Insulation monitoring device

ISOLGUARD HIG95-DELTA

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Used symbols

Warning, caution

This symbol informs about very important installation and operation instructions of the device or about hazardous situations that may happen during the installation and the operation.

Information

This symbol highlights particularly important characteristics of the device.

Note

This symbol indicates useful additional information.

1 Basic description

The insulation monitoring device produced by HAKEL, type ISOLGUARD HIG95-DELTA, is designed for monitoring the insulation status of single-phase ungrounded IT power supply systems in the health sector. These systems are created by isolation transformers. The device monitors ungrounded systems up to maximum operating voltage 264 V~. Device also allows the evaluation of thermal and current load of the isolation transformer.

The insulation monitoring device enables to display the numeric value of the measured insulation resistance and also current and thermal load of the isolation transformer. Then there are buttons for setting module parameters and signalling LED diodes to display the status of monitored power supply system.

Pair of built-in signalling relays with a switching contact enable remote signalling of the insulation status fault of the monitored system and signalling of the transformer overload fault.

HIG95-DELTA is equipped with RS485 communication bus, which enables connection to the ISOLGUARD master system. This provides remote monitoring of the IT power supply status. It is possible to connect MDS-D module with touch screen display, which serves to display current measured values and current device settings. It is also possible to use remote signalling modules of the MDS-DELTA series.

ISOLGUARD system also includes: isolation transformers, automatic switches of supply systems and auxiliary I/O modules for monitoring logic inputs, e.g. UPS statuses.

Only one insulation monitoring device can be connected to the same ungrounded IT power supply system.

HAKEL ISOLGUARD HIG95-DELTA

Type	Display menu	Signalling relay	Range of displayed value	Critical insulation resistance	Current load sensor	Temperature load sensor	Remote monitoring	Device type IEC 61557-8
HIG95-DELTA	Yes	2x SPST	5 kΩ to 10 MΩ	Adjustable 50 to 500 kΩ	Measuring current transformer with transfer to 5 A	One or two temperature sensors type: PT100 sensor or PTC thermistor or NC sensor	MDS-D MDS-DELTA	AC
Art. no. 70 940								MED

Table 1: Model and article number

Notes: SPST signalling relay with single-pole single-throw contact
MDS-DELTA remote monitoring module
MDS-D remote monitoring module including a display

HIG95-DELTA complies with standards:

- HD 60364-7-710:2012 - Low voltage electrical installations – Medical locations
- IEC 61557-8:2014 - Insulation monitoring devices for IT systems
- IEC 61557-1:2007 - Equipment for testing, measuring or monitoring of protective measures
- IEC 61010-1:2010 - Safety requirements for electrical equipment for measurement, control and laboratory use

Basic characteristics

- Insulation monitoring device for AC systems with voltage 85 to 264 V~, with frequency 50 / 60 Hz for medical ungrounded systems
- Indication of connection loss between monitored power supply and the ground
- Display of the measured insulation resistance value, current load and thermal load of the transformers
- Isolation transformer temperature measurement by using one of the 3 sensor types
- Isolation transformer current load measurement by the measuring current transformer
- Insulation status fault of the monitored power supply signalling relay with switching contact
- Transformer overload fault signalling relay with switching contact
- Connection to RS485 bus, insulation strength 2500 V_{rms} to the internal circuits and network circuits
- Connection to the HAKEL ISOLGUARD system for data collection and display, communication with other MIS parts
- Optional connection of the touch screen panel of HAKEL MDS-D remote monitoring system
- Optional connection of HAKEL MDS-DELTA remote monitoring system
- Optional setting of critical values, hysteresis values and other parameters by device's push-buttons
- Access to the IMD parameter settings with the push-buttons, IMD can be locked/unlocked by the button combination
- 2M (36 mm) device wide for DIN 35 rail assembly

2 ISOLGUARD HIG95-DELTA technical characteristics

Type		ISOLGUARD HIG95-DELTA
Monitored IT power supply system type		AC
Monitored IT power supply nominal voltage [1]	U_n	230 V~, 50 / 60 Hz
Nominal supply voltage [1]	U_s	$U_s = U_n$
Supply voltage range		85 ÷ 264 V~, 50 / 60 Hz
Power consumption	P	max. 4 VA
Measuring circuit		
Measuring voltage	U_m	12 V⎓
Measuring current	I_m	< 0,6 mA
Internal impedance of the measuring input	Z_i	> 1 MΩ
Internal DC resistance	R_i	> 32 kΩ
Delay in response of signalling the insulation status fault	t_{an}	< 5 sec
Leakage capacity	C_e	10 µF
Measuring range	R_F	5 kΩ ÷ 10 MΩ
Measurement accuracy 5 kΩ ... 10 kΩ 10 kΩ ... 900 kΩ 900kΩ ... 10 MΩ		2 kΩ ± 10 % ± 15 %
R_{an} reaction value settings range	R_{an}	adjustable 50 kΩ ÷ 500 kΩ
Monitored insulation resistance hysteresis	R_{hyst}	adjustable 0 ÷ +100 % R_{an}
Delay in response of signalling the insulation status	t_{ON}	adjustable 0 ÷ 60 sec, with a 1 sec step
Measuring principle		DC voltage 12 V, plus pole connected to a FE terminal
Transformer overload evaluation		
Current load measurement	CT_{type}	By measuring transformer with a transmission ratio:
		OFF / 25/5 A / 30/5 A / 50/5 A / 100/5 A / Adjustable in range 5/5 A to 100/5 A
Displayed current load value's range	I_{it}	0,5 A–100 A (depending on the type of the measuring transformer)
Critical current load value	I_{crit}	Adjustable according to measuring current transformer type with 1 A step, see I_{crit} value range for measuring transformers table
Current load hysteresis	I_{hyst}	adjustable 0 ÷ 20 % I_{crit}
Measurement accuracy of the current load		± 5 % (measuring transformer inaccuracy not included)
Max. input power of the current load [2]		360 mVA
Delay in response of signalling the current fault	I_{tON}	adjustable 0 ÷ 60 sec, with a 1 sec step
Isolation transformer temperature sensor	ϑ_{sensor}	1 to 2 NC sensors or 1 to 2 PTC thermistors or 1 to 2 PT100 sensors
Type and number of the temperature sensors selection, both sensors must be the same type		adjustable on the menu
Displayed isolation transformer temperature range	ϑ_1, ϑ_2	5 ÷ 220 °C (for PT100 only)
Critical value of the isolation transformer temperature	ϑ_{crit}	for PT100 adjustable in the range 50 ÷ 130 °C for PTC thermistor 1.6 kΩ is the threshold level for NC sensor 1.6 kΩ is the threshold level
Hysteresis of the isolation transformer temperature	ϑ_{hyst}	adjustable 0 ÷ 20 % ϑ_{crit} (for PT100 only)
Measurement accuracy of the isolation transformer temperature		± 5 % (sensor inaccuracy not included)
Delay in response of signalling the temperature fault	ϑ_{tON}	adjustable 0 ÷ 60 sec, with 1 sec step

Table 2: HIG95-DELTA technical parameters, part 1

Notes:

1. *Device is supplied by the monitored IT power supply system.*
2. *Recommended cross-section and length of wires for connection to current transformer is in table*

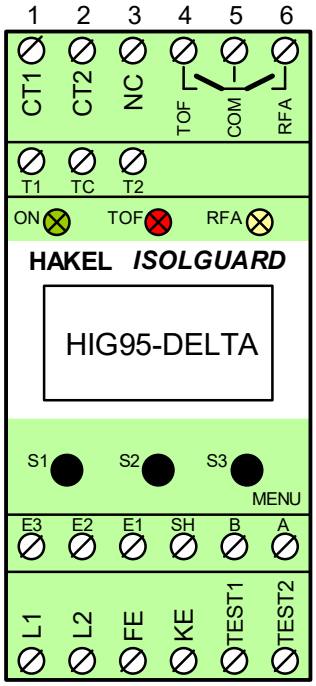
Outputs		
Two signalling switching contacts with optional position NO or NC Insulation barrier to the internal circuits Insulation barrier to the supply circuits		24 V~ / 1 A 30 V⎓ / 1 A 3000 V~ / 1 min. 3000 V~ / 1 min.
Remote monitoring		ISOLGUARD RS485 communication line with a possible connection of remote monitoring modules MDS-D and MDS-DELTA produced by HAKEL
Communication line: RS485 type MASTER-SLAVE, 9600 Bd, even count parity Insulating barrier to the internal circuits and to the network circuits		Yes 2500 V~ / 1 min.

General data		
Degree of protection according to IEC 60529		front panel IP40 covers except front panel IP20
Degree of protection provided by the cover		IK07
Weight	m	154 g
Housing material		PA – UL 94 V0
Method of assembly		DIN rail 35
Recommended cross-section of connected wires	S	1 mm^2
Recommended fuse		6 A / gG
Maximum cross-section of connected wires	S_{max}	2.5 mm^2
Minimum cross-section of connected wires	S_{min}	0.5 mm^2
Maximum tightening torque		0.5 Nm
Wire stripping length		7.6 mm
Article number		**70 940**

Operating conditions	
Operating temperature	-15 °C ÷ +60 °C
Storage temperature	-25 °C ÷ +70 °C
Shipping temperature	-25 °C ÷ +70 °C
Altitude	Up to 2000 m a.s.l.
Protection class	II according to IEC 61140:2016
EMC	EN 61326-2-4
Overvoltage category	III, according to IEC 60664-1:2007
Pollution degree	2, according to IEC 60664-1:2007
Working position	any
Operation type	permanent

Table 3: HIG95-DELTA technical parameters, part 2

3 HIG95-DELTA controls and connecting terminals



Picture 1: Terminal designation

Green indicator lamp ON

This control lights up when the device is ON (powered). It glimmers slightly after module activation and flashes in the event of a fault.

Red indicator lamp TOF

The light signals thermal or current transformer overload, TOF fault. Thermal overload means that one of the measured temperature values of the isolation transformer is higher than maximal set value ϑ_{crit} or one of the isolation transformer temperature sensors is disconnected. Current overload means that measured current load value of the isolation transformer is higher than set critical value I_{crit}. This status is also signalled by TOF relay contact.

Yellow indicator lamp RFA

The light signals RFA fault, when the measured insulation resistance value R_F is lower than set critical resistance value $R_{an.}$ This status is also signalled by *RFA* relay contact.

Display unit

It serves to display the measured values to shows function of the S1 – S3 push-buttons, to set the parameters and to displays information. For description of displayed information, see page 14 "*Displayed information".*

Display will go off if no button is pressed during a 5-minute period and will be restored by pressing any button. The insulation monitoring device operates even if the display is not active.

Left push-button S1

This is a module control button whose meaning in each menu is shown on the display. When the main screen viewed, this button has the meaning of device's TEST push-button and invokes the internal device function test, power supply insulation status test evaluation and also thermal and current load evaluation test of the isolation transformer. See page 14, "*Displayed information*".

Middle push-button S2

This is a module control button whose meaning in each menu is shown on the display. Display of the measured values allows switching between measured R_F, I_{it}, ϑ_1, ϑ_2 values.

Right push-button S3 MENU

This is a module control button whose meaning in each menu is shown on the display. When the main screen viewed, it activates the parameter settings menu.

Within the parameter settings menu, the prolonged pressing of this push-button terminates the data entering with memorizing the new value, whereas the short pressing of this push-button causes exit from the menu without memorizing the new parameter value.

Terminals L1, L2

Connection of the monitored IT power supply and also supply voltage of the device. Possible voltage range is 85 ÷ 264 V~, 50 / 60 Hz.

Terminals FE a KE

Input terminals for functional connection to PE bridge to evaluate insulation status of the monitored power supply. Both terminals have to be connected by separate conductor, see recommended connection of the device.

Terminals T1, TC, T2

Input terminals for temperature sensor of the isolation transformer. Temperature sensor PT100 or PTC thermistor or NC sensor is connected between T1-TC terminals and T2-TC terminals. The type of the temperature sensor must be set in the menu ϑ_{sensor}. If two temperature sensors are used, both must be the same type. It is recommended to use wire with minimum cross-section 1,5 mm^2.

Terminals TEST1 and TEST2

Terminals for connection with the remote test push-button. Remote test push-button is connected between *TEST1* and *TEST2* terminals. See recommended connection of the device.

Terminals CT1, CT2

Input terminals for sensor of the current load of the isolation transformer. The secondary winding of the current transformer is connected to these terminals. Maximum input current of these terminals is 6 A. The insulation monitoring device always uses current transformer with 5 A output.

Terminals of the signalling relays RFA, TOF

Two potential-free switching contacts with common supply COM for signalling the status of the monitored IT power supply system. Terminals load capacity is 24 V~ / 1 A or 30 V⎓ / 1 A. *TOF* and *RFA* relays are both set to the position open or close when fault occurs according to setting in service menu *Set RFA/TOF*. Relays are released when the device is connected to the power supply and is functional (the indicator lamp *ON* glimmers slightly). *RFA* relay is set on insulation status fault. *TOF* relay is set on current or thermal overload of the isolation transformer.

Terminals E1, E2, E3

Terminals are used for connection of additional modules, typically HIG-IFL DELTA fault location module. The connection of HIG95-DELTA and HIG-IFL DELTA fault location is described on page 22.

Terminals A, B, SH

Terminals intended for connection of galvanic isolated RS485 ISOLGUARD communication line. Each insulation monitoring device is connected with twisted pair between *A* and *B* lines. The *SH* terminal serves for connection of signal grounds by the interconnecting cable, see recommended connection of the device, page 9. For description of the communication line see page 32.

Terminal NC

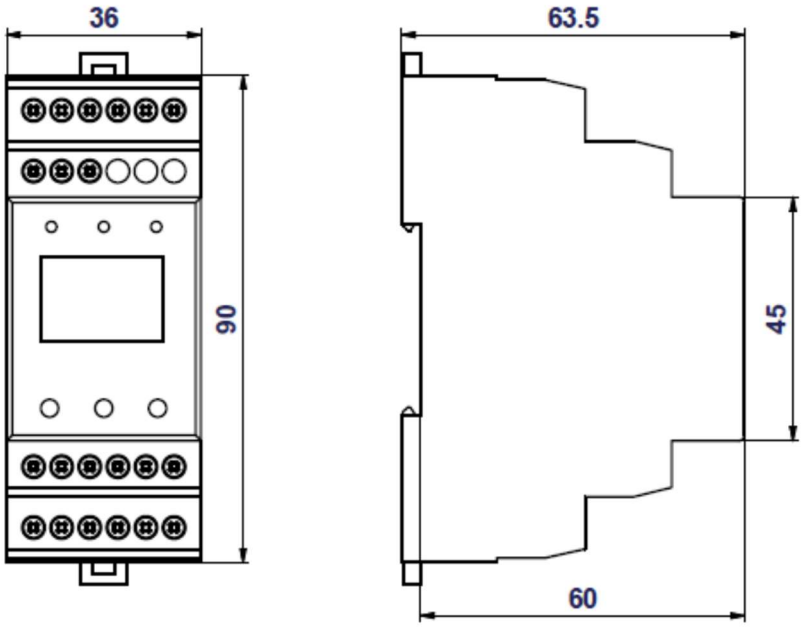
Terminal without connection (Not Connected) and cannot be connected in the application.

4 HIG95-DELTA device installation

Operation, installation and maintenance can be done only by qualified personnel according to assembling and safety regulations. If the device is used in the way not specified by the producer, protection provided by the device could be disrupted.

HIG95-DELTA is designed for assembling on 35 mm DIN rail according to IEC 715:1981. Any working position.

5 HIG95-DELTA device dimensions



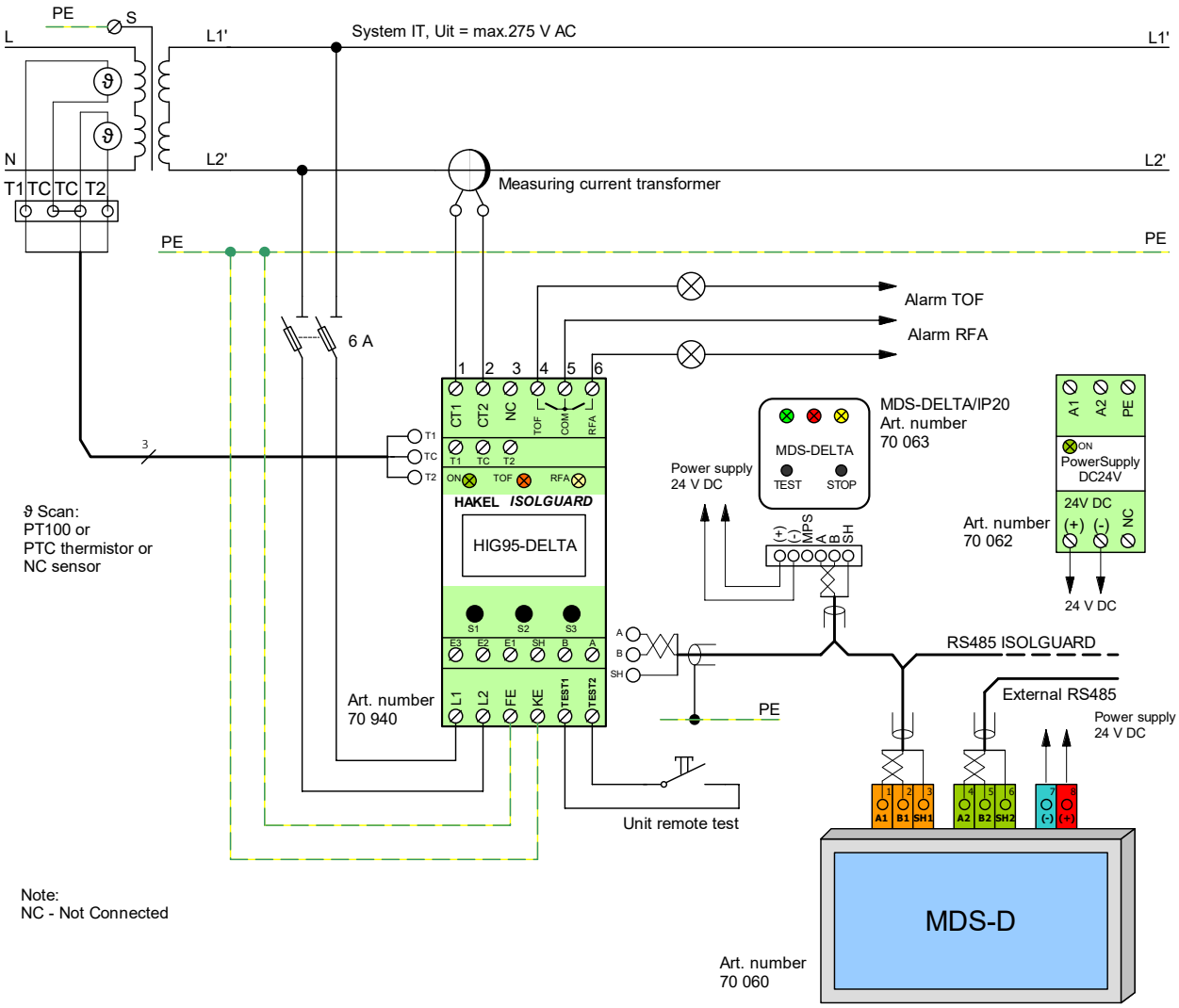
Picture 2: Device dimensions (mm)

6 Recommended connection of HIG95-DELTA to the monitored IT power supply system

Operation, installation and maintenance can be done only by qualified personnel according to assembling and safety regulations. If the device is used in the way not specified by the producer, protection provided by the device could be disrupting.

6.1 Connection with MDS-D remote monitoring module

IT power supply system 2PE~50Hz, 230V/IT with insulation monitoring device HIG95-DELTA and MDS-D and MDS-DELTA remote monitoring modules connection diagram.



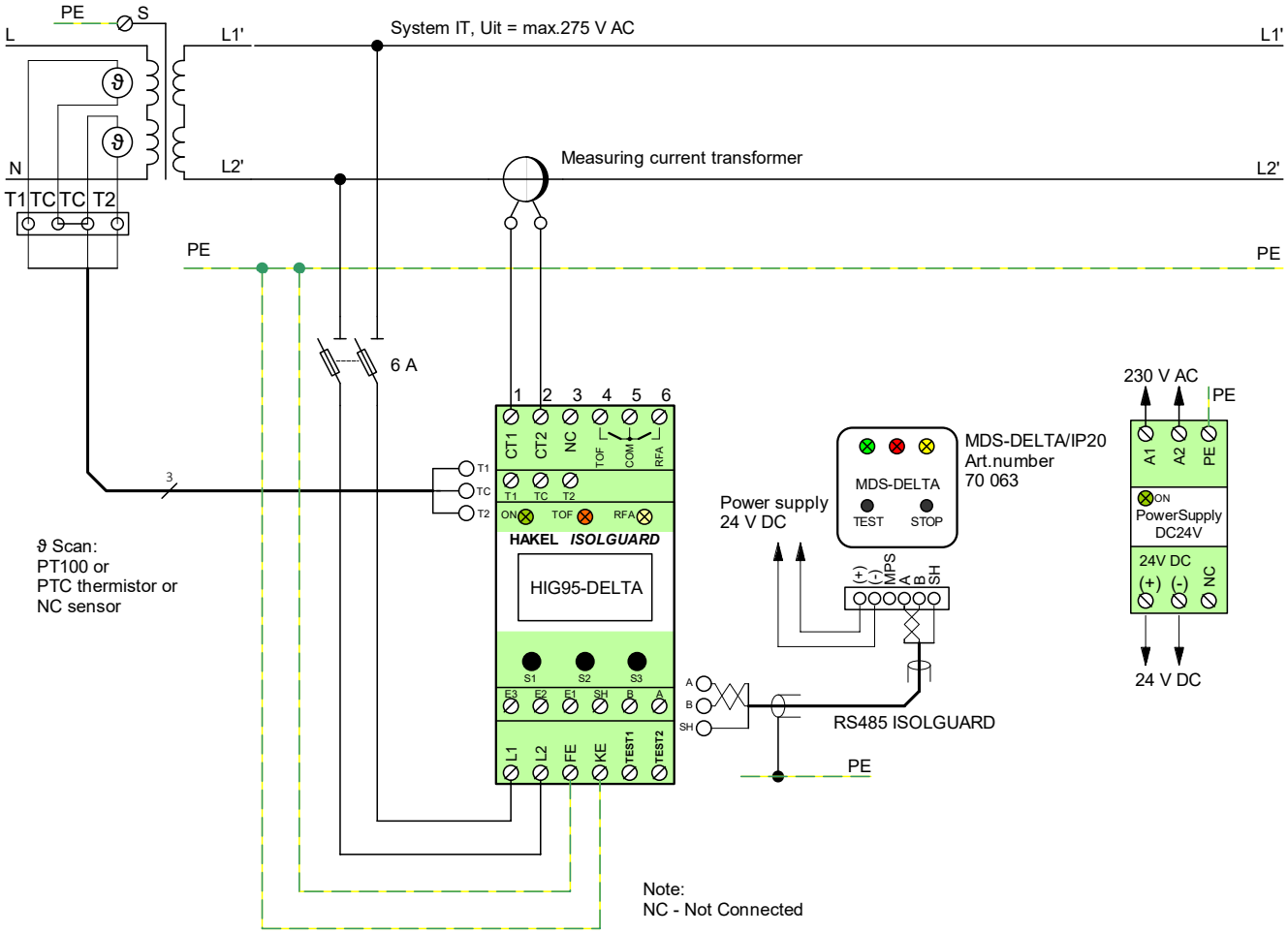
Picture 3: HIG95-DELTA with MDS-D module

Notes:

1. *Type of measuring current transformer should be selected according to table "I_{crit} values range for measuring current transformers" (page 34) and used isolation transformer.*
2. *Recommended cross-section and length of wires for connection to the current transformer is in table "Maximum length of wires for connection to the current transformer" (page 34).*
3. *Several MDS-DELTA modules can be connected to the device.*
4. *Terminals FE and KE must be connected by separate conductors to the to the PE bridge.*
5. *NC (Not Connected) this terminal should not be connected.*
6. *Recommended types and values of cable for the ISOLGUARD RS485 bus are listed in the MDS-D module instruction manual.*
7. *When using a shielded cable for the ISOLGUARD RS485 bus, bus shielding must be connected across whole length and grounded at one point.*
8. *It is necessary to follow a linear wiring of the ISOLGUARD RS485 bus, any taps are not allowed.*
9. *Install only one cable type along the whole length of the bus.*

6.2 Connection with MDS-DELTA remote monitoring module

IT power supply system 2PE~50Hz, 230V/IT with insulation monitoring device HIG95-DELTA and MDS-DELTA remote monitoring module connection diagram.



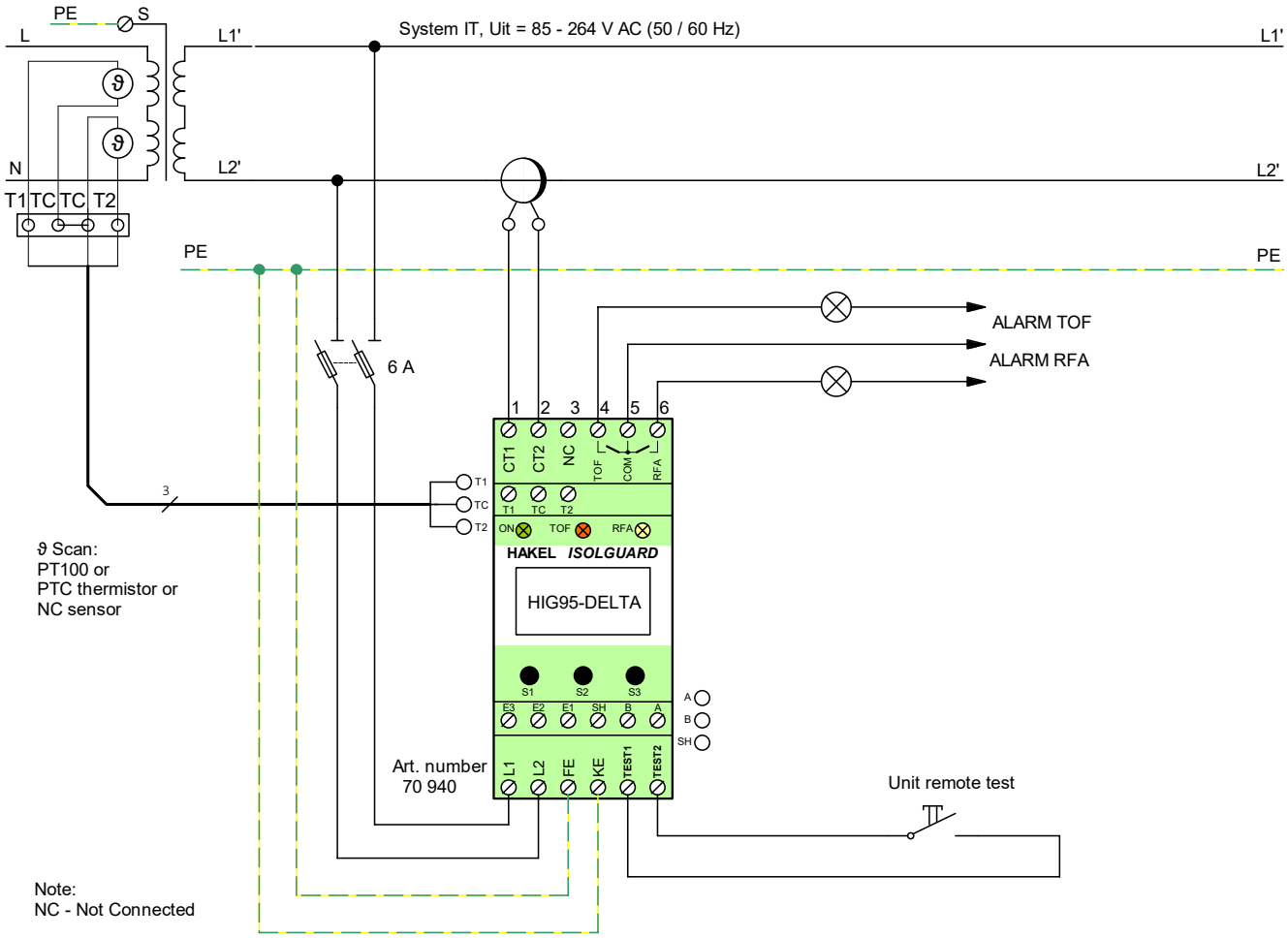
Picture 4: HIG95-DELTA with MDS-DELTA module

Notes:

1. *Type of measuring current transformer should be selected according to table "I_{crit} values range for measuring current transformers" (page 34) and used isolation transformer.*
2. *Recommended cross-section and length of wires for connection to the current transformer is in table "Maximum length of wires for connection to the current transformer" (page 34).*
3. *Several MDS-DELTA modules can be connected to the device.*
4. *Terminals FE and KE must be connected by separate conductors to the to the PE bridge.*
5. *NC (Not Connected) this terminal should not be connected.*
6. *Recommended types and values of cable for the ISOLGUARD RS485 bus are listed in the MDS-DELTA module instruction manual.*
7. *When using a shielded cable for the ISOLGUARD RS485 bus, the shielding must be connected across whole length and grounded at one point.*
8. *It is necessary to follow a linear wiring of the ISOLGUARD RS485 bus bar, any taps are not allowed.*
9. *Install only one cable type along the whole length of the bus.*

6.3 Connection with contact status signalling

IT power supply system 2PE~50Hz, 230V/IT with insulation monitoring device HIG95-DELTA with contact status signalling and remote test push-button connection diagram.



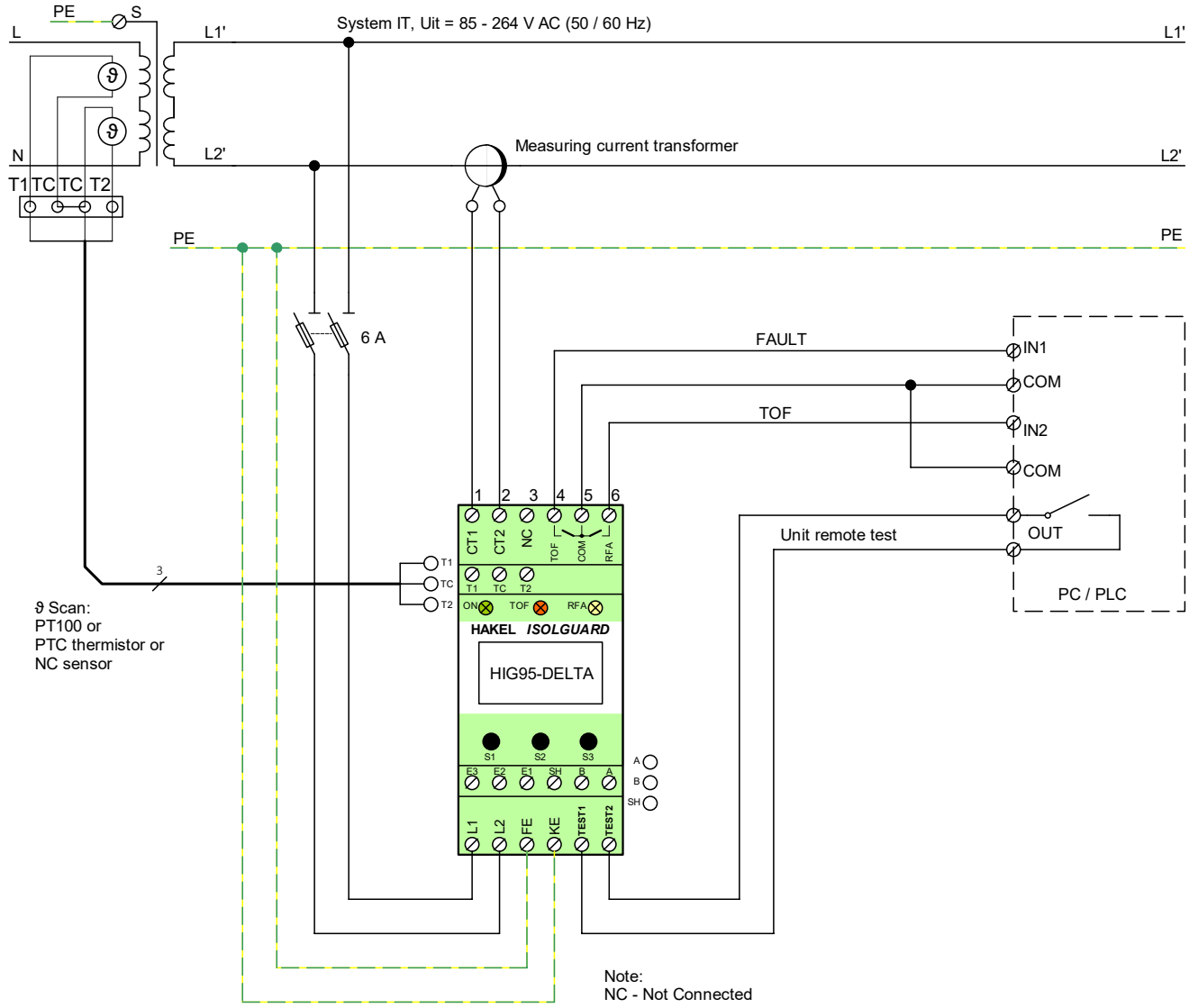
Picture 5: HIG95-DELTA contact status signalling

Notes:

1. *Type of measuring current transformer should be selected according to table "I_{crit} values range for measuring current transformers" (page 34) and used isolation transformer.*
2. *Recommended cross-section and length of wires for connection to the current transformer is in table "Maximum length of wires for connection to the current transformer" (page 34).*
3. *Terminals FE and KE must be connected by separate conductors to the to the PE bridge.*
4. *NC (Not Connected) this terminal should not be connected.*

6.4 Connection with PLC type control unit

IT power supply system 2PE~50Hz, 230V/IT with insulation monitoring device HIG95-DELTA and with control unit connection diagram.



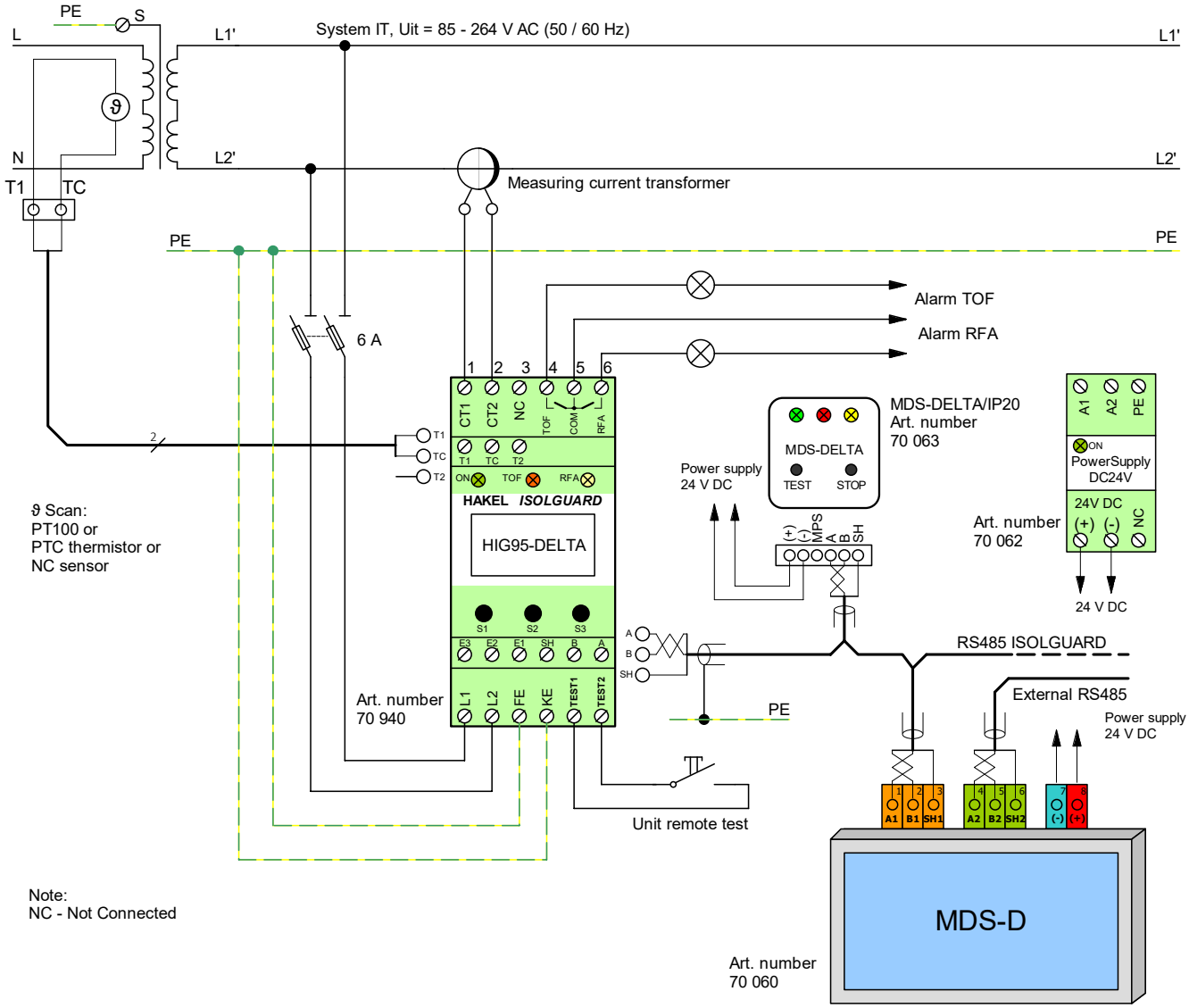
Picture 6: HIG95-DELTA connection with control unit

Notes:

1. *Type of measuring current transformer should be selected according to table "I_{crit} values range for measuring current transformers" (page 34) and used isolation transformer.*
2. *Recommended cross-section and length of wires for connection to the current transformer is in table "Maximum length of wires for connection to the current transformer" (page 34).*
3. *Terminals FE and KE must be connected by separate conductors to the to the PE bridge.*
4. *NC (Not Connected) this terminal should not be connected.*

6.5 Connection with MDS-D remote monitoring module

IT power supply system 2PE~50Hz, 230V/IT with insulation monitoring device HIG95-DELTA and MDS-D and MDS-DELTA remote monitoring modules and with one temperature sensor connection diagram.

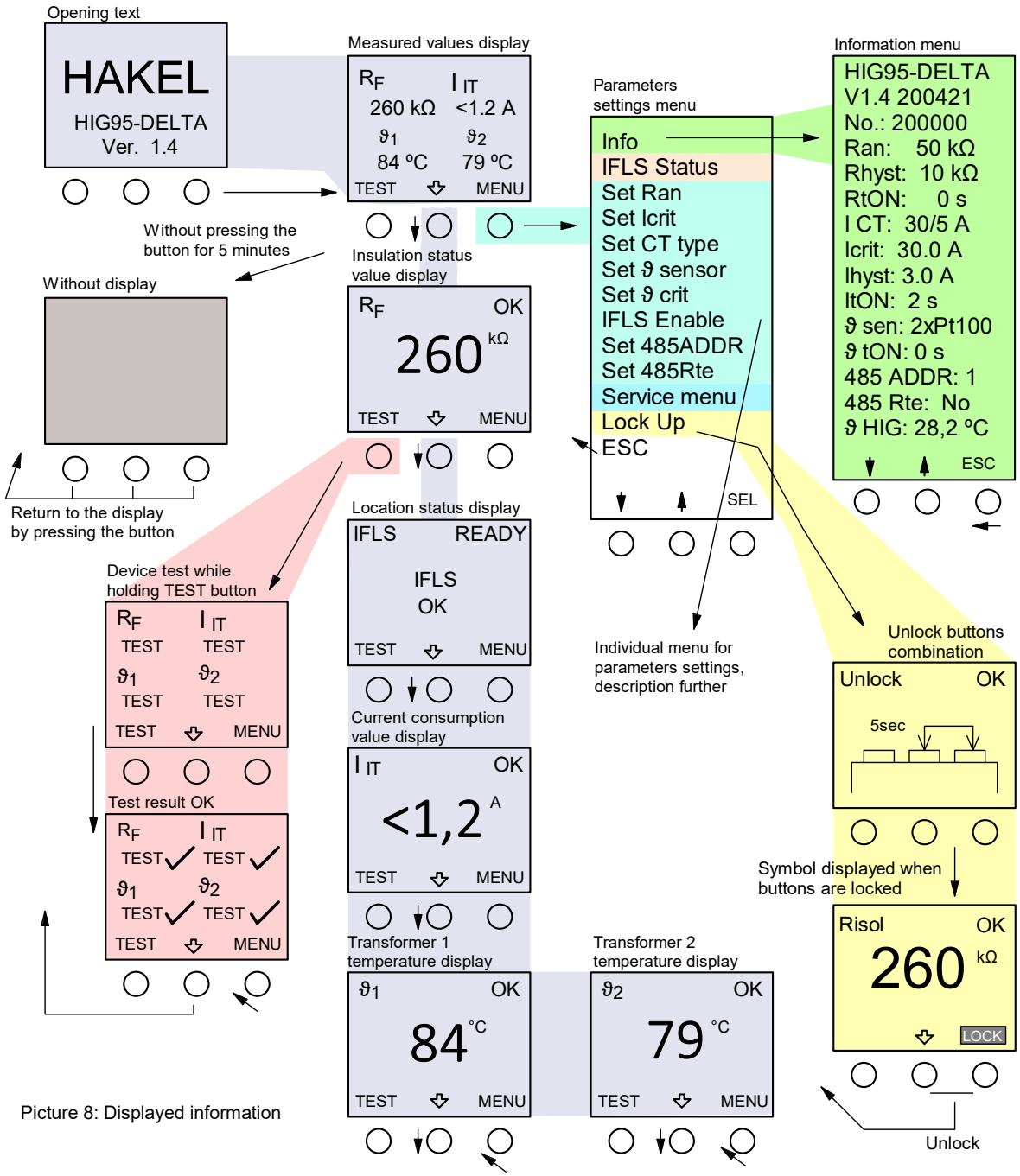


Picture 7: HIG95-DELTA with MDS-D and MDS-DELTA module

Notes:

1. *Type of measuring current transformer should be selected according to table "I_{crit} values range for measuring current transformers" (page 34) and used isolation transformer.*
2. *Recommended cross-section and length of wires for connection to the current transformer is in table "Maximum length of wires for connection to the current transformer" (page 34).*
3. *Several MDS-DELTA modules can be connected to the device.*
4. *Terminals FE and KE must be connected by separate conductors to the to the PE bridge.*
5. *NC (Not Connected) this terminal should not be connected.*
6. *Recommended types and values of cable for the ISOLGUARD RS485 bus are listed in the MDS-D module instruction manual.*
7. *When using a shielded cable for the ISOLGUARD RS485 bus, bus shielding must be connected across whole length and grounded at one point.*
8. *It is necessary to follow a linear wiring of the ISOLGUARD RS485 bus, any taps are not allowed.*
9. *Install only one cable type along the whole length of the bus.*

7 Displayed information



Picture 8: Displayed information

Operating principles

- The function of each push-button is shown on the display in all menus.
- By pressing the *MENU* push-button you enter into the parameter setting menu.
- Pressing the *SEL* push-button activates transition to the inversely displayed parameter settings menu.
- Short pressing the *ESC/SET* push-button causes exit from the menu without memorizing the new parameter value.
- Prolonged pressing the *ESC/SET* push-button causes memorizing the new parameter value and then exit from menu.
- When no push-button is pressed within 30 seconds, the new value setting menu will be automatically terminated.
- When no push-button is pressed within 5 minutes, display goes OFF.
- The insulation monitoring device is operational even if there is nothing shown on the display (display is not active).
- The display is recovered by pressing any of the push-buttons below the display.
- The display is also restored by pressing external remote test button.
- The unlocking of the device's control buttons is realized while holding the middle and right button for 5 seconds.

7.1 Information on the HIG95-DELTA display

Introductory text

It is displayed for a short time after switching ON the module. The name of the module and software version is displayed. After the measuring has started, the measured values are displayed automatically.

Measured values display

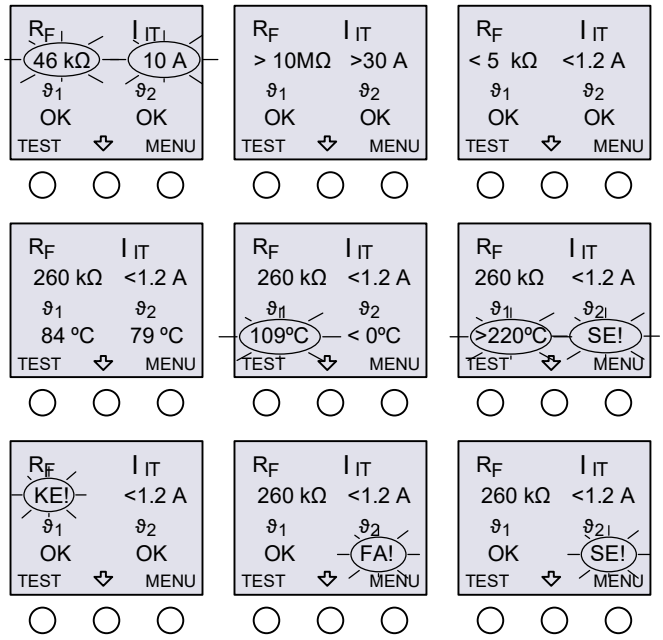
All values measured by the device according to its settings are displayed. Meaning of the values ***R_F / I_{it} / ϑ_1 / ϑ_2*** is listed below. Display of all possible monitored data, including localization status, is indicated on the Picture 8: . Some data may not be displayed according to specific settings.

Measured value of insulation resistance R_F is displayed in a measured values range in units of kΩ or MΩ. R_F value flashes when insulation status fault occurs. Flashing text "*PE*" is displayed while a connection fault of *FE* and *KE* terminals to the *PE* bridge occurs. Current consumption value is displayed in a range of used measuring current transformer, see *Table 9*. I_{IT} value flashes when the limit value is exceeded.

It is possible to select type and number of temperature sensors of the isolation transformer in the settings menu, *Set ϑ sensor* item. The type of sensor can be PT100, PTC thermistor or NC sensor. If two sensors are used, both must be the same type.

Display of the isolation transformer thermal load depends on the used sensor type. Temperature value, which flashes when critical value is exceeded, is displayed in a range 5 to 220 °C while using PT100 sensor. Text "*SE!*" is displayed while sensor connection fault evaluation.

Text *"OK"* is displayed in no overload status while using PTC thermistor or NC sensor. Text "*FA!"* is displayed if overload is evaluated.



Picture 9: Summary display of measured values

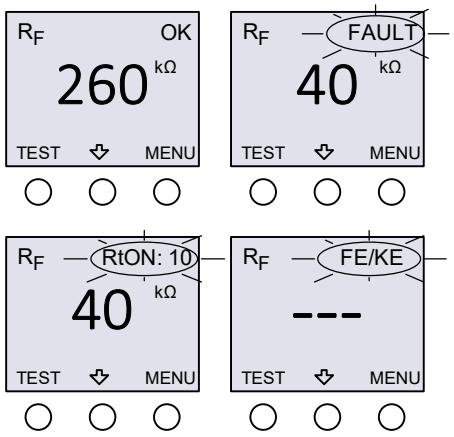
Display of R_F – Measured value of insulation resistance

It is displayed in a range as specified in the table of technical characteristics in units of kΩ or MΩ. Pressing *TEST* push-button activates test of the device, pressing *MENU* push-button invokes parameter settings menu. Middle push-button changes ***R_F*** display to display the value of additional data.

The insulation status is indicated by the text *OK* or *FAULT*. If there is no insulation status fault in the monitored power supply system, *OK* is displayed. If there is a fault signalled, flashing *FAULT* is displayed.

In a case the non-zero value for the ***R_{tON}***, time until the resistance fault is signalled, is set, then when ***R_F*** decreases below the ***R_{an}*** value the countdown of the time ***R_{tON}*** starts. The display shows the time until fault is signalled by flashing text *RtON: xx*. After the time ***R_{tON}*** is expired, the fault is signalled. ***R_{tON}*** time is set in service menu.

Flashing text *FE/KE* signals fault of the *FE* or *KE* terminal connection to PE bridge. At the same time, insulation status fault is signalled. Insulation resistance value is not displayed.



Picture 10: Display of insulation resistance value

Display of IFLS status – evaluation of the place localization of insulation fault in individual circuits

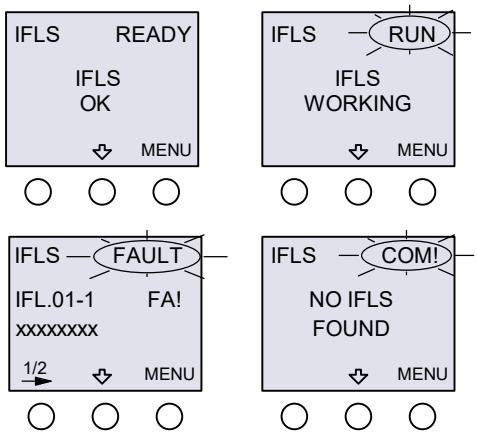
Status of the fault location device (IFLS) is displayed. Connection status is displayed by a text "*IFLS OK"*, when monitored power supply is without insulation status fault.

After the fault evaluation, the localization of circuit with the occurrence of the insulation status fault is started. The text "*IFLS WORKING"* and flashing text *"RUN"* are displayed.

After localization is complete, information about *IFL* module number and about number of *IN* input with founded insulation status fault is displayed. For the first *IFLS* module and *IN1* input text *IFL.01-1* is displayed. Also, circuit label text, set by the user is displayed. For example, see picture on the right, text IN1.1.

If the insulation status fault is found on multiple circuits, it is possible to sequentially display numbers and designations of all the circuits by the left push-button.

When communication with the fault location device (IFLS) is lost, text "*NO IFLS FOUND*" is displayed.

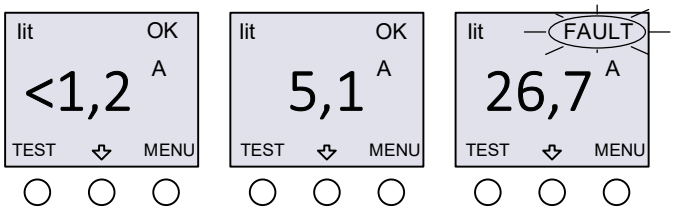


Picture 11: Display of IFLS status

Display of I_{it} – Measured value of transformer current load

The value of current flow ***I_{it}*** is displayed. Measuring current transformer transfer ratio, set in the menu, is considered. Therefore, the real value of the current is displayed.

HIG module test starts by pressing the ***TEST*** push-button. Pressing the ***MENU*** push-button displays the user menu. Middle push-button changes ***I_{it}*** display to display the value of following data.



Picture 12: Display of current consumption

The transformer current overload fault is signalled by the text *OK* or *FAULT*. If there is no fault in current overload, *OK* is displayed. If there is a fault signalled, flashing text *FAULT* is displayed.

In case the non-zero value for the ***I_{tON}***, time until current fault signalling, is set, then if ***I_{it}*** exceeds the ***I_{crit}*** value the countdown of the time ***I_{tON}*** starts. The display shows the time until fault signalling. After the time ***I_{tON}*** is expired, the fault is signalled. ***I_{tON}*** time is set in service menu.

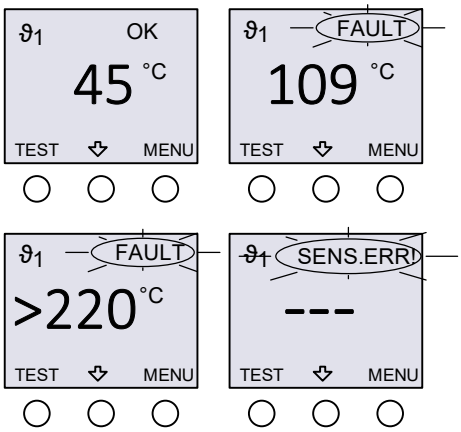
Display of ϑ_1 – Measured value of transformer temperature by T1 sensor

The actual value of the isolation transformer temperature ***ϑ_1*** is displayed. Displayed data depends on the temperature sensor type. HIG module test starts by pressing the ***TEST*** push-button. Pressing the ***MENU*** push-button displays the user menu. Middle push-button changes ***ϑ_1*** temperature display to display the value of another data.

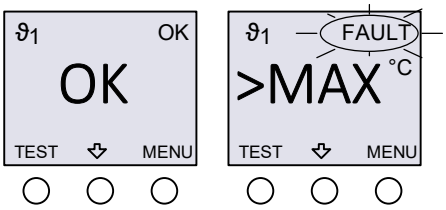
In the device menu, *Set ϑ sensor* item, the type and number of isolation transformer temperature sensors can be selected. PT100 sensor, PTC thermistor or NC sensor can be used. It is possible to use one or two sensors, but both must be the same type.

The actual measured temperature value in Celsius degrees is displayed, in the range defined in the technical data table, when using PT100 sensor.

In case the non-zero value for the ***ϑ_{tON}***, time until temperature fault signalling, is set, then if ***ϑ_1*** exceeds the ***ϑ_{crit}*** value the countdown of the time ***ϑ_{tON}*** starts. The display shows the time until fault signalling. After the time ***ϑ_{tON}*** is expired, the fault is evaluated. ***ϑ_{tON}*** time is set in service menu. Flashing text *"FAULT"* is displayed when exceeding critical temperature value. Flashing text *"SENS.ERR!"* is displayed when sensor connection fault is evaluated.



Picture 13: Display of transformer temperature – PT100 sensor



When using PTC thermistor or NC sensor, text *"OK*" is displayed, if there is no overload. Text ">MAX" is displayed if overload is evaluated.

Picture 14: Display of transformer temperature – PTC thermistor, NC sensor.

Display of ϑ_2 – Measured value of transformer temperature by T2 sensor

Display of temperature ϑ_2, measured by the T2 sensor, is the same as temperature ϑ_1 display. Middle push-button changes ϑ_2 display to display all measured values.

Information menu

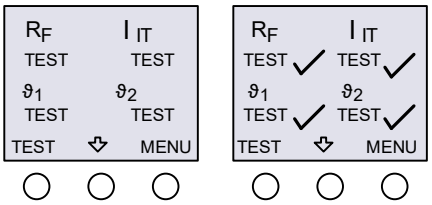
Operation program version of the HIG95-DELTA, serial number and main set parameters of device operation is displayed. For exit press the ***ESC*** button. Line with text *ϑHIG:* shows the temperature inside the device.

Insulation monitoring device test

Device test and insulation status fault evaluation tests, transformer current and thermal overload test are executed by pressing the ***TEST*** push-button on the device. This push-button provides device test and invokes insulation status fault and transformer overload fault.

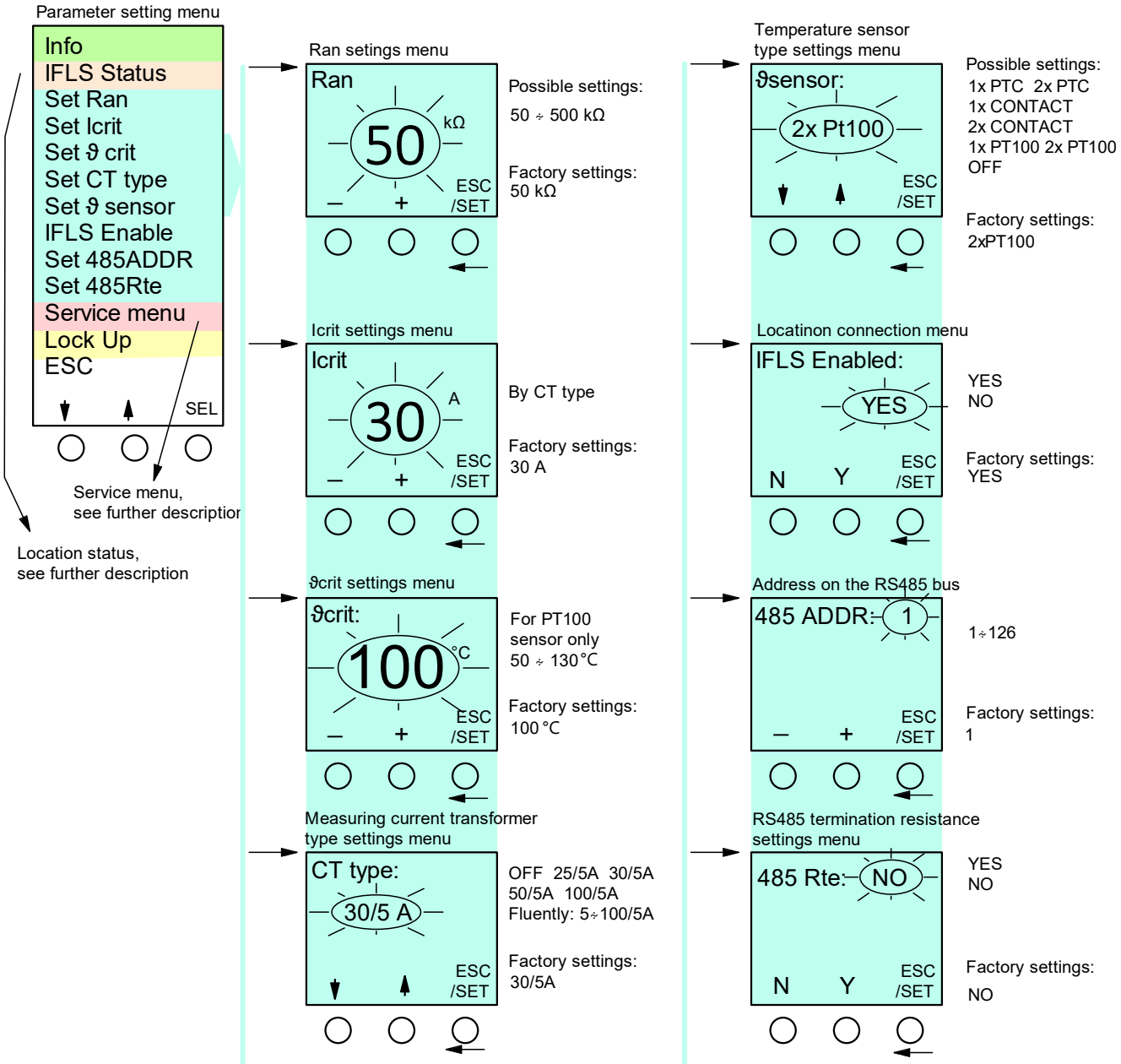
The device can be also tested by pressing the external remote test push-button, by the MDS-D and MDS-DELTA remote monitoring modules or via RS485 communication line and corresponding order.

Testing of the insulation monitoring device is performed for at least 10 seconds or during the time of holding the button. Test process is displayed. The fault is signalled on the indicator lamp and *RFA* and *TOF* relays. Measured values are not displayed during the test. Test result is displayed after test realization. Device test does not affect the insulation resistance of the measured power net.



Picture 15: Device test display

7.2 Users parameter settings menu



Picture 16: Users parameter settings menu

The following menu can be selected by using push-buttons arrow up and down:

- Main device parameters menu ***Info***
- Monitored critical resistance value, menu ***Set R_{an}***
- Monitored critical current load value, menu ***Set I_{crit}***
- Monitored critical thermal load value, menu ***Set $\vartheta_{crit.}$*** Menu is shown only if PT 100 sensor is selected.
- Transfer ratio of measuring current transformer, menu ***Set CT type***
- Temperature sensor type, menu ***Set ϑ_{sensor}***
- Connection of device to locate a fault of insulation fault location module, ***IFLS Enabled***
- Device address for communication via RS485 line, menu ***Set 485ADDR***
- Connection of RS485 line's terminating resistance (see page 32), menu ***Set 485Rte***
- Enter to the service (advanced) parameters menu, ***Service menu***
- Control buttons lock, menu ***Lock Up***

For initiating of all menus use the push-button ***SEL*** and for exit select ***ESC***.

Menu Set R_{an}

New value of the critical insulation resistance is set in kΩ by pressing or holding the **+** or **–** buttons. The value can be set in the range from 50 kΩ to 500 kΩ. New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and R_{an} value remains unchanged.

Menu Set I_{crit}

New value of the critical current load value of the isolation transformer is set in Amperes by pressing or holding the **+** or **–** buttons. The value can be set in a range as described in the table I_{crit} values range settings for current measuring transformers. I_{crit} limit value is determined by selected measuring current transformer's conversion ratio. New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and I_{crit} value remains unchanged.

Menu Set ϑ_{crit}

Setting ϑ_{crit} parameter can be done only if PT100 sensor is selected. New value of the critical thermal load value of the isolation transformer is set in Celsius degrees by pressing or holding the **+** or **-** buttons. The value can be set in a range as described in the technical data table. New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and ϑ_{crit} value remains unchanged.

When using PTC thermistor or NC sensor the value ϑ_{crit} is determined by used sensor and the item for setting ϑ_{crit} is not displayed in the menu. Decision level is in this case fixed at 1,6 kΩ resistance value (T1-TC and T2-TC terminals). At a higher value than 1,6 kΩ, the thermal load fault is signalized.

Menu Set CT type

Menu enables to change conversion ratio value setting of the measuring current transformer. Conversion ratio must be same as conversion ratio of the installed measuring current transformer. Conversion ratio *25/5A*, *30/5A*, *50/5A*, and *100/5A* can be selected directly. Menu X/5A is ready for setting different conversion ratio value and enables setting of any transmission ratio in a range *5/5A* to *100/5A.* Current load measuring is cancelled by selecting *OFF* and **the device does not provide and signal current overload of the isolation transformer**. New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and the value remains unchanged.

Menu Set ϑ_{sensor}

Menu selects the type of the isolation transformer's thermal load sensor for both inputs. Input terminals for thermal sensors are T1-TC and T2-TC. It is possible to select type and number, one to two, of isolation transformer's thermal sensor. PT100 sensor (measurement in Celsius degrees) or PTC thermistor (ON/OFF signalization type) or NC sensor (ON/OFF signalization type) can be selected. Selected sensor type must match the sensors built into the isolation transformer. Both connected sensors must by the same type. Thermal load measuring is cancelled by selecting *OFF* and **the device does not provide and signal thermal overload of the isolation transformer**. New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and the value remains unchanged.

Menu IFLS Enabled

This menu enables or disables the function of insulation fault location system (IFLS). If the menu ***IFLS Enabled*** is set to ***YES***, the IFLS system is active. If the insulation state fault occurs, the connected module HIG-IFL DELTA starts to locate the insulation fault. The reaction to end of insulation state fault can be delayed. If the menu ***IFLS Enabled*** is set to ***NO***, the function of IFLS is disabled. New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and the value remains unchanged.

Menu Set 485ADDR

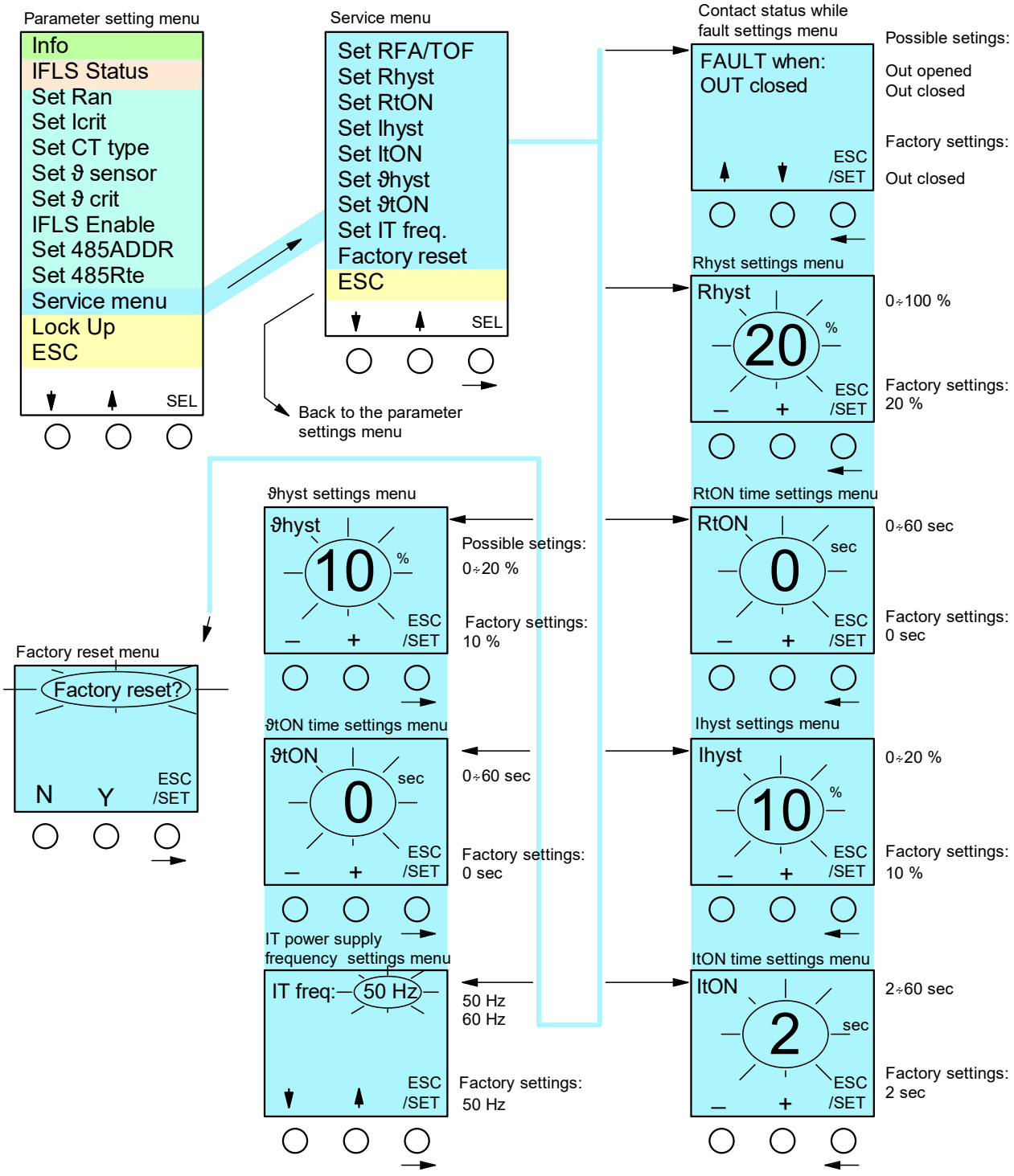
Menu sets unit address on the RS485 communication line. More about communication via ISOLGUARD RS485 on page 32. Address is set by pressing or holding the **+** or **–** buttons. New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and the value remains unchanged.

Menu Set 485Rte

Menu sets termination resistance of the ISOLGUARD RS485 communication line. It is set to value *YES* (resistance connected) or *NO* (resistance disconnected) using push-buttons *YES* and *NO*. New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and the value remains unchanged.

7.3 Parameter settings service menu

HIG95-DELTA insulation monitoring device service menu allows detailed settings of the device and is intended for professionals known of the device functions. It is recommended to leave the settings unchanged for common applications.



Picture 17: Parameter settings service menu

Advanced settings – Service menu

The following menu can be selected by using arrow push-buttons up and down:

- relay status when fault occurs, menu ***Set RFA/TOF***
- insulation resistance hysteresis, menu ***Set Rhyst***
- delay in response of signalling the insulation resistance fault, menu ***Set RtON***
- current load hysteresis, menu ***Set Ihyst***
- delay in response of signalling the current load fault, menu ***Set ItON***
- thermal load hysteresis, menu ***Set ϑhyst***, menu is shown only if PT 100 sensor is selected
- delay in response of signalling the thermal load fault, menu ***Set ϑtON***
- frequency of the monitored IT power supply, menu ***Set IT freq.***
- parameters factory setting, menu ***Factory reset***

For initiating of all menus use the push-button ***SEL*** and for exit select ***ESC***.

Menu RFA/TOF

It is possible to set *RFA* and *TOF* relays status while fault evaluation.

Both relays' contacts will be closed when fault occurs when set: ***FAULT when: Out closed***

or will be opened when fault occurs when set: ***FAULT when: Out opened***

New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and the value remains unchanged.

Menu Set R_{hyst}

New value of critical insulation resistance hysteresis is set in % by pressing or holding the **+** or **-** buttons. The value can be set in a range 0 to 100 % R_{an}. New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and the R_{hyst} value remains unchanged.

Menu Set RtON

In this menu delay in response of signalling the insulation status fault R_{tON} is set. Time can be set in seconds by pressing or holding the **+** or **–** buttons. The time can be set in a range 0 to 60 seconds. New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and the R_{tON} value remains unchanged.

Menu Set I_{hyst}

New value of critical current load value hysteresis is set in % by pressing or holding the **+** or **-** buttons. The value can be set in a range 0 to 20 % I_{crit}. New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and the I_{hyst} value remains unchanged.

Menu Set ItON

In this menu delay in response of signalling the transformer current overload I_{tON} is set. The setting range of the value is from 0 to 60 seconds.

Menu Set ϑ_{hyst}

This menu is shown only in case PT100 sensor is selected. Temperature hysteresis is not set for other sensor types and the menu is not displayed than.

New value of critical thermal load value hysteresis is set in % by pressing or holding the **+** or **-** buttons. The value can be set in a range 0 to 20 % ϑ_{crit}. New value is saved by long holding the ***ESC/SET***, pressing this button shortly ends setting procedure and the ϑ_{hyst} value remains unchanged.

Menu Set ϑtON

In this menu delay in response of signalling the transformer thermal overload ϑ_{tON} is set. The setting range of the value is from 0 to 60 seconds.

Menu Set IT freq

In this menu nominal frequency value of monitored IT power supply is set. Parameter can be set to 50 Hz or 60 Hz. Parameter is being used only applications where power supply frequency 60 Hz is used.

Menu Set Factory reset

This menu allows setting device parameters to default – factory settings. Key device parameters will be set to values according to table on page 28. "*Table 5: Factory values of device's operating* ".
Service device parameters will be set according to table on page 28. "*Table 6: Factory values of device's service parameters*".

8 System for insulation fault location

HIG-IFL DELTA module produced by HAKEL is device for fault location (IFL) for insulation monitoring device HIG95-DELTA. Both devices form together a system for fault location (IFLS). HIG95-DELTA device also contains localizing current injector (LCI). Localizing current sensors (LCS) are integrated in HIG-IFL DELTA module.

Location module is available according to article number and type in following table. Module description is also listed in separate documentation. Documentation designation is *"HIG-IFL DELTA Operating instruction."*, documentation number is "DOK-70959".

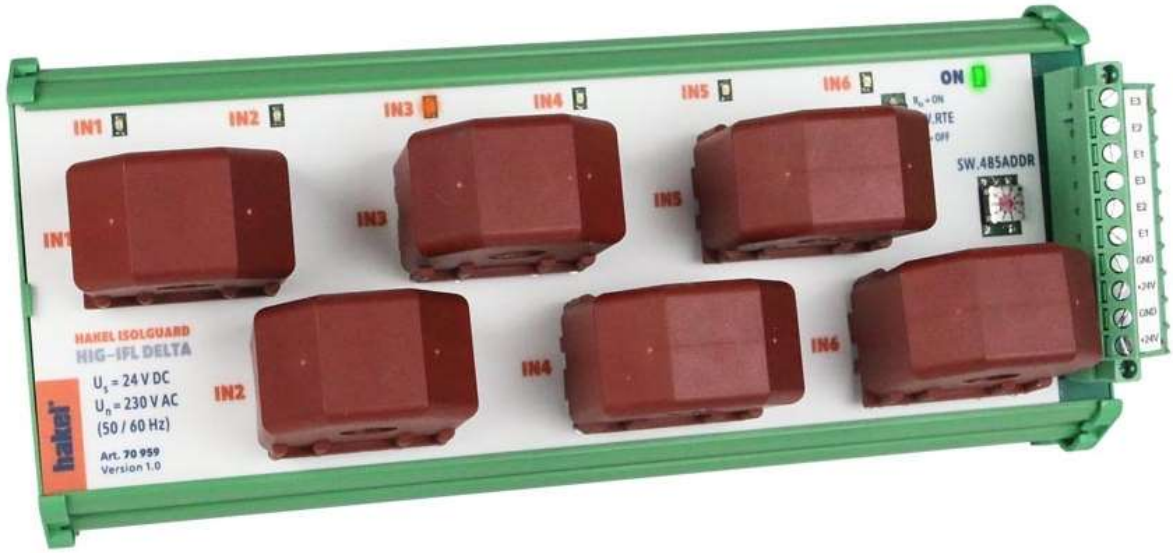
HIG-IFL DELTA insulation fault location module

Type	Number of localization circuits	Measuring transformers	Compatible with	Supply voltage	Assembling	Width
HIG-IFL DELTA	6	integrated	HAKEL ISOLGUARD HIG95-DELTA	24 V DC	On 35 DIN rail	12 M
Art. no.: 70 959						

Table 4: Fault location module type

The HIG-IFL DELTA is equipped with six measuring transformers, which are part of the product, and enables localization of faults on up to six circuits of the IT power supply system. It is designed for measuring IT power supply systems of the AC type, but mainly for single-phase AC systems, designed according to the standard HD 60364-7-710:2012 (Medical Isolated System - MIS)

The module is supplied with a low voltage of 24 V DC and it is connected to the HAKEL HIG95-DELTA device by *HAKEL IFLS* bus. Up to 10 HIG-IFL DELTA modules can be connected to a single insulation monitoring device to monitor up to 60 circuits. The signalling of the monitored circuits' status is performed by LED diodes on the module, in text on the HIG95-DELTA insulation monitoring device display and by the master monitoring system - MDS-D remote signalling module. Fault location status is not displayed on the MDS-DELTA modules.



Picture 18: HIG-IFL DELTA fault location module

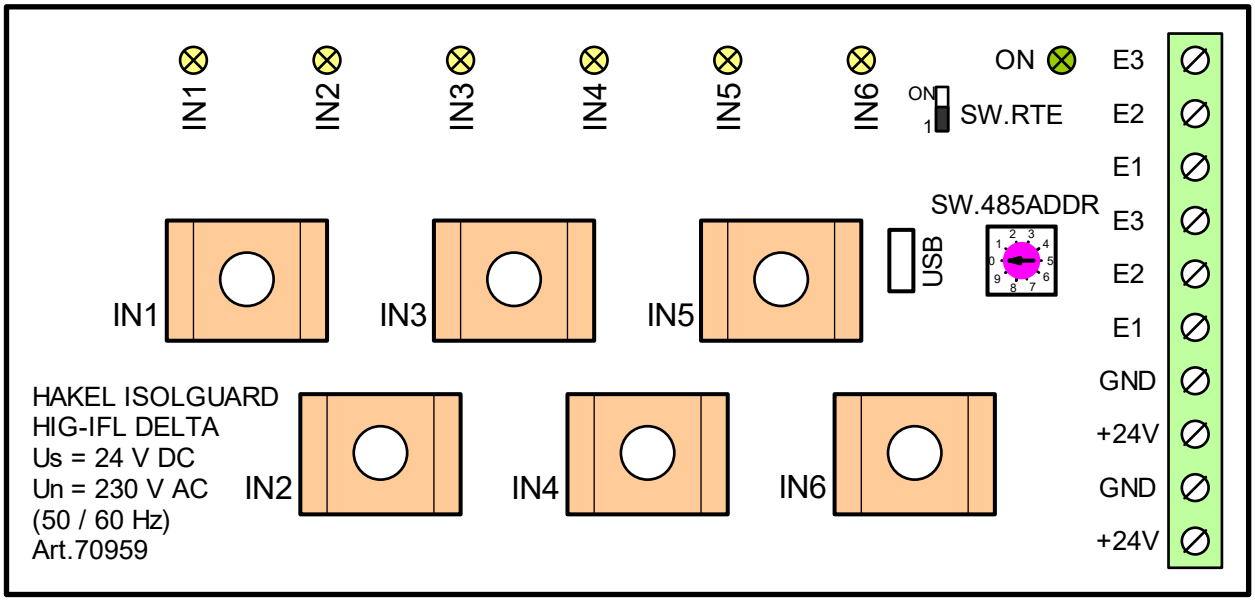
8.1 HIG95 DELTA device and HIG-IFL DELTA fault location module connection

Location module is connected to the insulation monitoring device by *HAKEL IFLS* bus on "*E1 E2 E3"* terminals according to recommended connection, see chapter 9. Module's power supply is connected on "*+24V"* and "*GND"* terminals. Nominal power supply voltage is 24 V DC. Both terminals on the module are doubled for possibility of bus and power supply connection to additional modules.

8.2 HIG-IFL DELTA control and connecting terminals

HIG-IFL DELTA fault location module is placed in a box for assembling on DIN 35 mm rail with 12M (210 mm) width.

On the module, there are: six yellow location status indicator lamps, green power supply indicator lamp, address setting switch and *HAKEL IFLS* bus termination. Then on the module is terminal for supply voltage connection and for IFLS bus connection.



Picture 19: HIG-IFL DELTA connection points and indicator lamps

8.3 Indicator lamps on the HIG-IFL DELTA location module

Green indicator lamp ON

It shines when power supply voltage is connected. It flashes slightly after starting the function of the module. Fast flashing signals localization module fault.

Yellow indicator lamps IN1 to IN6

indicate status of each of the six monitored circuits:

- all the yellow indicator lamps *IN1* to *IN6* are off – insulation status fault is not evaluated, so the fault location is not running
- all the yellow indicator lamps flash at the same time – there is no communication between the insulation monitoring device and the location module
- yellow indicator lamp *IN1* to *IN6* flashes – insulation status fault is evaluated, and fault localization is in progress
- yellow indicator lamp *IN1* to *IN6* constantly shines – insulation status fault has been evaluated on the particular circuit

8.4 Connection points of the HIG-IFL DELTA location module

Terminals GND, +24V

Connection of location module's power supply voltage. Nominal power supply voltage of the module is 24 V DC. Allowed voltage range on the terminals is 18 to 36 V DC. Power supply terminals are doubled.

It is recommended to use UTP cable for bus connection. Only type of cable must be used for the whole bus, so the same impedance of line is guaranteed. There is no reflection on the end of line, when the bus is properly terminated. Shielded cable should be used when it is installed in harsh environment. Shield must be grouded in one point.

Terminals E1 E2 E3

They are used for connection of *HAKEL IFLS* bus between HIG95-DELTA insulation monitoring device (*E1, E2, E3* terminals) and HIG-IFL DELTA location module. Terminals are doubled for possible connection with another location module.

Sensors IN1 to IN6

Each power supply circuits of the ZIS system are connected by passing both power supplied conductor through the *IN1* to *IN6* sensor hole. *PE* conductor cannot be passing through the sensor. Insulation status of each *IN1* to *IN6* input is shown by *IN1* to *IN6* indicator lamp. Short flash means particular input monitoring. Permanent shine signals insulation status fault on that IT power supply system's part, which is supplied through sensor *INx*.

Connector USB

It is intended for location module and PC computer connection. User program *"HIG-IFL DELTA Set-Up"* (Windows 10, .NET Framework 4.5.2. and higher) is provided by the producer. This program allows user parameters settings of the location

module. Program description is listed in separate documentation "*ISOLGUARD HIG-IFL DELTA Set-Up program for fault location settings"*: Connector "*micro USB B"* type is used on the location module.

8.5 HIG-IFL DELTA location module adjusting elements

SW.RTE switch

It is intended to adjust *HAKEL IFLS* bus termination on the location module. 120 Ω termination resistance is connected to the bus in *ON* position. Bus is without termination in *OFF* position.

SW.485ADDR switch

IT sets location module address on the *HAKEL IFLS* bus. The address is set in a range from 0 to 9 by turning the switch. Different address must be assigned to each module. Producer recommends assigning addresses from 1 to the number of modules.

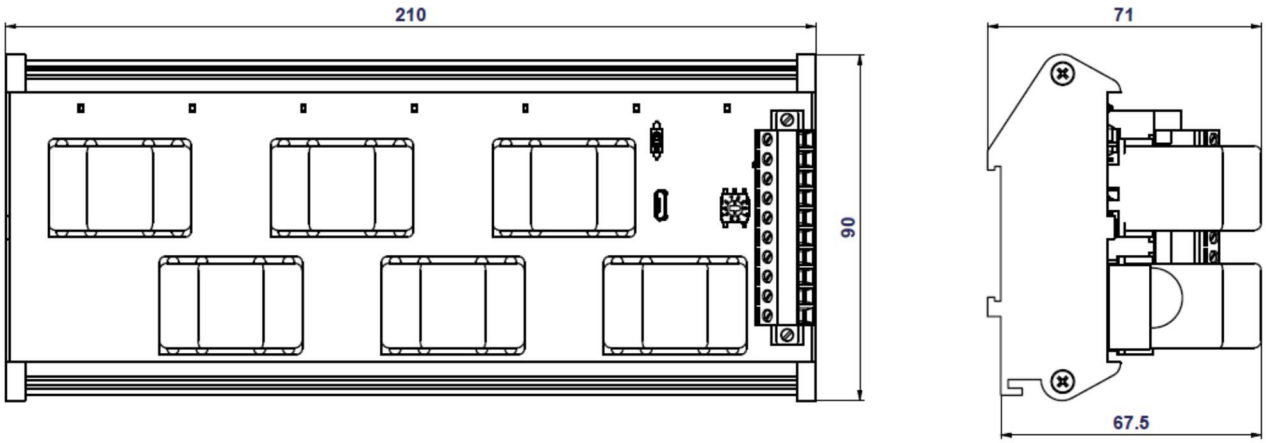
Assigned address determines module number in the location status menu (*IFLS STATUS*). Module with "1" address is labelled with text *"IFL.01"* in the status report, module with "2" address with text "*IFL.02"* etc. Module with adjusted address 0 is labelled with text "*IFL.10"*.

8.6 Faulting location module installation

Operation, installation and maintenance can be done only by qualified personnel according to assembling and safety regulations. If the device is used in the way not specified by the producer, protection provided by the device could be disrupted.

HIG-IFL DELTA is designed for assembling on 35 mm DIN rail according to IEC 715:1981. Any working position.

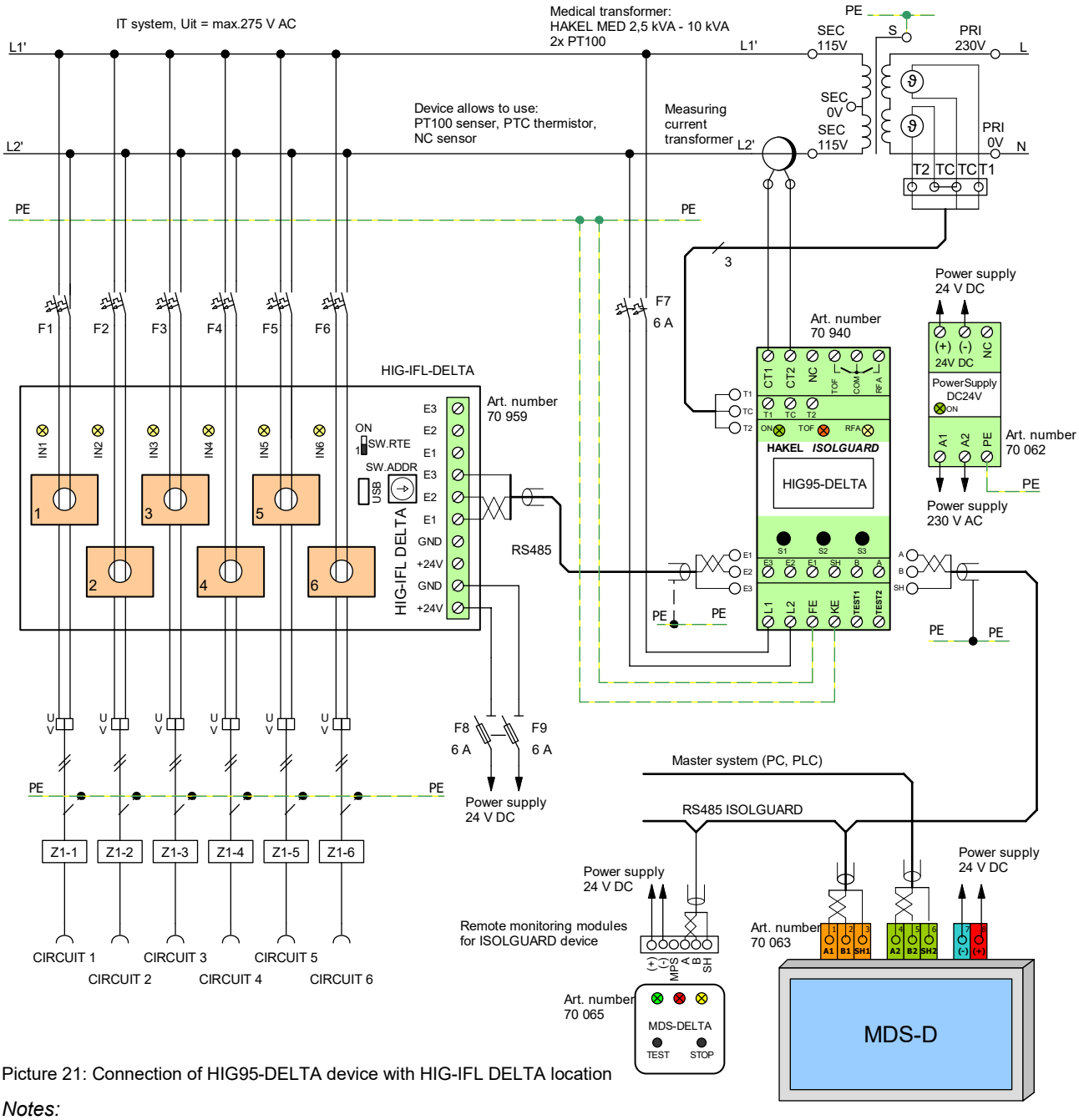
8.7 HIG-IFL DELTA device dimensions



Picture 20: HIG-IFL DELTA module dimensions (mm)

9 Recommended connection of insulation monitoring device with HIG-IFL DELTA fault location module

9.1 Example of connection IT power supply with HIG95-DELTA and fault location modules

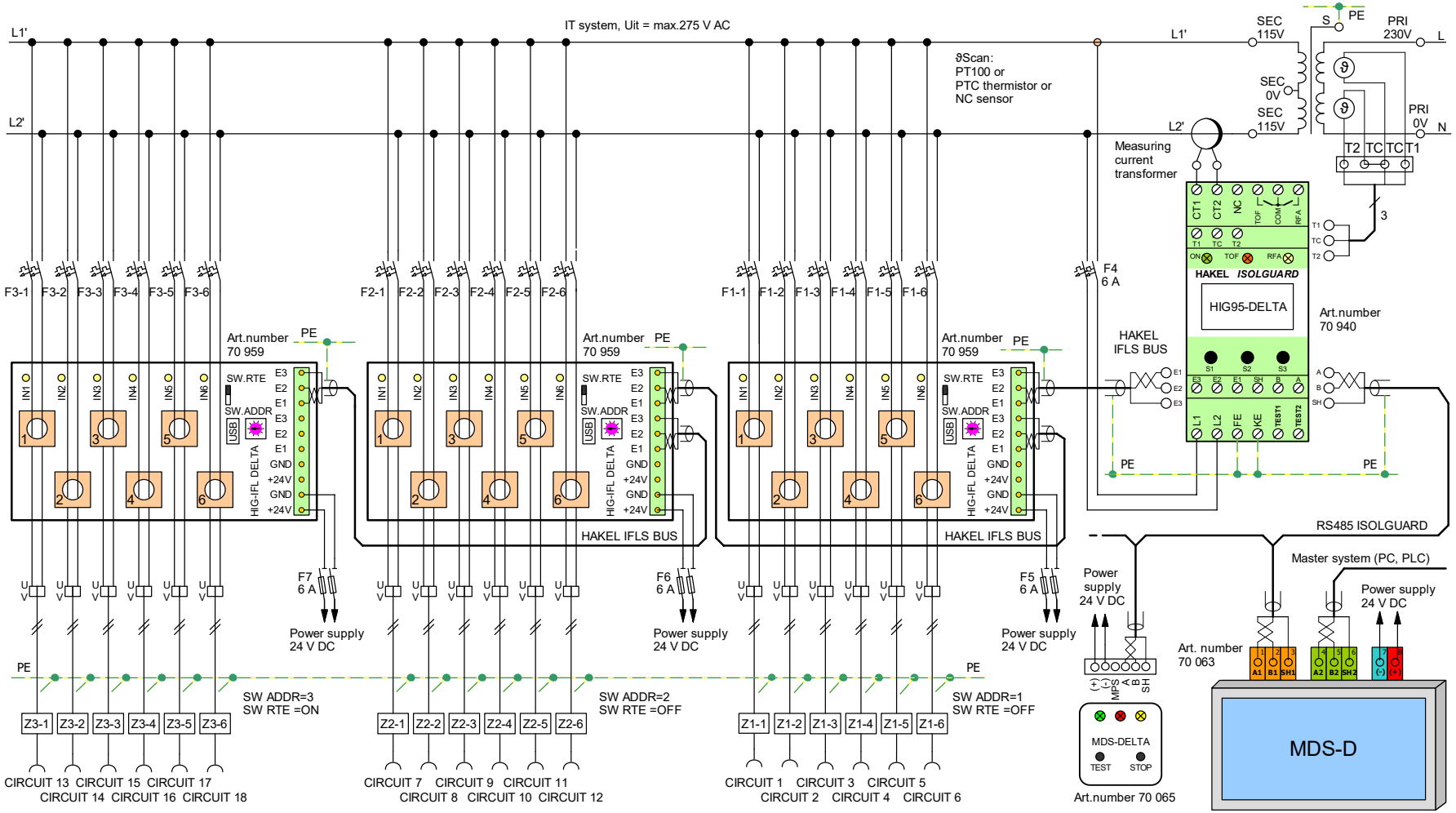


Picture 21: Connection of HIG95-DELTA device with HIG-IFL DELTA location

Notes:

1. *Power supply 2PE~50 Hz, 230 V/IT*
2. *Type of measuring current transformer should be selected according to table "I_{crit} values range for measuring current transformers" (page 34) and used isolation transformer.*
3. *Recommended cross-section and length of wires for connection to the current transformer is in table "Maximum length of wires for connection to the current transformer" (page 34).*
4. *Several MDS-DELTA modules can be connected to the device.*
5. *Terminals FE and KE must be connected by separate conductors to the to the PE bridge.*
6. *NC (Not Connected) this terminal should not be connected.*
7. *Recommended types and values of cable for the ISOLGUARD RS485 bus are listed in the MDS-D module instruction manual.*
8. *When using a shielded cable for the ISOLGUARD RS485 bus, bus shielding must be connected across whole length and grounded at one point.*
9. *It is necessary to follow a linear wiring of the ISOLGUARD RS485 bus, any taps are not allowed.*
10. *Install only one cable type along the whole length of the bus.*

9.2 Example of connection IT power supply with HIG95-DELTA and 3 fault location modules

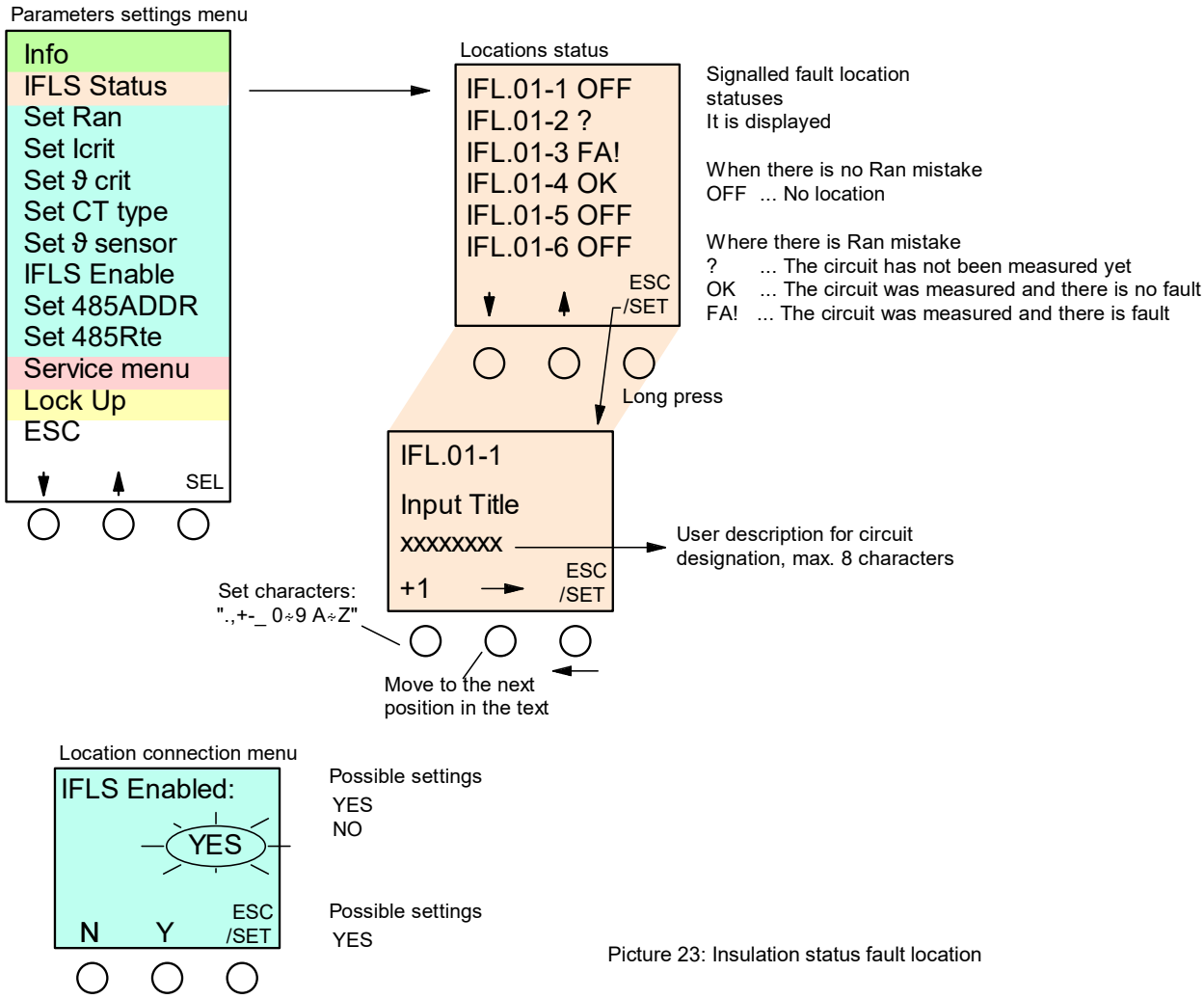


Picture 22: Connection of HIG95-DELTA device with several HIG-IFL DELTA modules

Notes:

1. *Terminals FE and KE must be connected by separate conductors to the to the PE bridge.*
2. *It is necessary to follow a linear wiring of the ISOLGUARD RS485 bus, any taps are not allowed.*
3. *Install only one cable type along the whole length of the bus.*

9.3 Insulation fault location menu



Picture 23: Insulation status fault location

In the menu "*Location status*" (*IFLS Status*) can be done:

- browsing individual monitored circuits statuses by using arrow push-buttons up and down
- individual monitored circuit status is displayed by IFL designation with *HAKEL IFLS* bus module number, with module's input number on and with text expressing insulation fault monitoring status.
  Displayed text *"IFL.01-1"* means circuit on the module with set address 1, input *IN1*.
- when the device does not signal R_{an} fault, text *"OFF"* is displayed
- when the device does signal R_{an} fault, text with the following meaning is displayed:
  - *"?"* the circuit has not been measured yet
  - *"OK"* …the circuit was measured and there is no fault
  - *"FA!"* the circuit was measured and there is fault
- long press can select individual circuit to display user description (*Input Title*)
- user description text can be set in this menu
- character selection of the user description text is done by pressing the push-button *"+1"* repeatedly
- middle push-button moves the character setting position one character to the right
- character flashes on the selected position
- long press saves the entered text
- the menus are closed by a short press of the push-button *ESC*
- user description text can be simply set with "*HIG-IFL DELTA Set-Up"* program by PC computer and USB line

10 HIG95-DELTA parameters factory settings

Device parameters are set to default values during production – factory values listed in following tables. There are parameters set in the main menu, see *Table* 5, and in the service menu, see *Table* 6. Device parameters are set to these values also when using *Factory reset* function.

Main menu parameters:

Parameter	Menu	Symbol	Value
Critical insulation resistance	Set Ran	R_{an}	50 kΩ
Critical current load value *Note 2*	Set Icrit	I_{crit}	30 A
Critical thermal load value *Note 1*	Set ϑcrit	ϑ_{crit}	100°C
Current transformer conversion ratio	Set CT type	CT_{type}	30/5 A
Temperature sensor type	Set ϑ sensor	ϑ_{sensor}	2x PT 100
HiG95 IFL Delta location connection	IFLS Enabled	IFLS Enabled	YES
RS485 line module address	Set 485ADDR	485 ADDR	1
RS485 line terminating resistance	Set 485Rte	485 R_{te}	No

Table 5: Factory values of device's operating parameters

Service menu parameters:

Parameter	Menu	Symbol	Value
RFA / TOF relay settings	Set RFA/TOF	FAULT when	Out closed
Critical insulation resistance hysteresis	Set Rhyst	R_{hyst}	20 %
Delay in response of signalling the resistance fault	Set RtON	R_{tON}	0 sec
Current load hysteresis	Set Ihyst	I_{hyst}	10 %
Delay in response of signalling the current fault	Set ItON	I_{tON}	2 sec
Thermal load hysteresis *Note.1*	Set ϑhyst	ϑ_{hyst}	10 %
Delay in response of signalling the temperature fault	Set ϑtON	ϑ_{tON}	0 sec
Monitored IT power supply frequency	Set IT freq.	IT_{freq}	50 Hz

Table 6: Factory values of device's service parameters

Notes:

1. *Parameter is set only for PT100 sensor, 1xPT100 or 2xPT100 settings.*
2. *Parameter is set only if current transformer conversion ratio is set*

11 Monitored power supply status evaluation

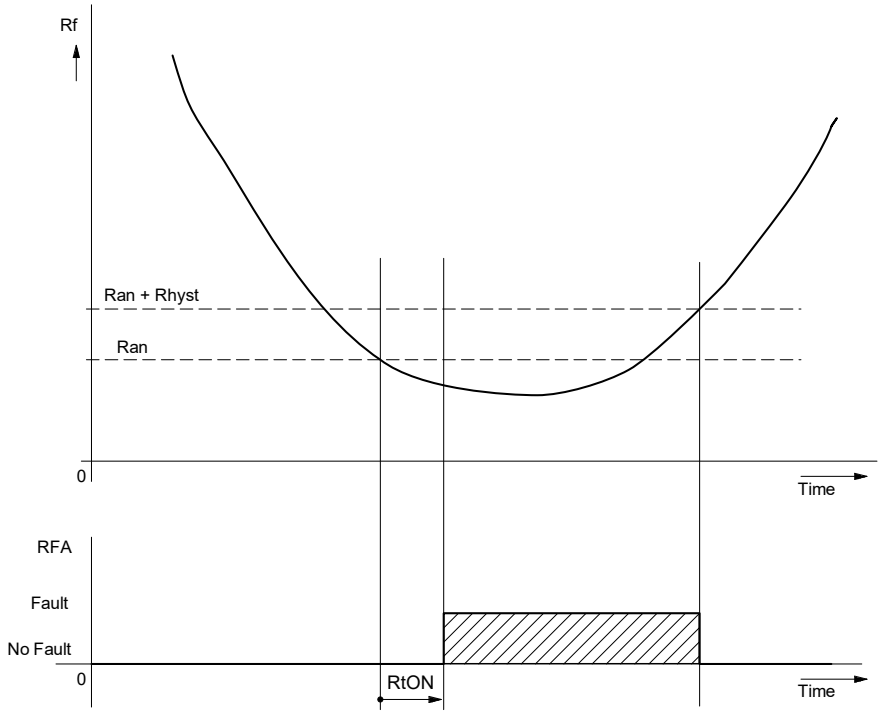
11.1 Insulation status fault evaluation

Insulation status of monitored power supply is signalled by signalling relay status and *RFA* indicator lamp on the device. Isolation transformer overload is signalled by signalling relay status and *TOF* indicator lamp.

Contact status of relay when fault occurs is set in service menu ***Set RFA/TOF***.

- When setting the parameter to *FAULT when: Out closed* *RFA* and *TOF* relays contacts are closed when fault occurs
- When setting the parameter to *FAULT when: Out opened* *RFA* and *TOF* relays contacts are opened when fault occurs

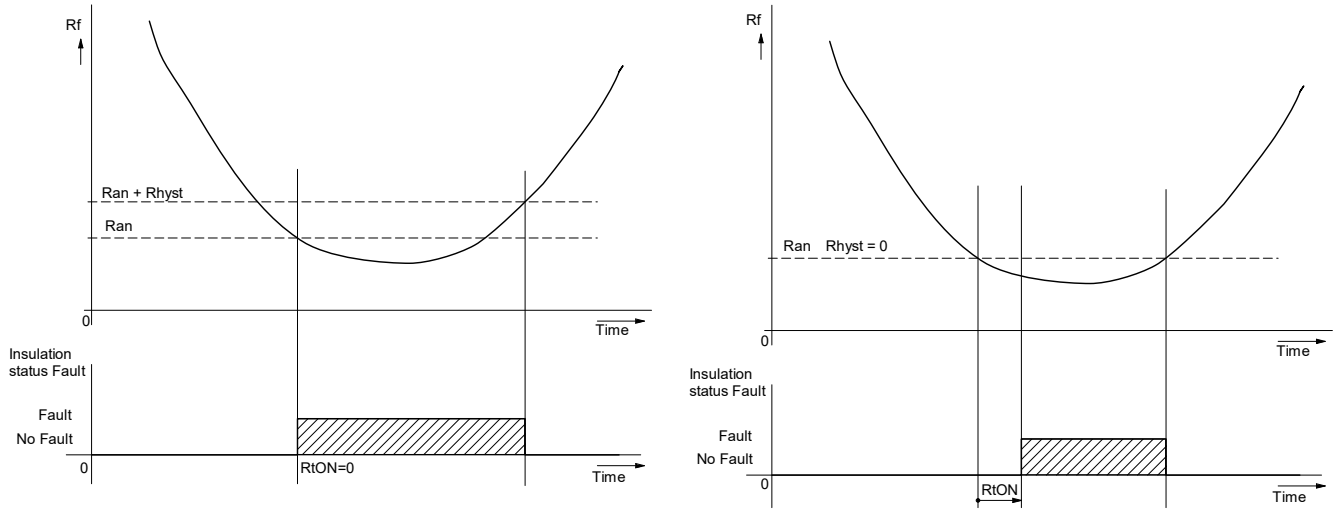
Insulation status fault evaluation with an influence of set R_{tON} and R_{hyst} parameters values is shown in the following picture.



Picture 24: Insulation resistance fault evaluation

In this example the set non-zero value for time R_{tON} and hysteresis R_{hyst} is shown. When the insulation resistance value of the monitored power supply system decreases below R_{an}, the countdown of the time R_{tON} starts. The remaining time is displayed. Once the time R_{tON} is expired, the insulation status fault is evaluated. The optical and acoustic signalling of the connected MDS remote monitoring module is activated. The fault is only terminated when the insulation resistance increases above the value of $R_{an} + R_{hyst}$.

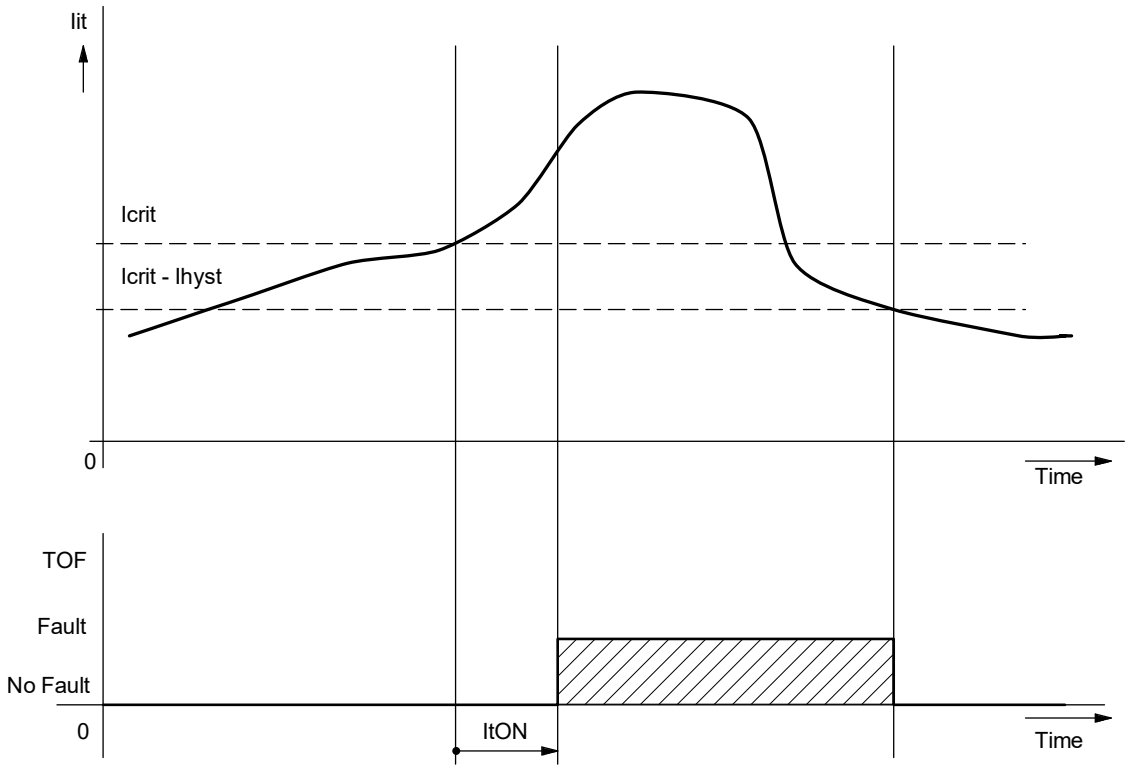
The following left picture shows fault evaluation process when insulation monitoring device is set with zero value R_{tON}. The following right picture shows example for device settings with the zero value R_{hyst} hysteresis.



Picture 25: Insulation resistance fault evaluation with R_{tON} or hysteresis zero value.

11.2 Current overload fault evaluation of the isolation transformer

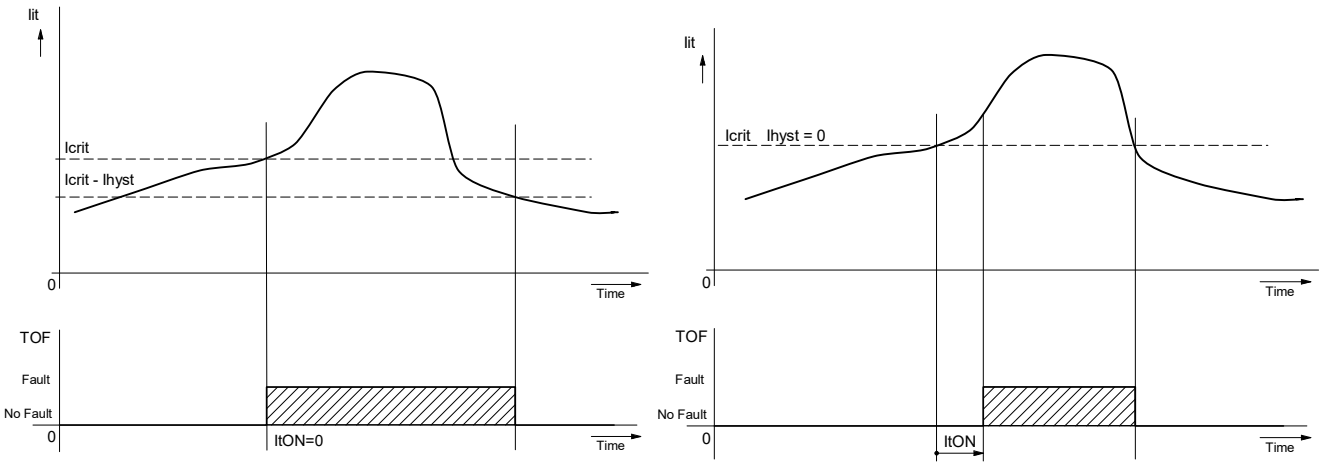
TOF fault evaluation according to set I_{tON} and I_{hyst} parameter values is shown in the following picture.



Picture 26: Current overload evaluation

In this example the set non-zero I_{tON} time value and I_{hyst} hysteresis is shown. When increasing the current load value of the isolation transformer exceeds the set I_{crit}, the countdown of the time I_{tON} starts. The remaining time is displayed. Once the time I_{tON} is expired, the fault invoked and the *TOF* indicator lamp on the device lights up. The optical and acoustic signalling of the connected MDS remote monitoring module is activated. The *TOF* fault is only terminated after decreasing current load value below $I_{crit} - I_{hyst}$.

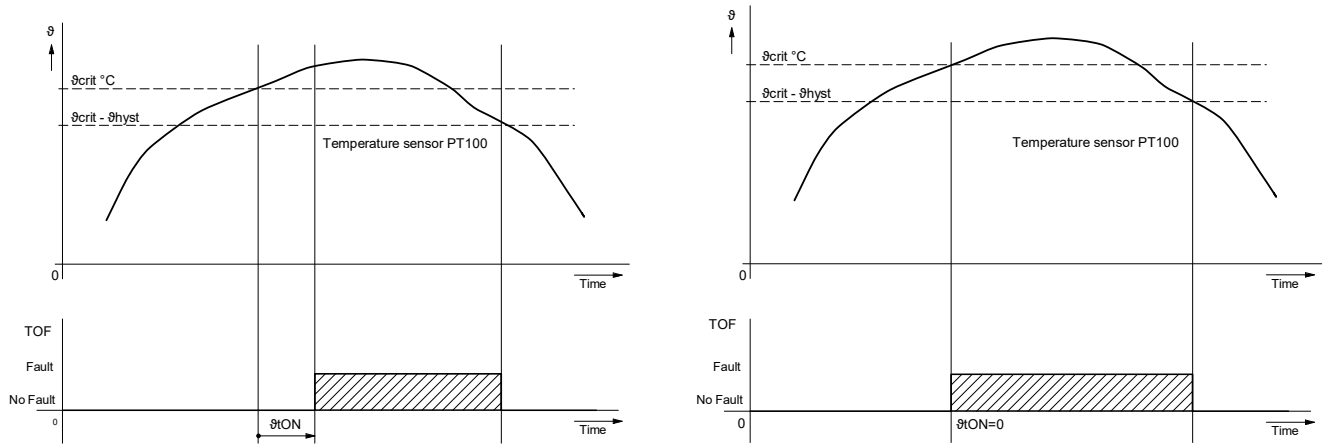
The following left picture shows fault evaluation process when insulation monitoring device is set with zero value I_{tON}. The following right picture shows an example for device settings with the zero value I_{hyst} hysteresis.



Picture 27: Current overload with delay evaluation

11.3 Thermal overload fault evaluation of the isolation transformer

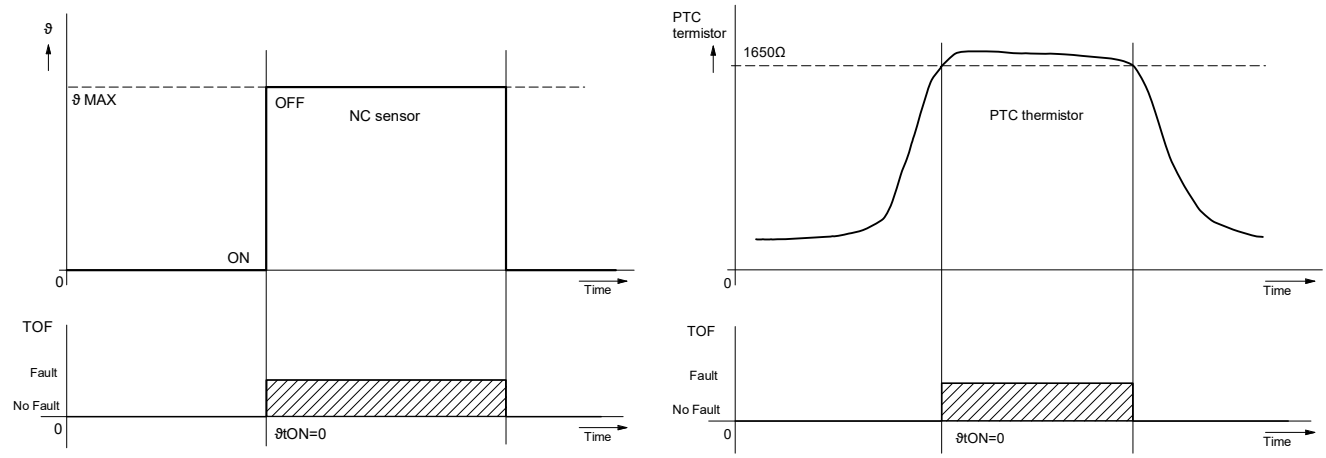
Fault evaluation with the influence of set ϑ_{tON} and ϑ_{hyst} parameters values, when using PT100 sensor, is shown in the following pictures. The left picture shows an example of the set non-zero value for time ϑ_{tON} and hysteresis ϑ_{hyst}. The right picture shows the fault evaluation process for device settings with the zero ϑ_{tON} value.



Picture 28: Thermal overload evaluation

When increasing the thermal load value of the isolation transformer exceeds the set ϑ_{crit}, the countdown of the ϑ_{tON} time starts. The remaining time is displayed. Once the ϑ_{tON} time is expired, the fault invoked and the *TOF* indicator lamp on the device lights up. The optical and acoustic signalling of the connected MDS remote monitoring module is activated. The *TOF* fault is only terminated after thermal load value decrees below $\vartheta_{crit} - \vartheta_{hyst}$.

The left picture shows fault evaluation example when using NC thermal sensor. The ϑ_{MAX} value is the limit value for the sensor. The right picture shows fault evaluation example when using PTC thermistor.



Picture 29: Thermal overload evaluation with NC sensor and PTC thermistor

12 Communication protocol

The unit HIG95-DELTA communicates via the industrial RS485 bus using the protocol based on the PROFIBUS protocol. Communication proceeds in the request – response mode. One MASTER station must be connected to the bus, whereas this MASTER station sends requests to the other SLAVE stations. The slave stations only respond to requests, they never start communication. The unit HIG95-DELTA is in the position of the slave station.

Individual stations are connected with TWISTED PAIR-TP. The first conductor is labelled A, the second one B. Logical 1 (respectively 0) is determined by the voltage between these conductors. During an idle state (logical 1), the A conductor is more positive than the B conductor (at least by 200mV).

An individual address must be set for each station being connected to the bus. The address for the unit HIG95-DELTA is adjustable within a range 1 to 126 (address 0 is reserved for the MASTER station).

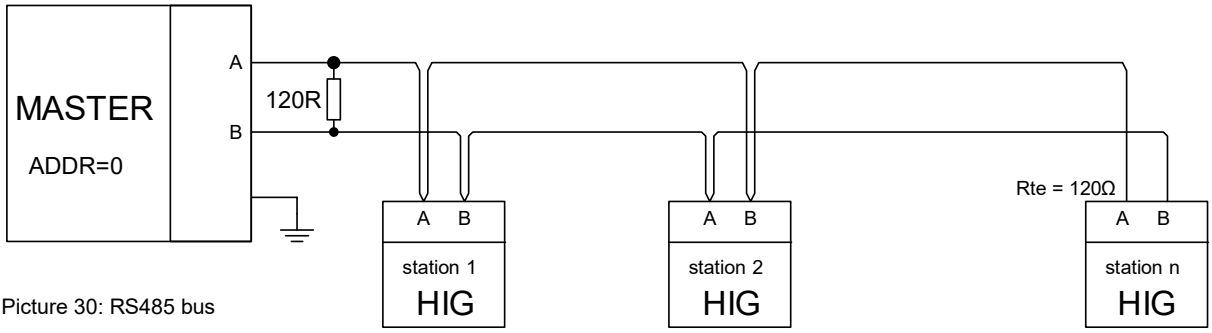
The length of the line can be up to 1200 meters; in view of proper installation, both ends of the line need to be terminated, namely by using the resistance of 120 Ω. At a given moment, each station connected to the line RS485 may transmit or receive. This mode is called half-duplex. In order to avoid any collision (i.e., two stations must not transmit simultaneously), the transmit right must be assigned by the MASTER station. In practice, the communication proceeds in such a way, that the MASTER station sends the requests subsequently to all connected units and the SLAVE stations response. The accessibility of the station is ensured by its address, which must be unique for every station on the line.

For ISOLGUARD system MDS-D module type is used as a MASTER station, which allows remote displaying of measured values and parameters and data transferring to the user master system.

12.1 RS485 line parameter settings

In the device menu can be selected ***Set 485ADDR*** and ***Set 485Rte*** menu.

Menu ***Set 485ADDR*** sets the HIG95-DELTA address on the RS485 bus. The address setting range is 1 to 126.



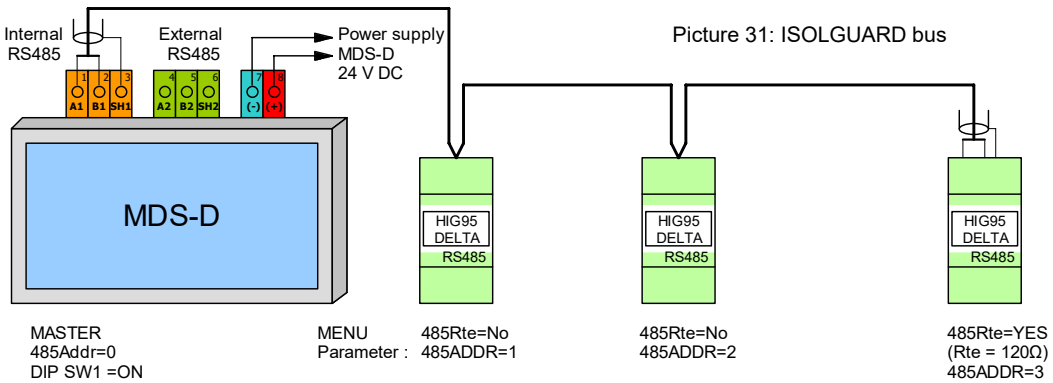
Picture 30: RS485 bus

Menu ***Set 485Rte*** sets the internal R_{te} terminating resistance connection to the RS485 line. This parameter can be set to ***YES*** (when the resistance 120Ω is internally connected to the module's RS485 line) or to ***NO*** (without connected resistance).

12.2 RS485 bus structure

Communication between HIG devices and MDS-D remote monitoring module

Using MDS-D as the MASTER station allows the user easy and convenient supervision of up to 24 IT power supply systems' status, monitored by HIG95-DELTA devices. MDS-D touch panel communicates with devices via ISOLGUARD protocol fully automatically, including the possibility to search monitoring devices on the connected bus. For proper function it is only necessary to set unique addresses in the device menu and connect monitoring devices with MDS-D panel by twisted pair. HIG devices are always connected to the internal RS485 line of the MDS-D module, i.e. terminals A1 B1.



Picture 31: ISOLGUARD bus

RS485 bus termination on the MDS-D is done by a switch available inside the case. The switch labelled SWITCH1 connects terminating resistance 120 Ω to internal RS485 line (A1 B1) in the ON position. The switch labelled SWITCH2 connects terminating resistance 120 Ω to external line RS485 (A2 B2) in the ON position.

13 Data transmitted via RS485 bus

HIG95-DELTA communicates on the RS485 bus by using the ISOLGUARD communication protocol. This protocol was designed by HAKEL as a universal command system for reading data from insulation monitoring devices of HIG9x series and additional products

ISOLGUARD communication protocol differentiates between 3 basic transmitted data types:

- Identification data through which the device displays its type designation
- Measured data, information on currently measured values and their statuses
- Device parameters, including the device settings values

For data identification the unit sends the codename of its design, the software version and program compilation date - which is not the date of device's production.

Measured data and parameters are sent in individual information blocks. Each information block contains the alphanumeric name, numerical value and measuring unit. In addition, a character is added to the measurement data, determining the status of this measurement (e.g. fault occurrence). Parameter data are extended of priority character, determining the importance of the set parameter. This character divides parameters up into eight groups, when in group no. 1 are the most important and necessary parameters for the proper functioning of the device (e.g. critical limits) and group no. 7 is the least important parameters. Parameters with priority no. 0 are operating parameters serving to inform additional HAKEL products and should be ignored by the user application.

The meaning of each character and the correct form of the protocol commands is described in the ISOLGUARD Protocol Programming Manual. Data that can be read from the HIG95-Delta are listed in the tables below.

13.1 Measurement data

Quantity		Symbol	Value (e.g.)	Units
Insulation resistance		R_F	500	kΩ
Isolation transformer current consumption		I_{it}	32	A
Isolation transformer temperature	PT100 sensor	ϑ_1, ϑ_2	85	°C
	PTC thermistor or NC sensor		"OK" or ">MAX"	- - -

Table 7: Measurement data transmitted via ISOLGUARD bus

13.2 Parameters data

Parameter name	Symbol	Value (e.g.)	Units	Priority
Critical limit of insulation resistance	R_{an}	50	kΩ	1
Critical limit of isolation transformer current load	I_{crit}	32	A	1
Critical limit of isolation transformer thermal load	ϑ_{crit}	130	°C	1
Device address on the RS485 line	485ADDR	1	- - -	1
Insulation resistance hysteresis	R_{hyst}	50	%	2
Current load hysteresis	I_{hyst}	5	%	2
Thermal load hysteresis	ϑ_{hyst}	5	%	2
Delay in response of signalling the insulation resistance fault	t_{ON}	0	sec.	3
Delay in response of signalling the current overload fault	It_{ON}	2	sec.	3
Delay in response of signalling the thermal overload fault	ϑt_{ON}	0	sec.	3
Temperature inside the HIG module	ϑHIG	32	°C	4

Table 8: Parameters data transmitted via ISOLGUARD bus

14 Measuring current transformers

Measuring current transformers series HIG-MT, supplied by HAKEL, are used for current load measuring in medical IT systems monitored by HIG95-DELTA insulation monitoring device. These transformers are produced in range of primary current from 25 to 100 A with secondary current 5 A. Their parameters are described in documentation *HAKEL ISOLGUARD HIG-MT* in detail.

14.1 Range of I_{crit} value for measuring current transformers

Type	Art. number	Transfer ratio	Measured range	Number of displayed decimals	Range of set Icrit value	For transformers with output
HIG-MT 25/5 A	71 530	25/5 A	1.0 ÷ 25 A	1	2 ÷ 25 A	3 150 VA až 5 000 VA
HIG-MT 30/5 A	71 531	30/5 A	1.2 ÷ 30 A	1	3 ÷ 30 A	3 150 VA až 5 000 VA
HIG-MT 40/5 A	71 532	40/5 A	2 ÷ 40 A	0	4 ÷ 40 A	8 000 VA
HIG-MT 50/5 A	71 533	50/5 A	2 ÷ 50 A	0	5 ÷ 50 A	10 000VA
HIG-MT 60/5 A	71 534	60/5 A	2 ÷ 60 A	0	6 ÷ 60 A	-
HIG-MT 80/5 A	71 535	80/5 A	3 ÷ 80 A	0	8 ÷ 80 A	-
HIG-MT 100/5 A	71 536	100/5 A	4 ÷ 100 A	0	10 ÷ 100 A	-

Table 9: Range of I_{crit} value for measuring current transformers

14.2 Recommended maximum length of wires for connection to the current transformer

Type	Art. number	Recommended maximum length of wire	
		Wire Cu, cross-section 2,5 mm^2	Wire Cu, cross-section 1,5 mm^2
HIG-MT 25/5 A	71 530	2,25 m (4,5 m whole sec. loop)	1,35 m (2,75 m whole sec. loop)
HIG-MT 30/5 A	71 531	3,75 m (7,5 m whole sec. loop)	2,25 m (4,5 m whole sec. loop)
HIG-MT 40/5 A	71 532	2,25 m (4,5 m whole sec. loop)	1,35 m (2,75 m whole sec. loop)
HIG-MT 50/5 A	71 533	2,25 m (4,5 m whole sec. loop)	1,35 m (2,75 m whole sec. loop)
HIG-MT 60/5 A	71 534	6,5 m (13 m whole sec. loop)	4 m (8 m whole sec. loop)
HIG-MT 80/5 A	71 535	6,5 m (13 m whole sec. loop)	4 m (8 m whole sec. loop)
HIG-MT 100/5 A	71 536	14 m (28 m whole sec. loop)	8 m (16 m whole sec. loop)

Table 10: Maximum length of wires for connection to the current transformer

15 Maintenance and service

It is necessary to follow specified conditions for reliable operation, do not expose the device to rough handling, keep it clean and do not exceed the maximum ambient temperature.

Only qualified person is allowed to install and set up the device. Only the producer provides repairs of the device. No personnel are needed to operate the insulation monitoring device. Technology service is during the operation informed by local and remote monitoring signalization about the monitored power supply and transformer status.

16 Producer

Producer of HIG95-DELTA insulation monitoring device is

HAKEL spol. s r. o.,
Bratří Štefanů 980, 500 03 Hradec Králové
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