INDUSTRIAL SHIELDS

Power Meter USER GUIDE

Power Meter User Guide

Revised February 2025

This user guide is for version Power Meter expansion module.

Preface

This User Guide has been implemented by Boot & Work, S.L. working under the name Industrial Shields.

Purpose of the manual

The information contained in this manual can be used as a reference to operate and get a better understanding of the technical data of the signal modules, power supply modules and interface modules.

Intended Audience

This User Guide is intended for the following audience:

- Persons in charge of introducing automation devices.
- Persons who design automation systems.
- Persons who install or connect automation devices.
- Persons who manage working automation installation.

Warnings:

- Unused pins should not be connected. Ignoring the directive may damage the controller.
- Improper use of this product may severely damage the controller.
- Refer to the controller’s User Guide regarding wiring considerations.
- Before using this product, it is the responsibility of the user to read the product’s User Guide and all accompanying documentation.
- Maintenance must be performed by qualified personnel familiarised with the construction, operation, and hazards involved with the control.
- Maintenance should be performed with the control out of operation and disconnected from all sources of power.
- Care should be taken when servicing electrostatic sensitive components. The manufacturer's recommendations for these components should be followed.
- The Power Meter modules are Open Type Controllers. It is required that you install the Power Meter module in a housing, cabinet, or electric control room. Entry to the housing, cabinet, or electric control room should be limited to authorised personnel. Failure to follow these installation requirements could result in severe personal injury

and/or property damage. Always follow these requirements when installing Power Meter modules.

- In case of installation or maintenance of the ESP32 14 please follow the instructions marked in the Installation and Maintenance section.
- Do not disconnect equipment when a flammable or combustible atmosphere is present. Disconnection of equipment when a flammable or combustible atmosphere is present may cause a fire or explosion which could result in death, serious injury and/or property damage.

Avertissements:

Les broches non utilisées ne doivent pas être connectées. Ignorer la directive peut endommager le contrôleur.

Une utilisation incorrecte de ce produit peut endommager gravement le contrôleur.

Reportez-vous au Guide de l'utilisateur du contrôleur pour les considérations de câblage.

Avant d'utiliser ce produit, il incombe à l'utilisateur de lire le Guide de l'utilisateur du produit et la documentation qui l'accompagne.

La maintenance doit être effectuée par personnel qualifié familiarisé avec la fabrication, le fonctionnement et les dangers liés au contrôleur.

La maintenance doit être effectuée avec l'équipement hors service et déconnectée de toutes les sources d'alimentation.

Faites attention lors de l'entretien des composants sensibles à l'électricité statique. Les recommandations du fabricant pour ces composants doivent être suivies.

Les automates de la famille Power Meter module sont des contrôleurs de type ouvert. Il est nécessaire d'installer l'automate Power Meter module dans un boîtier, une armoire ou une salle de contrôle électrique. L'accès au boîtier, à l'armoire ou à la salle de commande électrique doit être limité au personnel autorisé. Le non-respect de ces exigences d'installation peut entraîner des blessures graves et/ou des dommages matériels importants. Respectez toujours ces exigences lors de l'installation des automates de la famille Power Meter module.

En cas d'installation ou de maintenance du Power Meter module, veuillez suivre les instructions indiquées dans la section Installation et Maintenance.

Ne débranchez pas l'équipement en présence d'une atmosphère inflammable ou combustible. La déconnexion de l'équipement en présence d'une atmosphère inflammable ou combustible peut provoquer un incendie ou une explosion pouvant entraîner la mort, des blessures graves et/ou des dommages matériels.

Application Considerations and Warranty

Read and Understand this Manual

Please read and understand this manual before using the product. Please consult your comments or questions to Industrial Shields before using the product.

Application Consideration

THE PRODUCTS CONTAINED IN THIS DOCUMENT ARE NOT SAFETY RATED. THEY SHOULD NOT BE RELIED UPON AS A SAFETY COMPONENT OR PROTECTIVE DEVICE FOR ENSURING SAFETY OF PERSONS, AS THEY ARE NOT RATED OR DESIGNED FOR SUCH PURPOSES.

Please know and observe all prohibitions of use applicable to the products.

FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, NEVER USE THE INDUSTRIAL SHIELDS PRODUCTS.

NEVER USE THE INDUSTRIAL SHIELDS PRODUCTS BEFORE THEY ARE PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Industrial Shields shall not be responsible for conformity with any codes, regulations or standards that apply to the combination of products in the customer's application or use of the product.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses may be suitable for the products:

- Systems, machines, and equipment that could present a risk to life or property.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installation subject to separate industry or government regulations.
- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this document.

At the customer's request, INDUSTRIAL SHIELDS will provide applicable third-party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the system, machine, end product, or other application or use.

Intended use or of Industrial Shields products

Consider the following:

Industrial Shields products should only be used for the cases of application foreseen in the catalogue and the associated technical documentation. If third-party products and components are used, they must have been recommended or approved by Industrial Shields.

The correct and safe operation of the products requires that your transport, storage, installation, assembly, operation and maintenance have been carried out in a correct manner. It must respect the permissible ambient conditions. You should also follow the indications and warnings that appear in the associated documentation.

The product / system dealt with in this documentation should only be handled or manipulated by qualified personnel for the task entrusted and observing what is indicated in the documentation corresponding to it, particularly the safety instructions and warnings included in it. Due to their training and experience, qualified personnel are in a position to recognize risks resulting from the handling or manipulation of such products / systems and to avoid possible hazards.

Disclaimers

Weights and Dimensions

Dimensions and weights are nominal and they are not used for manufacturing purposes, even when tolerances are shown.

Performance Data

The performance data given in this manual is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of INDUSTRIAL SHIELDS's test conditions, and the users most correlate it to actual application requirements. Actual performance is subject to the INDUSTRIAL SHIELDS Warranty and Limitations of Liability.

Change in Specifications

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when features are changed, or published ratings or when significant construction changes are made. However, some specifications of the products may be changed without any notice. When in doubt, special numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your INDUSTRIAL SHIELDS representative at any time to confirm actual specifications of purchased products.

Errors and Omissions

The information in this document has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

Residual Risks

The control and drive components of an Industrial Shields PLC are approved for industrial and commercial use in industrial line supplies. Their use in public line supplies requires a different configuration and/or additional measures. These components may only be operated in closed housings or in higher-level control cabinets with protective covers that are closed, and when all of the protective devices are used. These components may only be handled by qualified and trained technical personnel who are knowledgeable and observe all of the safety information and instructions on the components and in the associated technical user documentation. When carrying out a risk assessment of a machine in accordance with the EU Machinery Directive, the machine manufacturer must consider the following residual risks associated with the control and drive components of a PDS.

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example: − Hardware defects and/or software errors in the sensors, controllers, actuators, and connection technology − Response times of the controller and drive − Operating and/or ambient conditions not within the scope of the specification − Condensation / conductive contamination − Parameterization, programming, cabling, and installation errors − Use of radio devices / cellular phones in the immediate vicinity of the controller − External influences / damage.

2. Exceptional temperatures as well as emissions of noise, particles, or gas caused by, for example: − Component malfunctions − Software errors − Operating and/or ambient conditions not within the scope of the specification − External influences / damage.

3. Hazardous shock voltages caused by, for example: − Component malfunctions − Influence of electrostatic charging − Induction of voltages in moving motors − Operating and/or ambient conditions not within the scope of the specification − Condensation / conductive contamination − External influences / damage

4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc. if they are too close.

5. Release of environmental pollutants or emissions because of improper operation of the system and/or failure to dispose of components safely and correctly.

Warranty and Limitations of Liability

Warranty

Industrial Shields's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by Industrial Shields.

INDUSTRIAL SHIELDS MAKES NO REPRESENTATION OR WARRANTY, EXPRESSED OR IMPLIED, REGARDING MERCHANTABILITY, NON-INFRINGEMENT, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. INDUSTRIAL SHIELDS DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED

Limitations of Liability

INDUSTRIAL SHIELDS SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS OR COMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

IN NO EVENT SHALL INDUSTRIAL SHIELDS BE RESPONSIBLE FOR WARRANTY, REPAIR OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS INDUSTRIAL SHIELDS'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Table of Contents

1. Power Meter Module: General Features

Power Meter MODULE		
Input Voltage	12 to 24Vdc ⎓	Fuse protection (2.5A) Polarity protection
Input rated voltage	24Vdc ⎓	
Rated Power	30W	
I Max.	1,5A	
Size	111x101x44	
Communications	I2C - RS232	DB-9 Connector

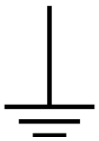
2. Technical Specifications

2.1 General Specifications

Item		Power Meter module
Power supply voltage	**DC power supply**	12 to 24 Vdc ⎓
Operating voltage range	**DC power supply**	11.4 to 25.4 Vdc ⎓
Power consumption	**DC power supply**	30 W min.
External power supply	**Power supply voltage**	24 Vdc ⎓
Insulation resistance		20mΩ min at 500Vdc between the AC terminals and the protective earth terminal.
Dielectric strength		2300Vac at 50/60Hz for one minute with a leakage current of 10mA max- Between all the external AC terminals and the protective ground terminal.
Shock resistance		80 m/s² in the X, Y and Z direction 2 times each,
Ambient temperature (operating)		0º to 50ºC with Raspberry OS Lite
Ambient humidity (operating)		10 % to 90 % (no condensation)
Ambient environment (operating)		With no corrosive gas
Ambient temperature (storage)		-20 º to 60 ºC
Power supply holding time		2 ms min.
Weight		208 g.

2.2 Symbology

Table that includes all the symbology that is used in the serigraph of the Power Meter Module:

Symbol	Standard No. / Standard Title	Standard Reference No. / Symbol Title	Symbol Meaning
	IEC 60417 / Graphical symbols for use on equipment	5031 / Direct Current	Indicates that the equipment is suitable for direct current only; to identify relevant terminals
	IEC 60417 / Graphical symbols for use on equipment	5032 / Alternating Current	Indicates that the equipment is suitable for alternating current only; to identify relevant terminals
	IEC 60417 / Graphical symbols for use on equipment	5130 / Pulse General	To identify the control by which a pulse is started.
	IEC 60417 / Graphical symbols for use on equipment	5017 / Earth, Ground	To identify an earth (ground) terminal in cases where neither the symbol 5018 nor 5019 is explicitly required.
	IEC 60417 / Graphical symbols for use on equipment	5115 / SIgnal lamp	To identify the switch by means of which the signal lamp(s) is (are) switched on or off.
	2004/108/EC / Electromagnetic Compatibility	CE Marking	CE marking indicates that a product complies with applicable European Union regulations
	ISO 7000/ Graphical symbols for use on equipment	0434B / Warning symbol	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury
	ISO 7000/ Graphical symbols for use on equipment	5036 / Dangerous Voltage	To indicate hazards arising from dangerous voltages

3. Precautions

Read this manual before attempting to use the Power Meter and follow its descriptions for reference during operation.

3.1 Intended Audience

This manual is intended for technicians, which must have knowledge on electrical systems.

3.2 General Precautions

The user must operate the Power Meter Module according to the performance specifications described in this manual.

Before using Power Meter under different conditions from what has been specified in this manual or integrating Power Meter Module to nuclear control systems, railroad systems, aviation systems, vehicles, combustion systems, medical equipment, amusement machines, safety equipment and other systems, machines, and equipment that may have a serious influence on lives and property if used improperly, consult your INDUSTRIAL SHIELDS representative. Ensure that the rating and performance characteristics of Power Meter Module are sufficient for the systems, machines, and equipment, and be sure to provide the systems, machines, and equipment double safety mechanisms. This manual provides information for programming and operating the Power Meter Module.

3.3 Isolation Precautions

Description:

This equipment does **not include galvanic isolation between the grounds** of the different systems. This means that if an external device or sensor that shares the same ground reference (GND) with the system is connected, any potential difference between these grounds could damage the connected components. To avoid issues with interference, ground loops, or damage to external equipment, ensure that all connected devices share the same ground reference or use systems with appropriate isolation.

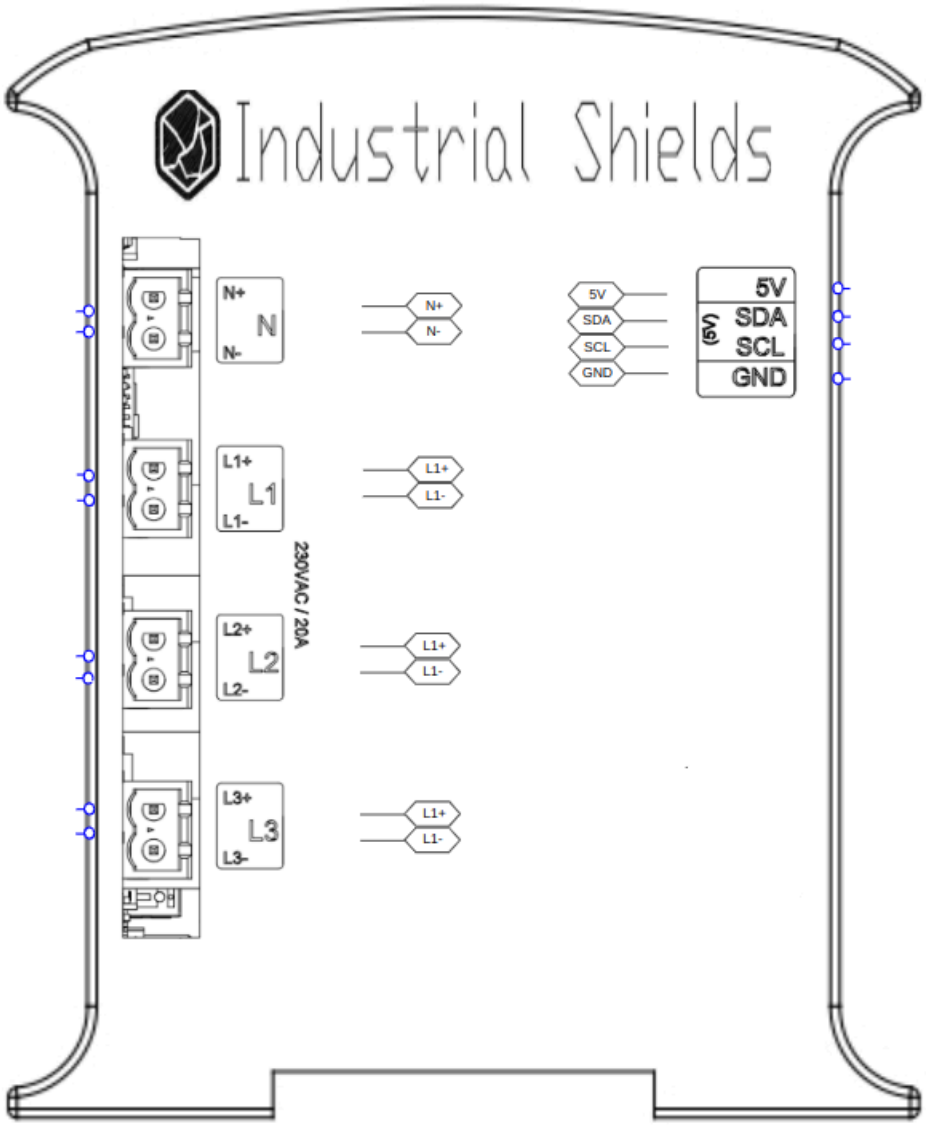
Recommendations:

- **Connection Review:** Verify that all ground connections are properly made and that there are no significant potential differences between them.
- **Use of Isolation:** Consider using **galvanic isolators** or **isolation transformers** if it is necessary to connect equipment with different ground references.

4. Power Meter Module serigraphy

Power Meter	Connector	Function
N+	N	Neutral
N+	N	Neutral
L1+	L1	Live1
L1+	L1	Live 1
L2+	L2	Live 2
L2+	L2	Live 2
L3+	L3	Live 3
L3+	L3	Live 3

Power Meter	Controller pin	Function
JTAG	-	JTAG
5V	-	Vcc
SDA	SDA	SDA (I2C)
SCL	SCL	SCL (I2C)
GND	GND	GND



5. Software set up

5.1 ESP32 PLC 14

The ESP32 PLC 14 with Power Meter module can be tested with the following Arduino IDE sketch:

To set-up and configure the module:

```
#include "PowerMeter.h"

PowerMeterCommunication com = PLC;
PowerMeterChannel channelA = CHA;
PowerMeterChannel channelB = CHB;
PowerMeterChannel channelC = CHC;
void setup() {
	// Initialize serial communication at 115200 baud rate
	Serial.begin(115200);
	Wire.begin();
	// Start communication with Power Meter (assuming PLC is the mode)
	delay(1000);
	selectCom(com);
}
```

To read its values the following functions can be used:

```
Serial.println((float)get_VRMS(channelX) / 1000.0, 3);
Serial.println((float)get_IRMS(channelX) / 1000.0, 3);
Serial.println((float)get_VPEAK(channelX) / 1000.0, 3);
Serial.println((float)get_IPEAK(channelX) / 1000000.0, 3);
Serial.println((float)get_PowerFactor(channelX) / 10000.0, 3);
Serial.println((float)get_Frequency(channelX) / 100.0, 3);
Serial.println((float)get_ActivePower(channelX) / 1000000.0, 3);
Serial.println((float)get_ReactivePower(channelX) / 1000000.0, 3);
Serial.println((float)get_ApparentPower(channelX) / 1000000.0, 3);
```

Where “channelX” can be either “channelA”, “channelB” or “channelC”, which stand for the 3 different live lines .

For the Powermeter source files, refer to this blog post.

6. I/Os Communications

6.1 RS-232

The DB-9 connector, located at the top of the Power Meter module, is used to calibrate and read the data that the Power Meter reads through its L1+, L2+ and L3+ connections. It is **NOT** designed to work as a conventional RS-232 communication protocol, and it is not connected to the controller in any way.

The DB-9 connector is directly connected to the MSP430 microcontroller, and communicates using the Energy Measurement Design Center (EMDC) communication protocol, allowing the user to both read and calibrate de MSP430 at any given time.

6.2 JTAG

The JTAG module, located on the side of the Power Meter module, is used in order to program the MSP430 microcontroller.

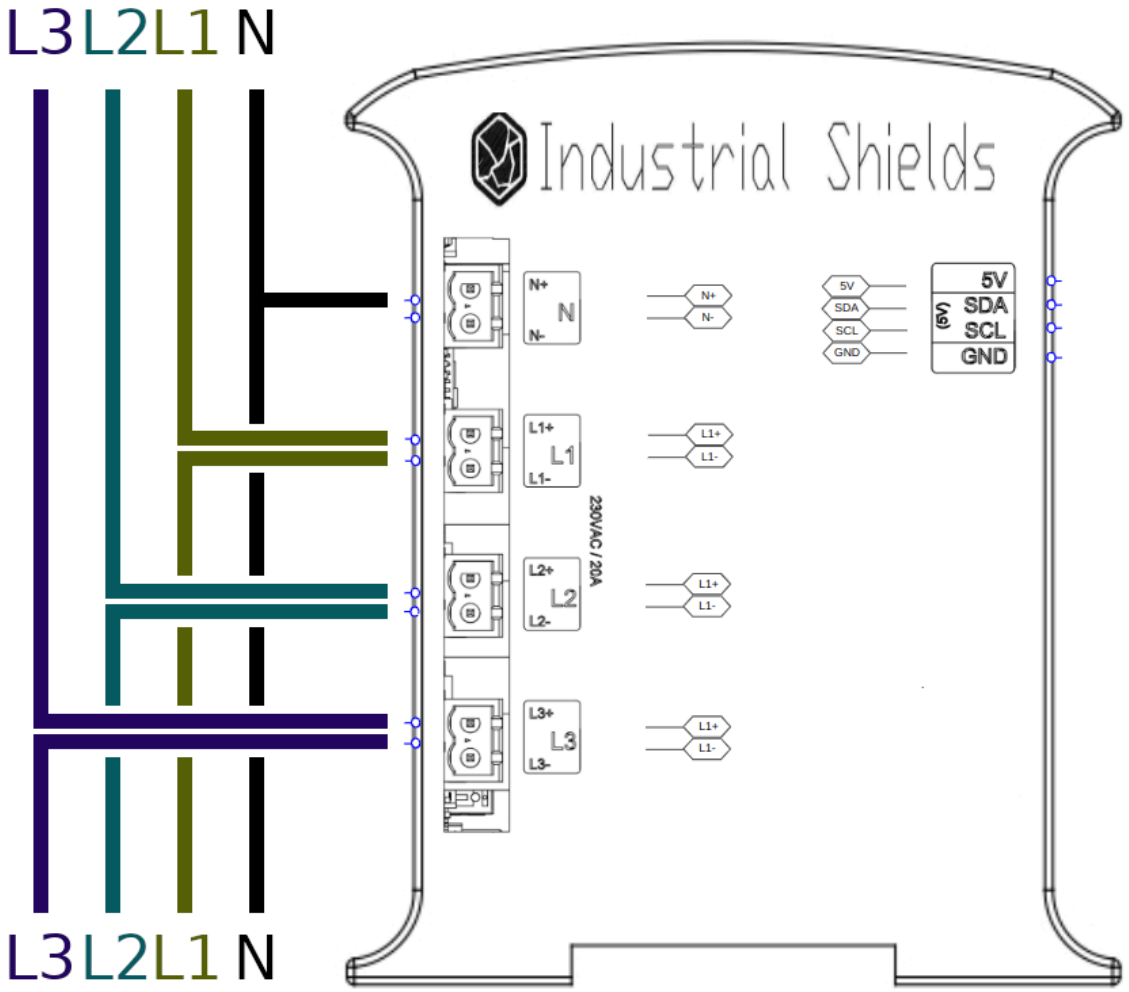
6.3 I2C

The I2C protocol is meant to work in a pull-up configuration. A pull-up configuration means that when the pin is at rest (nothing connected to it) it always reads a HIGH value. In this case it reads 5V when nothing is connected. The pull-up configuration is established by default in these pins.

The I2C communication can be achieved by using the Wire library from Arduino. Additionally, the Arduino IDE offers some examples under “File > Examples > Wire” such as “WireScan.ino” to scan the available I2C addresses.

Industrial Shields has developed an I2C library for easy intercommunication with the Power Meter module, but not all available tools are included. For a full understanding of the Energy Measurement Design Center (EMDC) communication protocol, which is the protocol the chip works with, refer to its Communication Protocol Spec.

7. Typical Connections



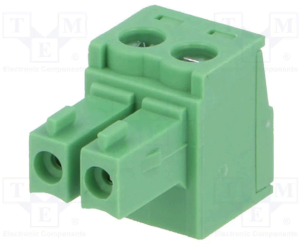
8. Connector details

For power supply there is a 15EDGK-3.81-02P-14-00A(H) connector from NINGBO.

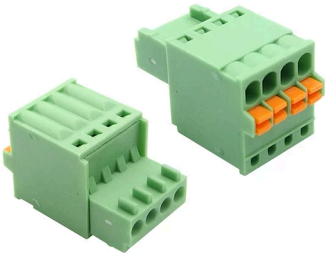
For I2C pinout there is a 15EDGKD-2.5-4P connector from NINGBO.

For power supply there is a 2EDGK-7.62-2P-14 connector from NINGBO.

Article reference	15EDGK-3.81-2P
Pitch	2,5mm
Wire Range	28-16AWG 1,5mm2
Voltage Rating	300V(UL)/250V(IEC)
Current Rating	8A(UL)/7A(IEC)



Article reference	15EDGKD-2.5-4P
Pitch	3,81mm
Wire Range	126-20AWG 0.5mm2
Voltage Rating	150V(UL)/250V(IEC)
Current Rating	4A(UL)/5A(IEC)



Article reference	2EDGK-7.62-2P
Pitch	5,08mm
Wire Range	28-12AWG 2,5mm2
Voltage Rating	300V(UL)/400V(IEC)
Current Rating	15A(UL)/20A(IEC)

9. Installation and Maintenance

Notes for installation:

- The installation position should be free from the following: dust or oil smoke, conductive dust, corrosive or flammable gas, high temperature, condensation, and rain.
- Besides, vibration and impact also affect the PLC normal operation and shorten its lifespan; electric shock, fire or misact also damages the product. During drilling or wiring, prevent the metal particles or wire segments from falling into the PLC casing, which may cause fire, fault or misact.
- After the PLC installation, clean the ventilation duct to prevent blocking, which may cause bad ventilation, or even fire, faults or misact.
- Do not online connect, plug or unplug cables, which are apt to cause electric shock or damage the circuit. Installation and wire connection must be firm and reliable. Poor connection could cause a misact.
- Use shielded twisted pairs for the I/O of high frequency signal and analog signal to improve system IMS.

The installation environment should be free from dust, oil smoke, conductive particles, corrosive or flammable gases, high temperature, condensation, and rain.

Besides, vibration and impact also affect the PLC normal operation and shorten its lifespan. It is recommended to install the PLC, together with the matching switches and contactors, in a dedicated electric cabinet and keep the cabinet ventilated. If the location has high ambient temperature or heat generating equipment nearby, install forced convection devices on top or sides of the cabinet to avoid over-temperature. During drilling or wiring, prevent the metal particles or wire segments from falling into the PLC casing, which may cause fire, fault or misact. After the PLC installation, clean the ventilation duct to prevent blocking, which may cause bad ventilation, or even fire, faults or misact.

The only way to disconnect the equipment from the electrical network is by removing the connectors that feed the equipment. Once installed in the electrical cabinet it is very important to ensure the power connectors for proper operation.

Separate the Power Meter MODULE from heat, high voltage and electrical noise:

Always separate the devices that generate high voltage and high electrical noise from the Power Meter Module. When configuring the layout of the Power Meter Module inside your panel, consider the heat-generating devices and locate the electronic-type devices in the cooler areas of your cabinet. Reducing the exposure to a high-temperature environment will extend the operating life of any electronic device. Also consider the routing of the wiring for the devices in the electric cabinet. Avoid placing low-voltage signal wires and communications cables in the same tray with AC power wiring and high energy, rapidly switched DC wiring.

Provide adequate clearance for cooling and wiring Power Meter Module. It is designed for natural convection cooling. For proper cooling, you must provide a clearance of at least 25 cm above and below the devices. Also, allow at least 25 cm of depth between the front of the modules and the inside of the enclosure.

Notes for maintenance:

A well-planned and executed maintenance program is essential to the satisfactory operation of solid-state electrical equipment. The kind and frequency of the maintenance operation will vary with the kind and complexity of the equipment as well as with the nature of the operating conditions. Maintenance recommendations of the manufacturer or appropriate product standards should be followed.

The following factors should be considered when formulating a maintenance program:

- Maintenance must be performed by qualified personnel familiar with the construction, operation, and hazards involved with the control.
- Maintenance should be performed with the control out of operation and disconnected from all sources of power.
- Care should be taken when servicing electrostatic sensitive components. The manufacturer's recommendations for these components should be followed.
- Ventilation passages should be kept open. If the equipment depends upon auxiliary cooling, e.g., air, water, or oil, periodic inspection (with filter replacement when necessary) should be made of these systems.
- The means employed for grounding or insulating the equipment from ground should be checked to assure its integrity.
- Accumulations of dust and dirt on all parts, including on semiconductor heat sinks, should be removed according to the manufacturer's instructions, if provided; otherwise, the manufacturer should be consulted. Care must be taken to avoid damaging any delicate components and to avoid displacing dust, dirt, or debris in a way that permits it to enter or settle into parts of the control equipment.
- Enclosures should be inspected for evidence of deterioration. Accumulated dust and dirt should be removed from the top of the enclosures before opening doors or removing covers.
- Certain hazardous materials removed as part of maintenance or repair procedure (e.g., polychlorinated biphenyls (PCBs) found in some liquid filled capacitors) must be disposed of as described in Federal regulations.

Safety rules for maintenance personnel

Consider the following steps to follow. A false manoeuvre could be the cause of an accident or material damage.

Do not disassemble or modify the modules. This could lead to breakdowns or malfunctions and could lead to injuries or fire.

- All types of radio communication devices, including mobile phones and personal handy-phone systems (PHS), must be kept more than **25cm** away from the PLC in all directions. Failure to observe this precaution exposes malfunctions caused by excess temperature.

- Disconnect the external power supply of the system (on all phases) before connecting or disconnecting a module. Failure to observe this precaution may cause faults or malfunctions of the module.
- Tighten the screws of the terminal ports and the screws of the connectors within the prescribed tightening torque. Insufficient tightening can lead to loose parts or wires and cause malfunctions. Excessive tightening can damage the screws and / or the module, with the risk of falling, short circuits and malfunctions.
- Before handling a module, dispose of the electrostatic charge accumulated by the human body by touching a suitable conductive object. Failure to observe this precaution may cause faults or malfunctions of the module.

Repair note:

If the equipment is suitable to be repaired, it must be verified that the equipment remains in a safe state after repair.

10. Revision Table

Revision Number	Date	Changes
0	12/02/2025	First Implementation

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