ISOLGUARD Insulation monitoring device HIG93T/24

The insulation monitoring device HIG93T/24 produced by HAKEL for the ISOLGUARD series is designed for monitoring the insulation status of single-phase and 3-phase ungrounded IT power supply systems, is designed and operated according to standards IEC 61010-1, IEC 60364-4-41:2007.

This device is intended for use on traction vehicles. It enables monitoring of single-phase and 3-phase ungrounded IT power supplies systems up to the maximum operating voltage 275V AC, eventually 3x275V AC. If the insulation status monitoring of a single-phase or 3-phase ungrounded IT power supply system with higher operating voltage is required, it is necessary to create an artificial centre using TL400T or TL500T inductors produced by HAKEL. Such a created centre is connected to the terminal of insulation monitoring device HIG93T/24.

There are signalling LED diodes for displaying the status of monitored power supply system and of the device.

HIG93T/24 device is equipped with RS485 communication line and can communicate with the master computer via industrial RS485 bus with the protocol based on the PROFIBUS protocol. Description of the protocol is available on request.

Two inbuilt signalling relays with switching contacts enable alarm signalling for two independently set values of critical insulation resistance. The insulation monitoring device has an optional alarm memory function with the option to terminate the alarm using the button on the insulation monitoring device. Local and remote testing of the insulation monitoring device function can be done.

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

HAKEL ISOLGUARD HIG93T/24

Model	Display Menu	Signalling relay 1	Signalling relay 2	Range of displayed value	Critical insulation resistance	RS485	Supply voltage	SW
HIG93T/24	No	1P	1P	5 kΩ to 900 kΩ	Adjustable 5 kΩ to 300 kΩ	Yes	24 V DC	V5.6
Art. No. 70 937								

Note: 1P signalling relay with one switching contact

HIG93T/24 device satisfies standards:

- IEC 61010-1
- IEC 60364-4-41:2007
- IEC 61557-8
- EN 50155
- EN 61373
- EN 45545-2
- EN 50121-3-2

Basic characteristics

- Insulation monitoring device for AC systems with 90 to 275 V voltage without additional devices, for greater voltages additional inductor is needed
- Certified for use on traction vehicles
- Two insulation resistance status signalling relays equipped with switching contact
- The possibility to read the current value of insulating resistance with RS485 communication line
- Connection to RS485 bus, insulation strength 2500 V_{rms} against the internal circuits and network circuits
- Optional memory of the invoked alarm with possibility to unlock by button on the device
- Option to set two values of monitored insulation resistance R_{crit1} and R_{crit2} via the RS485 communication line in the range of 5 kΩ to 300 kΩ
- Adjustable hysteresis of the insulation resistance limit value in the range from 0 to 100 % via RS485 communication line
- Adjustable t_{ON} signalling relay response delay via RS48 in the range from 0 to 60 seconds
- Separate supply voltage also allows to monitor IT power supply systems, which are not under voltage
- 2M (36 mm) module width for assembling on DIN rail 35
- It is required to comply with specified method of mounting by clamps while using on rail vehicles. These clamps are included.

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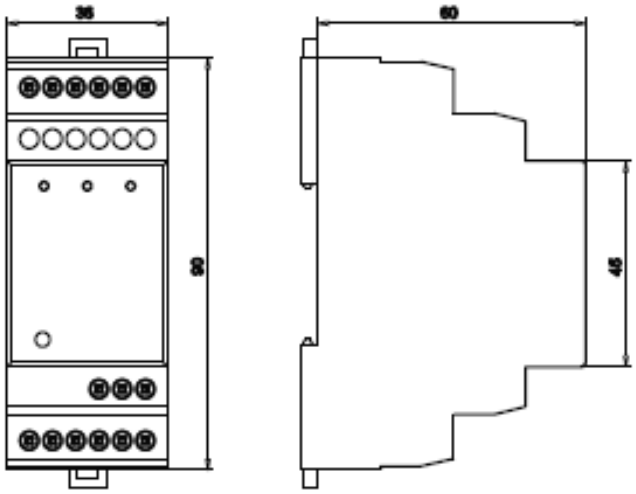
Technical characteristics – ISOLGUARD HIG93T/24

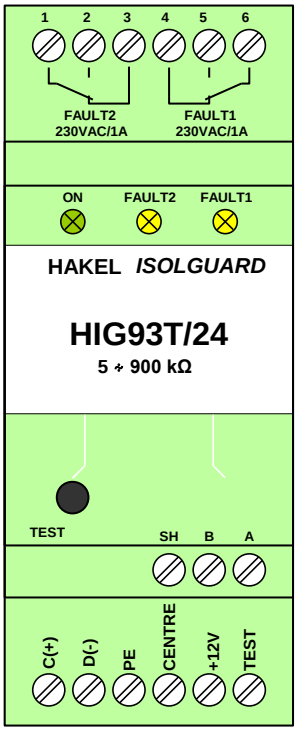
Type		HIG93T/24
Supply voltage range	U_n	18 ÷ 36 V DC
Maximum IT power supply system operating voltage (without external inductor)	U_{it}	275 V AC
Power consumption	P	max. 5 VA
Measuring voltage	U_m	12 V DC
Measuring current	I_m	< 0,6 mA
Internal resistance of the measuring input	R_i	> 220 kΩ
Displayed value's range	R_{isol}	5 kΩ ÷ 900 kΩ
Measurement accuracy 5 kΩ ... 10 kΩ 10 kΩ ... 900 kΩ		2 kΩ ± 10%
Critical insulation resistance	R_{crit1}, R_{crit2}	adjustable 5 kΩ ÷ 300 kΩ
Insulation resistance hysteresis	R_{hyst}	adjustable 0 ÷ +100% R_{crit}
Delay in response of signalling	t_{ON}	adjustable 0 ÷ 60 sec
Outputs		
Signalling relay 1 potential-free switching contact electrical strength to the internal circuits and supply circuits		230 V AC / 1A 3750 Vrms
Signalling relay 2 potential-free switching contact electrical strength to the internal circuits and supply circuits		230 V AC / 1A 3750 Vrms
Signalling relay 2 Signalling potential-free switching contact Electrical strength to the internal circuits and supply circuits		Yes 2500 Vrms
General data		
Degree of protection according to IEC 60529		IP20
Weight	m	144 g
Housing material		PA - UL 94 V0
Method of assembly		on the 35 DIN rail It is required to comply with specified method of mounting by clamps while using on rail vehicles
Recommended section of the connected conductors	S	1 mm^2
Article number		70 937

Operating conditions	
Operating temperature	-25°C ~ +60°C
Atmospheric pressure	86 ÷ 106 kPa
Operating position	any
External magnetic and electric field	max. 400A/m
Overvoltage category / testing voltage	III, according to standard IEC 60664-1:2007
Pollution degree	2, according to standard IEC 60664-1:2007
Duty type	permanent

Dimensional sketch



Controls and connecting terminals of HIG93T/24 modules



Green indicator lamp ON

This control lights up when the supply voltage is connected. It glimmers slightly after module activation.

Yellow indicator lamp FAULT1

It lights up, when the measured insulation resistance value is lower than the set critical resistance R_{crit1} value. It even lights after the fault status removal, if the fault memory function is active. At the same time, this status is signalled by the FAULT1 relay contacts.

Yellow indicator lamp FAULT2

It lights up, when the measured insulating strength value is lower than the set critical resistance R_{crit2} value. It even lights after the fault status removal, if the fault memory function is active. At the same time, this status is signalled by the FAULT2 relay contacts.

Left push-button TEST

This is a module control button intended for device test. Testing of the insulation monitoring device is performed for 5 seconds or during the time of holding the button. Insulation resistance value is set lower than R_{crit1} and R_{crit2} value. Invoked alarm is signalled by indicator lamp ***FAULT1, FAULT2*** and by inactive status of signalling relay. The test is performed immediately after pressing the Test push-buttons.

Svorky C(+), D(-)

Připojení napájecího napětí modulu. Napájecí napětí je 18 až 36 V DC.

Terminals CENTRE, PE

Input terminals for the insulation resistance measurement, see recommended connections of the insulation monitoring device. If the monitoring of IT power supply system with operational voltage higher than 275 V AC (without brought-out neutral conductor) is required, it is necessary to create an artificial centre using TL* inductors. This way created neutral is connected to the *CENTRE* terminal then. The value of external inductor DC resistance is set within the Parameter setting menu.

Terminals of the signalling relay FAULT1 230 V AC/1A

Terminals of the signalling relay FAULT2 230 V AC/1A

Potential-free switching contact for signalling the status of the monitored IT power supply system. Relay ***FAULT1*** (***FAULT2***) is released, when the device is connected to the power supply, is functional (the indicator lamp *ON* glimmers slightly) and the insulation resistance of the monitored system is higher than the set critical value R_{crit1} (R_{crit2}).

When R_{isol} is displayed the status of signalling relay's contacts is indicated by the symbol of contact. If both relays are released, the open contact is displayed. In case of fault, the close contact is displayed.

Terminal TEST

Terminal for connection with the remote test push-button. Remote test push-button is connected between *TEST* and *+12V* terminals. When using the remote test push-button, the test starts after t_{TEST} parameter delay

Terminal +12V

Terminal for connection with the remote monitoring push-button. See recommended connections of the insulation monitoring device.

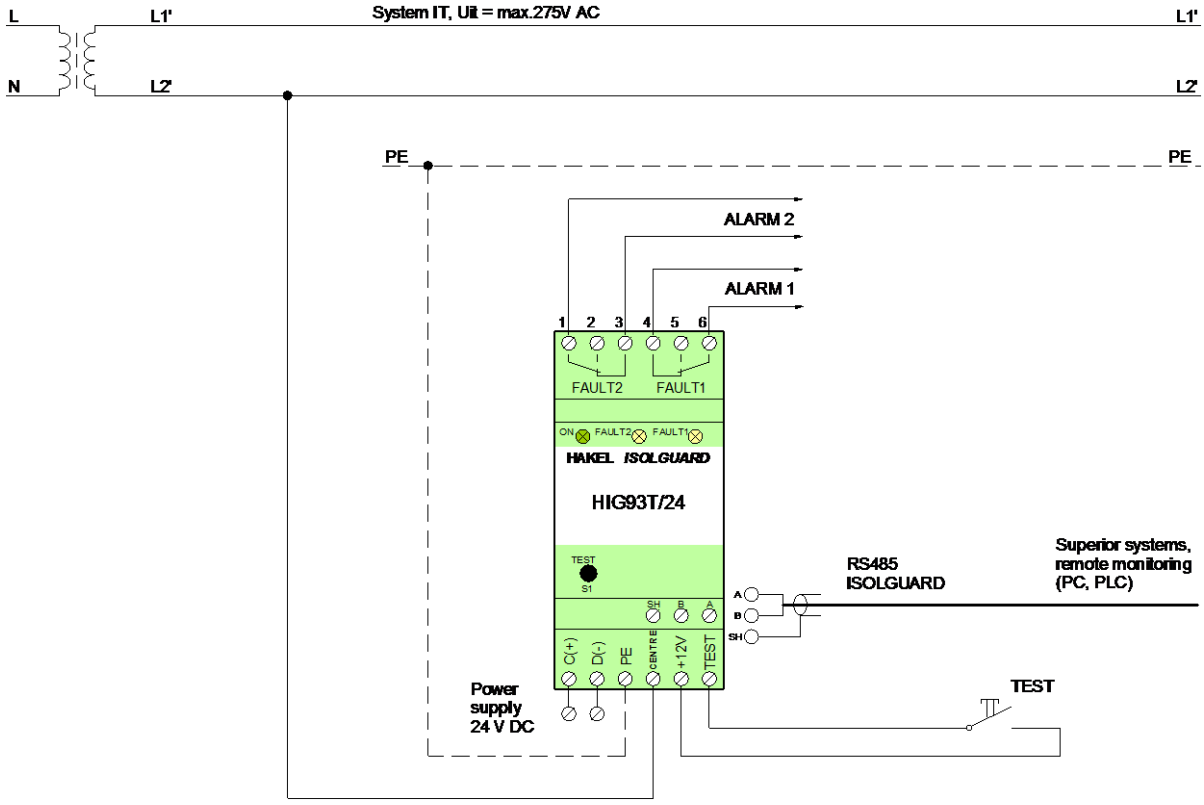
Terminals A B SH

These terminals are intended for connection of galvanic isolated communication line RS485. Individual insulation monitoring devices are connected with twisted pair between A and B conductors. The terminal SH serves for connection of shielded interconnecting cable. For description of the communication line, see page 11. This line may be also connected with a remote monitoring module MDS-D with display.

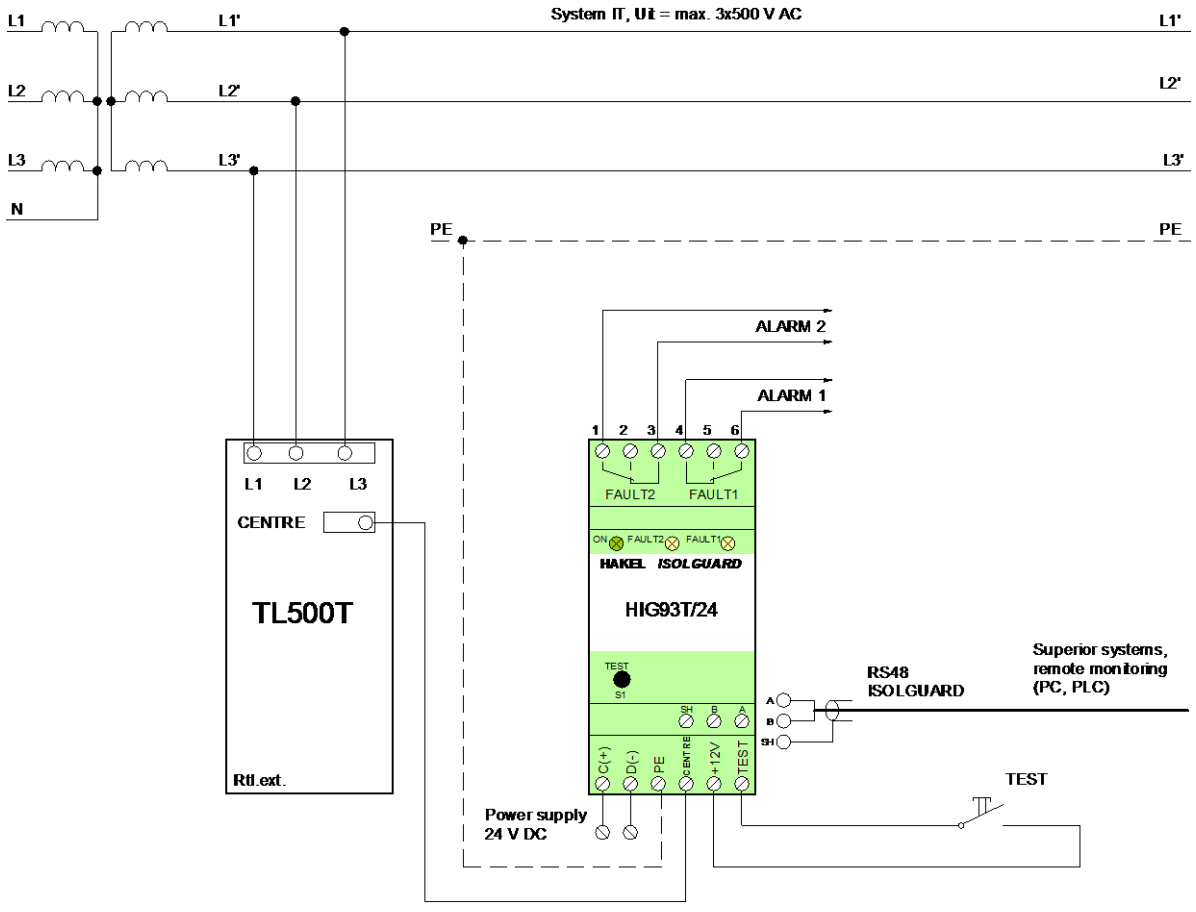
Note: Terminals +12V and TEST are exclusively intended for connection of the test push-button. These terminals cannot be used for connection of any other devices.

Recommended connection of HIG93T/24 to the monitored IT system

Single-phase IT system (maximum 275 V AC), HIG93T/24 with alarm signalling and with the remote test push-button



Three-phase IT system (3x500 V AC), HIG93T/24 with alarm signalling and with the remote test push-button



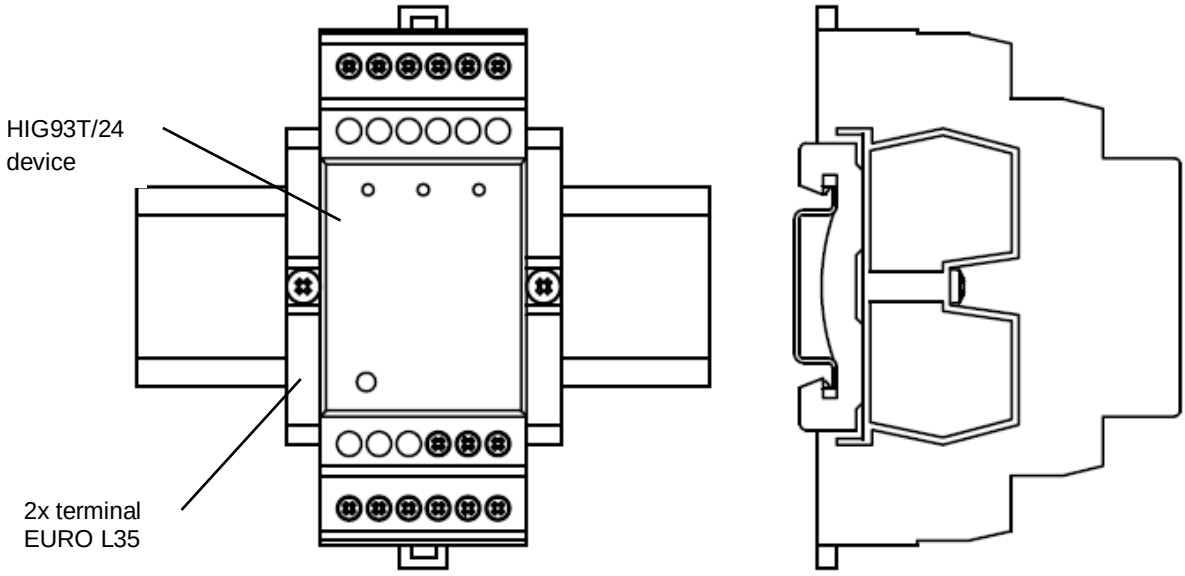
Method of assembly

Standard device assembly

HIG93T/24 device is standardly assembled on the 35 DIN rail according to EN 60715:2001.

Rail vehicles assembly

While rail vehicles application the device is installed on the 35 DIN rail between two terminals EURO L35. These terminals EURO L35 are included with the HIG9T/24 device.

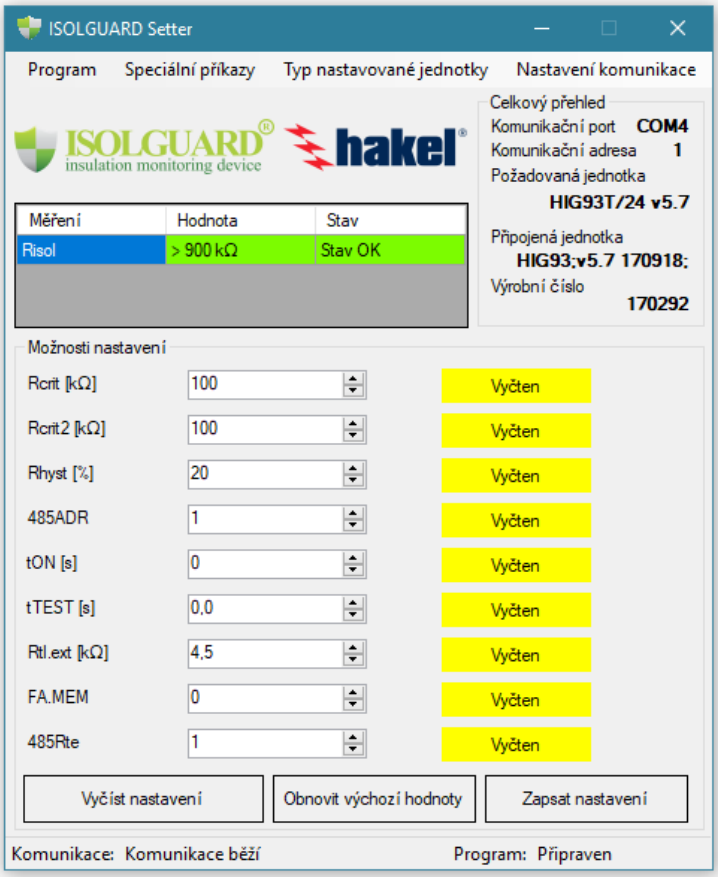


HIG93T/24 parameters setting HIG93T/24

HIG93T/24 device parameterization can be done using RS485 communication bus bar and ISOLGUARD Setter software. This software was developed by HAKEL and is intended to display and setting change of the device or to display the measured values.

ISOLGUARD SETTER Basic characteristics:

- Intended to display and setting change of the HAKEL ISOLGUARD HIG insulation monitoring device.
- Except the setting allows also to display: measured values, identification chain and device serial number.
- Inbuilt function for remote test and cancellation of the device memory fault.
- Available on request at the HAKEL company.
- Designed for Microsoft Windows 7, 8, 10 operation systems.
- It does not require installation.



Control principles

- Software is designed for Microsoft Windows 7, 8, 10 operation systems.
- Device must be connected to the PC using RS485 bus bar before running the program. It is possible to use RS485/USB convertor, for example SB485L
- Actual communication status and program mode is displayed in program's status bar.
- Menu *Communication settings* serves for setting of the used communication port and device address on the RS485 bus bar.
- Menu *Type of set unit* serves for required device type selection. So the HIG93T/24 of corresponding software version is selected.
- The PC and device are connected than.
- After the connection, the currently measured value is displayed in the upper left corner and the setting values are displayed as the default.
- Information about the set values are displayed in the *Setting options* box.
- *Read the settings* button reads the device actual setting.
- *Restore defaults values* button sets the parameters displayed in the program to the default parameters from production.
- *Enter settings* button saves the currently displayed settings into the insulation monitoring device.
- Next to each setting item, the value status is displayed. This may be the following:
  - *Default* – the default parameter setting as it should satisfy the production parameters.
  - *Read* – actual insulation monitoring device setting.
  - *Changed* – parameter value was changed by a user and differs from read/default value.
  - *Preparation for record* –initialization of record cycle proceeds.
  - *Recorded* – confirmation that the change was transferred into the device.
  - *Not recorded* – notice that an error occurred while recording the parameter.
  - *Saved* – confirmation that the change was saved in the permanent memory of the device.
- If the setting line is red, it means that the displayed value differs from the value set in the device.

HIG93T/24 parameters and information

Setting and reading of the parameters is done by the program HIGSET via RS485 communication bus bar on the device.

Introductory information

Basic information is displayed after connecting the device, namely:

- Device type
- Device version and its serial number
- Actual value of measured insulation resistance in kΩ. In the value range of the adjustable critical insulation resistance it is rounded to kΩ units. Values above this range are rounded to kΩ dozens.
- State of insulation status fault

Device test

Can be done by the operating program HIGSET. Remote test via the communication line is performed immediately after receiving the order and takes 5 seconds.

FAULT memory

Fault memory function can be turned on or turned off by the operating program. If the FAULT memory is set, the signalling relay remains in a status of alarm indication even after the test is over, until it is released by the operator pressing the button on the module

Using this function is not expected for device type HIG93T/24. Control button to deactivate the fault is not on the device.

Parameter setup menu

Device parameters can be set using the operation program:

- Critical resistance value, parameter R_{crit1}, R_{crit2}.
- Insulation resistance hysteresis, parameter R_{hyst},
- Delay in response of signalling the insulation status fault, parameter t_{ON} ,
- External inductor resistance, parameter TL_{ext},
- Delay in module test start by remote test button, parameter t_{TEST}
- Device address for communication via RS485 line, parameter ***485ADDR***
- Terminating resistance R_{te} of the RS485 line in the device, parameter $485R_{te}$

R_{crit1}, R_{crit2} setting

The value can be set in the range of 50 kΩ to 300 kΩ. Both R_{crit1} and R_{crit2} parameters can be set independently across the entire value range.

R_{hyst} setting

The value can be set in the range of 0 to 100 % R_{crit}. The hysteresis level in % applies to both of the critical insulation resistance levels R_{crit1} and R_{crit2}.

t_{ON} time setting

New value of the delay in response of signalling the insulation status fault *FAULT1* or *FAULT2* is set in seconds. The value can be set in the range of 0 to 60 sec.

$TL_{ext.}$setting

External inductor connected in front of the HIG93, HIG94 is necessary when monitoring higher operational voltages, see recommended connection diagrams. Value of $R_{tl.ext}$ DC resistance of the connected inductor winding is set in this menu. This value must be set zero in case of application without the external inductor.

New value of the $R_{tl.ext}$ resistance is set in kΩ to one decimal place in the range of 0 to 20,0 kΩ.

The value of $R_{tl.ext}$ inductor's AC resistance winding is indicated on the inductor's label as R_{in}. Typical values for three-phase HAKEL inductors are as follows: TL400 4,5 kΩ, TL500 4,5 kΩ. Exact values may be obtained by measuring the inductor's resistance winding with interconnected L outlets at the operational temperature.

t_{TEST} time setting

New value of the delay in module test by pressing remote test button is set in seconds in the range of 0 to 6 seconds at 0,1 second step.

Factory setting parameters of HIG93T/24

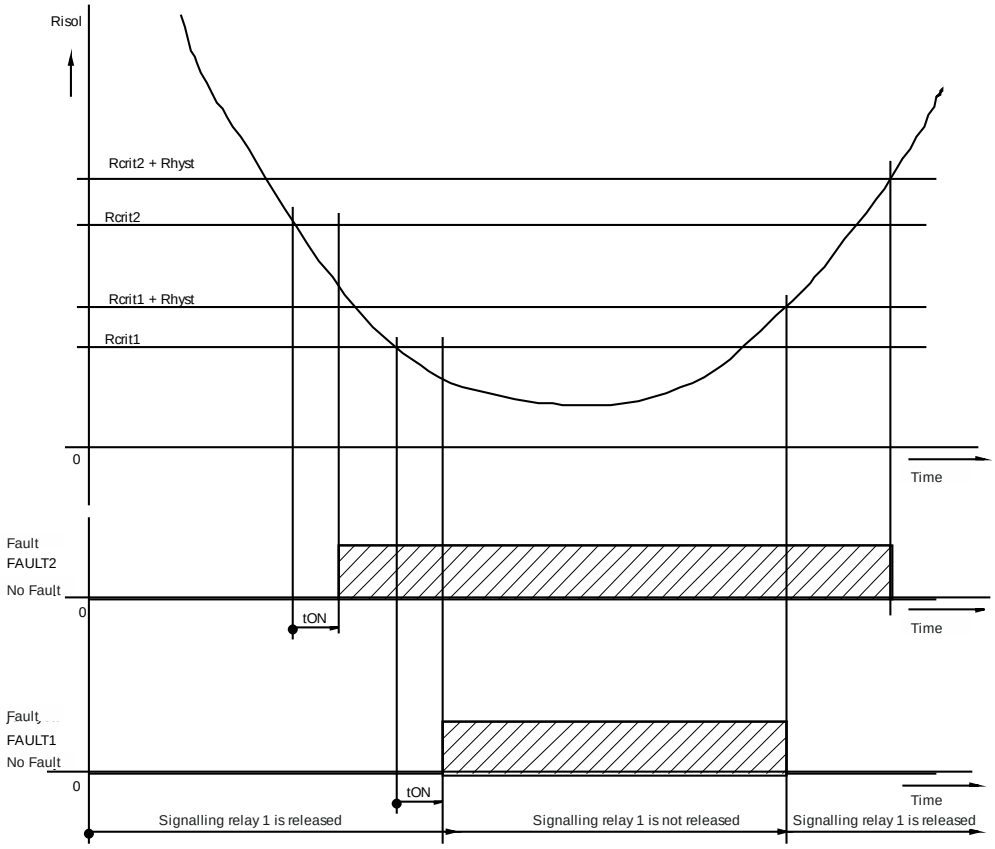
Factory settings of the insulation monitoring device are as follows:

Parameter	Symbol	HIG93T/24 value
Critical insulation resistance R_{crit1}	R_{crit1}	100 kΩ
Critical insulation resistance R_{crit2}	R_{crit2}	100 kΩ
Insulation resistance hysteresis	R_{hyst}	20 % z R_{crit}
Delay in response of signalling the insulation resistance fault	t_{ON}	0 sec
External inductor resistance	$R_{tl.ext.}$	0 kΩ
Delay in module test start by remote TEST button	t_{TEST}	0 sec
FAULT memory	FA.MEM	0, without memory fault
Module address on the RS485 bus bar	485 ADDR	1
Terminating resistance of the RS485 line	485 R_{te}	Connected

Note: For the meaning of RS485 line parameters see communication protocol description.

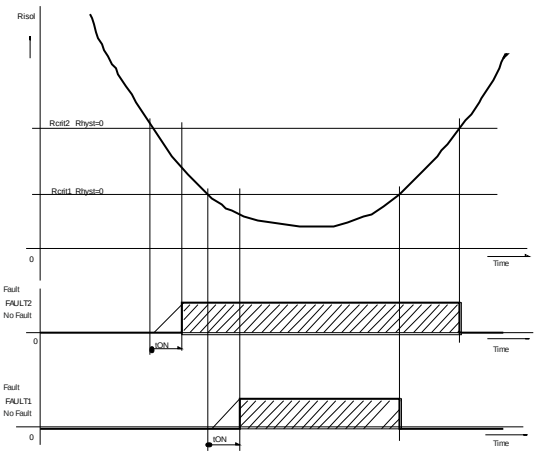
Insulation resistance fault evaluation

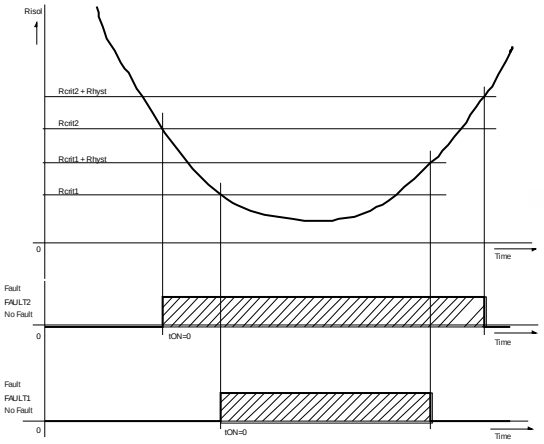
Evaluation of the *FAULT1, FAULT2* according to set t_{ON} and R_{hyst} parameter values is shown in the following figure.



In this example, the set non-zero value for t_{ON} and hysteresis R_{hyst} is shown without setting the FAULT memory parameter. When the insulation resistance value of the monitored power supply system decreases below R_{crit1} or R_{crit2}, 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 FAULT1, *FAULT2* indicator lamps on the device light up. Particular signalling relay release is cancelled and its contacts are set to the rest position. The *FAULT1 and FAULT2* is only terminated when the insulation resistance increases above the value $R_{crit1}+R_{hyst}$ or $R_{crit2}+R_{hyst}$. Signalling relay is released and FAULT1, FAULT signalling is terminated.

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





Communication protocol

The unit HIG93T/24 communicates via the industrial RS485 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 the other SLAVE stations. The SLAVE stations only respond to requests, they never start communication. The unit HIG93T/24 is in the position of the slave station.

Individual stations are interconnected 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 HIG93T/24 is adjustable within range 1 to 126 (address 0 is reserved for the MASTER station).

The maximum length of the line is 1200 meters; in view of proper installation, both ends of the line need to be terminated, namely using the resistance of 120 Ω. At a given moment, each station connected to the line RS485 may transmit or receive. This operational 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 PC computer, programmable logic controller with RS485 line or other control computer with RS485 line can be used as a MASTER station. Detailed description of HIG devices communication protocol is shown in the programming manual.

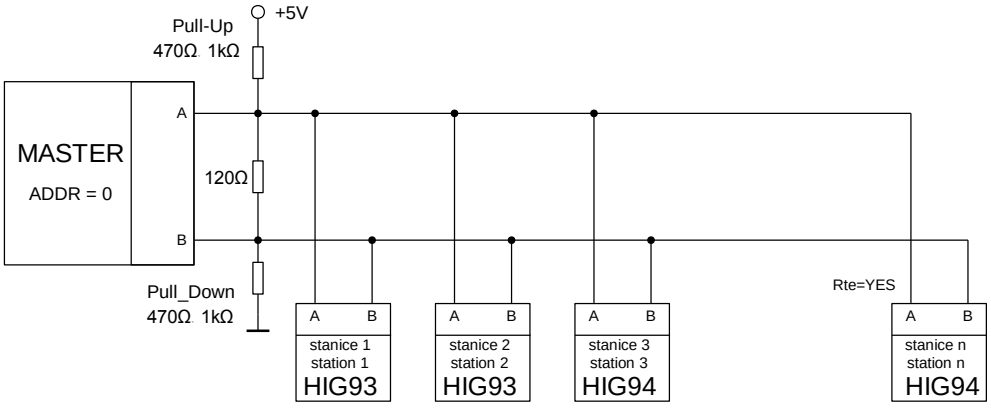
RS485 line parameter setup

In the ***Parameter setup*** menu may be selected the menus ***Set 485ADDR*** and ***Set 485Rte.***

Menu ***Set 485ADDR*** serves for setting the address of insulation monitoring device HIG93T/24 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*** (in case, that the resistance 120Ω is internally connected to the line RS485 of the module), or ***NO*** (without connected resistance).

Structure of the RS485 bus



Data transmitted via RS485 bus

HIG93T/24 devices communicate via RS485 bus bar using the ISOLGUARD communication protocol. This protocol is 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 the currently measured quantities and their states
- Equipment parameters, including the IMD setup values

For data identification the unit sends the codename of its design, the version of used software and program assembly date - this 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 state 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 are described in the ISOLGUARD Protocol Programming Manual. Data that can be read from the HIG93T/24 are identified in the tables below.

Measured data

Quantity	Symbol	Value (e.g.)	Unit
Insulation resistance	Risol	500	kΩ

Parameters data

Name	Symbol	Value (e.g.)	Unit	Priority
Critical limit of insulation resistance	Rcrit1	50	kΩ	1
Critical limit of insulation resistance	Rcrit2	100	kΩ	1
Device address on the RS45 line	485ADDR	1	-	1
Insulation resistance hysteresis	Rhyst	50	%	2
FAULT memory function	FA.MEM	1 = switch-on 0 = switch-off	-	2
Delay in response of signalling the insulation resistance fault	tON	0	sec	3
External inductor resistance	Rtl.ext	12,3	kΩ	3
Delay in module test start by remote test button	tTEST	6	sec	4
Temperature inside the HIG module	mTEMP	32	°C	4
Terminating resistance of the line RS485	485Rte	1 = connected 0 = disconnected	-	0