iPMCC
Thermal monitoring system

Implementation & commissioning guide

Life Is On | Schneider Electric

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1. Purpose

This guide is dedicated to the implementation and the commissioning, inside low voltage switchboards, of the solutions and architectures developed for the thermal monitoring of the bus bars and connections. Not considered, the implementation inside functional units or outgoing connections of the functional units. This solution can mitigate downtime, enhance safety, and even help reduce insurance premiums related to fire risks.

The guide covers the installation, the wiring, the setting and the functional testing of connected products and digital architectures where they are incorporated.

Note: The rules and recommendations given in this guide are focused on the implementation and commissioning of iPMCC solutions and architectures in low voltage switchboards. When used in other contexts the operation and the performances of the solutions can't be guaranteed.

The rules and recommendations apply to digital architectures implementation and the related products. The settings are limited to the key parameters of the communication. No information regarding the implementation and settings of the electrical functions supported by the products is given in this guide.

2. Safety information

2.1 Important information

Read these instructions carefully before trying to install, configure, or operate the system. The following special messages may appear throughout this document or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER
DANGER indicates an imminently hazardous situation which, if not avoided, **will result** in death or serious injury.

WARNING
WARNING indicates a potentially hazardous situation which, if not avoided, **can result** in death or serious injury.

CAUTION
CAUTION indicates a potentially hazardous situation which, if not avoided, **can result** in minor or moderate injury.

NOTICE
NOTICE is used to address practices not related to physical injury. The safety alert symbol shall not be used with this signal word. Failure to follow these instructions **can result** in equipment damage.

2.2 Please Note

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is accepted by Schneider Electric for any consequences arising from the use of this equipment.

A qualified person is one who has skills and knowledge related to the construction, installation, and operation of electrical equipment and has received safety training to recognize and avoid the hazards involved.

2.3 Safety Precautions

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Only qualified personnel familiar with low and medium voltage equipment are to perform the work described in this set of instructions. Workers must understand the hazards involved in working with or near low and medium voltage circuits.
- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See applicable local standards.
- Perform such work only after reading and understanding all of the instructions contained in this bulletin.
- Turn off all power before working on or inside equipment.
- Before performing visual inspections, tests, or maintenance on the equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, grounded, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of back feeding.
- Handle this equipment carefully and install, operate, and maintain it correctly in order for it to function properly. Neglecting fundamental installation and maintenance requirements may lead to personal injury, as well as damage to electrical equipment or other property.
- Do not make any modifications to the equipment or operate the system with the interlocks removed. Contact your local field sales representative for additional instruction if the equipment does not function as described in this manual.
- Carefully inspect your work area and remove any tools and objects left inside the equipment.
- Replace all devices, doors and covers before turning on power to this equipment.
- All instructions in this manual are written with the assumption that the customer has taken these measures before performing maintenance or testing.
- Turn off all power supplying this device and the equipment in which it is installed before working on the device or equipment.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Do not exceed the device's ratings for maximum limits.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme shall consider the potential failure modes of paths and, for certain critical control functions, shall provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and over travel stop.
- Separate or redundant control paths shall be provided for critical control functions.
- System control paths may include communication links. Consideration shall be given to the implications of anticipated transmission delays or failures of the link. *
- Each implementation of equipment utilizing communication links shall be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury or equipment damage.

*** For additional information about anticipated transmission delays or failures of the link, refer to NEMA ICS 1.1 (latest edition), *Safety Guidelines for the Application, Installation and Maintenance of Solid State Control* or its equivalent in your specific country, language, and/or location.**

The architecture described in this document has been fully tested and validated in our laboratories using all the specific device and accessory references available throughout this document. Of course, your specific application requirements may be different and will require additional and/or different components. In this case, information provided in this document shall be adapted to your specific needs. To do this, you will need to consult the specific product documentation of the components that you are substituting in this architecture. Pay attention in conforming to any safety information, different electrical requirements and normative standards that would apply to your adaptation.

It should be noted that there are some major components in the architecture described in this document that cannot be substituted without completely invalidating the architecture, descriptions, instructions, wiring diagrams and compatibility between the various software / firmware and hardware components specified herein. You must be aware of the consequences of component substitution in the architecture described in this document, as substitutions may impair the compatibility and interoperability of software and hardware.

⚠ CAUTION

EQUIPMENT INCOMPATIBILITY OR INOPERABLE EQUIPMENT

Read and thoroughly understand all hardware and software documentation and specification before attempting any component substitutions.

Failure to follow these instructions can result in injury or equipment damage.

3. About the document

3.1 References

The following table lists the documents which can be used to become familiar with the content of this guide.

Title	Doc number / name	Date - version
Easergy CL110 - Installation and Operation Manual	QGH40088-03	10/2019
Easergy TH110 Installation and Operation Manual	NVE62740-01	12/2020
EcoStruxure Panel Server Universal - Installation Sheet	GDE74119-02	10/2020
EcoStruxure Panel Server Universal User Guide	DOCA0172EN-00	05/2021
Okken Communications Cabling & Wiring Guide	DSED619001EN	09/2017

Table 1: Reference documents

Note: all documents and software can be found on the Schneider Electric website: https://www.se.com

3.2 Glossary

Term	Description
ACB	Air Circuit Breakers
EPC-D	EcoStruxure Power Commission Desktop version
iPMCC	intelligent Power & Motor Control Center
MCC	Motor Control Center
MCCB	Molded Case Circuit Breakers
PCC	Power Control Center
PLC	Programmable Logic Controller
PM	Power Meter
RF	Radio Frequency
SCADA	Supervisory Control And Data Acquisition
SF	Self-supervision Functionality

Table 2: Glossary

3.3 Prerequisites

The following prerequisites are recommended to correctly implement the solutions and architectures considered in this guide. This applies to:

- The networks and communication protocols used in the architectures:
  - IEEE802.15.4 protocol
  - Ethernet network
  - Modbus TCP/IP protocol
- The products used in the architectures:
  - EcoStruxure Panel Server Universal PAS600- L or T
  - Thermal sensor TH110
- The software used in the architecture:
  - EcoStruxure Power Commission Desktop is the software that helps to set up, test and commission the EcoStruxure Panel Server Universal (PAS600).
- Specific technical knowledges:
  - Radiofrequency propagation
- The EMC rules and recommendations for correct installation and wiring of digital devices inside low voltage switchboards, please refer to Okken Communications Cabling & Wiring Guide in chapter 3.1 References.

4. General implementation rules

4.1 List of the products incorporated in the architecture

The thermal monitoring system dedicated to low and high voltage switchboards or assemblies is built with the following connected products:

- EcoStruxure Panel Server Universal
- Easergy TH110 temperature sensor

EcoStruxure Panel Server is a high-performance gateway, a range of products to meet your requirements today and tomorrow. Panel Server provides easy and fast connection to edge control software such as EcoStruxure Power Monitoring Expert or to your BMS systems, and to cloud applications such as EcoStruxure Facility Expert and Asset Advisor

- All-in-one gateway to retrieve data from both your Wireless sensors and Modbus devices, and optimize your energy management solution
- Ease of commissioning with EcoStruxure Power Commission tool, enabling device plug & play and auto discovery features
- Ease of operation with user friendly embedded webpages, and data contextualization for more relevant analytics
- Enhanced Cybersecurity, designed through a Development Life Cycle in accordance to IEC 62443-4-1 and certified against IEC 62443 SL1

Equipped with several communication protocols (including Ethernet, IEEE802.15.4 wireless sensors, Bluetooth®, Wi-Fi, and optional cellular routers), the Panel Server adapts to fast evolving communication technologies.

Easergy TH110 (ref EMS59440) is a battery less and wireless temperature sensor. It is intended to be used within indoor low and high voltage switchboard or assemblies to monitor the temperatures of any live connection. This sensor is self-powered thanks to a ferromagnetic ribbon fixed on bus bars enabling energy harvesting. Easergy TH110 sensors communicate with the EcoStruxure Panel Server Universal access point using ZigBee Green power protocol.

For thermal monitoring applications, up to 65 wireless devices can be connected to a single EcoStruxure Panel Server Universal.

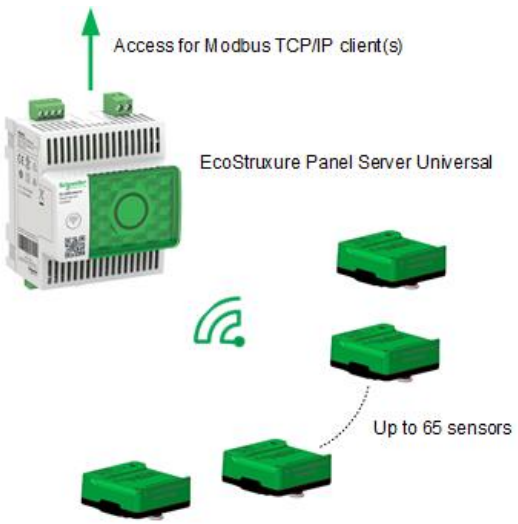


Figure 1: Thermal monitoring architecture

Note: Up to 100 wireless devices will be connectable to a single EcoStruxure Panel Server Universal in a future firmware update. Please refer to EcoStruxure Panel Server Universal User Guide in chapter 3.1 References for more information.

4.2 Received Signal Strength Indicator (RSSI)

The quality of the Radio Frequency (RF) communication between an EcoStruxure Panel Server Universal and each paired Easergy TH110 sensor can be evaluated by using a key parameter which is the Received Signal Strength Indicator (RSSI).

RSSI (unit dBm) decreases when:

- Distance between the EcoStruxure Panel Server Universal and TH110 increases
- The RF signal needs to go across a separation plate

To guaranty a robust RF communication, RSSI must be superior to -75 dBm

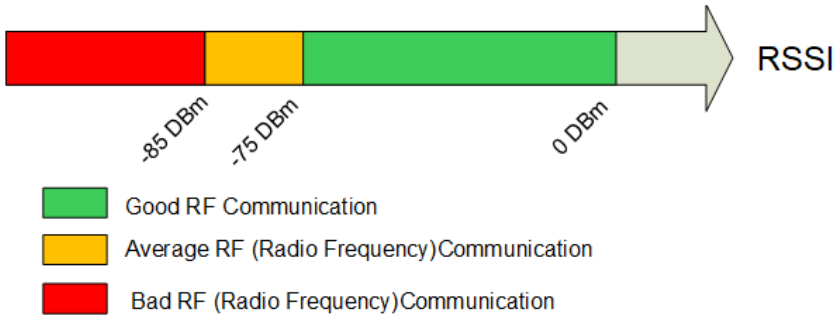


Figure 2: RSSI level

Due to the high density of metal partition in Okken switchboard, the position of the EcoStruxure Panel Server Universal is the key-factor of success.

4.3 TH110 sensors positioning

4.3.1 Thermal monitoring of ACB connections

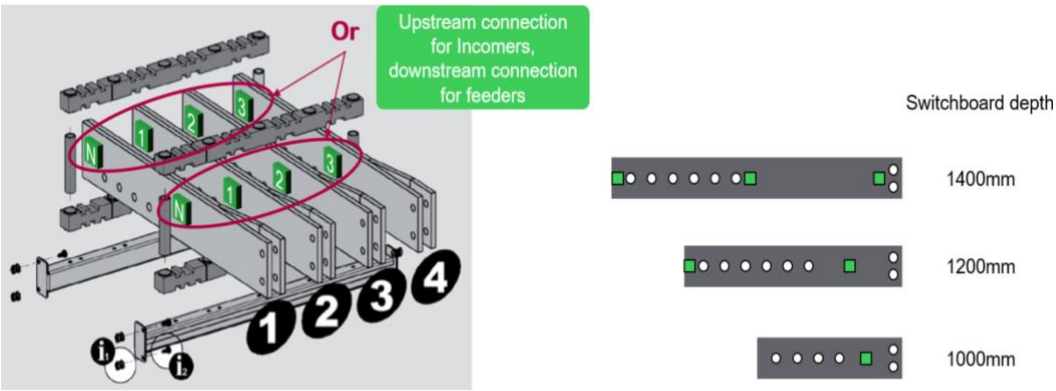


Figure 3: TH110 sensors positions for thermal monitoring of ACB upstream connection for incomers and downstream connection for feeders

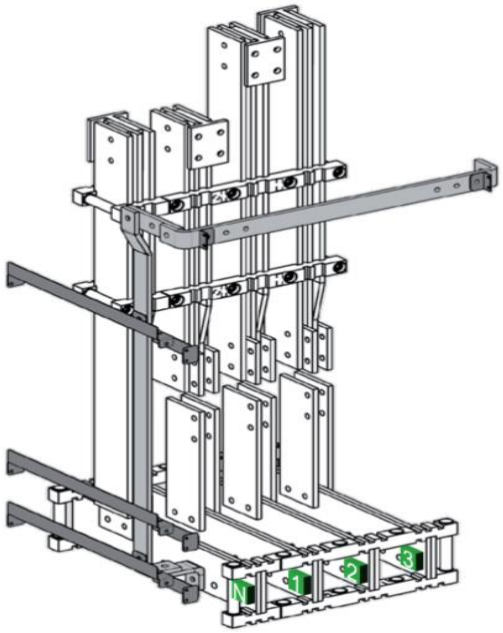


Figure 4: TH110 sensor positions for thermal monitoring of ACB - Bottom Direct Connection

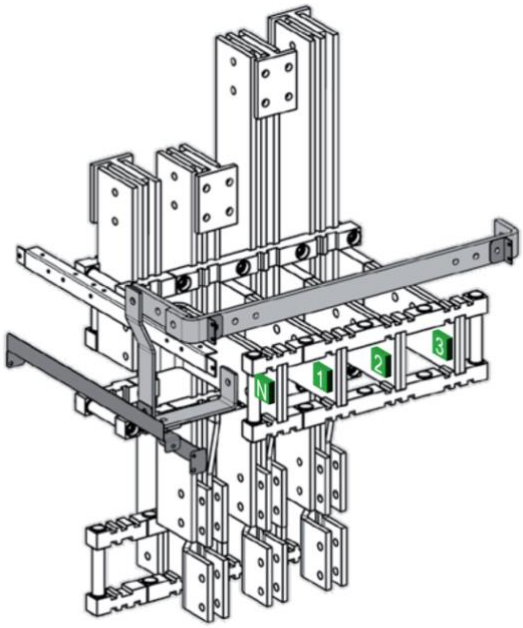


Figure 5: TH110 sensor positions for thermal monitoring of ACB - Top Direct Connection

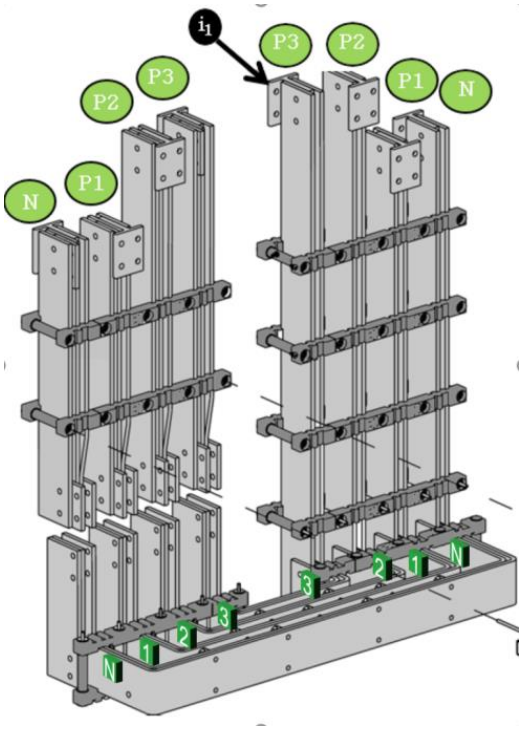


Figure 6: TH110 sensor positions for thermal monitoring of ACB coupling

4.3.2 Thermal monitoring of horizontal and vertical bus bars

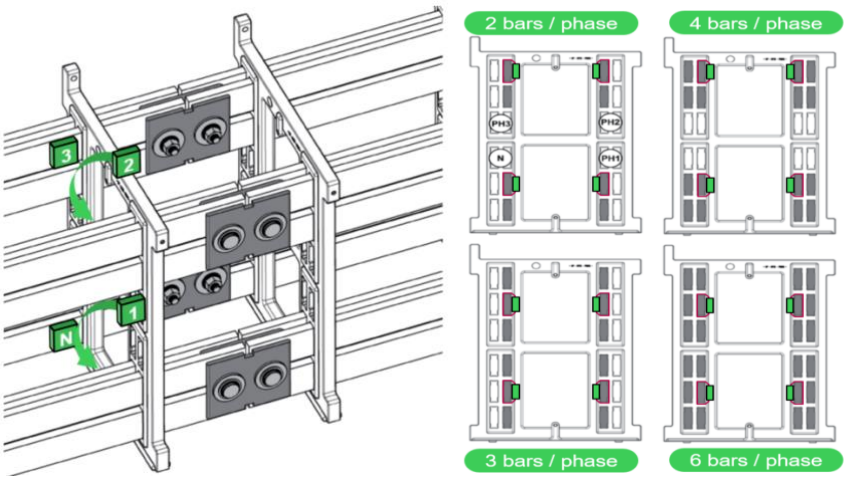


Figure 7: TH110 sensor positions for thermal monitoring of fishplates – Horizontal Bus Bar

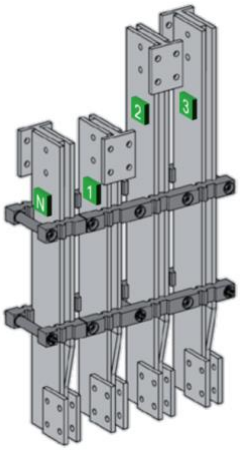


Figure 8: TH110 sensor positions for HBB VBB thermal monitoring

4.4 EcoStruxure Panel Server installation

4.4.1 Position of the EcoStruxure Panel Server inside OKKEN switchboard

EcoStruxure Panel Server Universal access point is a sensitive electronic device which needs to be mounted in an area with acceptable humidity and temperature conditions.

This type of area is characterized by a pollution degree **2 or 3**.

- Pollution degree 2 for the PAS600T (240 V AC)
- Pollution degree 3 for the PAS600L (24 V DC)

Note: From RF point of view, the best solution to maximize performances is to mount the EcoStruxure Panel Server Universal close to the TH110 sensors located in bus bars or ACB connections. However, Temperature and humidity conditions in these compartments of the Okken switchboard are less tolerant and characterized by a pollution degree 3 which doesn't allow to mount the EcoStruxure Panel Server Universal PAS600T inside.

A good compromise is to install the EcoStruxure Panel Server Universal in a dedicated compartment characterized by a lower degree of pollution as shown hereunder.

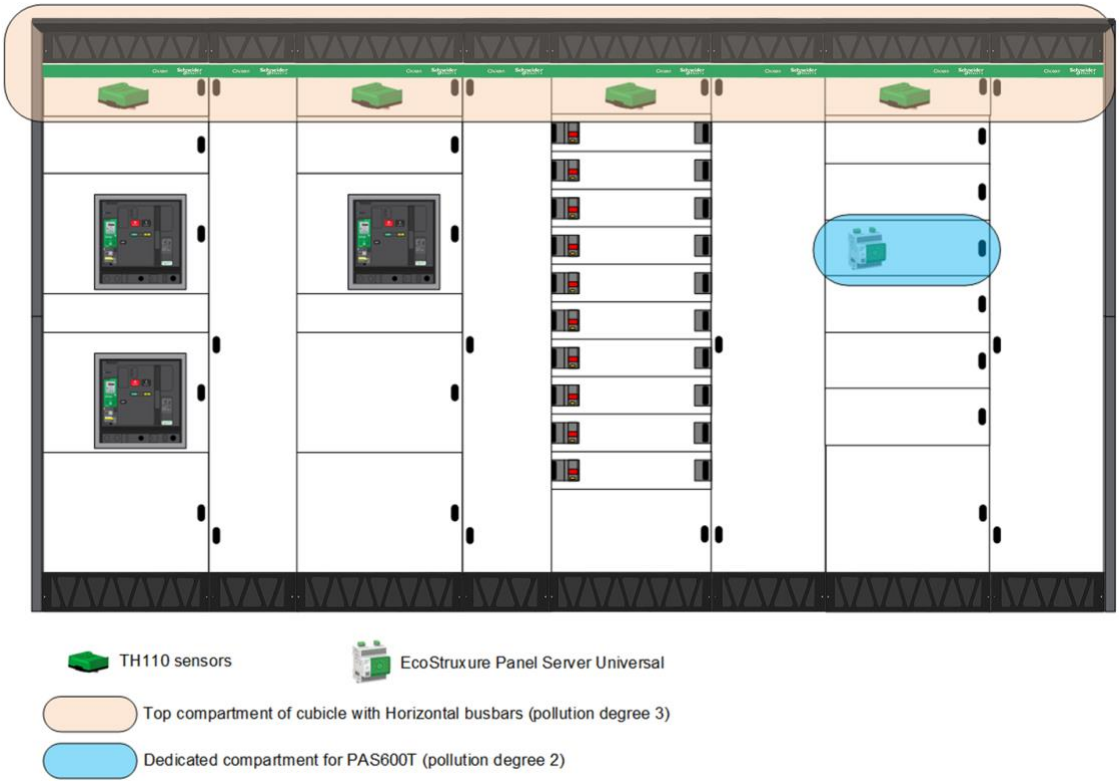


Figure 9: EcoStruxure Panel Server Universal position in an Okken switchboard

4.4.2 Radio frequency channel

The wireless channel is obtained automatically (default setting). We recommend keeping this setting. To do it manually, refer to EcoStruxure Panel Server Universal User Guide in chapter 3.1 References.

Note: Once the channel mode has been changed from Auto to Manual, it is not possible to configure it back to Auto.
Automatic channel selection is performed once, when the IEEE 802.15.4 network is first established.
Architectures implementation and commissioning.

4.5 TH 110 sensors, EcoStruxure Panel Server Universal rules of installation

Thermal Monitored switchboard part	EcoStruxure Panel Server Universal			Monitored connection	TH110 sensors		
	Reference	**Quantity**	**Position**		**Reference**	**Quantity**	**Position**
Incomers upstream connection and feeders downstream connection	PAS600	• 1 per 5 MasterPact cubicle • Max of 65 TH110 sensors connected to the PAS600	Refer to Chapter **4.4.1**	MasterPact Incomer upstream connection MasterPact Feeder downstream connection MasterPact coupling	EMS59440 (3 sensors set)	Depending of the number of connections	Refer to chapter **4.3.1**
Horizontal and vertical busbars		• 1 per 10 linear meters of linear switchboard (5 m on each side of the PAS600) • Max of 65 TH110 sensors connected to the PAS600	Refer to Chapter **4.4.1**	Fishplate for connection of two HBB HBB/VBB Link			Refer to chapter **4.3.2**

Note:

For Horizontal and vertical busbars, the recommended maximum distance between a sensor and the access point in an iPMCC switchboard is 4 columns in form 4b. This distance can be achieved thanks to the “tunnel” around the busbars which creates favorable conditions for RF propagation. For more information and detailed results, please refer to chapter 6 Annex.

5. Architectures implementation and commissioning

5.1 Architecture

The thermal monitoring system (EcoStruxure Panel Server Universal access points and Easergy TH110 sensors) communicates natively in Modbus TCP/IP. Therefore, it can be directly connected to the iPMCC Ethernet backbone to offer the possibility to be requested by clients (PLC, SCADA, DCS…) in Modbus TCP/IP.

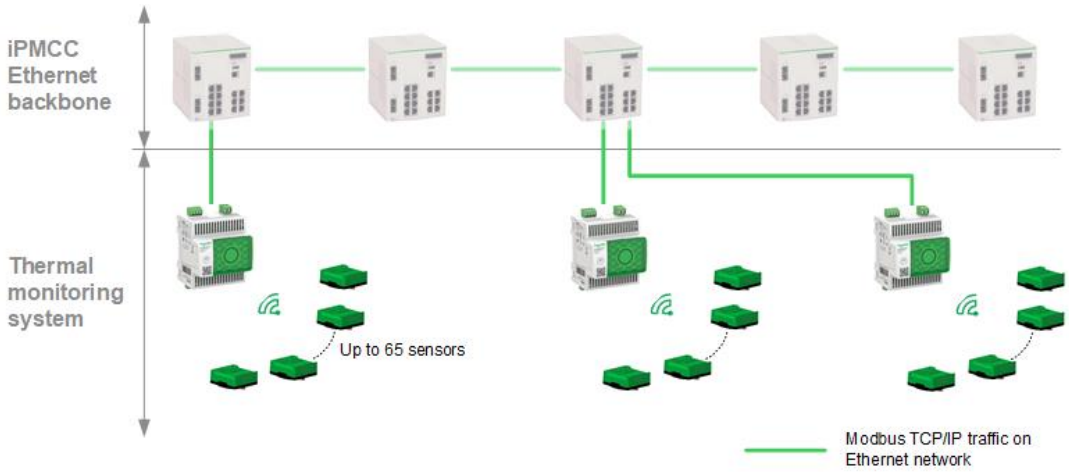


Figure 10: Digital architecture for thermal monitoring system

5.2 EcoStruxure Panel Server Universal Modbus table

The EcoStruxure Panel Server Universal concentrates measure of 65 Easergy TH110 sensors (max) in a Modbus table from register 10 (Decimal 1 Based) to register 529.

Register map for a sensor is described in following table. X is the ID of the sensor (Between 0 to 59).

Data Description	Unit	Modbus Address	Format
Battery Voltage	V	3315	Float32
Busbar Temperature value	°C	4000	Float32
Relative Humidity value (Example: 50% represented as 0.50)	% x100	4006	Float32
PER - Maximum value between Device and Gateway	%	31146	Float32
RSSI - Minimal value between Device and Gateway	dB	31148	Float32
LQI - Minimal value between Device and Gateway	NA	31150	UNIT16

Note: The data transmission period is 1 minute.

5.3 Configuration & setting

The following chapters explain a use case with a static IP address for the PAS600 and how to establish the communication with Zigbee devices.

To implement the TH110 solution, the EcoStruxure Panel Server Universal (PAS600) needs to be commissioned before having the possibility to pair the TH110.

The EcoStruxure Panel Server commissioning can be performed following the two possibilities:

- Using the software EcoStruxure Power Commission (EPC)
- From the EcoStruxure Panel Server webpages

It is recommended to use the software EcoStruxure Power Commission (EPC) to perform the commissioning of the EcoStruxure Panel Server (PAS600).

To install EcoStruxure Power Commission (EPC) software on your PC proceed as follow:

> Search for EcoStruxure Power Commission on “se.com” website.
> Download EcoStruxure Power Commission (EPC) software.
> Install EPC on your PC.

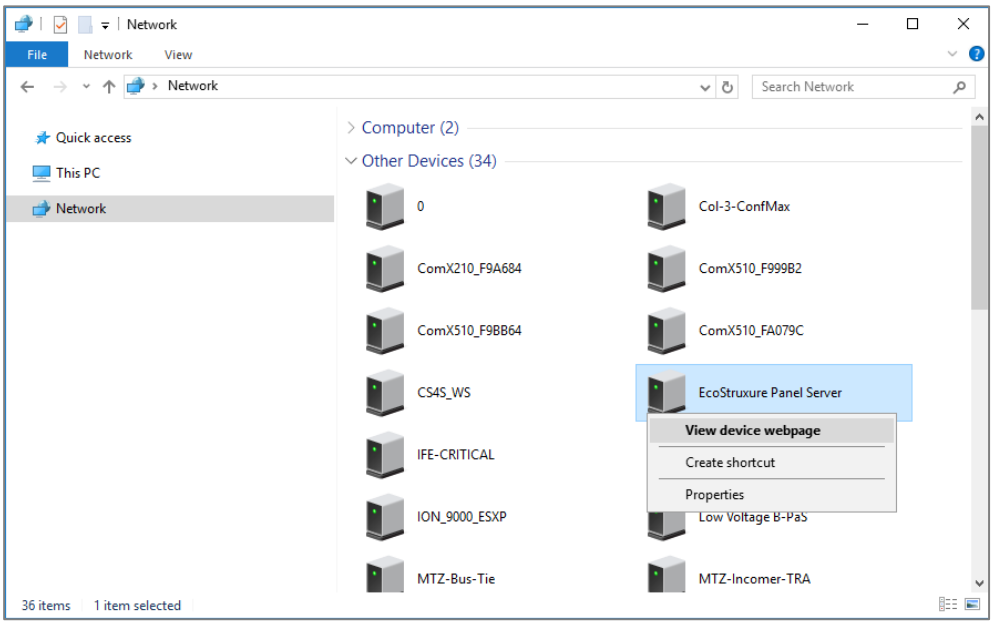
However, the first connection to the PAS600 is easily done through the webpages.

5.3.1 Commissioning a new EcoStruxure Panel Server Universal with a static IP address

5.3.1.1 1st connection to the PAS600

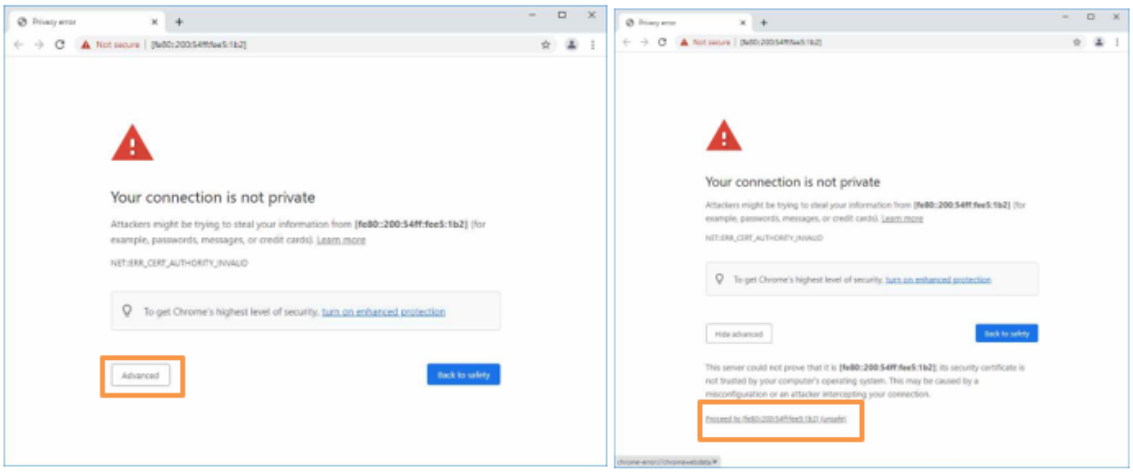
> Connect your computer to the same Ethernet network than the PAS600 and make sure that IPv6 is enabled.
> Connect the PAS600 to the Ethernet network.
> Go to “Network” in “Windows Explorer”.

If the “EcoStruxure Panel Server” appears in “other devices” then right click on the device and select “view device webpage”.
If the “EcoStruxure Panel Server” doesn’t appears then refresh the window until it appears.

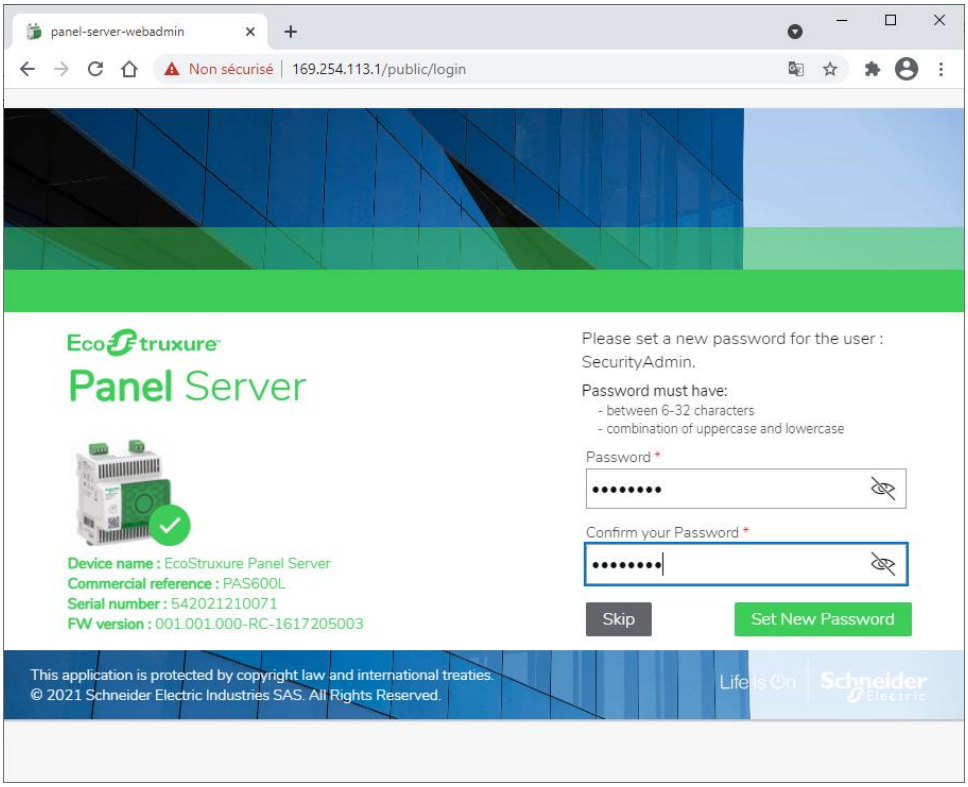


The EcoStruxure Panel Server has a self-signed security certificate. A security message appears on the web browser when connecting to the EcoStruxure Panel Server. Before accepting and continuing, check that communication with the EcoStruxure Panel Server has been established.

> Then select “advanced” and “proceed”.

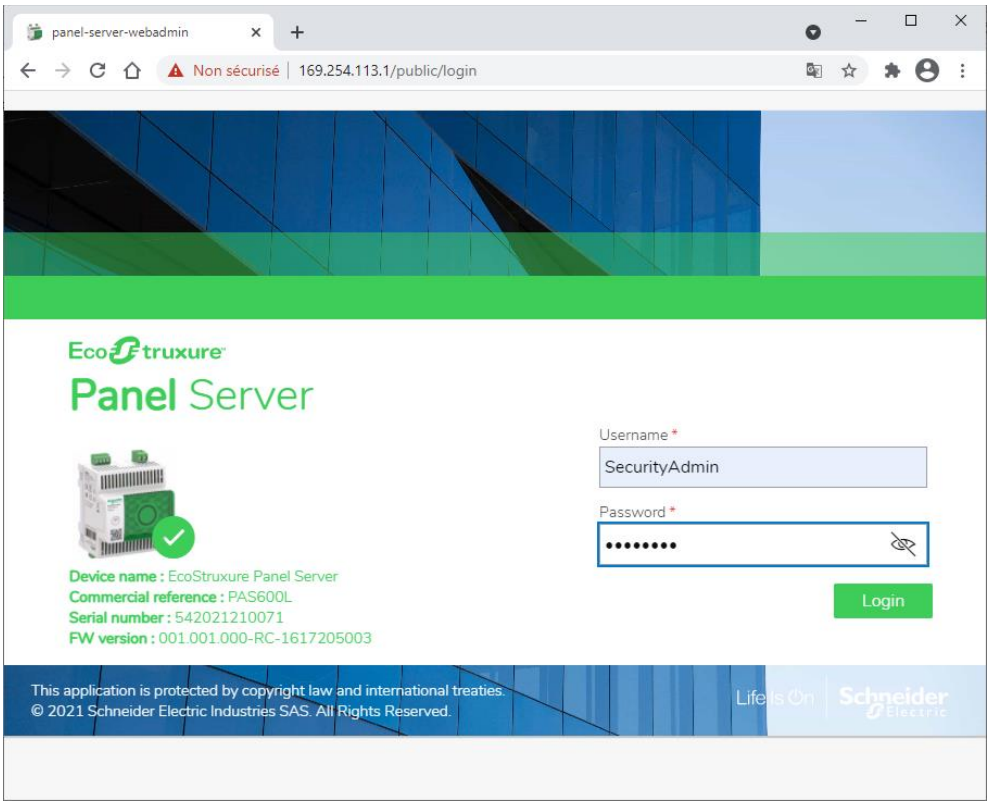


It’s the first time the PAS600 is commissioned so the password must be changed.



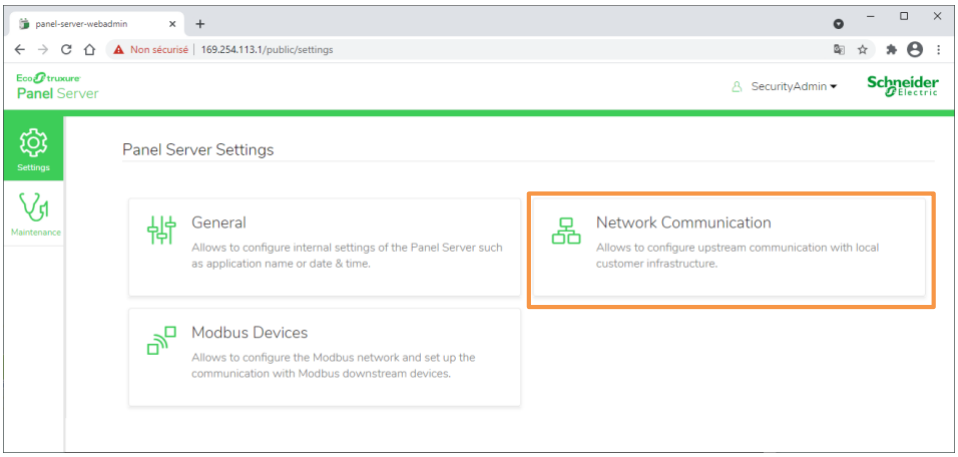
It is now possible to enter the login and password just created.

> Login is: “SecurityAdmin”.

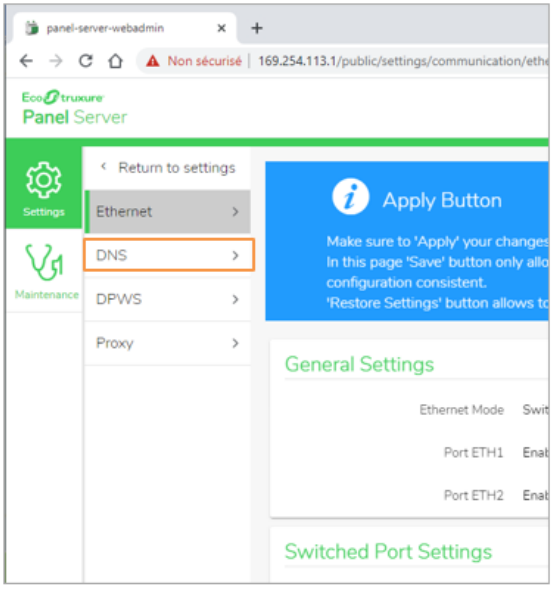


5.3.1.2 Set a static IP address

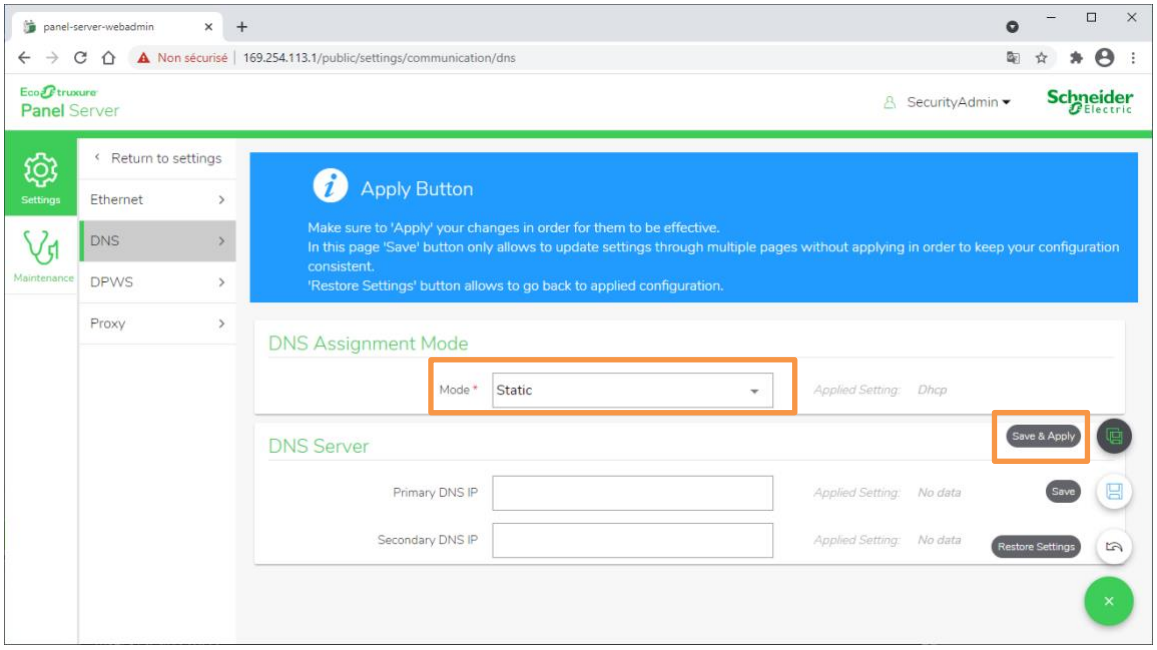
> Select “Network Communication”.



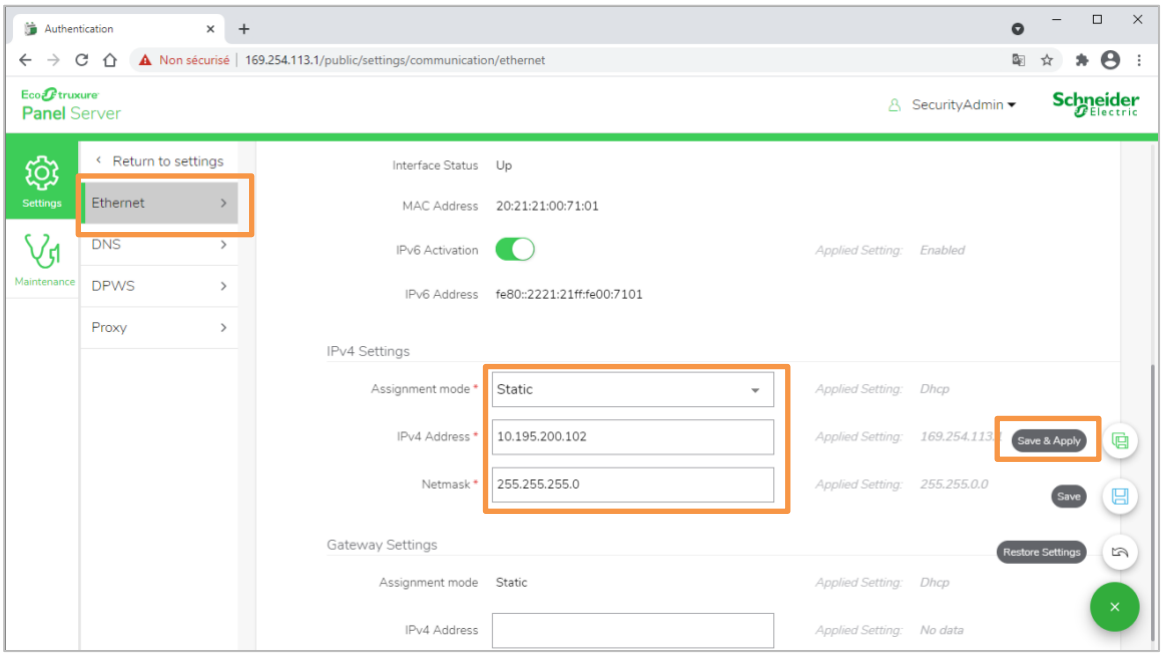
> Select DNS tab.



> Replace “Dhcp” by “Static” and “save and apply” setting.

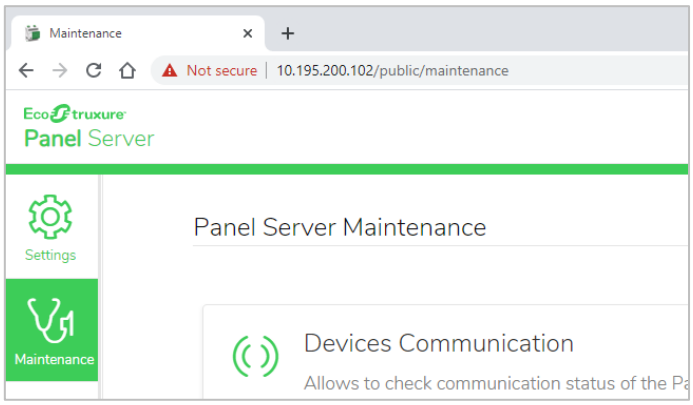


> Select Ethernet tab.
> Set the Static address IP and the mask for the PAS600.
> Save and apply settings.



5.3.1.3 Connect to the PAS600 with its static IP address

> Type the IP address of the PAS600 on a web browser (here Chrome).
> Pass the « security alarm. » page 17
> Now the web pages of the PAS600 can be accessed with PAS600 IP address.

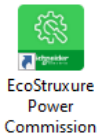


5.3.2 Commissioning a TH110 sensor with a PAS600 through EPC-Desktop

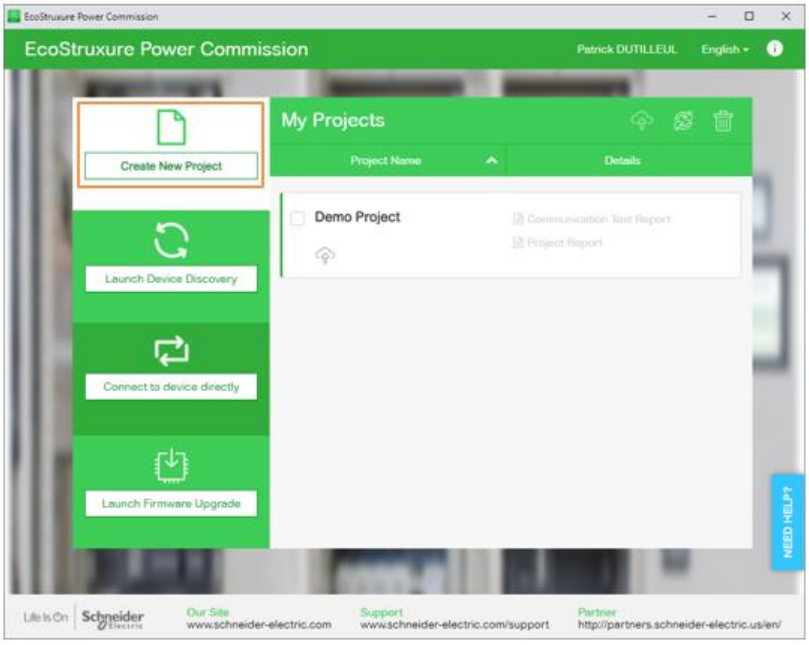
This part describes how to create a project and pairing a TH110 ZigBee sensor.
Refers to full or online help documentation for more information.

5.3.2.1 Creating a new EPC-D project

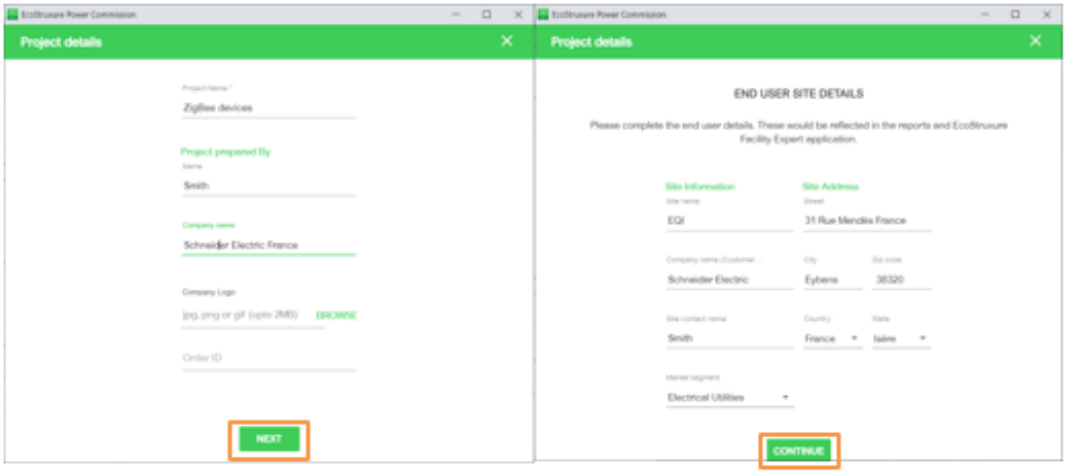
> Install and launch EPC-D software.



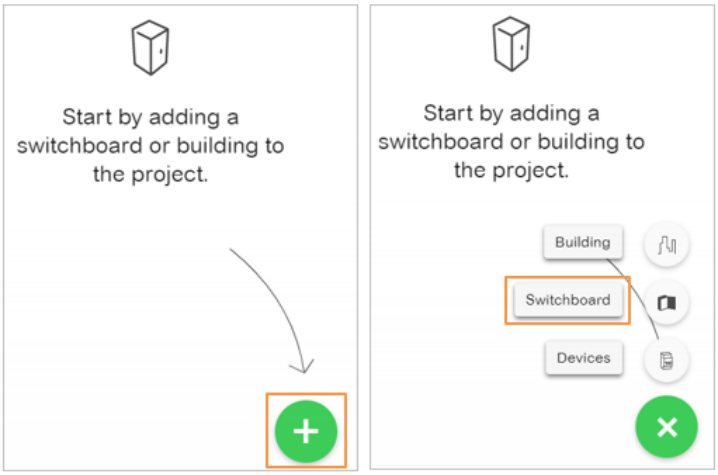
> Select “create a new project”.



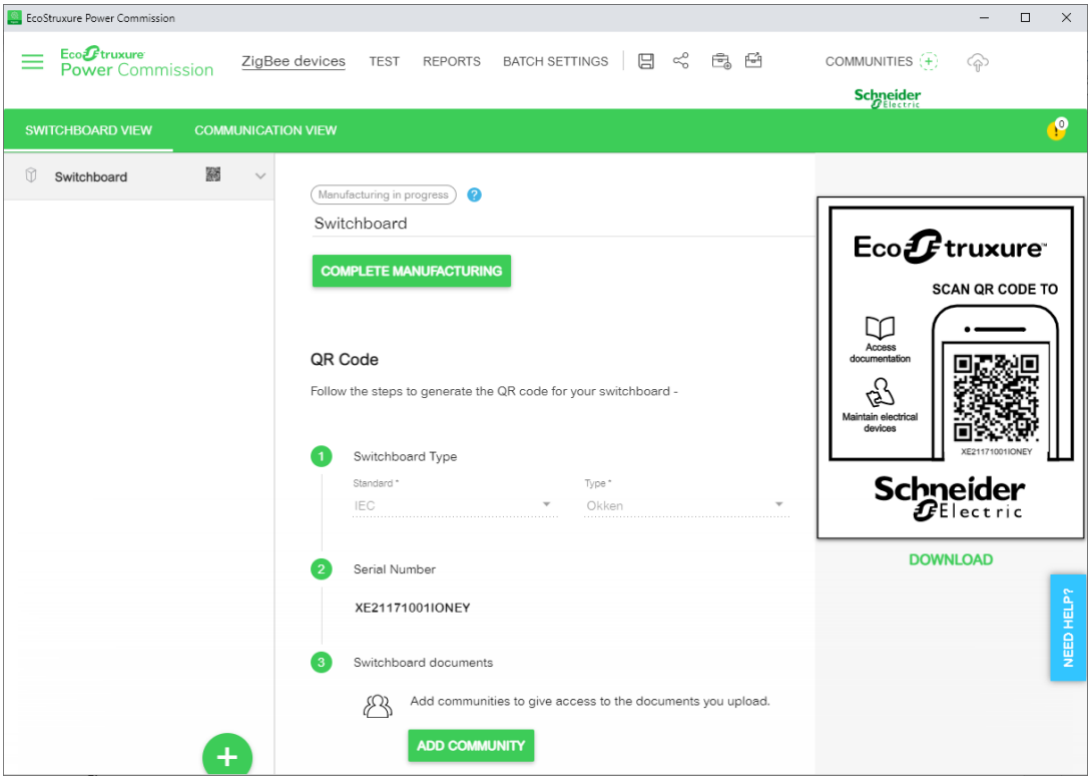
> Fill in the fields in following screens.



> Start the project by adding a new switchboard.



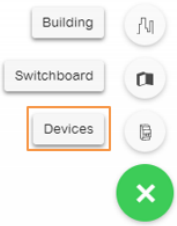
> To describe your switchboard in detail, fill in the fields in “switchboard view” settings screen.



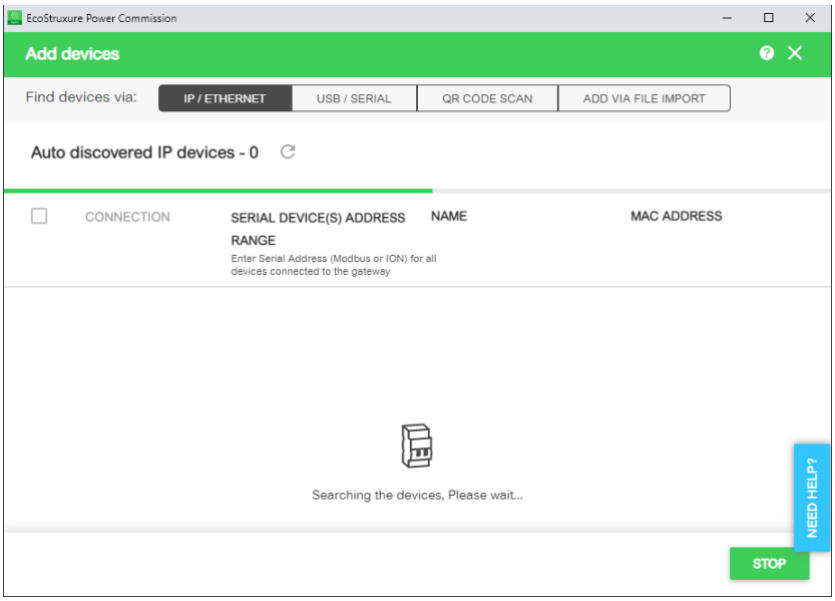
5.3.2.2 Adding a PAS600 in the project

> Adding the PAS600 as a device.

> Select the button and click on “Devices” button.

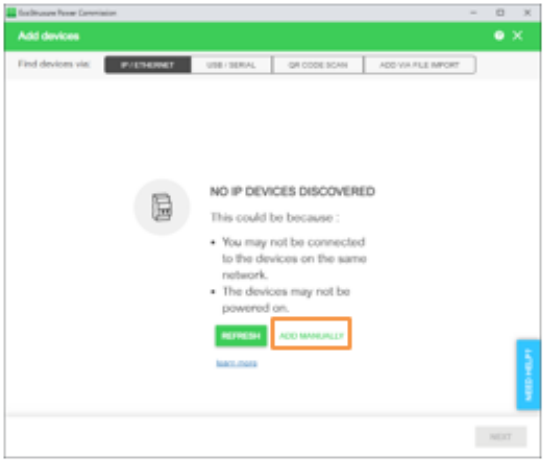


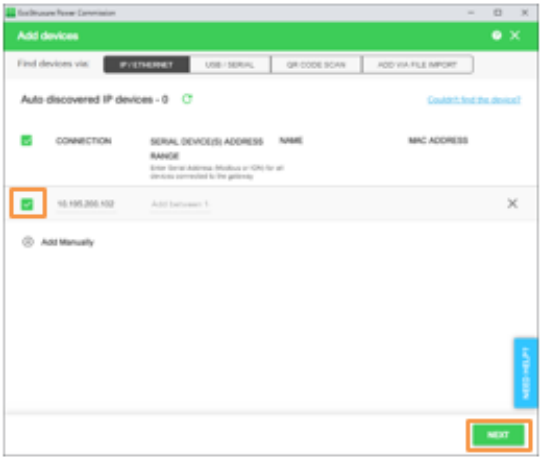
Scanning of IP/Ethernet devices starts automatically.

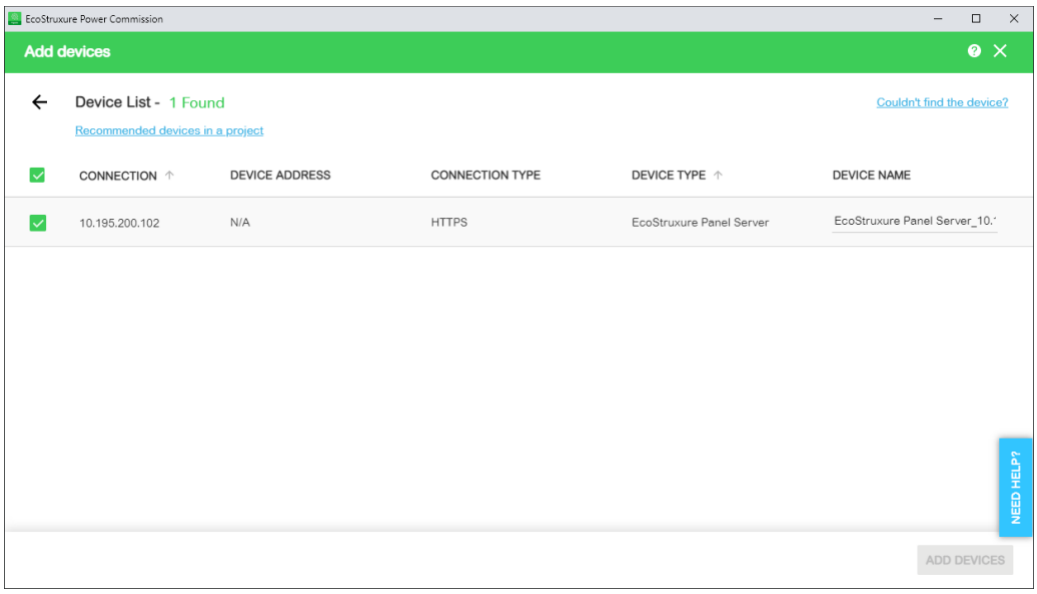


If the PAS600 is not automatically discovered, click on “STOP” and enter manually the IP address.

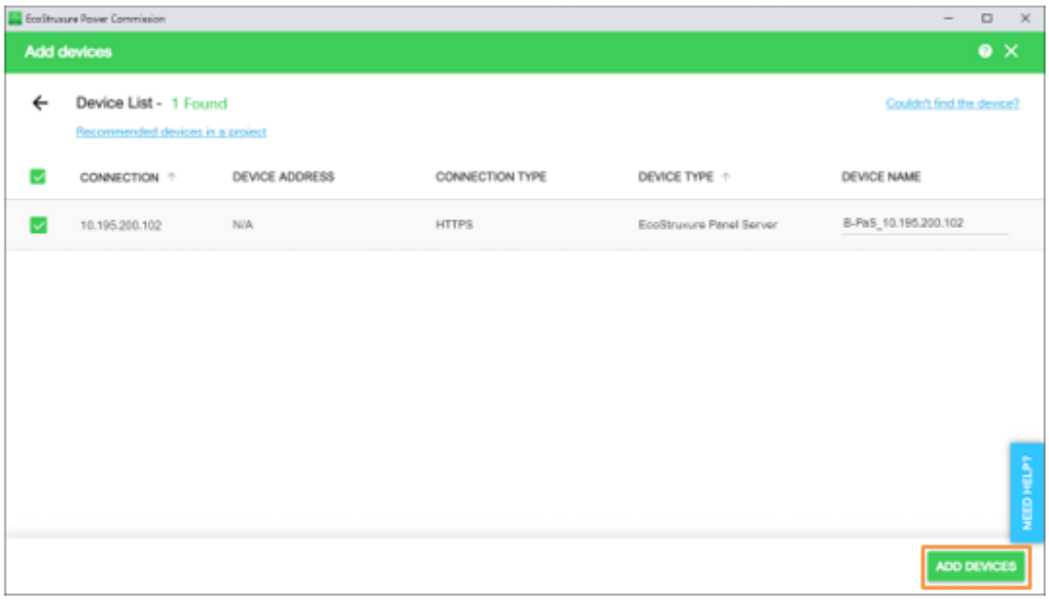
> Select the PAS600 and click on “NEXT”.



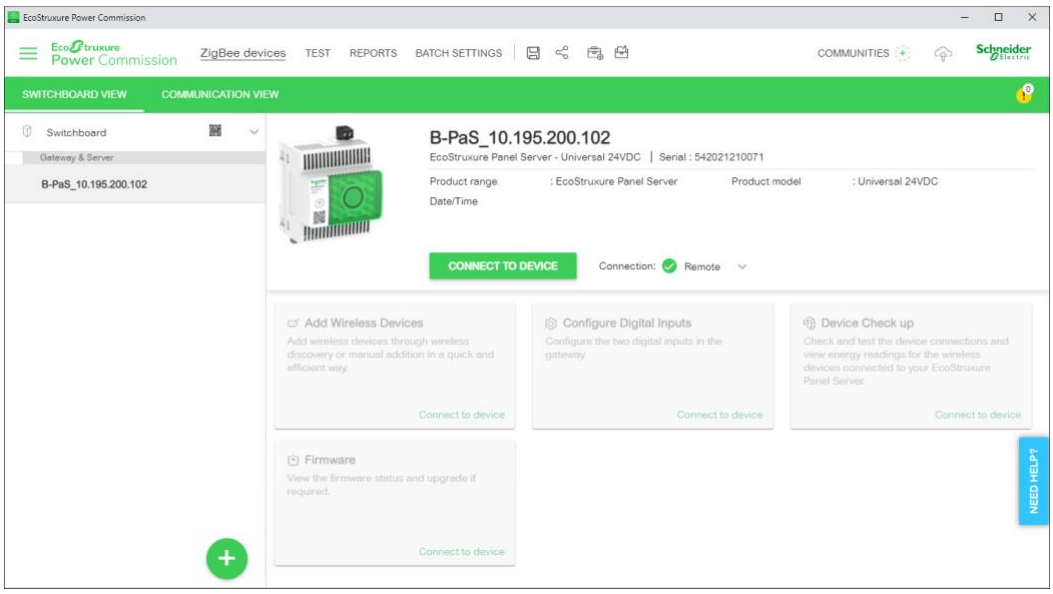




> Then click on “ADD DEVICES”.



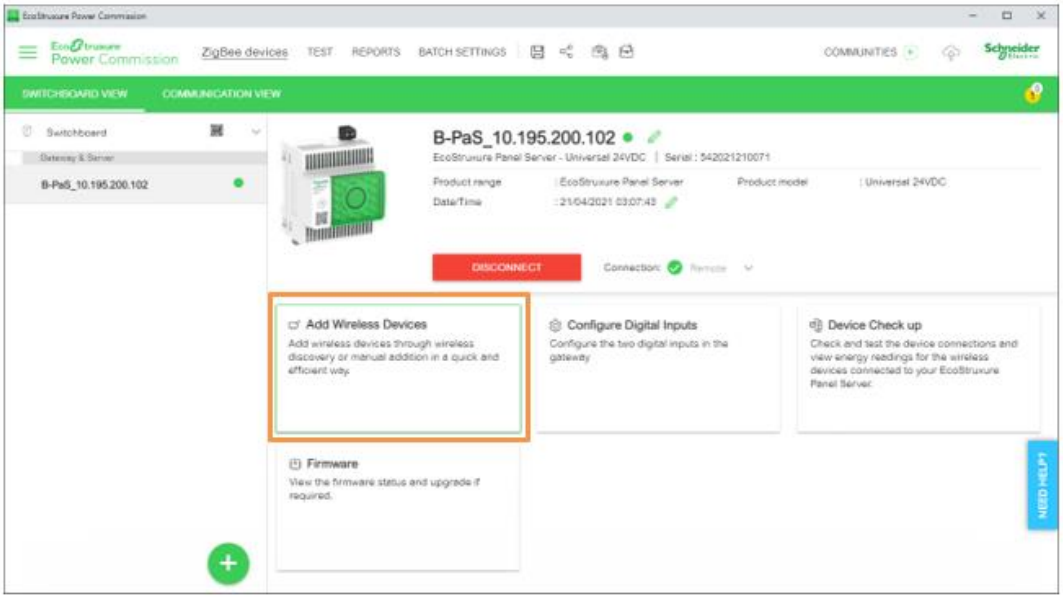
The PAS600 added is automatically displayed.



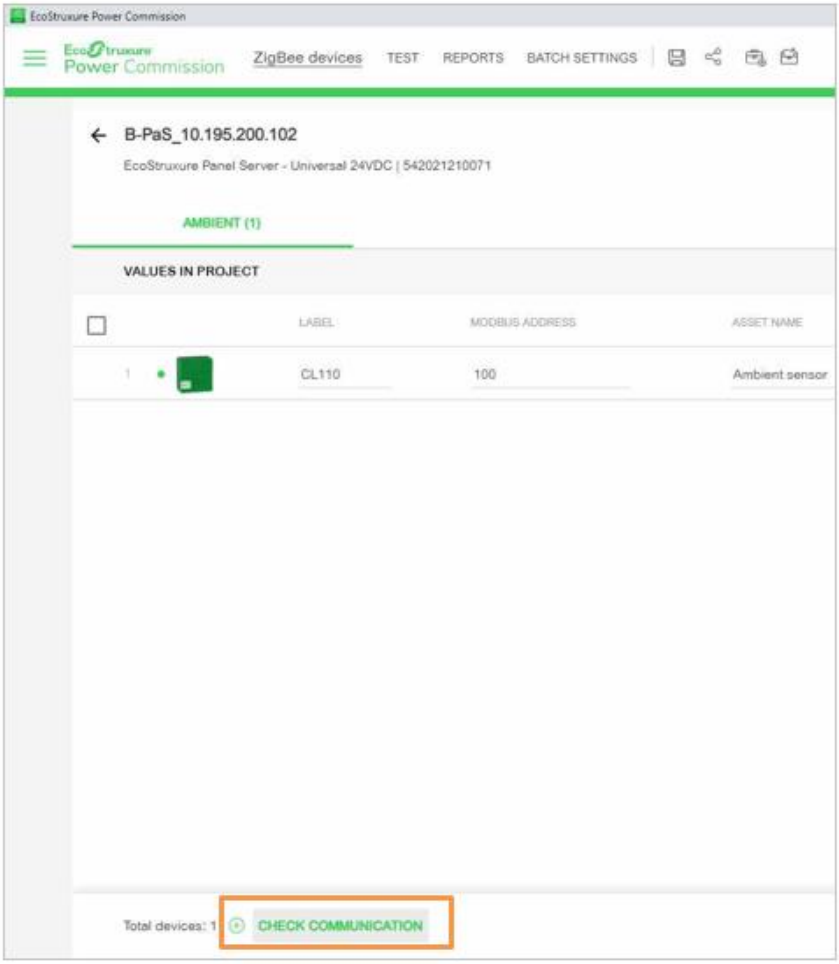
5.3.2.3 Adding a TH110 ZigBee sensor to the project and into the PAS600

> Click on “CONNECT TO DEVICE”.
> Enter the password defined in chapter **5.3.1.1.**

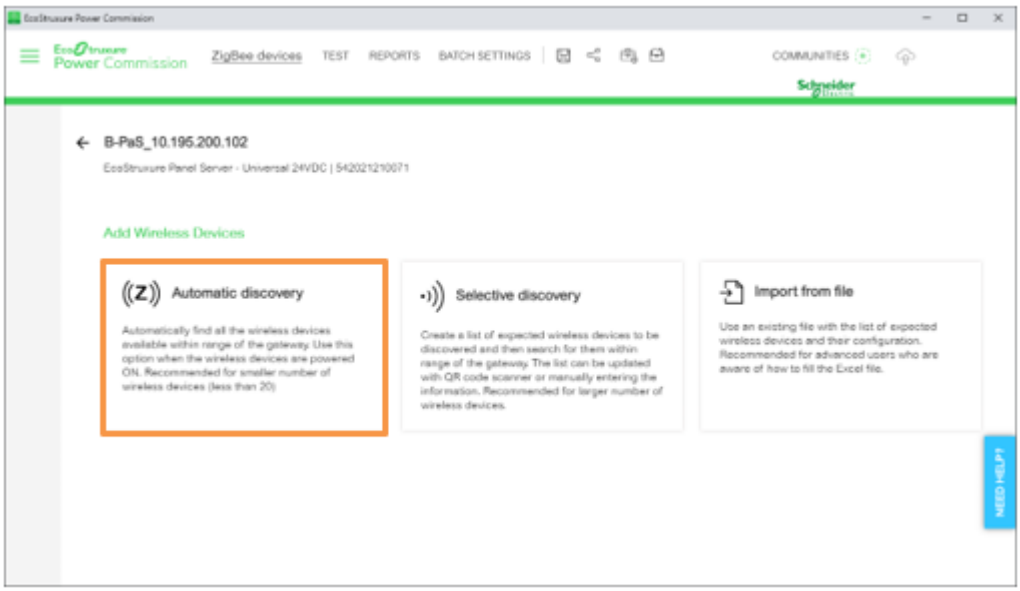
> Select “Add Wireless Devices”.



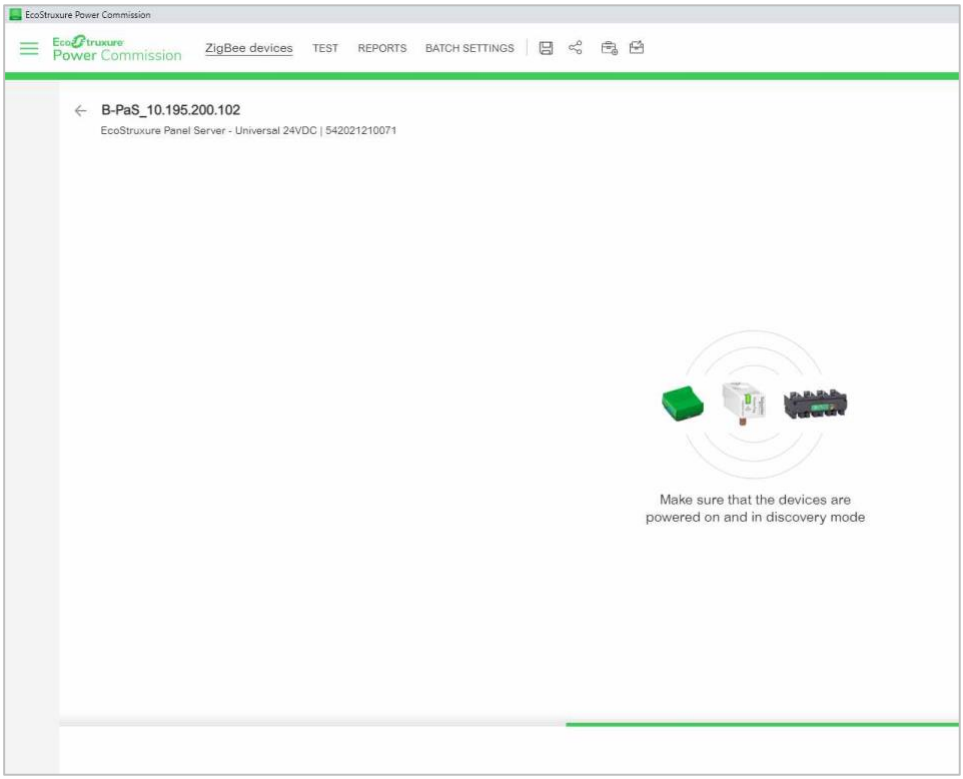
If a sensor is already associated to the PAS600 the sensors discovery screen is displayed with the sensors. Then click on “check communication” to associate a new sensor.



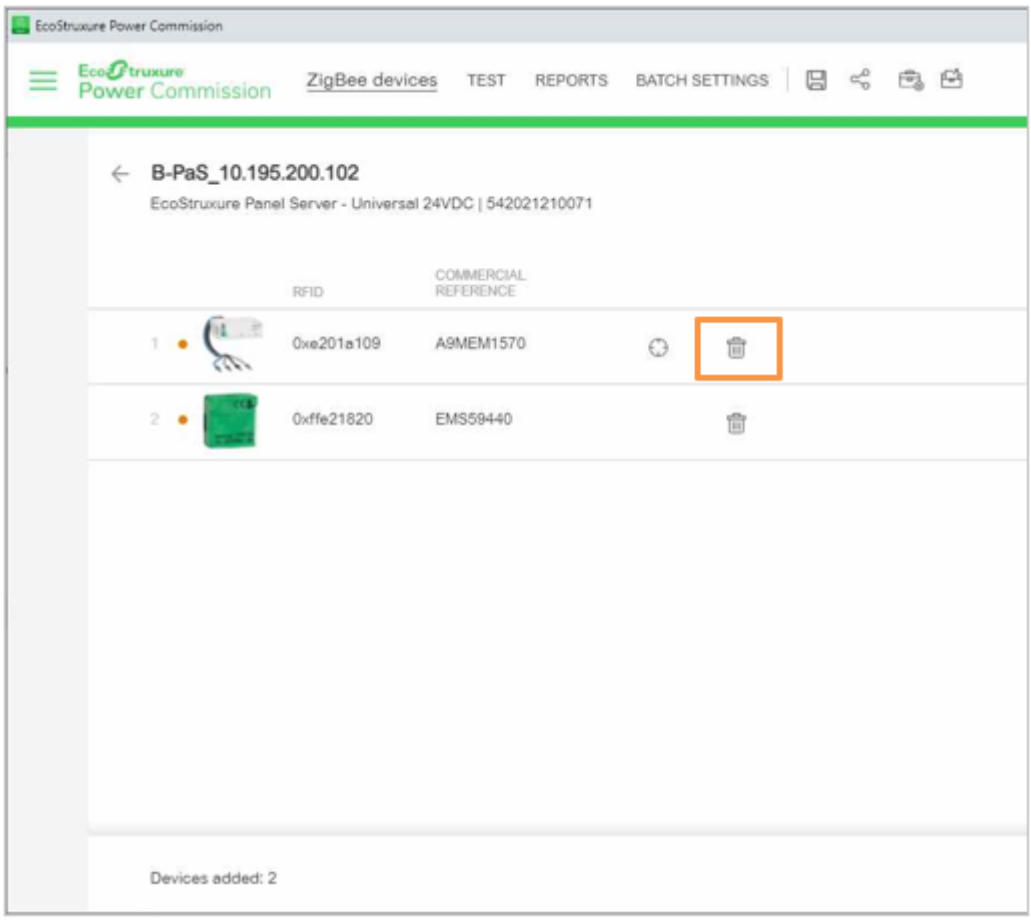
> Then press “Automatic discovery” to ask PAS600 to search for new sensors.



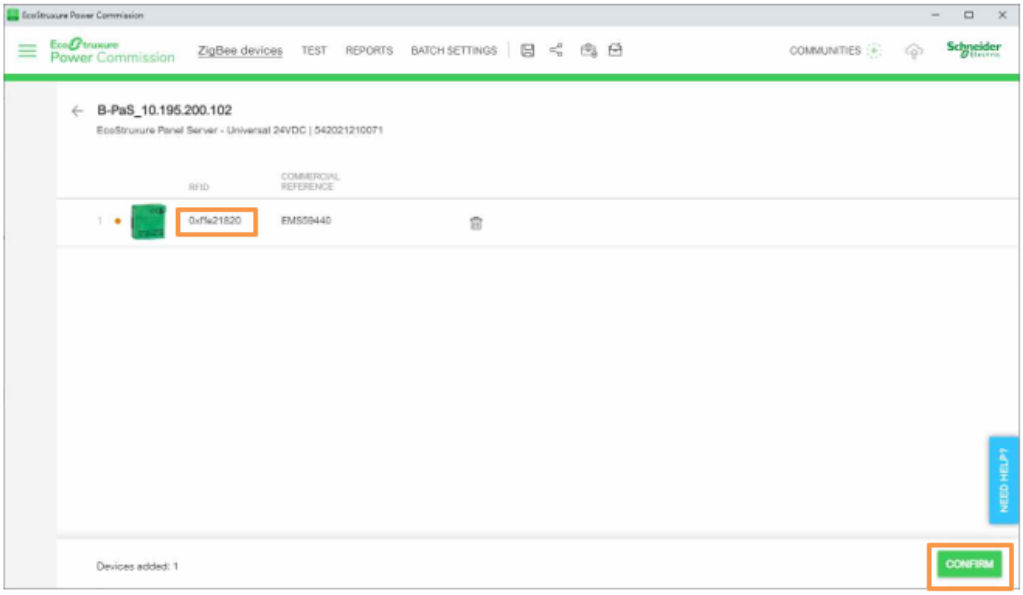
The search is running…



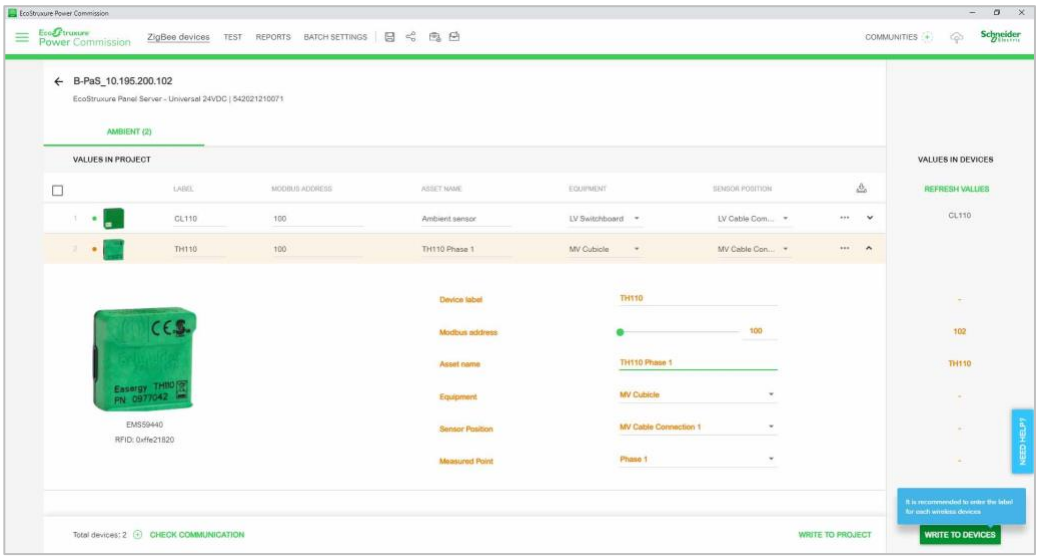
All sensors paired are displayed.
If some ZigBee sensors not desired are captured, release them using the trash icon.



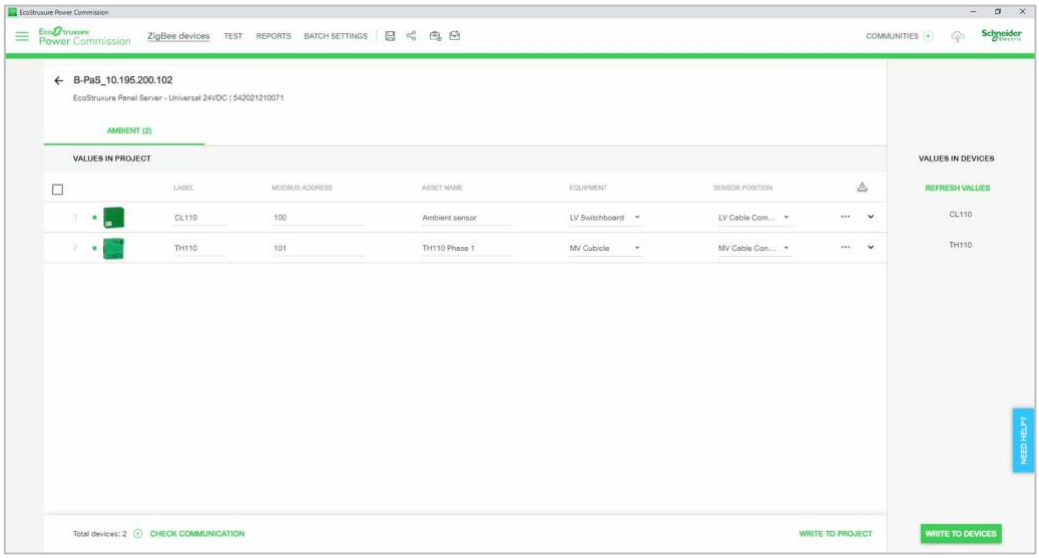
> Click on “Confirm” button to accept the TH110 found.



> Fill in the fields.
> Apply modifications into the PAS600 with “WRITE TO DEVICE”.



The TH110 is now completely associate and configured in the PAS600.



6. Annex

6.1 Introduction

6.1.1 Method

The **Thermal monitoring of Incomers upstream connection and feeders downstream connection** and **Thermal monitoring of horizontal and vertical busbars** has been successively tested.

Campaign of test has been executed:

- **Campaign based on TH110 sensors:** The objective was to give an overview of RF transmission inside the switchboard
- **Note**: RF transmission are equivalent for TH110 and CL110 sensors (same electronic components) but CL110 is self-powered (includes a battery) and easier to use and to move inside a switchboard than TH110.

6.1.2 Tested enclosure

RF transmission was characterized with RSSI measure in the less favorable configuration of switchboard:

- **Form 4b switchboard** with the high density of metal partition sheet
- **IP4X switchboard** with the high level of RF proof (partition without hole).

6.1.3 Conclusion

In both cases, Thermal monitoring of horizontal and vertical bus bars and Thermal monitoring of Incomers upstream connection and feeders downstream. The recommended maximum distance between a temperature sensor and the EcoStruxure Panel Server Universal (PAS600) in an iPMCC switchboard is 4 columns in form 4b.

In conclusion, for the switchboard with small size (busbars only on less six columns and breakers in just two or three columns), it's possible to use a single PAS600 to monitor the horizontal & vertical busbars and incomers upstream & feeders downstream connections. This PAS600 shall be mounted in the middle of the switchboard.

But in the other cases, you must use one PAS600 per configuration type as specified above.

For more details see following chapters.

6.2 Thermal monitoring of Incomers upstream connection downstream-TH110 measure and feeders

6.2.1 Position of the EcoStruxure Panel Server Universal recommendation

RF transmission are equivalent for TH110 and CL110 sensors (same electronic components) but CL110 is self-powered (includes a battery) and easier to use and to move inside a switchboard than TH110.

Example with:

- 4 TH110 sensors fixed in each MasterPact compartment.
- Switchboard is form4b (most critical use case due to the high density of metal partition.
- IP Level of the switchboard is IP4X (most critical use case due to the use of solid partition without hole)
- Inter column partition between the two MasterPact incomer's cubicles is doubled to be equivalent to an auxiliary cubicle with two inter partitions.

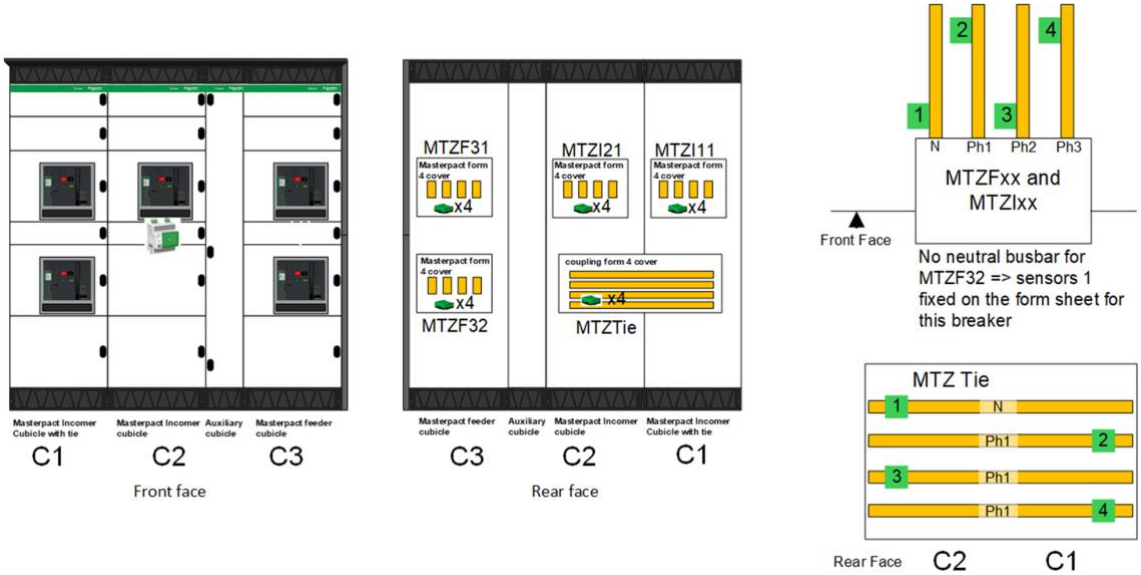


Figure 11: Test setup for thermal monitoring of ACB connections

EcoStruxure Panel Server Universal	RSSI (dBm) MTZF31	RSSI (dBm) MTZF32	RSSI (dBm) MTZI10	RSSI (dBm) MTZ20	RSSI (dBm) MTZTie
	RSSI average of the 4 sensors				
The PAS600 is mounted in the center of the MTZ cubicles	-55	-60	-45	-40	-40
	Values given as an indication for normal conditions of use				

Table 3: RSSI Test results for ACB connections

In this case, all RSSI measurements of the sensors with the PAS600 are over -75 dBm which is a good RF communication measurement to chapter **4.2.**

6.3 Thermal monitoring of horizontal and vertical bus bars – TH110 Sensors measure

6.3.1 Position of the EcoStruxure Panel Server Universal recommendation

RF transmission are equivalent for TH110 and CL110 sensors (same electronic components) but CL110 is self-powered (includes a battery) and easier to use and to move inside a switchboard than TH110.

Example with:

- 4 TH110 sensors fixed in the HBB compartment

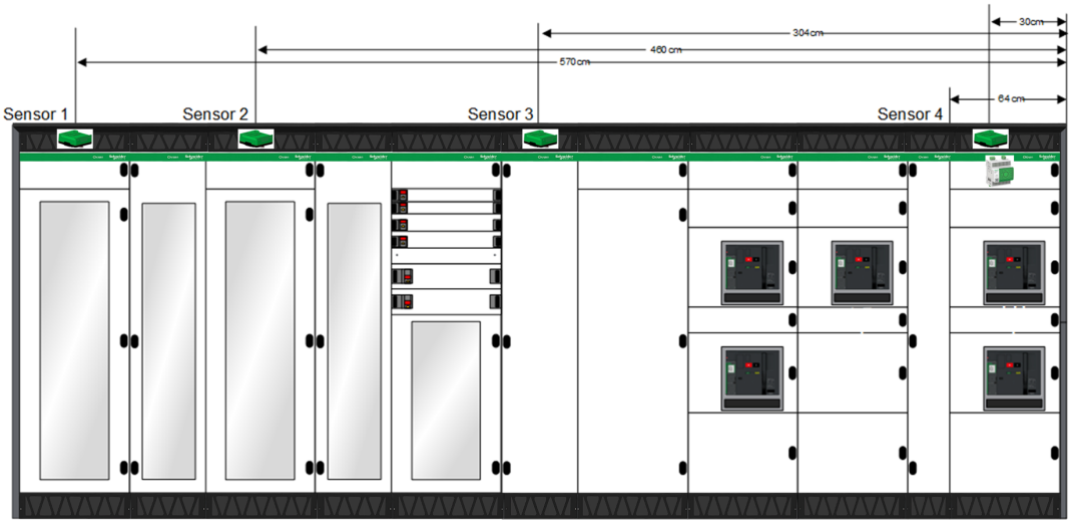


Figure 12: Test setup for thermal monitoring of horizontal and vertical bus bars

Recommended position of the EcoStruxure Panel Server Universal	RSSI (dBm) Sensor 1	RSSI (dBm) Sensor 2	RSSI (dBm) Sensor 3	RSSI (dBm) Sensor 4
The PAS600 is mounted horizontally in front of the horizontal busbar in the right cubicle	-43	-39	-41	-31
	Values given as an indication for normal conditions of use			

Table 4: RSSI Test results for horizontal and vertical bus bars

In this worst case, even the RSSI measurements of the sensor 1 with the PAS600 is over -75 dBm which is a good RF communication measurement in reference to chapter **4.2.**

Schneider Electric Industries SAS

35, rue Joseph Monier
CS 30323
92506 Rueil Malmaison Cedex (France)

RCS Nanterre 954 503 439
Capital social 896 313 776 €
www.se.com