to the equipment not expressly approved by eGauge Systems LLC could void the user's authority to operate the equipment.

A.2   Canada ICES-003 Compliance

CAN ICES-3 (B)/NMB-3(B)

B   Specifications

B.1   Applicable Model Numbers

This manual applies to eGauge Power Relay Module model PRM3.

B.2   Mechanical Specifications

- Enclosure compatible with 35 mm wide, 7.5 mm tall DIN rails.

- Dimensions: $90{\times}72{\times}60$ mm^3 (l×w×h).

- Weight: 175 g.

B.3   Electrical Ratings

- Relay contacts: normally open, 100,000 cycles durability

  - resistive load: 240 V AC, 15 A, 50–60 Hz.
  - motor load: 240 V AC, 15 FLA and 80 LRA.

- Relay wiring: stranded or solid copper, AWG 12–24, 600 V, 90 °C. Tighten screws to 0.56 NM (5 Lb-in).

- USB power supply: 5 V DC, 500 mA max.

- RS-485 power supply: 5 V DC $\pm$ 10 %, 500 mA max, Class 2 or LPS.

B.4   Environmental Conditions

Suitable for indoor and outdoor use. Enclosure with suitable rating for installation environment required. Pollution Degree 2, Overvoltage Category III (relay contacts). Not to be used at altitudes above 4000 m. Voltage fluctuations not to exceed $\pm$10%. Temperature range: -30...70 °C (-22...158 °F). Maximum relative humidity 80 % up to 31 °C, decreasing linearly to 50 % at 40 °C (non-condensing).

B.5   Regulatory Certificates

C (UL) US LISTED	UL File Number E524350 IEC/UL 61010-1 Ed. 3.0 B:2010
FCC	FCC's Title 47 CFR Part 15 Subpart B Class B ICES-003 Information Technology Equipment Class B