SUPERINTEND IM-04 and IM-04_24

IMD Insulation Monitoring device for non-grounded (IT) electrical networks for industrial applications

Instructions for installation and use v10.771

AC/DC



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INSTRUCTIONS

These instructions for use are intended for trained electrical engineering professionals. The IM-04 and IM-04_24 devices are marked with the symbol shown below, which indicates that if the device has been installed incorrectly or used in violation of instructions, safety could be jeopardised. The description of the symbol is presented in this manual instead of on the device due to space constraints. Such sections are marked with the symbol shown below.



A symbol indicating possible danger. A description of the symbol may be placed on the device or provided in the instructions for use.

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SYSTEM DESCRIPTION

IM-04 and IM-04_24 are devices with which the insulation resistance and capacitance of floating electricity networks can be measured and monitored in industrial applications.

INSTALLATION

PHYSICAL CONNECTION



The devices are connected to the electrical network, which may contain dangerous voltage. The device may be installed by a trained electrical engineering professional only. The device contains no user-serviceable parts and must not be opened. Using the device in violation of these instructions may compromise safety.

The IM-04/IM-04_24 unit is the main unit of the system and is installed in the switchboard. Two IM-04/IM-04_24 devices may not be installed galvanically in the same network, for example on the secondary side of the same transformer. The connection is performed as presented in Figures 1…3. The installation and wiring should be performed in accordance with standards IEC 60364 as well as EN 50110. The operating voltage connection of IM-04/IM-04_24 must always be equipped with a coupler or a line protection switch so that the electricity supply can be disconnected for the duration of maintenance work, for example. The location of the disconnectors must be clearly marked in the switchboard. The coupler or line protection switch should also control a relay or contactor, which separates the measuring wires from the network to be measured. The IM-04/IM-04_24 device is equipped with an internal 1 A fuse. In spite of this, the wires of the operating voltage supply should still be protected with an external fuse. A suitable size is, for example, 6 A. In a DC operating voltage supply with IM-04, an external Schurter 0001.2503 (T800mA) fuse should be used.

DEVICE MOUNTING

The IM-04/IM-04_24 device is intended for installation in a DIN TS35 rail in accordance with standard IEC 60715. They are installed by inserting the upper edge of the DIN TS35 rail in the groove intended for the DIN TS35 rail on the back of the device and by pushing the bottom edge of the device backward until the retaining latch clicks into place.
The IM-04/IM-04_24 unit comes with the connections shown in the following table. The shaded parts are optional and are installed as needed, while installing the other parts is mandatory.

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Category	Connector	Description	
Operating voltage connection	⏚	Protective earth, to be connected to the earthing circuit connector	
	+/L	IM-04	110…240 VAC, 48…62 Hz phase conductor, internal fuse 1A slow +/-110…300 VDC, use an external fuse Schurter 0001.2503 (T800mA)
		IM-04_24	+/-22…27 VDC
	-/N	IM-04	110…240 VAC neutral conductor -/+110…300 VDC
		IM-04_24	-/+22…27 VDC
RS-485	SH	RS-485 cable shield / ground	
	A	RS-485 data+ (two-way data)	
	B	RS-485 data- (two-way data)	
Measuring connectors	TG	Alarm terminal of protective earth, to be connected to the PE rail	
	MG	Electronics protective earth, to be connected to the PE rail	
	M1	Connection 1 of the network to be monitored; Max 300VAC/300VDC	
	M2	Connection 1 of the network to be monitored; Max 300VAC/300VDC	
	ISOL.	Not used	
Alarm relays	INS. ALARM NO	Alarm relay of the insulation resistance. NO-COM is an open circuit when the alarm in inactive and closes when the alarm is active. NC-COM functions in a reverse manner. Max load 250VAC/3A or 30VDC 3A	
	INS. ALARM NC		
	INS. ALARM COM		
	INS. WARN. NO	Pre-alarm relay of the insulation resistance. NO-COM is an open circuit when the alarm in inactive and closes when the alarm is active. NC-COM functions in a reverse manner. Max load 250VAC/3A or 30VDC 3A	
	INS. WARN. NC		
	INS. WARN. COM		

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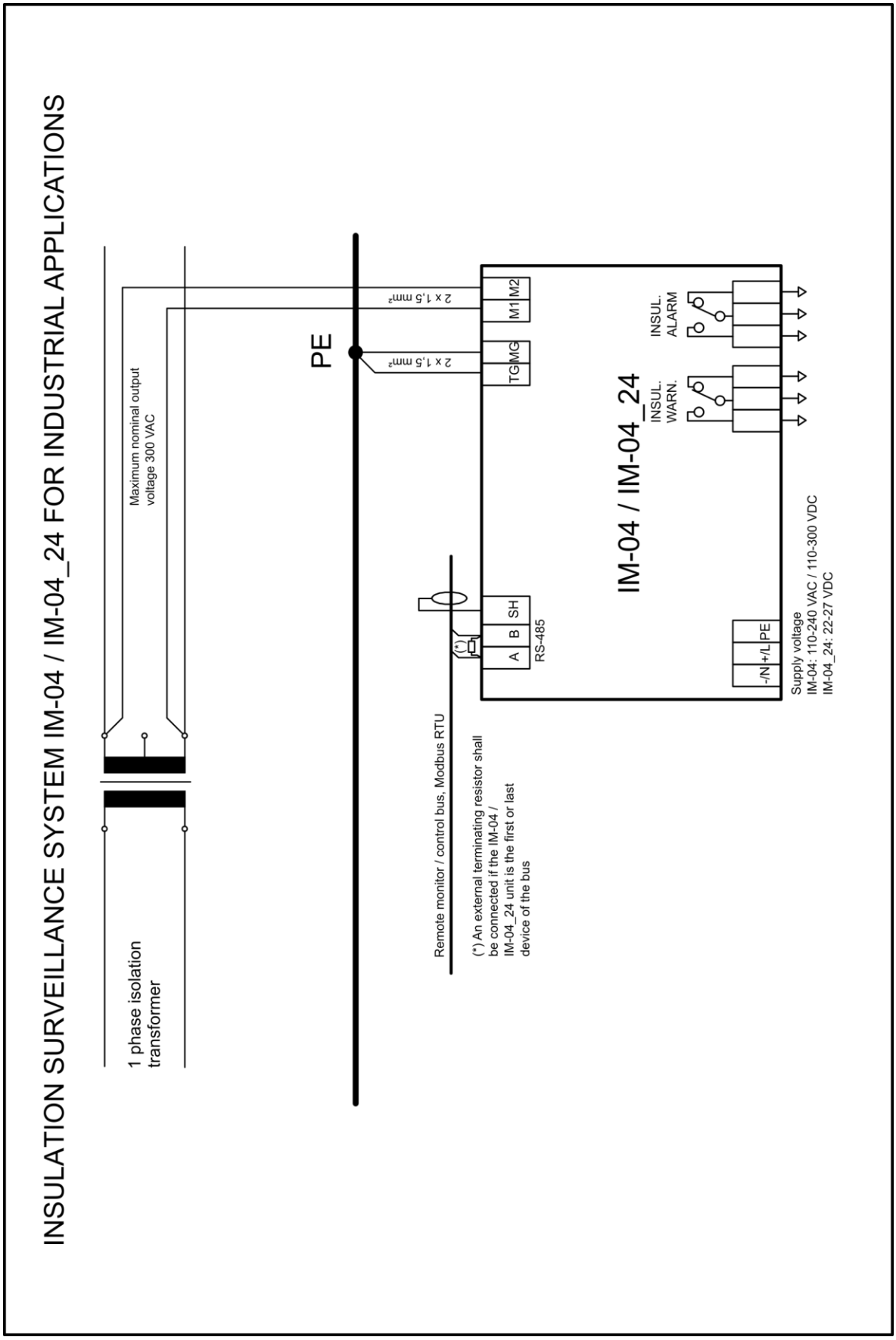


Figure 1. System connection of a 1 phase system.

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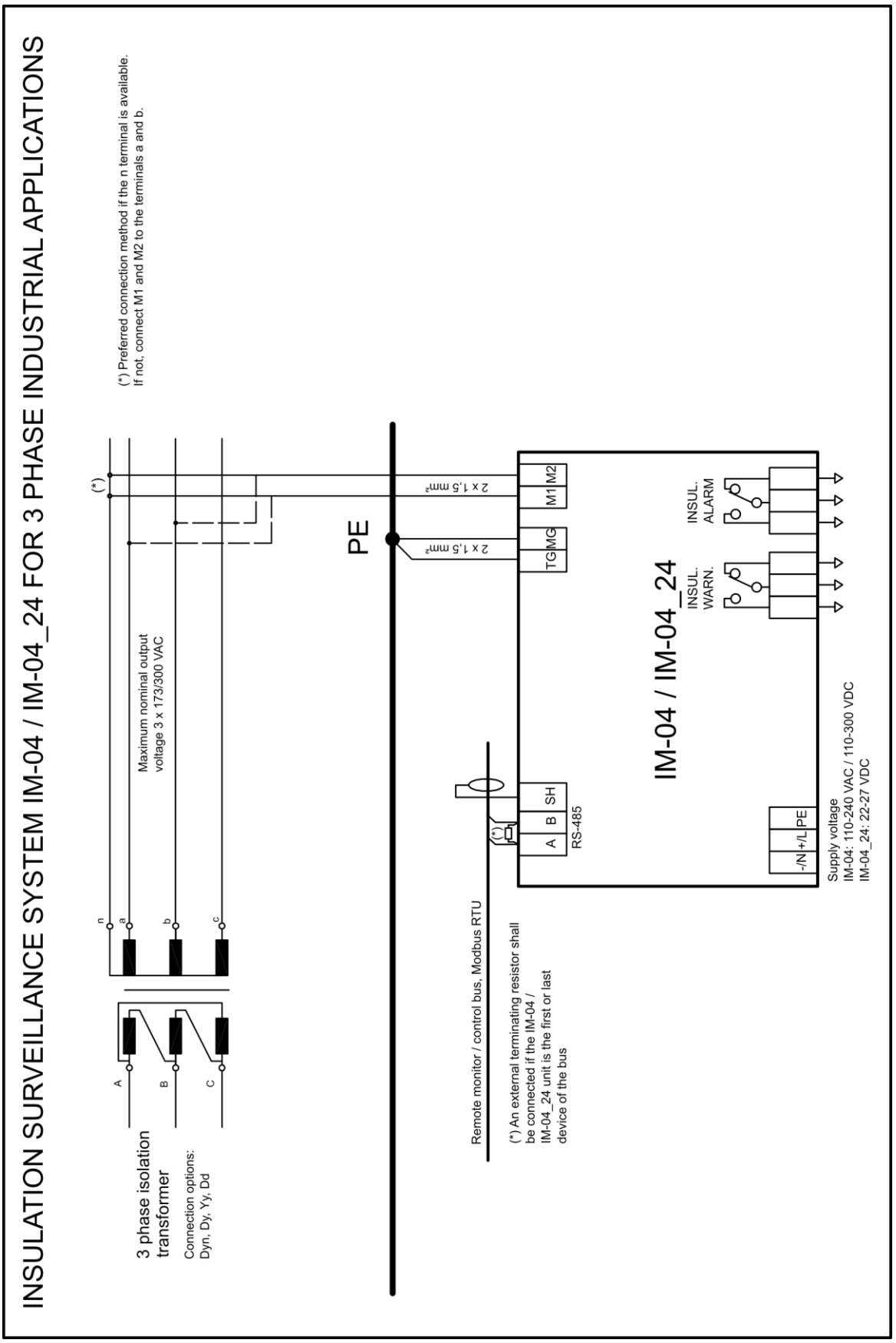


Figure 2. System connection of a 3 phase system.

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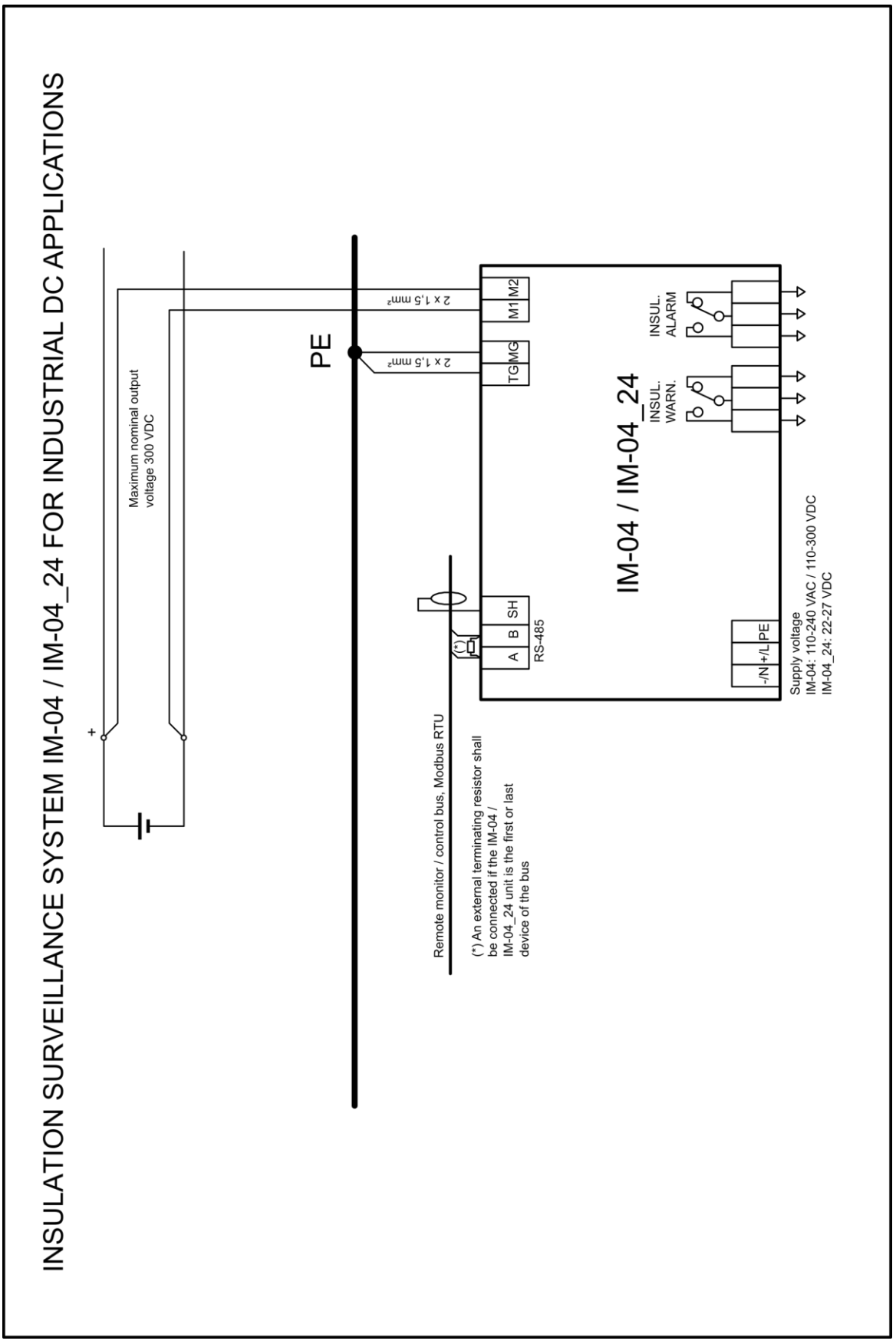


Figure 3. System connection of a DC system.

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RS-485 NETWORK CONNECTION

The IM-04/IM-04_24 unit includes a RS-485 bus connection with Modbus RTU protocol for remote monitoring and controlling.

The IM-04/IM-04_24 unit functions as a slave device. A unique address must be set for it (SETUP→MB Addr).

The RS-485 bus must form an uninterrupted chain, which is open at both ends, and contains no branches. Thus, a maximum of two RS-485 cables are installed in any unit: in other words, an incoming and an outgoing cable. A terminator is installed in the first and the last unit. If the IM-04/IM-04_24 unit is the first or last device of the bus, an external terminating resistor of 120 Ω must be connected between the terminals A and B. In all other units, the terminator must not be installed.

The cable shield is connected to the SH terminal of the IM-04/IM-04_24 unit.

SYSTEM CONFIGURATION

The most sensible configuration order for the settings is as follows:

- Set the correct time (SETUP→Time).
- Set the alarm parameters (SETUP→InsLimit, PrInsLim, StDelay).
- When needed, set the Modbus address (SETUP→MB Addr).
- If needed, enable the automatic alarm acknowledgement (SETUP→AutoRst).

A more detailed description of the configuration is provided in the Manual section “SETUP menu”.

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USE

GENERAL

The Superintend IMDM system includes one unit:

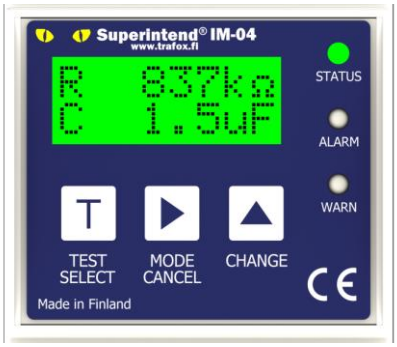
- The **IM-04/IM-04_24 unit** is the central unit of the system. It performs the measurements independently and controls the alarm relays. The IM-04/IM-04_24 unit is installed in the switchboard.

IM-04/IM-04_24 UNIT

The IM-04/IM-04_24 unit is the central unit of the system. The IM-04/IM-04_24 contains the user interface of the entire system. The error notifications are displayed on the screen of the IM-04/IM-04_24, and the fault information can be forwarded to another user-defined system through the alarm and pre-alarm relays. All alarm parameters are set through the user interface of the IM-04/IM-04_24 system.

Measurement values can be monitored and settings can be changed using the Modbus RTU protocol via the IM-04/IM-04_24 unit's RS-485 connection. For this purpose, the device must be connected to a RS-485 bus and the Modbus address must have been configured in the Setup menu.

The IM-04/IM-04_24 unit independently measures the insulation resistance and capacitance of the IT network to be monitored, in relation to protective earth. The measurement is performed by feeding two summed low frequency alternating voltages between the network and the PE conductor. These generate a low current that travels through the insulation resistance and capacitance to be measured. The insulation resistance and capacitance are calculated by FFT analysing the current and then measuring the amplitude and phase.



The system functioning can be tested by pressing the T button of the IM-04/IM-04_24 unit when the IM-04/IM-04_24 unit displays the Monitor menu. The device will test the

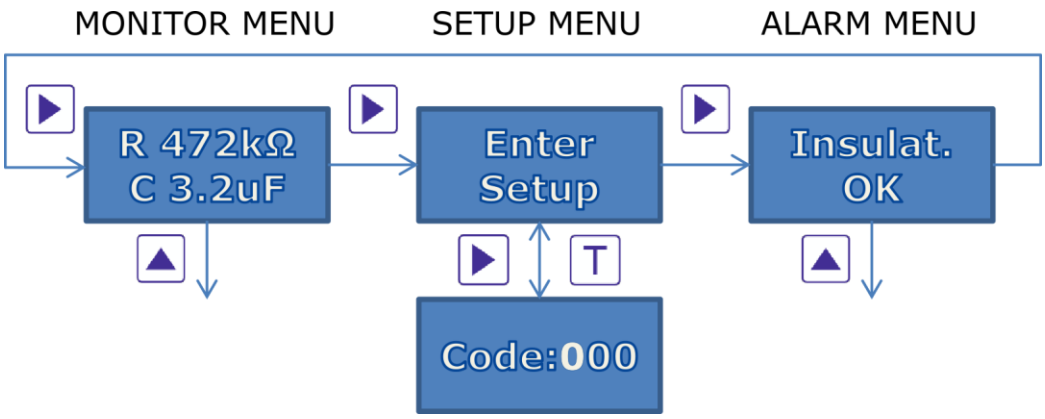
functioning of the internal measurement circuit. More detailed information on this is provided in the description of the Monitor menu.

MENU STRUCTURE

The menus of the IM-04/IM-04_24 unit have three main levels: MONITOR, SETUP and ALARM. The ▶ button is used to navigate between the main levels when the topmost parameter of each menu is highlighted on the screen.

The menus can be browsed down with the ▲ button. Access to the Setup menu is password-protected.

The Monitor menu is the default of the IM-04/IM-04_24 unit, to which the system returns in 20 minutes after the last time a button was pressed, or after a sufficient number of presses on the ▶ button in any screen mode.



- The Monitor menu mainly has one level. All information to be displayed can be viewed by browsing the menu with the ▲ button.
- The Alarm menu has two levels. The first level displays the reason for the alarm and the second level shows the alarm start time, the measured parameters, and alarm limits.
- The Setup menu mainly has two levels. The first level displays the valid parameter, which can be changed on the second level.

Hereafter, the screen modes are called as follows:

- The **main level** of the menu is the topmost menu level (MONITOR, SETUP and ALARM)
- The **menu level** is the sub-level of the aforementioned, and it is browsed using the ▲ button

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- The **screen mode** is the mode following the menu level, and it displays the value of the parameter/time; also displays a stopped AutoScroll mode. The screen mode can be accessed from the menu level by pressing the T button.
- The **AutoScroll** mode is in use in the Setup menu items where there are several parameters to display. In that case, the displayed parameters change every few seconds. You can stop the display with the ▲ button and return from the screen mode to the AutoScroll mode with the ▶ button. Use the T button to go to the edit mode or screen mode.
- The **Edit mode** is a Setup menu mode where the parameters to be displayed can be changed. In the Edit mode, the parameter to be changed flashes and it can be changed with the ▲ button. If there are several parameters to be changed in the same screen, you can move to the next one by pressing the ▶ button. After the editing is completed, press the T button, after which the values given must be approved by selecting "Yes" in the Confirm menu and pressing T. By selecting "No" or pressing the ▶ button in the conformation stage you return to the previous mode without saving the changes.

As a rule, the buttons function as follows:



Moving to the next parameter on the menu level and screen level. Increases the parameter on the edit level. In the AutoScroll mode, stops the display.



Moving to the next menu on the main level. Moves to the next editable parameter on the edit level. Also a general "reject button". Returns to the previous mode from all modes. Pressing the ▶ button an appropriate number of times takes you to the default mode of the main menu (insulation resistance/capacitance) from any mode.



A general "approval button". On the menu level, takes you to the AutoScroll or edit mode. On the edit level, approves the changes made. Pressing the button at the topmost item of the Monitor menu and approving the start of the test begins the system test.

MONITOR MENU

The Monitor menu is the default menu of the IM-04/IM-04_24 unit during use. All modes of the menu always return to the topmost item on the Monitor menu after 20 minutes from the last press of a button.

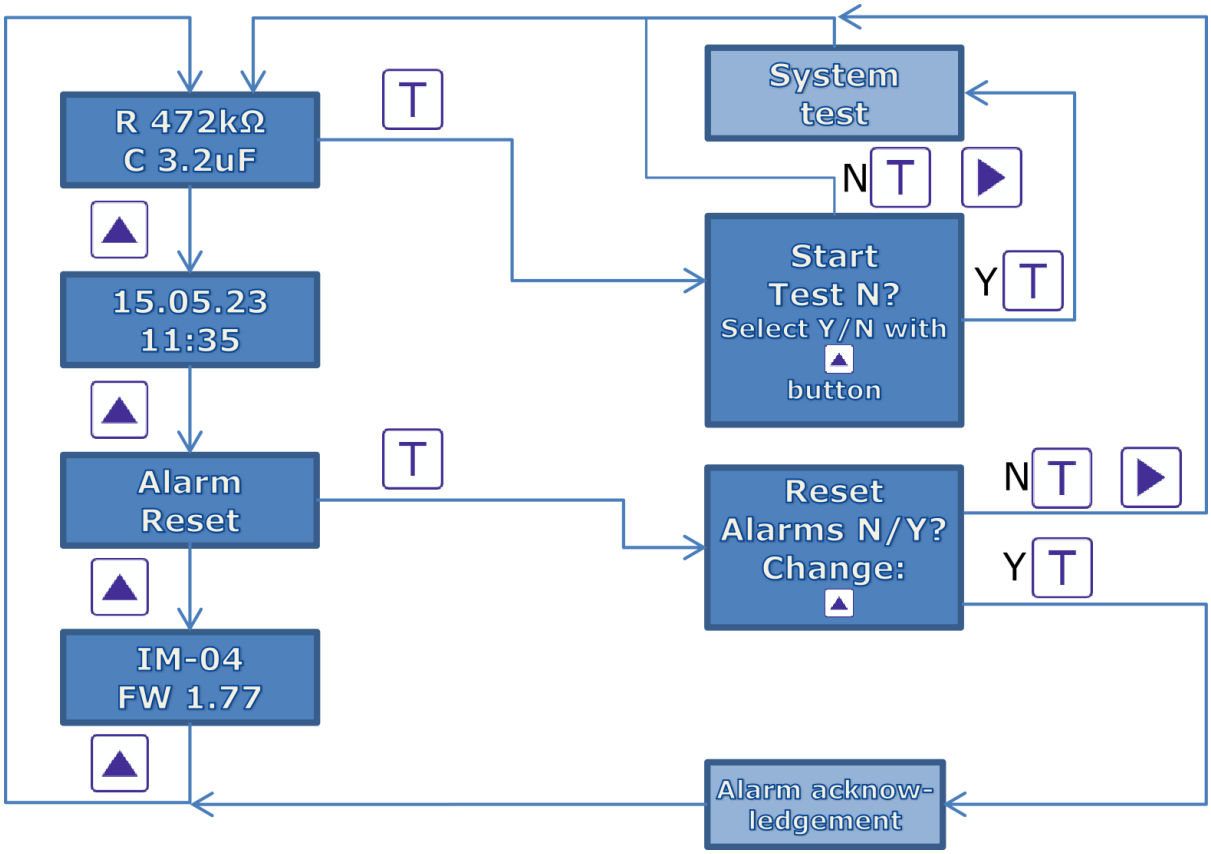
The following measured parameters are available in the Monitor menu screen:

- IT network's insulation resistance and capacitance in relation to protective earth. Displayed in kOhms and micro farads.
- Time and date
- All fixed alarms can be acknowledged on one go.
- Firmware version

The default display is insulation resistance and capacitance. Other parameters and functions can be viewed by using the ▲ button.

The system test is started from the Monitor menu by pressing T and then selecting Y in the Start test menu and pressing T. This starts the test of the internal measurement circuit of the IM-04/IM-04_24 unit. If the test is completed successfully, the screen displays momentarily the text Test OK; otherwise the text shown in Test FAILED, and an insulation fault alarm is given to indicate that the insulation resistance can no longer be measured.

The Monitor menu functions as follows:



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ALARM MENU

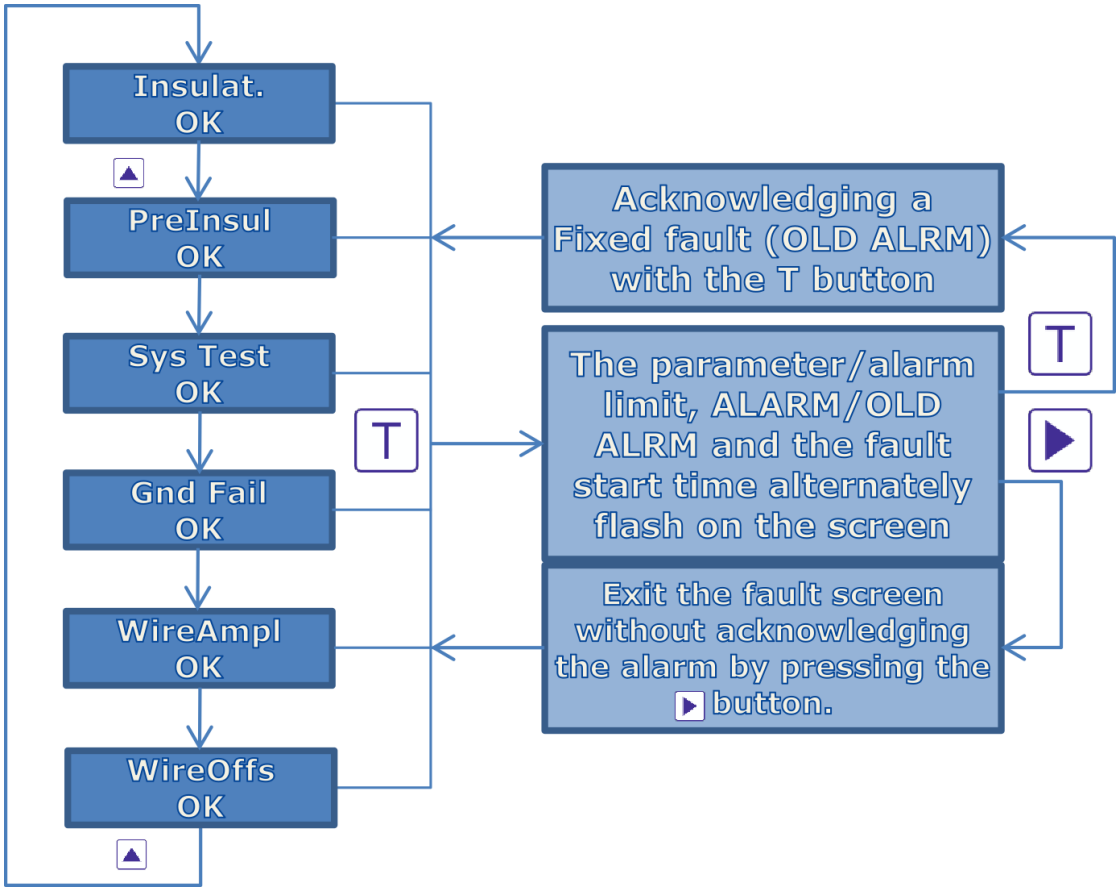
The alarm menu has two levels. The menu level shows if the alarm is active (ALARM), inactive but not acknowledged (OLD ALRM) or if the situation is normal (OK). The screen mode shows the value, alarm limit and time of the parameter that caused the alarm.

If the start-up delay has been enabled (SETUP→StDelay), the alarms cannot be activated before the set start-up delay has been elapsed after powering on the unit.

An alarm always indicates that the fault in question is still active. An active fault cannot be acknowledged until the issue that caused it has been fixed. The fixed fault is acknowledged when its time is checked and the T button is pressed. The ▶ button takes you back to the menu level without acknowledging the fault.

All fixed faults can also be acknowledged on one go by means of the Alarm reset function in the Monitor menu.

If the automatic alarm acknowledgement has been enabled (SETUP→AutoRst), the faults are acknowledged automatically as soon as they are fixed.



All alarms except pre-insulation (PreInsul) alarm are indicated by the red LED light ALARM, which BLINKS in fault situations and is on STEADILY if the fault has been fixed but not acknowledged (the OLD ALRM mode). The alarms which are related to disconnected measurement wires or internal errors, are indicated also with the red

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STATUS light. The pre-insulation alarm is indicated in the same way with the red LED light WARN.

The insulation resistance fault activates IMMEDIATELY when the measured parameter drops below the alarm limit. The alarms have a five-percent hysteresis. In other words, an alarm becomes active when the set limit is reached, but it is deactivated only when the measured value deviates by 5% in a safe direction from the limit given.

The screen mode of each parameter alternately displays the following:

- On the top row, the value / fault limit of the parameter that caused the fault, and on the bottom row, the current status: OK, ALARM or OLD ALRM
- Fault start time and date

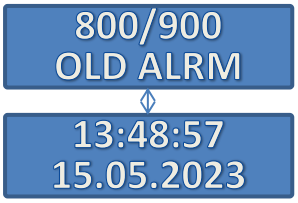
If the fault has been deactivated and becomes active again, the start time of the active fault is displayed. In the OK mode, nothing is displayed in the screen mode.

The screen always displays the measured quantity (the smallest value measured during the fault) / fault limit of the fault first, followed by the fault start time.



The insulation fault alarm is active.

The smallest insulation resistance measured during the fault is 850 kΩ and the alarm limit is 900 kΩ.



The insulation fault alarm has been deactivated but not acknowledged.
The smallest insulation resistance measured during the fault, the alarm limit's set value and the fault start time are displayed.

The **Insulat.** and **PreInsul** alarms are active if the measured insulation resistance is smaller than the alarm or pre-alarm limit.

The **Sys Test** alarm is active if the manual system test fails. In that case, the insulation resistance can not be measured either, so an insulation resistance alarm is also given.

The **Gnd Fail** alarm is active if the TG or MG wire of the IM-04/IM-04_24 unit is disconnected. In that case, the insulation resistance can not be measured either, so an insulation resistance alarm is also given.

The **WireAmpl** or **WireOffs** alarm is activated if the M1 or M2 wire of the IM-04/IM-04_24 unit is disconnected or the insulation resistance is short-circuited. In that case, the insulation resistance can not be measured either, so an insulation resistance alarm is also given.

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SETUP MENU

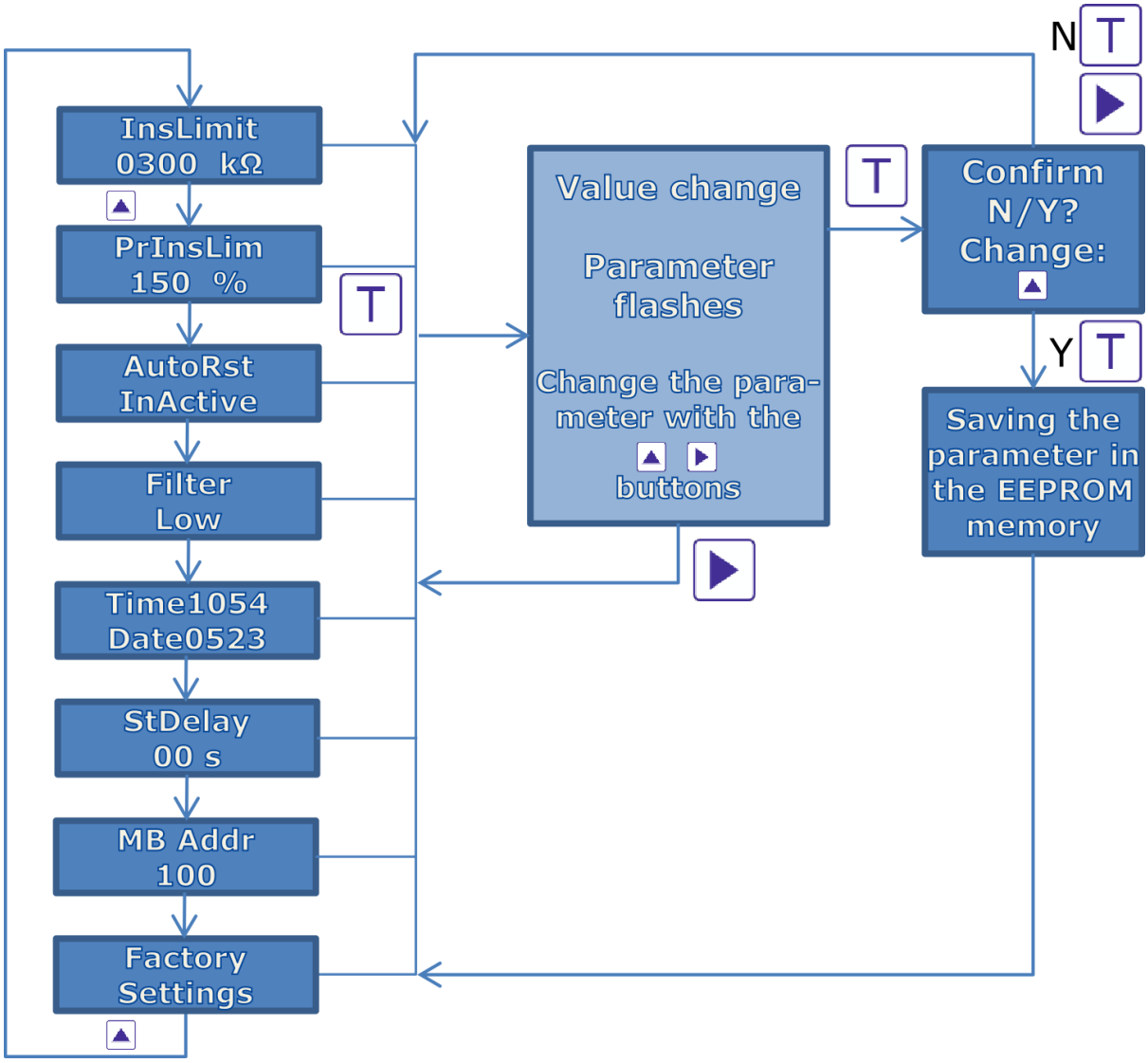
The Setup menu can be used to change system settings, alarm limits, time etc.

The Setup menu is password-protected and accessed as follows:

- Go to the Setup menu in the main menu. The screen displays “Enter Setup”. Press T.
- Change the blinking number with the ▲ button and press the ▶ button to move to the next digit. Enter the three digits and press T. After this, you can navigate the menu with the ▲ button.
- The ▶ button takes you to the initial mode.

The password is “123”.

All information on the settings of the device alarm limits and the system are saved in the internal EEPROM memory of the IM-04/IM-04_24 unit.



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The following parameters can be changed in the Setup menu:

- **INSULATION LIMIT**: Alarm limit of the insulation resistance. If the measured value is lower than the alarm limit, an alarm is given. The setup range is 10…100 kΩ with 10 kΩ intervals and 100 kΩ…1,000 kΩ with 50 kΩ intervals. Factory default value is 300 kΩ.
- **PRE INSULATION LIMIT:** The pre-insulation limit of the insulation resistance. Given as a percentage of the insulation limit. Activates the INS. WARN. relay. The setup range is 100…200%, at 10% intervals. Factory default value is 150%.
- **AUTOMATIC ALARM ACKNOWLEDGEMENT:** This setting determines whether all the alarms shall be acknowledged automatically as soon as they are deactivated.
- **Filter:** Not in use.
- **TIME:** The time and date of the real time clock.
- **START-UP DELAY:** The delay after powering on the unit during which the alarms will not be generated. The setup range is 0…60 s.
- **MODBUS ADDRESS:** The Modbus slave address of the unit. The setup range is 1…247.
- **FACTORY SETTINGS:** Returns all settings to their original values.

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ERRORS

The following table lists the functioning of the IM-04/IM-04_24 unit in various error situations.

Error	IM-04/ IM-04_24 ALARM LEDs	IM-04/ IM-04_24 ALARM menu	Alarm relay
The IM-04/IM-04_24 unit without operating voltage			ALM WRN
Insulation fault (R under InsLimit)	ALARM	Insulat.	ALM
Insulation fault (R under PrInsLim)	WARN	PreInsul	WRN
The IM-04/IM-04_24 unit TG wire is disconnected	STATUS ALARM	Gnd Fail	ALM
The IM-04/IM-04_24 unit MG wire is disconnected	STATUS ALARM	Gnd Fail	ALM
The IM-04/IM-04_24 unit M1 wire is disconnected	STATUS ALARM	WireAmpl, WireOffs	ALM
The IM-04/IM-04_24 unit M2 wire is disconnected	STATUS ALARM	WireAmpl, WireOffs	ALM
System fault (manual test)	STATUS ALARM	Sys Test	ALM

Alarm relays:

- ALM insulation alarm
- WRN insulation pre-alarm

Error situations are displayed by means of ALARM LEDs and the alarm menu of the IM-04/IM-04_24 unit. A blinking LED always means that an alarm is active, and a steady indicator indicates a fixed and unacknowledged fault.

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MODBUS RTU REMOTE CONTROL

When a suitable Modbus address has been set for the IM-04/IM-04_24 unit, the device can be connected to a RS-485 bus. The unit's Modbus RTU slave functionality is now ready for use. The unit's Modbus RTU register map is provided below. The Modbus functions to be used are Read Holding Registers (0x03) and Write Single Register (0x06).

Register	R/W	Name	Type	Unit	Description
1	R	Measured insulation resistance	uint16	kOhm	The measurement result is provided as kOhms. The register value 100 corresponds to insulation resistance of 100,000 ohms. At the fastest, it updates in seconds and at the slowest in hundreds of seconds, depending on the measurement frequency used.
2	R	Measured capacitance	uint16	0.1 uF	The measurement result is provided as 0.1uF intervals. The register value 5 corresponds to capacitance of 0.5uF. It is updated at the same time as the insulation resistance.
5	R/W	Limit parameter of the insulation resistance alarm	uint16	kOhm	Read and written in kOhms. The register value 100 corresponds to 100,000 ohms. The minimum, maximum and interval values are in channels 16, 17 and 18.
6	R/W	The limit parameter of the insulation resistance pre-alarm	uint16	%	Read and written in percentages. The register value 150 corresponds to 150%. The minimum, maximum and interval values are in channels 19, 20 and 21.
10	R/W	Start-up delay, a device parameter	uint16	s	Read and written in seconds. The register value 2 corresponds to 2 seconds. The minimum, maximum and interval values are in channels 31, 32 and 33.
11	R	Password of the local user interface	uint16	none	A three-digit password. Range 000…999. Default value 123. When needed, this can be used to prevent the parameters from being set through the Modbus RTU.
12	R	Device alarm and status register	uint16	none	Bit mask: 0x0001 = a fault or alarm related to insulation resistance, corresponds to the INSULATION alarm LED of the local user interface 0x0002 = insulation resistance pre-alarm 0x0004 = system test fault 0x0008 = fault in the M1 or M2 wire 0x0010 = fault in the TG or MG wire 0x0100 = system test active 0x0200 = internal calibration active (the insulation level measurement values are invalid) the statuses remain active until their cause has been eliminated
13	R/W	Start of the device system test	uint16	none	Start of the system test. Value 1 starts the test, other values are not taken into account. IM-04/IM-04_24 resets the request after reading it.
15	R/W	Joint acknowledgement of alarms	uint16	none	Joint acknowledgement of unacknowledged alarms. Value 1 acknowledges all alarms, other values are not taken into account. IM-04/IM-04_24 resets the request after reading it. This does not acknowledge/inactivate active alarms.
16	R	The lowest allowed value of the limit parameter of the insulation resistance alarm	uint16	kOhm	10
17	R	The highest allowed value of the limit parameter of the insulation resistance alarm	uint16	kOhm	1000

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18	R	The resolution (jog) of the limit parameter of the insulation resistance alarm	uint16	kOhm	50 if insulation resistance alarm limit 100 kOhm or above 10 if insulation resistance alarm limit below 100 kOhm
19	R	The lowest allowed value of the limit parameter of the insulation resistance pre-alarm	uint16	%	100
20	R	The highest allowed value of the limit parameter of the insulation resistance pre-alarm	uint16	%	200
21	R	The resolution (jog) of the limit parameter of the insulation resistance pre-alarm	uint16	%	10
31	R	Start-up delay, the lowest allowed value of the device parameter	uint16	s	0
32	R	Start-up delay, the highest allowed value of the device parameter	uint16	s	60
33	R	Start-up delay, the device parameter resolution (jog)	uint16	s	1
34	R	Status register of the unacknowledged alarms of the device	uint16	none	Bit mask: 0x0001 = a fault or alarm related to insulation resistance is inactivated, corresponds to the INSULATION alarm LED of the local user interface 0x0002 = insulation resistance pre-alarm deactivated 0x0004 = system test fault deactivated 0x0008 = fault in the M1 or M2 wire 0x0010 = fault in the TG or MG wire deactivated the statuses will activate when the corresponding active alarm has been deactivated and remain active until the cause has been acknowledged

TECHNICAL SPECIFICATIONS

IM-04/IM-04_24 UNIT

Voltage ranges

- Operating voltage [U_S]:

IM-04	110…240 VAC, frequency 48…62 Hz 110…300 VDC (use an external fuse Schurter 0001.2503 (T800mA))
IM-04_24	22…27 VDC

- Maximum voltage at the measurement connectors M1 and M2 [U_N]: 300VAC or 300VDC
- Frequency range of the network to be monitored: DC, 10…460Hz
- Input power: 3W. Internal fuse of the operating voltage: 1AT

Monitoring of the insulation level:

- Measurement voltage [U_m]: ± 25Vp
- Highest measurement current ([R_f] = 0 Ω): 165uA
- Measurement circuit resistance: 150kΩ, impedance: 150kΩ (50…400Hz)
- Highest allowed [U_{fg}]: 300V
- Alarm limit [R_{an}]: 10kΩ…1MΩ
- Relative uncertainty:
  - 20kΩ…1MΩ: ±15%
  - 5kΩ…20kΩ: ±3kΩ
- Hysteresis: 5%
- Maximum leakage capacitance: 100 uF
- Start-up delay: 0…60s

Alarm switches

- 5A (NO) / 3A (NC) @ 30VDC for resistive load
- 5A (NO) / 3A (NC) @ 277VAC for resistive load
- Maximum power: 1400VA / 150W (NO) and 850VA / 90W (NC)
- Insulation strength between contacts: 1000VAC 50/60Hz 1 min
- Useful life: 100,000 connections with the maximum nominal load

Serial bus

- RS-485, speed 9600bps, half duplex, Modbus RTU protocol

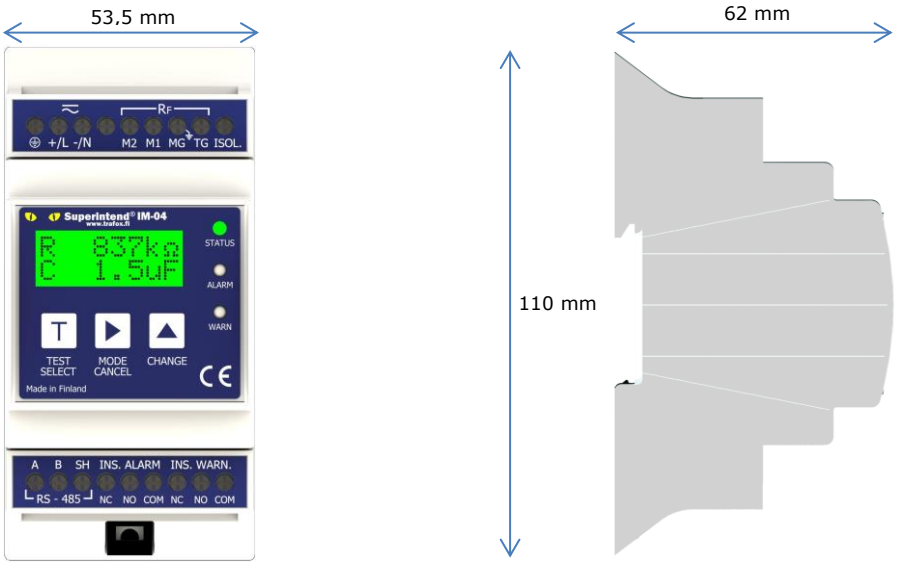
Other details

- Operating temperature: -25…55ºC, relative humidity: < 95%, non-condensing
- Overvoltage category III
- Pollution degree 2
- IP class (front panel): IP40

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- IP class (other casing): IP20
- Connector tightening torque: 0.45…0.5 Nm
- Stripping length: 6,5 mm
- Weight: 180 g
- Not suitable for connecting in parallel
- EMC standards: EN61326-2-4, EN55011, EN61000-4-2, EN61000-4-3, EN61000-4-4, EN61000-4-5, EN61000-4-6, EN61000-4-11
- Other standards: IEC61557-8, IEC61010-1:2010-3

MECHANICAL DIMENSIONS



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