iPMCC

Insulation Monitoring Vigilohm IM400 and IFL12 Fault Locators

Selection guide

Life Is On Schneider Electric

CONTENTS

1. Introduction 4

1.1 Purpose 4

1.2 Scope 4

1.2.1 Technology and Product range 4
1.2.2 Architecture Principles 4
1.2.3 Communication protocols 4

2. Safety information 5

2.1 Important information 5

2.2 Please Note 5

2.3 Safety Precautions 6

3. About the document 8

3.1 References 8

3.2 Glossary 8

3.3 The three types of iPMCC performance level 8

3.4 Prerequisites 9

3.5 Description of the products used in this document 10

3.5.1 IM400's Insulation monitoring device (IMD) 10
3.5.2 IFL12 Fault locators 10
3.5.3 EcoStruxure Panel Server Universal (PAS600) 11

4. Guidelines for the selection of an architecture 12

5. Architectures covered by this guide 13

5.1 Architecture 1: Standard level of performance 14

5.1.1 Description of the architecture 14
5.1.2 Architecture's dataset 14
5.1.3 Performances and behaviors of the architecture 15
5.1.4 Comments 15

5.2 Architecture 2: Advanced level of performance 15

5.2.1 Description of the architecture 15
5.2.2 Architecture's dataset 16
5.2.3 Performances and behaviors of the architecture 16
5.2.4 Comments 16

5.3 Architecture 3: High level of performance 17

5.3.1 Description of the architecture 17
5.3.2 Architecture's dataset 18
5.3.3 Performances and behaviors of the architecture 18
5.3.4 Comments 18

6. Examples 19

6.1 Example of architecture 19

6.2 Example of architecture sizing, rules, limitations and sizing tools 20

6.2.1 Basic rules for architecture sizing 20
6.2.2 Additional limitations for the Schneider PLC IO scanner mechanism 20
6.2.3 iPMCC Vigilohm system sizing tool 20
6.2.4 Example of architecture sizing based on the above rules 21

Reference table

Table 1: Reference documents....8
Table 2: Glossary....8
Table 3: fields of application and customer benefits of architectures....12
Table 4: IMD400 Modbus table for standard performance level....14
Table 5: IMD400's RTT time for Standard performance level....15
Table 6: IMD400 and IFL12's Modbus tables for advanced performance level....16
Table 7: IMD400 and IFL12's RTT time advanced performance level....16
Table 8: IMD400 and IFL12's Modbus tables for high performance level....18
Table 9: IMD400 and IFL12's RTT time for High performance level....18

Table of illustrations

Figure 1: Example of Insulation monitoring architecture....13
Figure 2: Standard electrical distribution....14
Figure 3: Standard digital architecture....14
Figure 4: Advanced electrical distribution....15
Figure 5: Advanced digital architecture....15
Figure 6: High Performance electrical distribution....17
Figure 7: High Performance digital architecture....17
Figure 8: Example of Vigilohm system integration in a typical IT Low voltage electrical distribution....19
Figure 9: Vigilohm system sizing tool – Customer parameters view....22
Figure 10: Vigilohm system sizing tool – Optimized digital architecture view....22
Figure 11: Vigilohm system sizing tool – Optimized digital architecture with customization view....23
Figure 12: Digital architecture example (customized)....24

1. Introduction

1.1 Purpose

This selection guide is dedicated to the insulation monitoring system for the detection and localization of phase to earth fault of ungrounded IT power system.

This document allows to easily select among the architectures and solutions developed for the detection and location of phase to earth fault in low voltage distribution those complying with specified requirements.

The selection criteria detailed in this guide are mainly focused on performances, availability and functionalities of the proposed architectures.

Use cases are exposed to illustrate their fields of application. Indications concerning the size and the limits of the architectures, the components, the wiring and the connections, etc. are given for information.

These subjects are deeply detailed the implementation and commissioning guide.

1.2 Scope

1.2.1 Technology and Product range

The architectures presented in this document are built with the following devices and accessories:

- IM400's Insulation monitoring devices
- IFL12's Fault locators
- Open and closed toroids
- Cardew surge limiter
- ZX Impedance
- IM400-1700, IM400-1700C, PTH 1000 voltage adaptors.
- EcoStruxure Panel Server Universal (PAS600)

1.2.2 Architecture Principles

- Serial lines fieldbus is used to link the IM400's and the FL12's with EcoStruxure Panel Server Universal (PAS600). The IM400's and the FL12's are connected to the serial links through their native Modbus RS485 communication ports.
- The EcoStruxure Panel Server Universal (PAS600) perform the interface between the IM400's and FL12's and an iPMCC Ethernet backbone

1.2.3 Communication protocols

Two communication protocols are used in the proposed architectures:

- Modbus-RTU for the communication between the IM400's, FL12's and the EcoStruxure Panel Server Universal (PAS600)
- Modbus-TCP for the communication between the EcoStruxure Panel Server Universal (PAS600) and an iPMCC Ethernet backbone.

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
2019 Vigilohm catalogue. Document reference	PLSED310020EN	03/2019
IM400 user manual	DOCA0049EN06	07/2020
IFL12's user manual	7EN02-0406-03	08/2020
EcoStruxure Panel Server Universal (PAS600) user guide	DOCA0172EN	05/2021

Table 1: Reference documents

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

3.2 Glossary

Term	Description
AC/DC	Alternative current/ Direct current
DCS	Distributed Control System
EPC	EcoStruxure Power Commission
I/O	Input/Output
iPMCC	intelligent Power & Motor Control Center
MCC	Motor Control Center
PCC	Power Control Center
PE	Protective Earth
PLC	Programmable Logic Controller
RTT	Round Trip Time
RTU	Remote Terminal Unit
SCADA	Supervisory Control And Data Acquisition
TCP/IP	Transmission Control Protocol/Internet Protocol
UPS	Uninterruptible Power Supply
VSD	Variable speed drive

Table 2: Glossary

3.3 The three types of iPMCC performance level

Standard performance

The "**Standard**" performance level refers to the usual data reporting of the installation, close to the conventional switchboard.

- This installation corresponds to the standard and simplest product use and implementation.
- The data set used to monitor the installation uses the core functionality of the product installed.
- This is the MVP (Minimum Viable Product).

Advanced performance

The “**Advanced**” performance level refers to the use of additional functionality provided by the connected product or dictated by the specific working conditions or specific constraints of the installation.

- This is used where the requirement is to go beyond the MVP and implement additional features designed to control and monitor the installation more effectively.
- The data set provides enough information to perform a first level of analysis of the installation.

High performance

The “**High-Performance**” performance level refers to the implementation of functions providing an extended data set for full control of all parameters of the installation.

- This installation is very large, complex and/or very sensitive to variations. Usually, the installation requires a high level of availability.
- The data set provides all the information required to perform a detailed analysis of the installation.

3.4 Prerequisites

The following prerequisites are recommended to become familiar with the contents of this guide. This applies to:

- The networks and protocols of communication used in the architectures: Modbus TCP/IP and Modbus RTU
- The software used in the architecture: EcoStruxure Power Commission (EPC)

We remind here below, for information, the principles of the three neutral systems commonly used in Low voltage electrical systems. The functions ensured by the insulation monitoring devices and fault locators in an IT neutral system are clarified

The IEC 60364-4-41 “Low voltage electrical installations-Protection for safety-Protection against electrical chock” defines three low voltage neutral systems:

The TN system

The neutral point of the power supply shall be solidly earthed. The exposed conductive parts of the installation shall be interconnected by a protective conductor (PE) which shall be connected to the power supply neutral point.

The TT system

The neutral point of the power supply shall be solidly earthed. The exposed conductive parts of the installation shall be interconnected by a protective conductor (PE) which shall be earthed.
The earthing location of the protective conductor and this of power supply neutral point can be separated.

For both TN and TT systems, the touch voltages occurring at the first insulation or phase to earth fault exceed 50 V. They are dangerous for the persons. The interruption of the supply is consequently mandatory. The continuity of the operation is not allowed.

The IT system

The neutral point of the power supply shall be insulated from the earth or connected to the earth through a sufficiently high impedance. The exposed conductive parts of the installation shall be interconnected by a protective conductor (PE) which shall be earthed. The fault current at the first insulation or phase to earth fault is low, the touch voltages are then low. They are not dangerous for the persons, the interruption of the supply is not required and the operation of the installation can be maintained with a good level of safety. The IT system is the only one allowing the operation of any low voltage installation affected by a permanent phase to earth fault.

The following requirements are however mandatory:

- The insulation level of the installation shall be permanently monitored
- Any detection of a first insulation or phase to earth fault shall initiate an alarm
- The first fault shall be located and eliminated by the maintenance staff.
- The interruption of the supply is mandatory at the occurrence of a second insulation or phase to earth fault

The Vigilohm system with the IM400's insulation monitoring devices, IFL12's fault locators, sensors and accessories brings appropriate answers to these requirements. It allows to build appropriate solutions for individual machines, low voltage motors, small size, medium size and large size low voltage installations.

3.5 Description of the products used in this document

For detailed information concerning the products used in the architectures defined in this document and their fields of application, please refer to the Vigilohm catalogue referenced in chapter **3.1 References**

3.5.1 IM400's Insulation monitoring device (IMD)

They are three types of IM400.

- The IM400: Auxiliary supplies 100-440 V AC/DC. (-25°C +55°C, max relative humidity 92%)
- The IM400C: Auxiliary supplies 100-440 V AC/DC. (-25°C +70°C, max relative humidity 95%)
- The IM400L: Auxiliary supplies 24 V-48 V DC. (-25°C +55°C, max relative humidity 92%)

The IM400's provides overall insulation monitoring of IT (Ungrounded) or HRG (High Resistance Grounded) low voltage electrical installations by injecting an auto adaptative low frequency signal between the installation and the earth.

The IM400's shall be associated with one or several of following accessories

- Cardew C surge limiter
- ZX impedance
- IM400-1700, IM400-1700C, PHT1000 Voltage Adaptors

3.5.2 IFL12 Fault locators

They are seven types of IFL12:

- The IFL12, IFL12L, IFL12C, IFL12MC, IFL12LMC, IFL12LMCT and IFL12MCT
- In the device designation, the meaning of the letters L, C, M, T is the following
  - L means auxiliary supply 24-48 V DC. Without L, the auxiliary supply is 100-440 V AC/DC
  - C means Modbus RS 485 communication
  - M means measures and historical data
  - T means harsh environment conditions (-25°C +70°C, max relative humidity 95%). Without T, the environment conditions are standard (-25°C +55°C, max relative humidity 92%)

The IFL12 and IFL12L without Modbus RS 485 communication are not considered in the present guide.

The IFL12's fault locators shall be associated with the IM400's insulation monitoring device. They measure and analyze the low frequency signal injected by the IM400 in the LV power system. They are autonomous, no hard-wired link nor digital communication are required between the IFL12's and IM400's.

3.5.3 EcoStruxure Panel Server Universal (PAS600)

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, WiFi, and optional cellular routers), the Panel Server adapts to fast evolving communication technologies.

The EcoStruxure Panel Server Universal (PAS600) provides fast Ethernet connectivity for most of applications, from a single building to a multi-site enterprise. It includes a reliable Modbus/Ethernet protocol conversion and can support meters, monitors, protective relays, trip units, motor controls, insulation monitoring devices, fault locators and other devices that need to communicate data quickly and efficiently.

For further information refer to the EcoStruxure Panel Server Universal (PAS600) user guide referenced in chapter **3.1 References.**

4. Guidelines for the selection of an architecture

The fields of application and customer benefits of the standard, advanced and high performance architectures defined in this guide are detailed in table 3 here below.

Level

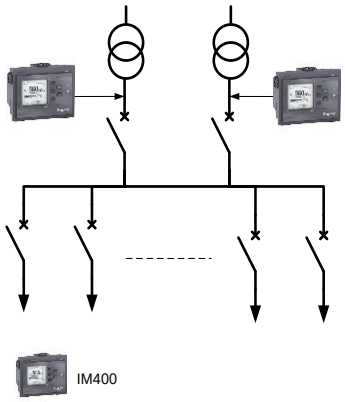
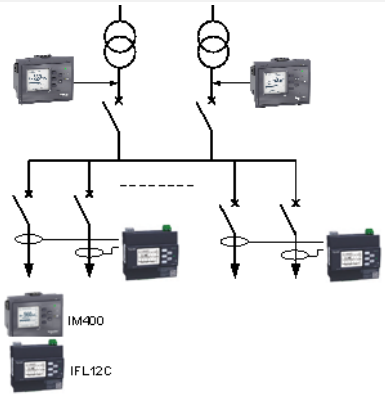
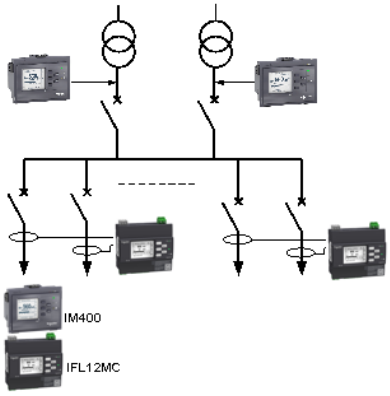
Standard	Advanced	High performance
Solution Description		
Insulation monitoring	**Insulation monitoring** + **Feeder fault location**	**Insulation monitoring** + **Feeder fault location** + **Feeder measurements, trending curves and historical data**
Vigilohm offer		
 IM400 with the associated accessories + PAS600	 IM400 with the associated accessories + IFL12C + PAS600	 IM400 with the associated accessories + IFL12MC-IFL12LMC-ILF12LMCT-ILF12MCT + PAS600
Uses		
• Limited number of LV feeders, all located in a single LV switchboard.	• Medium size IT installation including main and secondary LV switchboards. • Power system moderately disturbed by power electronic devices. • The installation is mainly located inside a large building or within a large area. Distances between switchboards can be important.	• Large size IT installations including main and secondary LV switchboards. • Power system highly disturbed by power electronic devices. • The installation incudes several buildings and areas. Distances between buildings and areas can be important.
Customer benefits		
• The first fault is detected by IM400, requiring the intervention of the maintenance staff. • Fault location is performed manually by means of portable devices such as the XRM mobile fault locator. • The insulation monitoring devices with the built-in Modbus RS485 communication port and PAS600 can be incorporated in the control and monitoring system of the installation.	• The first fault is automatically located by the fault locators. • The insulation monitoring devices and fault locators with the built-in Modbus RS485 communication port and PAS600 can be incorporated in the control and monitoring system of the installation.	• The first fault is automatically located by the fault locators. • Measurements of phase to earth insulation and cable leakage capacitance are performed on each individual feeder • Measurements, trending curves and historical data are made available for preventive and curative maintenance. • The insulation monitoring devices and fault locators with the built-in Modbus RS485 communication port and PAS600 can be incorporated in the control and monitoring system of the installation.

Table 3: fields of application and customer benefits of architectures

Note:

All the performances stated in this document are based on the IM400 and IFL12 Modbus exchange tables listed in Chapter **5 Architectures covered by this guide.**

5. Architectures covered by this guide

The Vigilohm devices (IMD's and IFL's) integrate natively Modbus RS485. They can be connected to the iPMCC Ethernet backbone through the EcoStruxure Panel Server Universal (PAS600). So, they can be incorporated in wide architectures of monitoring and control including PLC, SCADA, DCS, etc.

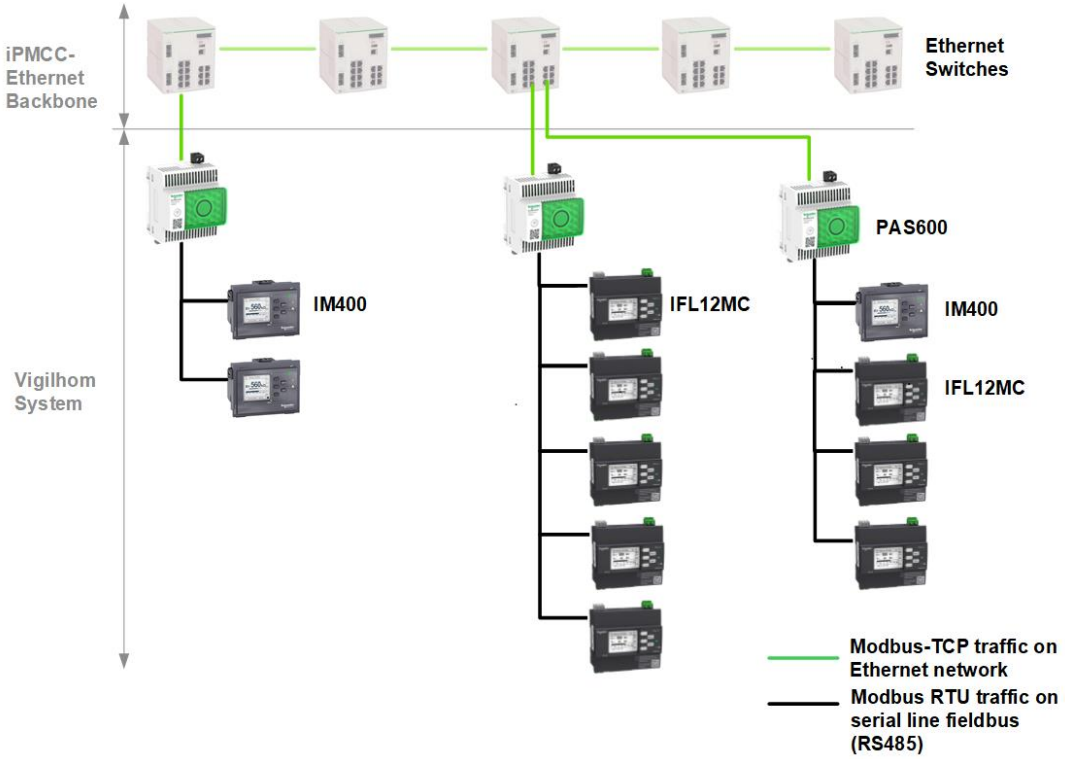


Figure 1: Example of Insulation monitoring architecture

The following architectures are presented in this guide:

- Architecture 1: Standard level of performance
- Architecture 2: Advanced level of performance
- Architecture 3: High level of performance

5.1 Architecture 1: Standard level of performance

5.1.1 Description of the architecture

With this architecture, the insulation is monitored from a global standpoint by the IM400. When a fault occurs, it is required to check the all installation to identify the location of the fault before the occurrence of a second default.

Therefore, this architecture can be applied for limited number of LV feeders, all located in a single LV switchboard.

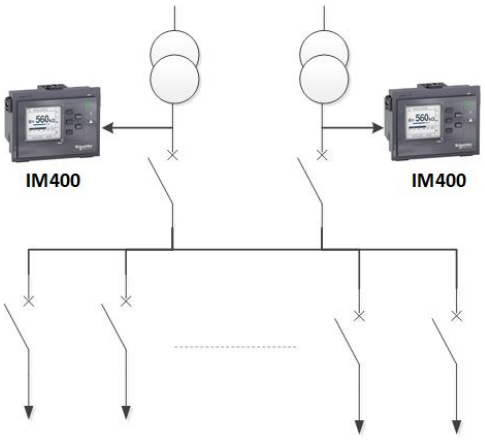


Figure 2: Standard electrical distribution

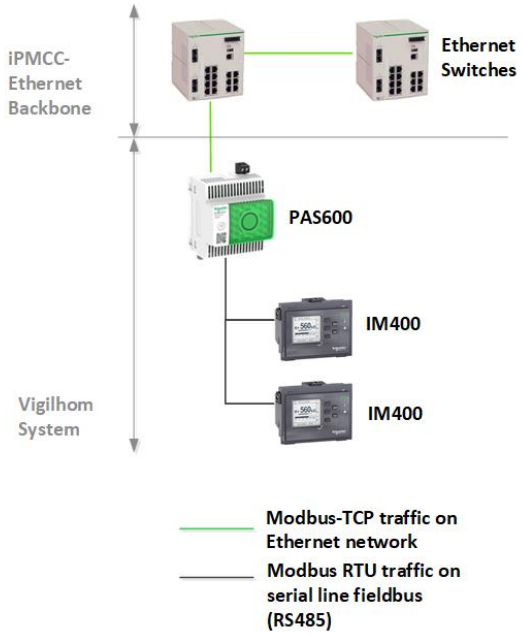


Figure 3: Standard digital architecture

5.1.2 Architecture's dataset

The following table is extracted from the Modbus register list of the Vigilohm system.

Please refer to chapter **3.5 Description of the products used in this document**

They summarize the main information made available for IM400 devices.

Device	Data type	Modbus table					
		Modbus request ID	Register address / decimal 0 based	Read / write	Type	Unit	Description
IM400	Insulation monitoring	1	114 to 115	R	Unit32	-	System Product state
		1	116	R	Unit16		System Product error code
		2	1020 to1021	R	Float32	Ω	Measured resistance
		2	1022 to 1023	R	Float32	F	Measured capacitance
		3	1100	R	Unit16	-	Insulation alarm status

Table 4: IMD400 Modbus table for standard performance level

5.1.3 Performances and behaviors of the architecture

The RS485 fieldbus downstream of the PAS600 is Modbus serial line. Each request from the PAS600 to the serial connected device books the fieldbus for exclusive use and consumes part of the bandwidth.

The time needed by the PAS600 to read/write the Modbus table in IMD for the standard solution level is 250 ms (assumption: PAS600 with factory Modbus settings: baud rate = 19200 bps / parity = even / stop bits = 1).

Devices	Solution level
	Standard
IMD	250 ms

Table 5: IMD400's RTT time for Standard performance level

5.1.4 Comments

The Rules to build, size and configure the architecture and its variants when applicable are detailed in the chapter **6.2**

5.2 Architecture 2: Advanced level of performance

With this architecture, the insulation is monitored from a global standpoint. When a fault occurs, the fault locator will provide the fault location allowing to speed up the maintenance operation before the occurrence of a second default.

Therefore, this architecture can be applied to medium size IT installation including main and secondary LV switchboards.

5.2.1 Description of the architecture

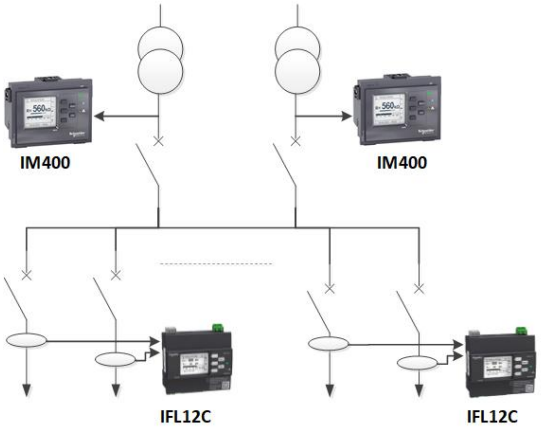


Figure 4: Advanced electrical distribution

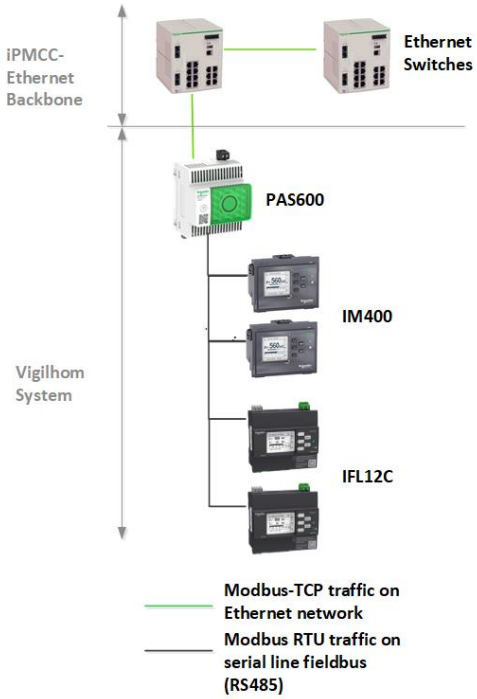


Figure 5: Advanced digital architecture

5.2.2 Architecture's dataset

IM400 Insulation monitoring device with IFL12C and PAS600 EcoStruxure Panel Server Universal (PAS600).

Please refer to chapter **3.5** Description of the products used in this document.

The following tables are extracted from the Modbus register list of the Vigilohm system.

They summarize the main information made available by each device (IMD's and IFL's).

Device	Data type	Modbus table					
		Modbus request ID	Register address / decimal 0 based	Read / write	Type	Unit	Description
IM400	Insulation monitoring	1	114 to 115	R	Unit32	-	System Product state
		1	116	R	Unit16		System Product error code
		2	1020 to1021	R	Float32	Ω	Measured resistance
		2	1022 to 1023	R	Float32	F	Measured capacitance
		3	1100	R	Unit16	-	Insulation alarm status
IFL12C	Feeder fault location	1	114 to 115	R	Unit32	-	System Product state
		1	116	R	Unit16		System Product error code
		2	1102	R	Unit16	-	Product alarm status

Table 6: IMD400 and IFL12's Modbus tables for advanced performance level

5.2.3 Performances and behaviors of the architecture

The RS485 fieldbus downstream of the PAS600 is Modbus serial line. Each request from the PAS600 to the serial connected device (IMD or IFL) books the fieldbus for exclusive use and consumes part of the bandwidth.

The following table indicates the time needed by the PAS600 to read/write a typical Modbus table in IMD or IFL for advanced solution level (assumption: PAS600 with factory Modbus settings: baud rate = 19200 bps / parity = even / stop bits = 1).

Devices	Solution level
	Advanced
IMD	250 ms
IFL	250 ms

Table 7: IMD400 and IFL12's RTT time advanced performance level

5.2.4 Comments

The Rules to build, size and configure the architecture and its variants when applicable are detailed in the chapter **6.2 Example of architecture sizing, rules, limitations and sizing tools.**

5.3 Architecture 3: High level of performance

5.3.1 Description of the architecture

With this architecture, the insultation is monitored from a global standpoint by the IM400. Thanks to the measurement capabilities of the IFL12MC, the fault locator will provide trending curves and historical data to trigger the maintenance operation before the occurrence of a first default. When a fault occurs, the fault locator IFL12MC will provide the fault location to the speed up the maintenance operation before the occurrence of a second default.

Therefore, this architecture can be applied to large size IT installations including main and secondary LV switchboards.

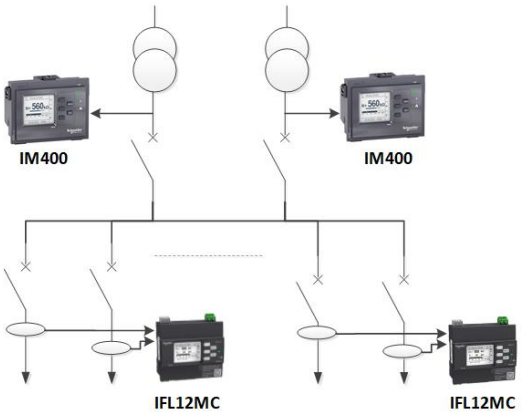


Figure 6: High Performance electrical distribution

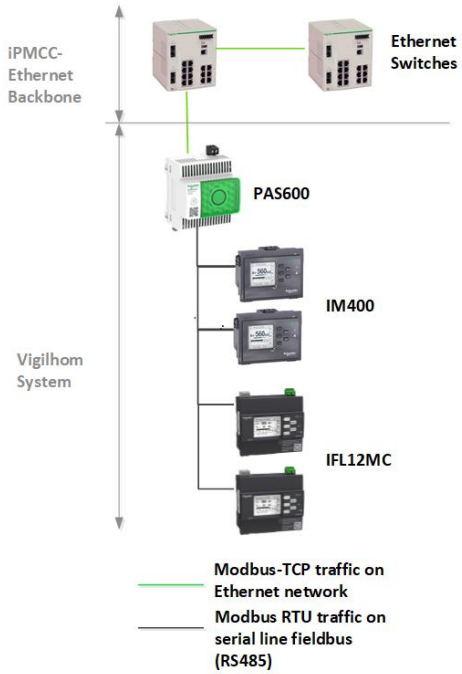


Figure 7: High Performance digital architecture

5.3.2 Architecture's dataset

IM400 Insulation monitoring device with IFL12C and EcoStruxure Panel Server Universal (PAS600).

Please refer to chapter **3.5 Description of the products used in this document**

The following tables are extracted from the Modbus register list of the Vigilohm system.

They summarize the main information made available by each device (IMD's and IFL's).

Device	Data type	Modbus table					
		Modbus request ID	Register address / decimal 0 based	Read / write	Type	Unit	Description
IM400	Insulation monitoring	1	114 to 115	R	Unit32	-	System Product state
		1	116	R	Unit16		System Product error code
		2	1020 to1021	R	Float32	Ω	Measured resistance
		2	1022 to 1023	R	Float32	F	Measured capacitance
		3	1100	R	Unit16	-	Insulation alarm status
IFL12MC IFL12LMC ILF12LMCT ILF12MCT	Feeder fault location	1	114 to 115	R	Unit32	-	System Product state
		1	116	R	Unit16		System Product error code
		2	1102	R	Unit16	-	Product alarm status
	Feeder measurement	3	10000 to 10023	R	Float32	Ω	Resistance channel 1 to 12
		3	10024 to 10047	R	Float32	F	Capacitance channel 1 to 12

Table 8: IMD400 and IFL12's Modbus tables for high performance level

5.3.3 Performances and behaviors of the architecture

The RS485 fieldbus downstream of the PAS600 is Modbus serial line. Each request from the PAS600 to the serial connected device (IMD or IFL) books the fieldbus for exclusive use and consumes part of the bandwidth.

The following table indicates the time needed by PAS600 to read/write a typical Modbus table in IMD or IFL for the high performance solution level (assumption: PAS600 with factory Modbus settings: baud rate = 19200 bps / parity = even / stop bits = 1).

Devices	Solution level
	High performance
IMD400	250 ms
IFL12MC	300 ms

Table 9: IMD400 and IFL12's RTT time for High performance level

5.3.4 Comments

The Rules to build, size and configure the architecture and its variants when applicable are detailed in the chapter **6.2 Example of architecture sizing, rules, limitations and sizing tools.**

6. Examples

6.1 Example of architecture

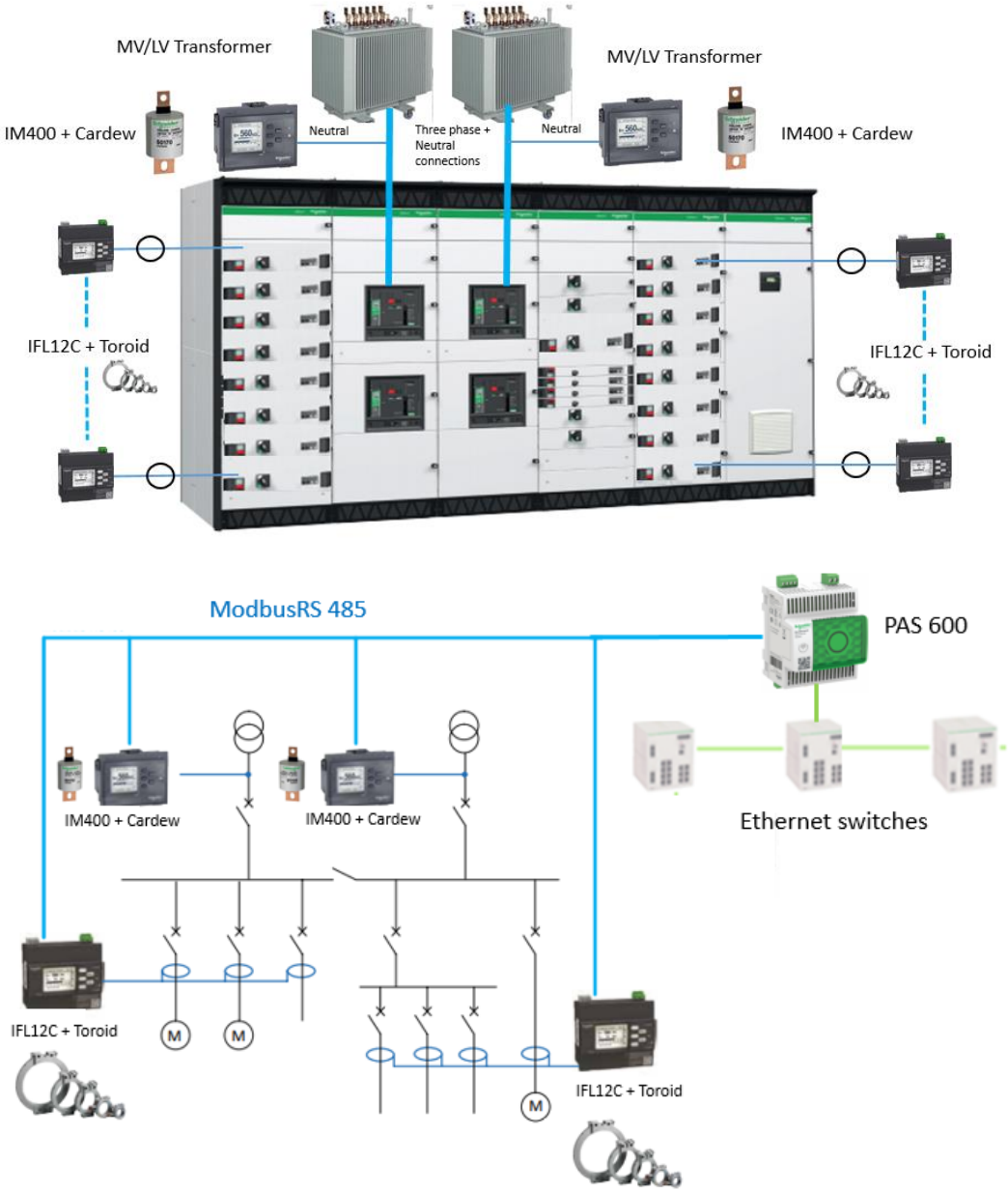


Figure 8: Example of Vigilohm system integration in a typical IT Low voltage electrical distribution

6.2 Example of architecture sizing, rules, limitations and sizing tools

6.2.1 Basic rules for architecture sizing

The RS485 fieldbus downstream PAS600 is serialized. Each request from PAS600 to the serial connected device (IMD or IFL) books the fieldbus for exclusive use and consumes part of the bandwidth.

The following table indicates the time needed by PAS600 to read/write a typical Modbus table in IMD or IFL for each solution level (assumption: PAS600 with factory Modbus settings: baud rate = 19200 bps / parity = even / stop bits = 1).

Devices	Solution level		
	Standard	**Advanced**	**High performance**
IMD	250 ms	250 ms	250 ms
IFL	N/A	250 ms	300 ms

The following rule based on the times given here above shall be respected to ensure efficient digital communication with the iPMCC network:

$$\sum \text{IMD communication times} + \sum \text{IFL communication times} < \text{refresh data period} \times \text{PAS600 max bandwidth load}$$

6.2.2 Additional limitations for the Schneider PLC IO scanner mechanism

The PAS600 may have 64 TCP connections maximum open simultaneously.

When the Modbus TCP client of PAS600 is a Schneider PLC, each request (or each line in the IO scanner table) for an IMD of IFL uses 1 TCP connection.

If we reach this limitation of 64 TCP connections, the communication performances will be degraded.

Our advice is to keep the limit at 60 and keep 4 TCP connections for EcoStruxure Power Commission (EPC) or webpage for instance.

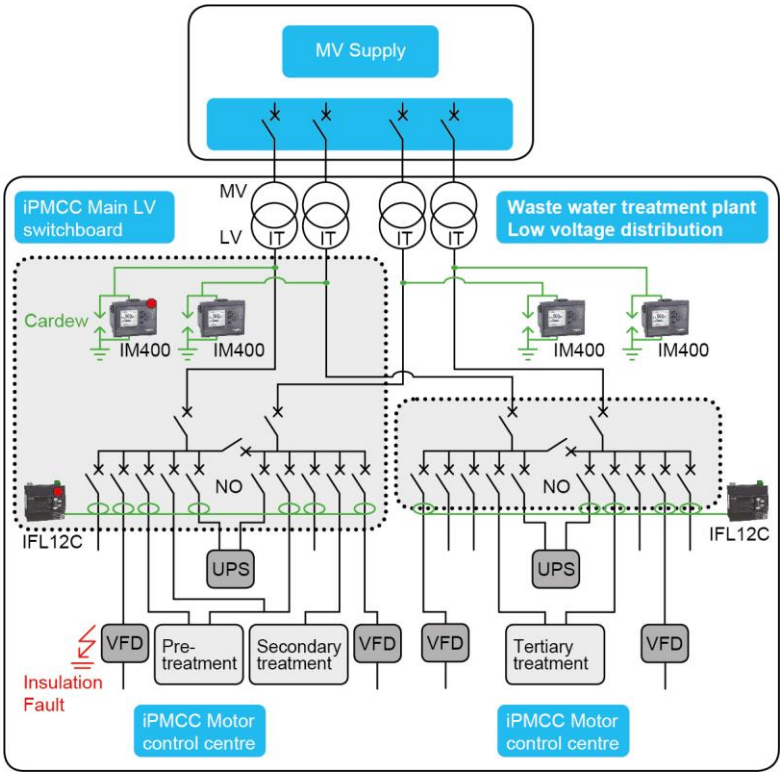
In **chapters 5.1.2, 5.2.2 and 5.3.2**, 2 to 3 requests are defined per IM400 / IFL12 which gives a maximum of 20 to 30 devices per PAS600 depending of the performance solution level.

This limitation can be more constraining than the RS485 fieldbus load limitation described in **chapters 5.1.3, 5.2.3 and 5.3.3.**

6.2.3 iPMCC Vigilohm system sizing tool

To simplify the engineering of iPMCC Vigilohm digital architecture and to take into account the two limitations explained in **chapters 6.2.1 and 6.2.2,** download the Excel workbook **iPMCC Vigilohm system Sizing tool.**

6.2.4 Example of architecture sizing based on the above rules



Requirements:

The installation includes **4 incomers and 140 feeders** (no spare feeders).

The customer wants to display in his SCADA insulation monitoring information, feeder fault location and measurements.

The customer's wishes to refresh all device data every **4 s** in his SCADA.

The integrator requires a maximum bandwidth load of **75%** for the EcoStruxure Panel Server Universal (PAS600).
This means that the **maximum communication time** of all the devices connected to the PAS600 **shall be less than 4 s x 0.75 = 3 s.**

Solution:

Because of the fault location and measurements need, the iPMCC Vigilohm solution level is **high performance**.

Hereunder the information entered in the sizing tool extracted from the above requirements:

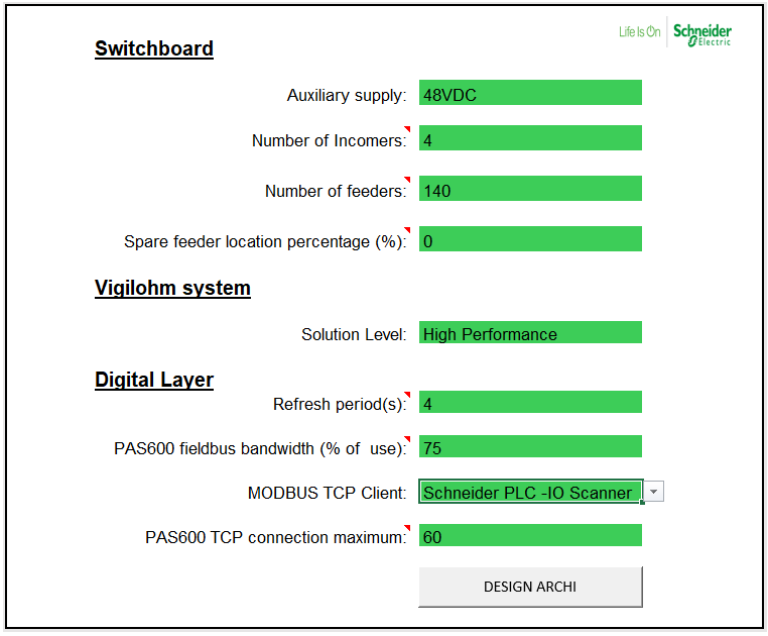


Figure 9: Vigilohm system sizing tool – Customer parameters view

Calculation:

4 IMDs (one per incomer) and **12 IFLs** (limitation max 12 feeders per IFL) are required to monitor the installation.

The sizing tools gives the following result:

	REFERENCE	QUANTITY
IMD	IMD-IM400L	4
IFL	IFL12LMC	12
Panel Server	PAS600L (T)	2

CHECK CUSTOMIZATION

PAS600 Id	IMD devices Number	IFL devices Number	Bandwidth load calcul/Max	TCP connection calcul/Max	Limitation Cause	Status
1	4	6	70 / 75	30 /60	PAS600 Serial Line Max TCP connection	OK
2	0	6	45 / 75	18 /60	End of calcul	OK

Figure 10: Vigilohm system sizing tool – Optimized digital architecture view

The sizing tool calculation is the following:

• **PAS600 n° 1:** connected to 4 IMDs and 6 IFLs

(4 x 250 ms) + (6 x 300 ms) = **2.8 s** which is **< at** 4 s x 0.75 = **3 s** to comply with the maximum required bandwidth load

• **PAS600 n° 2:** connected to 0 IMD and 6 IFLs

(0 x 250 ms) + (6 x 300 ms) = **1.8 s** which is **< at** 4 s x 0.75 = **3 s** to comply with the maximum required bandwidth load

However, the sizing tool allow to customize the proposed architecture to balance the load in a different way as follow:

	REFERENCE	QUANTITY
IMD	IMD-IM400L	4
IFL	IFL12LMC	12
Panel Server	PAS600L (T)	2

CHECK CUSTOMIZATION

PAS600 Id	IMD devices Number	IFL devices Number	Bandwidth load calcul/Max	TCP connection calcul/Max	Limitation Cause	Status
1	2	6	57 / 75	24 /48	User Customization OK	OK
2	2	6	57 / 75	24 /48	User Customization OK	OK

Figure 11: Vigilohm system sizing tool – Optimized digital architecture with customization view

The new calculation is the following:

• **PAS600 n° 1:** connected to 2 IMDs and 6 IFLs

(2 x 250 ms) + (6 x 300 ms) = **2.3 s** which is **< at** 4 s x 0.75 = **3 s** to comply with the maximum required bandwidth load

• **PAS600 n° 2:** connected to 2 IMD and 6 IFLs

(2 x 250 ms) + (6 x 300 ms) = **2.3 s** which is **< at** 4 s x 0.75 = **3 s** to comply with the maximum required bandwidth load

Note:

If the customization does not with the maximum required bandwidth load, **"NOK"** appears in the "Status" column.

Conclusion:

The iPMCC digital architecture of the switchboard must include 2 EcoStruxure Panel Server Universal (PAS600) in order to respect to bandwidth constrains and guarantee the data refresh requested for the SCADA.

Hereunder the digital architecture proposed for this example:

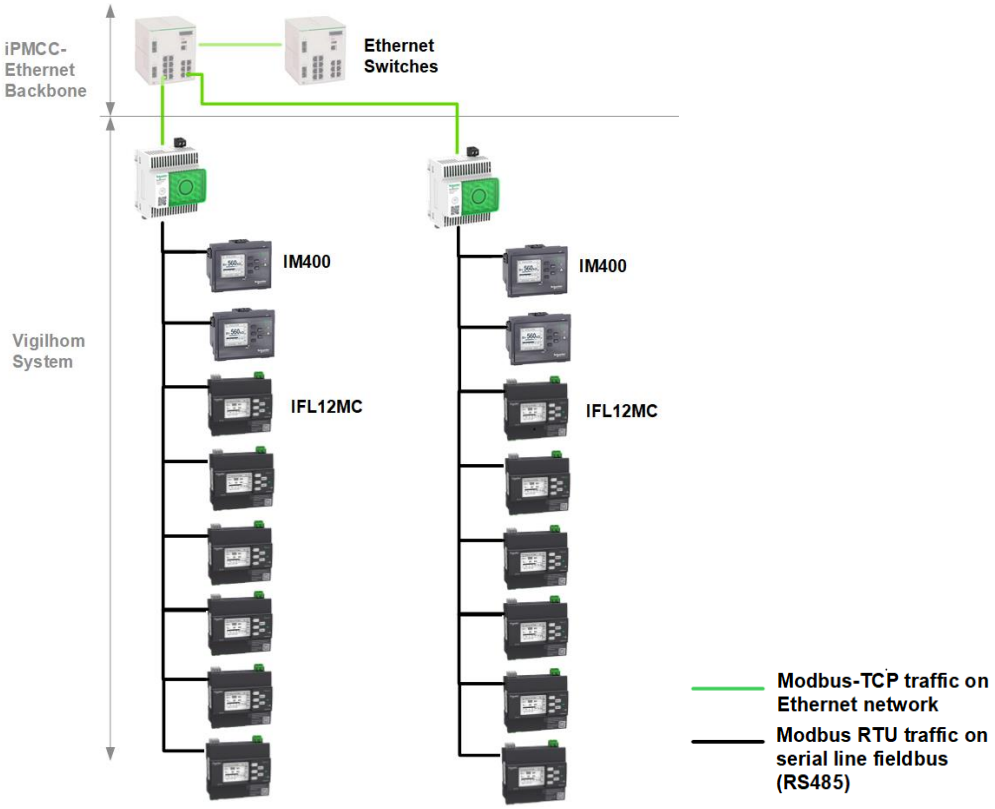


Figure 12: Digital architecture example (customized)

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