Contents

1. Introduction

1.1 Use

Fast and accurate measurements of ultra-small resistances can be made using the DO6 milliohmmeter. With its rugged table-top case and membrane keypad, this instrument is designed for both laboratory use and harsh industrial environments.

Temperature-compensated resistance-testing of wires and coils is possible using a Pt100 sensor or pyrometer to measure he temperature of the device under test. He instrument then corrects the resistance to e.g. 20°C (selectable)

The meter has a huge range of applications, such as measuring:

- Transformer / motor windings
- Coils of any kind
- Cables and wires on the drum or as meter samples
- Switch and relay contacts
- Heating elements
- Connections and contacts to power rails, and
- much more

Complete control capability via the RS232 PC interface means that fully automatic test stations can be set up. The meter includes a PLC interface for integration in production process controllers. A 2-way comparator with PLC and relay switching outputs is also provided for classification and selection of the devices under test.

1.2 Description

The meter works on the basis of the proven 4-wire measurement method, in which test-lead resistances and contact resistances are eliminated. The measurement technique also compensates automatically for any thermal EMF's in the measurement circuit. The instrument leads are monitored for damage by a built-in detector.

Of course the meter includes temperature compensation for any type of material under test such as copper, aluminium, brass, tungsten etc. using an externalPt100 sensor or external infrared thermometer (accessory) to measure the temperature. A special circuit for protecting the measurement input when measuring high-inductive devices has been developed to prevent damage to the meter from voltage peaks produced when disconnecting the device under test.

If there is a requirement to test devices using different parameters in an automatic test setup, then up to 16 device settings such as measuring range, limits, temperature coefficient etc. can be saved. All device-specific settings are shown on the display.

The settings can be retrieved via the keyboard or PLC interface using a bit pattern (4 bits). Of course all device settings can also be made via the RS232 interface.

A backlit, high contrast LCD display is used for displaying the readings, so it is extremely easy to read the measurement in both dark and well lit rooms.

2. Preparations for use

2.1 Unpacking the unit

The instrument weighs 3.5 kg and is packed accordingly to protect against shock. Unpack the instrument carefully and verify that all items are present.

This normally includes:
1 DO6 instrument
1 Power lead
1 Copy of this manual

Please inspect the instrument carefully for damage that might have happened in transit. If you suspect that the instrument has been damaged during shipping, you should contact the delivery company immediately. The packing should be retained for inspection by the manufacturer / delivery company. The DO6 milliohmmeter should be shipped only in its original packing or in packing capable of providing an equivalent degree of protection.

2.2 Using the instrument for the first time

If condensation has formed on the instrument, make sure that the instrument is completely dry (including inside) before switching it on. Connect the instrument to a standard grounding outlet using the power lead supplied.

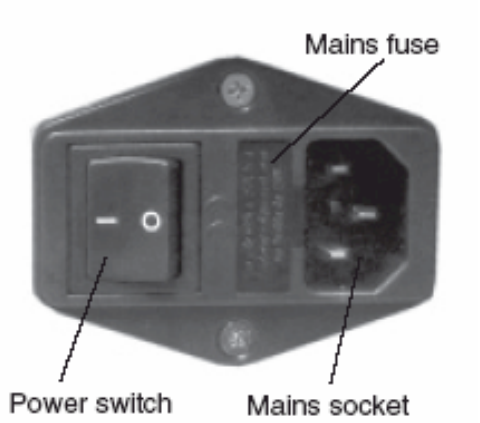
Warning: The instrument must never be switched on if it shows signs of damage during shipping. The case or measurement input can carry life-threatening voltages if the mains voltage is transferred as a result of damage.

2.3 Supply voltage, power switch and mains fuse

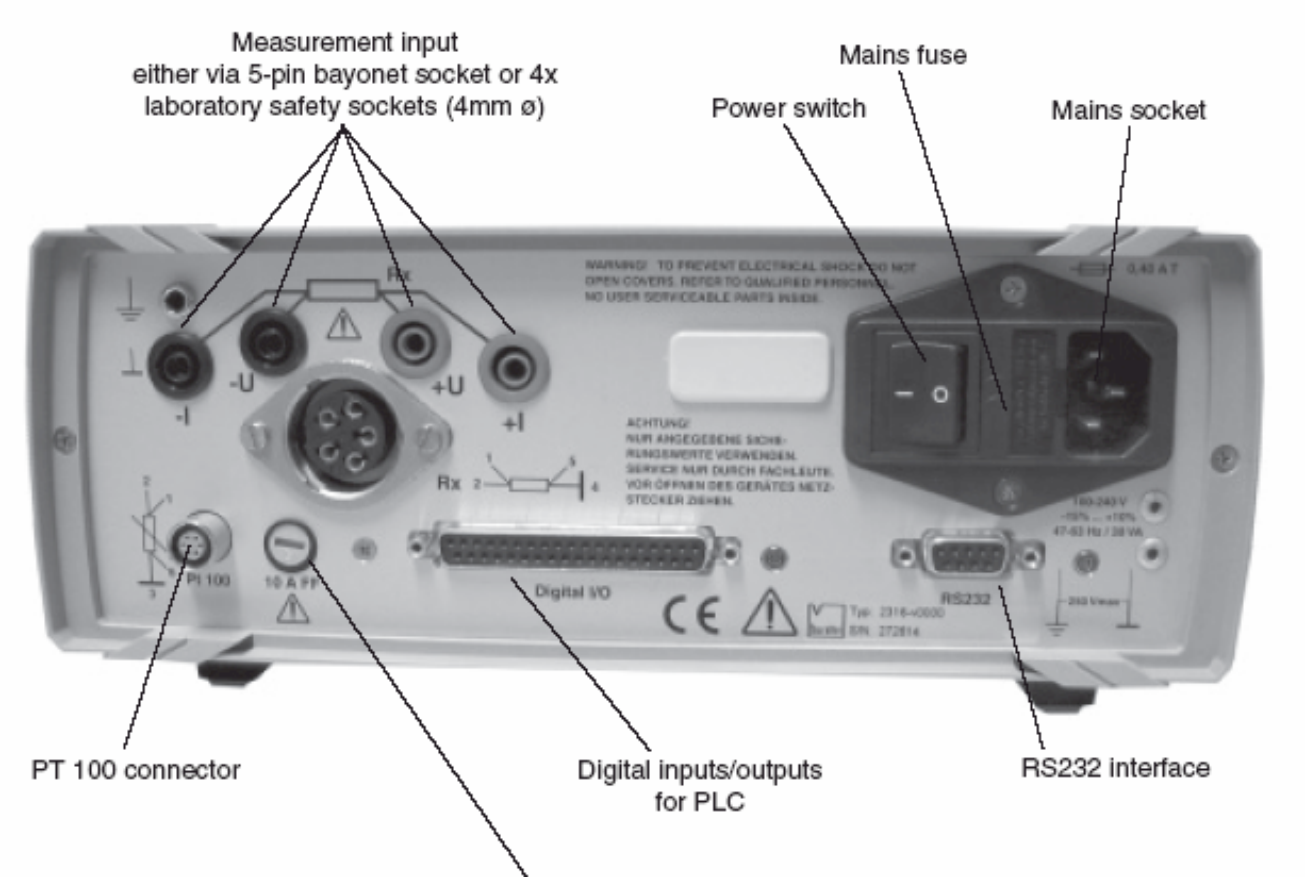
230V +6% -10% 45 …. 65 Hz, approx 30VA

The mains fuse is located between the mains sockets and power switch on the rear of the unit. **Make sure that the unit is fully disconnected from the electrical mains before changing the fuse.** This should be done by removing the power lead from the mains socket; always pull on the connector itself, never the cable.

Only use original fuses 5 x 20 mm 0.63 AT



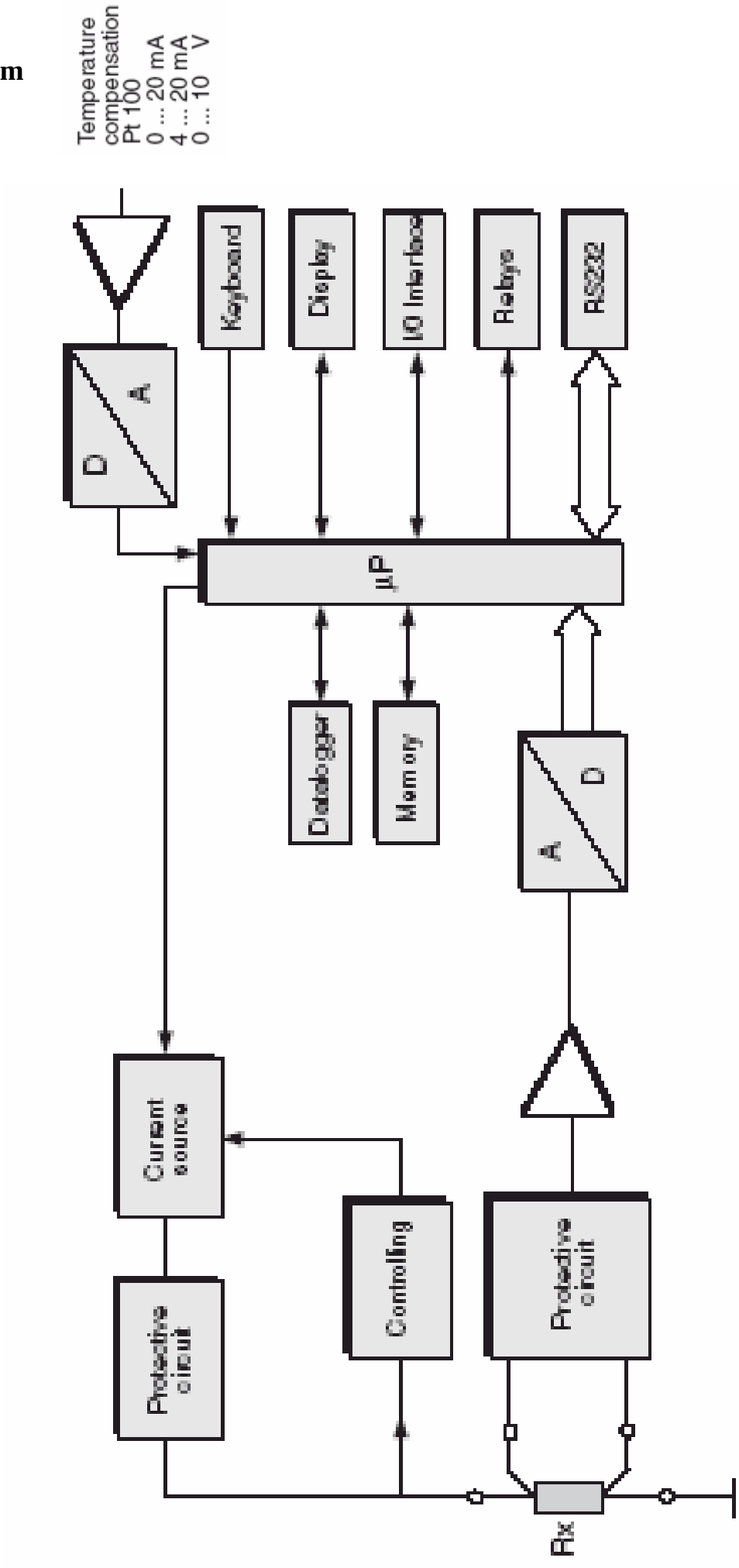
2.4 Power supply and signal-lead connectors



Additional protection of the measurement current using a super quick-acting 10 A fuse 6.3 x 32 mm
600 VAC
50000 A breaking capacity (or greater)
Use only this fuse

- Only ever use a shielded, twisted cable with shielded connectors for connecting to the standard RS232 interface connector.
- Always use a Pt100 sensor with shielded cable to connect to the Pt100 connector. The cable shield must not be in contact with the connector shell if grounding of the sensor is unclear. Otherwise currents circulating in a ground loop can cause measuring errors.
- **Only one device under test must be connected across the two parallel measurement inputs. No leads must be plugged into the unused connector for safety reasons.**

2.5 Block diagram

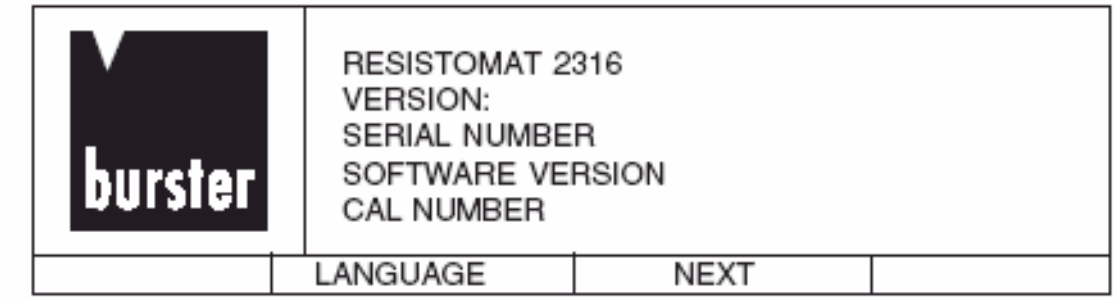


2.6 Setup and installation

- Ensure that there is an adequate supply of air to prevent heat building up in the instrument
- Do not place the instrument on surfaces such as carpets or cloths, or near materials such as curtains or wall hangings that could prevent the air circulating
- Do not place the instrument at an inclined angle; it should always be used in a horizontal position
- Keep the instrument away from apparatus, equipment, machines and installations that generate strong magnetic fields
- Do not place heavy objects on the instrument
- Condensation can form inside the instrument if it is taken from a warm room into a cold room; wait a few hours before switching on the instrument
- Make sure that the display panel is not mechanically stressed
- The instrument must have reached thermal equilibrium
- Select the installation location so that the instrument is not exposed to extreme temperatures (operating temperature range 0 to 50°C) or temperature variations, nor to humidity, direct sunlight, incandescent lamps, dust, oils, organic solvents, other aerosols, severe vibrations or mechanical shocks. In very dirty industrial environments, it is recommended touse a suitable protective enclosure.

2.7 Function test

After switching on the instrument, the following text appears on the display for about 3 seconds:



Then the instrument switches directly to the measurement menu.

2.8 Calibration

The meter was calibrated before shipping. The calibration history of the instruments used for the calibration can be traced to the government measurement standard in accordance with DIN ISO 9000 ff. The meter should be recalibrated after a period of about one year. Calibration is performed using the RS232 interface, and should only be performed at the manufacturers premises. The customer can perform the calibration in-house by purchasing the PC software DO6-P001.

2.9 Storage

For long term storage, pack the unit, along with a desiccant, into an airtight, sealed polythene bag. Do not store the unit where it will be exposed to sunlight or any other light sources. Take care to ensure that nothing comes in contact with the display panel. The storage temperature range is 0 to 70°C; however, to maximise the lifespan of the display, the temperature should not exceed 50°C.

3. Safety instructions

Whilst the hardware and software has been developed to a high specification and thoroughly tested, they cannot be totally guaranteed to be free of errors. Thus this instrument, or part of the instrument, must not be used to influence a control system from which risk to life or property can arise directly or indirectly, without additional protection. Maintenance and repair work must only be performed by trained, competent, technical personnel familiar with the associated risks.

- The instrument has 2 measurement inputs connected in parallel; only one of these inputs must be used at any one time. No leads must be plugged into the unused connector for safety reasons. The unused circular socket must be covered with the cap supplied.
- Before starting any measurement, make sure that the device under test does not carry an external voltage (e.g. mains voltage, voltage generated by a rotating motor etc.)
- Take care when handling inductive devices under test. By the physical nature of these devices, life-threatening induction voltages can be generated when the test current is disconnected. Read the instructions in the “Load selection” section.
- To avoid electric shock, never open the case. The instrument contains no components that can be maintained, adjusted or calibrated by the customer. The instrument can operate with all standard mains voltages in the world without needing to be switched over.
- Always replace fuses with fuses of the same type. Never use fuses with different characteristics or other related currents. Before changing the fuse, pull out the mains plug and short-circuit the device under test.
- Should foreign bodies or liquids get inside the unit, disconnect the main lead. Get the instrument checked over by qualified technical personnel before using it again.
- Always leave repair work to qualified technical personnel.
- If you do not intend using the instrument for a prolonged period, take the mains plug out of the socket. Always pull on the connector itself, never the cable.
- Should liquid from a broken display escape from the unit and get on your hands, wash your hands thoroughly using soap and water. Remove any residues of the liquid with acetone or ethanol.
- Always keep the instrument out of rain or away from moisture to prevent a fire hazard or the risk of electric shock.
- Check the mains lead before use.

4. Controls

4.1 Front panel

Front Panel with backlit LCD display and integral membrane keypad with tactile feedback

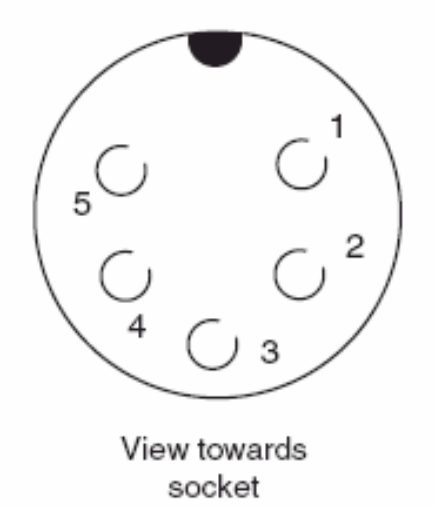
4.2 Button functions

[START]	In the measurement menu this button starts a measurement.
	In the configuration menu this button is assigned different functions depending on the text shown on the display above the button (soft key).
[STOP]	In the measurement menu this button stops a measurement.
	In the configuration menu this button is assigned different functions depending on the text shown on the display above the button (soft key).
[↑]	In the measurement menu and for manual range selection this button can be used to increase the measuring range.
	In the configuration menu this button has a curser (up) function.
[↓]	In the measurement menu and for manual range selection this button can be used to decrease the measuring range.
	In the configuration menu this button has a curser (down) function.
[↑] [↓]	Pressing both buttons simultaneously opens the Configuration menu

4.2 Rear panel

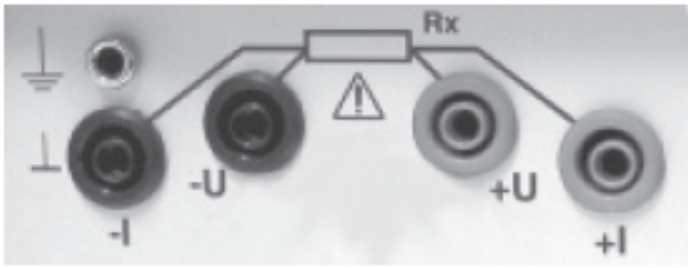
4.2.1 Description of connector sockets

Measurement input



1	+ U
2	+ I
3	Analogue GND
4	- I
5	- U

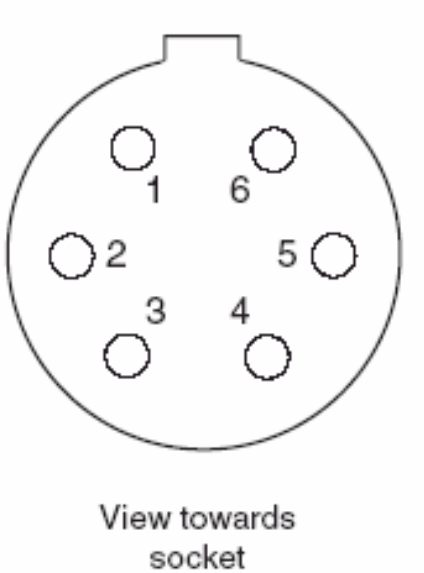
Connector shell:	PE (Protective ground) potential
Mating connector:	Burster type 9900-V172
Note:	The current branch is protected by a fuse 6.3 x 32 mm 10AFF. (Rear side of unit)



- I is at FE potential

Caution! Only one measurement input must be used at any one time. No leads must be plugged into the unused input for safety reasons.

Pt100 input



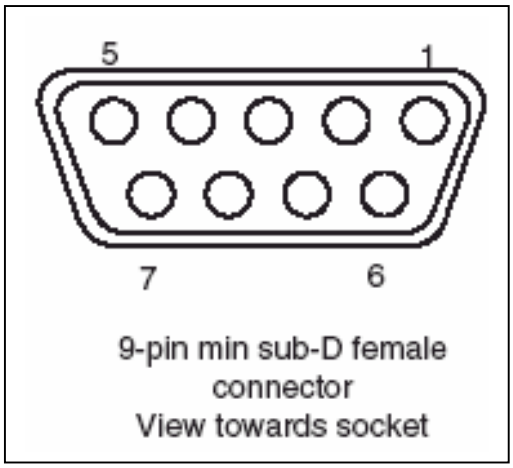
1	+ U
2	+ I
3	- I
4	Functional ground
5	Functional ground
6	- U

Connector shell:	PE (Protective ground) potential
Mating connector:	Burster type 4291-0

Two-wire technology is possible if the relevant conductors are joined together at the sensor.

Note: NEVER connect the cable shield to the connector shell if the grounding at the sensor end is unclear. Otherwise, if there is a ground connection at the temperature sensor, measuring errors may result from circulating ground-loop currents. (Connector shell is protective ground)

RS232 interface

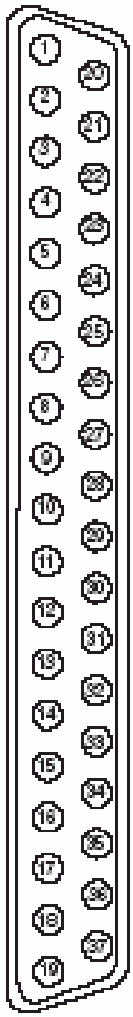


1	NC
2	TXD
3	RXD
4	
5	Digital GND (grounded internally)
6	
7	NC
8	
9	NC

Connected in instrument

Connector shell:	PE potential
Mating connector:	Type 9900-V209
Matching data cable:	Type 9900-K333

Digital I/O



37-pin min sub-D
View towards socket

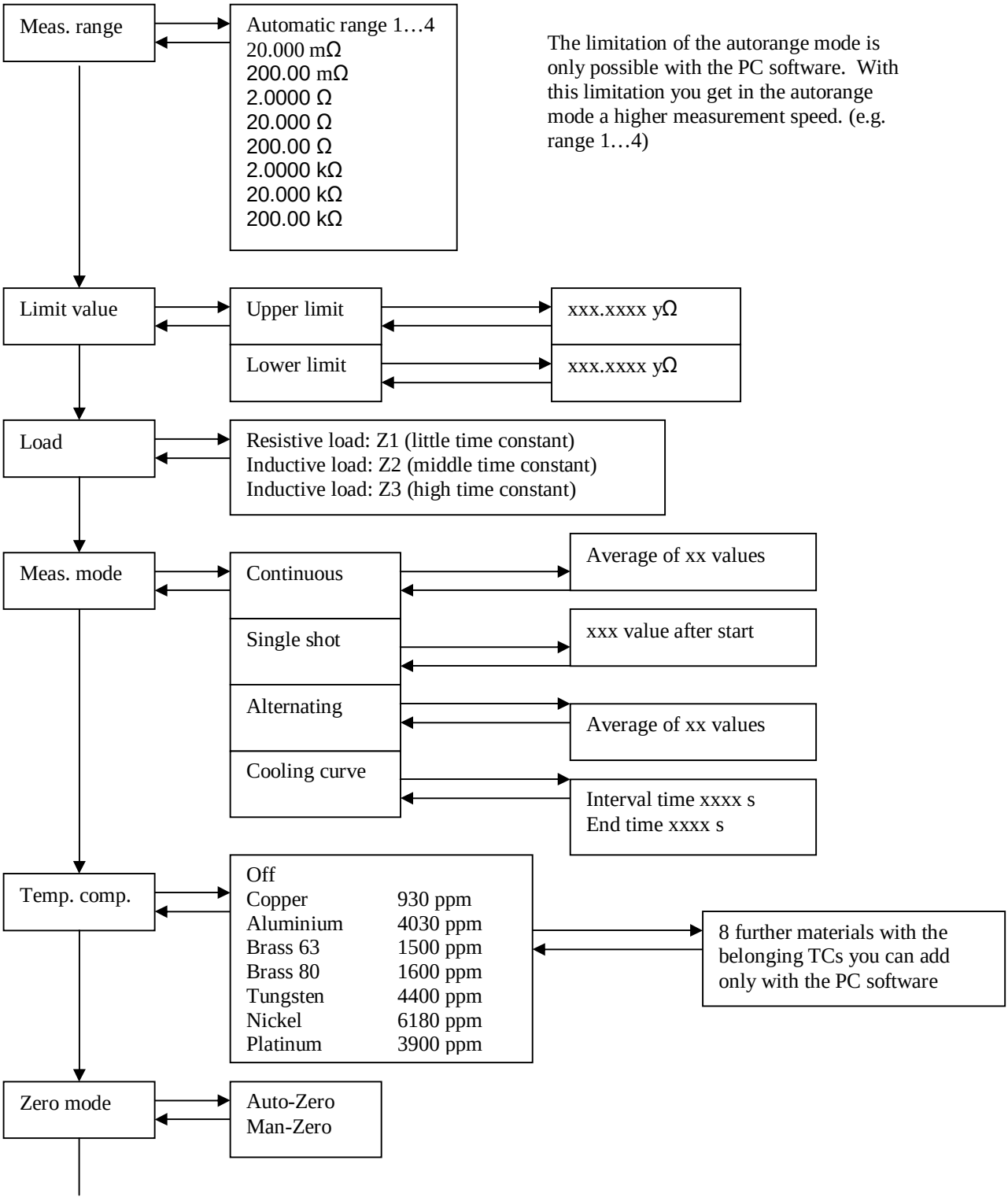
Connector shell PE potential
Mating connector: Type 9900-V165

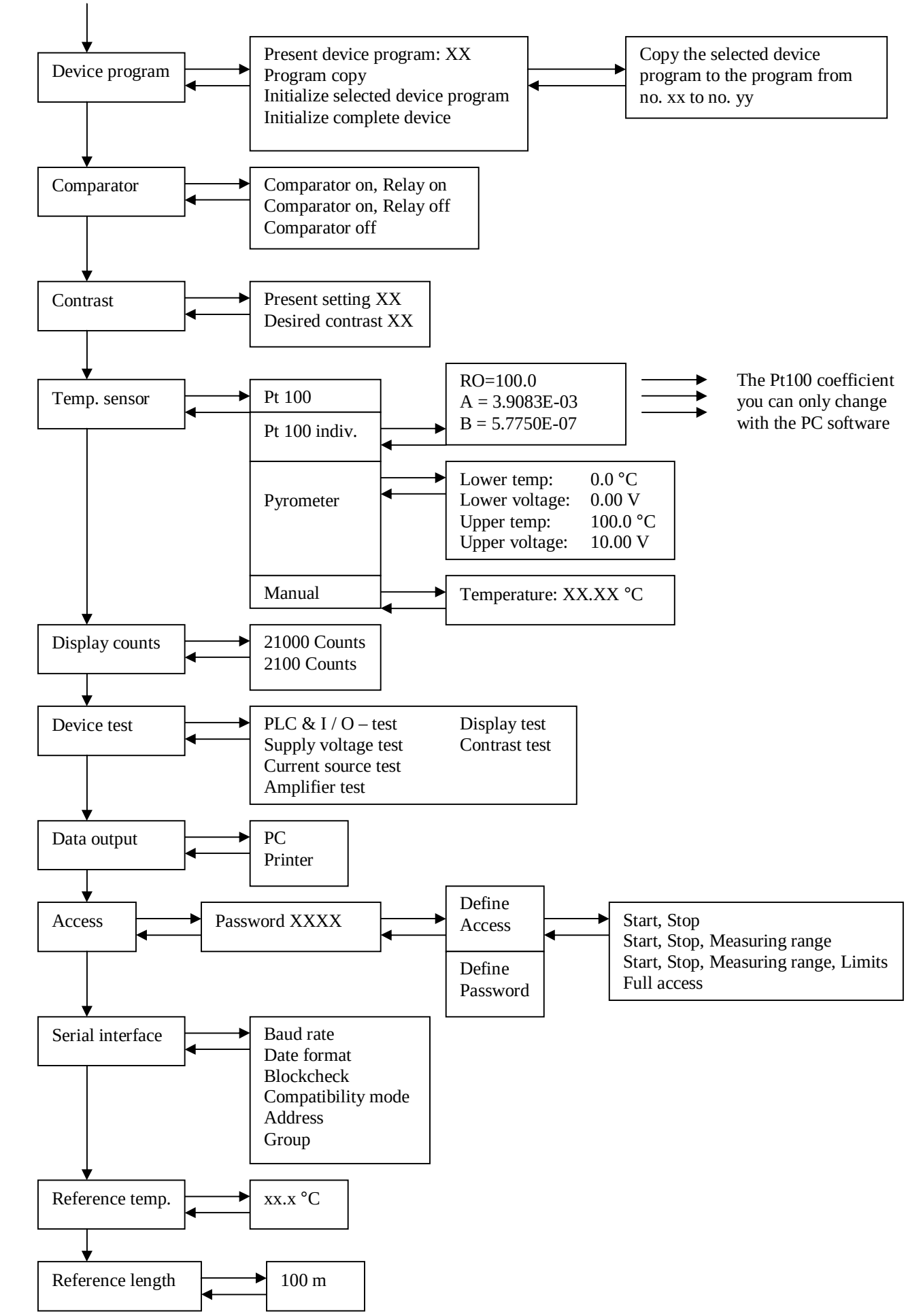
Pin	Function	Function
1	Relay	<, NO contact
2	Not used	
3	Relay	=, NO contact
4	PLC output	Device program saved ok
5	Relay	>, NO contact
6	Relay	Relay common contact
7	PLC output	Busy
8	PLC output	End of measurement
9	PLC output	Measuring error
10	PLC output	<
11	PLC output	Device program 0 mirrored
12	PLC output	=
13	PLC output	Device program 1 mirrored
14	PLC output	>
15	PLC output	DANGER
16	PLC output	Device program 2 mirrored
17	PLC output	Device program 3 mirrored
18	PLC	+ 24 V External
19	PLC	+ 24 V External
20	PLC	Ground 24 V External
21	PLC input	START / STOP measurement
22	PLC input	Comperator ON / OFF
23	PLC input	Remove load (cooling curve)
24	PLC input	Spare 1
25	PLC input	START printer
26	PLC input	Save device program
27	PLC input	Spare 2
28	PLC input	Device program 0
29	PLC input	Device program 1
30	PLC input	Device program 2
31	PLC input	Device program 3
32	PLC input	Spare 3
33	Not used	
34	Pyrometer	+ 10 V Analog input
35	Pyrometer	Ground, FE
36	Foot switch	NO contact
37	Foot switch	NO contact, DGND
Shell	Shield	Protective ground

5. Operating instructions in brief

After switching on the instrument, the operating language can be selected in the identification menu.

Pressing both arrow buttons simultaneously opens the configuration program. ENTER confirms the selected menu option. ESC can be used to return from any option in the configuration menu back to the next menu option down. If a value needs to be changed e.g. limit, arrows appear above the START/STOP buttons to move the cursor to the left/right. The numerical value is changed using the up/down arrow buttons (on the right hand side) on the front panel.




Device program
Present device program: XX
Program copy
Initialize selected device program
Initialize complete device
Copy the selected device program to the program from no. xx to no. yy
Comparator
Comparator on, Relay on
Comparator on, Relay off
Comparator off
Contrast
Present setting XX
Desired contrast XX
Temp. sensor
Pt 100
Pt 100 indiv.
RO=100.0
A = 3.9083E-03
B = 5.7750E-07
The Pt100 coefficient you can only change with the PC software
Pyrometer
Lower temp: 0.0 °C
Lower voltage: 0.00 V
Upper temp: 100.0 °C
Upper voltage: 10.00 V
Manual
Temperature: XX.XX °C
Display counts
21000 Counts
2100 Counts
Device test
PLC & I / O – test
Supply voltage test
Current source test
Amplifier test
Display test
Contrast test
Data output
PC
Printer
Access
Password XXXX
Define Access
Define Password
Start, Stop
Start, Stop, Measuring range
Start, Stop, Measuring range, Limits
Full access
Serial interface
Baud rate
Date format
Blockcheck
Compatibility mode
Address
Group
Reference temp.
xx.x °C
Reference length
100 m

6. Operation

6.1 Meaning of the individual display segments

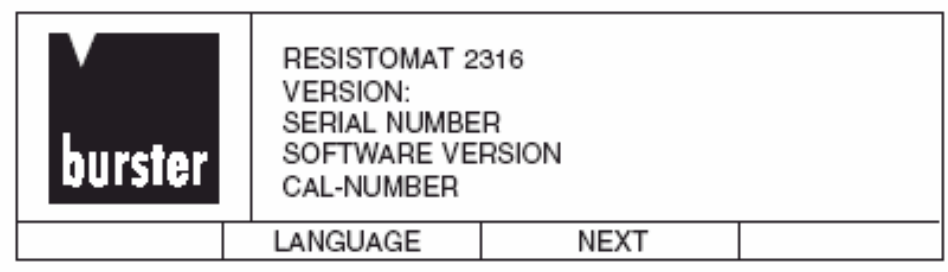
Limits and the evaluation result are only displayed when the computer is enabled. When a measurement is in progress, the measurement counter increments from 0 to 9, changing whenever a new measurement result is available

Danger warnings and error messages flash.

The animation indicator (-) flashes at second intervals to show that the meter is running and performing a measurement.

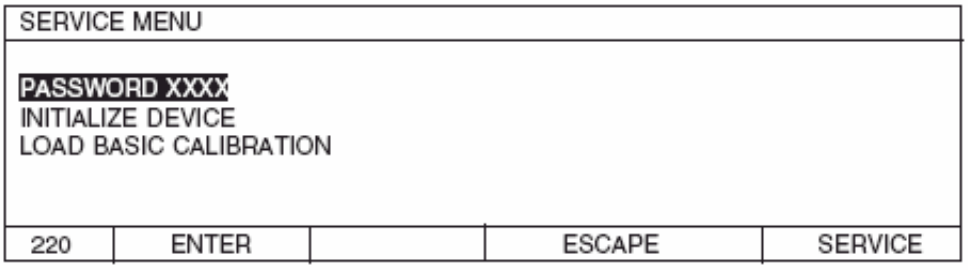
6.2 Start-up menu

The first menu is displayed after power up:



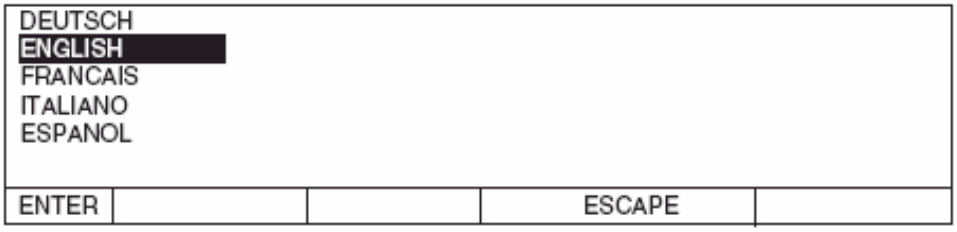
If LANGUAGE is not pressed within 3 seconds, the meter goes automatically into the measurement menu. NEXT switches to the measurement menu immediately.

Note: If the ↑↓ buttons are a pressed simultaneously in this menu, within the 3 seconds, the service menu opens.



This menu is protected by a secret password and can only be accessed by service personnel.

The following screen is displayed in LANGUAGE is pressed:



Selection bar has inverse display, press ↑↓ then ENTER to progress to menu 5.

6.3 Configuration menu

If the ↑↓ buttons are pressed simultaneously, the instrument goes into the configuration state and displays menu 5.

Menu 5 has three pages.

10	MEASURING RANGE	20mΩ ↓
20	LIMIT VAL.	10.000 mΩ, 20.000 mΩ
30	LOAD	RESISTIVE LOAD: Z1
40	MEASURING MODE	CONTINUOUS (1)
50	TEMP. COMPENSAT.	OFF
60	ZERO MODE	MAN ZERO
MENU 5	ENTER	ESCAPE

Selection bar has inverse display. Press ↑↓ to move selection bar, ENTER to select and proceed to menu 10 – 170, and ESCAPE to return setting to original value. The menu has a rolling display; after 170 comes 10. If you are in the bottom line, pressing ↓ displays the next page with the cursor in the top line. The same happens in reverse when scrolling up. The arrow in the top right hand corner ↓ indicates that this is the first menu page.

70	DEVICE PROGRAM	CURR.PRG.:0 ↓↑
80	COMPARATOR	1KO ON, REL ON R-
90	CONTRAST	60 %
100	TEMPERATURE SENSOR	PT-100 INDIV
110	DISPLAY COUNTS	21000 DIGITS
120	DEVICE TEST	
MENU 5	ENTER	ESCAPE

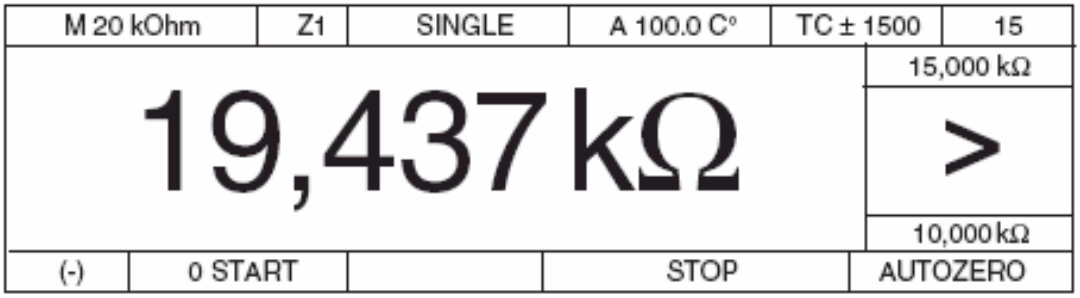
↓↑ Shows that this is the second menu page

130	DATA OUTPUT	PC ↑
140	ACCESS	LEVEL 1
150	SERIAL INTERFACE	9k8, 8n1, B0, G00, I00
160	REFERENCE TEMP	20 C°
170	REF. LENGTH	1.00 m
MENU 5	ENTER	ESCAPE

↑ Shows that this is the last menu page

6.4 Measurement menu

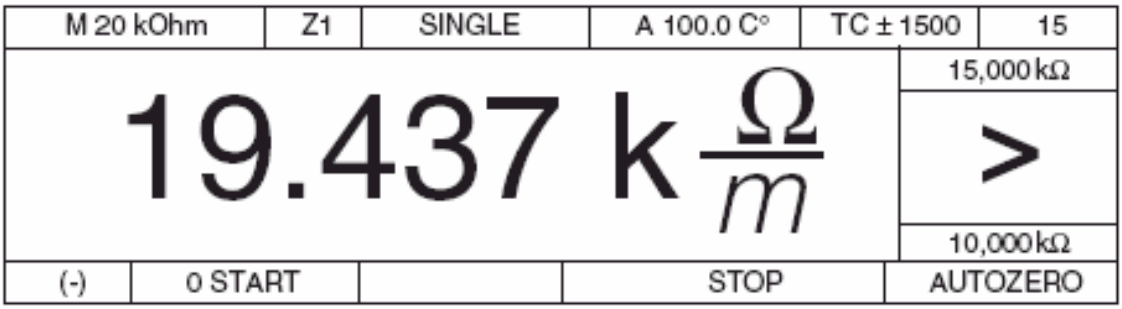
Measurement mode



Limits and the evaluation results are only displayed when the comparator is enabled. When a measurement is in progress, the measurement counter increments from 0 to 9, changing whenever a new measurement result is available.

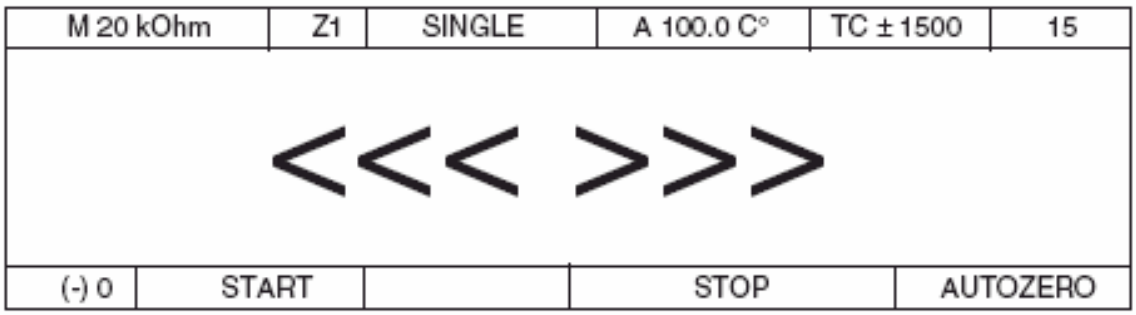
Danger warnings and error messages flash.

The animation indicator (-) flashes at second intervals to show that the meter is running and performing a measurement.



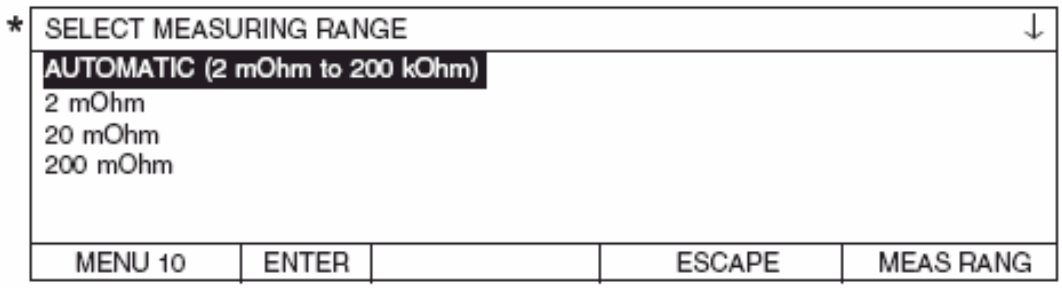
The units “Ohms per meter” can be selected as an alternative.

Over-range indication



6.5 Description of the individual setup menus

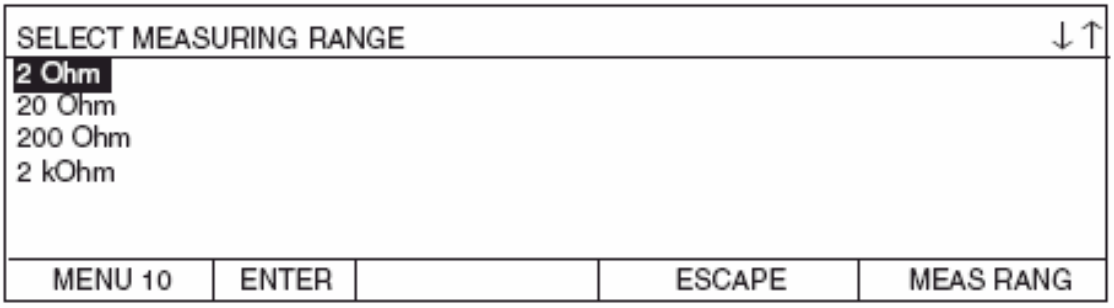
6.5.1 Measuring range



Selection bar has inverse display. Press ↑↓ to move selection bar, ENTER to select, and ESC to return to menu 5 without making a change. The arrow in the right hand corner ↓ indicates that this is the first menu page.

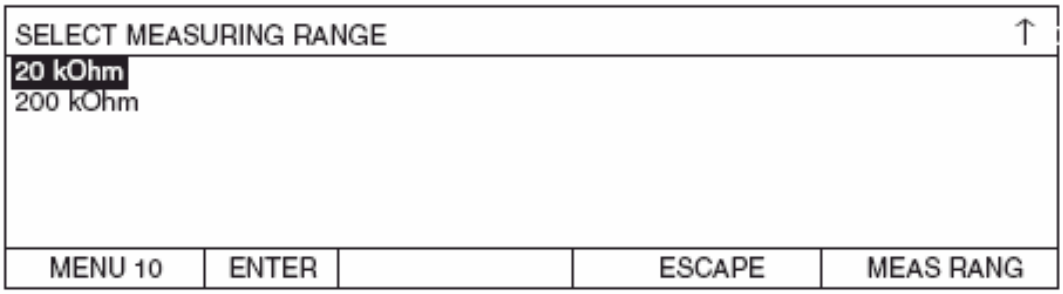
The measuring range can also be changed while measurement is in progress using the ↑↓ buttons in continuous measurement mode with Z1 and single shot mode with Z1, but in neither case with time constant Z2 or Z3 selected. Selecting AUTOMATIC in conjunction with MAN ZERO is pointless, because zeroing is only performed in one range in this case. Automatic mode is not possible with time constant Z2 or Z3. This is because high induction voltages can occur when the range is switched for inductive devices under test.

Purely resistive devices under test can be measured with Z1.



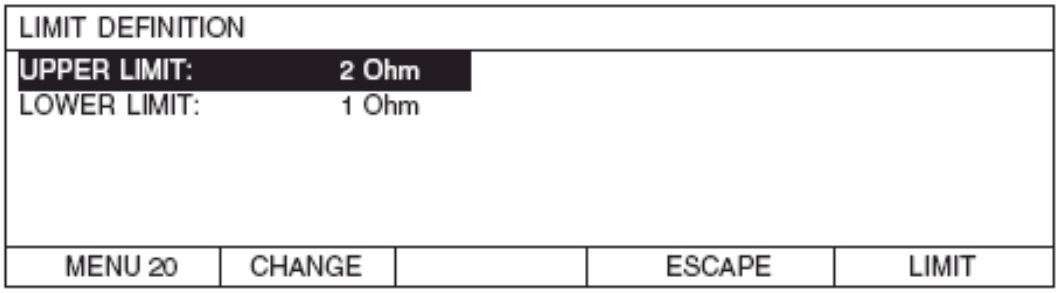
Selection bar has inverse display. Press ↑↓ to move selection bar, ENTER to select, and ESC to return to menu 5 without making a change. The arrow in the right hand corner ↓↑ indicates that this is the second menu page.

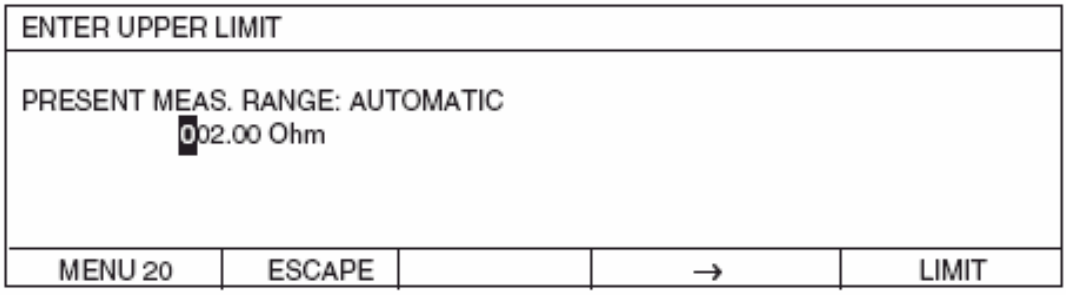
* In order to speed up measurement times in automatic mode (measuring-range selection), the automatic range can be restricted using the PC software (e.g. 20 mΩ to 20 Ω)



Selection bar has inverse display. Press ↑↓ to move selection bar, ENTER to select, and ESC to return to menu 5 without making a change. The arrow in the right hand corner ↑ indicates that this is the last menu page.

6.5.2 Limits



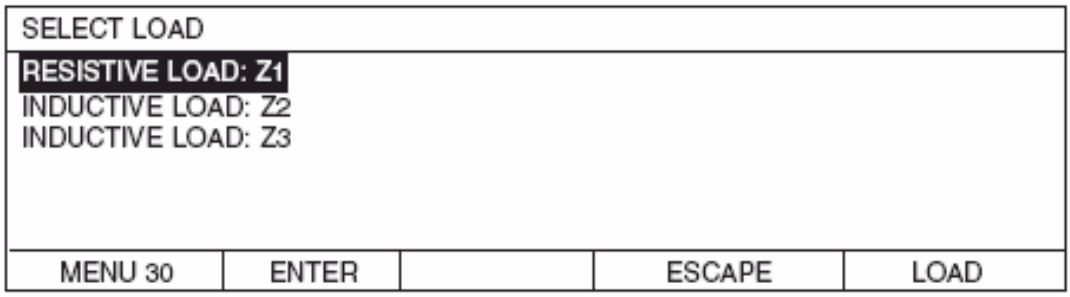


The cursor sits over the first 0. Pressing ↑↓ increases or decreases the numerical value, while → moves the cursor one position to the right within the input field. With the cursor directly over “Ohm” ↑↓ switches between m and k.

The limit is only saved when ENTER is pressed with the cursor in this position.

The lower limit is entered in the same way.

6.5.3 Load selection



Selection bar has inverse display. Press ↑↓ to move selection bar, ENTER to select and return to menu 5, and ESC to return to menu 5 without making a change.

Selection of LOAD / TIME CONSTANTS Z1, Z2, Z3

This is used to select the time constant Z of the current regulator:

Z1 is set for purely resistive devices under test.

The time constants Z2, Z3 are selected for devices under test that have an inductive component. The instrument does not automatically detect inductive devices under test. For time-critical applications, one can use trial and error to find out whether a faster measurement is possible by selecting a shorter time constant. Start with the longer time constant Z3 and select the next shorter time constant Z2. If the same measurement result is obtained, you can then select the shorter time constant for all further measurements. Always short-circuit the device under test before disconnecting it.

For Z2 and Z3, the measuring range cannot be changed while the measurement is in progress.

Danger warnings for Z2, Z3

A DANGER warning flashes in the display after pressing START. The DANGER warning is displayed during the measurement and for one second after pressing the STOP button. Just because the danger warning is no longer displayed does not mean that there is no longer any risk. Always short-circuit the device under test before disconnecting it.

Inadmissible instrument settings

The time constants Z2, Z3 cannot be used in conjunction with automatic measuring range and alternating measurement mode.

6.5.3.1 Handling inductive loads e.g. reactors, cables on reels, motors, coils, transformers

Safety instructions

- The instrument has two measurement inputs connected in parallel; only one of these inputs must be used at any one time. No leads must be plugged into the unused connector for safety reasons. The unused circular socket must be covered with the cap supplied.

- Before starting any measurement make sure that the device under test does not carry an external voltage (e.g. mains voltage, voltage generated by a rotating motor etc.).

- Take care when handling inductive devices under test. By the physical nature of inductive devices, life-threatening inductive voltages can be generated when the test current is disconnected.

- Dangerous induction voltages can occur if:

  - Ø The connectors are removed from the socket
  - Ø The test current (measuring range) is changed or switched off (STOP).
  - Ø The leads break
  - Ø The connections on the device under test are loose
  - Ø The instrument is switched off during the measurement
  - Ø The poser fails during the measurement
  - Ø The test current changes for whatever reason
  - Ø A fuse blows

- An inductive device under test must not be connected or disconnected in the START condition.

- **Always short-circuit the device under test before disconnecting.**

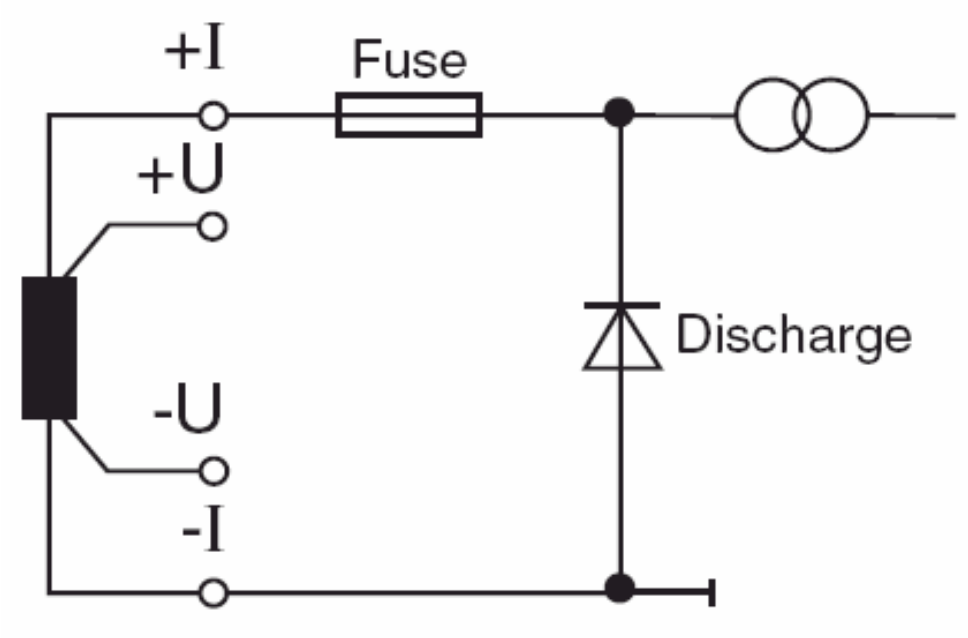
Protection circuit / Discharge circuit

This is an instrument protection circuit. The constant current source is protected by a fuse, an overvoltage arrester and other measures for protecting against external voltages. If external voltages greater than 90 V are accidentally input into the instrument, the overvoltage arrester actuates, and the 10 A test-current fuse may blow. Before changing the fuse, make sure that no external voltages are still applied to the instrument. Remove the mains lead and short-circuit the device under test. Always replace the fuse with a fuse of the same type. Never select a fuse with a higher rated current or a different time characteristic.

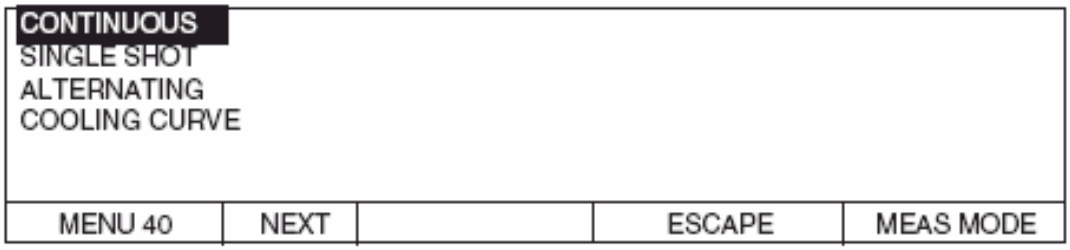
The instrument amplifier is also protected against external voltages. A replaceable fuse is not fitted here.

The circuit diagram for the protection circuit is shown below:

The diode provides a short-circuit for an inductive current and discharges an inductance down to a residual voltage of about 3 V. Even though particularly high-power diodes are used, sometimes there may be a problem at the end of the measurement (when disconnecting) if the device under test has a particularly high inductance. In addition, the device under test cannot be discharged if the test-current fuse has blown. **Therefore, for safety reasons, short-circuit the device under test before disconnecting it.**

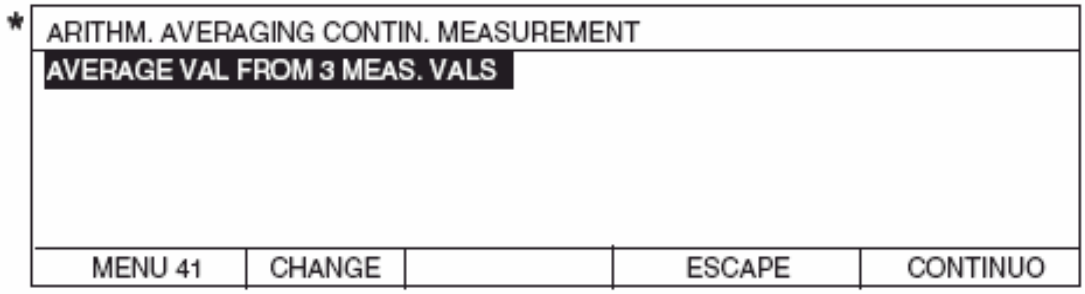


6.5.4 Measurement mode



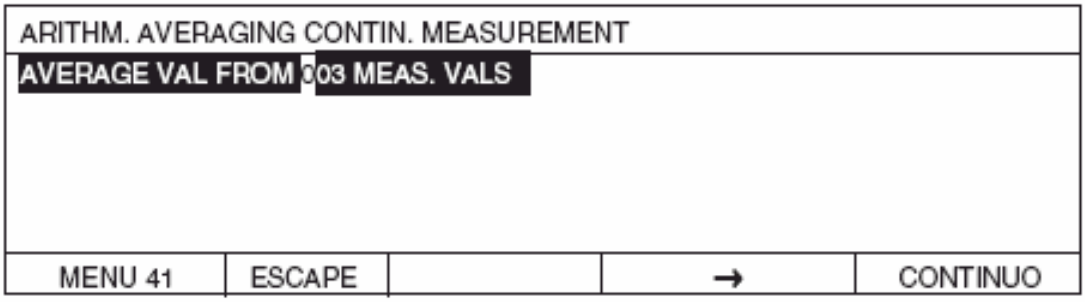
Use ↑↓ to move the selection bar, ENTER to select.

6.5.4.1 Continuous operation



Continuous operation means that the test current is switched on when the START button is pressed and not switched off until the STOP button is pressed. Mean values from n measurements are displayed. The first digitization takes about 550 ms (Z1, MAN ZERO, N=1), and subsequent digitizations about 210 ms each. The settling time depends on the time constant Z selected. For Z2 and Z3 the measuring range cannot be changed using the ↑↓ buttons while testing is in progress.

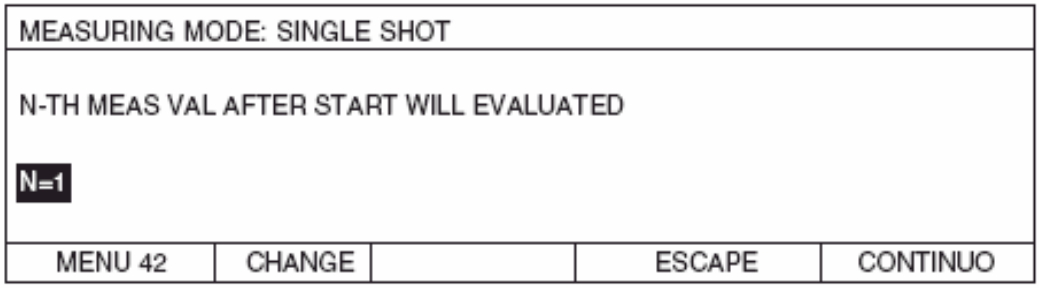
Pressing CHANGE displays the following screen:



The cursor sits over the first zero. Pressing ↑↓increases or decreases the numerical value, while → moves the cursor one position to the right within the input field. After selecting the value, press ENTER to save the value and close the menu.

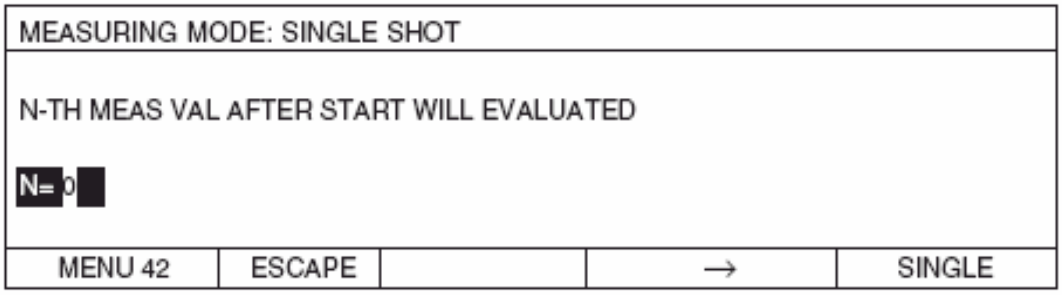
* If the measurement display flickers, averaging over n-values can produce a constant display.

6.5.4.2 Single shot



Single shot means that although all measurements are displayed, only the n'th measurement reading is saved and compared with the limits (comparator). Then the current source is switched off. The first digitization takes about 400 ms (Z1, MAN ZERO, N=1), and subsequent digitizations about 100 ms each. For Z2 ad Z£, and depending on the device under test, N needs to be set much higher; a correct result is not obtained with N=1. For Z2, Z3 the measuring range cannot be changed while the measuring is in progress.

Pressing CHANGE displays the following screen:



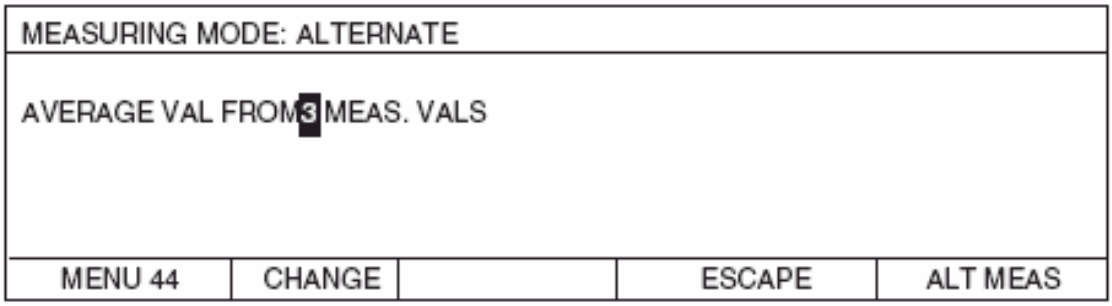
The cursor sits over the first zero. Pressing ↑↓increases or decreases the numerical value, while → moves the cursor one position to the right within the input field. After selecting the value, press ENTER to save the value and close the menu.

* This function is usually only required for inductive devices under test (coils). Since the instrument does not detect automatically when the magnetic field of the device under test is constant

$$\left(\tilde{I} = \frac{L}{R}\right)$$

the measurement time (n'th reading) must be found empirically.

6.5.4.3 Alternating measurement mode

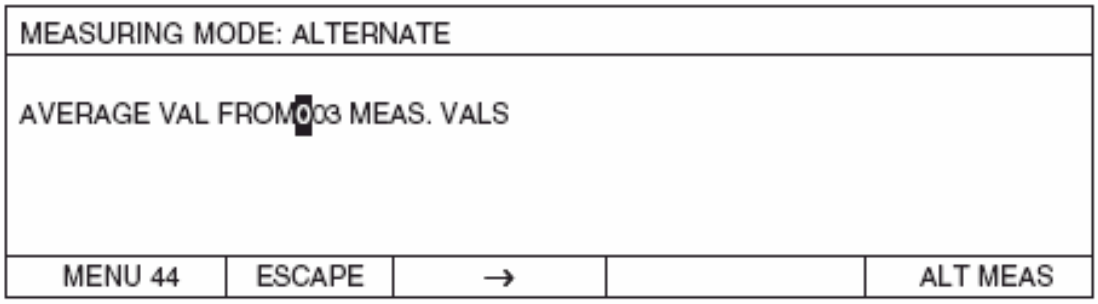


Alternating measurement mode means that the test current is switched on when the START button is pressed and not switched off until the STOP button is pressed. The current source is switched on and off continuously during the measurement to suppress any thermal EMF's, so that the instrument remains permanently correctly "zeroed". Select this measurement mode for ultra precise measurements that are not time critical.

Mean values of n values are displayed. One digitization takes about 2 s (Z1, N=1). While the measurement is in progress, the animation (-) indicator displayed on the lower left flashes at second intervals to show that the measurement is running. This setting cannot be used in conjunction with time constants Z2, Z3 or with an inductive load.

The setting MAN ZERO / AUTOZERO is ignored.

Pressing CHANGE displays the following screen:

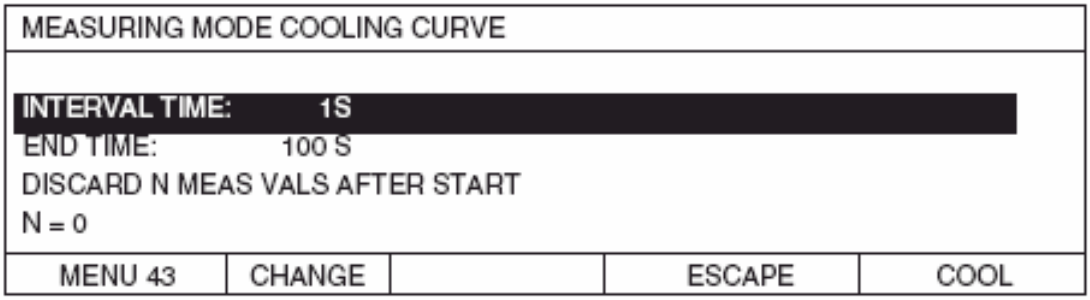


The cursor sits over the first zero. Pressing ↑↓ increases or decreases the numerical value, while → moves the cursor one position to the right within the input field. After selecting the value, pressing ENTER saves the value and closes the menu.

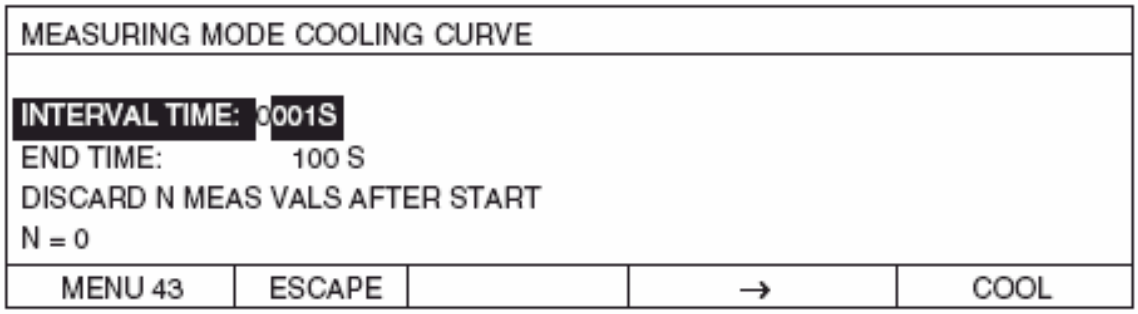
6.5.4.4 Cooling curve

The cooling curve measurement mode is allowed in conjunction with all times constants, and manual and automatic zero offset.

It is not allowed, however, in conjunction with comparator, automatic measuring range and automatic temperature compensation. The settling OHM/m is also ignored. Nor in this case is it possible to change the measuring range during the measurement time constant Z1.

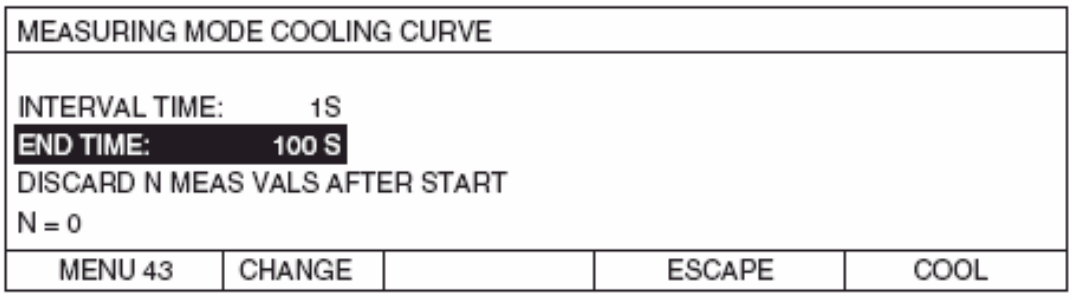


Pressing CHANGE displays the following screen:



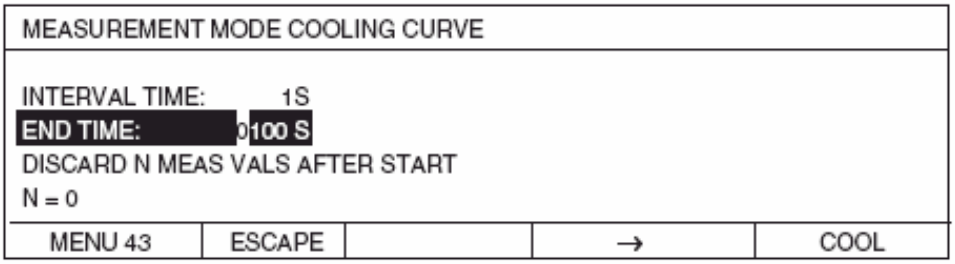
The cursor sits over the first zero. Pressing ↑↓ increases or decreases the numerical value, while → moves the cursor one position to the right within the input field. After selecting the value, pressing ENTER saves the value and closes the menu.

The INTERVAL TIME is the time between two measurements; it must always be shorter than the END TIME.

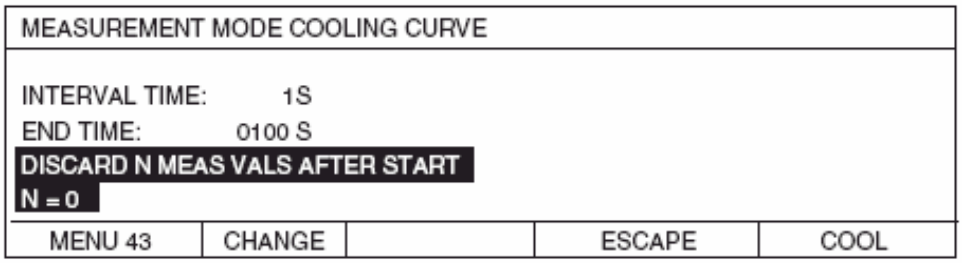


The END TIME is the time at which the measurement is terminated. Shown later as MAX in the display. It must always be greater than the INTERVAL TIME, which is the time between two measurements.

Pressing CHANGE displays the following screen:

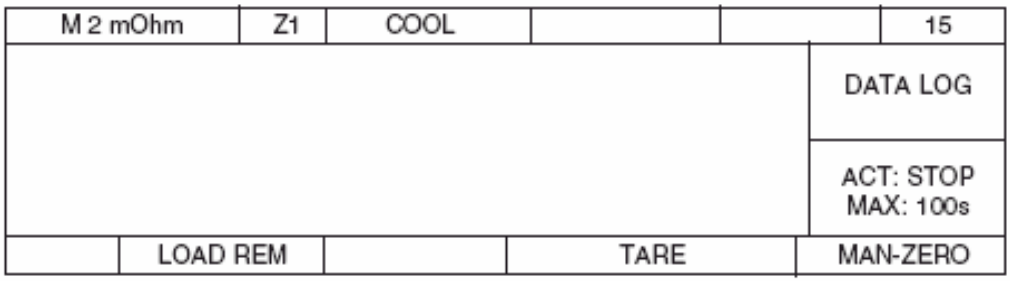


The cursor sits over the first zero. Pressing ↑↓ increases or decreases the numerical value, while → moves the cursor one position to the right within the input field. After selecting the value, pressing ENTER saves the value and closes the menu.

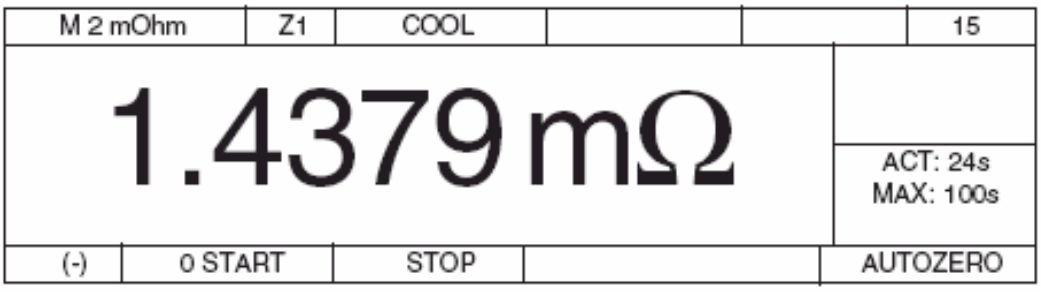


Depending upon the size of the inductance resp. time constant $\frac{L}{R}$ The first values after start are between zero and the real value. With this settling the first values can be discarded.

After closing menu 43, you return via menu 5 (now select measuring range) to measurement mode. With manual zero suppression selected, the display looks as follows:



TARE starts the zero offset process as normal. The time starts running from when LOAD REM is pressed (remove load, end of heating phase for device under test), and the previous values held in the data logger are deleted at his point in time. The instrument can also receive the LOAD REM command via the PLC or RS232 interface.



START launches the actual resistance measurement (with AUTOZERO set, there may be a slight delay of about 0.25 s to allow for the zero measurement) and the measurements are saved in the data logger (up to 999 values). The measurement can be stopped with STOP and resumed with START. The results of a second series of measurements are recorded in the

data logger under cycle B etc., so devices with more than one winding can be tested. The following screen is displayed after pressing the STOP button twice, or one the MAX time (END TIME) has elapsed.

After double pressing of the STOP key or after max. time (END TIME) you get the following display:

M 2 mOhm	Z1	COOL			15
					DATALOG
					ACT: STOP MAX: 100s
	B-END		TARA		MAN-ZERO

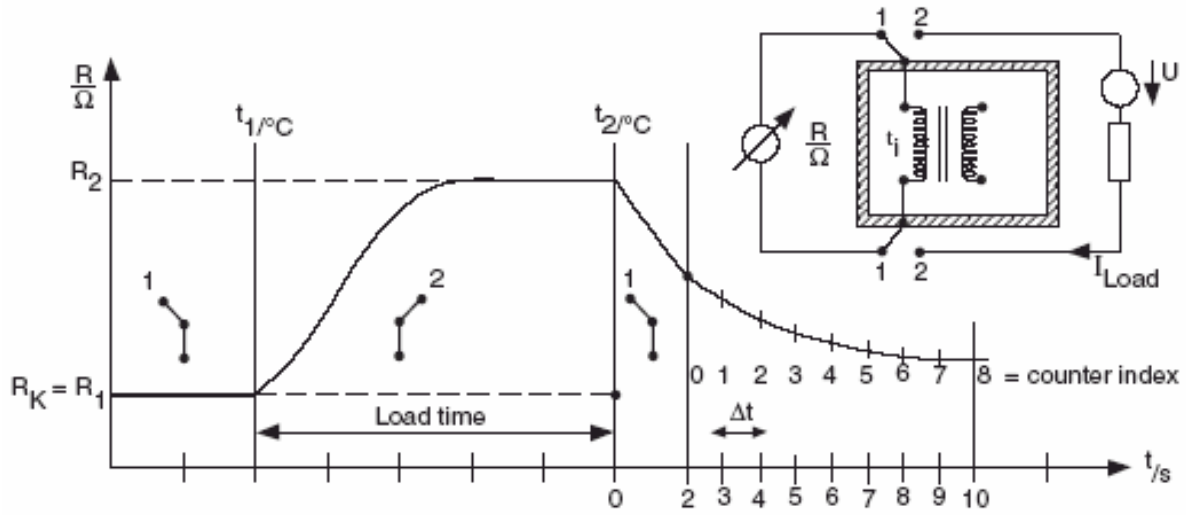
With the ↑ arrow button you can view the values.

NUM	REL.TIME	MEAS VALUE	CYCLE	
1	2 *s*	1.4379 mOhm	A	↑
2	3 *s*	1.4368 mOhm	A	
3	4 *s*	1.4354 mOhm	A	
4	13 *s*	1.2214 mOhm	B	↓
PRINT	ESCAPE			

Use the ↑↓ buttons to view the measured values.

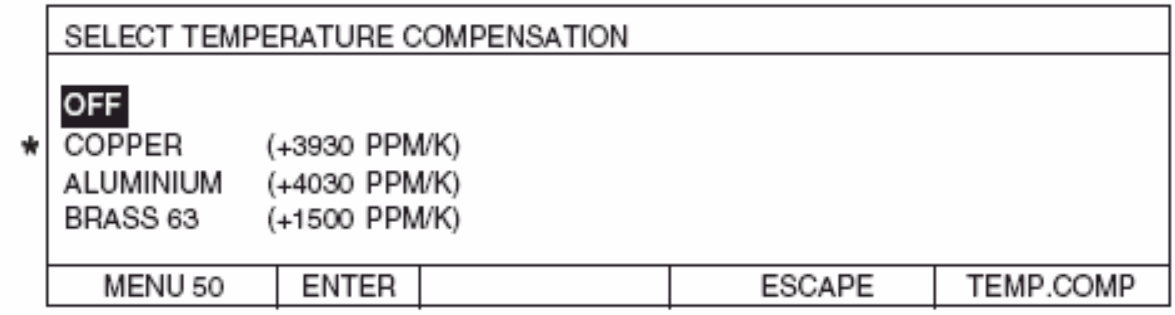
The REL TIME is the time elapsed after pressing LOAD REM.

If you have selected PRINTER as the data output device, you can now print out the table in full. If you have selected PC as the data output device, you can now transfer the values to the PC via the interface.



Since the first resistance value cannot be measured until after a short delay after switching off the load current; the actual resistance at the time when the load was removed can only be found by extrapolating the cooling curve. The add-on PC software package DO6-P001 can be purchased to help perform this calculation.

6.5.5 Temperature compensation



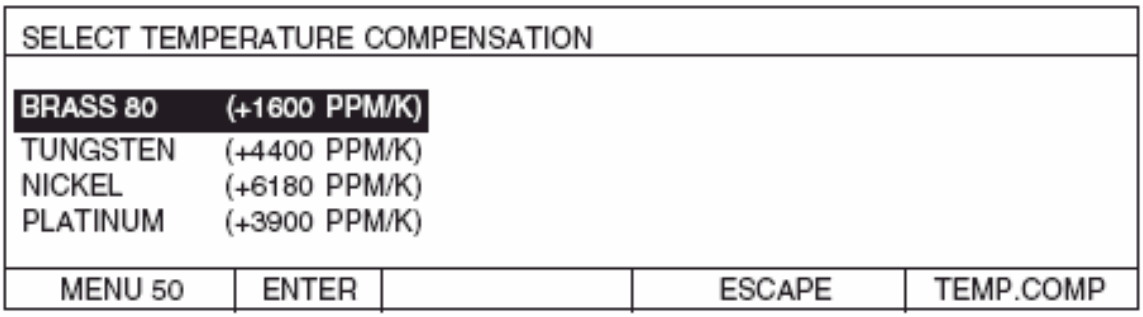
Selection bar has inverse display. Press ↑↓ to move selection bar, ENTER to select, and ESC to return to the menu.

Enabling temperature compensation changes the display value. The value displayed is the resistance that a device made of this material would have if its temperature were e.g. 20°C. The instrument converts the resistance in accordance with DIN VDE 0472:

$$R(T_0) = R_{(T)} \frac{1}{1 + \frac{TK}{1\,000\,000} * (T - T_0)}$$

Where;

R(T) is the resistance measured at temperature T
R(T0) is the resistance value at the reference temperature T0 (normally 20°C) **
TC is the temperature coefficient in ppm/K

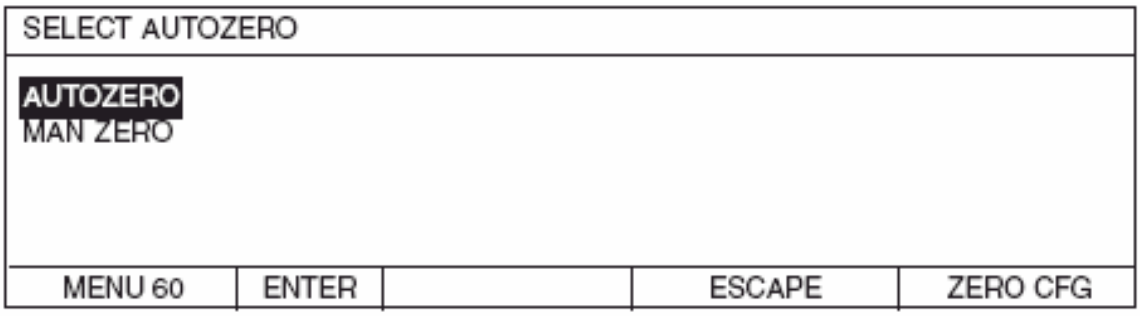


It is possible to enter another 8 custom TC's (max. 8 materials, text and numerical value) in the instrument via the interface using PC software. These are then displayed on the two subsequent pages.

*A TC of +3930 ppm/k means that the resistance of the device under test will be increased by 0.393% per degree C.

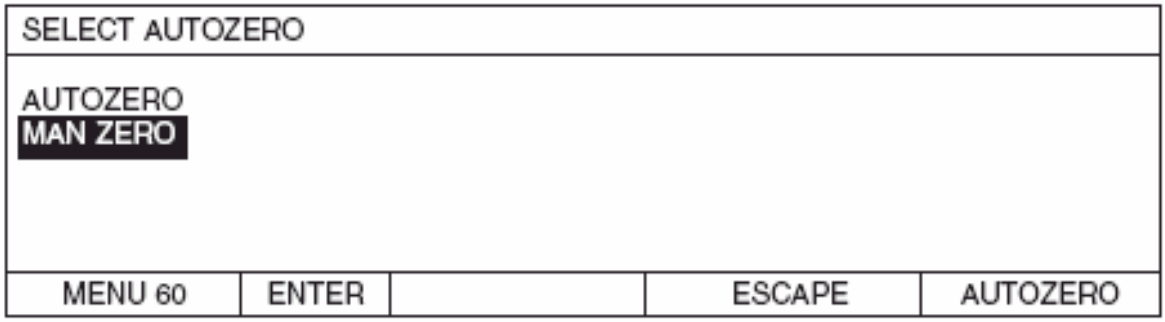
** In Europe, the specified test values are normally referred to 20°C, in USA to 23°C or 25°C. This reference temperature can be changed in menu 160.

6.5.6 Autozero / Man-Zero



Press ↑↓ to move selection bar, ENTER to select, and ESC to return to the menu.

When Autozero is enabled, after pressing the START button, the voltage across the U terminals is detected and zeroed n times, initially with the current still off. The measurement is made using the selected measurement mode and the selected load. This zeroing procedure is performed to compensate for the thermal EMF in the measurement circuit. Then the actual measurement is performed n times with the measurement current switched on. The connectors must be in thermal equilibrium for compensation of thermal EMFs to work perfectly. If possible, press STOP before changing the device under test. AUTOZERO is shown in the display.



In MAN-ZERO is selected, press STOP twice in the measurement menu.

The following screen is displayed for example:

Pressing the TARE button detects and zeros the voltage lying across the U terminals. The measurement current has not been switched on yet. Always make sure that you have selected the correct measuring range before zeroing. Automatic selection of the measuring range makes little sense here, but is permitted.

6.5.7 Device program

SELECT DEVICE PROGRAM				
PRESENT DEVICE PROGRAM: 0 PROGRAM COPY INITIALIZE SELECTED DEVICE PROGRAM INITIALIZE COMPLETE DEVICE				
MENU 70	CHANGE		ESCAPE	MEAS PROG

Pressing the CHANGE button displays the following screen:

SELECT DEVICE PROGRAM				
PRESENT DEVICE PROGRAM: 01 PROGRAM COPY INITIALIZE SELECTED DEVICE PROGRAM INITIALIZE COMPLETE DEVICE				
MENU 70	ESCAPE		→	MEAS PROG

Pressing ↑↓ increases or decreases the numerical value, while → moves the cursor to the right. Always enter a 2 digit number leading with zeros. ENTER loads the selected program.

SELECT DEVICE PROGRAM				
PRESENT DEVICE PROGRAM: 0 PROGRAM COPY INITIALIZE SELECTED DEVICE PROGRAM INITIALIZE COMPLETE DEVICE				
MENU 70	ENTER		ESCAPE	MEAS PROG

The following screen is displayed after pressing the ENTER button:

COPY DEVICE PROGRAM				
PRESENT DEVICE PROGRAM TO PROGRAMS FROM NO.: 1 TO NO.: 1 COPY				
MENU 71	ENTER		ESCAPE	PROG COPY

After pressing ENTER:

COPY DEVICE PROGRAM				
PRESENT DEVICE PROG. (1) TO PROGRAMS FROM NO.: 01 TO NO.: 1 COPY				
MENU 71	ESCAPE		→	PROG COPY

Pressing ↑↓ increases or decreases the numerical value, while → moves the cursor to the right. Always enter a 2 digit number leading with zeros. The value for TO NO is entered in the same way. Example: You copy the PRESENT device program no. 1 to program no. 2 up to no. 7 inclusive. Numbers from 00 to 15 are allowed.

6.5.8 Comparator

	SELECT COMPARATOR MODE				
*	COMPARATOR ON, RELAY ON COMPARATOR ON, RELAY OFF COMPARATOR OFF				
	MENU 80	ENTER		ESCAPE	COMPARAT.

The following menu is displayed if the comparator is enabled:

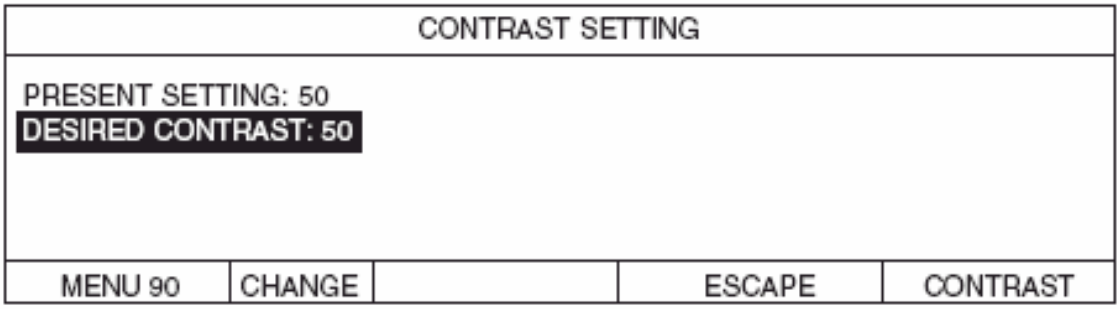
SELECT COMPARATOR RESET MODE				
STATIC DYNAMIC				
MENU 81	ENTER		ESCAPE	COMPARAT.

Use ↑↓ to move the selection bar, ENTER to select

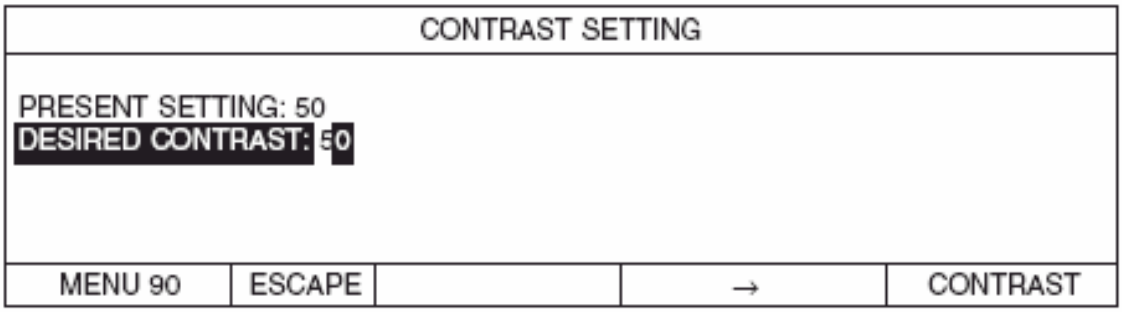
Static means that the comparator is reset immediately before the measurement starts. After pressing STOP the evaluation result (display, PLC, relay if applicable) continues to be available until START is pressed again.

* With the comparator enabled the optocoupler outputs for < = > are always active, even if the relay outputs are disabled.

6.5.9 Contrast



The following screen is displayed after pressing the CHANGE button:



Pressing ↑↓ increases or decreases the numerical value, while → moves the cursor to the right. Always enter a 2 digit number leading with zeros.

6.5.10 Temperature sensor

SELECT TEMPERATURE SENSOR				
PT-100 PT-100 INDIV PYROMETER MANUAL				
MENU 100	NEXT		ESCAPE	TEMP SENS

If PT-100 is selected the following screen is displayed for information; values cannot be changed.

PT-100 COEFFICIENTS (DIN EN 60751) (FIX)				
$R(T) = R0 * (1 + A*T + B*T^2)$ R0 = 100.0 A = 3.9083E-03 B = 5.7750E-7				
MENU 101	NEXT		ESCAPE	TEMP SENS

Permitted temperature range: 0°C to + 100°C

If PT-100 INDIV is selected the following screen is displayed for information:

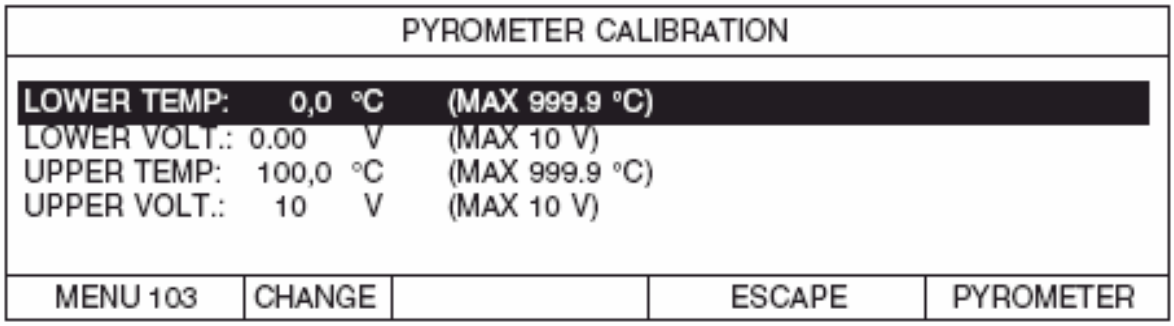
* PT-100 COEFFICIENTS (DIN EN 60751) (PC-INTERFACE)				
$R(T) = R0 * (1 + A*T + B*T^2)$ R0 = 100.0 A = 3.9083E-03 B = 5.7750E-7				
MENU 102	NEXT		ESCAPE	TEMP SENS

The custom values to be entered only by PC interface are shown.

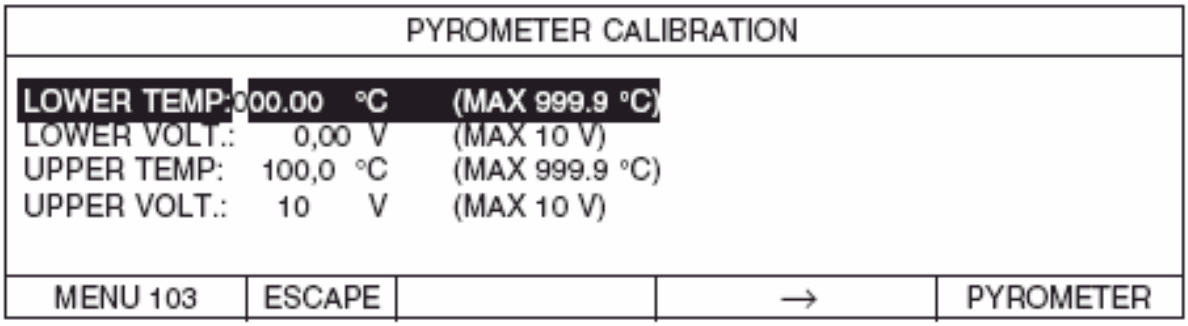
Permitted temperature range: 0°C to + 100°C

* The A-B factors measured for the Pt100 sensor and the value for Ro (e.g. DKD certificate) can be transferred to the instrument using the PC software DO6-P001 (purchased separately). This enables accurate temperature measurement.

The following screen is displayed if PYROMETER is selected:



Pressing CHANGE displays the following screen:

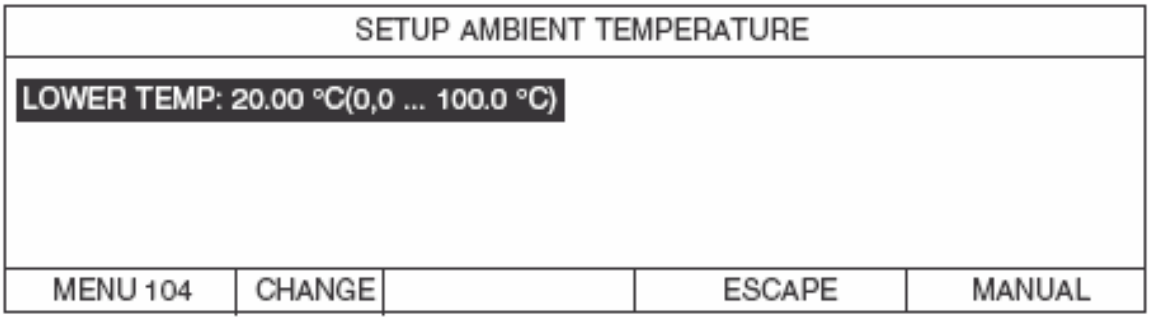


Pressing ↑↓ increases or decreases the numerical value, while → moves the cursor to the right. Always enter a 5 digit number leading with zeros.

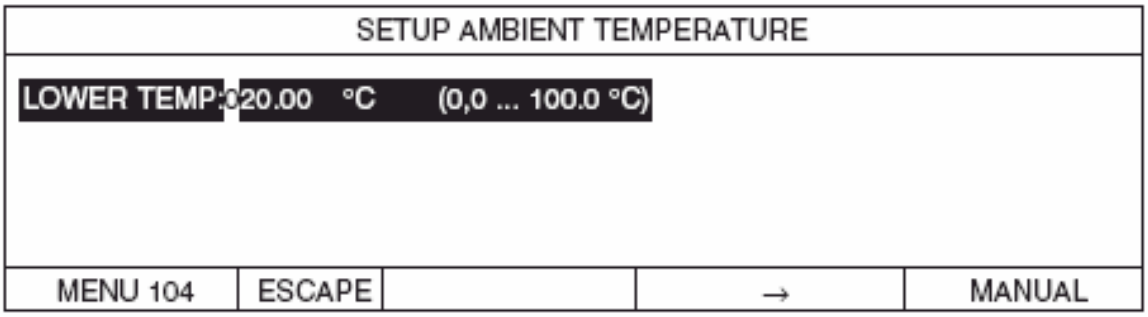
Note: permitted range 0 to 10 V

Example:
A pyrometer outputs a voltage of 0 V at 0°C and a voltage of 10 V at 100°C; the display above is then correct for this sensor. A pyrometer type 2328-Z001 is available as an extra device.

The following screen is displayed if MANUAL is selected:

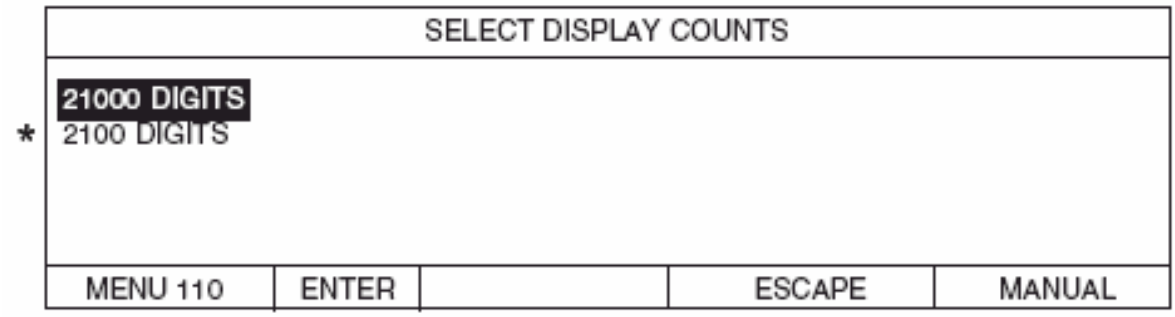


Pressing CHANGE displays the following screen:



Pressing ↑↓ increases or decreases the numerical value, while → moves the cursor to the right. Always enter a 5 digit number leading with zeros.

6.5.11



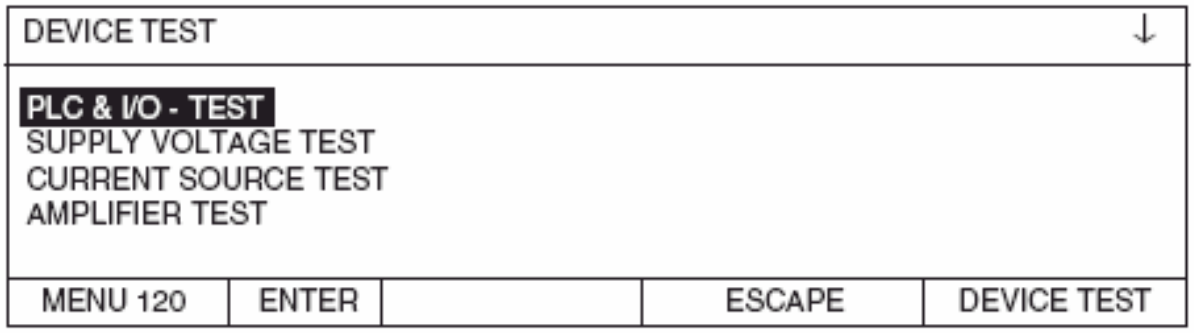
Use ↑↓ to move the selection bar, ENTER to select

Strictly speaking, the display counts up to 20999 or 2099.

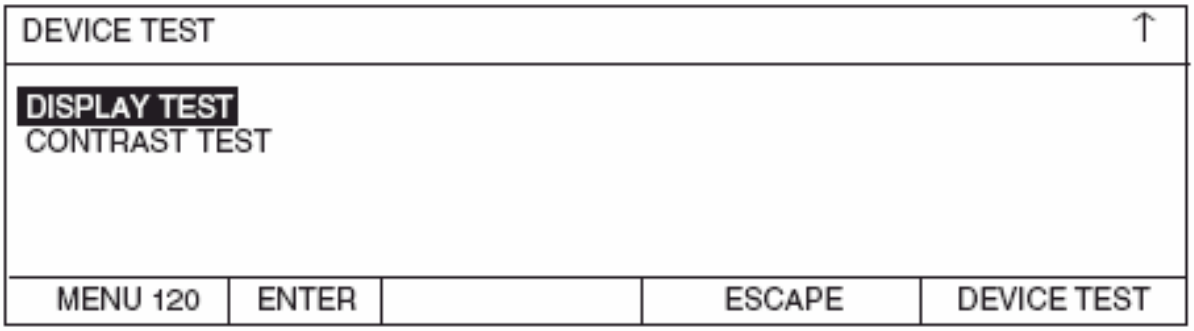
* If the last digit flickers because of interface, it is often useful to reduce the display counts.

6.5.12 Self test

The instrument has numerous built-in diagnostics, which you can use to check whether the instrument is working correctly, and for self-help troubleshooting.

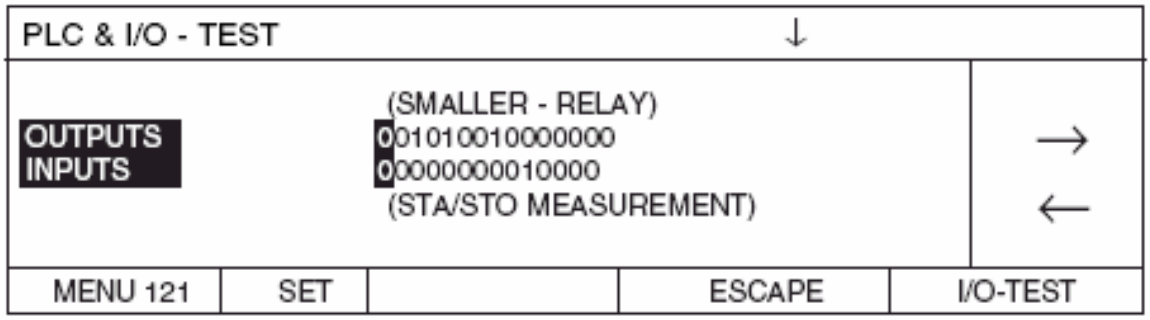


Use ↑↓ to move the selection bar, ENTER to select



Use ↑↓ to move the selection bar, ENTER to select

The following screen appears after selecting “PLC & I/O TEST”:



Use the ↑↓ buttons to move the cursor to the left or right.

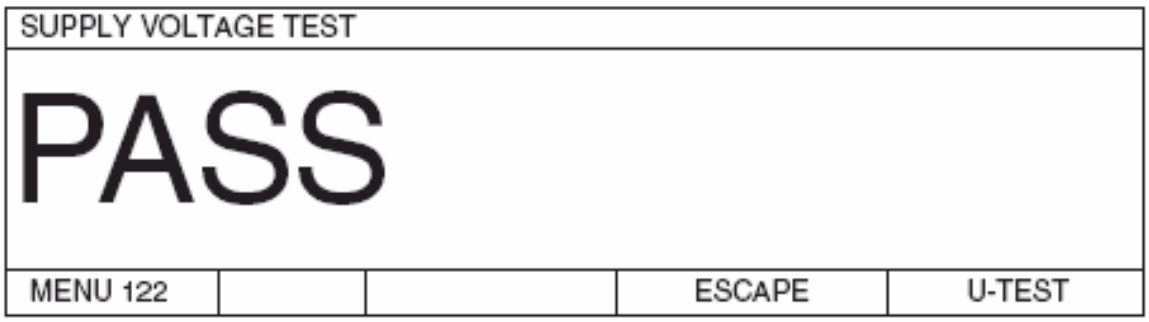
The present level of the control outputs is specified in the “OUTPUTS” line. The screen above shows the status of the comparator. The SET button can be used to set the level to ON=1, while RESET can set the level to OFF=0.

Note: the status that the outputs are meant to have is specified here. The output status is measured in the instrument. If the actual status does not match the assumed status, check if any of the leads or connectors are open-circuit or short-circuit.

Please note the polarity of the output levels. The I/Os can be implemented in accordance with the American standard as an option.

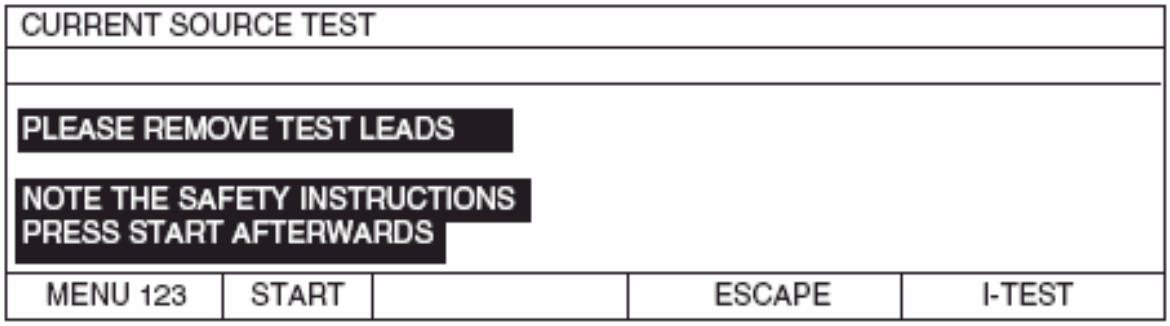
The present status of the control inputs is shown in the “INPUTS” line.

The following screen appears after selecting “SUPPLY VOLTAGE TEST”:

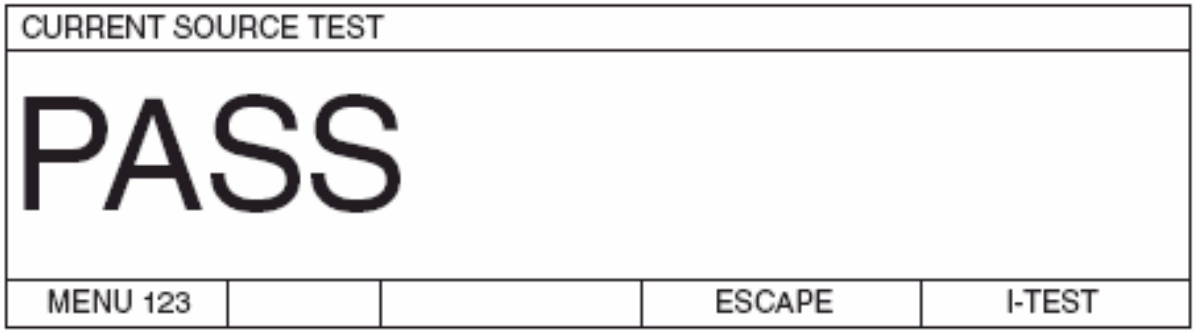


If the screen doesn’t appear, one of the internal supply voltages are off; switch the device off and on again and try again.

The following screen appears after selecting “SUPPLY VOLTAGE TEST”:



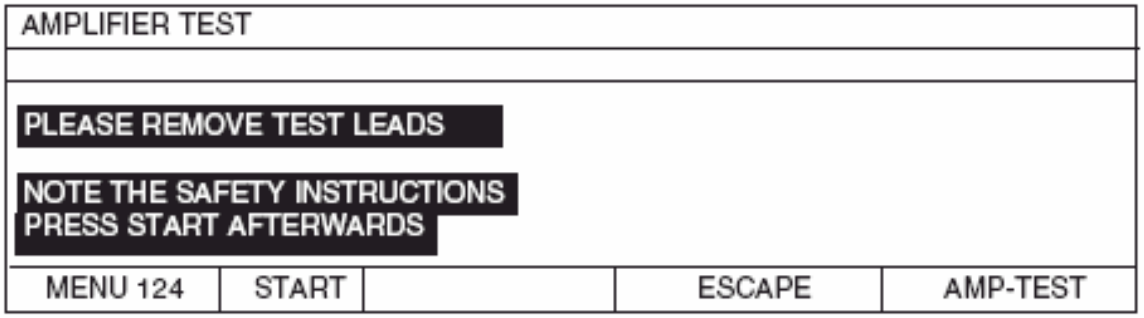
The following screen appears after a waiting period of 10 s.



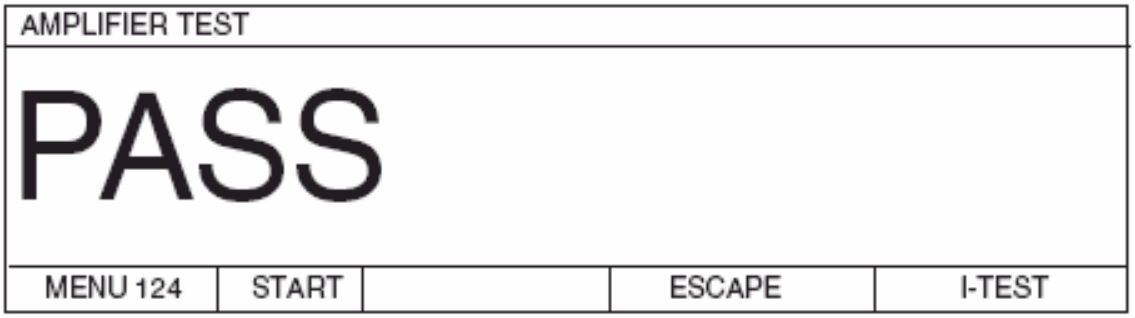
Note: If the current source test is without error and the device nevertheless works ok, please change the current source fuse on the back panel.
Please read chaper “safety instructions”

Fuse: Super quick acting 10A fuse 6,3*32mm, 600VAC, 50000A breaking capacity (or greater)
RS components #209-9383 (Germany)
Use only this fuse.

The following screen appears after selecting “AMPLIFIER TEST”:



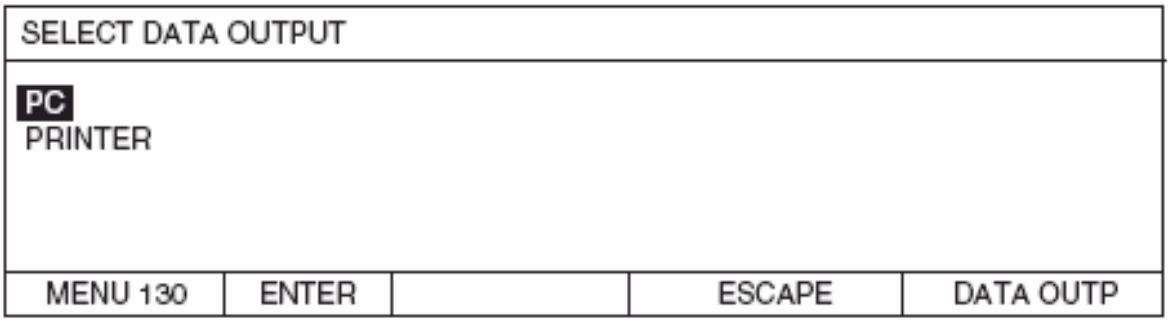
The following screen appears after selecting “CURRENT SOURCE TEST”:



After selecting “DISPLAY TEST” all the characters on the display are run through from left to right. This test is terminated automatically after about 35 s.

After selecting “CONTRAST TEST” the display contrast adjustment range is demonstrated. This test is terminated automatically after about 20 s.

6.5.13 Data output



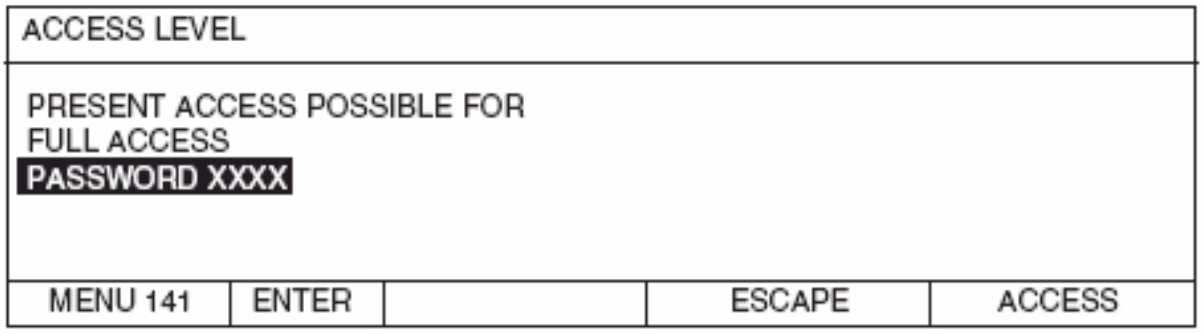
Use ↑↓ to move the selection bar, ENTER to select

Always print
Setting PRINTER as data output means that every valid measurement is sent to the printer. Depending on the instrument setup a large amount of data can accrue, so please set the instrument and printer to the largest possible common transmission rate.

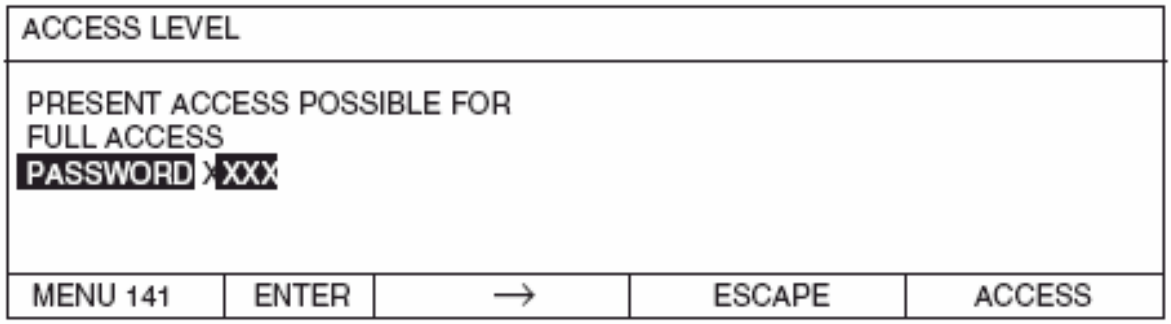
Print on demand
Set PC as the data output. Enable the “START PRINTER” input via the IO interface. Measurements are printed while this control signal is applied.

6.5.14 Access to password

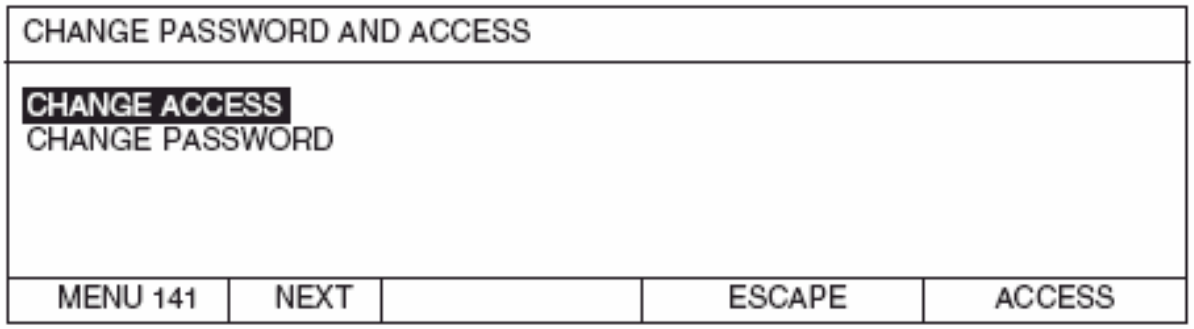
This is where one specifies whether the meter user can access all functions and settings of the instrument, or whether his access options are limited. On delivery, access is enabled for all settings.



Pressing the ENTER button allows you to enter the password.

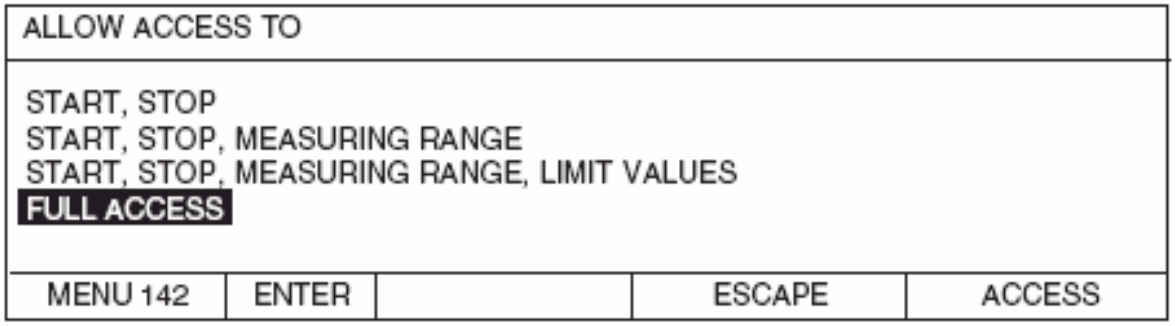


Use ↑↓ to increase or decrease the numerical value. Always enter a 4 digit number; the factory set code is 6948.



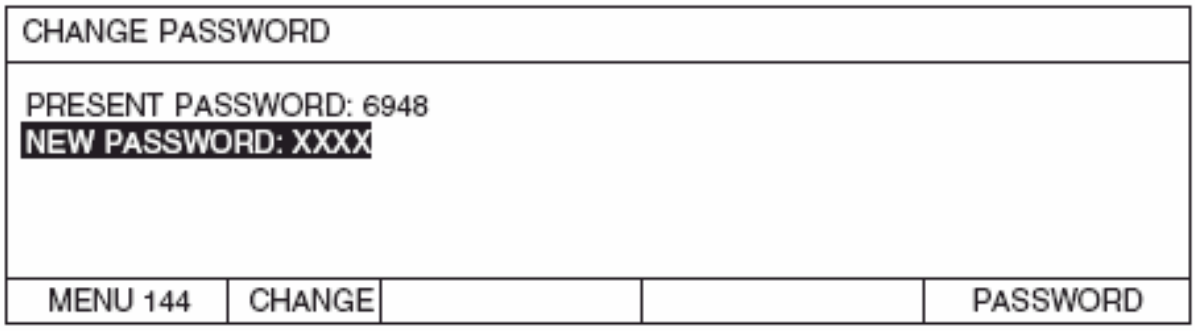
Use ↑↓ to move the selection bar.

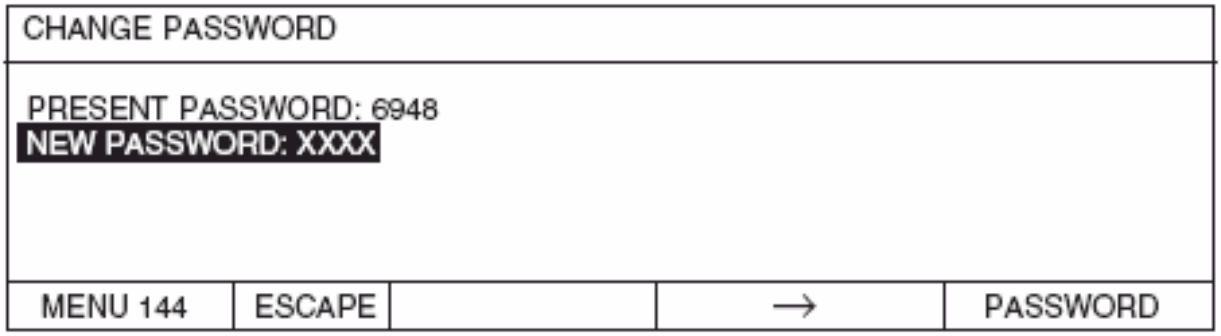
The following screen appears after selecting “CHANGE ACCESS”



The current selection is highlighted. Press ↑↓ to move the selection bar, ENTER to select.

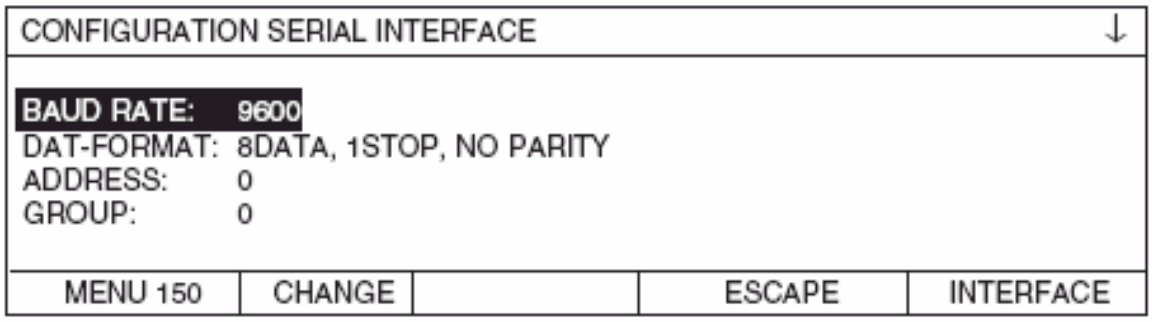
The following screen appears after selecting “CHANGE PASSWORD”



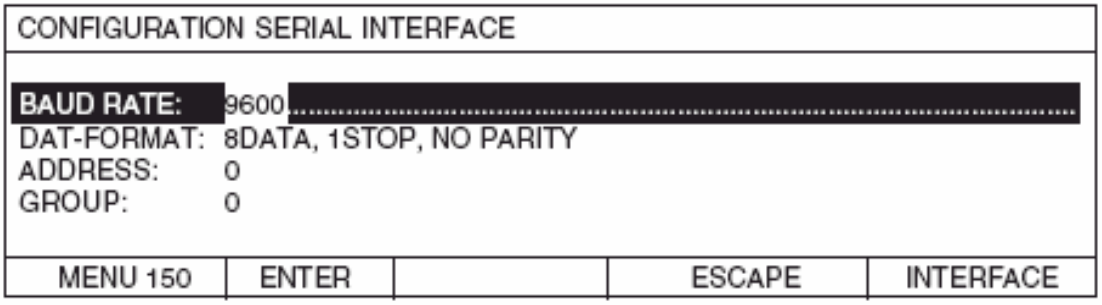


Use ↑↓ to increase or decrease the numerical value. Always enter a 4 digit number.

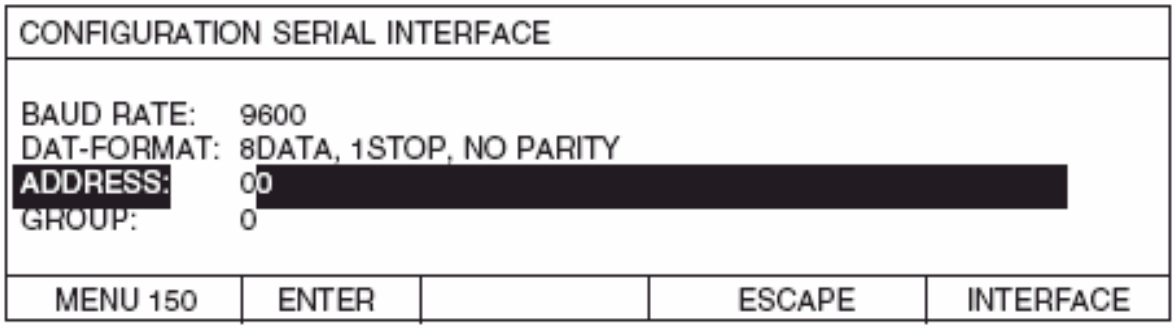
6.5.15 Interface



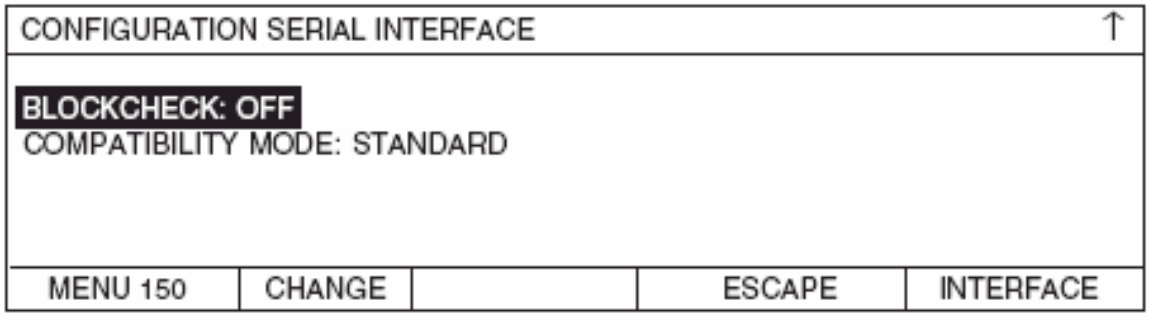
Use ↑↓ to move the selection bar, CHANGE to select. ↓ shows that there is a second page:



For “BAUD RATE” and “DAT-FORMAT” use the ↑↓ buttons to toggle between the possible settings, and ENTER to adopt the setting shown.

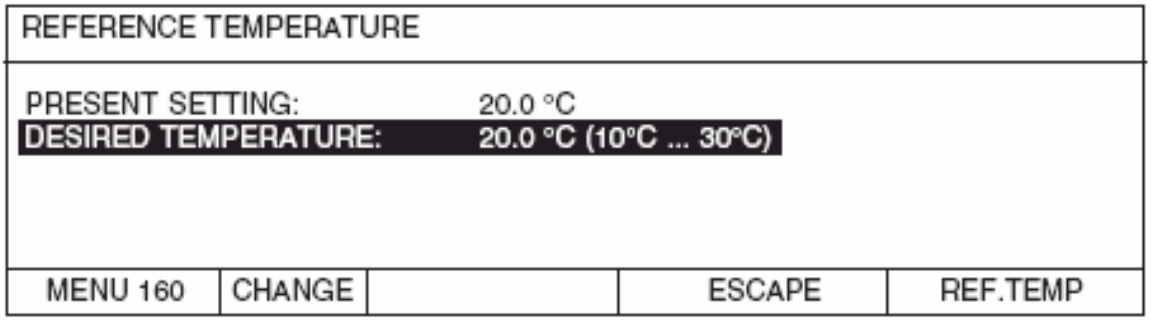


For “ADDRESS” and “GROUP” use the ↑↓ buttons to increase or decrease the numerical value.
Always enter a 2 digit number.
Values in the range 0 to 99 are possible.

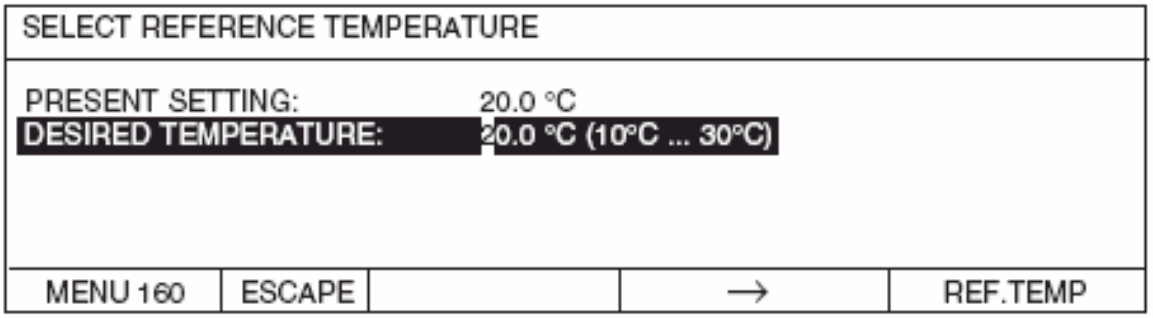


Use ↑↓ to move the selection bar, CHANGE to select. ↑ shows that there is a first page:
Use ↑↓ to toggle between the possible settings, and ENTER to adopt the setting shown.
Compatibility mode 2318 means that the old interface commands for the Resistomat…..

6.5.16 Reference temperature



Pressing the CHANGE button displays the following screen:

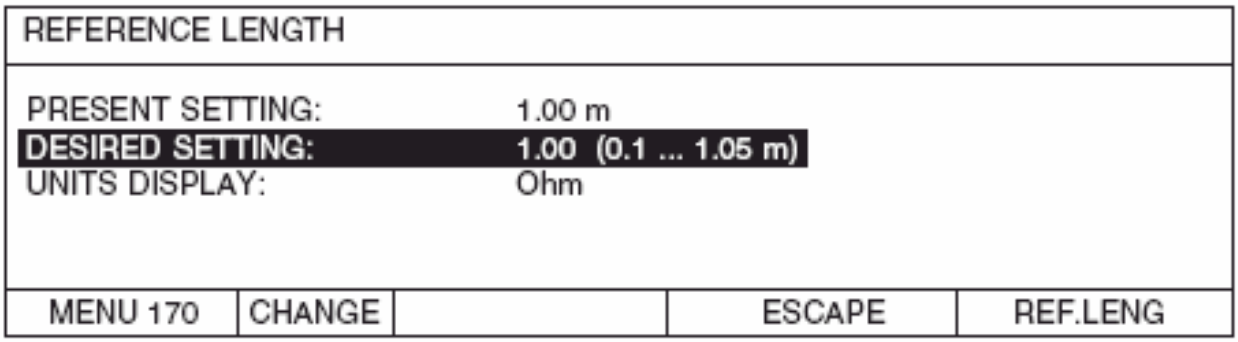


Use ↑↓ to increase or decrease the numerical value. Always enter a 4 digit number.

Important note:

- If the reference temperature does not equal 20°C, CAL is displayed in the bottom status bar.
- This temperature setting should not be changed if possible. In European countries the measured values are always referred to 20°C. In the USA, reference temperatures of 23°C or 25°C can be the norm.

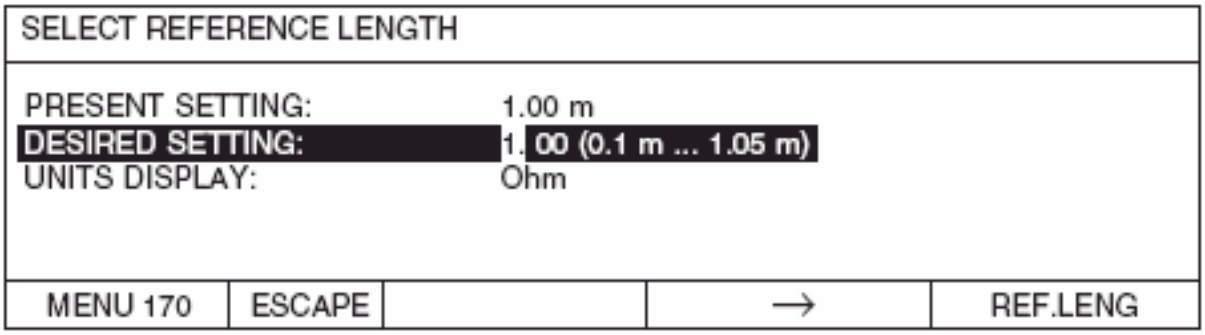
6.5.17 reference length



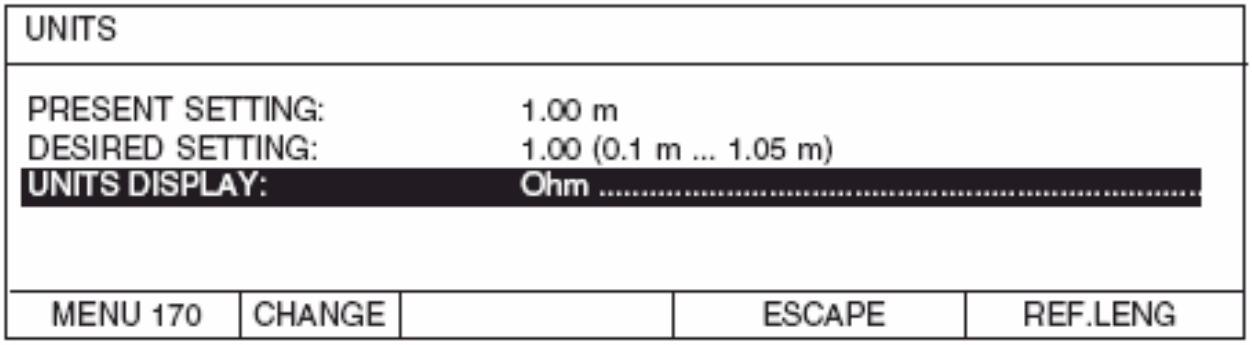
Use ↑↓ to move the selection bar, ENTER to select.

The default length is 1m.

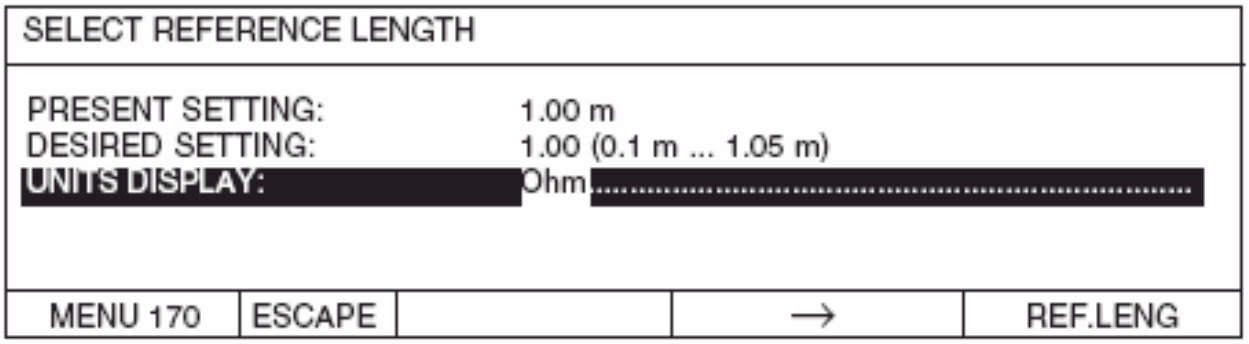
The following screen is displayed after pressing the CHANGE button.



Use ↑↓ to increase or decrease the numerical value.



Use ↑↓ to move the selection bar, ENTER to select.



Use ↑↓ to move the selection bar, ENTER to select.

This is where you select between “Ohm” and “Ohm/m” as the units set in the display. This setting also affects the limit values.

Make sure that the measuring ranges are always set in Ohm.

Important note if the reference length does not equal 1m:

The reference length is only taken into account and used for conversion in the instrument if “OHM PER METER” has been selected as the units.

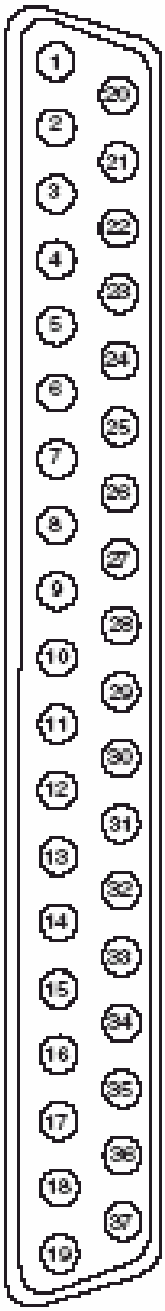
6.5.18 Calibration

The instrument is calibrated digitally. PC software type DO6-P001 and a range of series 1240 calibration resistances are required for this calibration.

7. Controlling the instrument remotely

7.1 Controlling the instrument via the PLC interface

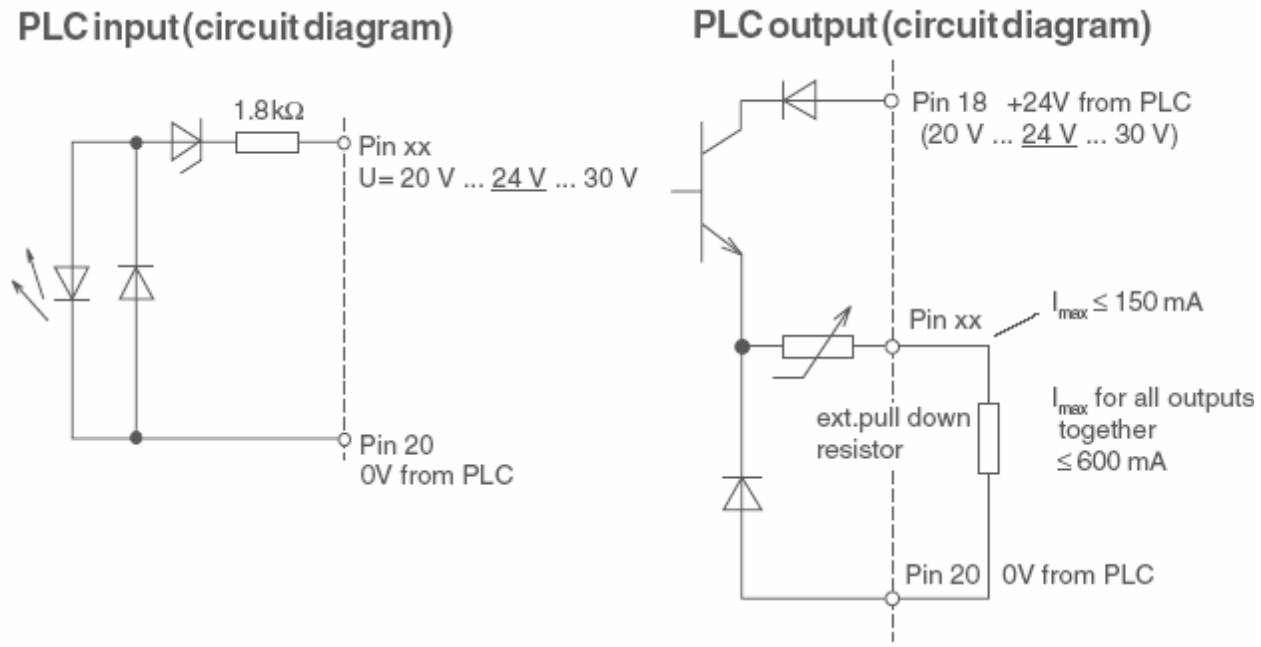
Digital I/O



37-pin min sub-D
View towards socket

Pin	Function	Function
1	Relay	<, NO contact
2	NC	Not used
3	Relay	=, NO contact
4	PLC output	Device program saved ok
5	Relay	>, NO contact
6	Relay	Relay common contact
7	PLC output	Busy
8	PLC output	End of measurement
9	PLC output	Measuring error
10	PLC output	<
11	PLC output	Device program 0 mirrored
12	PLC output	=
13	PLC output	Device program 1 mirrored
14	PLC output	>
15	PLC output	DANGER
16	PLC output	Device program 2 mirrored
17	PLC output	Device program 3 mirrored
18	PLC	+ 24 V External
19	PLC	+ 24 V External
20	PLC	Ground 24 V External
21	PLC input	START / STOP measurement
22	PLC input	Comparator ON / OFF
23	PLC input	Remove load (cooling curve)
24	PLC input	Spare 1
25	PLC input	START printer
26	PLC input	Save device program
27	PLC input	Spare 2
28	PLC input	Device program 0
29	PLC input	Device program 1
30	PLC input	Device program 2
31	PLC input	Device program 3
32	PLC input	Spare 3
33	NC	Not used
34	Pyrometer	+ 10 V Analog input
35	Pyrometer	Ground, FE
36	Foot switch	NO contact
37	Foot switch	NO contact, DGND
Shell	Shield	Protective ground, PE

Connector shell: PE potential
Mating connector: Type 9900-V165



DC voltage supply:	external 20 V ... 24 V ... 30 V
Grounding:	external
PLC inputs Low:	0 V ... + 5 V
PLC inputs High:	+ 15 V ... + 30 V
PLC - Input current:	(Ue -8.4 V) / 1.8 k Ohm
Outputs for current sinking inputs:	leakage current Low < 0.2 mA, total of all Ia < 0.6 A, Ia max.: 0.15 A

7.2 Controlling the instrument via the RS232 interface

7.2.1 Connector pin-out for the RS232 interface

The 9-pin min sub-D female connector is wired as follows:

For RS 232:

RESISTOMAT® Type 2316		Computer 9-pin		Computer 25-pin
Pin		Pin		Pin
2	TXD	2	RXD	3 RXD
3	RXD	3	TXD	2 TXD
8	-	8	CTS	5 CTS
7	connected in meter	7	RTS	4 RTS
4	-	4	DTR	20 DTR
6	-	6	DSR	6 DSR
5	GND	5	GND	7 GND

Note: For Basic programs, DTR, DSR and CTS must be connected together at the PC end.
This is not necessary if the 9-pin 1:1 cable type 9900-K333 is used, because these pins are connected in the instrument.

7.2.2 Interface parameters

The interface parameters can be set in menu 150 Interface.

Baud rates:	300, 600, 1200, 2400, 4800, 9600(*), 19200, 38400, 56000, 57600
Data bits:	7 or 8(*)
Stop bits:	1(*) or 2
Parity:	none (*), even, odd
Block check:	Enabled(*) or Disabled

(*) Default setting after initialisation

The instrument waits for a command in the form: <STX>command1<LF><ETX>

<STX>:	ASCII value 02
Command 1:	SCPI command without query form
<LF>:	ASCII value10
<ETX>:	ASCII value 03

7.2.3 Communications protocol

Control characters:	<STX>	0x02 => Start of text
	<ETX>	0x03 => End of enquiry
	<ENQ>	0x05 => Enquiry
	<ACK>	0x06 => Acknowledge
	<S>	0x20 => Space
	<NAK>	0x15 => Not acknowledged
	<LF>	0x0A => Line feed
	<EOT>	0x04 => End of transaction
	<NUL>	0x00 => NULL character

The ANSI standard X3.28-1976 Subcategory 2.5, A4 is used as the communications protocol. This standard is used in systems in which a number of secondary stations exist in a nonswitched multipoint connection, and all commands are sent by a control station. Only one transmitter (master) and one receiver (slave) are ever active on the bus at one time. One station is the control station. The control station is given master status and sends commands to a selected slave station, or relinquishes its master status to a secondary station and assumes slave status to receive data. A connection between two secondary stations is not allowed. The control station monitors the connection continuously.

7.2.4 Establishing a connection

Before a connection is established, the control station has master status and none of the secondary stations have slave status. The connection can be established in two different ways:

1. Selection with response

   In this case, addressing the device does not take place in the same communications step as sending the command. This method is useful when you want to send several commands to the same device and then retrieve the responses at one go (See communications example in section 8.16)

Or

2. Fast selection
In this case, addressing is combined with the command. This saves a communications step if you want to exchange data with several devices (via RS485) (see communications example in section 8.16).

When establishing a connection, the control station can either

- Specify a slave station
  In order to set up a connection i.e. send a command to the addressed slave

Or

- Poll
  In order to relinquish its master status to a secondary station i.e. query for a response to a previously sent command and hence assign the transmit right to the slave.

7.2.5 Selection with response

The control station sends a "selection supervisory sequence". The selection supervisory sequence is used to initialize the DO6 as slave so that it is then possible to send it commands. The prefix calls up a single secondary station. **<ENQ>** defines the end of the selection supervisory sequence.

The selection supervisory sequence of the DO6 has the following format:

<group_address><user_address>sr<ENQ>

- **<group_address>** Group address (decimal, 0 to 99)
- **<user_address>** User address (decimal, 0 to 99)
- **sr** ASCII characters s and r
- **<ENQ>** ASCII character ENQ

A secondary station that recognises its selection supervisory sequence assumes slave status and sends one of two responses.

- If the station is ready to receive data it sends back **<ACK>**. The master station starts the data transfer on receiving this response.

- If the station is not ready to receive data it sends back **<NAK>**. With this response the master station tries to call up the same station again.

If the master station receives an invalid response or none at all, it can try to address the same station again or end the transmission.

7.2.6 Fast selection

Instead of “selection with response”, the master station can send a selection supervisory sequence without **<ENQ>**. The master station calls up a secondary station as the slave station. It then shifts directly into data transfer without waiting for the acknowledgement response from the secondary station.

The fast selection supervisory sequence of the DO6 has the following format:

<group_address><user_address>sr<STX>command<ETX><BCC>

- **<group_address>** Group address (decimal, 0 to 99)
- **<user_address>** User address (decimal, 0 to 99)
- **sr** ASCII characters s and r
- **<STX>** ASCII character STX
- **command** Command sequence
- **<ETX>** ASCII character ETX
- **<BCC>** Optional Block check

7.2.7 Polling

The control station sends a “polling supervisory sequence” The polling supervisory sequence is used to retrieve requested data from the DO6. The prefix selects a single station. **<ENQ>** defines the end of the “polling supervisory sequence”.

The polling supervisory sequence of the DO6 has the following format:

<group_address><user_address>po<ENQ>

- **<group_address>** Group address (decimal, 0 to 99)
- **<user_address>** User address (decimal, 0 to 99)
- **po** ASCII characters p and o
- **<ENQ>** ASCII character ENQ

A secondary station that recognises its polling supervisory sequence responds using one of two options:

- If the station has data ready to send, it starts the data transfer. The control station assumes slave status

- If the station has no data ready to send, it sends **<EOT>** which terminates its master status. The master status returns to the control station.

If the control station receives an invalid response or none at all, it terminates the connection by sending **<EOT>**.

7.2.8 Data transfer

After establishing the connection the data is transferred in accordance with the rules of subcategory A4. The master station begins the transmission with **<STX>**, then sends the relevant data and terminates the data block with **<ETX>**. The **<ETX>** character is followed by the optional block check character **<BCC>**. This is formed from all the bytes that come after **<STX>, including <ETX>**. The **<BCC>** is obtained by performing an exclusive-OR operation on all these bytes. 80hex is also OR'd with the result of this operation in order to exclude any possible mix up with the control characters.

The slave station sends one of two possible responses after detecting the **<BCC>:**

- If the data has been accepted and the station is ready to receive new data it sends back **<ACK>**. On receiving this, the master station either sends new data or terminates the data transfer.

- If the data was not accepted and the slave station is ready to receive new data, it sends back **<NAK>**. On receiving this, the master station may either send other data or terminate the connection.

7.2.9 Terminating a connection

The master station sends **<EOT>** to indicate that it has no more data to transfer. **<EOT>** returns the master status to the control station.

7.2.10 Examples of the communication sequence

The following sequence illustrates the DO6 communicating with a host controller in the two communication modes, "selection with response" and "fast selection". In the example the *idn? query command is made, the DO6 has group address 00 and user address 00, and block check is disabled (in one example the block check is also shown for the given command / the given data).

7.2.10.1 Communication using "selection with response"

Controller sends: <EOT>
To make sure that all possible existing connections are terminated and the DO6 receive memory is cleared.

Controller sends: 0000sr<ENQ>
Controller wishes to address the DO6 with the group address 0 and the user address 0.

Controller sends: <ACK>
The DO6 signals that it accepts the addressing.

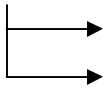
Controller sends, with block check off: <STX>*idn?<LF><ETX>
Command sequence: the idn? command is to be executed.

DO6 replies with: <ACK>
The DO6 signals that it recognises and has understood the *idn? command.

Controller sends: <EOT>
The host controller unaddresses the device in order to start a polling sequence immediately.

Controller sends: 0000po<ENQ>
The DO6 with group address 0 and user address 0 is required to send all responses waiting to be sent.

DO6 sends response, with block check off:
<STX>RESISTOMAT2316,3A,0123456789,V200401,09.12.2004,1<LF><ETX>



for type 2316-V0001
or 1A for type 2316-V0000

This is the correct response to the *idn? command.

Controller sends: <ACK>
The controller has received the responses and accepted it. Does the DO6 have other queries saved for which a response can now be sent?

DO6 replies with: <EOT>
No. This ends the communication sequence and the DO6 has unaddressed itself automatically.

7.2.10.2 Communication using “fast selection”

Controller sends: <EOT>
To make sure that all possible existing connections are terminated and the DO6 receive memory is cleared.

Controller sends: 0000sr<STX>*idn<LF><ETX>
Command sequence: Controller wishes to address the DO6 with the group address 0 and the user address 0 and then make the DO6 execute the idn? command.

DO6 replies with: <ACK>
The DO6 signals that it recognises and has understood the *idn? command.

Controller sends: <EOT>
The host controller unaddresses the device in order to start a polling sequence immediately.

Controller sends: 0000po<ENQ>
The DO6 with group address 0 and user address 0 is required to send all responses waiting to be sent.

DO6 sends response:
<STX>RESISTOMAT2316,3A,0123456789,V200401,09.12.2004,1<LF><ETX>
This is the correct response to the *idn? command.

Controller sends: <ACK>
The controller has received the responses and accepted it. Does the DO6 have other queries saved for which a response can now be sent?

DO6 replies with: <EOT>
No. This ends the communication sequence and the DO6 has unaddressed itself automatically.

7.3 General information

7.3.1 Interface watchdog timer

7.3.1.1 Timer A (response timer)

Timer A is used by the DO6 to protect itself from an invalid response or no response at all.

- **Start:** Timer A is started after data transfer has been terminated with <ETX>. The instrument waits for an acknowledgement by the master.
- **Stop:** Timer A is stopped if a valid response <ACK> has been received.
- **Timeout:** If a timeout occurs the DO6 sends an <EOT> and returns to the initial state (ready for a new command).

The timeout for Timer A is set to 5 seconds.

7.3.1.2 Timer B (receive timer)

Timer B is used by the DO6 to protect itself from the non recognition of the <ETX> character.

- **Start:** Timer B is started after receiving the <STX> character.
- **Restart:** Timer B is restarted as long as data is being received in order to allow variable datablock lengths to be received.
- **Stop:** Timer B is stopped if a valid response <ACK> has been received.
- **Timeout:** If a timeout occurs, the received data (command) is discarded. The DO6 returns to the initial state (ready for a new command).

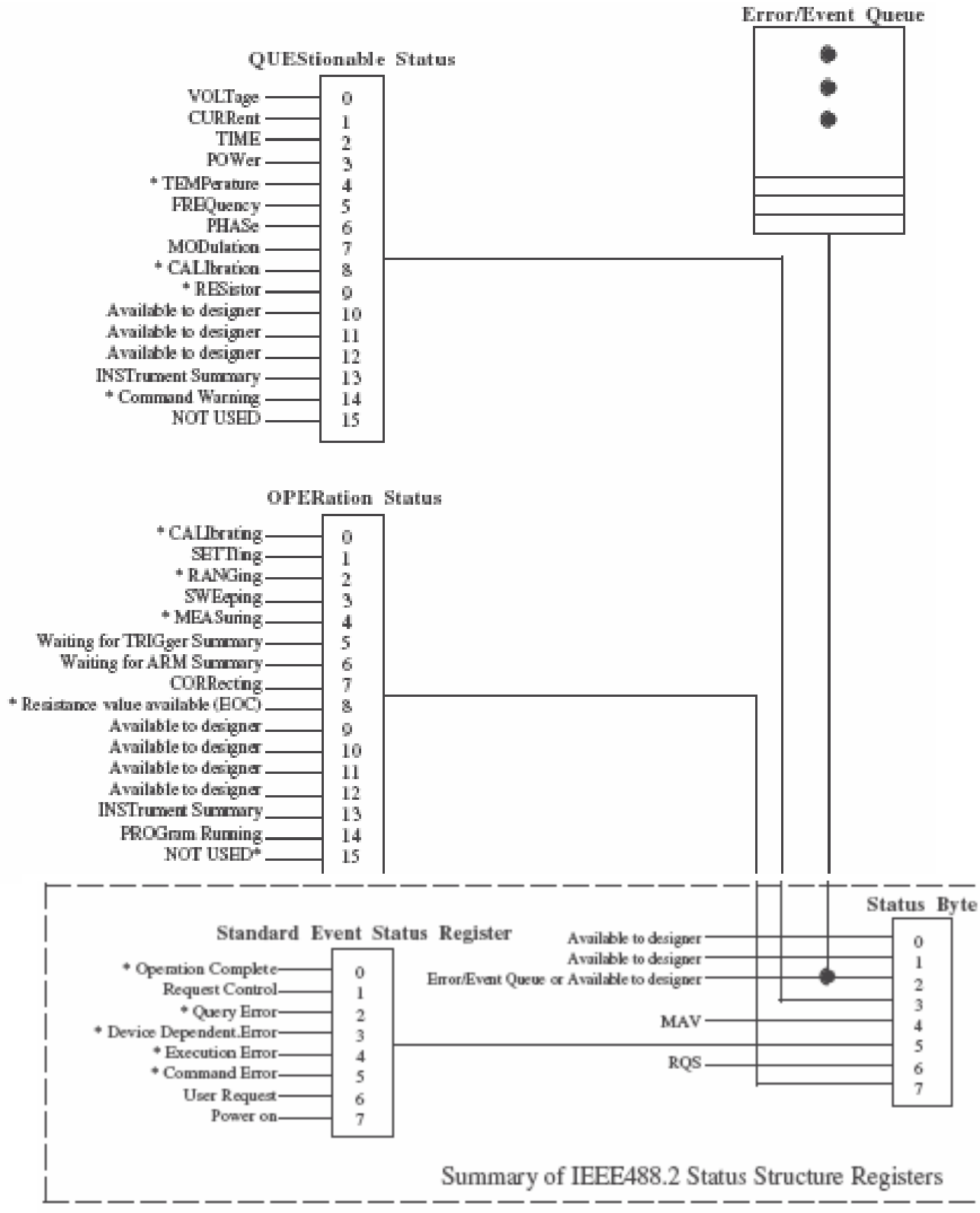
The timeout for Timer B is set to 5 seconds.

8. SPCI commands

8.1 General information

- Command sections contained in [ ] are optional
- Commands have a long form and a short form; both forms are valid
  - The short form is written in upper case
  - The long form is written in lower case
- The individual command levels are separated by a colon
- There must be a space between the command and the first parameter
- The individual parameters are separated by a comma
- The individual responses are separated by a comma
- The query form of a command is terminated with a question mark
- The query form can also be sent at the same time as the parameters; in this case the command is executed first and then the result (setting) returned.

8.2 SPCI registers



8.3 ACCess Subsystem

ACCess:LEVel

DESCRIPTION: Sets the access levels.

SYNTAX: ACCess:LEVel P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Permitted access	1 → Start and stop permitted 2 → Start, stop and measuring-range selection permitted 3 → Start, stop, measuring-range selection and comparator limits permitted 4 → Unrestricted access

QUERY FORM: ACCess:LEVel ?

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1	Permitted access	1 → If start and stop permitted 2 → If start, stop and measuring-range selection permitted 3 → If start, stop, measuring-range selection and comparator limits permitted 4 → If unrestricted access

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.4 DISPlay Subsystem

ACCess:LEVel

DESCRIPTION: Can be used to adjust the LCD contrast.

SYNTAX: DISPlay:CONTrast P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	LCD contrast	Floating-point value between 0.0 and 1.0 0.0 → minimum contrast 1.0 → maximum contrast

QUERY FORM: DISPlay:CONTrast ?

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1	LCD contrast	Floating-point value between 0.0 and 1.0 0.0 → minimum contrast 1.0 → maximum contrast Value to one decimal place is transferred.

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.5 CALCulate Subsystem

8.5.1 CALCulate:LIMit:STATe

DESCRIPTION: Enables or disables the comparator function.

SYNTAX: CALCulate:LIMit:STATe P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Comparator on/off	1 or ON → Comparator function enabled 0 or OFF → Comparator function disabled

QUERY FORM: CALCulate:LIMit:STATe ?

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1	Comparator on/off	1 or ON → If comparator function enabled 0 or OFF → If comparator function disabled

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.5.2 CALCulate:LIMit:RELais

DESCRIPTION: Enables or disables the relay function.

SYNTAX: CALCulate:LIMit:RELais P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Relay function on/off	1 or ON → Relay function enabled 0 or OFF → Relay function disabled

QUERY FORM: CALCulate:LIMit:RELais ?

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1	Relay function on/off	1 or ON → If relay function enabled 0 or OFF → If relay function disabled

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.5.3 CALCulate:LIMit:FAULt

DESCRIPTION: Sets the response of the comparator in the event of an error.

SYNTAX: CALCulate:LIMit:FAULt P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Comparator response value was too large	UPPer → Comparator responds as though the measured in case of error NONE → No response from comparator

QUERY FORM: CALCulate:LIMit:FAULt ?

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1	Comparator response value was too large	UPPer → Comparator responds as though the measured in case of error NONE → No response from comparator

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.5.4 CALCulate:LIMit:RESet

DESCRIPTION: Behaviour of comparator function. The comparator is reset with Start measurement (static behaviour) or not reset (dynamic behaviour).

SYNTAX: CALCulate:LIMit:RESet P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Behavior of comparator	1 or ON → Comparator is reset with Start measurement (static behavior) 0 or OFF → Comparator is not reset with Start measurement (dynamic behavior)

QUERY FORM: CALCulate:LIMit:RESet ?

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1	Behavior of comparator	1 → Comparator is reset with Start measurement (static behavior) 0 → Comparator is not reset with Start measurement (dynamic behavior)

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.5.5 CALCulate:LIMit:LOWer

DESCRIPTION: Sets the lower comparator limit. This value is not adopted, however, until the CALCulate:LIMit:ACKNowledge? command is received, once the upper comparator limit has also been transferred using the CALCulate:LIMit:UPPer command.

SYNTAX: CALCulate:LIMit:LOWer P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Lower comparator limit	Numerical value, optionally with units (UOHM, MOHM, OHM,KOHM) If no units are sent, then the value is interpreted as OHM

QUERY FORM: CALCulate:LIMit:LOWer?

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1	Present lower comparator limit	Numerical value with units of OHM

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.5.6 CALCulate:LIMit:UPPer

DESCRIPTION: Sets the upper comparator limit. This value is not adopted, however, until the CALCulate:LIMit:ACKNowledge? command is received, once the upper comparator limit has also been transferred using the CALCulate:LIMit:LOWer command.

SYNTAX: CALCulate:LIMit:UPPer P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Upper comparator limit	Numerical value, optionally with units (UOHM, MOHM, OHM,KOHM) If no units are sent, then the value is interpreted as OHM

QUERY FORM: CALCulate:LIMit:Upper?

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1	Present upper comparator limit	Numerical value with units of OHM

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.5.7 CALCulate:LIMit:ACKNowledge?

DESCRIPTION: Adopts the comparator limits. This command causes those comparator limits to be adopted that were previously transferred using the two commands CALCulate:LIMit:LOWer (lower comparator limit) and CALCulate:LIMit:UPPer (upper comparator limit).

SYNTAX: CALCulate:LIMit:ACKNowledge

No parameter

QUERY FORM: Query form only

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1	Status of adoption of comparator limits	1⟶ Limits have been adopted; all ok 1⟶ Limits have not been adopted

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.5.8 CALCulate:LIMit:CONTrol:DATA

DESCRIPTION: Sets the number of measurements after Start before evaluation made.

SYNTAX: CALCulate:LIMit:CONTrol:DATA P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	The number measurements after Start before evaluation	Integer between 1 and 999

QUERY FORM: CALCulate:CONTrol:DATA ?

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1	The number measurements after Start before evaluation	Integer between 1 and 999

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.5.9 CALCulate:MATH[:EXPRession]

DESCRIPTION: Switches the measurement display between Ohm and Ohm/m

SYNTAX: CALCulate:MATH[:EXPRession] P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Display in Ohm or Ohm/m	OHM → Measurement display in Ohm OHM/M → Measurement display in Ohm/m

QUERY FORM: CALCulate:CONTrol:DATA ?

RESPONSE: A1

Meaning of response An

Response	Meaning Value	
A1	Display in Ohm or Ohm/m	OHM → Measurement display in Ohm OHM/M → Measurement display in Ohm/m

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.6 REGister Subsystem

8.6.1 REGister:OUTPut

DESCRIPTION: Tests the PLC outputs. The PLC outputs can be set/reset

SYNTAX: REGister:OUTPut P1

Meaning of parameter Pn

Parameter	Meaning Value	
P1	Bit-coded pattern for setting/resetting the PLC outputs:	Value in hex between 0x0 and 0x7fff;

Bit-coding of the PLC outputs:

D0	→	OUT_PROG_OK	(Pin 4)
D1	→	OUT_PROG_3	(Pin 17)
D2	→	OUT_PROG_2	(Pin 16)
D3	→	OUT_PROG_1	(Pin 13)
D4	→	OUT_PROG_0	(Pin 11)
D5	→	OUT_>_COMP	(Pin 10)
D6	→	OUT_=_COMP	(Pin 12)
D7	→	OUT_<_COMP	(Pin 14)
D8	→	OUT_DANGER	(Pin 15)
D9	→	OUT_MEAS_ERROR	(Pin 9)
D10	→	OUT_MEAS_END	(Pin 8)
D11	→	OUT_BUSY	(Pin 7)
D12	→	OUT_>_RELAY	(Pin 5)
D13	→	OUT_=_ RELAY	(Pin 3)
D14	→	OUT_<_ RELAY	(Pin 1)

QUERY FORM: Query form only

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.6.2 REGister:INPut

DESCRIPTION: Tests the PLC inputs. The PLC inputs can be read

SYNTAX: REGister:INPut ?

QUERY FORM: Query form only

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Bit-coded status of the PLC inputs	Hex value between 0x0 and 0x3fff;

Bit-coding of the PLC inputs:

D0	→	IN_RESERVE_4	-
D1	→	IN_RESERVE_3	(Pin 32)
D2	→	IN_RESERVE_2	(Pin 27)
D3	→	IN_RESERVE_1	(Pin 24)
D4	→	IN_STASTOP_FOOT	(Pin 36)
D5	→	IN_30A_BOOSTER	-
D6	→	IN_PROG_3	(Pin 31)
D7	→	IN_PROG_2	(Pin 30)
D8	→	IN_PROG_1	(Pin 29)
D9	→	IN_PROG_0	(Pin 28)
D10	→	IN_MESSPROG_OK	(Pin 26)
D11	→	IN_STA_PRINTER	(Pin 25)
D12	→	IN_OUTPUT_COMP	(Pin 22)
D13	→	START_STOP_MEAS	(Pin 21)

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.7 SCALE Subsystem

8.7.1 SCALE:VOLTage

DESCRIPTION: Scales the voltage input from the pyrometer.

SYNTAX: SCALE:VOLTage P1, P2, P3, P4

Meaning of parameter Pn

Parameter	Meaning Value	
P1	Lower voltage	Floating-pt value optionally with units (UV, MV, V, KV, MAV)
P2	Upper voltage	Floating-pt value optionally with units (UV, MV, V, KV, MAV)
P3	Lower temperature	Floating-point value optionally with units (C, CEL)
P4	Upper temperature	Floating-point value optionally with units (C, CEL)

Condition:

Lower voltage < Upper voltage and lower temperature < Upper temperature

QUERY FORM: SCALe:VOLTage?

RESPONSE: A1, A2, A3, A4

Meaning of parameter An

Parameter	Meaning Value	
P1	Lower voltage	Floating-point value with units V
P2	Upper voltage	Floating-point value with units V
P3	Lower temperature	Floating-point value with units CEL
P4	Upper temperature	Floating-point value with units CEL

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.7.2 SCALE:PT100

DESCRIPTION: Sets the Pt100 coefficients for positive temperatures

SYNTAX: SCALE:PT100 P1, P2, P3

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Pt100 coefficient R0	Floating-point value
P2	Pt100 coefficient a	Floating-point value
P3	Pt100 coefficient b	Floating-point value

Equation: $Rt = R0 * (1 + a * t + b * t^2)$

QUERY FORM: SCALe:PT100?

RESPONSE: A1, A2, A3

Meaning of parameter An

Response	Meaning	Value
A1	Pt100 coefficient R0	Floating-point value
A2	Pt100 coefficient a	Floating-point value
A3	Pt100 coefficient b	Floating-point value

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.8 HCOPy Subsystem

8.8.1 HCOPy:DESTination

DESCRIPTION: Sets the function of the serial port (Printer output of PC interface)

SYNTAX: HCOPy:DESTination P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Function of the serial port	PRINTER→ Serial port is the printer output PC → Serial port is the PC interface

QUERY FORM: HCOPy:DESTination?

RESPONSE: A1

Meaning of parameter An

Response	Meaning Value	
A1	Function of the serial port	PRINTER→ Serial port is the printer output PC → Serial port is the PC interface

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.9 CCURve Subsystem

8.9.1 CCURve:TIME:END

DESCRIPTION: Sets the time length of the full cooling curve measurement (end time).

SYNTAX: CCURve:TIME:END P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	End time	Integer between 1 and 9999 in seconds

QUERY FORM: CCURve:TIME:END?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	End time	Integer between 1 and 9999 in seconds

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.9.2 CCURve:TIME:DELTa

DESCRIPTION: Sets the time interval between measurements (delta time) on the cooling.

SYNTAX: CCURve:TIME:DELTa P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Time interval between measurements on cooling curve	Integer between 1 and 9999 in seconds

QUERY FORM: CCURve:TIME:DELTa?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Time interval between measurements on cooling curve	Integer between 1 and 9999 in seconds

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.9.3 CCURve:COUNt

DESCRIPTION: Returns the number of measurements saved in the data logger.

SYNTAX: CCURve:COUNt?

No parameter

QUERY FORM: Query form only

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Number of measurements in the data logger	Numerical value

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.9.4 CCURve:DATA

DESCRIPTION: Can be used to read the individual entries in the data logger.

SYNTAX: CCURve:DATA?

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Entry number in the data logger	Numerical value

QUERY FORM: Query form only

RESPONSE: A1, A2, A3, A4

Meaning of parameter An

Response	Meaning	Value
A1	Entry number	Numerical value
A2	Time in seconds relative to when load removed	Floating-point value with units (s)
A3	Resistance value	Floating-point value with units
A4	Identification of start/stop cycles	Consecutive letters of the alphabet

NOTE:

Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.9.5 CCURve:CHARge

DESCRIPTION: START / STOP time from load removal.

SYNTAX: CCURve:CHARge P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Start / stop time from load removal	1 or ON → start time after load removal 0 or OFF→ stop time again

QUERY FORM: No query form

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.
Command only allowed in cooling curve mode.

8.9.6 CCURve:INITiate

DESCRIPTION: Starts the cooling curve measurement.

SYNTAX: CCURve:INITiate

No parameter

QUERY FORM: No query form

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.
Command only allowed in cooling curve mode.

8.9.7 CCURve:ABORt

DESCRIPTION: Stops the cooling curve measurement.

SYNTAX: CCURve:ABORt

No parameter

QUERY FORM: No query form

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.
Command only allowed in cooling curve mode.

8.10 TRACe Subsystem

8.10.1 TRACe:DATA:LENGth

DESCRIPTION: Transfers and queries the reference length.

SYNTAX: TRACe:DATA:LENGth P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Reference length	Floating-pt value optionally with units (UM, MM, CM, DM, M, KM)

QUERY FORM: TRACe:DATA:LENGth?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Reference length	Floating-point value with units M

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.11 TRIGger Subsystem

8.11.1 ABORT

DESCRIPTION: Stops a measurement that has been started.

SYNTAX: ABORt

No parameter

QUERY FORM: No query form

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement already stopped.

For speed reasons there is also a non-SCPI-compliant short form: AB

8.11.2 INITiate[IMMediate]

DESCRIPTION: Starts a measurement that has been stopped.

SYNTAX: INITiate[IMMediate]

No parameter

QUERY FORM: No query form

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement already started.

For speed reasons there is also a non-SCPI-compliant short form: IN

8.11.3 TRACe:DATA:LENGth

DESCRIPTION: Switches between single and continuous measurement mode.

SYNTAX: INITiate:CONTinuous?

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Single or continuous measurement	1 or ON -> continuous measurement
		0 or OFF -> single shot

QUERY FORM: INITiate:CONTinuous?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Single or continuous measurement	1 -> continuous measurement
		0 -> single shot

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.11.4 FETCh?

DESCRIPTION: Can be used to retrieve one measurement.

SYNTAX: FETCh?

No parameter

QUERY FORM: Query form only

RESPONSE: A1, A2

Meaning of parameter An

Response	Meaning	Value
A1	Measured resistance value	Floating-point value with units
A2	Comparator result, if comparator enabled	<, = or >

NOTE:
Command not allowed in calibration mode.

For speed reasons there is also a non-SCPI-compliant short form: FE

8.12 SYSTem Subsystem

8.12.1 SYSTem:VERSion

DESCRIPTION: Returns the SCPI version.

SYNTAX: SYSTem:VERSion?

No parameter

QUERY FORM: Query form only

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1	The SCPI version	1997.0

8.12.2 SYSTem:LANGuage

DESCRIPTION: Switches Sets and queries the operating language.

SYNTAX: SYSTem:LANGuage P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Operating language	GERMAN -> German operating language ENGLISH -> English operating language FRENCH -> French operating language ITALIEN -> Italian operating language SPANISH -> Spanish operating language

QUERY FORM: SYSTem:LANGuage?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Operating language	GERMAN -> German operating language ENGLISH -> English operating language FRENCH -> French operating language ITALIEN -> Italian operating language SPANISH -> Spanish operating language

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.12.3 SYSTem:PASSword

DESCRIPTION: Can be used to set and query the reset password and access password.

SYNTAX: SYSTem:PASSword P1, P2

Meaning of parameter Pn

Parameter	Meaning	Value
P1	The access password	Numerical value between 0000 and 9999
P2	The reset password	Numerical value between 0000 and 9999

QUERY FORM: SYSTem:PASSword?

RESPONSE: A1, A2

Meaning of parameter An

Response	Meaning	Value
A1	The access password	Numerical value between 0000 and 9999
A2	The reset password	Numerical value between 0000 and 9999

8.12.4 SYSTem:ERRor[:NEXT]?

DESCRIPTION: Can be used to query any errors that may have occurred in the instrument.

SYNTAX: SYSTem:ERRor[:NEXT]?

No parameter

QUERY FORM: Query form only

RESPONSE: A1

Meaning of parameter An

	Response	Meaning	Value
A1	Error status	0, NO ERROR:	No errors present.
		-100, COMMAND ERROR:	An invalid command was sent.
		-101, INVALID CHARACTER:	A command contains an invalid character.
		-105, GET NOT ALLOWED:	GET command was sent within a command.
		-108, PARAMETER NOT ALLOWED	Inadmissible parameter
		-109, MISSING PARAMETER:	No parameter supplied.
		-110, COMMAND HEADER ERROR:	A command with an invalid command header.
		-120, NUMERIC DATA ERROR:	An invalid numerical value.
		-200, EXECUTION ERROR:	The command could not be executed because of a particular device state.
		-204, ILLEGAL DEVICE STATE:	Command is valid, but cannot be executed in the current device state.
		-213, INIT IGNORED:	The INITialize command was ignored.
		-220, PARAMETER ERROR:	Command with an invalid parameter.
		-221, SETTING CONFLICT:	Because of the setting, a command with the given parameter cannot be executed.
		-222, DATA OUT OF RANGE:	A parameter lies outside the valid limits.
		-224, ILLEGAL PARAMETER VALUE:	A valid parameter, but not one used by the device.
		-231, DATA QUESTIONABLE:	The value of a parameter is questionable.
		-350, QUEUE OVERFLOW:	Error-buffer overflow.
		-400, QUERY ERROR:	A query was sent to the device without any data being available.
		-410, QUERY INTERRUPTED	The device was interrupted before it had sent a complete response.
		-420, QUERY UNTERMINATED:	A full response was not sent.

8.13 STATus Subsystem

8.13.1 STATus:PRESet

DESCRIPTION: Resets both the Operational Status Enable register and the Questionable Status Enable register to 0.

SYNTAX: STATus:PRESet

No parameter

QUERY FORM: No query form

8.13.2 STATus:OPERation:ENABle

DESCRIPTION: Sets the Operational Status Enable register.

SYNTAX: STATus:OPERation:ENABle P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Contents of the 16-bit Operation Status Enable register	Decimal value between 0 and 32767

QUERY FORM: STATus:OPERation:ENABle?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Contents of the 16-bit Operation Status Enable register	Decimal value between 0 and 32767

8.13.3 STATus:QUEStionable:ENABle

DESCRIPTION: Sets the Questionable Status Enable register.

SYNTAX: STATus:QUEStionable:ENABle P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Contents of the 16-bit Operation Status Enable register	Decimal value between 0 and 32767

QUERY FORM: STATus:QUEStionable:ENABle?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Contents of the 16-bit Operation Status Enable register	Decimal value between 0 and 32767

8.13.4 STATus:OPERation:CONDition?

DESCRIPTION: Reads the Operation Status Condition register.

SYNTAX: STATus:OPERation:CONDition

No parameter

QUERY FORM: Query form only

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Contents of the 16-bit Operation Status Condition register	Decimal value between 0 and 32767

Note:

For speed reasons there is also a non-SCPI-compliant short form: S:O:C?

8.13.5 STATus:QUEStionable:CONDition?

DESCRIPTION: Reads the Questionable Status Condition register.

SYNTAX: STATus:QUEStionable:CONDition?

No parameter

QUERY FORM: Query form only

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Contents of the 16-bit Questionable Status Condition register	Decimal value between 0 and 32767

Note:

For speed reasons there is also a non-SCPI-compliant short form: S:Q:C?

8.13.6 STATus:OPERation[:EVENt]?

DESCRIPTION: Reads the Operation Status Event register.

SYNTAX: STATus:OPERation:[EVENt]?

No parameter

QUERY FORM: Query form only

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Contents of the 16-bit Operation Status Event register	Decimal value between 0 and 32767

Note:

For speed reasons there is also a non-SCPI-compliant short form: S:Q:[E[?

8.13.7 STATus:QUEStionable[:EVENt]?

DESCRIPTION: Reads the Questionable Status Event register.

SYNTAX: STATus:QUEStionable:[EVENt]?

No parameter

QUERY FORM: Query form only

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Contents of the 16-bit Questionable Status Event register	Decimal value between 0 and 32767

Note:

For speed reasons there is also a non-SCPI-compliant short form: S:Q:[E[?

8.14 SENSe Subsystem

8.14.1 SENSe:TCOMpensate

DESCRIPTION: Sets the type of temperature sensor for the temperature compensation detected.

SYNTAX: SENSe:TCOMpensate P1

Meaning of parameter Pn

Parameter	Meaning	Value		
P1	How the	MAN	->	Manual temperature input
	temperature	PT100	->	Detected using Pt100 (default coefficients)
	is detected	PT100INDIV	->	Detected using Pt100 (selectable coefficients)
		UINP	->	Detected using pyrometer (U-input)

QUERY FORM: SENSe:TCOMpensate?

RESPONSE: A1, A2, A3, A4

Meaning of parameter An

Response	Meaning	Value		
A1	How the	MAN	->	Manual temperature input
	temperature	PT100	->	Detected using Pt100 (default coefficients)
	is detected	PT100INDIV	->	Detected using Pt100 (selectable coefficients)
		UINP	->	Detected using pyrometer (U-input)

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.14.2 SENSe:TCOMpensate:STATe

DESCRIPTION: Enables or disables temperature compensation.

SYNTAX: SENSe:TCOMpensate:STATe P1

Meaning of parameter Pn

Parameter	Meaning	Value	
P1	Temperature compensation on or off	1 or ON	Enable temperature compensation
		0 or OFF	Disable temperature compensation

QUERY FORM: SENSe:TCOMpensate:STATe?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Temperature compensation on or off	1 -> Enable temperature compensation 0 -> Disable temperature compensation

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.14.3 SENSe:TCOMpensate:TEMperature

DESCRIPTION: Sets the temperature for manual temperature compensation.

SYNTAX: SENSe:TCOMpensate:TEMperature P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Temperature for manual temperature compensation	Floating-pt value optionally with units (C or CL)

QUERY FORM: SENSe:TCOMpensate:TEMperature?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Temperature for manual temperature compensation	Floating-point value with units CEL

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.14.4 SENSe:TCOMpensate:TEMperature:REFerence

DESCRIPTION: Sets the reference temperature for temperature compensation.

SYNTAX: SENSe:TCOMpensate:TEMperature:REFerence P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Reference temperature for temperature compensation	Floating-pt value optionally with units (C or CEL)

QUERY FORM: SENSe:TCOMpensate:TEMperature?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Reference temperature for temperature compensation	Floating-point value with units CEL

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.

Note:
The reference temperature specifies the temperature to which the measurement is corrected. In Europe this temperature is usually 20°C, in USA 23°C or 25°C. This temperature has nothing to do with the measured room temperature.

8.14.5 SENSe:TCOMpensate:TCOefficient:SELect

DESCRIPTION: Selects a temperature coefficient for the temperature compensation.

SYNTAX: SENSe:TCOMpensate:TCOefficient:SELect P1

Meaning of parameter Pn

	Parameter	Meaning Value
P1	Number of the temperature coefficient	Numerical value between 1 and 16
	1	-> TEMPCOMP_OFF
	2	-> TEMPCOMP_COPPER
	3	-> TEMPCOMP_ALU
	4	-> TEMPCOMP_BRASS63
	5	-> TEMPCOMP_BRASS80
	6	-> TEMPCOMP_TUNGSTEN
	7	-> TEMPCOMP_NICKEL
	8	-> TEMPCOMP_PLATIN
	9	-> TEMPCOMP_USER 1
	10	-> TEMPCOMP_USER 2
	11	-> TEMPCOMP_USER 3
	12	-> TEMPCOMP_USER 4
	13	-> TEMPCOMP_USER 5
	14	-> TEMPCOMP_USER 6
	15	-> TEMPCOMP_USER 7
	16	-> TEMPCOMP_USER 8

QUERY FORM: SENSe:TCOMpensate:TCOefficient:SELect?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
P1	Number of the temperature coefficient	Numerical value between 1 and 16
	1	-> TEMPCOMP_OFF
	2	-> TEMPCOMP_COPPER
	3	-> TEMPCOMP_ALU
	4	-> TEMPCOMP_BRASS63
	5	-> TEMPCOMP_BRASS80
	6	-> TEMPCOMP_TUNGSTEN
	7	-> TEMPCOMP_NICKEL
	8	-> TEMPCOMP_PLATIN
	9	-> TEMPCOMP_USER 1
	10	-> TEMPCOMP_USER 2
	11	-> TEMPCOMP_USER 3
	12	-> TEMPCOMP_USER 4
	13	-> TEMPCOMP_USER 5
	14	-> TEMPCOMP_USER 6
	15	-> TEMPCOMP_USER 7
	16	-> TEMPCOMP_USER 8

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.14.6 SENSe:TCOMpensate:TCOefficient:USER:CHANge

DESCRIPTION: Can be used to set the user-defined temperature coefficients.

SYNTAX: SENSe:TCOMpensate:TCOefficient:USER:CHANge P1, P2, P3

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Number of the user-definable TC	Numerical value between 9 and 16
P2	TC identifier	String with up to 10 characters
P3	Value of the TC in ppm	Floating-point value

QUERY FORM: SENSe:TCOMpensate:TCOefficient:USER:CHANge?

RESPONSE: A1, A2, A3

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Number of the user-definable TC	Numerical value between 9 and 16

Meaning of response An

Response	Meaning	Value
A1	Number of the user-definable TC	Numerical value between 9 and 16
A2	TC identifier	String with up to 10 characters
A3	Value of the TC in ppm	Floating-point value

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.14.7 SENSe:FRESistance:RESolution

DESCRIPTION: Sets the resolution of the measurement display.

SYNTAX: SENSe:FRESistance:RESolution P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Resolution of the measurement display	0.0005 -> Low resolution (2000) 0.00005 -> High resolution (20000)

QUERY FORM: SENSe:FRESistance:RESolution?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Resolution of the measurement display	0.0005 -> Low resolution (2000) 0.00005 -> High resolution (20000)

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.
RESistance can also be used instead of FRESistance.

8.14.8 SENSe:FRESistance:MODE

DESCRIPTION: Selects the measurement mode.

SYNTAX: SENSe:FRESistance:MODE P1

Meaning of parameter Pn

Parameter	Meaning	Value		
P1	Measurement mode	SINGle	->	Single shot
		CONTinuous	->	Continuous measurement
		ALTernate	->	Alternating measurement
		CCURve	->	Cooling curve

QUERY FORM: SENSe:FRESistance:MODE?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Measurement mode	SING -> Single shot CONT -> Continuous measurement ALT -> Alternating measurement CCUR -> Cooling curve

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.
RESistance can also be used instead of FRESistance.

8.14.9 SENSe:FRESistance:TIME:CONStant

DESCRIPTION: Sets the load type of the device under test.

SYNTAX: SENSe:FRESistance:TIME:CONStant P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Time constant i.e. load type of device under test	T1 ->Resistive load Z1 T2 ->Inductive load Z2 T3 ->Inductive load Z3

QUERY FORM: SENSe:FRESistance:TIME:CONStant?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Time constant i.e. load type of device under test	T1 ->Resistive load Z1 T2 ->Inductive load Z2 T3 ->Inductive load Z3

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.
RESistance can also be used instead of FRESistance.

8.14.10 SENSe:FRESistance:RANGe

DESCRIPTION: Can be used to query the measuring range currently in use.

SYNTAX: SENSe:FRESistance:RANGe P1

No parameters

QUERY FORM: SENSe:FRESistance:RANGe?

RESPONSE: A1

Meaning of Response An

Response	Meaning	Value
A1	Measuring range currently set	1 -> 2 mΩ range
2		-> 20 mΩ range
3		-> 200 mΩ range
4		-> 2 Ω range
5		-> 20 Ω range
6		-> 200 Ω range
7		-> 2 kΩ range
8		-> 20 kΩ range
9		-> 200 kΩ range

NOTE:
Command not allowed in calibration mode.
RESistance can also be used instead of FRESistance.

8.14.11 SENSe:FRESistance:RANGe:AUTo

DESCRIPTION: Switches between manual and automatic range selection.

SYNTAX: SENSe:FRESistance:RANGe:AUTo P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Manual or automatic range-selection	1 or ON -> Automatic range-selection 0 or OFF-> Manual range-selection

QUERY FORM: SENSe:FRESistance:RANGe:AUTo?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Manual or automatic range-selection	1 -> Automatic range-selection 0 -> Manual range-selection

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.
RESistance can also be used instead of FRESistance.

8.14.12 SENSe:FRESistance:RANGe:UPPer

DESCRIPTION: Sets the maximum permitted measuring range for automatic range selection.

SYNTAX: SENSe:FRESistance:RANGe:UPPer P1

Meaning of parameter Pn

Parameter	Meaning Value	
P1	Max. measuring range for automatic range-selection	2 MOHM -> 2 mΩ range 20 MOHM -> 20 mΩ range 200 MOHM -> 200 mΩ range 2 OHM -> 2 Ω range 20 OHM -> 20 Ω range 200 OHM -> 200 Ω range 2 KOHM -> 2 kΩ range 20 KOHM -> 20 kΩ range 200 KOHM -> 200 kΩ range

QUERY FORM: SENSe:FRESistance:RANGe:UPPer?

RESPONSE: A1

Meaning of parameter An

Response	Meaning Value	
A1	Max. measuring range for automatic range-selection	2 MOHM -> 2 mΩ range 20 MOHM -> 20 mΩ range 200 MOHM -> 200 mΩ range 2 OHM -> 2 Ω range 20 OHM -> 20 Ω range 200 OHM -> 200 Ω range 2 KOHM -> 2 kΩ range 20 KOHM -> 20 kΩ range 200 KOHM -> 200 kΩ range

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.
The range must be greater than the minimum permitted measuring range set with SENSe:FRESistance:RANGe:LOWer
RESistance can also be used instead of FRESistance.

8.14.13 SENSe:FRESistance:RANGe:LOWer

DESCRIPTION: Sets the minimum permitted measuring range for automatic range selection.

SYNTAX: SENSe:FRESistance:RANGe:LOWer P1

Meaning of parameter Pn

Parameter	Meaning Value	
P1	Min. measuring range for automatic range-selection	2 MOHM -> 2 mΩ range 20 MOHM -> 20 mΩ range 200 MOHM -> 200 mΩ range 2 OHM -> 2 Ω range 20 OHM -> 20 Ω range 200 OHM -> 200 Ω range 2 KOHM -> 2 kΩ range 20 KOHM -> 20 kΩ range 200 KOHM -> 200 kΩ range

QUERY FORM: SENSe:FRESistance:RANGe:LOWer?

RESPONSE: A1

Meaning of parameter An

Response	Meaning Value	
A1	Min. measuring range for automatic range-selection	2 MOHM -> 2 mΩ range 20 MOHM -> 20 mΩ range 200 MOHM -> 200 mΩ range 2 OHM -> 2 Ω range 20 OHM -> 20 Ω range 200 OHM -> 200 Ω range 2 KOHM -> 2 kΩ range 20 KOHM -> 20 kΩ range 200 KOHM -> 200 kΩ range

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.
The range must be smaller than the maximum permitted measuring range set with SENSe:FRESistance:RANGe:UPPer
RESistance can also be used instead of FRESistance.

8.14.14 SENSe:FRESistance:RANGe:MANual

DESCRIPTION: Sets the measuring range for manual range selection.

SYNTAX: SENSe:FRESistance:RANGe:MANual P1

Meaning of parameter Pn

Parameter	Meaning Value	
P1	Measuring range for manual range-selection	2 MOHM -> 2 mΩ range 20 MOHM -> 20 mΩ range 200 MOHM -> 200 mΩ range 2 OHM -> 2 Ω range 20 OHM -> 20 Ω range 200 OHM -> 200 Ω range 2 KOHM -> 2 kΩ range 20 KOHM -> 20 kΩ range 200 KOHM -> 200 kΩ range

QUERY FORM: SENSe:FRESistance:RANGe:MANual?

RESPONSE: A1

Meaning of parameter An

Response	Meaning Value	
A1	Measuring range for manual range-selection	2 MOHM -> 2 mΩ range 20 MOHM -> 20 mΩ range 200 MOHM -> 200 mΩ range 2 OHM -> 2 Ω range 20 OHM -> 20 Ω range 200 OHM -> 200 Ω range 2 KOHM -> 2 kΩ range 20 KOHM -> 20 kΩ range 200 KOHM -> 200 kΩ range

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running and an inductive device under test is set.
RESistance can also be used instead of FRESistance.

8.14.15 SENSe:AVERage:COUNt

DESCRIPTION: Sets the number of measurements to be used for calculating the mean resistance.

SYNTAX: SENSe:AVERage:COUNt P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Number of values used for average	Numerical value between 1 and 99

QUERY FORM: SENSe:AVERage:COUNt?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Number of values used for average	Numerical value between 1 and 99

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.14.16 SENSe:CORRection:OFFset

DESCRIPTION: Start zero-offset measurement for automatic thermal-EMF compensation disabled (“MAN ZERO”).

SYNTAX: SENSe:CORRection:OFFset?

No parameter

QUERY FORM: No query form

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.14.17 SENSe:CORRection:OFFset:STATe

DESCRIPTION: Enables/disables the automatic thermal-EMF compensation.

SYNTAX: SENSe:CORRection:OFFset:STATe P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Status of autom. Thermal-EMF compensation	1 or ON -> Automatic thermal-EMF compensation on 0 or OFF -> Automatic thermal-EMF compensation off

QUERY FORM: SENSe:CORRection:OFFset:STATe?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Status of autom. Thermal-EMF	1 -> Automatic thermal-EMF compensation on 0 -> Automatic thermal-EMF compensation off compensation

NOTE:
Command not allowed in calibration mode.
Command not allowed when measurement is running.

8.15 IEEE-488.2 commands

8.15.1 *SRE command

DESCRIPTION: Sets the Service Request Enable register.

SYNTAX: *SRE P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Contents of the Service Request Enable register	Numerical value between 0 and 255

QUERY FORM: *SRE?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Contents of the Service Request Enable register	Numerical value between 0 and 255

8.15.2 *STB? command

DESCRIPTION: Reads the Status Byte register.

SYNTAX: STB?

No parameter

QUERY FORM: Query form only

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Contents of the Status Byte register	Numerical value between 0 and 255

8.15.3 *ESE command

DESCRIPTION: Sets the Standard Event Status Enable register.

SYNTAX: *ESE P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Contents of the Standard Event Status register	Numerical value between 0 and 255

QUERY FORM: *ESE?

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Contents of the Standard Event Status register	Numerical value between 0 and 255

8.15.4 *ESR? command

DESCRIPTION: Reads the Standard Event Status register.

SYNTAX: ESR?

No parameter

QUERY FORM: Query form only

RESPONSE: A1

Meaning of parameter An

Response	Meaning	Value
A1	Contents of the Standard Event Status register	Numerical value between 0 and 255

8.15.5 *OPC command

DESCRIPTION: Sets the device to the Operation Complete Active state (OCAS).

SYNTAX: OPC

NOTE:
This command has no function on the DO6
No point to it on the serial port with ANSI protocol.

8.15.6 *RST command

DESCRIPTION: Sets the device to a defined initial state.
Does not affect the setting for the serial port

SYNTAX: *RST

No parameter

QUERY FORM: No query form

8.15.7 *TST? command

DESCRIPTION: Self test query command. The command is recognised by the instrument but has no further function.

SYNTAX: *TST?

No parameter

QUERY FORM: Query form only

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1		Returns a 1.

8.15.8 *WAI command

DESCRIPTION: This command configures the device to handle all commands sequentially. This command has no function on the DO6 because commands are always handled sequentially. The command is merely recognised.

SYNTAX: *WAI

No parameter

QUERY FORM: No query form

RESPONSE: A1

8.15.9 *CLS command

DESCRIPTION: Clears the SCPI error buffer. Resets the Status Byte register.
Resets the Standard Event Status register.
Resets the Operation Status Event register.
Resets the Questionable Status Event register.

SYNTAX: *CLS

No parameter

QUERY FORM: No query form

8.15.10 *IDN? command

DESCRIPTION: Retrieves various information for device identification.

SYNTAX: *IDN?

No parameter

QUERY FORM: Query form only

RESPONSE: A1, A2, A3, A4, A5, A6

Meaning of response An

Response	Meaning	Value
A1	Device identification	RESISTOMAT® 2316
A2	Derivative	V0000 -> 1 Amp instrument V0001 -> 3 Amp instrument
A3	Serial number	String with up to 10 characters
A4	Version	String with up to 11 characters
A5	Calibration date	Date in the form dd.mm.yy
A6	Calibration counter	Sequential number

8.15.11 *IDN? command

DESCRIPTION: Can be used to select a measurement program (0 to 15).

SYNTAX: *RCl P1

Meaning of parameter Pn

Parameter	Meaning	Value
P1	Number of the measurement program	Numerical value between 0 and 15

QUERY FORM: *RCL?

RESPONSE: A1

Meaning of response An

Response	Meaning	Value
A1	Number of the present measurement program	Numerical value between 0 and 15

8.16 Programming examples

QBasic examples

These two examples were written using Quick-Basic, and in both methods shown retrieve the info string

8.16.1 Communication using “Selection with response”

```
REM ************************************************************************
REM ** **
REM ** 2316_1.bas                Developped by:MN,Li                       **
REM **                           Changed by:CS                             **
REM ** Communication             Prog. language: Qbasic 1.1                **
REM **         exe-File created with QB 4.5                                 **
REM ** with selection with                                                 **
REM ** response                  date: 13.03.2000, 09.12.2004              **
REM ** example: ask for ID-string                                          **
REM ** **
REM ************************************************************************

REM (1) Definition of ASCII-Control Characters

REM STX Start of text: 0x02
STX$ = CHR$(2)

REM ETX End of text: 0x03
ETX$ = CHR$(3)

REM EOT End of transmission: 0x04
EOT$ = CHR$(4)

REM ENQ Enquiry: 0x05
ENQ$ = CHR$(5)

REM ACK Acknowledge: 0x06
ACK$ = CHR$(6)

REM LF line feed: 0x0a
LF$ = CHR$(10)

REM CR carriage return: 0x0d
CRE$ = CHR$(13)

REM NAK not acknowledge: 0x15
NAK$ = CHR$(21)

REM+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
REM Dialog: Selection and opening/initialisation of PC-Interface
REM+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

CLS
INPUT „Which interface do you want to use? (1 -> COM1, 2 -> COM2)"; a
 IF ((a <> 1) AND (a <> 2)) THEN PRINT „illegal Interface": END
 IF (a = 1) THEN com$ = „COM1"
 IF (a = 2) THEN com$ = „COM2"
openstr$ = com$ + „:9600,N,8,1"
PRINT
```

```
PRINT „---->>>>> Connecting Device with adress 1...."

REM ** Sending „selection supervisory sequence" and pick up answer send EOT first to e
other (probably unanswered) enquiries
PRINT #3, EOT$ + „0000" + „sr" + ENQ$
REM clear answer string

ant$ = „"
REM read characters from serial interface
ant$ = INPUT$(1, #3)

REM new char should be an ACK
IF ant$ <> ACK$ THEN PRINT „Comunication error, not (ACK) received but:"; ant$
PRINT „selection supervisory string sent"
REM press ‚enter' to proceed
INPUT „ENTER TO GO ON"; a$: a$ = „"

REM ** Sending command „INFO?" to 2316 (enclosed with STX and ETX)
PRINT #3, STX$ + „*idn?" + ETX$

REM clear answer string
ant$ = „"
REM read characters from serial interface
ant$ = INPUT$(1, #3)

REM new char should be an ACK
IF ant$ <> ACK$ THEN PRINT „Comunication error, not (ACK) received but:"; ant$

REM !!IMPORTANT!! de-adress before start polling
PRINT #3, EOT$

PRINT „ID-Enquiry sent"
REM press ‚enter' to proceed
INPUT „ENTER TO GO ON"; a$: a$ = „"

REM 9310 wants to answer now and waits for polling

REM start polling
PRINT #3, „0000" + „po" + ENQ$

REM clear answer string
ant$ = „"

REM initialize variable char$ to anything but ETX
char$ = STX$
REM read from serial interface until ETX and add to answer-string
WHILE (char$ <> ETX$)
   char$ = INPUT$(1, #3)
   ant$ = ant$ + char$
WEND

REM ID-string received, send ACK
PRINT #3, ACK$

REM Printing „Dev 0 INFO:" on PC-sreen:
PRINT „DEVICE 0 answers: „, ant$

REM Reading EOT from 2316
ant$ = „"
ant$ = INPUT$(1, #3)

REM new char should be an EOT
IF ant$ <> EOT$ THEN PRINT „Comunication error, not (EOT) received but:"; ant$

PRINT „Program has ended successfully"

END
```

8.16.2 Communication using “Fast selection”

```
REM ************************************************************************
REM **                                                                    **
REM **         2316_2.bas        Developped by:MN,Li                     **
REM **                                 Changed by:CS                      **
REM **                           Prog. language: Qbasic 4.5               **
REM ** Communication                  exe-File created with QB 4.5        **
REM ** with fast selection            date: 13.03.2000 09.12.2004         **
REM ** example: ask for ID-string with fast selection                     **
Rem ************************************************************************

REM Definition of ASCII-Control Characters

REM STX Start of text: 0x02
STX$ = CHR$(2)

REM ETX End of text: 0x03
ETX$ = CHR$(3)

REM EOT End of transmission: 0x04
EOT$ = CHR$(4)

REM ENQ Enquiry: 0x05
ENQ$ = CHR$(5)

REM ACK Acknowledge: 0x06
ACK$ = CHR$(6)

REM LF line feed: 0x0a
LF$ = CHR$(10)

REM CR carriage return: 0x0d
CRE$ = CHR$(13)

REM NAK not acknowledge: 0x15
NAK$ = CHR$(21)

REM+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
REM Dialog: Selection and opening/initialisation of PC-Interface
REM+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

CLS
INPUT „Which interface do you want to use? (1 -> COM1, 2 -> COM2)"; a
 IF ((a <> 1) AND (a <> 2)) THEN PRINT „illegal Interface": END
 IF (a = 1) THEN com$ = „COM1"
 IF (a = 2) THEN com$ = „COM2"
openstr$ = com$ + „:9600,N,8,1"
PRINT

REM ** rs232 initialisation
OPEN openstr$ FOR RANDOM AS #3

PRINT „Please set up the 2316 with:"
PRINT „ baudrate = 9600, Data bits = 8,"
PRINT „ Stopp bits = 1, No parity, no blockcheck"
PRINT „ adress 0"
PRINT
```

```
REM+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
REM Ask Device (adr 0) for ID-String with Mode „fast selection"
REM (one of the two communication modes)
REM All commands in the user manual are described in this mode
REM+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

PRINT „———>>>>> Connecting Device with adress 0...."

REM send EOT first to end other (probably un-answered) enquiries (strongly recommended)
PRINT #3, EOT$

REM Create and send command
PRINT #3, „0000" + „sr" + STX$ + „*IDN?" + ETX$

REM clear answer string

ant$ = „"
REM read characters from serial interface
ant$ = INPUT$(1, #3)

REM new char should be an ACK
IF ant$ <> ACK$ THEN PRINT „Comunication error, not (ACK) received but:"; ant$

REM press ‚enter' to proceed
INPUT „ENTER TO GO ON"; a$: a$ = „"

REM !!IMPORTANT!! de-adress before start polling
PRINT #3, EOT$

REM 9310 wants to answer now and waits for polling

REM start polling
PRINT #3, „0000" + „po" + ENQ$

REM clear answer string
ant$ = „"

REM initialize variable char$ to anything but ETX
char$ = STX$
REM read from serial interface until ETX and add to answer-string
WHILE (char$ <> ETX$)
   char$ = INPUT$(1, #3)
   ant$ = ant$ + char$
WEND

REM ID-string received, send ACK
PRINT #3, ACK$

REM Printing „INFO" on PC-sreen:
PRINT „Device (0) answers: „, ant$

REM Reading EOT from 2316
ant$ = „"
ant$ = INPUT$(1, #3)

REM new char should be an EOT
IF ant$ <> EOT$ THEN PRINT „Comunication error, not (EOT) received but:"; ant$

PRINT „Program has ended successfully"

END
```

9. Maintenance, Customer service, Shipping, Cleaning

Maintenance

The DO6 requires no maintenance by the user. Any repairs that may be needed must be performed only at the manufacturer's premises. Recalibration is recommended every 24 months.

Customer Service

Queries: Please supply the serial number and software version when contacting the manufacturer with technical queries, only then can the manufacturer find out the technical status of the equipment and hence provide help quickly. This information is displayed in the start up menu.

Shipping: If the DO6 needs to be returned for repairs, please note the following requirements for packing and shipping:
The original or equivalent packaging should be used whenever possible for shipping. The warranty does not cover transportation damage caused by inadequate packaging. if you have a problem with the instrument, please attach a note to the instrument summarising the fault; including your name and contact details will help to speed up the process.

Factory warranty: The DO6 is guaranteed trouble free operation for 24 months after delivery. Any repairs required during this time will be made without charge. Damage caused by improper use of the equipment is not covered by the warranty. The technical data can change at any time without notification. We also state that we do not accept liability for consequential damage.

Cleaning: Please do not use any cleaning agents that contain organic solvents or concentrated inorganic constituents. Thus never use acetone, toluene, xylene, benzene, ethanol, isopropyl alcohol, naptha etc… Usually just a cotton cloth moistened with a mild soap solution is sufficient. Never use a cleaning agent that contains abrasives.

10. Appendix

10.1 Technical data

Only values that include tolerances or limits are data covered by the warranty. Values that do not include tolerances are provided for information and do not come under the warranty. The instrument is designed for easy servicing and is housed in a rugged metal case. The individual components are easily accessible, ensuring ideal servicing conditions.

Display counts:	Approx. 21000 digits, last digit can be disabled.
Display:	High contrast graphics LCD with bright, white LED backlighting. Black and white display 264 * 64 dots, approx. 127mm * 34mm
Keypad:	Robust membrane keypad, good tactile feedback, suitable for use with gloves.
Operation:	Via keypad or interface.
Measuring error:	≤± 0.03% of reading ± 3 digits
Temperature sensitivity:	< 50 ppm/k

Upper Range	Test current	Resolution		
2 mΩ	3 A	100 nΩ	300 nV	150 µA
20 mΩ	1 A	1 µΩ	1 µV	50 µA
200 mΩ	100 mA	10 µΩ	1 µV	5 µA
2 Ω	10 mA	100 µΩ	1 µV	500 nA
20 Ω	10 mA	1 mΩ	10 µV	500 nA
200 Ω	1 mA	10 mΩ	10 µV	50 nA
2 kΩ	1mA	100 mΩ	100 µV	50 nA
20 kΩ	100 µA	1 Ω	100 µV	5 nA
200 kΩ	10 µA	10 Ω	100 µV	500pA

Measuring technique:	Ratiometric constant current technique
Sample rate:	Approx. 5 / s in the display
Single shot:	Measurement time approx. 400 ms (step to 99.97%) for purely resistive devices under test
Zero-offset/ Thermal EMF compensation:	Automatic before start of measurement, can be disabled.
Test connection:	4 wire technology, 5 pin circular socket 4 x 4 mm banana plug sockets
Ground connection:	Separate FE PE, 250 V potential to ground
Compliance voltage:	Approx. 5 V max
Selection of measuring range:	Manual and automatic (not for inductive loads).

Inductive loads:	Three different regulator parameters preset to give optimum speed, protection circuit, discharge of inductance.
Measurement fault:	Oscillation detection Open circuit detection Pt100 absence detection
Warm up time:	< 15 mins until error tolerances are reached
Auxiliary power:	100 … 240 V ac 50/60 Hz
Power consumption:	30 VA max
Protection circuit:	Circuit providing protection against induction voltages and against external voltages up to 400 V
Temperature compensation:	Measurement inputs for Pt100 and 0 to 10V pyrometer, TC can be defined, known materials can be selected, LEMO connector
Limits:	Can be entered via keypad
Control inputs:	PLC and foot switch
Evaluation results:	PLC level and / or relay 24 V / 1 A * Um
PLC level:	Positive, optionally negative
Interface:	RS232, ANSI X328, 2400 … 38000 baud, SCPI
Printer output:	RS232, measured value, temp., comparator evaluation
User language:	English, German, French, Spanish, Italian
Device program memory:	For 16 device programs
Case:	Rugged table top case made of aluminium section with plastic frame, RAL 7035
Case dimensions (HxWxD):	240 x 220 x 100 mm
Weight:	Approx. 3.5 kg
Safety:	Usual EN standards, CE, EN 61010-1
Use:	Indoors
Altitude:	Up to 2000 m above sea level
Operating temperature:	0 …. +23 … +50 °C
Storage temperature range:	0 … +70 °C
Humidity:	Up to 31 °C 80%, decreasing linearly above that temperature to 50 % at T max, no condensation
Design:	Suitable for industrial use in a production environment (dusty, normal EMC interference)
Degree of pollution:	2
Degree of protection:	IP 40
Overvoltage category:	2
Class of protection:	1
Position for use:	Horizontal

10.2 Calibration

The instrument is calibrated digitally. PC software (to be purchased separately) and a range of calibration resistances are required for the calibration.

10.3 Error messages and troubleshooting

Fault	Possible cause	Remedial action
Display does not come on.	Mains fuse blown. Mains lead faulty or loose.	Remove mains lead. Replace mains fuse 0.63 A slow-blowing. Check mains lead.
Flashing zeros, Overload indicator, Overdriven.	Wrong measuring range selected, test lead open-circuit +U or –U, load impedance too high.	Select correct measuring range. Connect test leads correctly.
Display difficult to read.	Adjust contrast via interface or manually. Temperature range exceeded.	Set contrast initially to 50%. Run instrument at correct temperature.
Measured values flickering.	Interface picked up by test leads.	Position test leads differently.
Error message, Current source oscillating.	Unsuitable load.	Select next longer time constant.
Error message.	Fuse in current source under test.	Short-circuit supply lead to device current too low has blown, disconnect. Remove mains lead. Replace fuse. Use only Superquick-acting fuse 10 6.3*32mm, 600VAC, 50000 breaking capacity. Check teat leads.
Error message Pt100 fault.	Pt100 contact problems.	Not present, check leads and connections to Pt100 sensor.
Error message Pyrometer.	0-10 V exceeded.	Check pyrometer voltage.
Error message Measurement current too high.	Current source faulty.	Return instrument for repair.

Internal device errors

After power up, the instrument checks the calibration data in the data memory, the non-volatile variables in the data memory and the EEPROM on the analogue card. Since more than one error can occur at once, the errors are binary coded and displayed on the LCD in the event of an error.

Bit 0 set means that	non-volatile data in the RAM has been lost.
Bit 1 set means that	a new device software version has been found (version number).
Bit 2 set means that	the EEPROM has not been programmed yet or is faulty.
Bit 3 set means that	calibration data in the data memory has been lost.
Bit 4 set means that	there is a hardware fault (the node voltage (approx. 0.95V) is not OK)
Bit 5 set means that	the internal protection circuit has been damaged.

The error code is displayed as a hexadecimal code:

Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Error code
0	0	0	0	0	1	0x01
0	0	0	0	1	0	0x02
0	0	0	0	1	1	0x03
0	0	0	1	0	0	0x04
0	0	0	1	0	1	0x05
0	0	0	1	1	0	0x06
0	0	0	1	1	1	0x07
0	0	1	0	0	0	0x08
0	0	1	0	0	1	0x09
0	0	1	0	1	0	0x0A
0	0	1	0	1	1	0x0B
0	0	1	1	0	0	0x0C
0	0	1	1	0	1	0x0D
0	0	1	1	1	0	0x0E
0	0	1	1	1	1	0x0F

This error menu can only be closed by entering a code:

Please notify our service department.