

Packet Power™
Wireless Smart DC Power Monitoring System
User's Manual

Version 1.1



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Indicates a POTENTIAL HAZARD. Consult documentation carefully.



CAUTION

- ☐ Read all instructions carefully prior to installation.
- ☐ The DC Power Monitor should only be connected to DC power sources in the range noted in the manual and / or label.
- ☐ Installation shall only be performed by a qualified electrical professional.
- ☐ Adhere to voltage and amperage guidelines and utilize a proper branch circuit protector.
- ☐ No field-serviceable parts. Do not attempt to disassemble the product as potentially severe electrical shock may result. Installation and maintenance must be performed by qualified personnel.
- ☐ Follow basic safety precautions to reduce the risk of electrical shock and damage to equipment.
- ☐ Store in a clean, dry location. Clean with a dry cloth.
- ☐ Intended for indoor use only, do not install in a wet location.
- ☐ Adhere to all local electrical codes and guidelines.
- ☐ Failure to use the product in the specified manner may lead to injury or death and damage to equipment.

REGULATORY INFORMATION



This product has been certified to meet the following requirements:

- Conforms to UL/ANSI/EN/IEC STD 61010-1
- Conforms to CAN/CSA STD C22.2 No. 61010-1
- CAN/CSA-C22.2 No. 61010-1, second edition, including Amendment 1, or a later version of the same standard incorporating the same level of testing requirements.
- Council Directive 2006/95/EC (December 12, 2006) on Low Voltage Equipment Safety; IEC 61010-1:2001 (Second Edition) and EN 61010-1:2001 (Second Edition)
- Council Directive 1999/05/EC - European Union (EU) Radio & Telecommunications Terminal Equipment Directive (R&TTE) ETSI EN 300 220-2, Issued:2006/04/01 and ETSI EN 301 489-3, Issued:2002/08/01 V1.4.1
- Council Directive [2004/108/EC](#) (December 15, 2004) on Electromagnetic Compatibility CENELEC EN 61326-1 Issued:2006/05/01; IEC 61326-1:2005;:1997 –
- AS/NZS 4268: 2008

Class B Device Statement / FCC Regulations:

Section 15.105(a) of the FCC Rules: 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 when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

Section 15.19 of the FCC Rules: This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Pursuant to Part 15.21 of the FCC Rules, any changes or modifications to this product not expressly approved by Packet Power LLC might cause harmful interference and void the FCC authorization to operate this product.

Pursuant to part 2.1091c of the FCC rules device is categorically excluded from routine RF Exposure regulations.

Industry Canada (IC) Compliance Statement

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

(1) This device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Per section RSS-102, 2.5 of Industry Canada regulations, this device is categorically excluded from Routine Evaluation Limits.

Industrie Canada (IC) Déclaration de conformité




Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement. Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isosotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Safety summary and specifications

This manual is intended for use by personnel responsible for installing the Packet Power Wireless Smart DC Monitoring System. Packet Power LLC assumes no liability for user's failure to comply with these safety guidelines. Please read this manual carefully before proceeding.



This symbol is used throughout this manual to indicate critical safety information. Failure to observe the information following this symbol may result in injury or death.

- ☐  Wireless Smart DC Monitors should only be connected to the type of power source indicated on the label or manual.
- ☐  Do not connect to AC line voltage sources. For use with DC power sources only.
- ☐ Wiring must have the appropriate electrical rating.
- ☐ Adhere to all local and national electrical codes and guidelines.
- ☐ Prior to installation, check to make sure the Smart DC Monitor has not been damaged.
- ☐ Store in a clean, dry location.
- ☐ Intended for indoor use only. Do not install in a wet location.
- ☐ No field-serviceable parts. Do not attempt to disassemble the product as potentially severe electrical shock may result. Installation and maintenance must be performed by qualified personnel.
- ☐ This product is intended for installation in an approved fire enclosure.
- ☐  Failure to use the product in the specified manner may lead to injury or death and damage to equipment.
- ☐ The voltage monitor is certified for use in Measurement Category IV metering applications per part 5.4.1 of IEC 61010-2-030.

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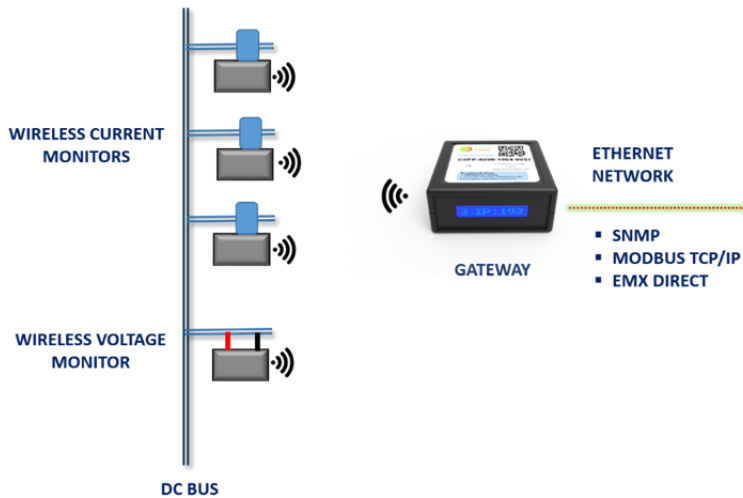
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System Overview

Wireless Smart DC Monitors Overview

Wireless Smart DC Power Monitors enable the measurement of DC current and voltage and together provide can provide power and energy information. The system utilizes independent current and voltage monitors. These monitors report the respective voltages and currents wirelessly to a Gateway. The Gateway aggregates the information from all monitors and places the data on a conventional Ethernet network. The information can be sourced from the Gateway in Modbus TCP/IP or SNMP protocol for use with any third party monitoring system as well as routed directly to Packet Power's EMX Energy portal, a local or cloud application for instant access to the data.

DC MONITORING SYSTEM OVERVIEW



System Components

Wireless Current Monitors: Wireless current monitors sense the current on the DC bus and transmit the data via an integrated radio.

There are two types of wireless current monitors; versions with integrated solid core current transducers (CTs) for applications 65A and below and versions with remote current transducers for higher current applications or for use with split core current transducers to enable installation without removing the conductor.

Wireless Current transducers are supplied by a DC source. This source can come from the Universal Power Supply (see power supply section) or directly from the DC bus. See the

P5C-DCX1 chart for input voltage specifications and make sure that the monitor matches the voltage level of the DC bus.

Each monitor will report current and an Amp Hour (Ah) total for it's circuit. An unlimited number of current monitors can be used in an network as long as sufficient Gateway capacity is available.



Wireless Current Monitor for integrated current transducer



Wireless Current Monitor for remote current transducer

Wireless Current Monitor (P5C-DCX1) Models

Product Number	CT Range	Max. Current (A DC)	Input Voltage Range (V DC)
P5C-DCIL65A	0-65A	65 A	5-24V (max. 36V)
P5C-DCIH65A	0-65A	65 A	48V (max. 65V)
P5C-DCIL35A	0-35A	35 A	5-24V (max. 36V)
P5C-DCIH35A	0-35A	35 A	48V (max. 65V)
P5C-DCEL	External CT	Dependent on the external current transducer rating. ¹	5-24V (max. 36V)
P5C-DCEH	External CT	Dependent on the external current transducer rating. ¹	48V (max. 65V)

1: Consult external CT specification sheets for details. All external CTs provide a low voltage DC output with no potential overcurrent exposure to the monitoring device.

Power Usage is less than 0.25 W per device.

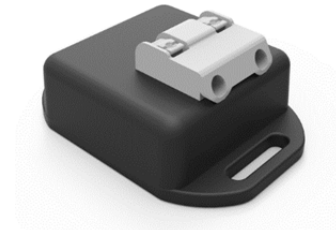
WARNING: DC Current Monitors are designed to monitor current using via inductive “non contact” current transducers. Do not apply DC current path directly to any part of the monitor. The voltage supply sensors are only provided for acquiring power for the monitoring device and not intended to sustain the load current path.

Wireless Voltage Monitors

The Wireless Voltage Monitor is used to sense the voltage on the DC bus and transmit the information wirelessly to the Gateway. The monitor is designed to utilize the sensing / line voltage as a power source facilitating a very simple installation. Typical installations only require a single voltage monitor for the entire DC bus.

Wireless Voltage Monitor (P5C-DCV1) Models

Product Number	Input Voltage Range
P5C-DCV1L	5-24V (max. 36V)
P5C-DCV1H	48V (max. 65V)
P5C-DCV1HV	100-200V
P5C-DCVHZ	100-400V



Wireless Voltage Monitor

Power Usage is less than 0.25 W per device.

WARNING: The voltage supply sensors are only provided for acquiring power and voltage for the monitoring device and not intended to sustain the load current path.

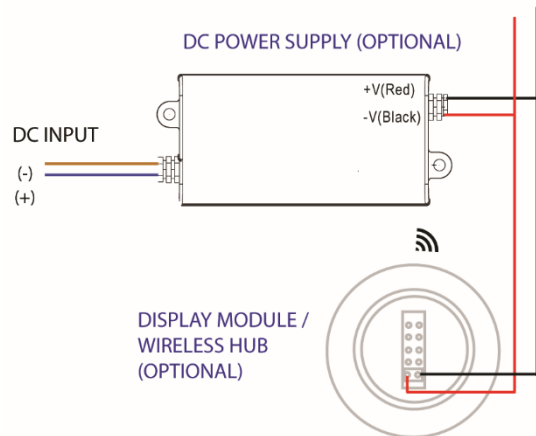
Display Module / Wireless Hub

The Display Module displays values for all monitors within range. It can also act as a Wireless Hub or “repeater” for modules housed inside a metallic enclosure or in areas that limit the radio propagation. Note that this module requires a 5VDC source which is typically provided by universal power supply.



Display Module / Wireless Hub

DISPLAY MODULE / WIRELESS HUB



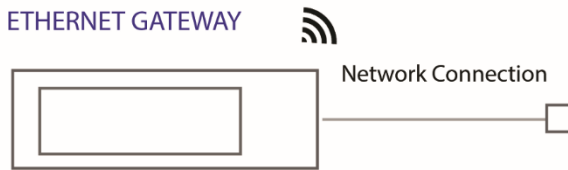
Wireless Ethernet Gateway

The Wireless Ethernet Gateway receives information from up to 150 monitors and places them on the network. The Gateway can provide data in SNMP, Modbus TCP/IP protocols or directly to Packet Power EMX Energy Portal.



WIRELESS GATEWAY

WIRELESS
ETHERNET GATEWAY



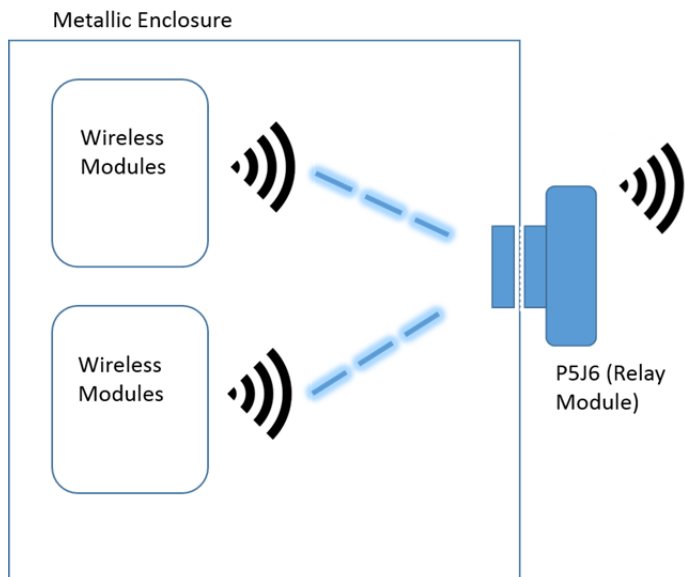
Ethernet Gateway

Monitor Installation

Module Placement

IMPORTANT: *All monitoring modules utilize radio frequency transmission to communicate. If the modules are mounted inside a fully enclosed metal enclosure it will impair the radio signal.*

In cases where monitors are fully enclosed in a metallic enclosure, it is required to use a “Wireless Hub / Display Module” that penetrates the metallic enclosure to allow the signal to be propagated. For more information on how to install the relay module refer to the “Smart Current Monitor” manual.



Wireless Hub / Display Module used when monitors are fully enclosed in metallic enclosures or have poor radio propagation

Module Mounting Options

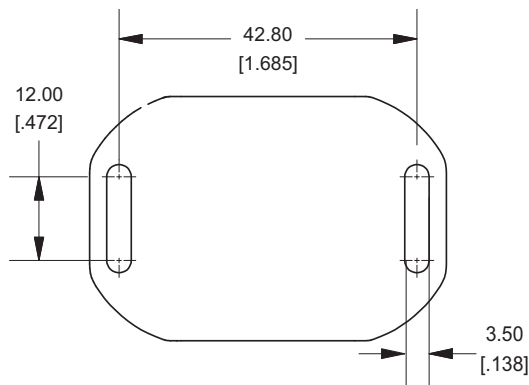
DIN RAIL: The DIN Rail mounting kit provides a means to mount the modules using standard DIN rail. The back of the module(s) is fitted with a standard 35mm DIN rail. Up to two modules can be mounted to a single rail.



DIN rail mounts affix to the base of the modules.

ADHESIVE: Modules can be mounted using the available high strength adhesive tabs. When mounting using adhesive tabs, the opposing surface must be clean, dry and have a suitable mating surface.

MECHANICAL: Modules are available with mounting tabs. The mounting tabs can be used to mechanically fasten the modules using wire ties, screws or other mechanical fasteners.



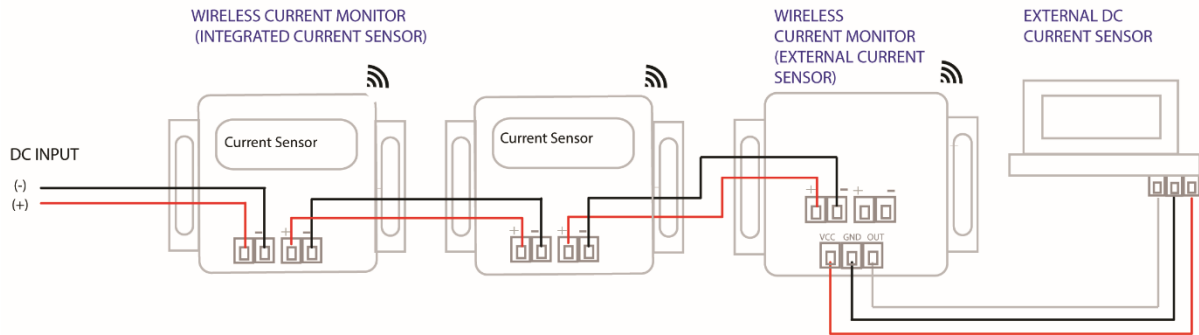
Wireless Monitor mechanical mounting tabs.

Current Monitor Installation

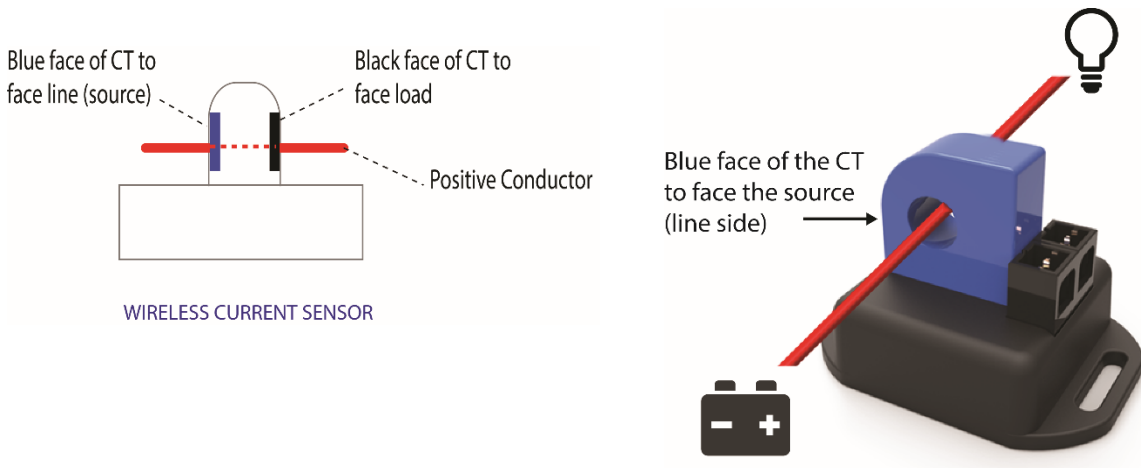
Wireless Current Monitors are connected using the specified wiring harness assemblies that are terminated with polarized locking connectors. Modules can share a single power supply which can be daisy chained to other modules. The current monitoring system consists of:

- 1) DC input power supply
- 2) Module interconnect harnesses to distribute power between modules
- 3) Monitoring Modules (either with an integrated CT or remote CT)
- 4) External CT and External CT harnesses (when using external CTs)

CURRENT SENSING SYSTEM

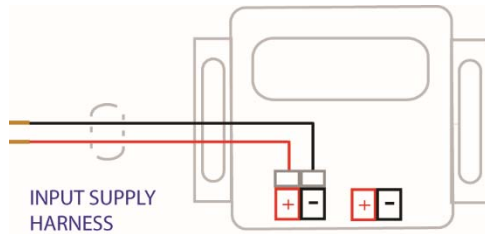


Current Transducer Placement and Orientation: It is critical to correctly orientate the direction of the current transducer in relation to the conductor to avoid getting negative power readings. When using the models with an integrated current transducer, follow the directions below. For models with an external current transducer, consult the CT specification sheet for the correct orientation.



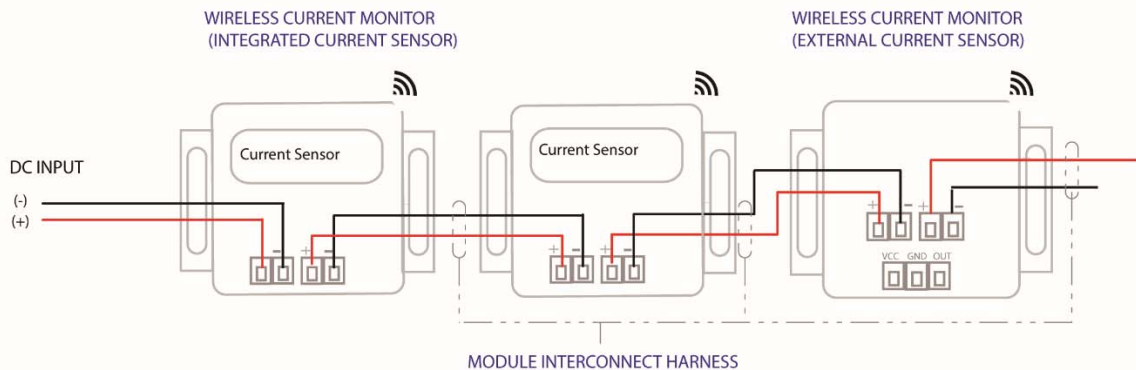
DC Input Supply Harness: The DC Input Supply Harness is designed to bring power from the DC bus to the first Current Monitor. This harness is designed with a bare wire end for connection to a DC voltage source. The other end utilizes a 2 pin polarized connector and can terminate on either of the two DC source points on the modules as these connections are common to allow daisy chain connections for the power source.

Always make sure the polarity and voltage are correct before connecting the harness to a module.

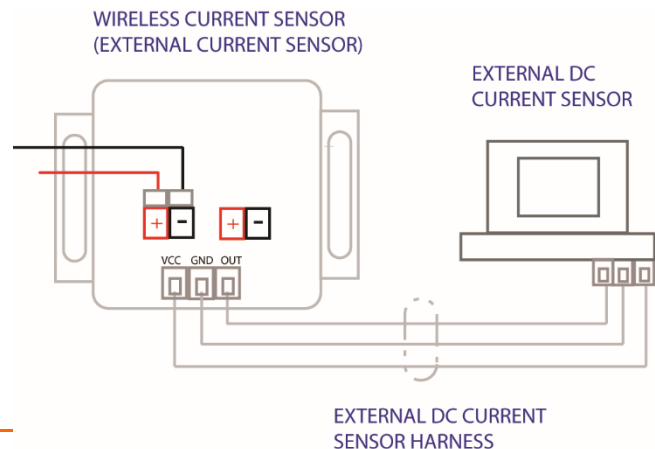


DC Input Supply Harness

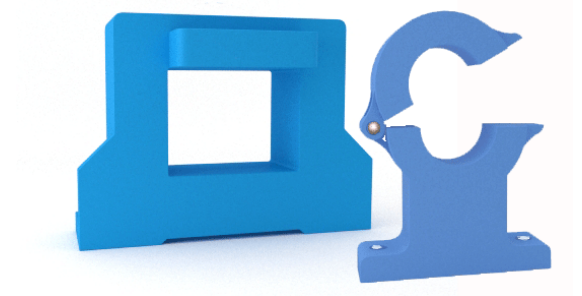
Module Interconnect Harness: The module interconnect harnesses facilitate sharing a power source between multiple modules. The harnesses are terminated with 2 pin polarized connectors and are available in different lengths. The connector can terminate on either of the two DC source points on the modules as these connections are common.



Remote CT Harness: When using remote CT versions of the current sensing modules, the remote CT is connected with a three pin polarized connector to the remote CT. Harnesses may be field extended if required or can be ordered in specific lengths.



Remote Current Transducers: Remote current transducers are used in applications requiring higher current sensing or a larger diameter window than can be provided by the integrated current sensor or when the conductor cannot be removed and requires a split core transducer. The remote current transducers are available in a wide variety of form factors and current ratings. Consult Packet Power for a full listing of available remote current transducers.



Remote Current Transducers (CTs)

Wireless Voltage Monitor Installation



WARNING: Always observe caution working with DC voltage. Failure to do so can result in death or severe injury. This system is intended for installation by qualified electrical professionals.

Power for the voltage monitor is sourced directly from the DC bus being monitored so the monitor must always be connected to the same DC bus it is monitoring. Only one Wireless Voltage Monitor is needed per DC bus to allow the Gateway to provide power calculations as the voltage can be shared between any numbers of current monitors on the bus.

Note that if there are significant line voltage drops on the bus being monitored, the Wireless Voltage Monitor should be placed in a location on the bus where the best representative voltage can be sourced.

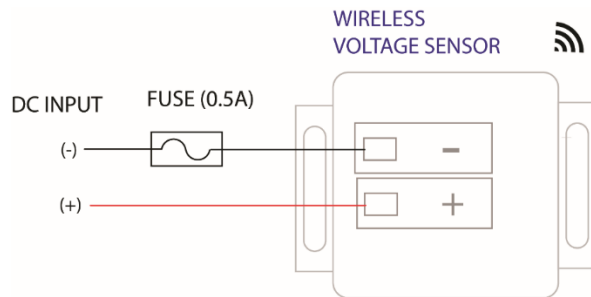
Be sure to use the correct rated Wireless Voltage Monitor for the specified current range.

Always observe the correct polarity of the connections. Failure to do so may result in permanent damage to the meter.

Connections to the Wireless Voltage Monitor can be made through the two terminals on the top of the module which are designed to accommodate bare conductor from 12 AWG to 20 AWG. To insert the wiring into push down on the connector tab, insert conductor and release tab. Always make sure the conductor is secured by giving a slight pull on the cable.

The Wireless Voltage Monitor is internally fused but it is suggested that external overcurrent protection in the form of an inline fuse with a 0.5A rating be used with the voltage sensing

leads. The polarity of the fusing may vary depending on the configuration of your DC system.



Wireless Voltage Monitor with overcurrent protection.



Wireless Voltage Monitor with wiring installed.

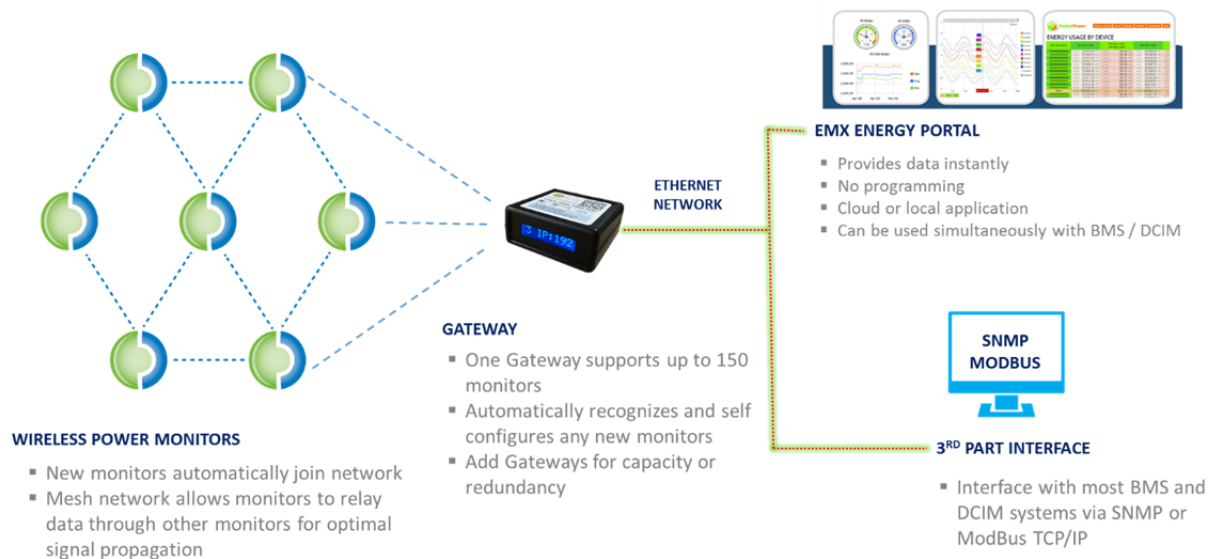
Communications

Information gathered by the Wireless DC Monitors is transmitted via a Packet Power radio network operating at 2.4 GHz. The network operates in a mesh topology. Each device in the network must be within range of at least one other device (either another monitoring node or the Gateway) in the network. The effective range of the radio in the Wireless DC Monitors varies depending on several factors, including the environment in which the product is used. Typically, each device has an effective range of 20 to 50 meters. The Wireless DC Monitors will not transmit effectively if it is installed in an enclosure that entirely blocks radio signals such as fully enclosed metallic enclosures. In such cases a Wireless Hub must be used to relay the signal to outside the enclosure.

Every site where a Smart Power Cable is deployed must have installed at least one compatible Packet Power Gateway and associated software to collect data and prepare it for transmission to approved monitoring and analysis applications. It is not necessary for all Wireless DC Monitors to communicate directly with the Gateway. As long as each monitor can communicate with at least one other monitor in a sequential relay mode, and one monitor in the network can also communicate with the Gateway, information from all monitors will reach the Gateway.

The rate at which power monitoring information is gathered from a cable depends primarily on the ratio of the number of monitors to the number of gateways. As an example, at a ratio of 100 monitors per Gateway, a Gateway should read from each cable every 5 to 15 seconds. The system will automatically reallocate network traffic across Gateways when new Gateways or devices are added. Ideally one Gateway shall be used for a maximum of every 150 Wireless DC Monitors reporting to the Gateway.

NETWORK ARCHITECTURE



MODULE IDENTIFICATION

Each monitor is assigned a specific identification code in the form of a 16 digit alpha numeric code which can be seen on the front of the module as well as a QR code which can be read to save the module identification.



Technical Specifications

Communications

Operating frequency	2.4 GHz
Wireless protocol	Proprietary frequency hopping, self-configuring, load-balancing mesh network
Wired network protocol	TCP/IP (one IP address needed per Gateway), support for Modbus TCP/IP and SNMP protocols
Firmware updates	Wireless
Typical transmission range	10 to 50 meters indoors from any one device to any other
Antenna	Fully enclosed, fixed configuration
Monitor to Gateway ratio	Up to 150 cables per gateway (unlimited Gateways per system)
Multi-site support	Yes
Encryption	Optional 128-bit

Environmental and Power Usage

Operating temperature	-7° to +70°C (+20° to +113°F)
Operating humidity	5% to 95% non-condensing
Water and dust resistance	Indoor applications
Max. operating altitude	3,300 meters (10,000 feet)
Power usage	< 0.25W

Outputs (Optional Display Module)

LED status indicators	Power (Red / Orange), Status (Red/Orange), Communications (Green)
Local display	3 Digit LED (cycles Amps, Volts, Watts by phase);
Monitored points	Voltage (V), Current (A), Power (W), (Ah)

Measured Parameters

System Level	Voltage (V), Current (A), Power (W), Energy Usage (Ah)
Measurement Category	Measurement Category IV (applicable to voltage monitor only)

Size and Weight

Voltage Monitor	52mm x 35mm x 25mm
Current Monitor (Integrated CT)	65mm x 35mm x 25mm
Current Monitor (Remote CT)	52mm x 35mm x 25mm
5 VDC Power Supply	90mm x 40mm x 30mm
Display Module / Wireless Hub	Display Bezel: 51 mm diameter x 20 mm H: Stem: 32 mm diameter x 13mm H
Remote CTs	Consult CT specification sheet

Safety Label

