Vigilohm IM400

Insulation Monitoring Device
User Manual

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CE

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The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Schneider Electric nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.

All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

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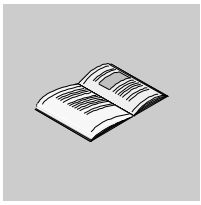
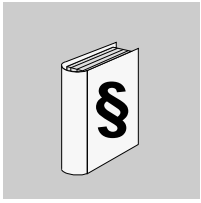


Safety Information



Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger 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.

PLEASE NOTE

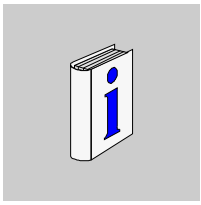
Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

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

FCC Notice

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designated to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at this own expense.

About the Book



At a Glance

Document Scope

This manual is intended for use by designers, panel builders, installers, system integrators and maintenance technicians who use ungrounded power systems (IT) with insulation monitoring devices (IMDs).

Validity Note

The Vigilohm IM400 is used to monitor lines to earth insulation of ungrounded power systems. This includes industrial and marine electrical systems, infrastructures, and power generation systems such as photovoltaic and wind turbines. Thanks to the adaptive multi-frequency injection signal, the Vigilohm IM400 is suitable for power and control circuits that contain switching power electronics (speed drives, motor starters, inverters, Thyristors) and DC components. The Vigilohm IM400 allows automatic and manual fault location.

Related Documents

Title of Documentation	Reference Number
Instruction Sheet: Vigilohm IM400 Insulation Monitoring Device	S1B90076
The IT earthing system: a solution to improve industrial electrical network availability - Application guide	PLSED110006EN
Système de liaison à la terre IT - Une solution pour améliorer la disponibilité des réseaux électriques dans l'industrie - Guide d'application	PLSED110006FR
System earthings in LV Les schémas des liaisons à la terre en BT (régimes du neutre)	Cahier technique n° 172
The IT system earthing (unearthed neutral) in LV Le schéma IT (à neutre isolé) des liaisons à la terre en BT	Cahier technique n° 178

You can download these technical publications and other technical information from our website at www.schneider-electric.com.

User Comments

We welcome your comments about this document. You can reach us by e-mail at techcomm@schneider-electric.com.

Presentation

1

What Is in This Chapter?

This chapter contains the following topics:

Presentation

Using Ungrounded IT System to Improve Power Availability and Reduce Risk of Fire

Continuity of service is an essential operational requirement for power systems, as it helps protecting people and property. The use of ungrounded IT power system is mandatory when power interruption would lead to a hazard for people and equipment. It is the case of medical operating theaters and marine applications.

Ungrounded IT system is recommended when unavailability of power would result in losing production, or occur significant downtime costs. When the first insulation fault current can lead to a risk of fire or explosion, it is recommended to limit the first fault current by using ungrounded systems. It is the case in environments such as oil and gas, chemical, or photovoltaic. The IT grounding system is chosen in certain cases because it can help facilitating preventive and corrective maintenance operations.

The ungrounded IT system helps making continuity of service. Even after a first insulation fault has occurred, the installation can continue to function without presenting any danger to people or equipment. However, the faulty circuit must be detected and repaired before a second insulation fault occurs. The fact that the IT system can tolerate a first insulation fault means that maintenance operations can be improved, planned, and carried out in good conditions.

Monitor Insulation Resistance (R)

Standards IEC 60364 and IEC 61557-8 state that IT systems must be either ungrounded or grounded using a sufficiently high value impedance (resistance or inductance).

In the event of a first insulation fault, the ground fault current is low and interrupting the faulty circuit is unnecessary. However, given the fact that a second insulation fault could potentially cause the circuit breaker to trip, an insulation monitoring device must be installed to indicate a first insulation fault. This device must trig an audible or a visual signal.

By constantly monitoring the insulation resistance, you can track the system insulation quality, which is an insight for preventive maintenance.

Monitor the Leakage Rate (C)

According to standard IEC 60364-4-41, the following conditions must apply to provide protection against indirect contact in AC power systems:

$R_A \times I_d \leq 50\ V$

Where:

- R_A is the resistance value of the grounding connection of the equipment exposed-conductive-parts.
- I_d is the ground fault current, in A.
- 50 V is the maximal acceptable voltage for indirect contacts.

In ungrounded, 3-phase, AC power systems, fault current I_d is $I_d = 2\pi \text{ x} F \text{ x} C \text{ x} V$.

Where:

- C is the earth leakage capacitance of the power system.
- F is the frequency of the power system.
- V is the phase to neutral voltage.

Therefore the following condition must apply to provide protection against indirect contacts:

$2\pi \text{ x} F \text{ x} V \text{ x} C \text{ x} R_A \leq 50\ V$.

Thus it is necessary to monitor the earth leakage capacitance C and to have a low resistance value of grounding connections.

For more information, see *Cahier technique n° 178*.

Functions of Vigilohm IM400 Insulation Monitoring Device

Vigilohm IM400 is a digital insulation monitoring device (IMD) for low-voltage IT power systems with ungrounded neutral. Vigilohm IM400 can be used to monitor the insulation of a system and to signal insulation faults.

Vigilohm IM400 applies several patented combinations of a low-frequency AC voltage between the system and ground to provide accurate insulation monitoring in complex applications. The insulation is then assessed based on the current value returned. This method is used for all types of systems: AC, DC, mixed, with rectifiers, with variable speed drives, with inverters, and so on.

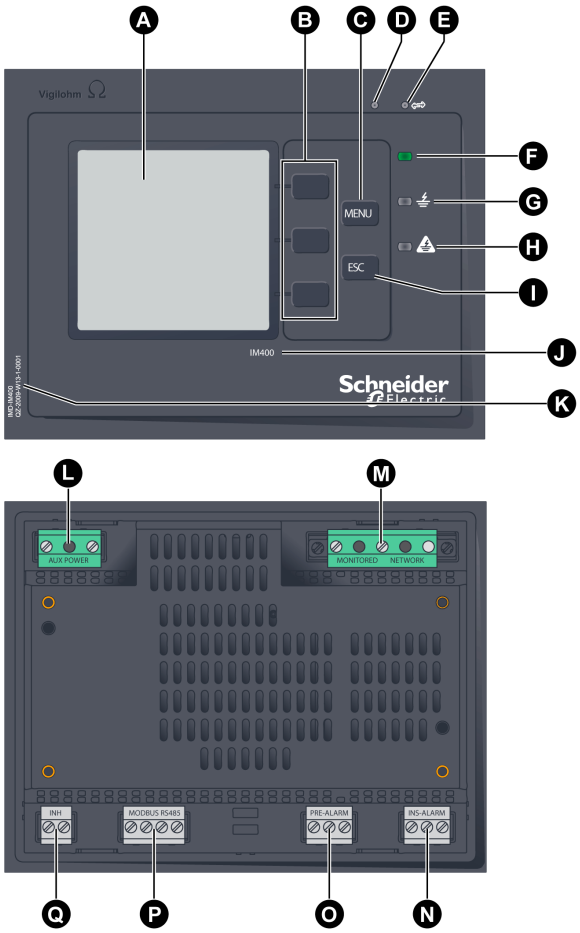
Vigilohm IM400 offers the following functions:

- Insulation resistance display (R)
- Detection of insulation faults in accordance with a configurable threshold
- Display of earth leakage capacitance (C) and associated impedance (Zc)
- Communication via the Modbus RS 485 protocol
- Injection inhibition via logic input
- Insulation fault log
- Trending of the insulation resistance (R) from last hour to last year
- Quick setup of the monitoring parameters according to the applications
- Compatibility with voltage adaptors (Umax = 1,700 Vac Ph-Ph or Umax = 1,200 Vdc)

Physical Description

Physical Description

Physical Description



A Display
B Contextual menu buttons
C **MENU** button
D Red indicator light for Vigilohm IM400 product status
E Yellow indicator light for Modbus communication indication
F Green indicator light for correct insulation indication
G White indicator light for preventive insulation alarm
H Yellow indicator light for insulation alarm
I **ESC** button for returning to previous menu or canceling a parameter entry
J Vigilohm product catalog number
K Vigilohm serial number
L Auxiliary power supply terminal block
M Injection terminal block
N Insulation alarm relay terminal block
O Preventive insulation alarm relay terminal block
P Modbus RS 485 terminal block
Q Injection inhibition input terminal block

Accessories

Presentation

The following accessories are required depending on the type of installation on which Vigilohm IM400 is installed:
- a Cardew C surge limiter
- a ZX limiting impedance
- a voltage adaptor

Below is a list of accessories for the Vigilohm devices:

Accessory	Catalog Number
250 V Cardew C surge limiter	50170
440 V Cardew C surge limiter	50171
660 V Cardew C surge limiter(1)	50172
1,000 V Cardew C surge limiter(1)	50183
Cardew C base(2)	50169
ZX limiting impedance	50159
IM400-1700 voltage adaptor(3)	IMD-IM400-1700
PHT1000 voltage adaptor(4)	50248

1 Compatible with the Vigilohm IM400 when used with voltage adaptor IM400-1700 or PHT1000.
2 Compatible with all Cardew C catalog numbers.
3 For power systems with Umax > 480 Vac Ph-Neutral, or Umax > 830 Vac Ph-Ph, or Umax > 480 Vdc without insulation fault locator.
4 For power systems with Umax > 480 Vac Ph-Neutral, or Umax > 830 Vac Ph-Ph, or Umax > 480 Vdc with insulation fault locator.

NOTE: For information regarding automatic and mobile insulation fault locating accessories, refer to the relevant section *(see page 47)*.

Cardew C Surge Limiter

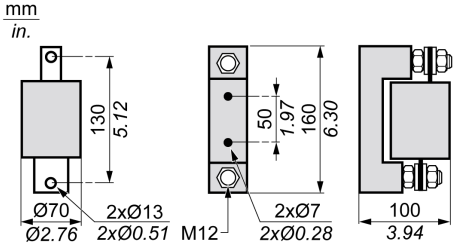
Function

The Cardew C is used if the insulation monitoring device is connected to the secondary of an MV/LV transformer (according to the rules and conventions that apply in the various countries).
It helps protecting the low-voltage (LV) installation against overvoltage hazards.
It is connected to the transformer secondary.
The Cardew C can be used on the following systems:
- U < 1000 Vac
- U < 300 Vdc

Selection table

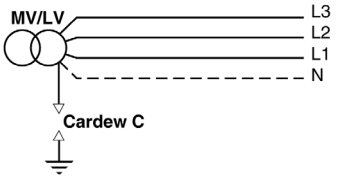
Un: Nominal Phase-to-Phase Voltage of AC System		Ui: Arcing Voltage	Type of Cardew C
Not accessible neutral	Accessible neutral		
U ≤380 V	U ≤220 V	400 V < Ui ≤750 V	250 V
380 V < U ≤660 V	220 V < U ≤380 V	700 V < Ui ≤1,100 V	440 V
660 V < U ≤1,000 V	380 V < U ≤660 V	1,100 V < Ui ≤1,600 V	660 V
1,000 V < U ≤1,560 V	660 V < U ≤1,000 V	1,600 V < Ui ≤2,400 V	1,000 V

Dimensions

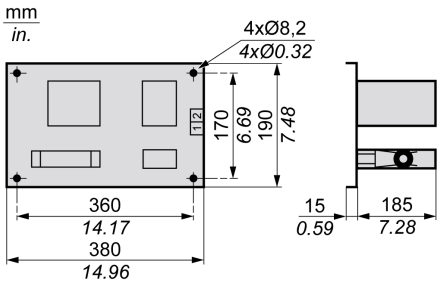
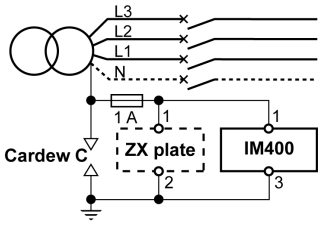


Mounting
- Cardew C mounted directly on busbars
- Mounting with plate-mounted base

Connection

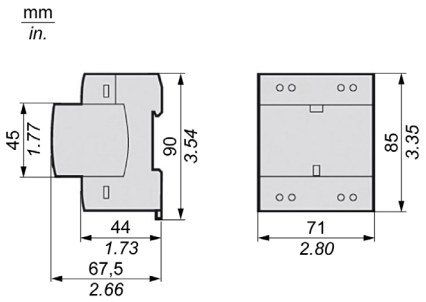
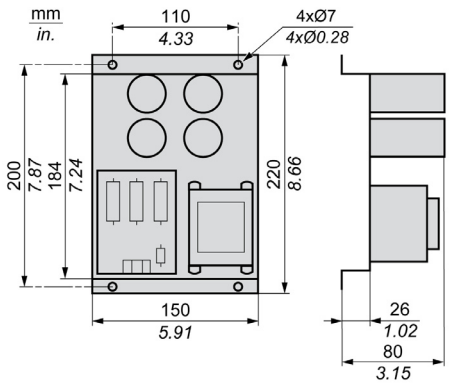
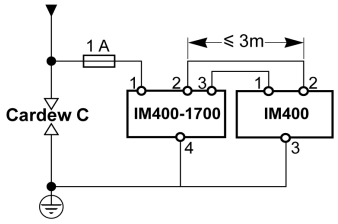
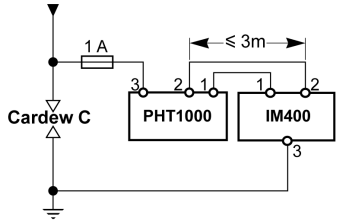


ZX Limiting Impedance

Function	The ZX limiting impedance creates an installation with an impedance grounded neutral system (1500 Ω at 50 Hz). The ZX remains connected during insulation fault locating at 2.5 Hz: ● 1,500 Ω at 50 Hz ● 1M Ω at 2.5 Hz The ZX limiting impedance must be used on systems with U ≤500 Vac.
Dimensions	
Mounting	On mounting plate
Connection	

Voltage Adaptors

The optional voltage adaptors are:
- IM400-1700
- PHT1000

Function	The IM400-1700 and PHT1000 voltage adaptors can be used to connect a Vigilohm IM400 to voltage systems higher than 480 Vac L-L. The wire connecting IM400-1700 to Vigilohm IM400 must have the same voltage rating than the monitored network. The compatibility of voltage adaptors with insulation fault location is as follows: ● The IM400-1700 voltage adaptor is not compatible with insulation fault location. ● The PHT1000 voltage adaptor is compatible with insulation fault location.	
Dimensions	IM400-1700 	PHT1000 
Mounting	On DIN rail	On mounting plate
Connection	Monitored network **480 V∼ < U ⩽ 1000 V∼ L-L** (1) **830 V∼ < U ⩽ 1700 V∼ L-L** (2) **480 V⎓ < U ⩽ 1000 V⎓**  **1** Voltage adaptor connected to a phase **2** Voltage adaptor connected to neutral	Monitored network **480 V∼ < U ⩽ 1000 V∼ L-L** (1) **830 V∼ < U ⩽ 1700 V∼ L-L** (2) **480 V⎓ < U ⩽ 1200 V⎓**  **1** Voltage adaptor connected to a phase **2** Voltage adaptor connected to neutral

S3 Subassembly (Retrofit)

Insulation alarm thresholds of the Vigilohm IM400 must be set higher than 2 kΩ to take into account internal impedance of S3 subassembly.

Installation

2

What Is in This Chapter?

This chapter contains the following topics:

Safety Measures

Specific Hazard Associated with Insulation Monitoring Devices (IMDs)

In the case of almost all electric and electronic devices, the device power supply is the root cause of electrical hazards. The hazard can be mostly reduced by disconnecting the power supply.

This is not the case with insulation monitoring devices, which are connected to the system via the injection wire.

So this connection must be broken before carrying out any kind of work on the product.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Before carrying out work of any kind, disconnect the Vigilohm IM400 from the monitored system by disconnecting wiring terminals 1, 2, and 3 of injection terminal block. Disconnect all the power supplies running to the Vigilohm and the equipment on which it is installed.
- Always use a correctly calibrated voltage tester to check that the injection wire and power supply have been properly disconnected.

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

Specific Hazard Associated with IM400-1700 Voltage Adaptor

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Connect the ground wiring terminal (4) on the IM400-1700 voltage adaptor to a protective earth ground (PE) conductor.

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

Other Safety Measures

Carefully read through the safety measures described below. You are always required to implement them fully before attempting to install, repair, or service electrical equipment.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Wear suitable personal protective equipment and follow the currently applicable electrical safety instructions.
- This equipment may only be installed by qualified electricians who have read all the relevant information.
- NEVER work alone.
- Before performing visual inspections, tests, or maintenance on this equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all power supply sources, particularly the potential for backfeed.
- Before closing protective covers and doors, carefully inspect the work area to ensure that no tools or objects have been left inside the equipment.
- Take care when removing or replacing panels. Take special care to ensure that they do not come into contact with live busbars. To minimize the risk of injuries, do not tamper with the panels.
- The successful operation of this equipment depends upon proper handling, installation, and operation. Failure to follow basic installation procedures can lead to personal injury as well as damage to electrical equipment or other property.
- NEVER shunt an external fuse/circuit breaker.
- The Vigilohm must be installed in a suitable electrical cabinet.

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

A dielectric test (Hi-Pot) or a Megger test on a device installed in the power system monitored by the Vigilohm IM400 can damage the Vigilohm IM400.

NOTICE

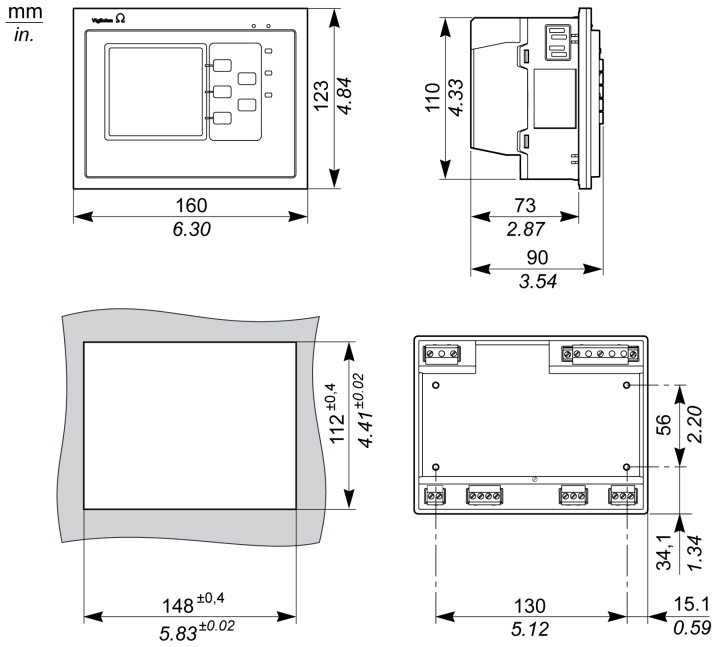
HAZARD OF PRODUCT DAMAGE

Before performing a dielectric test (Hi-Pot) or a Megger test, disconnect the Vigilohm input and output wires.

Failure to follow these instructions can result in equipment damage.

Dimensions

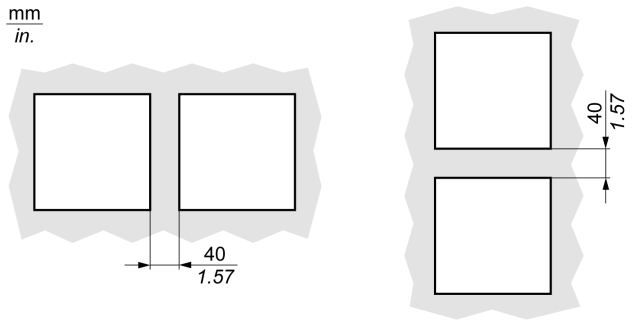
Vigilohm IM400 Dimensions



⚠ CAUTION
CUTTING HAZARD
Trim the edges of the cut-out plates to remove any jagged edges.
Failure to follow these instructions can result in injury or equipment damage.

Constraints for Flush Mounting

Observe the correct distances between devices.



Flush Mounting and Dismantling

Presentation

Vigilohm IM400 can be attached to any flat, rigid vertical support using the spring clips supplied. The device must not be tilted following installation.

To free up useful space for control gear, you can attach the Vigilohm to the front panel of the floor-standing or wall-mounted enclosure.

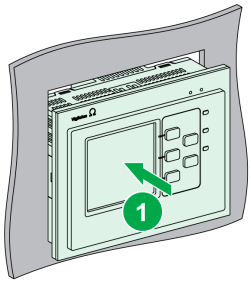
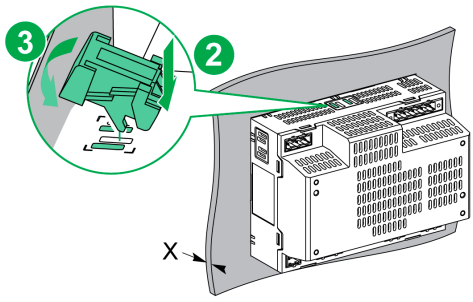
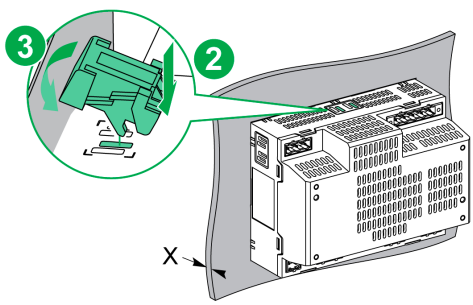
For USA and Canada, Vigilohm IM400 mounting is to be open type only.

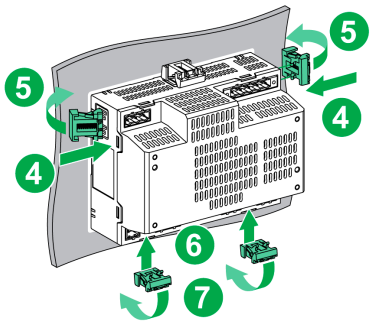
Installing

Before attaching the Vigilohm, check the following:

- The mounting plate must have a thickness of between 0.8 mm (0.03 in) and 3.2 mm (0.12 in).
- A rectangle measuring 148 x 112 mm (5.83 x 4.41 in) must be cut out from the plate so the device can be installed.
- No terminal blocks are connected to the unit.

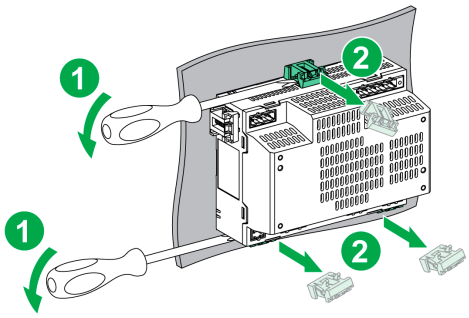
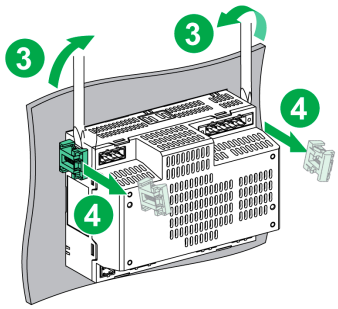
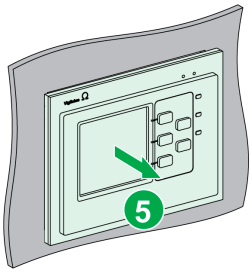
To install the Vigilohm, proceed as follows:

<table>
<tr><th>Step</th><th colspan="2">Action</th></tr>
<tr><td>1</td><td colspan="2">Insert the Vigilohm in the cut-out in the mounting plate by tilting the device forward slightly.
 
</td></tr>
<tr><td rowspan="3">2</td><td colspan="2">Depending on the thickness of the mounting plate, clip the spring clips into the mounting slots on the device as described below. First, clip the spring clip at the top.</td></tr>
<tr><td>If the mounting plate thickness (X) is:
0.8 mm ≤X ≤2 mm
(0.03 in ≤X ≤0.08 in)</td><td>The mounting slot to be used is:
 
</td></tr>
<tr><td>If the mounting plate thickness (X) is:
2 mm < X ≤3.2 mm
(0.08 in ≤X ≤0.12 in)</td><td>The mounting slot to be used is:
 
</td></tr>
</table>

Step	Action
3	Clip the 2 spring clips on the device sides then the 2 spring clips at the device bottom. 
4	Wire up and insert the terminal blocks as shown in the relevant wiring diagram *(see page 25)*.

Removing

To remove the Vigilohm from a mounting plate, proceed as follows:

Step	Action
1	Disconnect the terminal blocks from the Vigilohm.
2	Deal with each of the spring clips as follows: insert the blade of a screwdriver between the spring clip and the device. Then use the screwdriver as a lever to release the spring clip. Start releasing the spring clips at the top and bottom of the device. 
3	Release the 2 spring clips at the device sides. 
4	Remove the Vigilohm from the plate. 
5	Reinsert the terminal blocks, making sure that the correct positions on the device are observed *(see page 12)*.

Mounting on and Dismantling from a Grid

Presentation

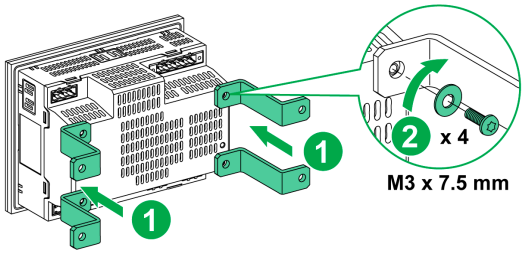
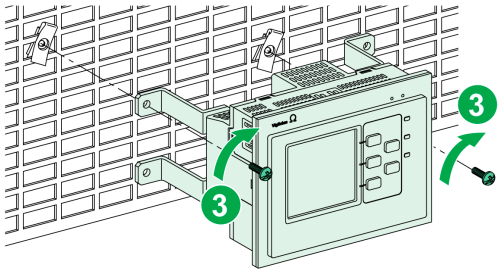
You can install the Vigilohm on a grid using mounting brackets (reference 01199) or equivalent. The device must not be tilted following installation.

When mounting the device or dismantling it using clamps, you can keep the terminal blocks connected and wired up, or you can remove them and keep them to hand.

For USA and Canada, Vigilohm IM400 mounting is to be open type only.

Mounting

To install the Vigilohm on a grid using mounting brackets, proceed as follows:

Step	Action
1	Position the mounting brackets on the Vigilohm and tighten the screws and washers as described below (tightening torque: 1.2 N.m (8.85 lb-in). 
2	Attach the assembly to the grid using clamps. 

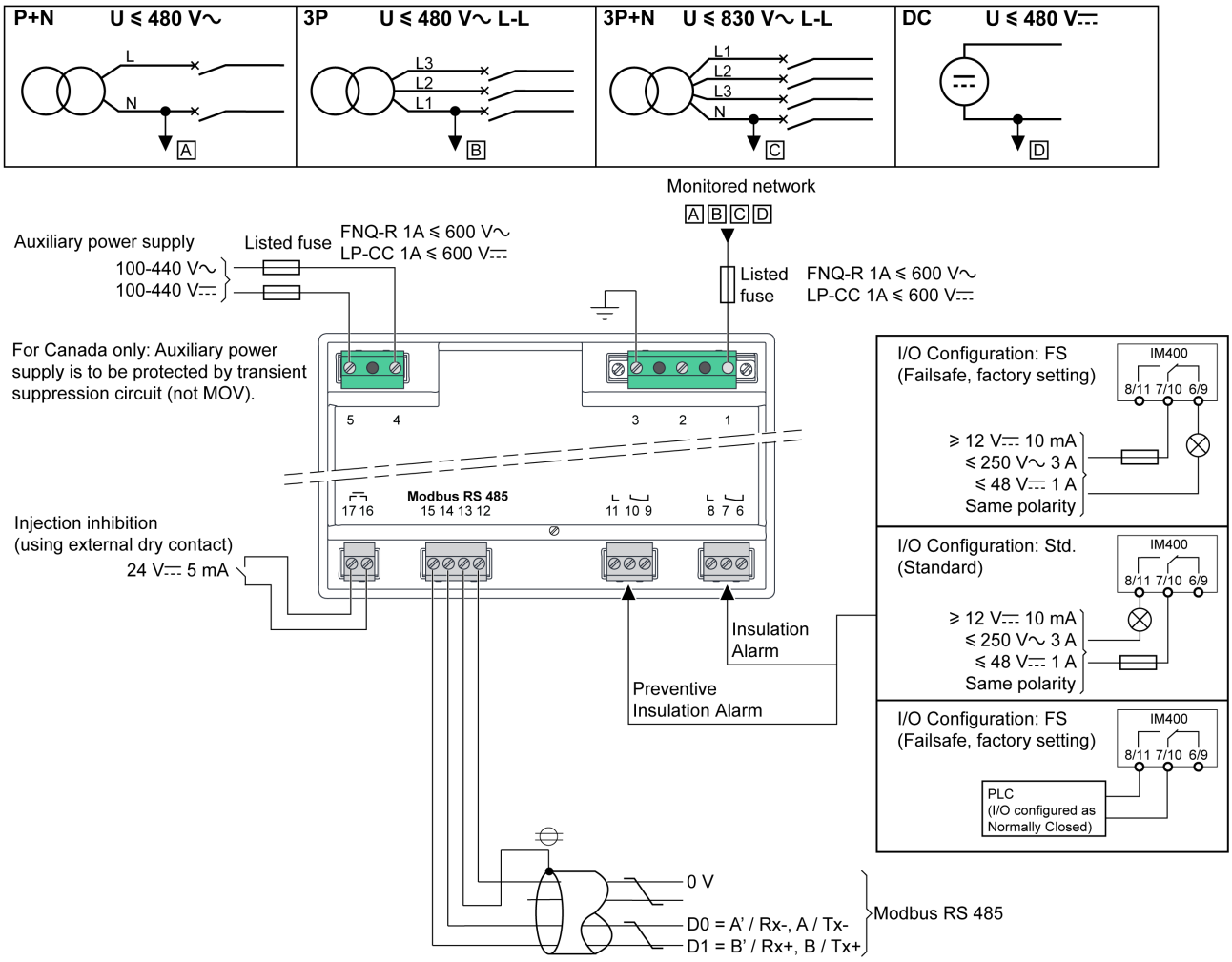
Removing

To remove the Vigilohm from a grid, unscrew the clamps from the grid to release the device.

Connection

Connection Diagram

The diagram below illustrates how to connect the Vigilohm to a single-phase or three-phase 3- or 4-wire power system, or a DC power system.



The relay operating mode (failsafe or standard) is controlled via the HMI of the Vigilohm device or with Modbus communication.

NOTE: Listed circuit breakers (reference MGN61334 or equivalent) can be used to replace listed fuses.

Connection Characteristics

All the Vigilohm IM400 wiring terminals have identical wiring capabilities.

The table shows the characteristics of the cables that can be used to connect the wiring terminals:

Stripped Length	Cross-Section Area	Tightening Torque	Type of Screwdriver
7 mm (0.27 in)	0.2...2.5 mm² (AWG 24...14)	0.8 N.m (7 lb-in)	Flat, ≤3 mm (≤0.10 in)

Cross-section area and voltage rating of wires must be suitable to the load current and to the voltage to which it is connected. The following characteristics need to be considered:

- auxiliary power supply consumption: 25 VA / 10 W
- current flowing to the monitoring network wiring terminal: less than 20 mA
- current flowing to the injection inhibition wiring terminal: 5 mA
- current flowing to the insulation alarm and to the insulation preventive alarm wiring terminals depends on the power rating of the alarm indicator.

Typical Applications

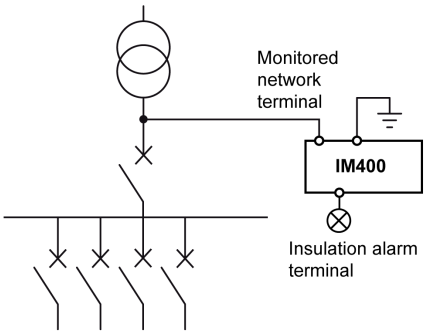
Presentation

The following section presents 5 insulation monitoring applications for an IT power system:
- 1 application with a standalone Vigilohm IM400
- 1 application with Vigilohm IM400 where the insulation alarm and preventive insulation alarm outputs are sent to a supervisor
- 1 application with Vigilohm IM400 where the insulation alarm and preventive insulation alarm outputs are sent to a supervisor, and locating the insulation fault is done using an XD301 or XD312 automatic fault locator and an XRM mobile fault locator
- 1 application with a Vigilohm IM400 connected to a communication network
- 1 application with a Vigilohm IM400 connected to a communication network, and locating the insulation fault is done using an XD308C insulation fault locator

Monitoring the Insulation of an IT Power System with a Standalone Vigilohm IM400

An IT power system is a system involving the use of a transformer whose neutral is not grounded.

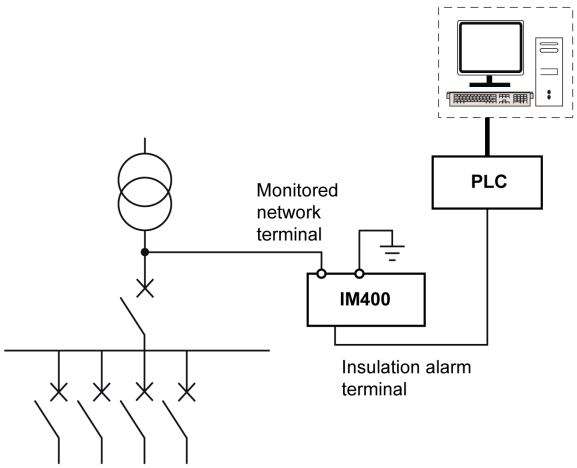
The insulation is monitored by one Vigilohm IM400 with the following characteristics:
- IM400 is powered by the system that it monitors.
- IM400 is connected to neutral (or to one phase) and ground.
- The insulation fault threshold level is the only IM400 setting to be set up. The preventive insulation alarm can be set up.
- Vigilohm IM400 has a single relay output to a light or alarm sound.



Monitoring the Insulation of an IT Power System with a Vigilohm IM400 Where the Insulation Alarm Is Sent to a Supervisor

The insulation is monitored by a Vigilohm IM400 whose insulation alarm and preventive insulation alarm outputs are connected to an available input on a networked device (a PLC, for example). This device is itself connected to a supervisor via a communication network.

As far as this architecture is concerned, the restriction is that only the insulation fault and preventive insulation alarm information is available at supervisor level.



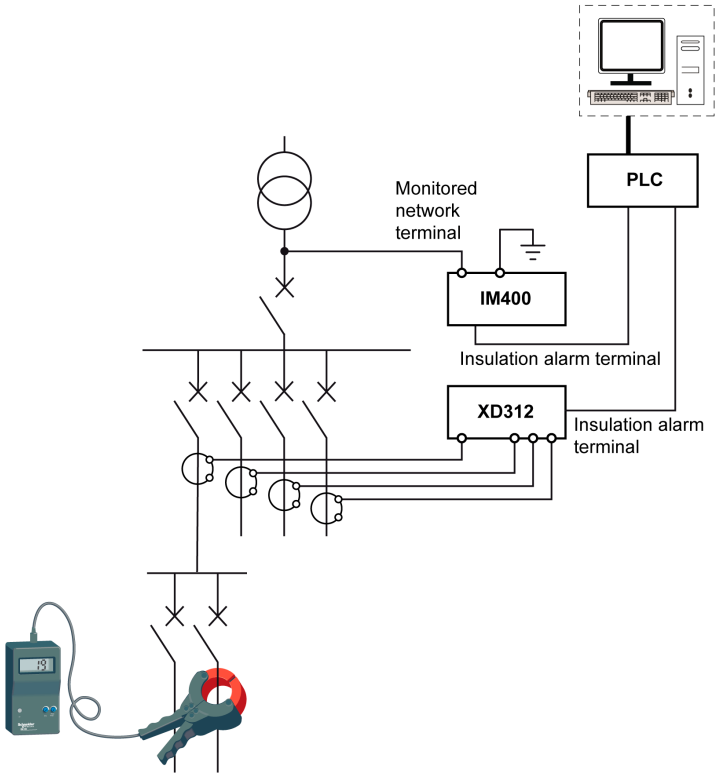
Monitoring the Insulation of an IT Power System with a Vigilohm IM400 and Insulation Fault Location Where the Insulation Alarm Is Sent to a Supervisor

The insulation is monitored by a Vigilohm IM400 whose insulation alarm and preventive insulation alarm outputs are connected to an available input on a networked device (a PLC, for example). This device is itself connected to a supervisor via a communication network.

Locating the insulation fault is done using XD301 or XD312 devices. The XD301 or XD312 output relay is connected to an available input on a networked device.

The XRM mobile insulation fault locator is used to locate accurately the area where the insulation fault is.

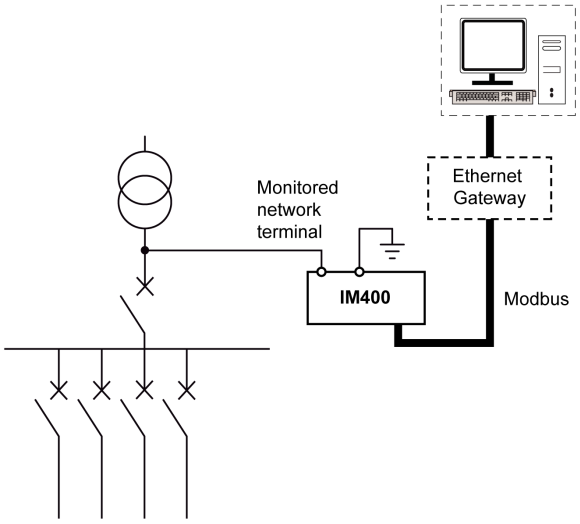
As far as this architecture is concerned, the restriction is that only the insulation fault information and group of faulty feeder are available at supervisor level.



Monitoring the Insulation of an IT Power System with a Vigilohm IM400 Connected to a Communication Network

When the Vigilohm IM400 insulation monitoring device is linked to the supervisor via a Modbus connection, the following actions are supported:

- Display:
  - Product status
  - Status of the insulation alarm (active, not active, acknowledged) and status of the preventive insulation alarm
  - Details of the last 30 time-tagged events
  - Values for R and C to create tables or curves for monitoring these values over variable periods
- Configuring the product remotely: all the settings can be accessed remotely, except for the Modbus parameters (**Address**, **Auto Config**, **Baudrate**, and **Parity**).



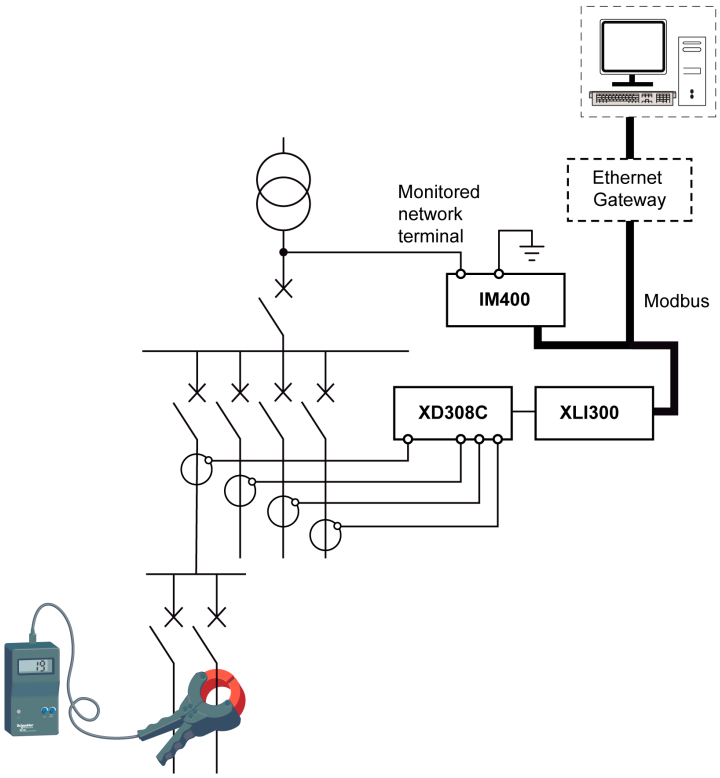
Monitoring the Insulation of an IT Power System with a Vigilohm IM400 Connected to a Communication Network and Insulation Fault Location

When the Vigilohm IM400 insulation monitoring device is linked to the supervisor via a Modbus connection, the following actions are supported:

- Display:
  - Product status
  - Status of the insulation alarm (active, not active, acknowledged) and status of the preventive insulation alarm
  - Details of the last 30 time-tagged events
  - Values for R and C to create tables or curves for monitoring these values over variable periods
- Configuring the product remotely: all the settings can be accessed remotely, except for the Modbus parameters.

Using the XD308C insulation fault location device in addition with the XLI300 communication interface allows also the supervisor to monitor remotely all the feeders and so to report precisely any insulation fault location.

The XRM mobile insulation fault locator is used to locate accurately the area where the insulation fault is.



Functions

3

What Is in This Chapter?

This chapter contains the following topics:

R and C Measurement

Insulation Measurements

Vigilohm IM400 is designed:
- to monitor the IT power system insulation,
- to measure:
  - the insulation resistance R (Ω) continuously,
  - C, which is the leakage capacitance of the distribution system to ground (µF),
- to calculate the impedance Zc (kΩ) associated with C.

General Information on the Measurement Accuracy of R

There are 2 effects on the measurement accuracy of R:
- the effect of the leakage capacitance (C)
- the effect of the frequency disturbances (for example, speed drives or inverters)

Effect of Leakage Capacitance on the Measurement Accuracy of R

For IMDs using switching mode measurement signals, the leakage capacitance (C) has an impact on the measurement accuracy of R. The leakage capacitance (C) creates a leakage path for the measurement signal, and reduces the level of the useful signal that flows through the insulation resistance (R).

The Vigilohm IM400 injects a signal with very low frequencies and includes high-performance integration algorithms. It makes it compatible with large power systems that have a high value of leakage capacitance.

The Vigilohm IM400 correctly operates in power systems with leakage capacitance up to 500 µF and photovoltaic systems with leakage capacitance up to 2,000 µF.

Effect of Frequency Disturbances on the Measurement Accuracy of R

Switching mode power electronic devices apply residual voltages between the power system and ground. These voltages may interfere with IMDs measurements.

The Vigilohm IM400 injects an adaptive multi-frequency measurement signal that makes it operate out of the disturbance range. This measurement signal is combined with efficient integration algorithms to allow accurate measurements regardless of the frequency disturbances.

Configuration and Accuracy Zones by Application

Configuration by Application

Vigilohm IM400 is designed and tested to be compliant with different applications:

- Power circuits: industrial or marine applications that contain power loads and power electronics such as speed drives, inverters, or rectifiers.
- Control circuits: auxiliary control circuits used to drive power systems. These circuits contain sensitive loads such as PLCs, IOs, or sensors.
- Photovoltaic systems: large photovoltaic power generation systems. This application is characterized by high DC rated voltage (1,000 V) and high system leakage capacitance (up to 2,000 µF).

Applications

To optimize the measurement performances of Vigilohm IM400 according to the application, set the application parameter by selecting **Menu** →**Settings** →**Network** →**App.**.

Set the **App.** parameter value depending on the type of application on which Vigilohm IM400 is installed:

Parameter Value	Application
Power C. (factory setting)	Power circuits
Control C.	Control circuits
Photovolt	Photovoltaic

The measurement parameters accessible in the **Network** menu are automatically preset depending on the set-up application:

- **Filtering**
- **Fault Locating**
- **V. Adaptor**
- **Frequency**
- **Injection**

There is no need to configure these parameters in typical conditions.

The table shows the preset values of the measurement parameters according to the application parameter:

Preset Values	Applications		
	Power C.	**Control C.**	**Photovolt**
Filtering	**Medium**	**Medium**	**Medium**
Fault Locating	**ON**	**ON**	**OFF**
V. Adaptor	**None**	**None**	**HV1700**
Frequency	**50 Hz**	**DC**	**DC**
Injection	**Std**	**Min**	**Max**

Filtering (Measurement Quality)

The Filtering parameter is to be set depending on the installation type. This parameter is used to smooth out values of insulation measures that always depend on equipment operating on the system. Criteria with an impact can be especially:

- Number of loads
- Type of loads
- Size of the system (affects C)
- Load switching

The Vigilohm IM400 is designed to provide accurate insulation resistance and capacitance measurement on highly disturbed systems with power electronic devices. However, to avoid effects such as display fluctuation or undesired transient insulation, or preventive insulation alarm, a filtering function is embedded to improve the measurement stability. The response time associated with this filtering function does not create any problems within the context of IT power system.

3 settings are available for the **Filtering** parameter.

Parameter Value	Example of Use	Measurement Refresh Time	Response Time Required to Detect an Insulation Fault (for C = 1 µF)
Short	Recommended in maintenance mode. Diagnose fast variation of the insulation resistance and leakage capacitance. Mostly used in the following cases: ● Detecting short time transient insulation faults. ● When manually locating insulation faults by opening circuit breakers.	0.8 s (not available in photovoltaic application)	1 s (not available in photovoltaic application)
Medium	Recommended in operation mode. Dedicated to monitor insulation of typical installations.	8 s	40 s
Long	Recommended in operation mode. Dedicated to monitor insulation of highly disturbed installations and/or installations with high leakage capacitance.	80 s	400 s

Locating Insulation Faults

The Vigilohm IM400 can be used with XD301, XD312, or XD308C automatic insulation fault locator or XRM mobile insulation fault locators to detect where the insulation fault is located. Activate or deactivate this feature through **Fault Locating** parameter.

2 settings are available for the **Fault Locating** parameter.

Parameter Value	Description
OFF	The Vigilohm IM400 does not inject a fault locating current.
ON	The Vigilohm IM400 injects a fault locating current compatible with XD301, XD312, XD308C, and XRM devices. Insulation fault location is not compatible with HV1700 voltage adaptor.

Voltage Adaptors

The Vigilohm IM400 can be used with IM400-1700 and PHT1000 voltage adaptors to monitor power systems with a rated voltage above 480 Vac/dc.

IM400-1700 voltage adaptor can also be used in power systems below 480 Vac/dc to increase the internal impedance of the Vigilohm IM400.

3 settings are available for the **V. Adaptor** parameter.

Parameter Value	Description
None	Vigilohm IM400 is directly connected to the monitored power system. The power system should have a rated voltage lower or equal to 480 Vac/dc.
HV1700	Vigilohm IM400 uses IM400-1700 voltage adaptor to connect to the monitored network *(see page 15)*. Locating an insulation fault cannot be done using Vigilohm IM400 with IM400-1700. HV1700 cannot be set up when the parameter **Fault Locating** is set to **ON**.
PHT1000	Vigilohm IM400 uses PHT1000 voltage adaptor to connect to the monitored network *(see page 15)*. Locating an insulation fault can be done using Vigilohm IM400 with PHT1000.

System Frequency

This is the rated frequency of the monitored power system.

4 settings are available for the **Frequency** parameter:
- **DC**
- **50 Hz**
- **60 Hz**
- **400 Hz**

Injection

This is the level of measurement voltage and measurement current that are injected between the monitored power system and ground.

4 settings are available for the **Injection** parameter.

Parameter Value	Example of Use	Measurement Voltage Value	Measurement Current Value
Min	Sensitive control circuits	< 15 Vpeak	< 375 µApeak
Low	Not sensitive control circuits or power circuits with low values of leakage capacitance	< 33 Vpeak	< 825 µApeak
Std	Power circuit applications with high values of leakage capacitance	< 120 Vpeak	< 3 mApeak
Max (setting applicable only for Vigilohm IM400 used with IM400-1700)	Photovoltaic application	< 120 Vpeak	< 300 µApeak

Impedant IT Networks (HRG)

The Vigilohm IM400 can be used to monitor power systems with a grounding resistance inserted between the neutral and the earth.

If the value of this neutral grounding resistance is entered through the **HRG** (High Resistance Grounding) parameter, the Vigilohm IM400 compensates the measured insulation resistance. It does it with the value of the neutral grounding resistance, offsetting it to report the actual insulation resistance. In this case, the actual insulation resistance (offset of the neutral grounding resistance) is used against the insulation alarm threshold and the preventive insulation alarm threshold to trigger the insulation and preventive insulation alarm relays.

HRG compensation is applicable only if the neutral is connected to ground through a resistance. HRG is not compatible with RLC (non-linear) grounding circuits.

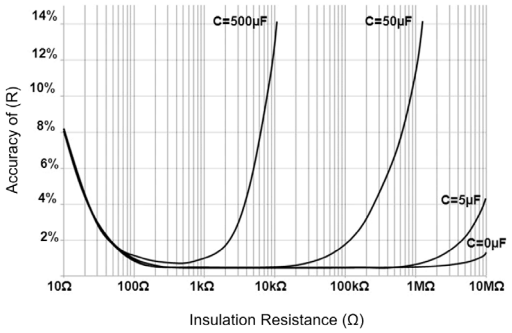
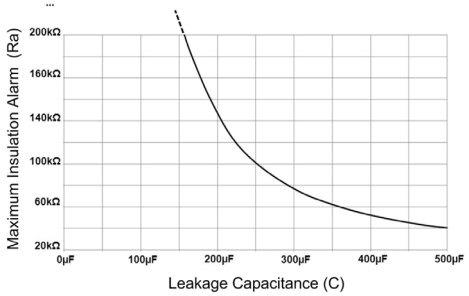
2 settings are available for the **HRG** parameter.

Parameter Value	Description
OFF	The Vigilohm IM400 does not compensate the reported insulation resistance with the value of the neutral grounding resistance.
0.1...500 kΩ	The Vigilohm IM400 compensates the measured insulation resistance with the value of the neutral grounding resistance.

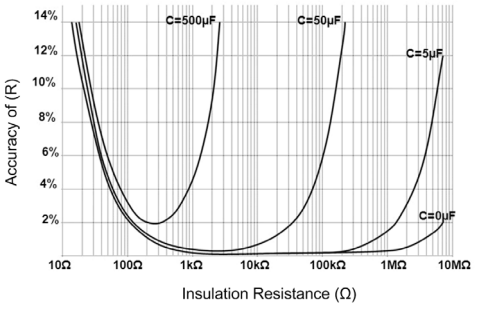
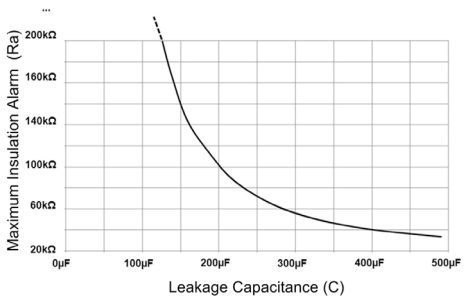
Accuracy by Application

The graphs illustrate the accuracy zones for Vigilohm IM400 depending on the application.

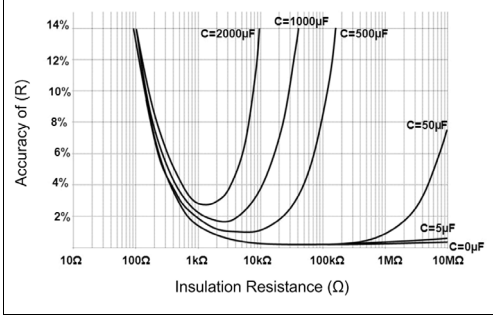
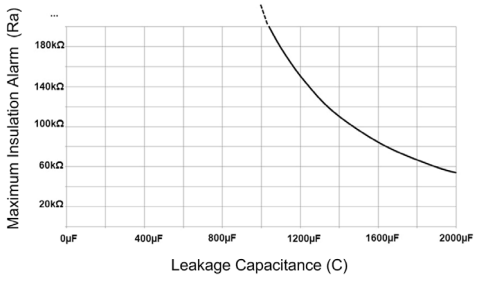
- Typical performance characteristics for power circuit application (parameter **App.** set to **Power C**.)

Relative Error of Insulation Resistance Measurement over Leakage Capacitance	Maximum Configurable Insulation Alarm Threshold as a Function of Leakage Capacitance
	

- Typical performance characteristics for control circuit application (parameter **App.** set to **Control C**.)

Relative Error of Insulation Resistance Measurement over Leakage Capacitance	Maximum Configurable Insulation Alarm Threshold as a Function of Leakage Capacitance
	

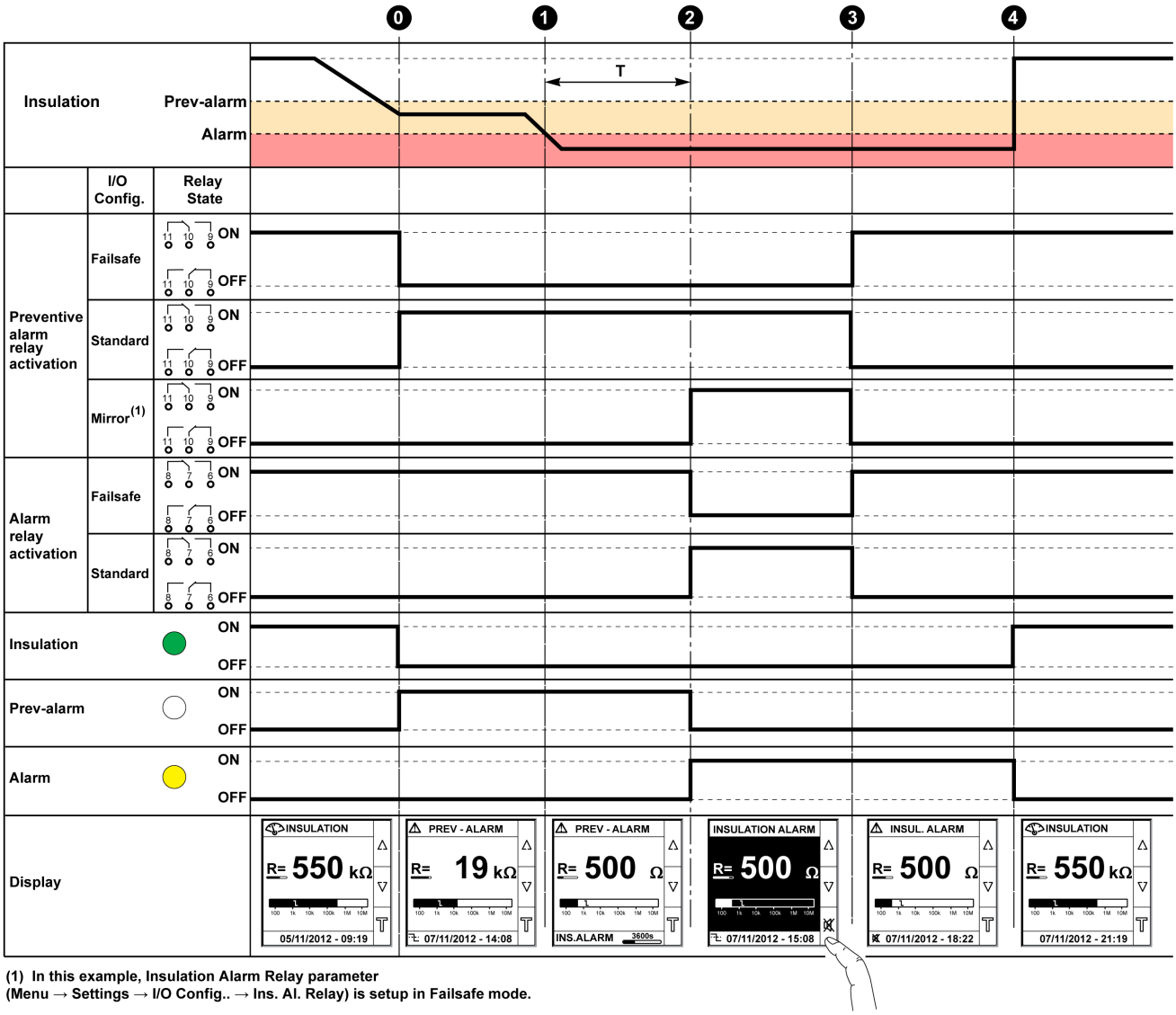
- Typical performance characteristics for photovoltaic application (parameter **App.** set to **Photovolt**.)

Relative Error of Insulation Resistance Measurement over Leakage Capacitance	Maximum Configurable Insulation Alarm Threshold as a Function of Leakage Capacitance
	

Monitoring the System Insulation

Functional Description

The Vigilohm monitors the IT system insulation resistance (kΩ) in accordance with the following timing diagram:



(1) In this example, Insulation Alarm Relay parameter (Menu → Settings → I/O Config.. → Ins. Al. Relay) is setup in Failsafe mode.

0 An insulation decrease is detected on the system. The insulation resistance drops below the preventive insulation alarm threshold. The preventive insulation alarm relay switches and the preventive insulation alarm indicator light lights up.

1 An insulation fault is detected on the system.

2 Once T (time delay) has elapsed, Vigilohm IM400 switches to the insulation alarm state. The insulation alarm relay switches and the insulation alarm indicator light lights up.

3 Press the button to acknowledge the insulation alarm.
Both the insulation alarm relay and the preventive insulation alarm relay toggle back to their initial state. Depending on the setup of the I/Os, the preventive insulation alarm relay and the insulation alarm relay may or may not toggle back to their initial states. The timing diagram above represents the case when the I/Os are set up to acknowledge the relays.

4 The insulation fault has been corrected or disappeared. Vigilohm IM400 reverts to normal status.

When the Vigilohm is in the insulation alarm state that is not acknowledged, and the insulation rises again, then the insulation fault is transient.

Status Information

The display and the 5 indicator lights on Vigilohm IM400 indicate the current status of the product.

Indicator Lights					Description
Product Status	**Modbus Communication Status**	**Insulation Status**	**Preventive Insulation Alarm**	**Insulation Alarm**	
OFF	OFF	OFF	OFF	OFF	Vigilohm IM400 de-energized.
OFF	–	ON	OFF	OFF	Vigilohm IM400 energized. No insulation fault detected.
OFF	–	OFF	ON	OFF	Vigilohm IM400 energized. Preventive insulation alarm detected.
OFF	–	OFF	OFF	ON	Vigilohm IM400 energized. Insulation fault detected.
OFF	–	ON	OFF	Flashing	Vigilohm IM400 energized. No insulation fault detected but transient insulation fault has been detected.
OFF	–	OFF	ON	Flashing	Vigilohm IM400 energized. Preventive insulation alarm detected. Transient insulation fault has been detected.
OFF	–	Flashing	OFF	OFF	Vigilohm IM400 energized. Injection de-activated by using injection inhibition input.
OFF	Flashing	–	–	–	Vigilohm IM400 energized. Modbus communication active.
	OFF	OFF	OFF	OFF	Vigilohm IM400 energized but inoperative. The IM400 product and its installation should be checked by a maintenance operator.

Insulation Alarm and Preventive Insulation Alarm Thresholds

2 methods are available for changing the Vigilohm IM400 insulation alarm and preventive insulation alarm thresholds:

- manually set the corresponding parameter by selecting **Menu** →**Settings** →**Ins. Alarm**, or
- use Modbus communication *(see page 70)*.

The available settings for the insulation alarm and preventive insulation alarm thresholds are as follows:

Threshold	Setting Range	Factory Value
Insulation alarm	0.1...500 kΩ	1 kΩ
Preventive insulation alarm	• 1 kΩ..1 MΩ • OFF	OFF

Insulation alarm and preventive insulation alarm thresholds are saved in an internal non-volatile memory. They remain unchanged after a power cut.

The preventive insulation alarm threshold must always be set higher than the insulation alarm threshold.

Insulation Alarm and Preventive Insulation Alarm Time Delays

Insulation alarm and preventive insulation alarm delays are time filters. They are used to filter transient insulation faults. The Vigilohm IM400 does not report insulation faults that do not remain for a duration longer than the delays set up.

To access the time delay parameter, select **Menu** →**Settings** →**Ins. Alarm**.

Setting	Setting Range	Factory Value
Ins. Al. Delay (insulation alarm time delay)	0...120 min	0 s
Prev. Al. Del. (preventive insulation alarm time delay)	0...120 min	0 s

NOTE: The preventive insulation alarm time delay setup is not displayed when the preventive insulation alarm threshold value is set to **OFF**.

Detecting Disconnection of Injection Wiring Terminal

This function allows the detection of the disconnection of the injection wire or ground wire. It also allows the disconnection between Vigilohm IM400 and IM400-1700 or PHT1000 voltage adaptors to be detected. This function is based on the detection of a very high insulation in the system.

To access the parameter, select **Menu** →**Settings** →**Ins. Alarm**.

Setting	Setting Range	Factory Value
Disconnect. Inj. (disconnected injection)	ON / OFF	OFF

On small networks without loads and IT transformer, where the insulation level is very high, or during commissioning without loads and without IT transformer, it is recommended to set the parameter to **OFF**.

Detection of disconnection between Vigilohm IM400 and IM400-1700 or PHT1000 voltage adaptors is always active and does not depend on the value of the **Disconnect. Inj.** parameter.

Insulation Alarm Relay

Depending on the status of the insulation, the insulation alarm relay is activated or deactivated according to the mode selected:
- failsafe (factory setting)
- standard

To access the insulation alarm relay parameter, select **Menu** →**Settings** →**I/O Config.**.

Setting	Setting Range	Factory Value
Ins. Al. Relay (insulation alarm relay)	FS / STD	FS

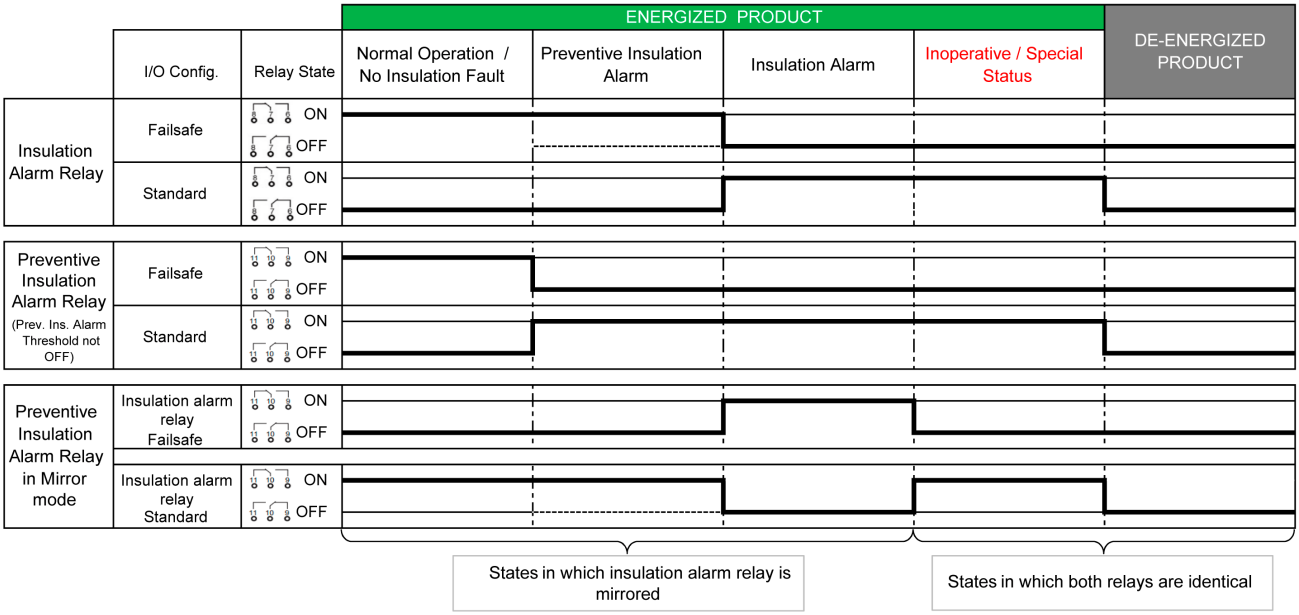
When the insulation alarm relay is configured in failsafe (**FS**) mode:
- The insulation alarm relay is activated, that is, energized, in the following cases:
  - No insulation fault is being detected.
  - Insulation fault is being detected and acknowledged. Acknowledgement of the insulation alarm relay is activated (selecting **Menu** →**Settings** →**I/O Config.** →**Ack. Al. Relay**, set to **ON**).
- The insulation alarm relay is deactivated, that is, de-energized, in the following cases:
  - Insulation fault is being detected.
  - A special insulation status is detected *(see page 61)*.
  - The product is inoperative (detected by self-test).
  - The auxiliary power supply is lost.
  - Corrected insulation fault signal: the insulation fault relay toggles for 3 seconds when an insulation fault has been detected, acknowledged, and later corrected in the power system *(see page 44)*.
  - When the user triggers a self-test with relays (selecting **Menu** →**Settings** →**I/O Config.** → **Test. w. Relays**, set to **ON**), the insulation alarm relay toggles for 3 seconds *(see page 53)*.

When the insulation alarm relay is configured in standard (**Std.**) mode:
- The insulation alarm relay is activated (energized) in the following cases:
  - The insulation fault is being detected.
  - A special insulation status is detected *(see page 61)*.
  - The product is inoperative (detected by self-test).
  - Corrected insulation fault signal: the insulation fault relay toggles for 3 seconds when an insulation fault has been detected, acknowledged, and later corrected in the power system *(see page 44)*.
  - When the user triggers a self-test with relays (selecting **Menu** →**Settings** →**I/O Config.** → **Test. w. Relays**, set to **ON**), the insulation alarm relay toggles for 3 seconds *(see page 53)*.
- The insulation alarm relay is deactivated (de-energized) in the following cases:
  - No insulation fault is being detected.
  - Insulation fault is being detected and acknowledged. Acknowledgement of the insulation alarm relay is activated (selecting **Menu** →**Settings** →**I/O Config.** →**Ack. Al. Relay**, set to **ON**).
  - The auxiliary power supply is lost.

Preventive Insulation Alarm Relay

To access the preventive insulation alarm relay parameter, select **Menu** →**Settings** →**I/O Config**.

Setting	Setting Range	Factory Value
Prev. Al. Relay (preventive insulation alarm relay)	Std. / FS / Mirror	FS



When the preventive insulation alarm relay is configured in failsafe (**FS**) mode:

- The preventive insulation alarm relay is activated (energized) in the following cases:
  - No preventive insulation fault is being detected.
  - Insulation fault is being detected and acknowledged. Acknowledgement of the insulation alarm relay is activated (selecting **Menu** →**Settings** →**I/O Config.** →**Ack. Al. Relay**, set to **ON**).
- The preventive insulation alarm relay is deactivated (de-energized) in the following cases:
  - Insulation fault is being detected.
  - A special insulation status is detected *(see page 61)*.
  - The product is inoperative (detected by self-test).
  - The auxiliary power supply is lost.
  - When the user triggers a self-test with relays (selecting **Menu** →**Settings** →**I/O Config.** → **Test. w. Relays**, set to **ON**), the insulation alarm relay toggles for 3 seconds *(see page 53)*.

When the preventive insulation alarm relay is configured in standard (**Std.**) mode:

- The preventive insulation alarm relay is activated (energized) in the following cases:
  - The preventive insulation fault is being detected.
  - A special insulation status is detected *(see page 61)*.
  - The product is inoperative (detected by self-test).
  - When the user triggers a self-test with relays (selecting **Menu** →**Settings** →**I/O Config.** → **Test. w. Relays**, set to **ON**), the insulation alarm relay toggles for 3 seconds *(see page 53)*.
- The preventive insulation alarm relay is deactivated (de-energized) in the following cases:
  - No insulation fault is being detected.
  - Insulation fault is being detected and acknowledged. Acknowledgement of the insulation alarm relay is activated (selecting **Menu** →**Settings** →**I/O Config.** →**Ack. Al. Relay**, set to **ON**).
  - The auxiliary power supply is lost.

When the preventive insulation alarm relay is set up in mirror mode (selecting **Menu** →**Settings** → **I/O Config** →**Prev. Al. Rel**, set to **Mirror**):

- The preventive insulation alarm relay mirrors (symmetrically matches) the insulation alarm relay as long as the Vigilohm IM400 is operating correctly *(see page 26)*.
- The preventive insulation alarm relay stops mirroring the insulation alarms when the Vigilohm IM400 is de-energized or inoperative. This feature can be used to detect an inoperative product.

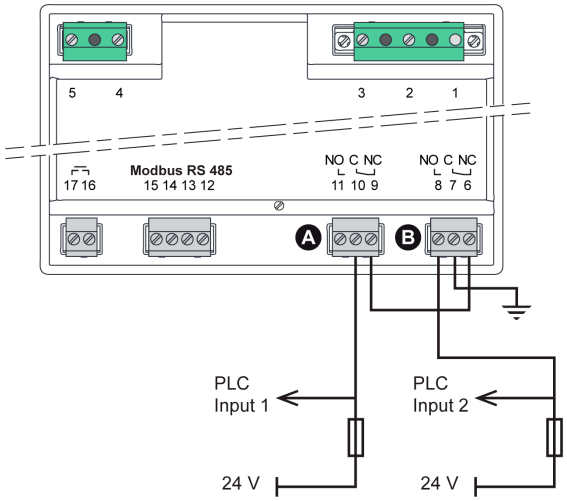
Example of Application of Preventive Alarm Relay Mirror Mode

Some applications require that when an IMD device becomes inoperative, the system automatically switches to another IMD device by managing exclusions using the injection inhibition input *(see page 48)*.

Using the preventive insulation alarm relay configured in mirror mode, the relays can be wired in series creating a logical AND function. It is recommended to configure the insulation alarm relay in failsafe mode and wire both relays in failsafe mode as well (NC/C).

In this case, the logical function returns true only when the device is inoperative or de-energized, or when a special status is active.

The wiring diagram shows how to wire the Vigilohm IM400 in Mirror mode:



A Preventive insulation alarm
B Insulation alarm

Mode	PLC Input	IM400 State				
		No fault	Preventive alarm	Alarm	Inoperative product	IM400 de-energized
Failsafe	1	1	1	1	0	0
Failsafe	2	0	0	1	1	1

Insulation Alarm Relay Acknowledgement

When the relays are connected to loads (for example, horns or lamps), it is recommended to turn off these external signaling devices before the insulation level rises back to a level above the setup thresholds. This can be done by clicking the acknowledge button while in insulation alarm state.

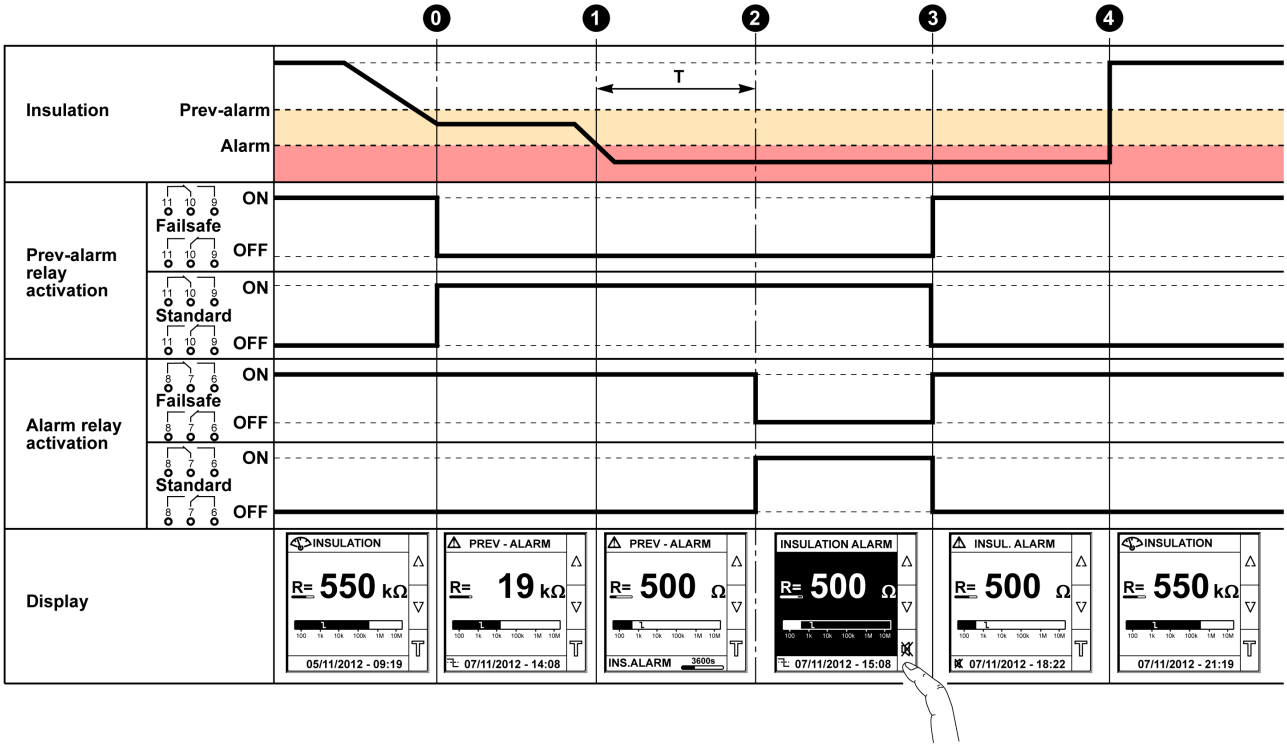
In certain system configurations, it is required to prevent this type of user acknowledgement and only retrigger the relays when the insulation level rises above the setup thresholds. This is done by changing the corresponding parameter.

To acknowledge the insulation alarm relay parameter, select **Menu** →**Settings** →**I/O Config**.

Setting	Setting Range	Factory Value
Ack. Al. Relay (acknowledgement insulation alarm relay)	ON / OFF	ON

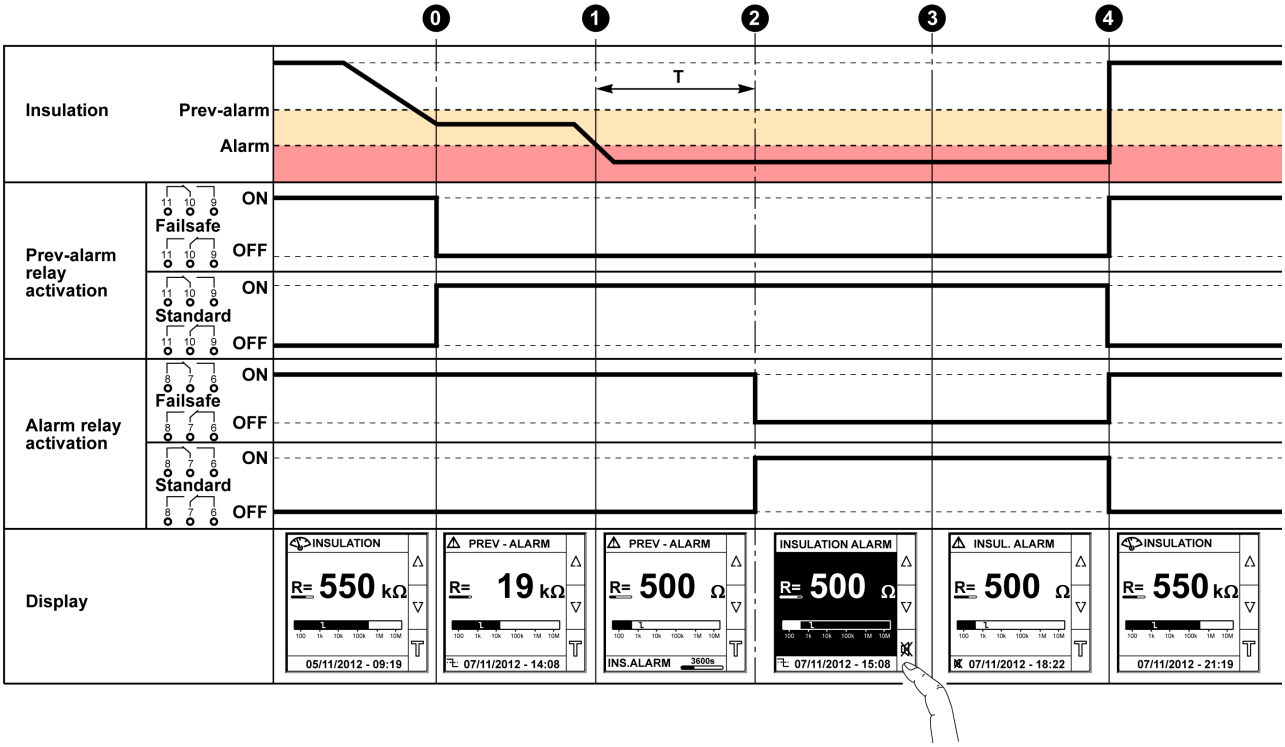
When the Vigilohm IM400 detects an insulation fault, both the preventive insulation alarm relay and the insulation alarm relay are triggered, depending on the setup.

- Acknowledgement of relays set to **ON**



3 Insulation fault alarm acknowledgement switches back the relays to their initial position.

- Acknowledgement of relays set to **OFF**



3 Insulation fault alarm acknowledgement does not switch back the relays to their initial position.

Corrected Insulation Fault Signal

In order to facilitate insulation fault detection, the insulation alarm relay can be reactivated for 3 seconds when the insulation level rises above the setup threshold.

This makes it easier to locate the insulation fault when using the method that involves opening each of the circuit breakers in turn. Given that the circuit breakers may be located at some distance from the Vigilohm IM400, the external signal allows you to identify and locate the insulation fault when working remotely. This option can be activated by changing the corresponding parameter.

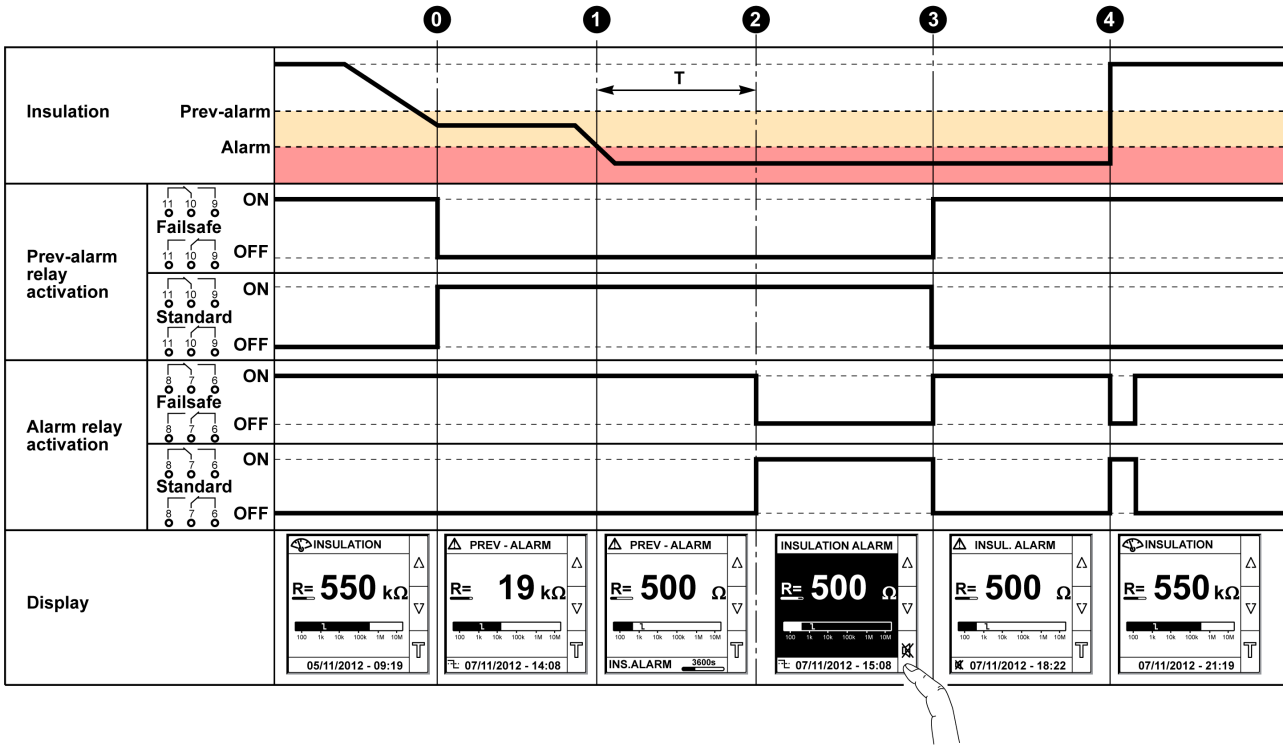
To access the option, select **Menu** →**Settings** →**I/O Config**.

Setting	Setting Range	Factory Value
Corr. Flt Signal (corrected fault signal)	ON / OFF	OFF

NOTE: Corrected insulation fault signal is applicable only if the parameter **Ack. Al. Relay** (acknowledgement insulation alarm relay) is set to **ON**.

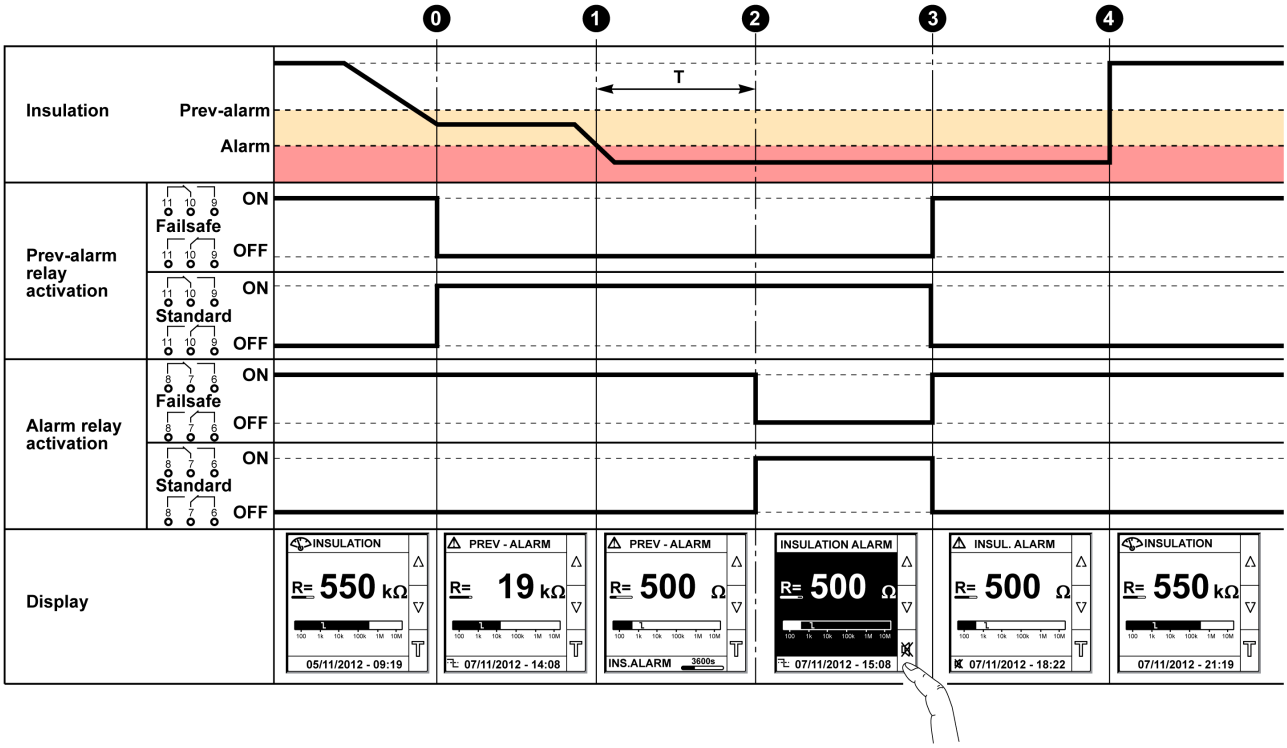
In system configurations where the insulation alarm relay is connected to an external signaling device (for example, horns or lamps), the relays are triggered back to their normal position, depending on their setup, when the insulation alarm is acknowledged.

- Corrected insulation fault signal set to **ON**



4 After correcting the insulation fault in the power system, the insulation fault alarm relay toggles for 3 s.

- Corrected insulation fault signal set to **OFF**



4 After correcting the insulation fault in the power system, the insulation fault alarm relay does not toggle for 3 s.

Operation on Systems with a Voltage Greater Than 480 Vac/dc

Operation

A voltage adaptor is required when the device is connected to one of the following systems:
- system voltage greater than 830 Vac Ph-Ph and the Vigilohm IM400 is connected to an accessible neutral.
- system voltage greater than 480 Vac and the Vigilohm IM400 is connected to a phase (non-accessible neutral).
- system voltage greater than 480 Vdc.

See the specifications for information about the maximum voltage *(see page 84)*.

For Vigilohm IM400 operation without insulation fault location (XD301, XD312, XD308C, or XRM not used), the IM400-1700 voltage adaptor can be used.

For Vigilohm IM400 operation with insulation fault location (XD301, XD312, XD308C, or XRM used), the PHT1000 voltage adaptor must be used.

NOTE: The **V. Adaptor** parameter cannot be set up as **HV1700** if the parameter **Fault locating** is set to **ON**.

V. Adaptor Parameter

Configure the **V. Adaptor** parameter as follows:
- **HV1700** for the IM400-1700 voltage adaptor
- **PHT1000** for the PHT1000 voltage adaptor

The factory value is **None** (operation without voltage adaptor).

Insulation Fault Location

Locating Insulation Faults Automatically

Vigilohm IM400 is compatible with the XD••• range of insulation fault locators from the Vigilohm offer:
- XD301: 1-channel insulation fault locator with indicator light and 1 output relay (commercial references 50506, 50507, and 50508)
- XD312: 12-channel insulation fault locator with 1 indicator light per channel and 1 output relay (commercial references 50535, 50536, and 50537)
- XD308C: 8-channel insulation fault locator with communication (requires an XLI300 communication interface) (commercial references 50723, 50724, and 50725)

The **Insulation Fault Locating** parameter must be configured to **ON** for proper operation. The factory value is **OFF** in photovoltaic application, **ON** for the other applications *(see page 33)*.

Locating Insulation Faults Manually

From the Vigilohm offer, the mobile insulation fault locating devices must be used for:
- the insulation fault location on a feeder not equipped with an automatic insulation fault locator or
- facilitating the location of an insulation fault on a feeder.

The **Insulation Fault Locating** parameter must be configured to **ON** for proper operation. The factory value is **ON**.

The signal injected by IM400 is compatible with the XP15, XP50, XP100, and XRM devices. Proceed as follows:
1. Use the XRM connected to an XP•• current probe on the injection connection wire close to IM400, and calibrate the XRM to 18.
2. Use the XRM on the cables to locate the insulation fault. When the XRM is reporting 18, it means that the insulation fault is on the cable or the load downstream to the clamp.

Refer to the *Vigilohm Catalog* for information about the mobile insulation fault locating devices:
- XRM locating signal receiver (commercial reference 50278)
- Open-clamp current probes (commercial references 50494, 50498, and 50499)

Injection Inhibition Input and Exclusion Management

Exclusion

The IMD injects several patented combinations of low frequency voltage into the system. In a system with several incoming feeders, depending on the circuit breaker position, there must be no more than 1 IMD injecting into the system.

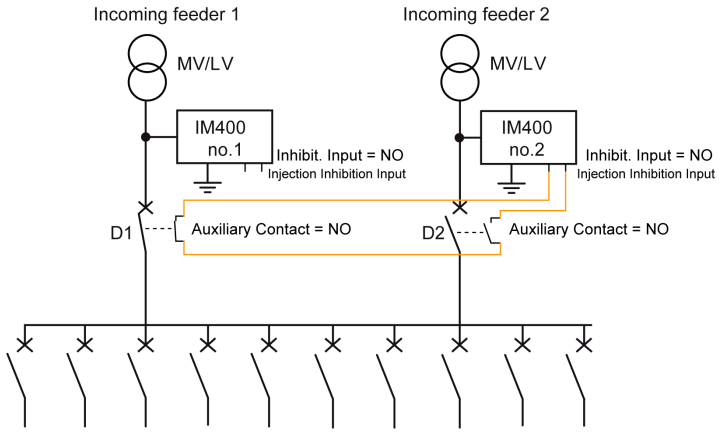
This injection exclusion is managed by the inhibition input of Vigilohm IM400, which is connected to the auxiliary contacts of the circuit breakers.

The injection inhibition input can be configured to use an NO or an NC contact as shown below:

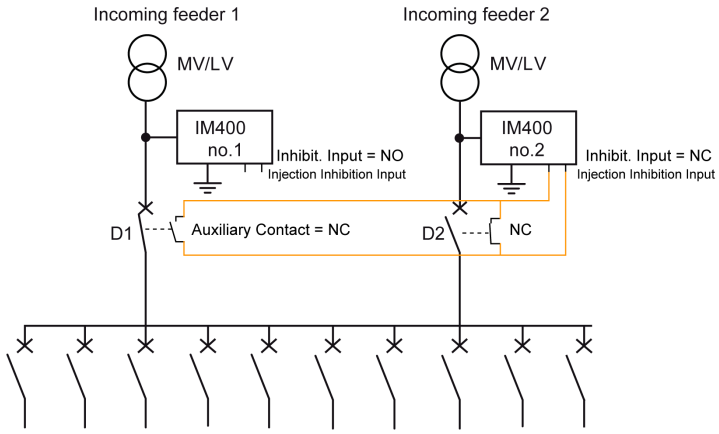
Contact Type	Injection Activated when the Contact is...	Injection Deactivated when the Contact is...
NO (factory value)	open	closed
NC	closed	open

Example of Exclusion with 2 Incoming Feeders

Using circuit breakers with Normally Open (NO) auxiliary contacts:



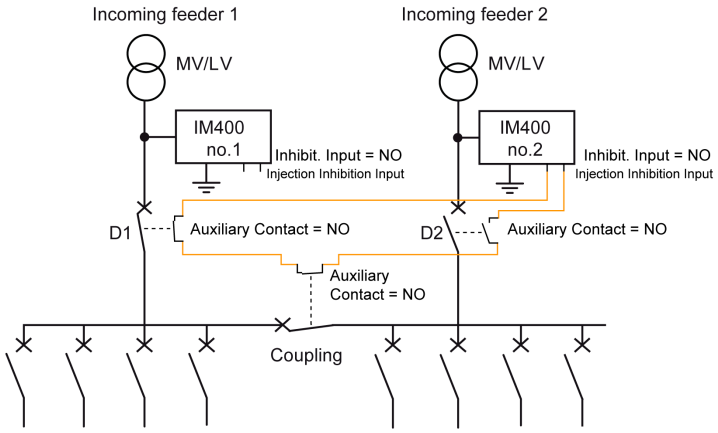
Using circuit breakers with Normally Closed (NC) auxiliary contacts:



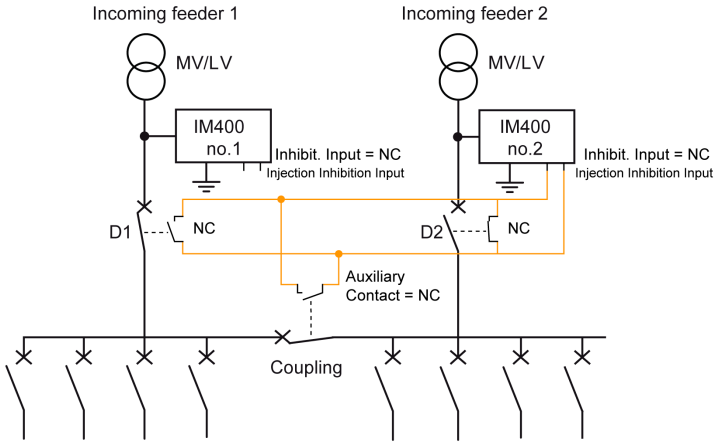
If...	Then...
• D1 is closed and • D2 is open	The 2 Vigilohm IM400 devices are active: • Vigilohm IM400 no.1 monitors the system insulation. • Vigilohm IM400 no.2 only monitors the insulation of the transformer 2 connection as far as D2.
• D1 is open and • D2 is closed	The 2 Vigilohm IM400 devices are active: • Vigilohm IM400 no.1 monitors the insulation of the transformer 1 connection as far as D1. • Vigilohm IM400 no.2 monitors the system insulation.
• D1 is closed and • D2 is closed	• Vigilohm IM400 no.1 monitors the system insulation. • Vigilohm IM400 no.2 must be inhibited.

Example of Exclusion with 2 Incoming Feeders and 1 Coupling

Using circuit breakers with Normally Open (NO) auxiliary contacts:



Using circuit breakers with Normally Closed (NC) auxiliary contacts:

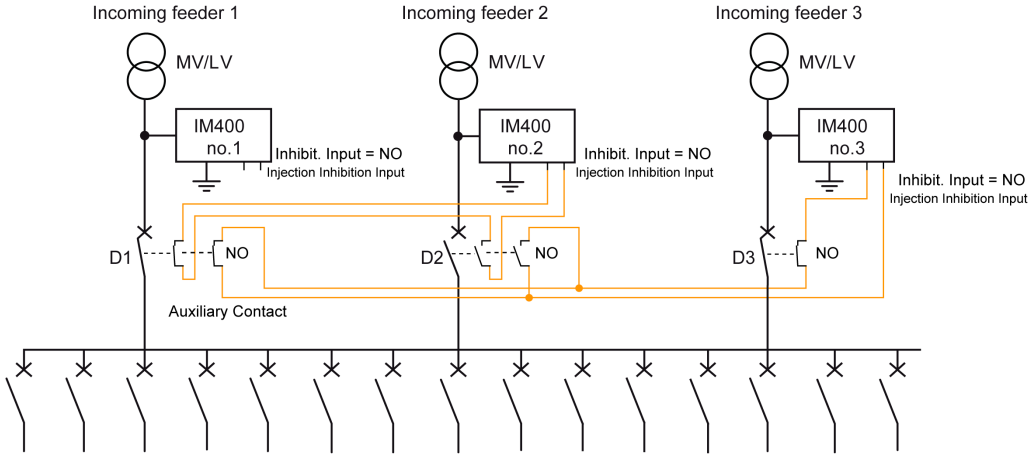


If...	**Then...**
The coupling (C) is closed	the same applies as in the exclusion example above involving 2 incoming feeders.
• The coupling is open and • D1 is closed • D2 is closed	the 2 Vigilohm IM400 devices are active: • Vigilohm IM400 no.1 monitors the insulation of system 1. • Vigilohm IM400 no.2 monitors the insulation of system 2.

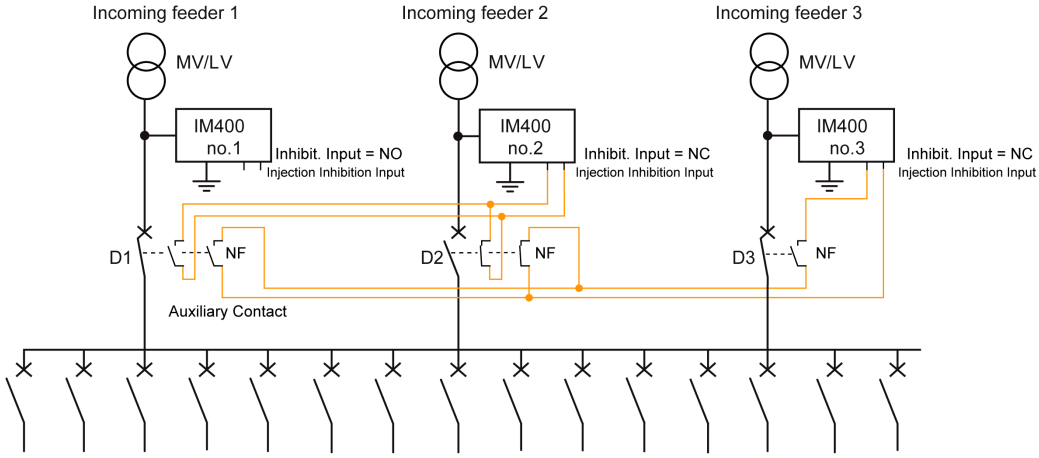
Vigilohm IM400 no.2 must be inhibited when the following 3 conditions are met:
- D1 is closed.
- D2 is closed.
- C is closed.

Example of Exclusion with 3 Incoming Feeders

Using circuit breakers with Normally Open (NO) auxiliary contacts:



Using circuit breakers with Normally Closed (NC) auxiliary contacts:



The IMD priority is as follows:

- IM400 no.1 is the IMD with the highest priority 1: it always injects into the systems no matter if D1 is closed or open.
- IM400 no.2 is the IMD with priority 2: it always injects into the system except when there is a closed path between it and one IMD with a higher priority, that is, in this case IM400 no.1. Therefore, IM400 no.2 is inhibited when D2 and D1 are closed:
  IM400 no.2 injection inhibition = D1 AND D2.
  This logic is implemented by wiring the injection inhibition of IM400 no.2 to the 2 auxiliary contacts of D1 and D2.
- IM400 no.3 is the IMD with priority 3: it always injects into the system except when there is a closed path between it and one IMD with a higher priority, that is, in this case IM400 no.1 or IM400 no.2. Therefore, IM400 no.2 is inhibited when D3 and D2 are closed, or D3 and D1 are closed:
  IM400 no.3 injection inhibition = (D3 AND D1) OR (D3 AND D2) = D3 AND (D1 OR D2)This logic is implemented by wiring the injection inhibition of IM400 no.3 to the auxiliary contacts of D1 and D2 and D3.

Example of Exclusion with Multiple Incoming Feeders and Couplings

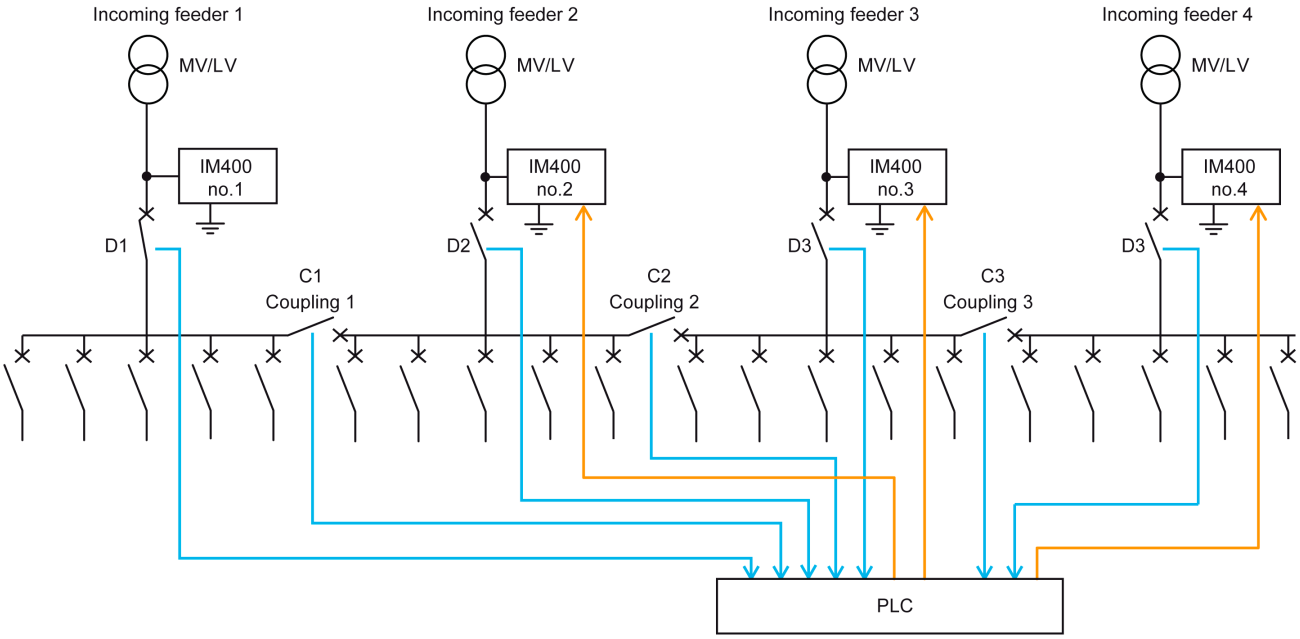
For complex configurations where there are multiple incoming feeders and couplings, it is required to use a basic Programmable Logic Controller (PLC) to manage the exclusion of IMD.

The PLC can have the following characteristics:

- Number of digital inputs: is the number of circuit breakers for incoming feeder and for coupling. These inputs can be self-powered by the PLC or powered by an external power supply.
- Number of digital outputs: is the number of IMDs -1. These digital outputs can be electromechanical or solid-state outputs.
- Processing cycle is equal to 0.1 s or less.

Using a basic PLC to manage IMD exclusion allows to:

- monitor continuously each part of IT power system.
- have a short response time to detect insulation faults.
- be compatible with complex power systems with high number of incoming feeders and couplings.

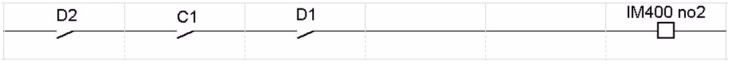


There are 2 methods to determine the logic driving the injection inhibition input of each IMD:

Method 1: Give a priority to each IMD using indexes of incoming feeders. In this example:

- priority of IM400 no.1 is 1 (highest priority),
- priority of IM400 no.2 is 2,
- priority of IM400 no.3 is 3,
- priority of IM400 no.4 is 4 (lowest priority).

- IM400 no.1 with the highest priority is always injecting, its injection inhibition input is left unwired.
- IM400 no.2 with the priority 2 always injection into the system except when there is a closed path between itself and one IMD with a higher priority, that is, IM400 no.1 in this case. The closed path occurs when D2, C1 and D1 are closed.
  Therefore:
  Injection inhibition of IM400 no2 =
  D2 AND C1 AND D1
  The representation in Ladder PLC programming language is as follows:



- IM400 no.3 with the priority 3 always injection into the system except when there is a closed path between itself and one IMD with a higher priority, that is, IM400 no. 2 and IM400 no.1 in this case. The closed path occurs when:
  - (D3, C2, and D2) are closed, or
  - (D3, C2, C1, and D1) are closed.

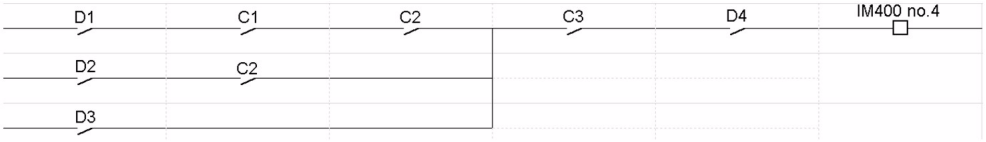
  Therefore:
  - Injection inhibition of IM400 no.3 =
    (D3 ANDC2 ANDD2) OR (D3 AND C2 AND C1 AND D1)
  - Injection inhibition of IM400 no.3 =
    (D3 AND C2) AND (D2 OR (C1 AND D1))

The representation in Ladder PLC programming language is as follows:

- IM400 no.4 with the priority 4 always injection into the system except when there is a closed path between itself and one IMD with a higher priority, that is, IM400 no. 3, IM400 no.2, and IM400 no.1 in this case.
  The closed path occurs when:
  - (D4, C3, and D3) are closed, or
  - (D4, C3, C2, and D2) are closed, or
  - (D4, C3, C2, C1, and D1) are closed.

  Therefore:
  - Injection inhibition of IM400 no.4 =
    (D4 AND C3 AND D3) OR (D4 AND C3 AND C2 AND D2) OR (D4 AND C3 AND C2 AND C1 AND D1)
  - Injection inhibition of IM400 no.3 =
    (D4 AND C3) AND (D3 OR (C2 AND D2) OR (C2 AND C1 AND D1))

  The representation in Ladder PLC programming language is as follows:



Method 2: Use a truth table.

Possible Configurations							**1 = Injection Inhibition**			
D1	**D2**	**D3**	**D4**	**C1**	**C2**	**C3**	**IM400 no.1**	**IM400 no.2**	**IM400 no.3**	**IM400 no.4**
0	0	0	0	0	0	0	0(1)	0(1)	0(1)	0(1)
0	0	0	0	0	0	1	0(1)	0(1)	0(1)	0(1)
...										
0	1	1	1	1	0	1	0(1)	0(2)	0(2)	1(3)
...										
1	1	1	1	0	0	0	0(2)	0(2)	0(2)	0(2)
...										
1	1	1	1	1	1	1	0(2)	1(3)	1(3)	1(3)

(1) Vigilohm IM400 monitors the transformer.
(2) Vigilohm IM400 injects a signal into the system.
(3) Vigilohm IM400 is excluded from the system (injection inhibited).

Injection Inhibition Screen

When the injection inhibition function of Vigilohm IM400 is activated (that is, **Inhibit. Input** set to **N.O.**), the screen below appears and replaces any system status screen that may be showing already (insulation measurement, insulation alarm, or preventive insulation alarm):

You can perform the following actions on this screen:
- Press the **MENU** button to access the main menu.
- Press the arrow contextual menu buttons to view the setting screen.
- Press the T contextual menu button to launch the self-test.

NOTE: When activating injection again (that is, **Inhibit. Input** set to **N.C.**), a self-test is launched automatically before returning to the default insulation monitoring screen.

Self-Test

Description

The Vigilohm has a self-test function for testing:
- the product: indicator lights, internal electronics
- the measurement system, and the insulation alarm and preventive insulation alarm relays

Running the Self-Test

The test can be run/runs:

- Manually at any time by pressing the contextual menu button on one of the system insulation monitoring screens
- Automatically:
  - Whenever the device starts up (power-up or reset)
  - Every 5 hours (except when the device is in the insulation alarm status, regardless of whether the insulation alarm is active or has been acknowledged)
  - Whenever leaving the inhibited injection state (**Inhibit. Input**) when injection is activated again.

Sequence of Indicator Lights

During the verification sequence, the indicator lights light up in the following order:
- insulation status yellow
- preventive insulation alarm white
- insulation status green
- Modbus communication yellow
- product status red

Test with Relays

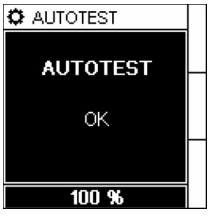
Use this setting to select whether to include a 3-second toggle of the preventive insulation alarm relay and insulation alarm relay during a manually launched self-test.

To access the test with relay parameter, select **Menu** →**Settings** →**I/O Config**.

Setting	Setting Range	Factory Value
Test w. Relays (test with relays)	ON / OFF	ON

Self-Test OK

If the self-test is successful, the following screen appears for 3 seconds:



After that, a measurement phase shown by a progress bar at the bottom of the screen appears, and then 1 of the status screens automatically appears (system insulation resistance measurement or insulation fault alarm).

Self-Test Not OK

If the self-test is not successful, the product automatically restarts. If the problem persists, the red product status indicator light lights up and a message is displayed to indicate that the product is inoperative.

If this happens, briefly disconnect the auxiliary power supply of the Vigilohm. If the problem persists, contact the Schneider Electric Customer Care Center.

Human Machine Interface

4

Presentation

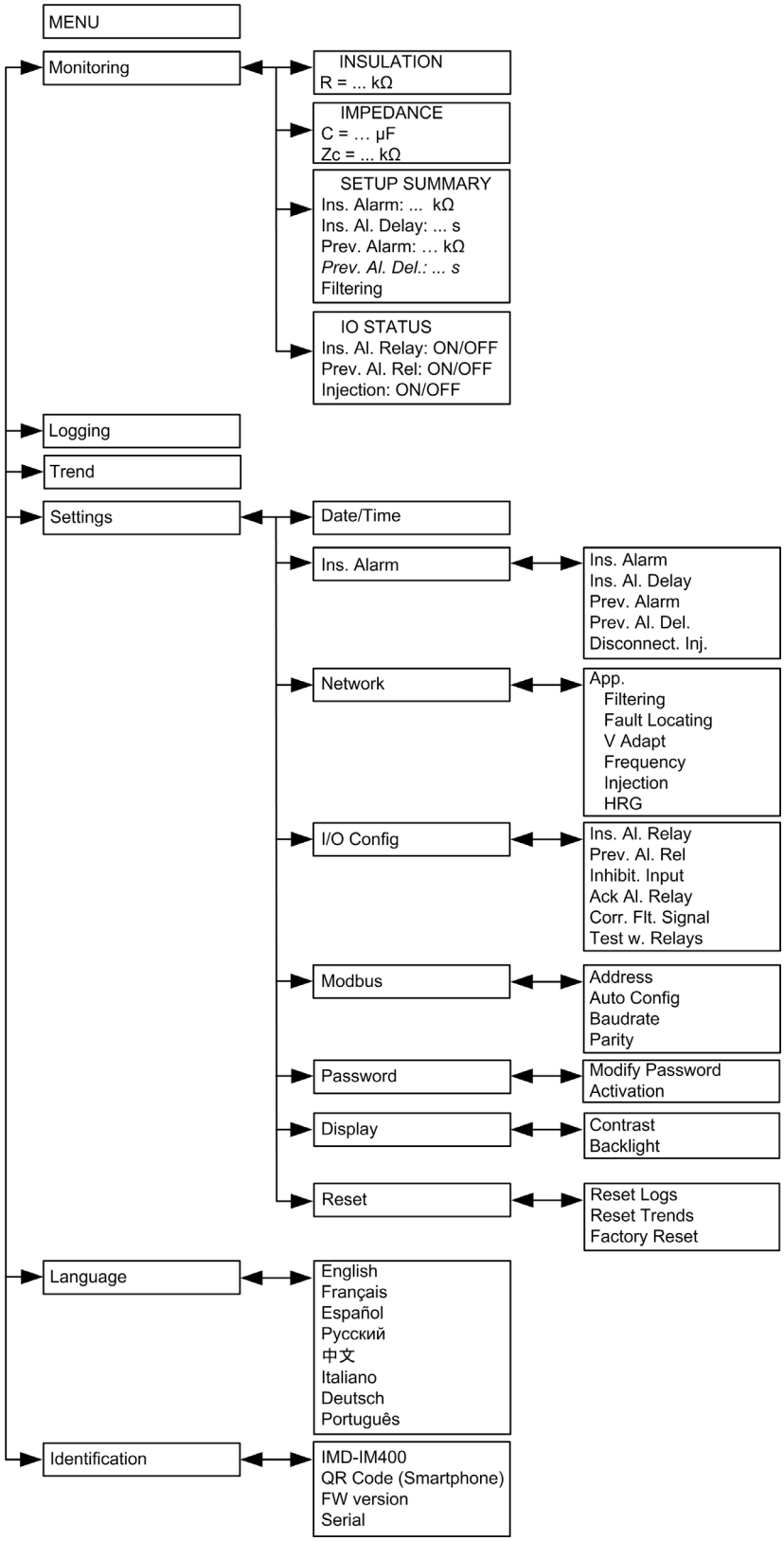
The Vigilohm features a sophisticated and intuitive human machine interface (HMI) with signaling indicator lights, a graphic display, and contextual menu buttons for accessing the information required to operate the Vigilohm and make parameter settings.

What Is in This Chapter?

This chapter contains the following topics:

Vigilohm IM400 Menu Structure

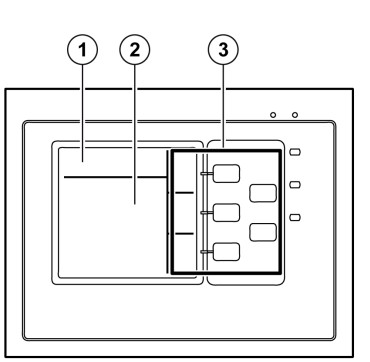
Vigilohm IM400 Menu Structure



Navigating the Interface

Presentation

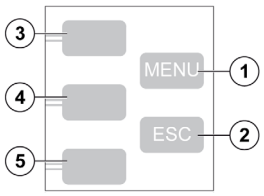
The diagram below illustrates the various elements for operating the Vigilohm.



1 Screen identification area containing a menu icon, and the name of the menu or parameter
2 Information area for displaying screen-specific details (measurement, insulation alarm, setting)
3 Navigation buttons

Navigation Buttons

The navigation buttons enable quick and intuitive navigation:



Legend	Button	Icon	Description
1	**MENU**	–	Displays the level 1 main menu
2	**ESC**	–	Takes you back to the previous level
3	Contextual menu button 3		For scrolling up the display or moving to the previous item in a list
			For accessing the date and time setting If the clock icon flashes, it means that the Date/Time parameter needs to be set.
			For increasing a numerical value
4	Contextual menu button 2		For scrolling down the display or moving to the next item in a list
			For moving one digit to the left within a numerical value. If the digit on the far left is already selected, pressing the button loops you back to the digit on the right.
			For moving 1 digit to the right within a numerical value
5	Contextual menu button 1		For validating the selected item
			For executing the manual test
			For accessing a menu or submenu, or for editing a parameter
			For acknowledging insulation alarms

Information Icons

This table describes the icons provided for information in the information area of the LCD display. Among other things, they indicate which menu is selected or the insulation alarm status.

Icon	Description
	Main menu
	• Identifies the system resistance when there is no insulation fault • Measurement parameter menu
	Insulation fault log menu
	Trend menu
	Setting parameter menu
	Interface language selection menu
	Product identification
	Indicates an insulation fault alarm or preventive insulation alarm

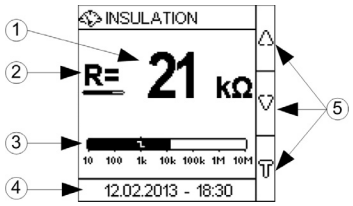
Status Screens

Presentation

The default screen shows the insulation resistance value of the system. This screen is automatically replaced by an alert screen when an insulation alarm occurs.

The screen backlight flashes to indicate an insulation alarm.

Each insulation measurement screen displays a status bar at the bottom that provides additional information. In general, it shows the date and time of the insulation fault.



1 Insulation value
2 Progress bar for the refresh time
3 Bargraph indicating the insulation level on a logarithmic scale. The symbol indicates the insulation alarm threshold value.
4 Status bar displaying additional information related to the current insulation alarm state. Different types of status bar are available (see note below).
5 Contextual buttons for navigating the insulation screens or for launching a manual self-test.

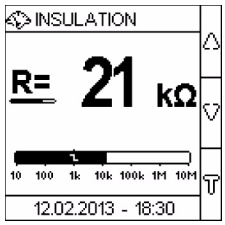
NOTE: The different types of status bar are:

- Current date and time: displayed when product is in normal operation (no insulation fault detected)
- Insulation alarm active time delay: an insulation fault has been measured and the insulation alarm time delay is active. This bar shows a progress bar for the time delay.
- Insulation alarm pickup date and time
- Insulation alarm dropout date and time
- Insulation alarm relay acknowledgment

The bars can also indicate:
- a cyclic self-test is running in the background
- a first measurement is in progress (at startup or after reactivating the injection function)

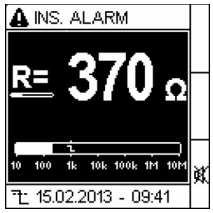
System Insulation Resistance Measurement (R)

The Vigilohm displays the insulation resistance measurement for the system by default. The status bar shows the current time of the IMD.



Insulation Alarm Detected: Insulation Fault Message

The following screen displays when the insulation value drops below the insulation alarm threshold:

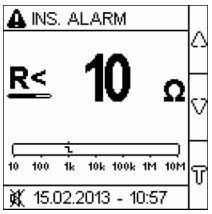


There are 2 possible scenarios:

- Acknowledge the insulation alarm by pressing the contextual menu button.
- If you do not acknowledge the insulation alarm and the system insulation returns to a value above the insulation alarm threshold, this results in a transient insulation fault.

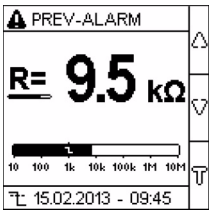
Insulation Alarm Acknowledged

The following screen appears once the insulation alarm is acknowledged. The status bar shows the time when the insulation fault is acknowledged.



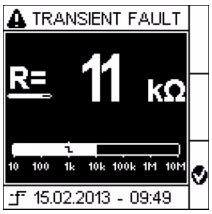
Preventive Insulation Alarm Activated

The following screen appears when the preventive insulation alarm is activated:



Transient Insulation Fault Message

The following screen appears in the event of a transient insulation fault:



Acknowledge the transient insulation fault by pressing the ✔ contextual menu button.

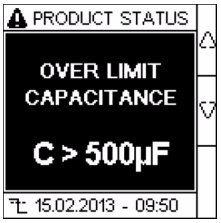
Special Status Screens

Presentation

The special status screens are displayed depending on events that occur during the product life. The screens depend on the event type but always trigger the red product status indicator light and the insulation alarm relay is active. If the preventive insulation alarm relay is configured in mirror mode, it is also triggered and no longer mirrors the insulation alarm relay.

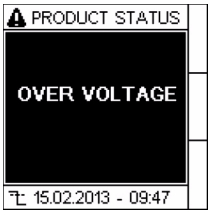
Over-Limit Capacitance Detection

The over-limit capacitance detection state is triggered when the capacitance of the monitored system becomes too high. For details on the Vigilohm IM400 limits, refer to the product performances. In case of detected over-limit capacitance, the Vigilohm IM400 is no longer able to monitor the IT system.

Power Circuit or Control Circuit	Photovoltaic Circuit
	

Overvoltage

The overvoltage state is triggered when the voltage of the monitored system becomes too high. For details on the Vigilohm IM400 limits, refer to the product performances. In case of overvoltage, the Vigilohm IM400 is no longer able to monitor the IT system and automatically disconnects of the power system until the product is manually reset by briefly disconnecting the auxiliary power supply.



Disconnected Injection Detection

The state of disconnected injection is triggered when the Vigilohm IM400 detects that the ground conductor or the injection wire is disconnected. In case of disconnected injection detected, the Vigilohm IM400 is no longer able to monitor the IT system.

If the **Disconnect Inj.** parameter in the **Ins. Alarm** menu is set to **ON**, the following screen displays:

If the **Disconnect Inj.** parameter is set to **OFF**, the Vigilohm IM400 displays **R > 10 MΩ**

Inoperative Product

The inoperative product state is triggered when the Vigilohm IM400 is inoperative.

Modifying Parameters

Presentation

To modify any of the values, you must be familiar with how the interface menus are structured and the general navigation principles. For more information about how the menus are structured, refer to the Vigilohm IM400 menu structure *(see page 56)*.

To modify the value of a parameter, follow either of the 2 methods described below:
- Select an item (value plus unit) in a list.
- Modify a numerical value, digit by digit.

The parameters listed below are the only ones where the numerical value can be modified:
- date
- time
- password
- Modbus address

Selecting the Value in a List

To select a value in a list, use the ▽ or △ contextual menu buttons to scroll through the parameter values until you reach the desired value. Then press ✔ to confirm the new parameter value.

Modifying the Numerical Value

The numerical value of a parameter is made up of digits and it is the one on the far right that is selected by default.

To modify a numerical value, use the contextual menu buttons as described below:
- ✣ allows you to modify the selected digit.
- ◁ allows you to select the digit to the left of the one that is selected, or to loop back to the digit on the right.
- ✔ confirms the new parameter value.

Saving a Parameter

After you have confirmed the modified parameter, 1 of the 2 screens appears:
- If the parameter has been saved correctly, the screen displays **Saved** and then automatically reverts to the previous display.
- If the parameter has not been saved correctly, the screen displays **Error** and the editing screen remains active. It happens when:
  - a value is deemed to be out of range (for example the value is classed as forbidden),
  - there are several interdependent parameters.

Aborting an Entry

To abort the current parameter entry, press the **ESC** button. The screen reverts to the previous display.

Editing Protected Settings

You can set a password to limit access to configuration of Vigilohm IM400 parameters to authorized personnel only. When a password has been set, the information displayed by the device can be viewed but the parameter values cannot be edited.

The password is inactive by default. When password protection is enabled, the default password is 0000. If you want to change the factory value, you must enter a 4-digit password from 0000 to 9999 when editing a parameter.

The procedure for setting a password is the same as editing a numerical value.

Step	Action
1	Navigate to **MENU** →**Settings** →**Password**.
2	Select **Modify Password**. Press ⟲ to edit the new password digit by digit (editing starts from the digit furthest to the right).
3	Use ✣ to increase the value of the digit. It will automatically roll over from 9 to 0. **NOTE:** Keep the ✣ button pressed down to accelerate scrolling through the values.

Step	Action
4	Press ◁ to move to the next digit. Pressing this button on the last digit (furthest left) loops you back to the first one.
5	Repeat steps 3 and 4 for all other digits.
6	Press ✔ to save the new password. A message indicates that the password was saved successfully. The screen reverts to the previous one.
7	Select **Activation**. Press ⊙.
8	Change value list to **ON** by pressing the △ or ▽ arrows. Validate the entry by selecting ✔. A message indicates that the parameter was saved successfully. **Result**: The password protection is now active.

The procedure for entering a password is similar to editing a numerical value.

Step	Action
1	Press the contextual menu navigation keys to navigate to the parameter to edit.
2	Press ⊙. The screen to enter the password is displayed. The first (furthest left) digit is selected and ready to edit.
3	Use ✥ to increase the value of the digit. It will automatically roll over from 9 to 0. **NOTE:** Keep the ✥ button pressed down to accelerate scrolling through the values.
4	Press ▷ to move to the next digit. Pressing this button on the last digit (furthest right) loops you back to the first one.
5	Repeat steps 3 and 4 for all other digits.
6	Press ✔ to validate the password entry. If the password has been entered correctly, the protection system stays unlocked for 30 seconds or as long as you are editing parameters. If the password has been entered incorrectly, an error message is displayed and you must enter the password again. Use the **ESC** button to revert to the previous screen.

Clock

Description

Vigilohm IM400 uses the date and time parameter to time-tag the system insulation faults recorded.

The time must be set:
- whenever the power supply is interrupted,
- when switching from winter to summer time and back.

If the auxiliary power supply is interrupted, Vigilohm IM400 retains the date and time setting from immediately before the interruption.

Icon

When Vigilohm IM400 is powered up, the clock icon flashes on the system monitoring screens to indicate that the clock needs to be set.

Pressing the top contextual button displays the clock setup screen.

Setting

To set the date and time, refer to the procedure for modifying a numerical value *(see page 62)*.

Date/Time Format

The date is displayed in the format: dd/mm/yyyy.

The time is displayed using the 24-hour clock in the format: hh/mm.

Insulation Fault Log

Description

Vigilohm IM400 records the details of the 30 most recent insulation fault events that have triggered one of the 2 statuses below:

- preventive insulation alarm
- insulation alarm

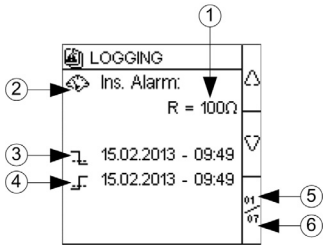
Event 1 is the one that was recorded most recently and event 30 is the oldest recorded event.

The oldest event is deleted when a new event occurs. Due to the rolling buffer the Vigilohm IM400 may show 28 logs maximum. To reset all the events, select **Settings** →**Reset** →**Reset Logs**.

Using this information, the performance of the distribution system can be improved and maintenance work facilitated. It is also available through Modbus *(see page 67)*.

Insulation Fault Event Screen

The figure below shows the display elements associated with an insulation fault event:



Legend	Description
1	Insulation fault value recorded
2	Type of insulation fault recorded: insulation alarm, preventive insulation alarm, transient insulation alarm
3	Date and time when the insulation alarm fault, preventive insulation alarm, or transient insulation fault occurred
4	Date and time when the event disappeared: ● Insulation alarm acknowledgment ● Disappearance of preventive insulation alarm or transient insulation alarm
5	Number of events displayed
6	Total number of events recorded

Trend Screens

Presentation

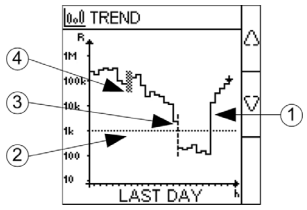
Vigilohm IM400 records and can display curves of the average of the system insulation over the following durations:

- last hour (1 point every 2 minutes)
- last day (1 point per hour)
- last week (1 point per day)
- last month (1 point per day)
- last year (1 point per month)

The chart scale automatically adjusts to the shown data to optimize the display accuracy.

The curves show a general trend how the system insulation evolves over time. They are calculated from averages related to shorter or longer durations depending on the charts. So charts may not show transient insulation faults when they are smoothed over time.

Trend Screen



Legend	Description
1	Trend
2	Current value of the insulation alarm threshold
3	Vertical dotted line: indicates a power interruption (duration undefined)
4	Squared area: indicates that the injection has been inhibited

Communication via Modbus RS 485

5

What Is in This Chapter?

This chapter contains the following topics:

Configuring RS 485 Communication Port

Communication Parameters

Before initiating any communication processes, configure the Modbus communication port via the HMI on Vigilohm IM400 selecting **Menu** →**Settings** →**Modbus**.

Parameters	Authorized Values	Factory Value
Address	1...247	1
Auto Config	ON / OFF	OFF
Baud rate	• 4800 Baud • 9600 Baud • 19 200 Baud • 38 400 Baud	19 200 Baud
Parity	• Even • Odd • None	Even

In point-to-point mode, when the device is directly connected to a computer, the reserved address 248 can be used to communicate with the device whatever the device internal address.

Signaling of Communication Activity

The yellow  indicator light indicates the status of the activity on the Modbus RS485 bus as follows:

If...	Then...
the indicator light is flashing	communication on the bus is active
the indicator light is off	there is no active communication between master and slave

NOTE: The yellow indicator light flashes on every valid Modbus frame even if the Vigilohm IM400 is not addressed directly.

Table of Modbus Functions

Modbus Functions

Function Code		Function Name
Decimal	**Hexadecimal**	
3	0x03	Read Holding Registers(1)
4	0x04	Read Input Registers(1)
6	0x06	Write Single Register
8	0x08	Diagnostics
16	0x10	Write Multiple Registers
67 / 14	0x43 / 14	Read Device Identification
67 / 15	0x43 / 15	Get Date/Time
67 / 16	0x43 / 16	Set Date/Time
(1) The Read Holding and Read Input registers are identical		

The read device identification request is as follows:

Number	Type	Value
0	VendorName	Schneider Electric
1	ProductCode	IM400
2	MajorMinorRevision	vX.Y.Z
3	VendorURL	www.schneider-electric.com
4	ProductName	Insulation Monitoring Device
5	ModelName	IMD-IM400

The product answers any types of requests (basic, regular, extended).

Modbus Registers Tables

Table Format

Modbus register tables have the following columns:

Address		Register Number		RW	Unit	Type	Range	Description
hex	dec	hex	dec					

- **Register Address**: Address of register encoded in the Modbus frame, in hexadecimal (hex) and decimal (dec) formats
- **Register Number**: corresponds to the Register Address + 1, in hexadecimal (hex) and decimal (dec) formats
- **RW**: Whether the register is read only (R) or read-write (RW)
- **Unit**: The unit the information is expressed in
- **Type**: The encoding data type
- **Range**: The permitted values for this variable, usually a subset of what the format allows
- **Description**: Provides information about the register and the values that apply

System Status

Address		Register Number		RW	Unit	Type	Range	Description
hex	dec	hex	dec					
0x0064	100	0x0065	101	R	–	Uint16	• 17000 - IM10 • 17001 - IM10H • 17002 - IM20 • 17003 - IM20H • 17004 - IM400	Device identifier
0x0066... 0x0067	102...103	0x0067... 0x0068	103...104	R	–	Uint16	Encoded version X.Y.Z	Firmware version X.Y.Z: • X represents the primary revision number, which is encoded in the most significant byte of register 102. • Y represents the secondary revision number, which is encoded in the least significant byte of register 102. • Z represents the quality revision number, which is encoded in register 103.
0x0069... 0x006C	105...108	0x006A... 0x006D	106...109	RW	–	–	–	Date/Time (TI081 format *(see page 77)*)

0x006D	109	0x006E	110	R	–	Uint16	–	Product status:
								• Most significant byte = error code
								• Least significant byte = product status
								  • 0x00 - Normal operation
								  • 0x01 - Self-test
								  • 0x02 - Insulation fault
								  • 0x03 - Disconnected injection detected
								  • 0x04 - Over-limit capacitance
								  • 0x05 - Inoperative product
								  • 0x06 - Injection disabled
								  • 0x07 - Overvoltage

Monitoring

Address		Register Number		RW	Unit	Type	Range	Description
hex	dec	hex	dec					
0x03E8	1000	0x03E9	1001	R	Ohm	Float32	–	Resistance. When injection is inhibited, the value NaN (Not a Number) 0xFFC00000 is returned during self-test.

Address		Register Number		RW	Unit	Type	Range	Description
hex	dec	hex	dec					
0x03EA	1002	0x03EB	1003	R	F	Float32	–	Capacitance. When injection is inhibited, the value NaN (Not a Number) 0xFFC00000 is returned during self-test.
0x03F0	1008	0x03F1	1009	R	–	Uint16	• 0 = Injection activated • 1 = Injection deactivated	Injection status

Insulation Alarm Status

Address		Register Number		RW	Unit	Type	Range	Description
hex	dec	hex	dec					
0x044C	1100	0x044D	1101	R	–	Uint16	• 0 = No insulation alarm • 1 = Insulation alarm active • 2 = Preventive insulation alarm active • 4 = Transient insulation alarm • 8 = Insulation alarm acknowledged	Insulation alarm status

Trending Data

Address		Register Number		RW	Unit	Type	Range	Description
hex	dec	hex	dec					
0x04B0	1200	0x04B1	1201	R	–	Uint16	Hour trending	Number of new records in trending buffer not yet read by the Modbus master
0x04B1	1201	0x04B2	1202	R	–	Uint16	Day trending	Number of new records in trending buffer not yet read by the master
0x04B2	1202	0x04B3	1203	R	–	Uint16	Week trending	Number of new records in trending buffer not yet read by the master
0x04B3	1203	0x04B4	1204	R	–	Uint16	Month trending	Number of new records in trending buffer not yet read by the master
0x04B4	1204	0x04B5	1205	R	–	Uint16	Year trending	Number of new records in trending buffer not yet read by the master
0x04BA	1210	0x04BB	1211	R	–	Float32	Hour value	Reading hour values. Each reading decrements the counter at address 1200.
0x04BC	1212	0x04BD	1213	R	–	Uint16	Hour value status	Status: • 0x0000 - Data not initialized • 0x0001 - Data invalid • 0x0002 - Data valid • 0x0003 - Power supply loss after this value • 0x0004 - Injection after this value • 0x0005 - Power supply loss and injection disable after this value

Address		Register Number		RW	Unit	Type	Range	Description
hex	dec	hex	dec					
0x04BD	1213	0x04BE	1214	R	–	Float32	Day value	Reading day values. Each reading decrements the counter at address 1201.
0x04BF	1215	0x04C0	1216	R	–	Uint16	Day value status	Status: ● 0x0000 - Data not initialized ● 0x0001 - Data invalid ● 0x0002 - Data valid ● 0x0003 - Power supply loss after this value ● 0x0004 - Injection disable after this value ● 0x0005 - Power supply loss and injection disable after this value
0x04C0	1216	0x04C1	1217	R	–	Float32	Week value	Reading week values. Each reading decrements the counter at address 1202.
0x04C2	1218	0x04C3	1219	R	–	Uint16	Week value status	Status: ● 0x0000 - Data not initialized ● 0x0001 - Data invalid ● 0x0002 - Data valid ● 0x0003 - Power supply loss after this value ● 0x0004 - Injection disable after this value ● 0x0005 - Power supply loss and injection disable after this value
0x04C3	1219	0x04C4	1220	R	–	Float32	Month value	Reading month values. Each reading decrements the counter at address 1203.
0x04C5	1221	0x04C6	1222	R	–	Uint16	Month value status	Status: ● 0x0000 - Data not initialized ● 0x0001 - Data invalid ● 0x0002 - Data valid ● 0x0003 - Power supply loss after this value ● 0x0004 - Injection disable after this value ● 0x0005 - Power supply loss and injection disable after this value
0x04C6	1222	0x04C7	1223	R	–	Float32	Year value	Reading year values. Each reading decrements the counter at address 1205.
0x04C8	1224	0x04C9	1225	R	–	Uint16	Year value status	Status: ● 0x0000 - Data not initialized ● 0x0001 - Data invalid ● 0x0002 - Data valid ● 0x0003 - Power supply loss after this value ● 0x0004 - Injection disable after this value ● 0x0005 - Power supply loss and injection disable after this value

Diagnostic

Address		Register Number		RW	Unit	Type	Range	Description
hex	dec	hex	dec					
0x07D0	2000	0x07D1	2001	W	–	Uint16	–	Write 0xA456 to start self-test
0x07D1... 0x07D4	2001...2004	0x07D2... 0x07D5	2002...2005	R	–	–	–	Total uptime since first power-up of product. Registers correspond to (result - 01/01/2000) = total uptime. TI081 date format *(see page 77).*
0x07D5	2005	0x07D6	2006	R	–	Uint32	–	Total number of power cycles since first power-up of the product
0x0802	2050	0x0803	2051	W	–	Uint16	–	Write 0x1919 to reset factory settings (default factory settings)
0x0803	2051	0x0804	2052	W	–	Uint16	–	Write 0xF0A1 to reset all logs
0x0804	2052	0x0805	2053	W	–	Uint16	–	Write 0x25AB to reset all graphs

Settings

Address		Register Number		RW	Unit	Type	Range	Description
hex	dec	hex	dec					
0x0BB7	2999	0x0BB8	3000	R	–	Uint16	–	Total number of settings changed since first power-up. Incremented by 1 for each change of one or several parameters.
0x0BB8	3000	0x0BB9	3001	RW	–	Uint16	• 0 = Normally open • 1 = Normally closed	Injection inhibition input configuration. Factory value: 0 (Normally open).
0x0BB9	3001	0x0BBA	3002	RW	–	Uint16	• 1 = Standard connection • 2 = Failsafe	Insulation alarm relay logic command. Factory value: 2 (Failsafe).
0x0BBA	3002	0x0BBB	3003	RW	Ohm	Uint32	100 Ω..500 kΩ	Insulation alarm threshold. Factory value: 1 kΩ
0x0BBC	3004	0x0BBD	3005	RW	Ohm	Uint32	• 1 kΩ..1 MΩ • 0xFFFFFFFF = OFF	Preventive insulation alarm threshold. OFF is used to deactivate the preventive insulation alarm. Factory value: 0xFFFFFFFF (Deactivated).
0x0BBF	3007	0x0BC0	3008	RW	s	Uint16	0...7200	Insulation alarm time delay. Factory value: 0.
0x0BC0	3008	0x0BC1	3009	RW	s	Uint16	• 0 = Short (4 s) • 1 = Medium (40 s) • 2 = Long (400 s)	Network filtering. Factory value: 1 (40 s).
0x0BC1	3009	0x0BC2	3010	RW	Hz	Uint16	• 0 (for DC system) • 50 • 60 • 400	System frequency. Factory value: 50 Hz.
0x0BC6	3014	0x0BC7	3015	RW	–	Uint16	0000...9999	Password. Factory value: 0000.
0x0BC7	3015	0x0BC8	3016	RW	–	Uint16	• 0 = OFF • 1 = ON	Password protection. Factory value: 0 (password protection deactivated).

Address		Register Number		RW	Unit	Type	Range	Description
hex	dec	hex	dec					
0x0BC8	3016	0x0BC9	3017	RW	–	Uint16	• 0 = English • 1 = French • 2 = Spanish • 3 = Russian • 4 = Chinese • 5 = Italian • 6 = German • 7 = Portuguese	Interface language. Factory value: 0 (English).
0x0BC9	3017	0x0BCA	3018	RW	%	Uint16	10...100	Display contrast. Factory value: 50.
0x0BCA	3018	0x0BCB	3019	RW	%	Uint16	10...100	Display brightness. Factory value: 100.
0x0BCB	3019	0x0BCC	3020	RW	–	Uint16	• 0 = None • 1 = IM400-1700 • 2 = PHT1000	Voltage adaptor. Factory value: 0 (no plate).
0x0BCC	3020	0x0BCD	3021	RW	–	Uint16	• 1 = Standard connection • 2 = Failsafe • 3 = Mirror	Preventive insulation alarm relay logic command. Factory value: 2 (failsafe).
0x0BCD	3021	0x0BCE	3022	RW	s	Uint16	0...7200 s	Preventive insulation alarm time delay
0x0BCE	3022	0x0BCF	3023	RW	–	Uint16	• 0 = OFF • 1 = ON	Insulation alarm relay reactivation. Factory value: 0. ON = relay triggers 3 s if insulation fault disappears in insulation alarm acknowledgement mode
0x0BCF	3023	0x0BD0	3024	RW	–	Uint16	• 0 = OFF • 1 = ON	Insulation alarm relay acknowledgement. Factory value: 1.
0x0BD0	3024	0x0BD1	3025	RW	–	Uint16	• 0 = Min (15 V) • 1 = Low (33 V) • 2 = Medium (120 V) • 3 = Max (150 V) (only with IM400-1700 voltage adaptor)	Injection voltage. Factory value: 2.
0x0BD1	3025	0x0BD2	3026	RW	–	Uint16	• 0 = Power (Industry) • 1 = Control Circuits • 2 = Photovoltaic	Customer application. Factory value: 0.
0x0BD2	3026	0x0BD3	3027	RW	–	Uint16	• 0 = ON • 1 = OFF	Disconnected injection detection. Factory value: 0.
0x0BD3	3027	0x0BD4	3028	RW	–	Uint16	• 0 = OFF • 1 = ON	Insulation fault locating. Factory value: 0.
0x0BD5	3029	0x0BD6	3030	RW	–	Uint16	• 0 = OFF • 1 = ON	Self-test: test with relays. Factory value: 1.
0x0BD6	3030	0x0BD7	3031	RW	Ω	Uint16	• 0.1...500 kΩ • 0xFFFFFFFF = OFF	Grounding resistance for impedant IT systems (HRG). Factory value: 0xFFFFFFFF (disabled).

Log

Address		Register Number		RW	Unit	Type	Range	Description
hex	dec	hex	dec					
0x4E20	20000	0x4E21	20001	R	–	Uint16	1...60	Number of event records
0x4E21	20001	0x4E22	20002	R	–	Uint16	–	Number of the most recent record
0x4E22... 0x4E2D	20002... 20013	0x4E23... 0x4E2E	20003... 20014	R	–	Record	–	Record 1
0x4E2E... 0x4E39	20014... 20025	0x4E2F... 0x4E3A	20015... 20026	R	–	Record	–	Record 2
...								
0x50E6... 0x50F1	20710... 20721	0x50E7... 0x50F2	20711... 20722	R	–	Record	–	Record 60

Each event is stored using 2 records:

- A primary record, which is created when the insulation alarm or preventive insulation alarm occurs. This contains the insulation value.
- A secondary record, which is created when the insulation alarm or preventive insulation alarm disappears. This contains the type of event (acknowledged insulation alarm, transient insulation alarm, preventive insulation alarm).

The 2 records are logged consecutively.

Description of an Event Record in the Log

Register	Unit	Type	Range	Description
Word 1	–	Uint16	1…65535	Event record number
Word 2 Word 3 Word 4 Word 5	–	Uint64	–	Time tagging of event (using the same code as for the product date/time)
Word 6 Word 7	–	Uint32	• 0...1 • 0x40, 0x10 • 1000, 1100	Record identifier: • Word 6, most significant byte: Information for primary/secondary record. This field assumes a value of 1 for the primary record and a value of 0 for the secondary record. • Word 6, least significant byte: Type of data stored in the **Value** field • Word 7: Address of the Modbus register that is the source of the data in the **Value** field
Word 8 Word 9 Word 10 Word 11	–	Uint64	–	Depending on the type of record (primary or secondary): • Insulation resistance value (in ohms) at the time of the event occurrence (encoded in Float32 in the last 2 registers) • Insulation alarm type (encoded in Uint16 in the last register)
Word 12	–	Uint16	1...65534	Primary/secondary record identifier for event: • In the case of a primary record for an event, this identifier is an odd integer; numbering starts at 1 and the number is incremented by 2 for each new event. • In the case of a secondary record for an event, this identifier is equal to the primary record identifier plus 1.

Example of an Event

The 2 records below represent an insulation alarm that occurred at 12:00 on October 1, 2010 and was acknowledged at 12:29.

Record number: 1

Address		Register Number		Unit	Type	Value	Description
hex	dec	hex	dec				
0x4E22	20002	0x4E23	20003	–	Uint16	1	Record number
0x4E23	20003	0x4E24	20004	–	Uint64	• 10 • 0 • 10 • 1 • 12 • 0 • 0	Date when insulation alarm occurred (October 1, 2010, 12:00)
0x4E27	20007	0x4E28	20008	–	Uint32	• 1 • 0x40 • 1000	Record identifier: • Primary record plus secondary record • Float32 value (insulation resistance) • Value of register 1000 (register for insulation resistance monitoring)
0x4E29	20009	0x4E2A	20010	Ohm	Uint64	10000	Insulation resistance value at the time of the insulation alarm
0x4E2D	20013	0x4E2E	20014	–	Uint16	1	Secondary record identifier for event

Record number: 2

Address		Register Number		Unit	Type	Value	Description
hex	dec	hex	dec				
0x4E2E	20014	0x4E2F	20015	–	Uint16	2	Record number
0x4E2F	20015	0x4E30	20016	–	Uint64	• 10 • 0 • 10 • 1 • 12 • 29 • 0	Date when insulation alarm disappeared (October 1, 2010, 12:29)
0x4E33	20019	0x4E34	20020	–	Uint32	• 1 • 0x10 • 1100	Record identifier: • Secondary record • Uint16 value (insulation alarm acknowledged) • Value of register 1100 (insulation alarm status register)
0x4E35	20021	0x4E36	20022	–	Uint64	8	Value of insulation alarm register at the time of insulation alarm acknowledgement
0x4E39	20025	0x4E3A	20026	–	Uint16	2	Secondary record identifier for event

Date and Time

The following structure is used for date-time information exchange using Modbus protocol.

The date/time are encoded in 8 bytes as follows:

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00	Word
0	0	0	0	0	0	0	0	R4	Y	Y	Y	Y	Y	Y	Y	Word 1
0	0	0	0	M	M	M	M	WD	WD	WD	D	D	D	D	D	Word 2
SU	0	0	H	H	H	H	H	iV	0	mn	mn	mn	mn	mn	mn	Word 3
ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	Word 4

- R4: Reserved bit (reserved by IEC870-5-4), set to 0
- Y - Years
  - 1 byte
  - Value from 0...127 (1/1/2000 to 31/12/2127)
- M - Months
  - 1 byte
  - Value from 1...12
- D - Days
  - 1 byte
  - Value from 1...31
- H - Hours
  - 1 byte
  - Value from 0...23
- mn - Minutes
  - 1 byte
  - Value from 0...59
- ms - Milliseconds
  - 2 byte
  - Value from 0...59999

The following fields are in **CP56Time2a** standard and are considered as optional:

- WD - Week Day
  - If not used, set to 0 (1 = Sunday, 2 = Monday...)
  - Value from 1...7
- SU - Summertime
  - If not used, set to 0 (0 = standard time, 1 = summertime)
  - Value from 0...1
- iV - Validity of the information contained in the structure
  - If not used, set to 0 (0 = valid, 1 = not valid or not synchronized in system)
  - Value from 0...1

This information is encoded in binary form.

Maintenance and Troubleshooting

6

What Is in This Chapter?

This chapter contains the following topics:

Safety Precautions

Safety Precautions

The following safety precautions must be thoroughly implemented before commissioning or attempting to repair electrical equipment or carry out maintenance. Carefully read and follow the safety precautions described below.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ARC FLASH OR BURNS

- Wear suitable personal protective equipment and follow the currently applicable electrical safety instructions. See, for example, standard NFPA 70E when carrying out work in the USA.
- Only qualified personnel should maintain this equipment. Such work should be performed only after reading all the installation instructions.
- Turn off all power supplying this equipment before working on or inside it.
- NEVER work alone.
- Beware of potential hazards and wear personal protective equipment.

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

NOTICE

HAZARD OF PRODUCT DAMAGE

- Never open the Vigilohm unit.
- Do not attempt to repair any components in the Vigilohm range, either in the unit or an accessory.

Failure to follow these instructions can result in equipment damage.

Commissioning

Validating Correct Insulation Monitoring With Exclusion Management

In order to have proper insulation monitoring of the electrical power system, it is important that it is monitored by one and only one insulation monitoring device at a time.

For most of the systems that do not include multiple incomers or coupling of multiple busbars this is easily achieved as there is only one IMD in the system permanently active.

For systems with multiple incomers or power busbar coupling, the monitoring system embeds several Vigilohm IMDs as explained in the Injection Inhibition Input and Exclusion Management section *(see page 48)*. The exclusion/activation of each IMD according to the electrical power system configuration is managed through the injection inhibit contact. It is then important at commissioning to validate that insulation of every part of the electrical power system is monitored by an active IMD, and that the management of exclusion/activation of each IMD does not lead to a part of the power system monitored by more than one IMD or by no IMD. This in order to avoid insulation fault not being reported.

Insulation Metering and Insulation Fault Detection Testing

To verify that Vigilohm IM400 is correctly installed and configured:

- It is recommended to check the installation by connecting a known impedance between wiring terminals 1 and 3 of the Vigilohm IM400 (10 kΩ) and verifying that the impedance is correctly measured.
  For this test, do not connect Vigilohm IM400 to the monitored network.
- It is recommended to check the insulation fault detection by strapping wiring terminals 1 and 3 of Vigilohm IM400 (creating a 0 Ω insulation fault).
  For this test, do not connect Vigilohm IM400 to the monitored network.

Insulation Alarm Relay Wiring Testing

To check that the insulation alarm relay is correctly wired in the installation, it is recommended to perform a device test with relay.

Disconnected Injection Detection

If required in the application enable the disconnected injection detection parameter so that Vigilohm IM400 continuously performs this checking, and reports any connection or wiring issue.

The Vigilohm IM400 is delivered with the disconnected injection detection parameter set to **OFF**. This setting helps avoiding an undesired **Disconnected Injection Detected** message from appearing when installing and commissioning the device before connecting it to the power system and loads.

According to the system or application requirements, it may be needed to enable the disconnected injection detection parameter (setting it to **ON**) when executing the final commissioning. Thus the Vigilohm IM400 can continuously perform this checking during operation and report any injection connection or wiring issue.

HV1/HV2 Wiring Testing

The connection between Vigilohm IM400 and the voltage adaptors IM400-1700 or PHT1000 is key for a correct behavior of IM400.

It is recommended to check the wiring of HV1 and HV2 wiring terminals to the voltage adaptor. It can be done by connecting a known impedance (for example, 10 kΩ) between IM400-1700 wiring terminal 1 and IM400 wiring terminal 3, or between PHT1000 wiring terminal 3 and Vigilohm IM400 wiring terminal 3.

Check that Vigilohm IM400 correctly measures.

For this test, do not connect IM400-1700 or PHT1000 to the monitored power system.

Protection Password Setting

To avoid any unintended operation by not authorized or untrained personnel, it is recommended to set the protection password.

Maintenance and Troubleshooting

Product Status Indicator Light

The red product status indicator light indicates an error relating to one of the following:
- interruption of the injection circuit
- self-test not OK
- inoperative product
- over-limit capacitance (C > 500 µF or C > 2,000 µF in photovoltaic mode)

Interruption of the Injection Circuit

If the injection circuit of the Vigilohm is interrupted, the display shows the message below and starts flashing:

Self-Test

The Vigilohm performs a series of self-tests on start-up, and then at regular intervals during operation to detect any potential inoperations in its internal and external circuits. For more information on the self-test function, refer to the relevant section *(see page 53)*.

Troubleshooting

The table describes the potential problems and their probable causes. It also indicates the checks that can be carried out or provides possible solutions for each scenario. If you are still unable to resolve a problem after consulting the table, contact your Schneider Electric regional sales representative for assistance.

Potential Problem	Probable Cause	Possible Solution
The device displays nothing when switched on.	The device is not being supplied.	Check the auxiliary supply is present.
	The auxiliary supply does not comply.	Check the value of the auxiliary voltage: U = 110...480 Vac.
The device signals an insulation fault, but your system shows no signs of abnormal behavior.	The insulation fault alarm threshold is not appropriate.	Check the value of the insulation alarm threshold. Modify the insulation alarm threshold if necessary.
	The preventive insulation fault alarm threshold is not appropriate.	Check the value of the preventive insulation alarm threshold. Modify the preventive insulation alarm threshold if necessary.
You deliberately create an insulation fault, but the device does not detect it.	The resistance value used to simulate the insulation fault is greater than the value of the fault threshold.	Use a resistance value that is lower than the insulation alarm threshold or modify the insulation alarm threshold.
	The insulation fault is not detected between neutral and ground.	Start again verifying that you are between neutral and ground.
The product status indicator light is red and the display shows **Disconnected Injection Detected**.	The Vigilohm injection circuit is cut off.	• Check the connection on the injection terminal block (wiring terminals 1 and 3) and restart the self-test. • Disable the function during the commissioning.
	The power system being small, the Vigilohm IM400 interprets the low capacitance and high resistance of the power system as a disconnected injection.	
The product status indicator light is red and the display indicates that an error occurred during the self-test.	The Vigilohm injection circuit is cut off.	Briefly disconnect the auxiliary power supply for the Vigilohm.
Although the Vigilohm is being supplied with power, the product status indicator light does not light up.	Inoperative indicator light.	Restart the self-test and check that the product status indicator light lights up briefly.
The insulation alarm indicator light does not light up in the event of an insulation fault.	Inoperative indicator light.	Restart the self-test and check that the insulation alarm indicator light lights up briefly.

Specifications

7

Specifications

Type of Installation to Be Monitored

Characteristic		Values
AC or mixed AC/DC IT systems(1)	Phase-to-phase voltage with IM400 connected to neutral	≤830 Vac(1)(2) or ≤1,700 Vac(3)
	With IM400 connected to phase	≤480 Vac(1)(2) or ≤1,000 Vac(3)
	Frequency	45...440 Hz
DC or rectified systems	Line voltage	< 480 Vdc(1)(2) or ≤1,200 Vdc(3)(4)
(1) When the insulation monitor is linked to a non-insulated inverter, it is necessary to take into account the DC voltage limit rather than the AC limit. **(2)** IM400 directly connected to the power system. **(3)** IM400 used with IM400-1700 or PHT1000 subassemblies. **(4)** 1000 Vdc with IM400-1700 and 1200 Vdc with PHT1000.		

Electrical Characteristics

Characteristic			Values
Range for insulation resistance readings			10 Ω..10 MΩ
Range for capacitance readings			0.1...500 µF (2,000 µF for PV applications)
Insulation fault signaling	Number of thresholds		2 (protected password)
	Threshold settings	Insulation alarm	0.1...500 kΩ
		Preventive insulation alarm	1 kΩ..1 MΩ
Time delay for signaling			0...7,200 s
Dielectric strength			4000 Vac / 5500 Vdc 7.3 kV impulse
Auxiliary supply voltage	50/60/400 Hz		100...440 Vac
	DC		100...440 Vdc
Auxiliary supply voltage tolerances			+/-15 %
Monitored system voltage tolerances	IM400 directly connected		+5%
	IM400 used with IM400-1700		+15%
Maximum device consumption			25 VA / 10 W
Measurement voltage	Variable		15 Vp, 33 Vp, 120 Vp
Measurement current	Variable		375 µAp, 825 µAp, 3 mAp
Fault locating current			3.75 mAp
Extraneous DC voltage Ufg			506 V
Device operating test			Self-test / manual test
Internal impedance	At 50/60/400 Hz		40 kΩ
Internal resistance Ri of the measuring circuit			40 kΩ

Characteristic			Values
Output contact	Quantity		2 (standard and failsafe)
	Type of contact		SPDT one changeover contact
	Operating principle		N/O N/C operation
	Electrical endurance		30,000 cycles
	Breaking capacity	250 Vac	3 A
		48 Vdc	1 A, 10 mA minimum load
Injection inhibition (voltage supplied by IM400)		Voltage	24 Vdc
		Current	5 mA
Installation category			300 V/OVC III, degree of pollution 2
			600 V/OVC II, degree of pollution 2

Electrical Characteristics of IM400-1700 Voltage Adaptor

Characteristic		Value
Dielectric strength		15.4 kV impulse
Measurement current	Variable	30 µAp, 60 µAp, 220 µAp
Extraneous DC voltage Ufg		1,150 Vdc
Internal impedance	At 50/60/400 Hz	430 kΩ
Internal resistance Ri of the measuring circuit		430 kΩ

Mechanical Characteristics

Characteristic		Value
Weight		0.75 kg
Thermoplastic case	Mounting	Flush mount or on grid
Degree of protection	Front	IP54
	Back	IP20

Other Characteristics

Characteristic		Value
Temperature range	For operation	–25...+55 °C (65 °C)(1)
	For storage	–40...+70 °C
Climatic conditions(2)		IEC 60068
Use		Indoors
Altitude		Up to 3000 m
Degree of pollution		2
Overvoltage category		300 V / OVCIII, 600 V / OVCII
Standards	Product	IEC 61557-8
	Safety	IEC 61010-1, UL 508, C22.2 no. 14-05
	Installation	IEC 60364-4-41
	Output contact	IEC 61810-2

(1) With IM400-1700 voltage adaptor and 230 V ±15 % auxiliary supply.
(2) Suitable for use in all climates:
- Damp heat, equipment not operating (IEC 60068-2-30)
- Damp heat, equipment operating (IEC 60068-2-56)
- Salt mist (IEC 60068-2-52)

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Schneider Electric Industries SAS
35, rue Joseph Monier
CS30323
F - 92506 Rueil Malmaison Cedex

www.schneider-electric.com

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