Insulation monitoring device

HIG24VDC, HIG24VDC-L

HIG48VDC, HIG48VDC-L

HIG72VDC, HIG72VDC-L

HIG110VDC, HIG110VDC-L

Operating instructions

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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 Insulation monitoring device HAKEL ISOLGUARD HIG24VDC(-L), HIG48VDC(-L), HIG48VDC(-L), HIG110VDC(-L)

The insulation monitoring device produced by HAKEL, type ISOLGUARD HIG24VDC(-L), HIG48VDC(-L), HIG72VDC(-L), HIG110VDC(-L), is designed for monitoring the insulation status of direct IT power supply systems with 24 V⎓, or 48 V⎓, or 72 V⎓, or 110 V⎓ nominal voltage.

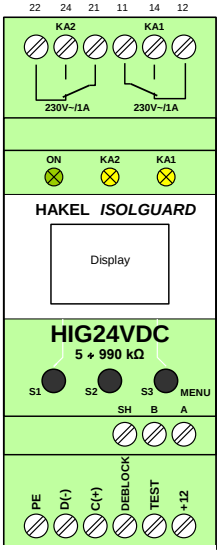
The unit monitors continuously the insulation status of both branches of the ungrounded IT system against a reference point. Typically, the PE conductor in stationary systems or a skeleton of the vehicle for mobile devices. In the case of an insulation status fault in the positive branch *R*+ or in the negative branch *R*-, the status is signalled by relay *KA1*/*KA2* settings. At the same time the fault status is indicated by a LED control on the front panel.

The device is equipped with a display to indicate the numerical value of the insulation resistance. The measured insulation resistance value, in both branches of the monitored system, is displayed. Then there are push-buttons for setting device parameters and signalling LED diodes to display the status of monitored power supply system and of the device.

It is possible to connect MDS-DELTA module or MDS-D module with touch screen display via *RS485 ISOLGUARD* bus. Modules serve to display current measured values and current device settings.

HIG48VDC insulation monitoring devices can communicate with a master computer via industrial *RS485* bus with a protocol based on the PROFIBUS protocol.

The manufacturer's instructions must be followed for use on rolling stock (so-called “/T“ variant), for more information see chapter 13.2 Installation for rail vehicles.



Picture 1: HIG24VDC

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

2 Variants of IMD HIG24VDC(-L), HIG48VDC(-L), HIG72VDC(-L), HIG110VDC(-L)

Model	IT power supply voltage	Range of displayed R_F value	Critical insulation resistance R_{an}	Display Menu	Signalling relay	Remote monitoring	RS485	Device type according to IEC 61557-8
HIG24VDC *Art. no. 70 933*	12 to 36 V⎓	5 kΩ to 990 kΩ	Adjustable 5 kΩ to 500 kΩ	Yes	2x SPDT relay	MDS-D MDS-DELTA	RS485 ISOLGUARD	DC
HIG48VDC *Art. no. 70 935*	32 to 60 V⎓							
HIG72VDC *Art. no. 70 942*	55 to 90 V⎓							
HIG110VDC *Art. no. 70 934*	75 to 140 V⎓							
HIG24VDC-L *Art. no. 70 933L*	12 to 36 V⎓	2 kΩ to 550 kΩ	Adjustable 2 kΩ to 500 kΩ					
HIG48VDC-L *Art. no. 70 935L*	32 to 60 V⎓							
HIG72VDC-L *Art. no. 70 942L*	55 to 90 V⎓							
HIG110VDC-L *Art. no. 70 934L*	75 to 140 V⎓							

Table 1: Variants, type and article numbers

Notes: SPDT - signalling relay with one switching contact
MDS-D remote monitoring module with a display and with communication via RS485 ISOLGUARD bus
MDS-DELTA remote monitoring module with communication via RS485 ISOLGUARD bus

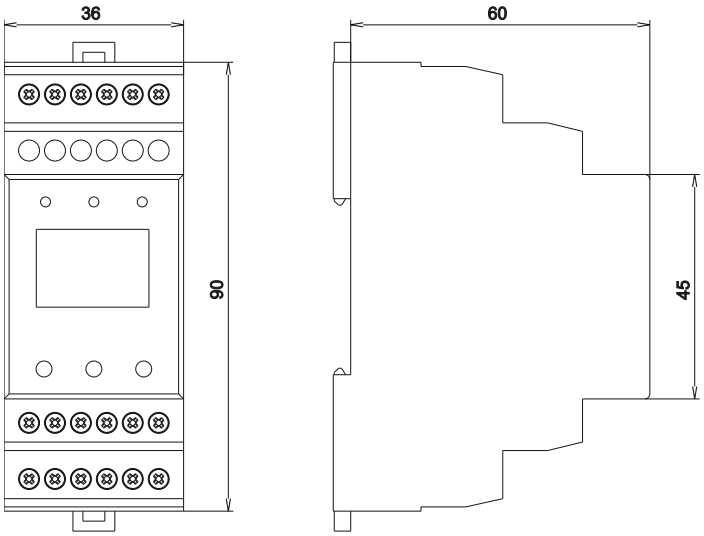
2.1 Device HIG24VDC(-L), HIG48VDC(-L), HIG72VDC(-L), HIG110VDC(-L) complies with standards

- HD 60364-4-41:2017 Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock
- IEC 61557-8:2014 Insulation monitoring devices for IT systems
- IEC 61557-1:2007 Equipment for testing, measuring or monitoring of protective measures
- IEC 60664-1:2007 Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests
- EN 50155:2007 Rolling stock – Electronic equipment
- IEC 61373:2010 Railway applications – Rolling stock equipment – Shock and vibration tests
- EN 45545-2:2013 Railway applications – Fire protection on railway vehicles
- EN 50121-3-2:2016 Railway applications – Electromagnetic compatibility

2.2 Basic characteristics

- Insulation monitoring device for DC systems with 24 V⎓, or 48 V⎓, or 72 V⎓, or 110 V⎓ nominal voltage
- Display of the measured insulation resistance values for both positive and negative branches of the monitored power supply system
- Two variants of the critical insulation resistance limit available
- Two signalling relays with switching contacts
- Signalling relays function is set in device's user menu
- Optional fault memory with possibility of unblocking by a push-button on the device or by a remote push-button
- Device is designed for use in railway applications
- Device is suitable for monitoring IT power supplies created by battery
- Device is suitable for monitoring IT power supplies of communication and security technology
- Connection to *RS485 ISOLGUARD* bus, insulation strength 2500 V_{rms} to the internal circuits and to power supply system circuits
- Optional connection of the touch screen panel of HAKEL MDS-D remote monitoring system
- Optional connection of HAKEL MDS-DELTA remote monitoring system
- Optional communication with a master system via *RS485 ISOLGUARD* bus
- Communication protocol description available on request
- Option to set critical values, hysteresis values and other parameters by device's push-buttons
- Access to the device parameter setting with pushbuttons can be locked/ unlocked by a button combination
- 2M (36 mm) device wide for DIN 35 rail assembly

3 Device dimensions



Picture 2: Device dimensions

4 Technical data ISOLGUARD HIG24VDC, HIG48VDC, HIG72VDC, HIG110VDC

Type		HIG24VDC	HIG48VDC	HIG72VDC	HIG110VDC
Monitored IT power supply system type		DC			
Voltage of monitored IT system /*1	U_n	24 V⎓	48 V⎓	72 V⎓	110 V⎓
Nominal supply voltage /*1	U_s	$U_s = U_n$			
Supply voltage range		12 to 36 V⎓	32 to 60 V⎓	55 to 90 V⎓	75 to 140 V⎓
Power consumption	P	max. 2 VA			
Measuring circuit					
Internal direct resistance	R_i	> 120 kΩ			
Measuring range	R+/R–	5 kΩ to 990 kΩ			
Measuring accuracy		± 10%			
Critical insulation resistance	R_{crit}=R_{an}	adjustable 5 kΩ to 500 kΩ			
Insulation resistance hysteresis	R_{hyst}	adjustable 0 to +100% R_{crit}			
Delay in response of signalling the insulation status	t_{ON}	adjustable 0 to 60 sec, with 1 sec step			
Outputs					
Signalling relay *KA1*. Potential-free switching contact, electric strength to the internal circuits and to the supply circuits		250 V~ / 1A 3750 Vrms			
Signalling relay *KA2*. Potential-free switching contact, electric strength to the internal circuits and to the supply circuits		250 V~ / 1A 3750 Vrms			
Communication line: RS485 type MASTER-SLAVE, 9600 Bd, even count parity Insulating strength to the internal circuits and to the network circuits		Yes 2500 Vrms			
General data					
Degree of protection according to IEC 60529		front panel IP40 protection except front panel IP20			
Weight	m	110 g			
Housing material		PA – UL94 V0			
Method of assembly		On the DIN 35 rail			
Recommended section of the connected conductors	S	1 mm^2			
Article number /*2		70 933	70 935	70942	70 934

Table 2: Technical parameters of HIG24VDC, HIG48VDC, HIG72VDC, HIG110VDC, part 1

*Notes: /*1 Device is supplied from the monitored IT power supply system*
*/*2 To use HIG**VDC device in railway applications, the set is supplied under the designation HIG24VDC/T, HIG48VDC/T, HIG72VDC/T, HIG110VDC/T, see 13.2 Installation for rail vehicles.*

Operating conditions	
Operating temperature	-25 °C ÷ +70 °C
Storage temperature	-40 °C ÷ +70 °C
Transport temperature	-40 °C ÷ +70 °C
Altitude	Up to 2000 meters above sea level
Protection class	II according to IEC 61140:2016
Electromagnetic compatibility	EN 50121-3-2 ed.4
Overvoltage category / testing voltage	III, according to IEC 60664-1:2007
Pollution degree	2, according to IEC 60664-1:2007
Recommended protection	6 A / gG
Duty type	permanent, any position

Table 3: Technical parameters of HIG24VDC, HIG48VDC, HIG72VDC, HIG110VDC, part 2

5 Technical data ISOLGUARD HIG24VDC-L, HIG48VDC-L, HIG72VDC-L, HIG110VDC-L

Type		**HIG24VDC-L**	**HIG48VDC-L**	**HIG72VDC-L**	**HIG110VDC-L**
Monitored IT power supply system type		DC			
Voltage of monitored IT system /*1	U_n	24 V⎓	48 V⎓	72 V⎓	110 V⎓
Nominal supply voltage /*1	U_S	$U_S = U_n$			
Supply voltage range		12 to 36 V⎓	32 to 60 V⎓	55 to 90 V⎓	75 to 140 V⎓
Power consumption	P	max. 2 VA			
Measuring circuit					
Internal direct resistance	R_i	> 55 kΩ			
Measuring range	R+/R–	2 kΩ to 550 kΩ			
Measuring accuracy		± 10%			
Critical insulation resistance	R_{crit}=R_{an}	adjustable 2 kΩ to 500 kΩ			
Insulation resistance hysteresis	R_{hyst}	adjustable 0 to +100% R_{crit}			
Delay in response of signalling the insulation status	t_{ON}	adjustable 0 to 60 sec, with 1 sec step			
Outputs					
Signalling relay *KA1*. Potential-free switching contact, electric strength to the internal circuits and to the supply circuits		250 V~ / 1A 3750 Vrms			
Signalling relay *KA2*. Potential-free switching contact, electric strength to the internal circuits and to the supply circuits		250 V~ / 1A 3750 Vrms			
Communication line: RS485 type MASTER-SLAVE, 9600 Bd, even count parity Insulating strength to the internal circuits and to the network circuits		Yes 2500 Vrms			
General data					
Degree of protection according to IEC 60529		front panel IP40 protection except front panel IP20			
Weight	m	110 g			
Housing material		PA – UL94 V0			
Method of assembly		On the DIN 35 rail			
Recommended section of the connected conductors	S	1 mm^2			
Article number /*2		70 933L	70 935L	70 942L	70 934L

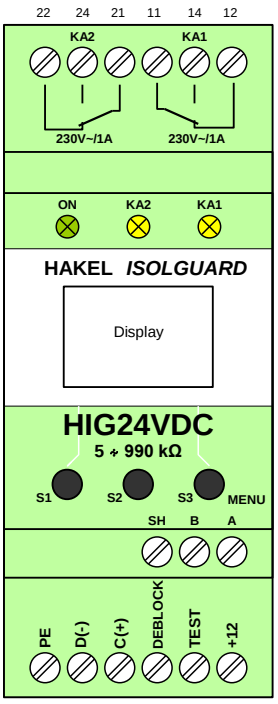
Table 4: Technical parameters of HIG24VDC-L, HIG48VDC-L, HIG72VDC-L, HIG110VDC-L, part 1

*Notes: /*1 Device is supplied from the monitored IT power supply system*
*/*2 To use HIG**VDC device in railway applications, the set is supplied under the designation HIG24VDC-L/T, HIG48VDC-L/T, HIG72VDC-L/T, HIG110VDC-L/T, see 13.2 Installation for rail vehicles.*

Operating conditions	
Operating temperature	-25 °C ÷ +70 °C
Storage temperature	-40 °C ÷ +70 °C
Transport temperature	-40 °C ÷ +70 °C
Altitude	Up to 2000 meters above sea level
Protection class	II according to IEC 61140:2016
Electromagnetic compatibility	EN 50121-3-2 ed.4
Overvoltage category / testing voltage	III, according to IEC 60664-1:2007
Pollution degree	2, according to IEC 60664-1:2007
Recommended protection	6 A / gG
Duty type	permanent, any position

Table 5: Technical parameters of HIG24VDC-L, HIG48VDC-L, HIG72VDC-L, HIG110VDC-L, part 2

6 Controls and connecting terminals



Picture 3: Terminals designation

Green indicator lamp ON

It shines when device is connected to the power supply. It glimmers slightly after module activation.

Yellow indicator lamp KA1, KA2

Status signalization of *KA1* and *KA2* relays.

Display

It serves to display the measured values, to show the meaning of the *S1* to *S3* pushbuttons, to set the parameters and to display important information. For description of displayed information see page 11, Displayed information. The display will go off if no button is pressed during 5-minute period and will be restored by pressing any button. The device is operational even if the display is not active.

Left push-button S1

This is a device control button whose meaning in each menu is shown on the display. When the *R+/R-* insulation resistance level viewed, this button has the meaning of *TEST* push-button. See chapter Displayed information, page 11.

Middle push-button S2

This is a device control button whose meaning in each menu is shown on the display. It initiates transition to the menu selection screen if *R+* and *R-* levels are only displayed.
Holding this button when menu is displayed initiates displaying *R+* and *R-* back again.

Right push-button S3 MENU

This is a device control button whose meaning in each menu is shown on the display. It initiates transition to the menu selection screen if the *R+* and *R-* levels are only displayed.
Within the parameter setting 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 C(+), D(-)

These terminals are designed to connect the device to the monitored IT power supply system and also serve to connect the device to the power supply

Nominal voltage of HIG24VDC(-L) is 24 V⎓. Minimum and maximum power supply voltage of the device is 12 to 36 V⎓.
Nominal voltage of HIG48VDC(-L) is 48 V⎓. Minimum and maximum power supply voltage of the device is 32 to 60 V⎓.
Nominal voltage of HIG72VDC(-L) is 72 V⎓. Minimum and maximum power supply voltage of the device is 55 to 90 V⎓.
Nominal voltage of HIG110VDC(-L) is 110 V⎓. Minimum and maximum power supply voltage of the device is 75 to 140 V⎓.

Terminal PE

Functional grounding. This terminal is intended to connect the reference point of the insulation status measurement of the monitored IT power supply system, see chapter *Recommended connection of the device*, page 10.

Terminals of KA1, KA2 signalling relay

Potential-free switching contact of the monitored IT power supply system status signalling. Function of both relays is set in the user's menu ***Set KA1/KA2***. In this menu it is possible to set the insulation status fault signalization of the positive power supply pole, negative power supply pole, both poles of the power supply, then device testing process or internal device fault. For description see chapter Displayed information, page 11.

Terminal +TEST

This terminal serves to connect the remote test push-button. Remote test push-button is connected between the *TEST* and *+12V* terminal.

Terminal DEBLOCK

This terminal serves to connect the push-button for releasing the insulation status fault signalization while the fault memory function is active. Switch push-button is connected between the *DEBLOCK* and *+12V* terminal.

Terminal +12V

This terminal serves to connect the remote test push-button and the insulation status fault signalization release push-button, see recommended connection of the device.

Terminals A, B, SH

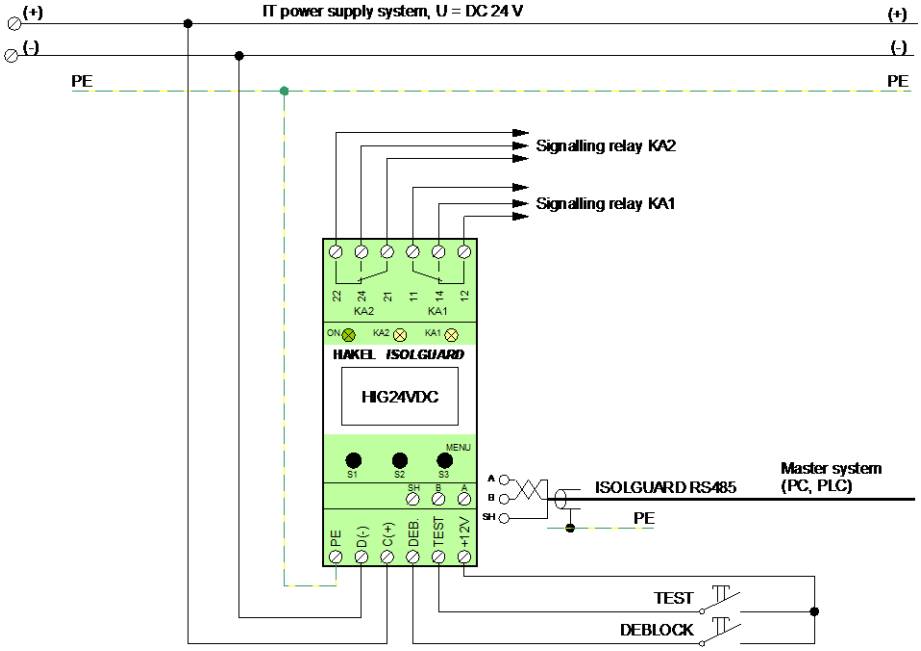
Terminals intended to connect the *RS485 ISOLGUARD* communication line. This line is galvanic isolated. Individual insulation monitoring device is connected with twisted pair between *"A"* and *"B"* terminal. The *SH* terminal is intended to connect the signal ground using a connecting cable. For description of the communication line see chapter *Communication protocol*.

Note:
Terminals +12, TEST, DEBLOCK are solely designed for connecting the buttons according to recommended connections. No other devices can be connected via these terminals.

7 Recommended connection of HIG**VDC

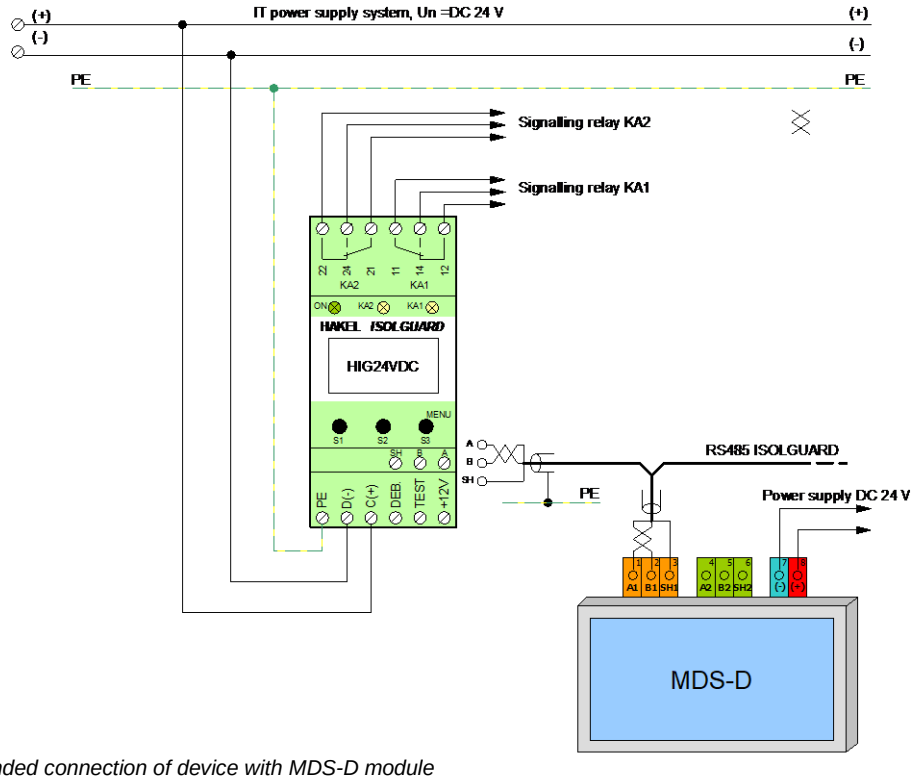
The below listed connections apply analogously to all types of insulation monitoring devices (i.e., HIG24VDC, HIG48VDC, HIG72VDC, HIG110VDC, HIG24VDC-L, HIG48VDC-L, HIG72VDC-L, HIG110VDC-L). The only difference is the nominal voltage of the monitored isolated system.

7.1 HIG24VDC device, IT power supply system DC 24 V, status signalling with relay contacts, remote test with push-button



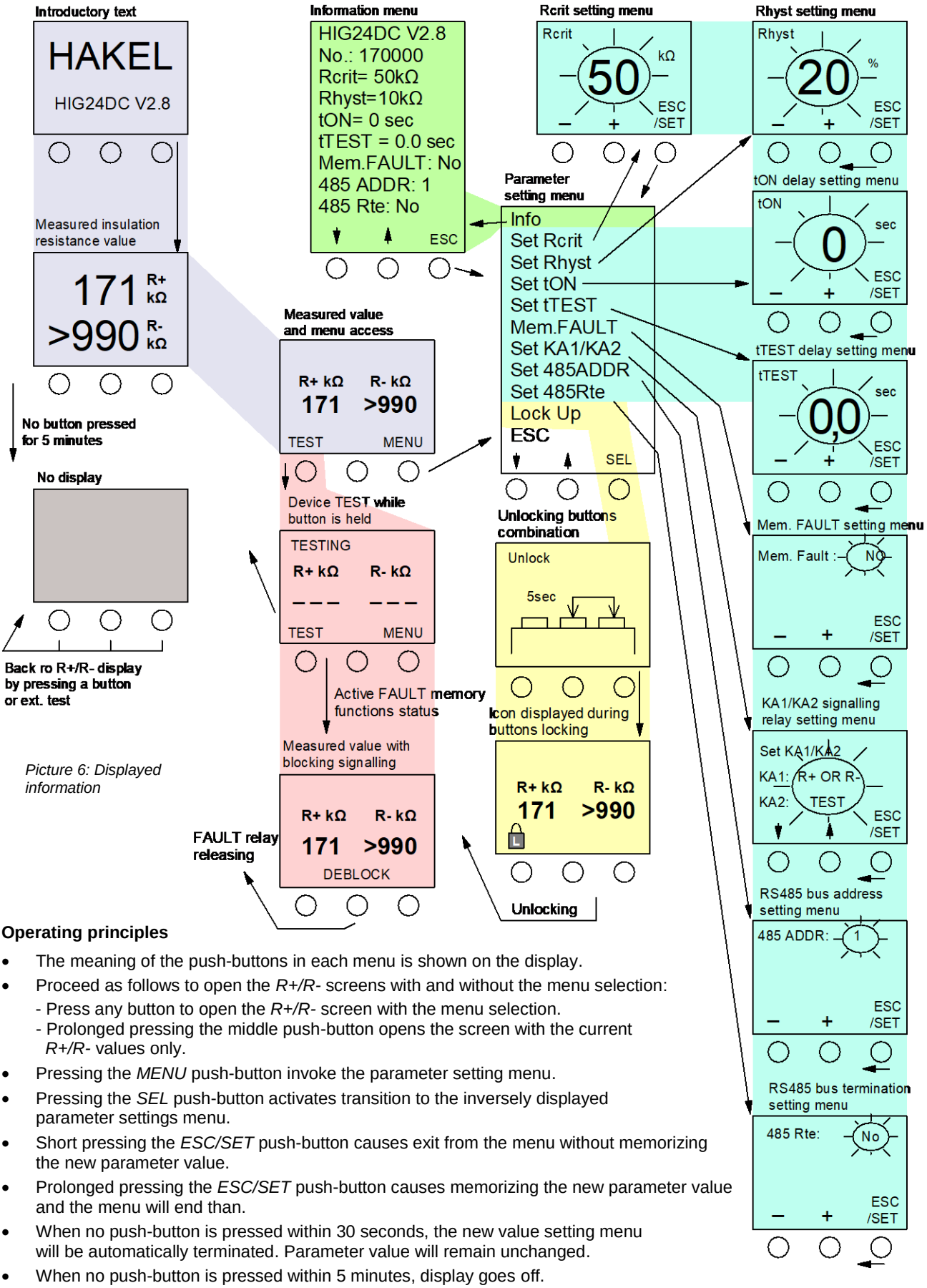
Picture 4: Recommended connection of device

7.2 HIG24VDC device, IT power supply system DC 24 V, MDS-D remote monitoring module connection



Picture 5: Recommended connection of device with MDS-D module

8 Information on the HIG24VDC display (same for the all nominal voltage variants)



Picture 6: Displayed information

Operating principles

- The meaning of the push-buttons in each menu is shown on the display.
- Proceed as follows to open the *R+/R-* screens with and without the menu selection:
  - Press any button to open the *R+/R-* screen with the menu selection.
  - Prolonged pressing the middle push-button opens the screen with the current *R+/R-* values only.
- Pressing the *MENU* push-button invoke 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 the menu will end than.
- When no push-button is pressed within 30 seconds, the new value setting menu will be automatically terminated. Parameter value will remain unchanged.
- 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.

8.1 Displayed information

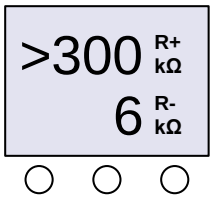
Opening text

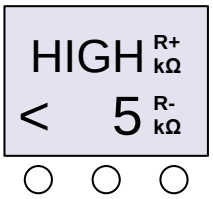
It is displayed for a short time after switching on the device. The name of the device and software version is displayed. After the insulation status measuring is started, the measured value of insulation resistance is displayed automatically.

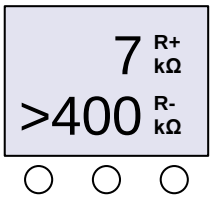
Measured value of insulation resistance

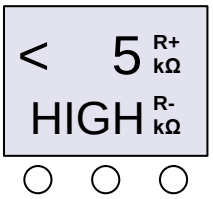
This value is displayed within the range of 5 to 990 kΩ for HIG24VDC, HIG48VDC, HIG72VDC, HIG110VDC devices and in the range of 2 to 550 kΩ for HIG24VDC-L, HIG48VDC-L, HIG72VDC-L, HIG110VDC-L devices. The values above 300 kΩ are rounded to tens of kΩ.

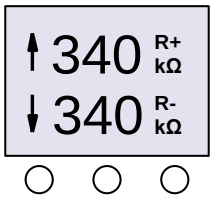
If the insulation resistance of the monitored power supply system is significantly lower in one branch than in the other branch, the value in the high-resistance branch is shown as tentative data either as a figure preceded by the ">" symbol or as the "HIGH" text only. There was a rapid insulation status change if an arrow is displayed before the value R.



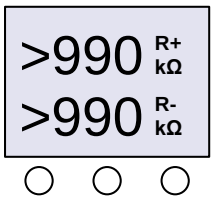


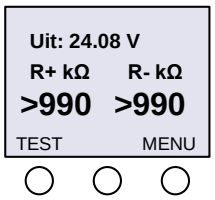






The insulation resistance values are shown in two different formats. In the first format only ***R+*** and ***R-*** values with maximum digits size are displayed. By pressing any button second format is displayed, where ***R+*** and ***R-*** values are completed with the contact symbol and with the option to enter the menu or device test. By short pressing the middle push-button the measured voltage of the monitored power supply system can be viewed. Prolonged pressing the middle push-button displays the first format of ***R+/R-*** again.





Pressing ***TEST*** push-button activates test of the device, pressing ***MENU*** push-button displays the parameters setting menu. Prolonged pressing the middle push-button displays *R+* and *R-* values back again without menu. The signalling relay status is indicated by the symbol of contact. If signalling relay is released (there is no fault in the monitored power supply system), the open contact is displayed. If there is a ***FAULT*** signalled, the close contact is displayed.

In a case the non-zero value for the time t_{ON} (time until the fault signalling) is set, then when *R+* or *R-* drops below the R_{crit} value the countdown of the time t_{ON} will start. After the time t_{ON} is expired, the fault is signalled.

Test of the insulation monitoring device

Test may be performed by pressing the push-button on the module, by the remote ***TEST*** button or by sending an order through the *RS485 ISOLGUARD* communication line.

Device test is performed for at least 5 seconds or during the time of holding the push-button and is signalled by indicator lamp. Insulation resistance value is set lower than R_{crit} value. Invoked alarm is signalled by indicator lamp and also by inactive status of signalling relay ***KA2*** in a case of TEST function setting. The insulation resistance value is not shown on the display while testing.

Remote test through the communication line is performed immediately after receiving the order and takes 5 seconds.

FAULT memory

This parameter is set in the menu as *Mem.FAULT*.

If this parameter is set to *YES* value, the relay signalling the *R+*/*R-* faults status stays in the fault signalling status even after insulation resistance fault termination. This status is indicated by word *DEBLOCK* on the display. It is possible to release the relay by pressing middle S2 push-button on the device or by remote *DEBLOCK* button. This push-button can be used even when locked device is indicated by the padlock symbol on the display. Relay can be also released by the order from the communication line.

The usage of the *Mem FAULT* memory including relay status after fault termination is defined by the user.

Parameters setup menu

Menu to set one of the following values can be selected by using push-buttons arrow up and down

- display of device's set parameters, menu ***Info***
- monitored critical resistance, menu ***Set R_{crit}***.
- insulation resistance hysteresis, menu ***Set R_{hyst}***
- delay in response of signalling the fault, menu ***Set t_{ON}***
- delay in start of module test by remote test push-button, menu ***Set t_{TEST}***
- *FAULT* memory parameter, menu ***Mem.FAULT***
- signalling relays function setting, menu ***Set KA1/KA2***
- device addresses on the RS485 bus, menu ***SET 485ADDR***
- terminating resistance ***R_{te}*** of the RS485 bus in the device, menu ***Set 485Rte***

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

Information menu

Displays control program version of the device and set operation parameters of the device. Serial number of the device is also displayed. For exit select the push-button ESC

Menu Set R_{crit}

New value of the critical insulation resistance is set in kΩ by pressing or holding the **+** or **–** push-buttons. The value can be set in the range of 5 kΩ to 500 kΩ for HIG24VDC, HIG48VDC, HIG72VDC, HIG110VDC- devices and in the range of 2 kΩ to 500 kΩ for HIG24VDC-L, HIG48VDC-L, HIG72VDC-L, HIG110VDC-L devices. New value is saved by long holding the ***ESC/SET*** push-button, pressing this push-button shortly ends setting procedure and R_{crit} value remains unchanged. R_{crit} parameter corresponds semantically to the R_{an} parameter according to IEC 61557-8.

Menu Set R_{hyst}

New value of the critical insulation resistance hysteresis is set in % by pressing or holding the **+** or **-** push-buttons. The value can be set in the range of 0 to 100 % R_{crit}. New value is saved by long holding the ***ESC/SET*** push-button, pressing this push-button shortly ends setting procedure and the R_{hyst} value remains unchanged. Minimum hysteresis value is 1 kΩ.

Menu Set t_{ON} time

New value of the delay in response of the *FAULT* is set in seconds by pressing or holding the **+** or **–** push-buttons. The value can be set in the range of 0 to 60 sec. New value is saved by long holding the ***ESC/SET*** push-button, pressing this push-button shortly ends setting procedure and t_{ON} value remains unchanged

Menu Set t_{TEST} time

New value of the delay in device test start when pressing remote test push-button is set in seconds by pressing or holding the **+** or – push-buttons. The value can be set in the range of 0 to 6 seconds at 0,1 second step. New value is saved by long holding the ***ESC/SET*** push-button, pressing this push-button shortly ends setting procedure and t_{TEST} value remains unchanged.

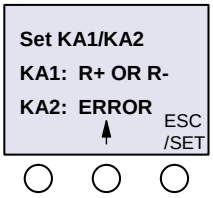
When setting t_{TEST} value greater than 0 the display is re-activated immediately after pressing the remote test button

Menu Set Mem.FAULT

Menu for setting the insulation status fault memory. This parameter can be set to ***YES***, when the relay remains in alarm signalling status even after the fault is terminated and the button on the device must be pressed by the operator to release the relay. Parameter can be also set to ***NO*** without fault memorizing. An order through the RS485 communication line can also release the relay.

Menu Set KA1/KA2

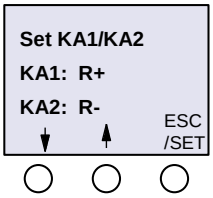
Menu for setting the signalling relay *KA1* and *KA2*. It is possible to set 3 different combination of relay *KA1* and *KA2* function in this menu.



This option sets:

Relay *KA1* with ***R+ OR R-*** function. Relay *KA1* signals the insulation status fault in positive or negative branch of the monitored system's source.

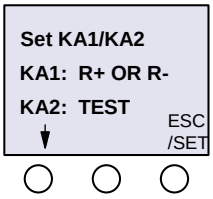
Relay *KA2* with ***ERROR*** function. Relay *KA2* switches on fault of insulation status evaluation. Device does not measure the insulation resistance.



This option sets:

Relay *KA1* with ***R+*** function. Relay *KA1* signals the insulation status fault in positive branch of the monitored system's source.

Relay KA2 with ***R-*** function. Relay *KA2* signals the insulation status fault in negative branch of the monitored system's source.



This option sets:

Relay *KA1* with ***R+ OR R-*** function. Relay *KA1* signals the insulation status fault in positive or negative branch of the monitored system's source.

Relay *KA2* with ***TEST*** function. *Relay KA2* switches when the module test is invoked.

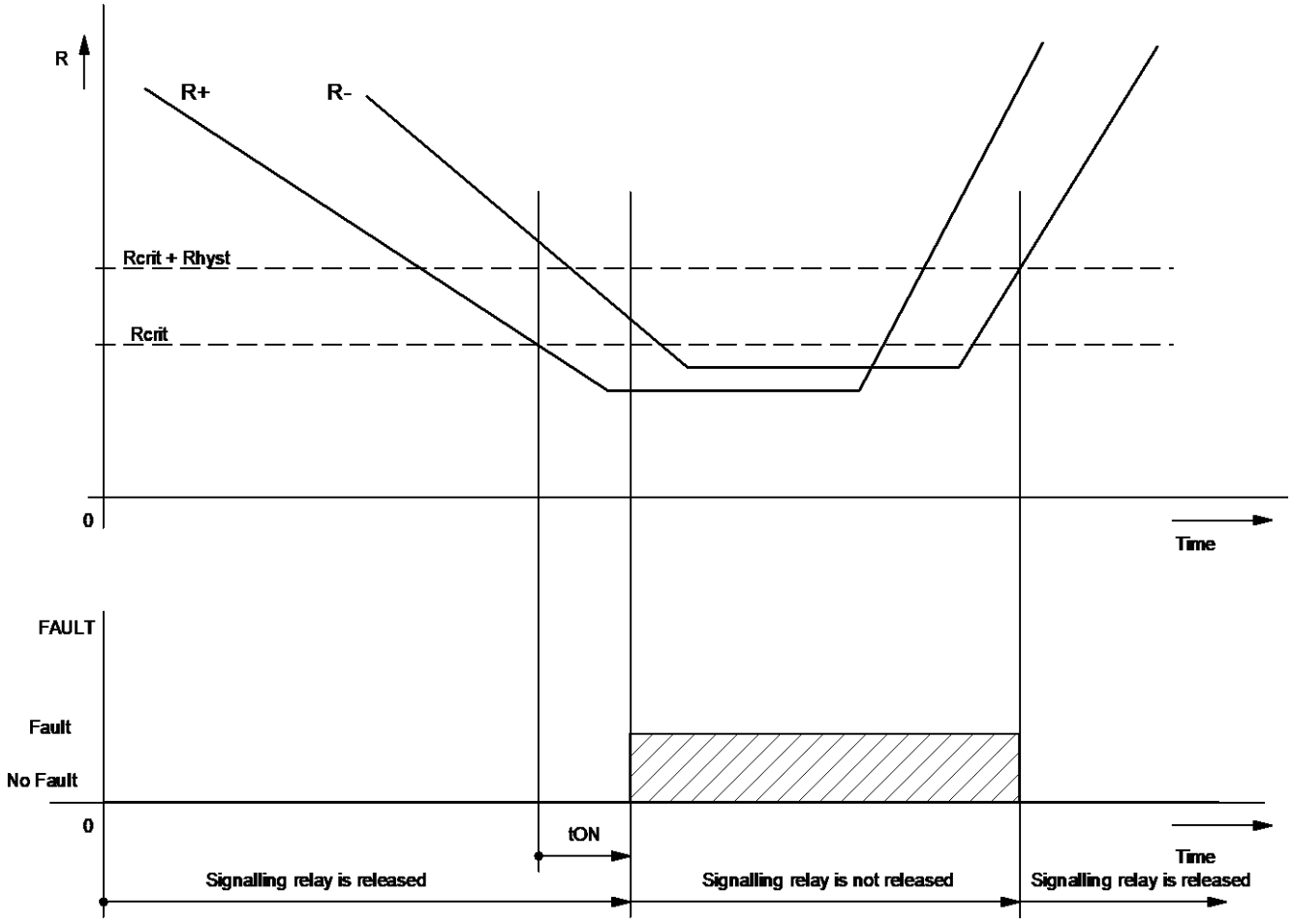
The requested function is selected by means of the above options always for both relays simultaneously. New value is saved by long holding the ***ESC/SET***

Menu Lock Up

Menu is intended for locking the device's control buttons. After selecting this menu, button combination for unlocking the module is shown while holding the push-button. After exiting the menu, the measured R_{isol} value and device lock symbol is displayed. The module is unlocked while holding the middle and right push-button together for more than 5 sec.

9 Insulation status fault evaluation

Evaluation of a *FAULT* with the effect of set t_{ON} and R_{hyst} parameter levels is shown in the following figure.

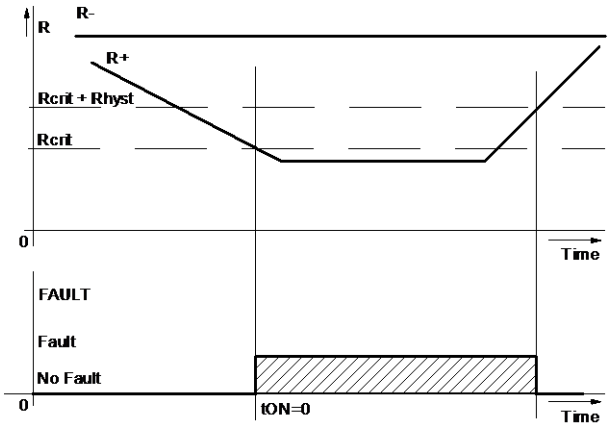


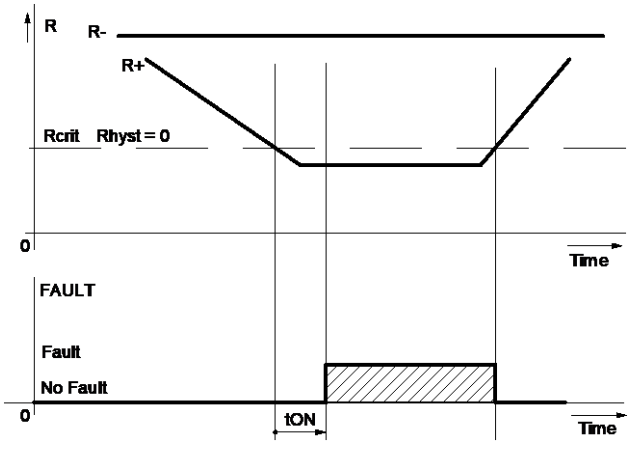
Picture 7: Insulation resistance fault evaluation

In this example, the set non-zero value for t_{ON} and hysteresis R_{hyst} is shown. When the insulation resistance value of the monitored power supply system ***R+*** or ***R-*** decreases below R_{crit}, the countdown of the time t_{ON} starts. The remaining time is displayed. Once the time t_{ON} is expired, the fault is signalized and the indicator lamp on the device lights up. Signalling relay release is cancelled and its contacts are set to the rest position. The *FAULT* is only terminated, when both insulation resistance **R+** and **R-** levels increase above the $R_{crit}+R_{hyst}$ value. The signalling relay is released and the *FAULT* signalling is terminated.

The *FAULT* is evaluated according to the equation: *FAULT = FAULT(R+) or FAULT(R-).*
Setting of the function *FAULT* occurrence evaluation is done in the ***Menu Set KA1/KA2.***

The following left figure shows fault evaluation process when insulation monitoring device is set with zero value t_{ON}. The following right figure shows example of setting the device with zero value hysteresis R_{hyst}.





Picture 8: Insulation status fault evaluation with RtON or hysteresis zero value

10 Communication protocol

Unit HIG**VDC communicates via the industrial *RS485 ISOLGUARD* bus using the protocol based on the PROFIBUS protocol. Communication proceeds in the request – response mode. One MASTER station has to be connected to the bus, whereas this MASTER station sends requests to other SLAVE stations. Slave stations only respond to requests, they never start communication. Unit HIG24VDC is in position of the slave station.

Individual stations are connected with twisted pair (TWISTED PAIR - TP). One 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 HIG**VDC device 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 RS485 bus 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 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.

MDS-D type of module, made by HAKEL, is used as a MASTER station for ISOLGUARD system. This module serves to remote display of measured values and set parameters and also allows data transferring to the user's master system. Detailed description of HIG**VDC communication protocol is given in the programming manual.

PC computer or control unit with RS485 communication line can be also used as the MASTER station.

RS485 ISOLGUARD line parameter setting

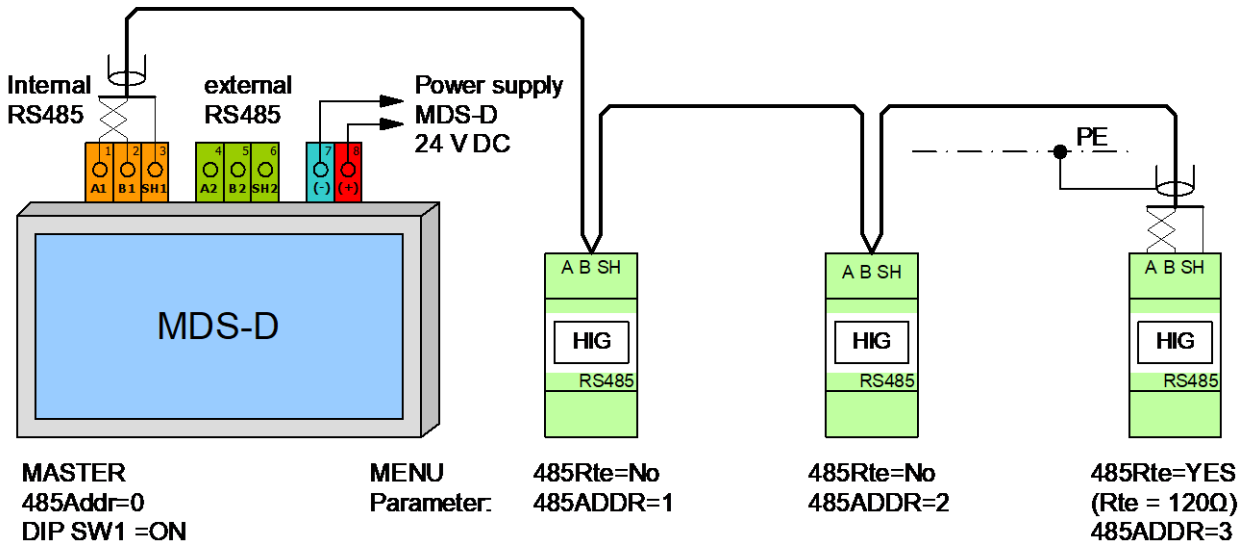
Menu ***Set 485ADDR*** and ***Set 485Rte*** may be selected in the parameter settings menu.

Menu ***Set 485ADDR*** serves for setting the address of HIG24VDC device on the RS485 bus. The setting range for the address is 1 to 126.

Menu ***Set 485Rte*** serves for setting the connection of an internal terminating resistor R_{te} to the RS485 line. This parameter may be set to ***YES*** (when the resistance 120Ω is internally connected to the RS485 line of the module), or ***NO*** (without connected resistance).

Communication between HIG devices and MDS-D remote monitoring module

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



Picture 9: RS485 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 RS485 line (A2 B2) in the ON position.

11 Data transmitted via *RS485 ISOLGUARD* bus

Insulation monitoring device (v3.2) communicates on the RS485 bus by using the ISOLGUARD communication protocol (v1.1). This protocol was designed by HAKEL as a universal command system for reading data from insulation monitoring devices and additional products.

ISOLGUARD communication protocol differentiates between basic transmitted data types:

- identification data, through which the device displays its type designation
- information messages about the unit status, text description of the current status
- measured data, information on currently measured quantities and their status
- device parameters, that contain the device settings values

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

Measured data and parameters are sent in individual information blocks. Each information block contains the alphanumeric name, numerical value and units in which the value is sent. 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 devices and should be ignored by the user application.

The meaning of each character and the correct form of the protocol commands are described in the ISOLGUARD Protocol Programming Manual. Data that can be read from the HIG**VDC using this protocol are listed in the tables below.

Measurement data

Quantity	Name	Value (e,g.)	Units
Insulation resistance of IT system's positive branch	R_p	500	kΩ
Insulation resistance of IT system's negative branch	R_n	123	kΩ

Table 6: Measurement data transmitted via ISOLGUARD bus

Parameters data

Parameter name	Name	Value (e.g.)	Units	Priority	R/W
Critical limit of insulation resistance	R_{crit}	50	kΩ	1	R/W
Device address on the RS485 line	485ADDR	1	- - -	1	R/W
Insulation resistance hysteresis	R_{hyst}	50	%	2	R/W
Delay in response of signalling the insulation resistance fault	t_{ON}	0	Sec.	3	R/W
Delay in device test start	tTEST	0.5	Sec.	3	R/W
Using the fault memory function	FA.MEM	1 (Yes) / 0 (No)	- - -	4	R/W
Connection of terminating resistance of the RS485 line	485Rte	1 (Yes) / 0 (No)	- - -	0	R/W
KA1 and *KA2 signalling relays function*	KA1/KA2	0 = KA1: FAULT Rp or Rn, KA2: ERROR		0	R/W
		1 = KA1: FAULT Rp; KA2: FAULT Rn			R/W
		2 = KA1: FAULT Rp or Rn; KA2: TEST			R/W

Table 7: Measurement data transmitted via ISOLGUARD bus

12 HIG24VDC parameters factory settings

Device parameters are set to default values during production:

Parameter	Menu	Symbol	Value
Critical insulation resistance	Set Rcrit	R_{crit}	50 kΩ
Insulation resistance hysteresis	Set Rhyst	R_{hyst}	20 %
Delay in response of signalling the fault	Set tON	t_{ON}	0 sec
Delay in device test start by remote test button	Set tTEST	t_{TEST}	0.0 sec
FAULT memory	Mem.FAULT	Mem.FAULT	No
Module address	Set 485ADDR	485 ADDR	1
Terminating resistance of the RS485 line	Set 485TE	485 R_{te}	No
KA1 and KA2 signalling relays function	Set KA1/KA2	KA1/KA2	KA1: FAULT Rp or Rn, KA2: ERROR

Table 8: Factory settings of device's parameters

Note: Parameters meaning of RS485 line is given in communication protocol description.

13 Installation instructions

Operation, installation and maintenance of this device 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.

13.1 Standard assembly of the device

HIG24VDC(-L), HIG48VDC(-L), HIG110VDC(-L) is intended for assembling on 35 mm DIN rail according to EN 60715. Any working position.

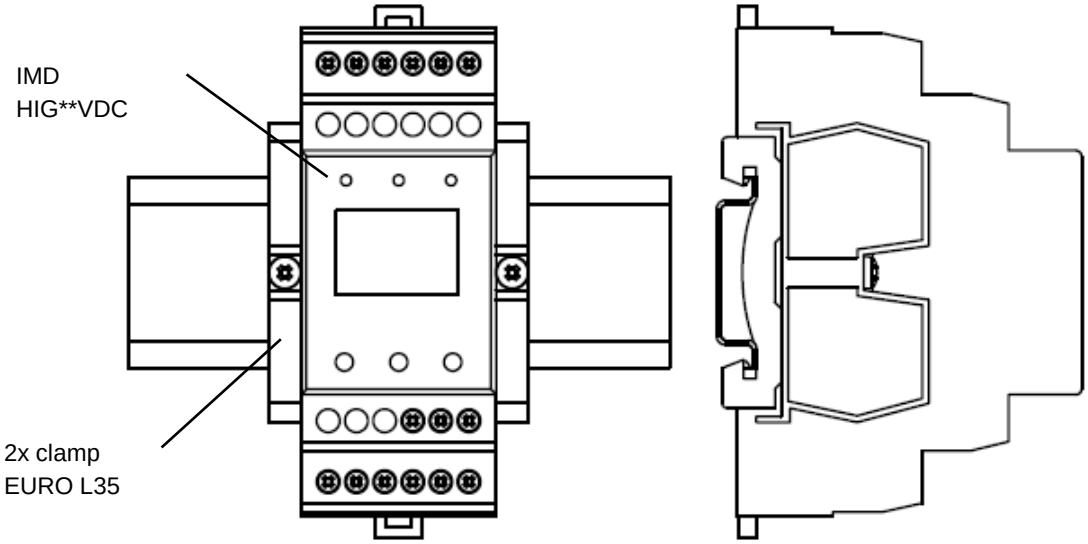
- *PE* terminal must be connected by separate conductor to the PE bridge.
- *C(+)* and *D(-)* terminals are connected to the monitored system.
- *+12, TEST, DEBLOCK* are solely designed for connecting the buttons according to recommended connections. No other devices can be connected via these terminals.
- It is possible to use *485 Rte* setting in device menu for *RS485 ISOLGUARD* bus termination.
- Follow the *RS485 ISOLGUARD* bus line connection, any taps are not.
- Install only one cable type along the whole length of the *RS485 ISOLGUARD* bus.

13.2 Installation for rail vehicles

The manufacturer specifies a set under the designation **HIG**VDC/T**, with own article number, for installation of HIG**VDC device in rail vehicles.

The design of HIG**VDC/T is supplied including accessories for assembly. It undergoes further tests during the expedition according to EN 50155.

In rail vehicles applications apply, that the device is installed on DIN35 rail between two EURO L35 terminals. These EURO L35 terminals are part of the HIG**VDC/T delivery.



Picture 10: Device assembly in railway applications

13.3 Table of article numbers for installation in rail vehicles

Standard, industrial type	Type designation for rail vehicles	Article number of type for rail vehicles
HIG24VDC	HIG24VDC/T	70 933/T
HIG48VDC	HIG48VDC/T	70 935/T
HIG72VDC	HIG72VDC/T	70 942/T
HIG110VDC	HIG110VDC/T	70 934/T
HIG24VDC-L	HIG24VDC-L/T	70 933L/T
HIG48VDC-L	HIG48VDC-L/T	70 935L/T
HIG72VDC-L	HIG72VDC-L/T	70 942L/T
HIG110VDC-L	HIG110VDC-L/T	70 934L/T

14 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 ensure maximum admissible temperature of the environment.

Only qualified personnel are allowed to install and set up the device and the instructions in this documentation must be followed. 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 system's status.

15 Producer

Producer of HIG24VDC, HIG48VDC, HIG72VDC, HIG110VDC, HIG24VDC-L, HIG48VDC-L, HIG72VDC-L, HIG110VDC-L insulation monitoring device is

HAKEL spol. s r. o.,

Bratří Štefanů 980, 500 03 Hradec Králové, Czech Republic, www.hakel.com