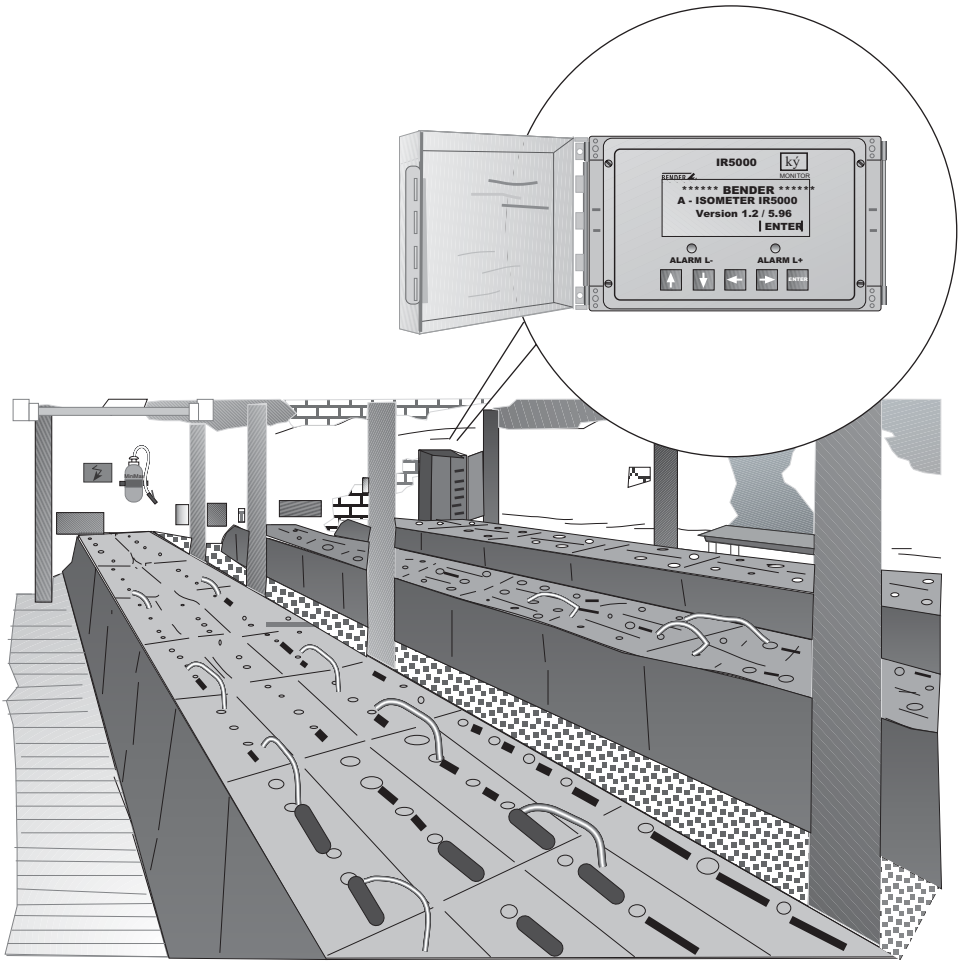
BENDER



Insulation monitoring device for IT DC systems 350 ... 800 V

IR5003

Operating Manual

TGH 1363en
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Operating manual
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1 General

About the IR5003

With the insulation monitoring device IR5003, BENDER offers a special equipment for continuous monitoring of the insulation resistance of IT DC systems to earth. The device is intended to indicate when the value falls below a preset response value.

The IR5003 is suitable for IT DC systems involving:

- systems with low insulation resistance and high nominal voltages
- systems with water-cooled components
- heating systems with ionizing air
- smelting plants
- extended systems

Special features of the IR5003 are:

- voltage range of the system to be monitored: DC 350 ... 800 V
- 3-voltmeter method for fast detection of symmetrical and asymmetrical insulation faults
- wide response range: 50Ω ... 100 kΩ
- integrated voltage monitoring
- two serial interfaces: RS232 and RS485
- linear analog output 0...20 mA
- three different alarm relays for earth fault at L+, earth fault at L- and system faults
- large LC display
- control via microcontroller
- real-time clock
- menu-driven operating and setting
- robust enclosure for surface mounting

IT System

If increased availability of power supply is concerned, the IT system, i.e. the unearthed system, is the right choice. In contrast to the earthed system, the first insulation fault does not lead to a disconnection. Combined with a well-chosen insulation monitoring device, insulation faults and deteriorations are recognized early, possibly when developing. Hence, increased availability of power supply in an IT system stands and falls with the well-chosen insulation monitoring device.

Maintaining a good insulation condition is decisive for reliable power supply. Therefore the relevant standards demand that the first fault is to be cleared as soon as possible.

Underlying standards

IEC 60364-4-41, Punkt 413.1.5.4 (Note):
It is recommended that the first fault should be eliminated with the shortest practical delay.
The A-ISOMETER ® IR5003 complies with the requirements of IEC 61557-8. The internal resistance has been adapted to the special applications for systems with low insulation resistance values.
The standard deals with constructional and measuring parameters as well as the test procedures, and the safety aspects of the insulation monitoring devices in IT systems, including the use in IT AC systems, IT DC systems and IT DC systems with galvanically connected DC circuits.

General

The concept of IR5003

IR5003 works according to a passive 3-voltmeter method. Different voltages are measured within the system to be monitored. Comparative measurements of the internal resistor network are carried out in order to determine the correct insulation resistance of the system.

For calculation of the insulation resistance, the measured analog voltages are digitilized by a 22-bit AD converter which is connected to the microcontroller via a serial bus.

The detection, processing, analysis and output of the measured values are controlled by a microcontroller which allows the setting of different parameters. The measured values can be transmitted to peripheral devices, e.g. computers or PLC via serial interfaces.

The device parameter settings are stored in a non-volatile EEPROM. The values of the insulation resistance and the time when the measurements are carried out are indicated by the internal real-time clock.

The measuring circuit is isolated from the output circuits (relays, interfaces). That provides adequate safety of the IR5003 and the connected peripheral devices.

Coupling device AG5003

IR5003 can be used as an independent device or in combination with the coupling device AG5003. If response values below 1000 are to be set, the use of a coupling device AG5003 will be necessary. IR5003 recognizes automatically if a coupling device has been connected.

2 Safety information

Intended use

IR5003 is intended exclusively for measuring and evaluating the insulation resistance in IT DC systems of 350 V to 800 V.

Any other use, or any use which goes beyond the foregoing, is deemed to be use other than for the intended purpose. The BENDER companies shall not be liable for any losses or damage arising therefrom.

The basic requisite for handling the IR5003 in accordance with safety requirements, and for it to operate without faults, is a knowledge of the fundamental safety information and the safety regulations.

This manual contains important information needed in order to operate the IR5003 in accordance with safety requirements. This manual, and in particular the safety information, must be noted by all persons who work with the IR5003.

In addition, it is essential to comply with the rules and regulations on accident prevention which are valid for the place of use.

Personnel

Only appropriately qualified personnel may work on the IR5003. "Qualified" means that such personnel are familiar with the installation, commissioning and operation of the product and that they have undergone training or instruction which is appropriate to the activity.
The personnel must have read and understood the safety chapter and the warning information in this operating manual.

Copyright

Warranty and liability

As a basic principle, our "General Conditions of Sale and Delivery" shall apply. At the latest, these shall be available to the operator when the contract is concluded. Warranty and liability claims in cases of damage to persons and property shall be excluded if they are attributable to one or more of the following causes:

- use of the IR5003 other than for the intended purpose
- incorrect assembly or installation, commissioning, operation and maintenance of the IR5003
- failure to comply with the information in the operating instructions regarding transport, storage, assembly or installation, commissioning, operation and maintenance of the IR5003
- unauthorized structural modifications to the IR5003
- failure to comply with the technical data
- improperly executed repairs, and the use of spare parts or accessories which are not recommended by the manufacturer
- cases of disaster and force majeure
  normal control, e.g. acts of God

Safety information

Explanations of symbols and warnings

The following designations and signs are used for hazards and warnings in Bender documentation.

This symbol means an immediate threat of danger to the life and health of human beings.
Failure to comply with these warnings means that death, serious physical injury or substantial damage to property will ensue if the relevant precautions are not taken.

This symbol means a possible threat of danger to the life and health of human beings.
Failure to comply with these warnings means that death, serious physical injury or substantial damage to property may ensue if the relevant precautions are not taken.

This symbol means a possible dangerous situation.
Failure to comply with these warnings means that slight physical injury or damage to property may ensue if the relevant precautions are not taken.

This symbol gives important information about the correct handling of the IR5003.
Failure to comply with this information can result in faults on the IR5003 or in its environment.

Where you see this symbol, you will find application tips and other particularly useful information.
This information will help you to make optimal use of the IR5003.

Hazards when handling the system

The IR5003 is constructed according to the state-of-the-art and the recognized safety engineering rules. Nevertheless, when it is being used, hazards may occur to the life and limb of the user or of third parties, or there may be adverse effects on the IR5003 or on other valuable property. The IR5003 must only be used:

- for the purpose for which it is intended
- when it is in perfect technical condition as far as safety is concerned

Impermissible modifications and the use of spare parts and additional devices which are not sold or recommended by the manufacturer of the devices may cause fire, electric shocks and injury.

Make sure that the operating voltage is correct!
Unauthorized persons must not have access to or contact with the IR5003.
Warning signs must always be easily legible. Damaged or illegible signs must be replaced immediately.

Inspection, transport and storage

Check the dispatch packaging and the equipment packaging for damage, and compare the contents of the package with the delivery documents. In the event of damage during transport, please notify BENDER immediately.
The IR5003 must only be stored in rooms where it is protected against dust and moisture, and spraying or dripping water, and where the indicated storage temperatures are maintained.

Warranty statement

In respect of the IR5003, BENDER provides a warranty of fault-free execution and perfect material quality under normal operation and maintenance conditions, for a period of 24 months from the date of delivery. This warranty does not extend to all accessories and consumable components.

For warranty the device must be returned, prepaid, to the nearest authorized Bender service representative.

The warranty shall only be valid for the first purchaser, and shall not extend to products or individual parts thereof which have not been correctly used, or which have undergone modifications. Any warranty shall lapse if the IR5003 is used other than for the intended purpose.

The warranty obligation is limited to the repair or the exchange of a product which has been sent to BENDER within the warranty period. The qualifying conditions are that BENDER shall recognize the product as being faulty, and that the fault cannot be attributed to improper handling or modification of the device, nor to abnormal operating conditions.

Any warranty obligation shall lapse if repairs are undertaken on the IR5003 by persons who are not authorized by BENDER.

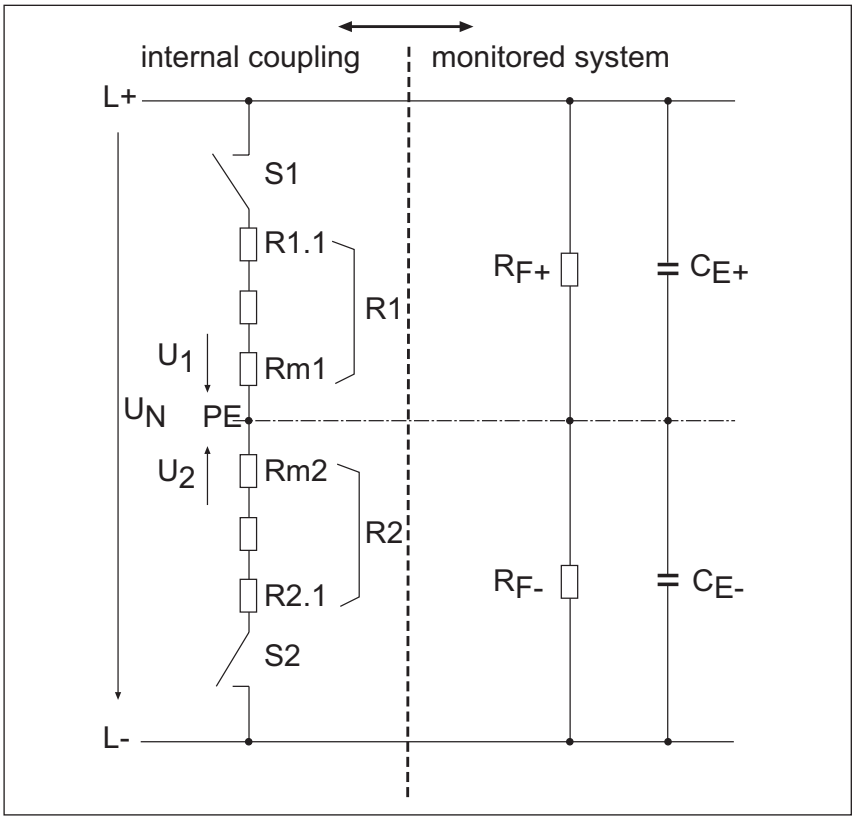
The foregoing warranty provisions are valid exclusively, and instead of all other contractual or legal warranty obligations, including (but not restricted to) the legal warranty of marketability, suitability for use and expediency for a specified use.
BENDER shall not assume any liability for direct or indirect concomitant or subsequent damage, regardless of whether these are attributable to legal, illegal or other actions.

This statement of warranty shall only be valid in conjunction with the delivery note from BENDER company.

3 Principle of operation

IR5003 uses the measuring principle "3-Voltmeter-Method". Asymmetrical as well as symmetrical insulation faults in IT DC systems can be detected according to this measuring principle. In combination with the microcontroller a fast, safe and exact measurement and evaluation can be realized.

In some respect, the measuring time is dependent on the system leakage capacitances C_{E+} and C_{E-} (illustrated below). The capacitances are always recharged when the coupling switches are closed resp. opened.



The time delay prevents false trippings during recharging:

- S1 closed, S2 opened — measuring of the voltage U1 at Rm1
- S1 opened, S2 closed — measuring of the voltage U2 at Rm2
- S1 and S2 closed — measuring of the voltage U_N

$$U_N = (U1+U2) \times \frac{R1+R2}{Rm1+Rm2}$$

The insulation resistances RF+ and RF- can be calculated according to the following equations:

- for symmetrical coupling, i.e R1=R2 and Rm1=Rm2

$$R_{E+} = \frac{(U_N \times Rm1 - (U1+U2) \times R2)}{U2}$$

$$R_{E-} = \frac{(U_N \times Rm2 - (U1+U2) \times R1)}{U1}$$

- for asymmetrical coupling, i.e. relation AK+ / AK- = 2:1

$$R_{E+} = \frac{(U_N \times Rm1 \times (U_N \times Rm2 - R2 \times (U1 + U2)))}{(U2 \times (U_N \times Rm1 - U1 \times R2))}$$

$$R_{E-} = \frac{(U_N \times Rm1 \times (U_N \times Rm2 - R2 \times (U1 + U2)))}{(U1 \times (U_N \times Rm2 - U2 \times R2))}$$

Condition: $R1 = 2 \times R2$
$Rm1 = 2 \times Rm2$

These calculations of the insulation resistances are done by the integrated microcontroller. The results are indicated on the display.

Symmetrical and asymmetrical insulation faults

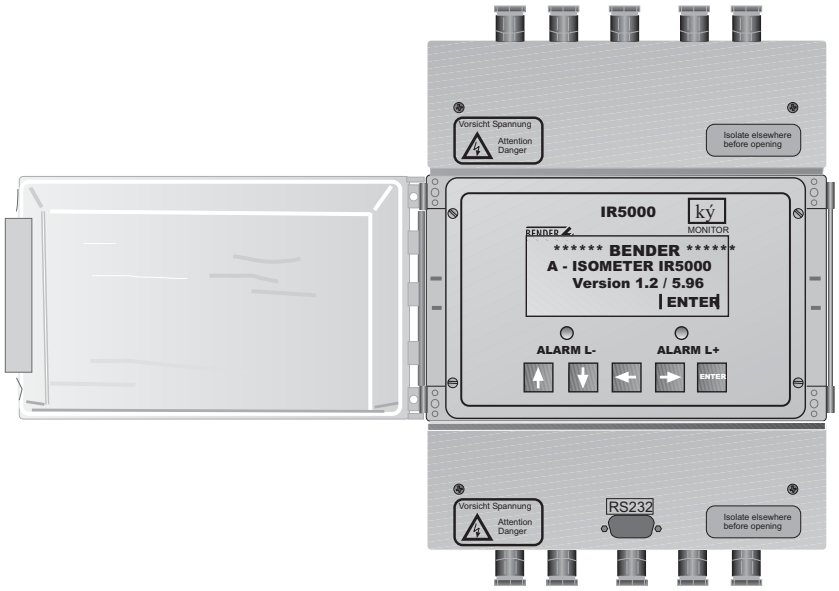
The measuring values are determined by the device with a passive measuring principle. This entails some specialities regarding the measured insulation values.

If the relation between the single insulation values RF+ and RF- is high (asymmetrical faults) the accuracy of the higher value is less than the accuracy of the lower value, because the measuring voltage drop for an insulation fault is gathered at the opposite side of the coupling network. That means that the main measuring voltage for the higher value decreases with the dropping of the lower insulation value. In the reverse case the measuring voltage of the lower value increases with the dropping of this value. Because of this, the lower value is measured with the highest accuracy.

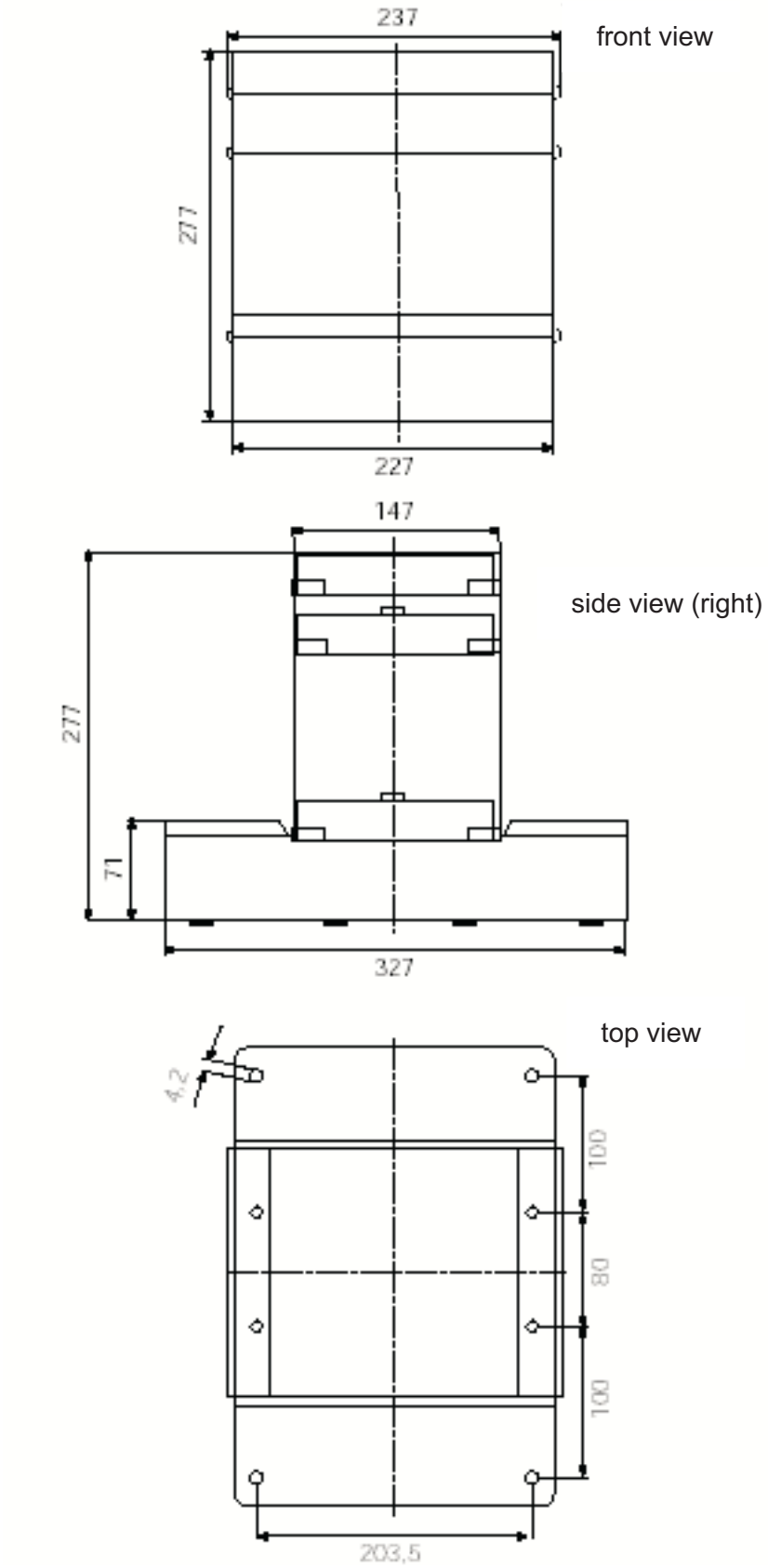
In practice, this effect may entail a little change of the higher value in display when the lower value increases or decreases.
The accuracy of both values is identical if the insulation values are symmetrical.

Mechanical design

IR5003 is mounted in a 19"-inch plastic casing with a lockable transparent cover. The casing is equipped with two separate terminal boxes. The upper terminal box contains terminals for the coupling to the system to be monitored as well as to the optional coupling device AG5003. The lower terminal box contains terminals for PE coupling, supply voltage, contacts of the alarm relay, serial interfaces, temperature sensor input, digital inputs, and analog output.

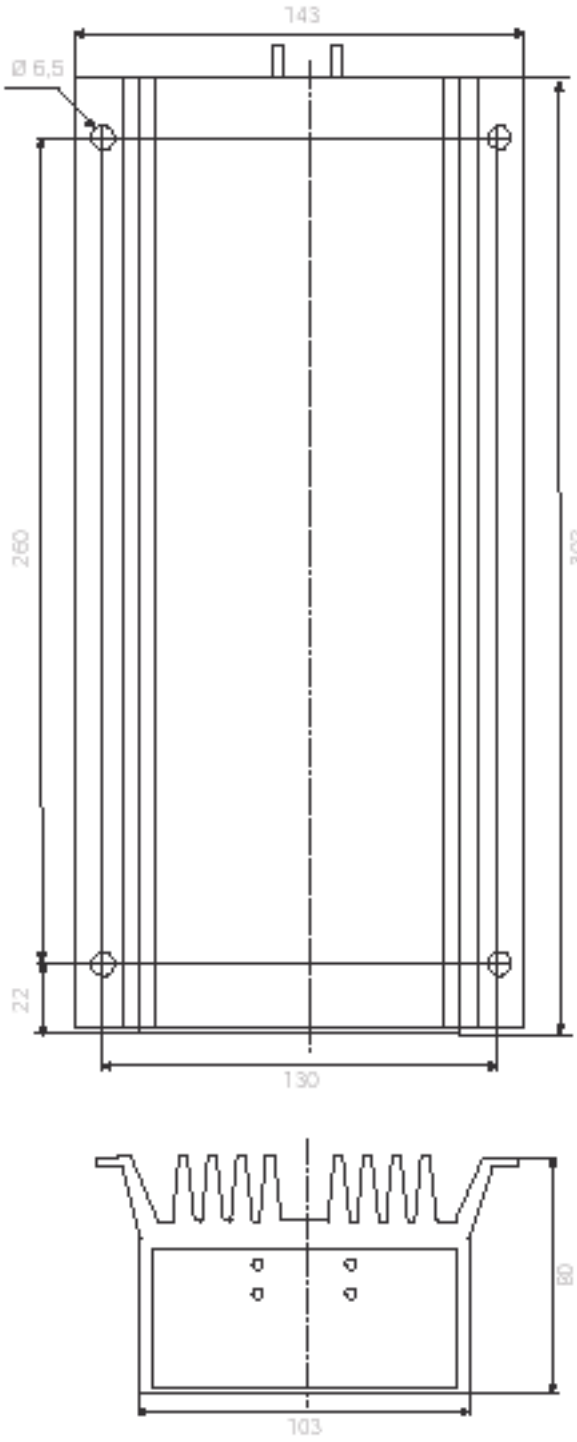


Dimension diagrams

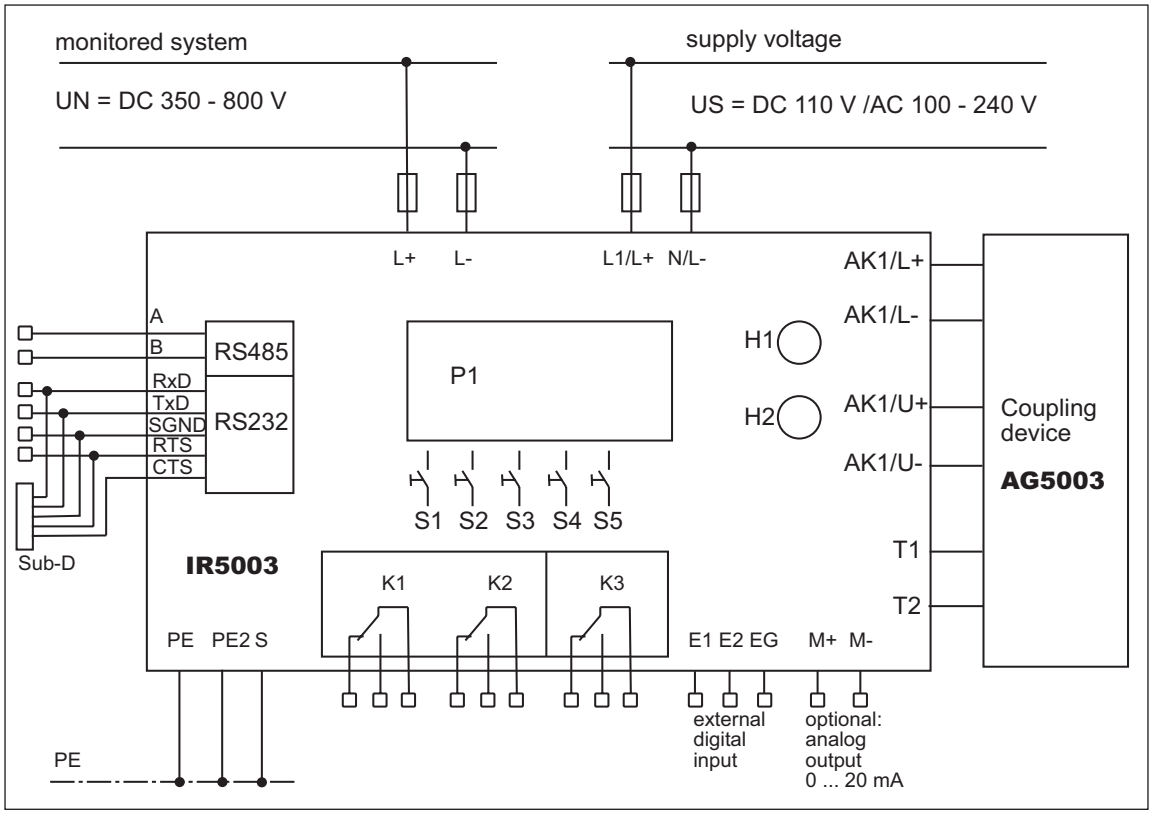


General dimensions according to DIN 7168, dimensions in mm

Dimensions coupling device AG5003



Wiring diagram



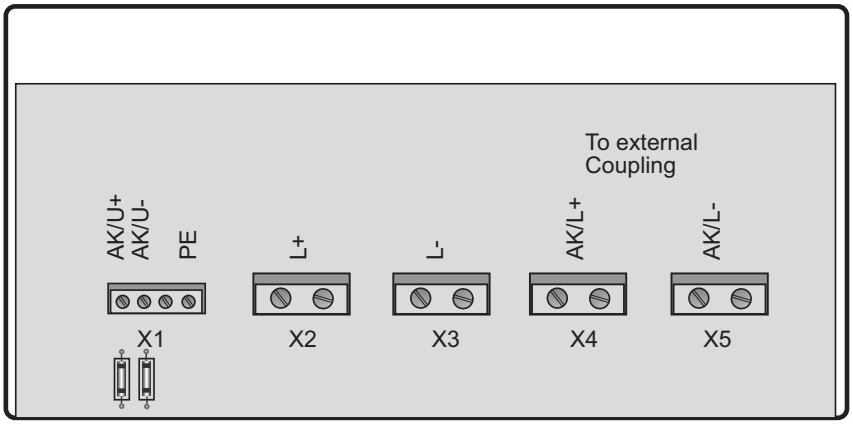
Legend to wiring diagram

Designation	Terminal designation	Explanation
P1		LC display, 4 lines á 20 characters
H1		alarm LED red, alarm L+
H2		alarm LED yellow, alarm L-
K1	11,12,11,14	alarm relay alarm L+, 1 change-over contact
K2	21,22,21,24	alarm relay alarm L-, 1change-over contact
K3	31,32,31,34	alarm relay system fault, 1 change-over contact
S1		UP-Taste
S2		DOWN-key
S3		RIGHT-key
S4		LEFT-key
S5		ENTER-key
E1	E1	digital input 1, measurement suppression
E2	E2	digital input 2, switching of response values
EG	EG	earth terminal of the digital inputs 1 and 2
L+	L+	system coupling L+
L-	L-	system coupling L-
AK1/L+	AK1/L+	output L+ of coupling device AG5003
AK1/L-	AK1/L-	outputg L- of coupling device AG5003
AK1/U+	AK1/U+	input U+ of coupling device AG5003
AK1/U-	AK1/U-	input U- of coupling device AG5003
T1	T1	positive input temperature measuring of cou-
pling		device AG5003
T2	T2	negative input temperature measuring of cou-
pling		device AG5003
PE	PE	coupling PE (earth)
PE2	PE2	control earth (connection monitoring)
S	PE	connection for cable shielding
A	A	output A RS485 interface
B	B	output B RS485 interface
M+	M+	analog output + (0...20 mA, linear)
M-	M-	analog output - (0...20 mA, linear)
RxD, TxD	RxD, TxD	output RS232 interface on the terminal strip
SGND	SGND	and on 9-pole Sub-D connector (f)
RTS, CTS	RTS, CTS	

Terminal strips

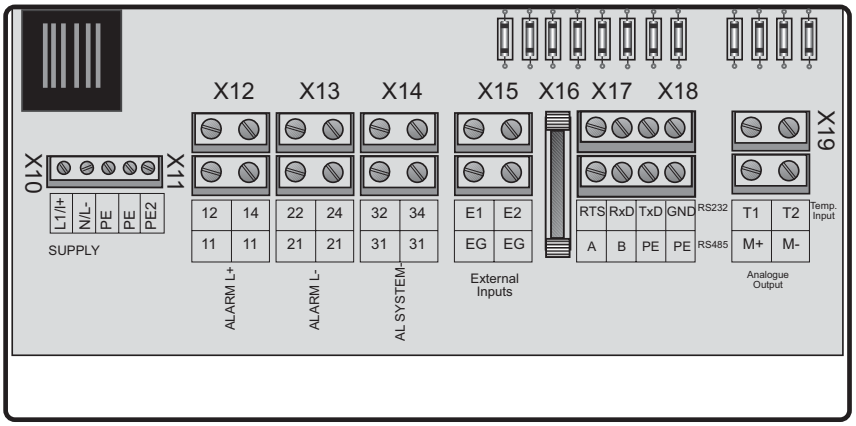
IR5003 is equipped with two separate terminal boxes. The cables are led into the terminal boxes using screwed cable glands (PG9 and PG11).

Upper terminal box



The upper terminal box is exclusively used for the coupling of the measuring circuit to the system to be monitored and the connection to the optional coupling device AG5003.

Lower terminal box

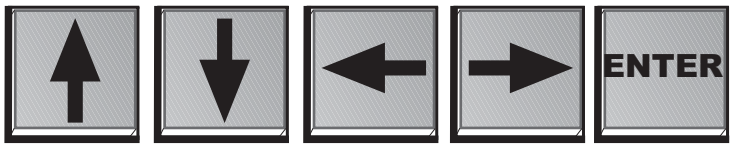


The lower terminal box is equipped with the strip terminals X10...X19. These terminals are used to connect the supply voltage, PE connections as well as all inputs and outputs. See also the wiring diagram on page 27.

5 Setting and operation

Function keys

Operation as well as all the settings are carried out by means of the software using 5 function keys.

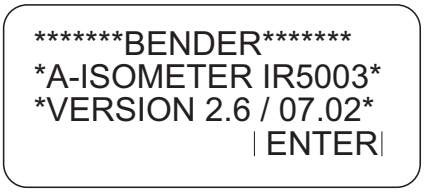


UP-key DOWN-key LEFT-key RIGHT-key ENTER-key

When operating under normal conditions, the main screen displays the currently applicable measuring values. For changing parameters or settings, the main menue has to be selected.

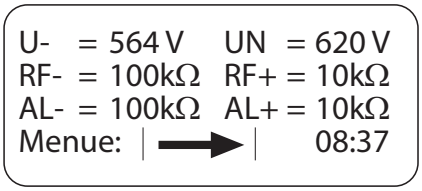
Welcome screen

Once the power supply is switched on, the welcome screen appears displaying the manufacturer's name (BENDER), the device type, and the firmware version.



Main screen

The welcome screen is displayed for about 5 seconds and then automatically changes to the main screen. If the ENTER-key is activated within this time, the main screen will be displayed immediately.



The picture above shows a main screen typical for IR5003 during operation.

U- = 564 V	The currently applicable measuring value of the negative pole-to-earth voltage is 564 V
U_N = 620 V	The current measured value of the nominal system voltage is 620 V
RF- = 100k	The negative pole-to-earth insulation resistance is 100 k (calculated value)
RF+ = 10 k	The positive pole-to-earth insulation resistance is 10 k (calculated value)
AL- = 100 k	The pre-set response value for the negative fault is 100 k
AL+ = 10 k	The pre-set response value for the positive fault is 10 k
Menue: →	Press the RIGHT-key to change to the respective menu
08:37	System time of the IR5003 (real time clock)

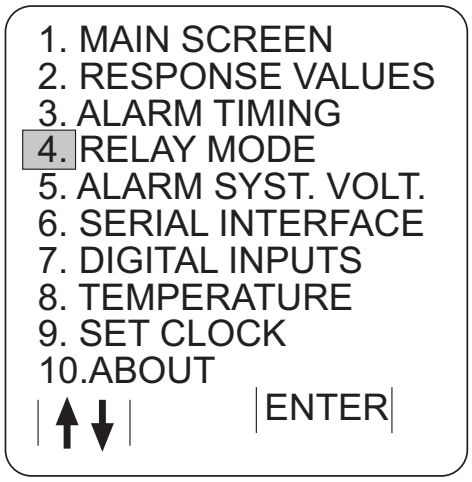
The following picture shows a main menu indicating that the measurement suppression has been activated. Measurement suppression can be activated or deactivated by digital input 1. IR5003 is isolated from the system to be monitored during measurement suppression.

Menus

IR5003 offers 10 different menus for setting and operation. Pushing the RIGHT-key from the main screen opens the screen with the menu selection.

Of course, not all the menus can be presented within one four-line LC display. You can choose between 3 menus by scrolling the display via the UP and DOWN keys. The other menus can be selected by scrolling the DOWN key.
In order to activate the desired menu, scroll the UP and DOWN keys and position the cursor on the respective digit. Then activate the menu by pushing the ENTER-key.

All menus are displayed in the following picture:

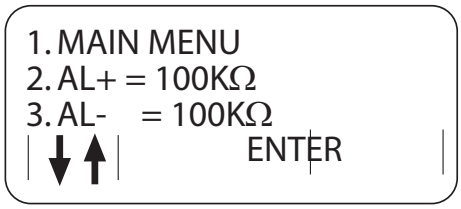


The individual menus

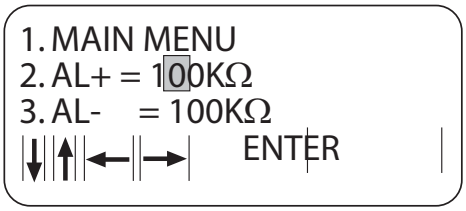
After positioning the cursor on menu 1 MAIN SCREEN by means of the UP and DOWN keys and activating the ENTER-key, the already familiar screen appears.

Setting the response values

In menu 2 RESPONSE VALUES it is possible to set the response values for positive and negative faults separately.



By positioning the cursor on 1 MAIN SCREEN, the IR5003 links to the MAIN SCREEN for setting the response values. Selecting 2 (AL+) allows for setting the response value for positive faults.



After selecting 2 AL+ by activating the ENTER-key, use the LEFT and RIGHT-key to select the respective digit you are going to change. Select the appropriate value by scrolling the UP and DOWN key. The digit can be changed in 1-unit steps. If you position the cursor on k of the dimension k, for example, you can change the dimension from into k or vice versa by scrolling the UP and DOWN key.

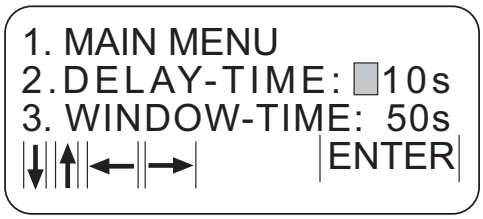
Confirming with ENTER after finishing the modifications returns you to the previous screen. In the same way, the response value for the negative fault AL- can be changed.

Positioning the cursor onto 1 MAIN SCREEN and confirming with ENTER opens the MAIN MENU.

Time response

From the main menu select the submenu 3 ALARM TIMING for setting the delay time.

In the submenu 2 DELAY TIME, it is possible to set a delay time between 0 and 100 seconds for the alarm relays. To open this sub menu position the cursor onto 2 and confirm with ENTER.

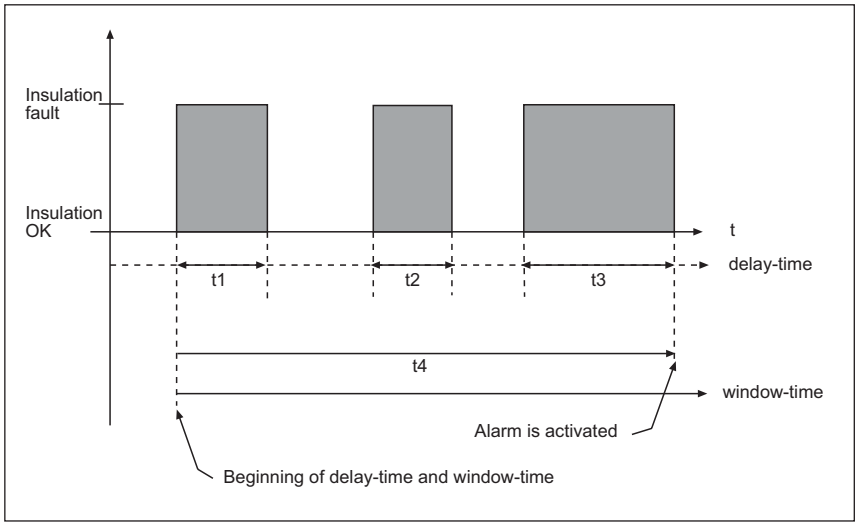


As shown in the picture above, the cursor is now positioned before the time display (10s). Now choose the new value by scrolling the UP and DOWN keys. This is possible in five-second steps. Confirming with ENTER accepts the selected value and returns you to the sub menus 1, 2 or 3. Proceed in the same way if you are going to set the value for WINDOW TIME. Here you can choose the value in 10-seconds steps between 10 and 300 seconds.

DELAY TIME and WINDOW TIME are dependent on each other. Accordingly some explanations:

If an insulation fault occurs the DELAY TIME starts running and stops when the pre-set delay time is reached unless the insulation fault has been cleared. The counter stops running as soon as the insulation fault is cleared within the running DELAY TIME.

The WINDOW TIME also starts running when an insulation fault is detected. Yet, unlike the DELAY TIME, the WINDOW TIME will not be interrupted if the insulation fault is cleared within this period.
The following diagram shows the correlation between fault detection and the different times.

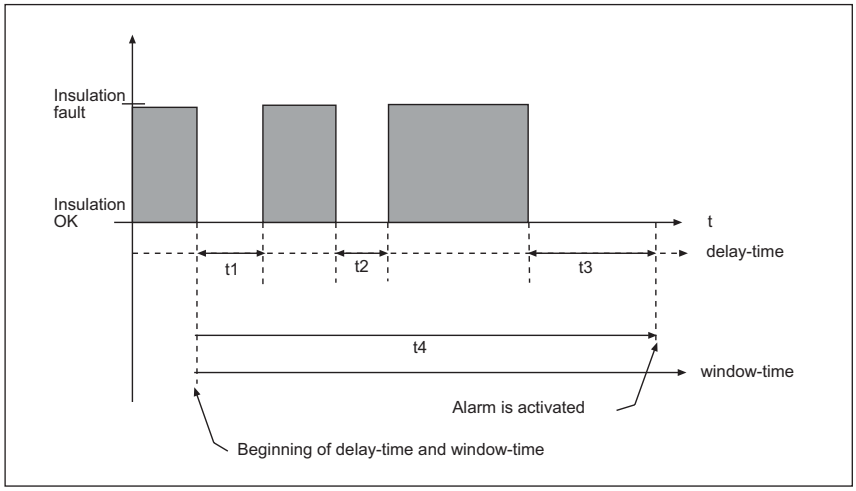


After detecting the insulation fault the DELAY TIME and WINDOW TIME start running. The pre-condition for the activation of the alarm relay is:

Activation if:
(t1 + t2 + t3) > delay-time .AND. (t4 < window-time)

Important:
The pre-set value for the WINDOW TIME has always to be greater than the pre-set DELAY TIME.

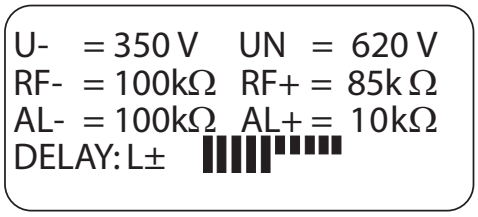
If you are going to re-set an activated alarm proceed in the way as has been explained before, except the fact that the times without insulation faults are summarized. This is clearly shown in the diagram below:



Indication of the time response

If an insulation fault occurs, a bar graph is displayed on the screen showing the elapsed time of the fault. The bar graph appears in the last line of the LC display whilst the other information and the actual time disappear.

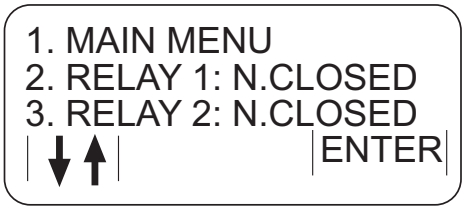
Note: The bar graph indication of the time elapse is only displayed during setting of alarm not during resetting of alarm.



After setting the DELAY TIME and WINDOW TIME confirm with ENTER to return to the main menu.

Operating principle of the alarm relays

Select menu 4 RELAY MODE to set the operating principle of the two alarm relays. to positive resp. negative faults.



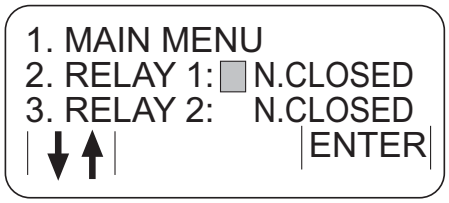
N/O or N/C operation

Optionally, N/O or N/C operation can be selected. Within the menus, the English terms N.CLOSED resp. N.OPEN are used:

N.CLOSED:	normally closed	=>	N/C operation
N.OPEN:	normally open	=>	N/O operation

N/C operation means: In normal condition, the respective alarm relay of the IR5003 is energized and is de-energized in fault condition.
N/O operation means: In normal condition, the respective alarm relay of the IR5003 is de-energized and energized in fault condition.

For changing the operating principle of the alarm relay, select the respective relay by using the UP and DOWN keys. RELAY1 is the alarm relay for insulation faults at the positive conductor (positive fault), RELAY2 is the alarm relay for insulation faults at the negative conductor (negative fault).

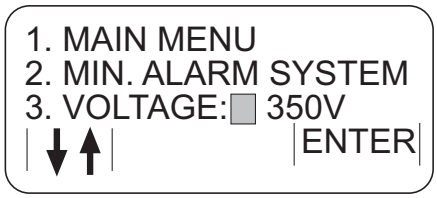


If, for example, the alarm relay 2. RELAY 1 is selected for the positive fault and confirmed with ENTER, the cursor jumps to line 2. RELAY 1 and is positioned before the designation N.CLOSED, as shown in the picture above.
By scrolling the UP and DOWN keys it is possible to select between N.CLOSED and N.OPEN. Confirming with ENTER returns you to the previous mask. From there you will return to the main menu.

Setting the threshold of the voltage

Select 5 ALARM SYST. VOLTAGE from the main menu to set the threshold of the system voltage. If the value falls below the set threshold of the system voltage, it will be signalled by the alarm relay K3 (N/C operation). Thresholds of 350 V and 100 V can be selected.
Attention: if the value falls below the set threshold in the event of an insulation fault, no alarm will be actuated.
Setting the threshold to 100 V does not change the permissible operating range of IR5003 from 350 to 800 V for the insulation monitoring function.

By positioning the cursor onto sub menu 2 and confirming with ENTER , the cursor jumps to line 3 and is positioned in front of the value of the voltage.

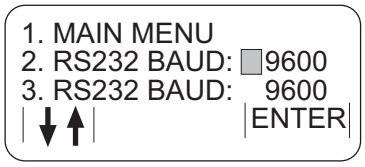


By scrolling the UP and down keys either 350 V or 100 V can be selected. ENTER confirms the selected value and returns you to the previous menu.

Setting the serial interface

Select the sub menu 6 SERIAL INTERFACE from the main menu for the configuration of the serial interfaces.

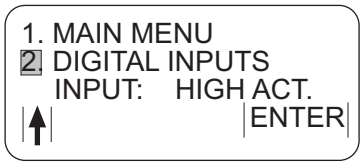
Selecting 2 RS232 BAUD changes the baud rate of the RS232 interface. The baud rate can be set between "No" (interface deactivated) and 19200 baud.



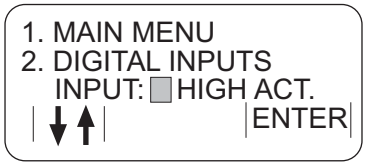
By scrolling the UP and DOWN keys the desired baud rate can be selected. Confirming the selected value with ENTER returns you to the previous menu. In the same way the baud rate of the RS485 interface can be set.

Adjusting digital input 1

If you are going to adjust the digital input 1 (connection terminals E1 and EG), select the sub menu 7 ENABLE MEASUREM. from the main menu.



After selecting the sub menu 2 ENABLE MEASUREM INPUT and confirming with ENTER select between NOT ACTIVE, HIGH ACTIVE and LOW ACTIVE by scrolling the UP and DOWN keys.



Explanation:
NOT ACTIVE
The external digital input 1 (E1/EG) is not activated. The device is working independently of the signal at the external input.

HIGH ACTIVE E1/EG
A D.C. voltage of 24 V (± 25%) activates the device. If no DC voltage is detected the intenal measuring suppression will be activated, the measurement is disabled. The LC display indicates MEASURING SUPPRESSION ACTIVE.

LOW ACTIVE E2/EG
A D.C. voltage of 24 V (± 25%) switches the response values to a fixed value of 20 kΩ for RF+ and RF-. If no DC voltage is detected, the response values which are set by the menu are active.

LOW ACTIVE — A D.C. voltage of < 5 V at E1/EG activates IR5003. If a high signal (24 V) is detected the measurement will be disabled.

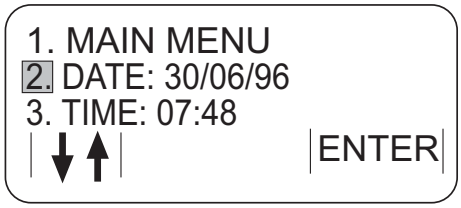
Temperature display

IR5003 measures the temperature inside its housing as well as the temperature inside the coupling device. In this way, internal defective components (in so far as they cause a temperature rise) or overvoltages existing for a long time can be detected. The measured values are used to compensate the response of the measuring resistors to temperature changes. Therefore it is recommended to check the temperature regularly.

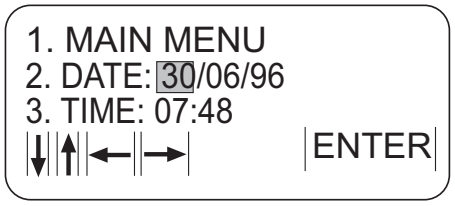
Select the menu item 8 TEMPERATURE from the main menu to check the temperature. This menu displays both the internal temperature and the temperature inside the coupling device. It is not possible to make any settings.
The measured values of the temperature are transmitted via the serial interfaces RS232 and RS485 as part of the data record.

Setting date and time

Select the submenu 9 SET CLOCK from the main menu for setting the real-time clock. Date and time can be set.



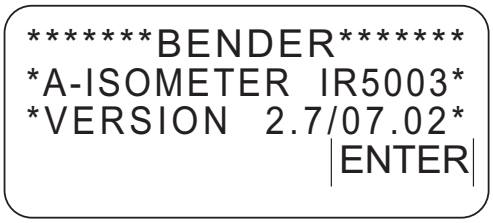
Position the cursor onto the submenu 2.DATE and confirm with ENTER for setting the date. The cursor will move to the array DATE (in this picture the 30th).



By scrolling the UP and DOWN keys the date can be changed upwards or downwards. Using the LEFT and RIGHT keys you can move to the month display resp. to the year display. There you can change the digits by scrolling the UP and DOWN keys. Confirming with ENTER returns you to the previous menu. Now you have the possibility of positioning the cursor onto the sub menu 3 TIME in order to change the time in the same way. It is also possible to change the indication of hours and minutes.

Software version

Selecting the last sub menu 10.ABOUT opens a screen with information about the manufacturer (BENDER), designation of the device and the software version (identical with the welcome screen).
If problems arise or information about IR5003 is required, the first thing the user wants to know is the software version. Information can be interrogated from this sub menu.



Factory settings

The settings described in this chapter allow for optimal adaptation to the individual application of the system. Before starting operation please check if the factory settings suit your needs. If necessary make the respective changes.
The following parameters are pre-set:

Response values (Menu 2 RESPONSE VALUES)	100 Ω / 100 Ω
Response times (Menu 3 ALARM TIMING)	Delay-time: 0 s, Window-time: 50 s
Relay mode (Menu 4 RELAY MODE)	K1 and K2: N/O operation; K3: N/C operation (fixed setting)
Alarm indication voltage (Menu 5 ALARM SYST. VOLT.)	DC 100 V
Serial interfaces (Menu 6 SERIAL INTERFACE)	9600 baud. Further parameters are 8N1 (not adjustable).
Digital input 1 (Menu ENABLE MEASUREM.)	NOT ACTIVE

6 Wiring and commissioning

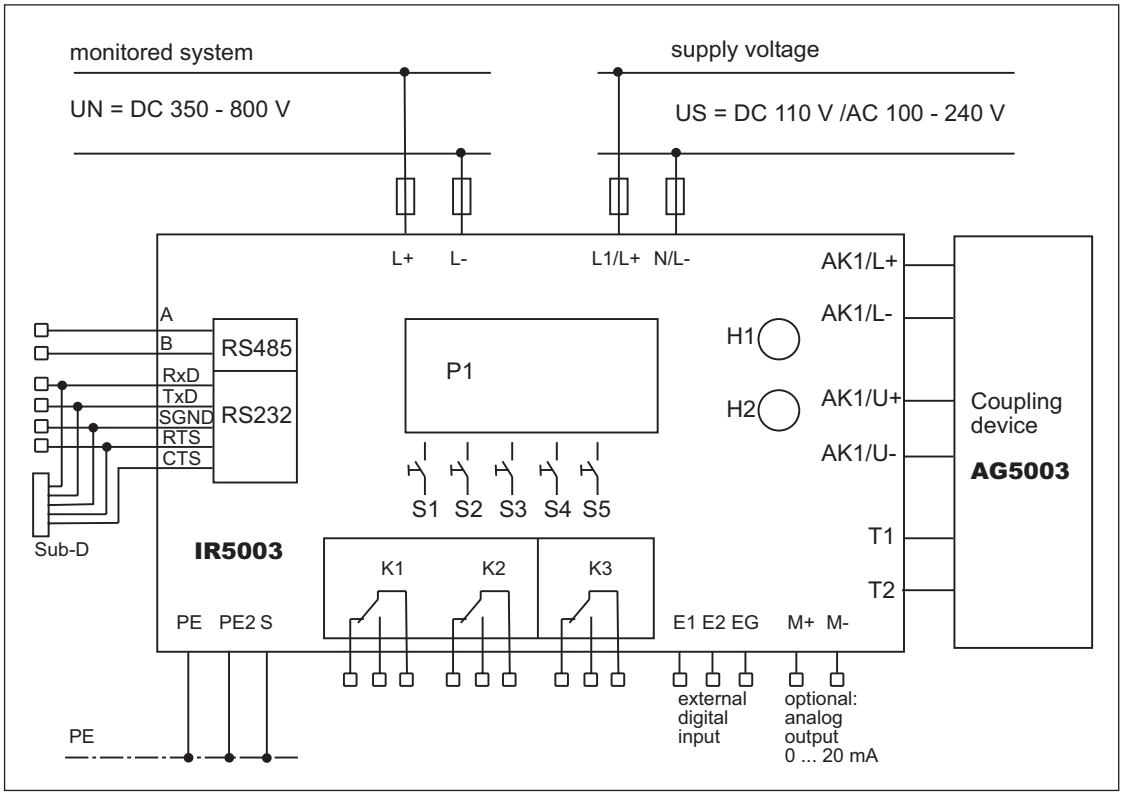
Wiring and commissioning may only be carried out by qualified personnel in consideration of the current safety regulations.

First fix the IR5003 to the wall using the intended mounting holes in the enclosure.
Then all the electrical connections can be carried out.
Attention: Make sure that the installation is voltage-free before connecting the device!

Follow these steps :

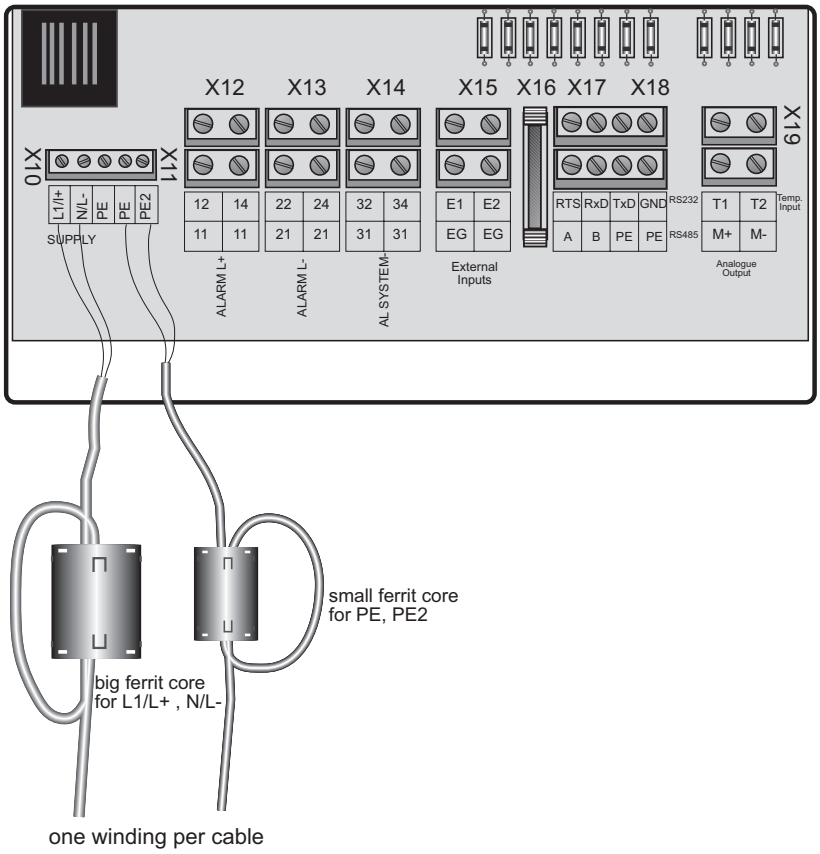
- Connect the PE conductor to the PE and PE2 terminals.
- If you use the coupling device AG5003, connect the leads of the coupling device to the terminals AK/L+, AK/L-, AK/U+, AK/U-, T1 and T2.
  Attention: Be sure not to mix up the connecting leads !
  The connecting leads of the coupling device AG5003 are labelled.
- Connect the contacts of the alarm relays, the external digital input 1 and the serial interface.
- Connect the positive pole of the IT system to the IR5003 terminal L+.
- Connect the negative pole of the IT system to the IR5003 terminal L-.
  Attention: For short-circuit protection, the connections to the system coupling L+ and L- have to be equipped with a protective device (a fuse of 6 A is recommended).
- Connect the supply voltage to the IR5003 terminals L1/L+ and N/L-.
  For short-circuit protection, the connection to the supply voltage has to be equipped with a protective device according to IEC 60364-4-473 (a fuse of 6 A is recommended).
- Switch on the supply voltage.
- If necessary, make the respective adaptations via software (described in chapter SETTING AND OPERATION).
- Connect the system voltage. After approx. 10 seconds a screen appears displaying the measuring values.

Important note:
Be sure not to disconnect the PE conductor from the system to be monitored unless all other wires are disconnected.



Designation	Terminal designation	Explanation
P1		LC display, 4 lines á 20 characters
H1		Alarm LED red, alarm L+
H2		Alarm LED yellow, alarm L-
K1	11,12,11,14	Alarm relay alarm L+, 1 change-over contact
K2	21,22,21,24	Alarm relay alarm L-, 1 change-over contact
K3	31,32,31,34	Alarm relay system fault, 1 change-over contact
S1		UP key
S2		DOWN key
S3		RIGHT key
S4		LEFT key
S5		ENTER key
E1	E1	Digital input 1, measurement suppression
E2	E2	Digital input 2, switching of response values
EG	EG	Earth terminal of digital inputs 1, 2
L+	L+	System coupling L+
L-	L-	System coupling L-
AK1/L+	AK1/L+	Output L+ of coupling device AG5003
AK1/L-	AK1/L-	Output L- an of coupling device AG5003
AK1/U+	AK1/U+	Input U+ of coupling device AG5003
AK1/U-	AK1/U-	Input U- of coupling device AG5003
T1	T1	Positive input, temperature measuring of coupling device AG5003
T2	T2	Negative input, temperature measuring of coupling device AG5003
PE	PE	Coupling PE (earth)
PE2	PE2	Control earth (connection monitoring)
S	PE	Connection for cable shielding
A	A	Output A RS485 interface
B	B	Output B RS485 interface
M+	M+	Analog output + (0 ... 20 mA, linear)
M-	M-	Analog output - (0 ... 20 mA, linear)
RxD, TxD	RxD, TxD	Output RS232 interface on the terminal strip
SGND	SGDN	and on 9-pole Sub-D connector (f)
RTS, CTS	RTS, CTS	

Important note:
to fulfil the EMC requirements it is necessary to mount ferrite cores to the wires for the supply voltage and the earth wires. The bigger ferrit core is for the power supply (terminals L1/L+ and N/L-), the smaller ferrit core is for the earth wires PE and PE2. All of these terminals are in the lower terminal box.
Please install the ferrit core according to the following diagram:



Error messages

Various error messages may occur during operation. Error messages are indications of internal or external faults of the IR5003 excluding the response of the device when the pre-set response value of the insulation resistance has been exceeded.

CRITICAL ERRORS are signalled when certain internal errors occur. CRITICAL ERROR means, for example, that the system voltage has fallen below the pre-set minimum value (<350 V resp. < 100 V DC).

As shown in the picture above, IR5003 provides detailed descriptions about the nature of error. In this case, it is recommended to measure the system voltage.

From the display CRITICAL ERROR you have the possibility to get to the setting menu by activating the RIGHT key.

The indication MEASURING SUPPRESSION ACTIVE shows that the measuring suppression has been activated via the digital input 1 (E1/EG).

System errors, CRITICAL ERRORS

If one or more CRITICAL ERRORS occur, the relay K3 energizes and the corresponding error (system error) will be displayed. IR5003 interrupts its measurements when a CRITICAL ERROR occurs. The error code will be output via both serial interfaces.

All CRITICAL ERRORS with code and short description are listed in the table below:

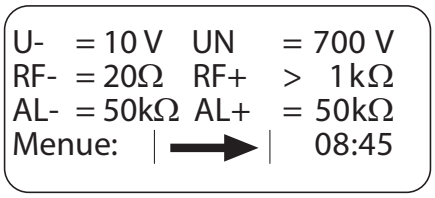
Code N0.	System error	Short description
1	RTC-Error	Error of the internal real-time clock of the microcontroller. IR5003 defective!
2	ADC-Error	Error in the analog/digital converter of the AD unit. IR5003 defective!
3	Display-Error	Error of the display or its control circuit. IR5003 defective.
4	I²C Error	Error of the non-volatile memory. IR5003 defective!
5	Temperature	Temperature inside the casing of IR5003 or the Error external coupling device AG5003 is too high. Measurements will be stopped as soon as the tempe rature inside the coupling device exceeds 150 °C.
6	No-PE	There is no PE connection to IR5003. Touching the device may result in harmful effects to persons. By all means, the device must be checked by a qualified electrician.
7		Polarity Wrong polarity of the network coupling L+/L. Check system cou pling!
8		Low-UN System voltage is too low! System voltage is below the pre-set value MINIMUM SYSTEM VOLTAGE ALARM. Check system voltage and connection.

Indication of asymmetrical faults

The chapter FUNCTIONAL PRINCIPLE already refers to the fact that symmetrical and asymmetrical insulation faults have to be considered separately. In particular, asymmetrical faults have to be considered.

If the ratio between the higher and the lower insulation value is greater than 50, the measured value for the higher insulation resistance insulation will not be displayed directly. Since in this case the limits of accuracy have been exceeded, the only indication is: > 50 x RF-.

Example:



If the insulation resistance of one conductor falls below 5 , the shift voltage of the other conductor is too low to calculate any value. In this case, the LC display indicates XXXX for this high resistance insulation fault.

Different insulation faults and the respective indications are listed in the table below:

Value of insulation fault		**Indication**		**Remarks**
RF+	**RF-**	**RF+**	**RF-**	
20 Ω	100 Ω	20 Ω	100 Ω	Ratio of positive/negative faults is < 50
20 Ω	15kΩ	20 Ω	>1kΩ	Ratio of positive/negative faults is > 50
15 kΩ	20 Ω	>50kΩ	20 Ω	Ratio of positive/negative faults is > 50
1kΩ	80kΩ	1kΩ	>50kΩ	Ratio of positive/negative faults is >50
80kΩ	1kΩ	>50kΩ	1kΩ	Ratio of positive/negative faults is >50

Data output

Data determined by measuring and calculating are output via the interfaces RS 232 and RS 485. By means of appropriate programs (e.g. ISODATA for IR5003) data can be indicated and evaluated.

The following values are available via both serial interfaces:

AL+	Response value positive fault
AL-	Response value negative fault
MeasCount	Internal counter calculating the number of measuring passes for each valid measuring
RF	Total insulation resistance (+ and -) in parallel
RF+	Insulation resistance, positive conductor against PE
RF-	Insulation resistance, negative conductor against PE
UN	Voltage of the system being monitored
UL+	Shift-voltage, positive conductor against PE
UL-	Shift-voltage, negative conductor against PE
Alarm L+	Alarm, relay K1
Alarm L-	Alarm, relay K2
Contact Rel.1	Operating mode of alarm relay 1
Contact Rel.2	Operating mode of alarm relay 2
Temp-Int	Temperature inside the casing of IR5003
Temp-Ext	Temperature inside the coupling device AG5003
Coupling No	Coupling being switched on (High/Low)
Meas. En/Dis	Measurement suppression active/passive
Time	Time of day
Date	Date
Failure-Code	Code of internal CRITICAL ERROR
Checksum	Checksum of the transmitted data

A semicolon (;) is transmitted as a separator between data. At the beginning of a data record a STX and at the end of a data record an ETX (End of text, 03Hex) will be transmitted.
Below an example of a data record:

AL+;AL-;MeasCount;RF;RF+;RF-;UN;UL+;UL-;AlarmL+;AlarmL-;
ContactRel1;ContactRel2; Temp-Int; CouplingNo; Meas.En/Dis; Time; Date; FailureCode;
Checksum;

001000; 001000; 001; 000796; 000803; 090000; 569; 005; 564; 1; 0; 1; 0; +30; +40;
LOW;
ME; 09:32 21/06/96; 02; 127;

7 Technical data

Insulation coordination acc. to IEC 60664-1:	
Rated insulation voltage	DC 800 V
Rated impulse withstand voltage/contamination level	8 kV/3
Dielectric test acc. to IEC 60255	4 kV
System being monitored:	
Rated mains voltage U_N	DC 350...800 V
Operating range U_N	DC 100...1100 V
Supply voltage:	
Supply voltage U_S AC	AC 50...60 Hz 100...240 V
Operating range U_S AC	0.9...1.1 U_S
Supply voltage U_S DC	d.c. 110 V
Operating range U_S DC	0.8...1.2 U_S
Max. power consumption	30 W max.
Response values:	
Response value R_{ALARML}(Low)	50 ....100 kΩ
Response value R_{ALARML}(High)	(fixed value) 20 kΩ
For response values <1000 Ω a coupling device AG5003 must be used.	
Alarm indication threshold voltage exceeded	350 or 100 V
	factory setting = 100 V
Max. system leakage capacitance	10 µF
Response times:	
Delay time	0...100 s
Window time	0...300 s
Measuring circuit:	
Internal resistance DC Ri	500 kΩ
Internal resistance DC Ri with AG5003	50 kΩ
Relay outputs	
Contact circuit	
Switching components	3 change-over contact
Contact class acc. to DIN IEC 60255 Teil 0-20	IIB
Rated contact voltage	AC 250 V/DC 300 V
Admissible number of operations	12000 cycles
Limited making capacity	UC 5 A
Limited breaking capacity	
at AC 230 V and cos phi = 0.4	AC 2 A
at DC 220 V and L/R = 0.04 s	DC 0.2 A
Operating principle, K1 and K2, selectable	N/O / N/C operation
Pre-set by factory, K1 and K2	N/O operation
Operating principle K3	N/C operation
Serial interfaces	RS 232 and RS 485
Outputs	
*analog output M+/M-	0...20 mA, linear
Inputs	
Digital input 1 (E1/EG)	selectable, DC 24 V or DC 5 V
Digital input 2 (E2/EG)	switching of response values

*) see diagram on page 35

Type tests

Test of the Electromagnetic Compatibility (EMC):	
Immunity for industrial environments acc. to IEC 61000-6-2:	
Electrostatic discharge immunity test acc. to IEC 61000-4-2	severity degree 3
Radiated, radio-frequency, electromagnetic field immunity test EM acc. to IEC 61000-4-3	severity degree 3
Burst immunity test acc. to IEC 61000-4-4	severity degree 3
Surge immunity test acc. to IEC 61000-4-5	severity degree 3
Immunity to conducted disturbances, induced by radio-frequency fields acc. to IEC 61000-4-6	severity degree 3
Power frequency magnetic field Immunity test acc. to IEC 61000-4-8	severity degree 3
Voltage dips, short interruptions and voltage variations, immunity tests acc. to IEC 61000-4-11	severity degree 3
Emissions acc. to EN 50081-2:	
Emissions acc. to EN 55011/CISPR11	class B
Mechanical tests:	
Shock resistance acc. to IEC 6068-2-27	15 g/11 ms
Bumping acc. to IEC 6068-2-29	40 g/6 ms
Vibration strength acc. to IEC 6068-2-6	10...150 Hz/0.15 mm - 2g

Environmental conditions

Ambient temperature, during operation	-15°C...+55°C
Storage temperature range	-40°C...+70°C
Climatic class acc. to IEC 60721 (except condensation and formation of ice)	3K5

General data

Operating mode	continuous operation
Mounting	any position
Connection	terminals with self-lifting clamp-washers
	Cross sectional area of connecting cable,
single wire	0.2...4 mm2
Cross sectional area of connecting cable, flexible	0.2...2.5 mm2 (AWG 24 12)
Casing	19" casing 30 TE /4 HE for wall-mounting
Protection class acc to EN 60529	IP 65

Ordering details

IR5003	Art. No. 91 059 010
AG5003	Art. No. 98 039 002

Analog output IR5003 (0-20 mA)

Analog output IR5003

The IR5003 provides one analog output of 0…20 mA which is specified in the table below:

Current resistance table

I/mA	Rf/kΩ	I/mA	Rf/kΩ	I/mA	Rf/kΩ
0.0	20	7.0	13	14.0	6
1.0	19	8.0	12	15.0	5
2.0	18	9.0	11	16.0	4
3.0	17	10.0	10	17.0	3
4.0	16	11.0	9	18.0	2
5.0	15	12.0	8	19.0	1
6.0	14	13.0	7	20.0	0

Diagram current output IR5003

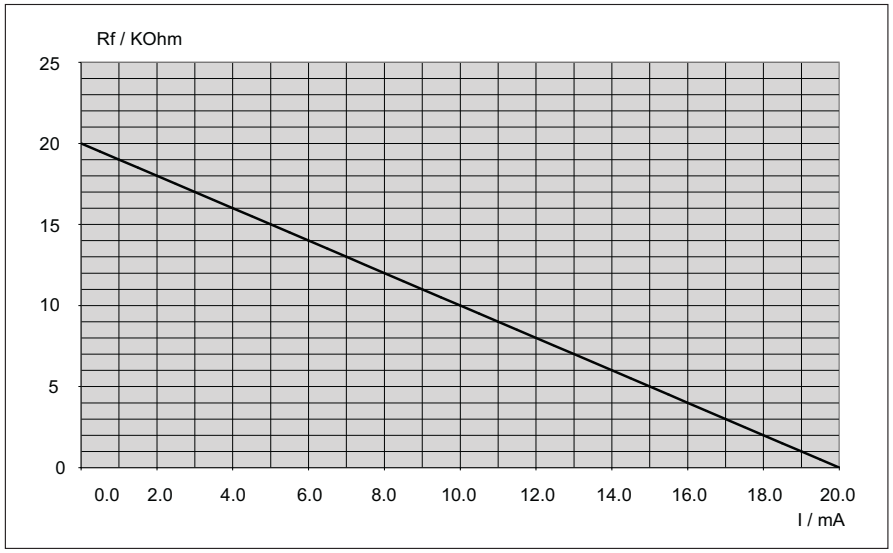


Diagram: current output 0 … 20 mA

Calculating formula IR5003

1 kΩ is 1 mA

$$Rf\ [k\Omega] = -I\ [mA] + 20$$