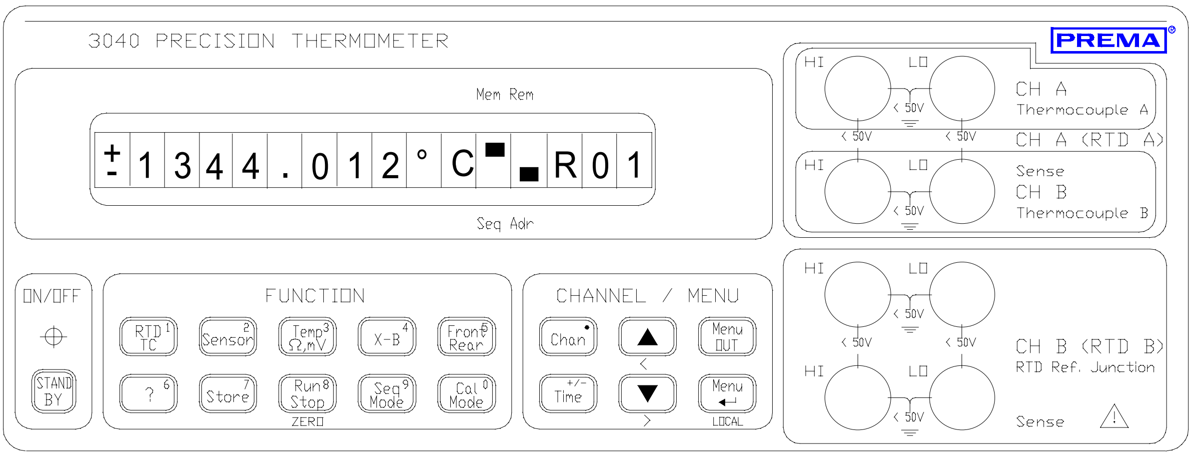
Precision Thermometer PTM 3040

Multi Channel Precision Thermometer with IEEE488 and RS232 Interface



PTM 3040
User Manual

PREMA Semiconductor GmbH
Robert-Bosch-Str. 6 • D-55129 Mainz • Germany
Tel. +49-6131-5062-20 • Fax +49-6131-5062-22
E-Mail: instruments @ prema.com
Internet: http: / / www . prema.com

AS3040 0045
Subject to changes without notice

Table of Contents

1 Introduction

With the Precision Thermometer 3040 you are now the owner of a very high precise measurement instrument with excellent qualities.
This instrument is convincing by virtue of its outstanding measuring capabilities and functional versatility.

1.1 Features

The following features of the 3040 are of special interest:

- High stability of ± 2 mK and 1-year accuracy of ± 10 mK (for Pt500/3mA, 0°C).
- Resistance and voltage measurement with 26 bit A/D converter with a 24-h stability of 4ppm and 8 ppm
- A variety of sensors is supported (Thermocouples and platinum sensors)
- Up to 18 platinum sensors or 34 thermocouples can be connected
- Entry of sensor linearisations for max. 34 sensors
- Automatical channel switching with an inbuilt sequencer
- Memory for up to 100,000 values including time stamp
- Alarm outputs and entry of limits for each channel
- Inbuilt real-time clock
- Good system capabilities with the RS232- and the IEEE488 interface
- Large clearly readable liquid crystal display (LCD)
- Standard case dimensions: Half 19 inch width and 2 height units

1.2 Important Safety Instructions

Reading the User Manual

Proper working procedure with this instrument is possible only after reading all instructions, hints and procedure specifications attentively and understanding them.

Please get in touch with PREMA before commencing operation of the instrument if you do not understand something in the user manual or the instructions, procedural descriptions and safety regulations are unclear.

This user manual has been written to make the instrument understandable for operation in the manner intended. It contains important instructions for safe, correct and efficient operation of the instrument.
Dangers are avoided, repair costs and downtime reduced and the service life of the instrument is extended only when these instructions are observed. The user manual should always be available at the place where the instrument is operated.
Incorrect manual control or failure to observe the instructions given here may endanger persons (also third parties) or cause material damage.

Personnel entrusted with operating this instrument must have read this user manual attentively and must be familiar with all safety instructions.
In addition to the instructions given in this user manual, the local regulations for preventing accidents in force at the operating site apply, as well as the relevant rules for safe and proper working procedure.

Further Safety Instructions

Further safety instructions are contained in the chapter headed "Getting Started". Explanations and instructions are given there for the warning signs and symbols on the instrument for recognising specific sources of danger. It is essential to observe and comply with all safety instructions. The warning symbols must be held complete and in good readable condition.

Predictability of Dangers

The manufacturer cannot anticipate every conceivable danger.
If a task is not carried out in the manner recommended, the operator must make sure that this does not entail any danger for himself and other persons.
He should also make sure that the instrument cannot be damaged or endangered by the chosen manner of operation.
This user operating manual is not an instruction manual for making repairs.
The instrument should be returned to the factory for any necessary repairs.

Proprietary Rights

Conformity Declaration

PREMA has issued an EC conformity declaration for this instrument. This declaration certifies that the instrument complies with the relevant requirements of the EC directives.

Proper Utilization as intended

These instruments have been built conforming to the recognized technical safety principles, but nevertheless if it is not used and operated in the manner intended, dangers may arise for body and life of the user or third persons, or damage may be incurred by the instrument and other objects.
The instrument may therefore be operated only in technically perfect condition, in the manner intended and with due awareness of safety considerations and dangers, observing the contents of the user manual and the regulations for the prevention of accidents. It should be used exclusively for the tasks described in this user manual.

All faults on the instruments which impair the safety of the user or third persons must be remedied immediately.

PREMA accepts no liability for damage resulting from utilization of this instrument in any manner other than the intended manner described in the user manual. The user alone carries the risk and responsibility for any deviating utilization of the instrument.

Availability of the User Manual

The user manual must always be available at the place where this instrument is operated. The personnel entrusted with operation of this instrument must be familiar with all task procedures described in the user manual and with all safety instructions.
All warning and safety instructions attached to the instrument must be held complete and in clearly readable condition.
No modifications, attachments or conversions of the instruments are permitted without consent and approval by PREMA, otherwise the conformity becomes void.

2 Getting Started

2.1 Delivery

Every PREMA unit is thoroughly and carefully checked before it is shipped, to ensure that it is in flawless condition, and that its technical characteristics are within specifications.
Consequently, upon receipt, the unit should be in perfect condition, mechanically and electrically.

To make sure that the unit has not been damaged during transport, it should be thoroughly checked out immediately after receipt. If damage is detected, a damage claims form should be completed with the shipping carrier.

Please use the following list to assure that delivery is complete:

☞
1. Power Cable
2. User Manual, English
3. Calibration Certificate with Date and Signatures
4. Product Registration Card, which you should fill out and mail back to PREMA
5. Any optional equipment ordered

Please ensure also, that the unit is set up for the right AC Voltage, with the right type of fuse (see chapter "Connecting the Unit to Main Power").

Important: Do not throw the box and packaging materials away!
If the unit has to be sent back to the factory for recalibration or repair, only the original packaging materials will provide sufficient protection against damage.

2.2 Safety Guidelines

Also refer to the safety guidelines in the "Introduction" chapter, please.

The multimeter may only be operated if it is in perfect and safe condition. Accident prevention and environmental protection rules must also be followed.
All power-up and power-down procedures described next must be followed. Problems, such as loose connections, damaged or scorched cables, oxidized contacts, and damaged fuses must be immediately removed by a professional.
A safe and ecologically sound disposal of operating and support materials, as well as replacement parts, must be arranged. Only genuine replacement parts shall be used. Otherwise, the manufacturer's warranty and the instrument's conformity will be voided.

Any changes to the device, which cause any functional changes, may only be carried out by the manufacturer, or after discussion with and permission by the manufacturer.

Utilization

The device may only be utilized for the measurement functions that are described in the Technical Specifications. It is especially important to adhere to the load limits of the input connectors. PREMA accepts no responsibility for any damage arising from improper operation.

2.3 Safety Symbols

The signs and symbols on the multimeter, which provide guidelines for safety and handling, are displayed and described below.

This symbol advises the user of a possible danger area.
Please consult the manual (see “Connection of Measurement Leads” and Chapter “Operating Instructions”).

The CE mark means, that the manufacturer has issued an EC Declaration of Conformity for this instrument. This declaration certifies, that this instrument conforms to the pertinent requirements of EC directives.

2.4 Accident Prevention

While using this measurement unit, precautions to prevent an accident should be taken, appropriate to the use of a measurement device.

2.5 Connecting the Unit to Main Power

This PREMA measurement unit is designed to be connected to AC Main Voltage, at a frequency of 50 Hz or 60 Hz. The rear panel of the unit is equipped with a standard DIN grounded power connector.

Before connecting the unit to power, you should make sure that it is set to the right voltage (indicator and fuse).

The voltage selection switch with integrated fuse is located right under the power connector, where you can also read off the current voltage setting; a setting of "220V" represents an AC voltage from 220V to 240V, "110V" represents a voltage from 100V to 120V.

Switching the AC Voltage is done as follows:

☞
1. Unplug the unit.
2. The clamp for the fuse is located between the plug and the power selector and must be removed. For a setting of "110V" you will need a fuse rated at 0.4A; for "220V" you'll need a fuse rated at 0.2A.
3. Place the necessary fuse in the clamp and push the clamp back in.
4. Turn the cylinder with the voltage indicators once left or once right to the desired setting, so that the voltage that is currently set is indicated by the white arrow on top.
   The indicators are used as follows:

Setting	Voltage Range
110 V	90 V_{RMS} to 130 V_{RMS}
220 V	180 V_{RMS} to 265 $_{RMS}$

Table: Main Voltage Ranges

2.6 Grounding

In order to protect the user, the unit's case is grounded through the grounding lead of the power cable. To ensure proper grounding, the power cable should always be connected to a properly grounded power connector.
The unit case is galvanically separated from the measurement connectors and interface ports.

The back of the unit is equipped with a grounded screw, identified by the ⏚ symbol, where the user can connect a separate ground line (rack mounting bracket).

2.7 Warranty

PREMA warrants the reliable function of the unit for a period of two years from the date of delivery.
Repairs that need to be carried out during the warranty period are not billed to you.

Damage caused by inappropriate use of the unit, or by surpassing specified limits, does not fall under PREMA's warranty obligations.
Please be aware, also, that PREMA will not be held liable for damages, incidental or coincidental, associated with the use of this measurement device.

2.8 Certificate

Each Precision Thermometer 3040 is provided with a calibration certificate at the factory, certifying the location, date, and traceability of the unit's calibration to the user.
Please look for this certificate at delivery time. It can also be useful as a control for yearly recalibrations, since PREMA warrants that the unit will remain within specifications for one or two years, and recommends recalibration after that time.

2.9 Turning it on

The device can be switched on with the STANDBY KEY after connecting the power cable.
A device setting with sensor selection, measurement range and measurement time can be stored as a power-on setting in the "Main Menu, Settings, Save Settings".
Switch off the instrument also with the STANDBY KEY.

The 3040 is then in standby mode. The red LED at the bottom left of the front panel lights up.
The analog board of the unit is provided with power, even in standby mode, so that no warm-up time needs to be taken into account when the unit is turned on.
Otherwise, warm-up times, as provided in Chapter "Technical Specifications", should be heeded.

Note: The transformer is not disconnected from Mains Power in standby mode.

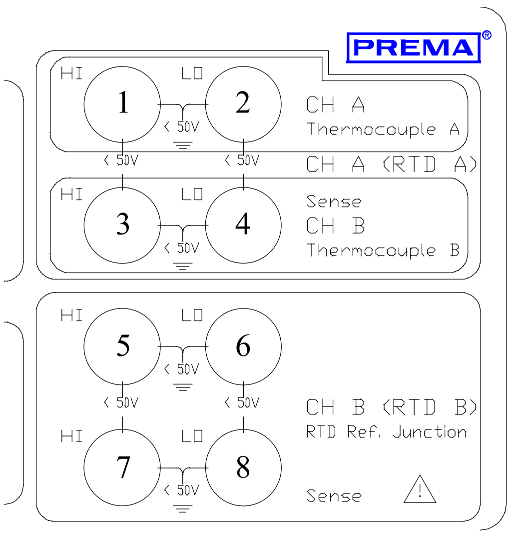
Please, do not disconnect the power cable before having pressed the STANDBY KEY.

2.10 Restart of the Instrument after Power-down

The instruments restarts automaitcally after an interruption of the mains power. This is important for the remote control that the instrument can be controlled from the computer after power-down of the mains voltage.

2.11 Connection of Measurement Leads

The measurement inputs on the front panel are implemented as safety connectors. PREMA strongly recommends the use of safety banana plugs with contact protection (see Appendix A, “Accessories, Safety Lead Set”).



Channel A, TC (Plug 1 and 2)

Channel A, RTD (Plug 1, 2, 3 and 4)

Channel B, TC (Plug 3 and 4)

Channel B, RTD (Plug 5, 6, 7 and 8)

Figure: Measurement Connectors

Connection of measurement leads should be carried out according to the following table.

Measurement	Hi	Lo
Thermcouple Channel A	1	2
Thermocouple Channel B	3	4
Platinum Sensor Channel A Source Sense	 1 3	 2 4
Platinum Sensor Channel B or Cold Junction for TC Source Sense	 5 7	 6 8

Table: Connection of the measurement cables

Two 50-pole Sub-D-connectors are available for rear panel connection. PREMA offers adaptercards (for platinum sensors) and an isothermal connection block (for thermocouples) to equip the rear panel connectors (see chapter „Accessories“).

The number of sensors that can be connected depend on the setting in the calibration menu (CAL-MODE-KEY) „6 No. of Sensors“. 8 platinum sensors and 16 thermocouples are set as standard. Please have a look into the chapter „Quickstart“ to change this settings.

2.12 Rack Mounting

A rack adapter with two height units is offered for the 3040. The unit has a width of one-half 19-inch, so it can be combined with another half-19-inch unit. More information about rack mounting can be found in the Chapter "Accessories."

When installing the unit into a 19-inch rack, you should take into account, that the ventilation openings in the back are not covered up. In addition, it should be possible to cut power to the unit in an emergency, through the use of an EMERGENCY OFF switch somewhere nearby.

3 Quick Start

3.1 Presettings

The following status exists after switching-on for the first time:

- Channel RA , front, measuring unit °C
- Sensor: Pt100, measuring current 3 kΩ/1mA (with TC Type J) for all channels
- True Ohm switched off, time 30s
- X-B switched off, time 30s
- Measurement readings memory off, N = 100 000
- Sequencer off, no channels activated, trigger delay time = 120ms, switch-on time = 1s, interval time = 5s
- Cal mode off, PIN=0000000, no customer calibration exists
- Integration time 1 s for all channels
- Fast automatic filter on
- Auto zero off, time 30s
- IEEE488 interface activated, address 07, RS232 off , no handshake
- Contrast 6
- Beeper off
- Cold junction, fixed value T = 0 °C, auto CJ off, time = 30s, channel front

The power-on status can be saved in the menu option „Settings, Save Settings“. The instrument can be set to a factory-programmed basic status with „Settings, Load Fact. Set“.

3.2 Measuring with Platinum Sensors

Connectable RTD sensors
Pt10, Pt25, Pt100, Pt500 and Pt1000 (4-wire circuit in all cases).
Keystroke sequence: "RTD" KEY (the display shows R for RTD), "SENSOR" KEY, ⇧⇩ KEYS, activate desired sensor with the "MENU IN" KEY, "MENU OUT" KEY.

Measuring currents
2.7 mA / 1 mA / 0.3 mA / 0.1 mA (differs depending on sensor type).
Keystroke sequence: "RTD" KEY (the display shows R for RTD), "SENSOR" KEY, ⇧⇩-KEYS until „*Ranges...*“, activate the desired range with the "MENU IN" KEY, "MENU OUT" KEY.

Integration times	Resolution
100 ms / 200 ms / 400 ms	0.01 °C / 0.01 °F / 10 mK
1 / 2 / 4 / 10 / 20 / 40 / 100 s	0.001 °C / 0.001 °F / 1 mK

Keystroke sequence: "TIME" KEY, select the desired integration time with the ⇧⇩ KEYS, terminate with the "MENU IN" KEY.

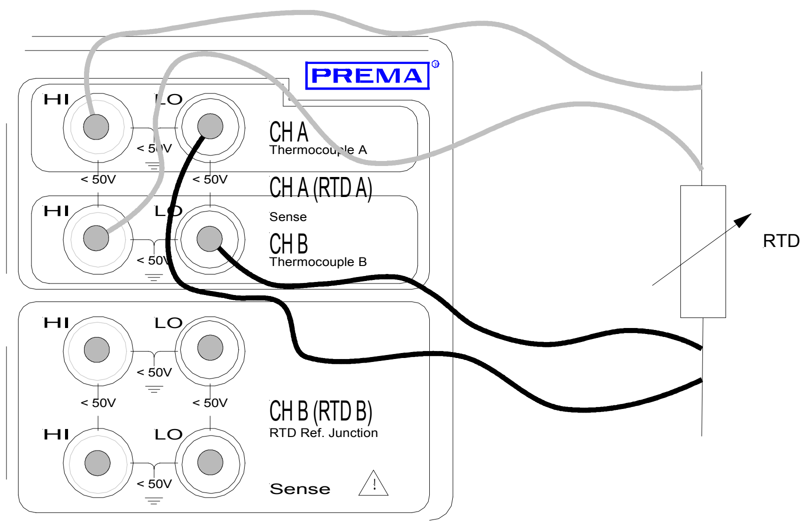


Fig. Measuring lead connections for platinum sensors

Further settings: True Ohm, X-B (in the sensor menu)
On the rear side of the instrument there are two 50-pole subminiature-D socket connectors for connecting the measuring cables. Adapter cards for making connections via screw terminals are available as accessory items. The pinout of the socket connectors is described in the "Technical Data" chapter.

3.3 Measuring with Thermocouples

Connectable thermocouples
Type J, K, T, E, R, S, B, L ,U, N
Keystroke sequence: "TC" KEY (the display shows T for TC), "SENSOR" KEY, ⇧⇩ KEYS, activate the desired sensor with the "MENU IN" KEY, "MENU OUT" KEY.

Cold junction compensation
For making a cold junction compensation, the terminal temperature of the thermocouples can be measured with a platinum sensor either at the front panel connection for channel B or at the rear connection for channel CJ, or a fixed value can be entered for the terminal temperature (see also "Accessories, isothermal block for thermocouples").
Keystroke sequence: "TC" KEY (the display shows T for TC), "MENU IN" KEY, ⇧⇩ KEYS until "Cold junction", make the desired settings with the "MENU IN" KEY and the ⇧⇩ KEYS.

Integration times	**Resolution**
100 ms / 200 ms / 400 ms	0.01 °C / 0.01 °F / 10 mK
1 / 2 / 4 / 10 / 20 / 40 / 100 s	0.001 °C / 0.001 °F / 1 mK

Keystroke sequence: "TIME" KEY, select the desired integration time with the ⇧⇩ KEYS, terminate with the "MENU IN" KEY.

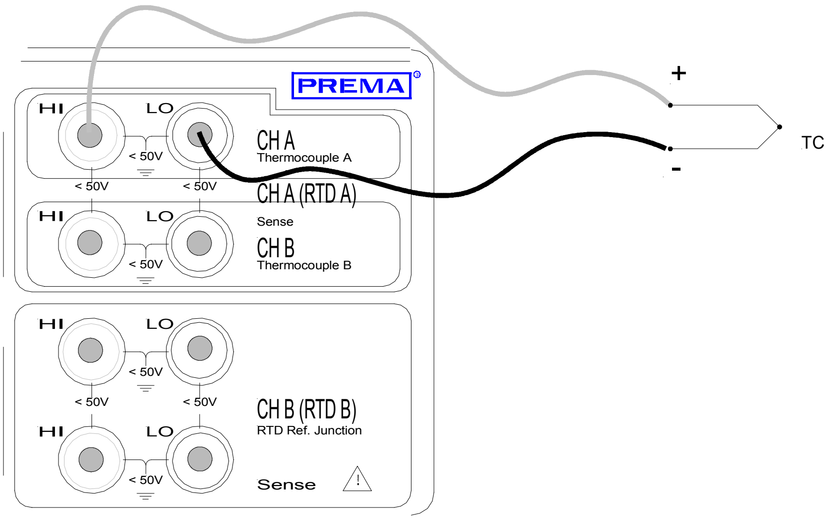


Fig. Measuring lead connections for thermocouples on channel A

Further settings: X-B (in the sensor menu)

Two 50-pole subminiature-D socket connectors for connecting the measuring cables are located on the rear of the instrument. An isothermal connecting block is available as accessory item for making connections with screw terminals. The pinout of the socket connectors is described in the "Technical Data" chapter.

3.4 Measuring Resistances

Keystroke sequence: "RTD" KEY, "TEMPΩ, mV" KEY (the measuring unit in the display is Ω).

Measuring ranges:

100 Ω/1mA	300 Ω/2.7mA	400 Ω/0.1mA	400 Ω/0.3mA
1kΩ/0.3mA	1kΩ/2.7mA	3kΩ/0.1mA	3kΩ/1mA
10kΩ/0.3mA	30kΩ/0.1mA (depending on selected sensor)		

Keystroke sequence: "RTD" KEY (the display shows R for RTD RTD), "SENSOR" KEY, ⇧⇩ KEYS until „*Ranges...*“, activate the desired measuring range with the "MENU IN" KEY, "MENU OUT" KEY.

Integration times	**Resolution**
20 ms / 40 ms / 100 ms	1 mΩ (5½ digits)
200 ms / 400 ms / 1 s	100 µΩ (6½ digits)
2 / 4 / 10 / 20 / 40 / 100 s	10 µΩ (7½ digits)

Keystroke sequence: "TIME" KEY, select the desired integration time with the ⇧⇩ KEYS, terminate with the "MENU IN" KEY.

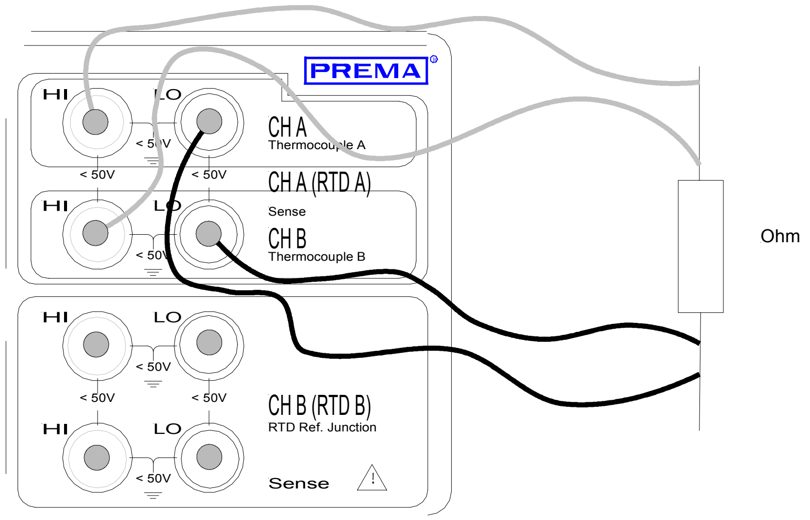


Fig. Measuring cable connections for platinum sensors

Further settings: True Ohm (in the sensor menu)

On the rear of the instrument there are two 50-pole subminiature-D socket connectors for connecting the measuring cables. Adapter cards for screw terminal connections are available as accessory items. The pinout of the socket connectors is described in the "Technical Data" chapter.

3.5 Measuring Direct Voltages

Keystroke sequence: "TC" KEY, "TEMPΩ/mV" KEY (The measuring unit in the display is V (Volt)).

Measuring range: ± 300 mV

Integration times	**Resolution**
20 ms / 40 ms / 100 ms	1 µV (5½-digit)
200 ms / 400 ms / 1 s	100 nV (6½-digit)
2 / 4 / 10 / 20 / 40 / 100 s	10 nV (7½-digit)

Keystroke sequence: "TIME" KEY, select the desired integration time with the ⇧⇩ KEYS, terminate with the "MENU IN" KEY.

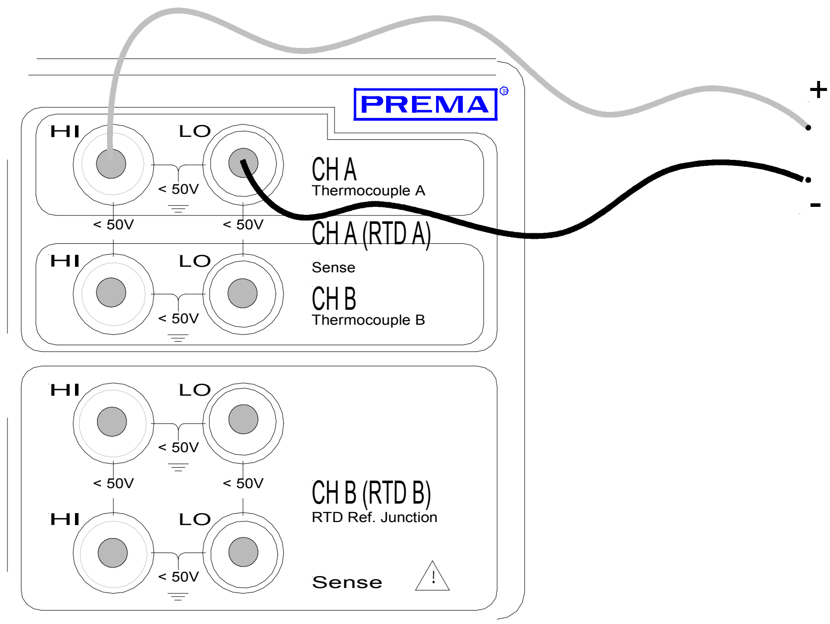


Fig. Measuring cable connections for voltage measurements on channel A

Further settings

There are two 50-pole subminiature-D socket connectors on the rear of the instrument for connecting the measuring cables. Adapter cards are available as accessory items for making connections via screw terminals. The pinout of the socket connectors is described in the "Technical Data" chapter.

3.6 Channel Selection

Channel A is active after the first power switch-on. Channel B can be activated by pressing the ⇩ KEY. In the display you see "RB" or "TB" in the last three digits.

If you want to switch the rear channels please press the FRONT-REAR KEY . In the display appears the channel no. "R01" or "T01".

The channels of the scanner can be selected as follows:

1st possibility

Keypress	Display / Action
⇧ KEY	Increments the channel number by one.
⇩ KEY	Decrements the channel number by one.

Table: Channel selection with the cursor keys

2nd possibility

Keypress	Display / Action
CHAN	25.439°C R░4 Permits entry of a channel number at the position marked by the cursor, using the numerical keys in the function field.
⇧ KEY	Cursor move to the left (tens digit)
⇩ KEY	Cursor move to the right (units digit)
MENU IN KEY	Terminates the entry and switches the selected channel to the active state.

Table: Channel selection by direct numerical entry

Sensor, measuring time, sensor calibration and various other settings are stored for each channel and thus remain valid even after switchover.

3.7 Switching and Storing Channels automatically

Proceed as follows for automatic channel switching and storing the respective measurement readings in memory:

1. Select the desired channel and make the settings (sensor type, integration time...).
2. "SEQ MODE" KEY, set „Channel active" with the "MENU IN" KEY, terminate with the "MENU OUT" KEY.
3. Repeat steps 1 and 2 until all desired channels have been activated.
4. Set the interval time (this is the time for one cycle of sequential switching of all activated channels) with the "SEQ MODE" KEY, ⇩ KEY until „Interval time" and set the time with the "MENU IN" KEY and the ⇧⇩ KEYS, terminate with the "MENU OUT" KEY.
5. Press the "RUN-STOP" KEY to start the automatic sequence channel switching.
6. Press the "STORE" KEY to write the measurement readings into memory.

The trigger delay time and the channel switch-on duration can be set too in step 2.

3.8 Specifying the Number of Sensors

The number of **connectable thermocouples and platinum sensors** can be specified in the calibration menu (CAL MODE KEY) „6 No. of Sensors“. The standard setting is 8 platinum sensors and 16 thermocouples. Proceed as follows to change these values:

	Keypress	Display / Action
1.	Press the "Cal" key on the rear of the instrument.	PIN:0000000 Enter the PIN number (0000000 in the state as delivered from the factory). After entering the correct PIN number, the display alternatingly shows "CAL" and the measurement reading.
2.	CAL MODE KEY	6 No. of Sensors. If this display does not appear, press the ⇧⇩ KEYS until it does appear.
3.	MENU-IN KEY	1 No.RTD 01 Enter the number of channels for platinum sensors.
4.	⇩ KEY	2 No.TC 16 Enter the number of channels for thermocouples
5.	MENU-IN KEY	2βNo.TC 16 Setting the number of channels with the cursor keys
6.	⇧ KEY	Increases the number of channels by one.
7.	⇩ KEY	Decreases the number of channels by one.
8.	MENU IN KEY	Numerical entry of the number of channels.
9.	MENU IN KEY	takes over the entry
10.	MENU OUT KEY	Goes one menu level higher.
11.	3 X ⇧ KEY	3 Store Cal. This, followed by pressing the "MENU IN" KEY , stores the calibration result permanently
12.	Press the "Cal" key on the rear of the instrument	This terminates the calibration procedure.

Up to 16 platinum sensors or up to 32 thermocouples can be set. Altogether 64 poles are available, of which each thermocouple occupies 2 and each platinum sensor occupies 4.

The front plugs (two channels each) are also connected to the rear Sub-D connectors with the corresponding PINs. So 18 RTDs or 34 TCs can be connected to the rear side of the instrument. Please see the corresponding PIN No. in the list in chapter "Technical Specifications".

4 Manual Operation

4.1 Keyboard

The user-friendly design of the front panel permits quick efficient working with this instrument. The keyboard provides quick access to the important device functions such as switchover to the basic measuring units, saving measurement readings or starting the sequencer. Complicated settings are easily possible too with the cursor and menu control functions.

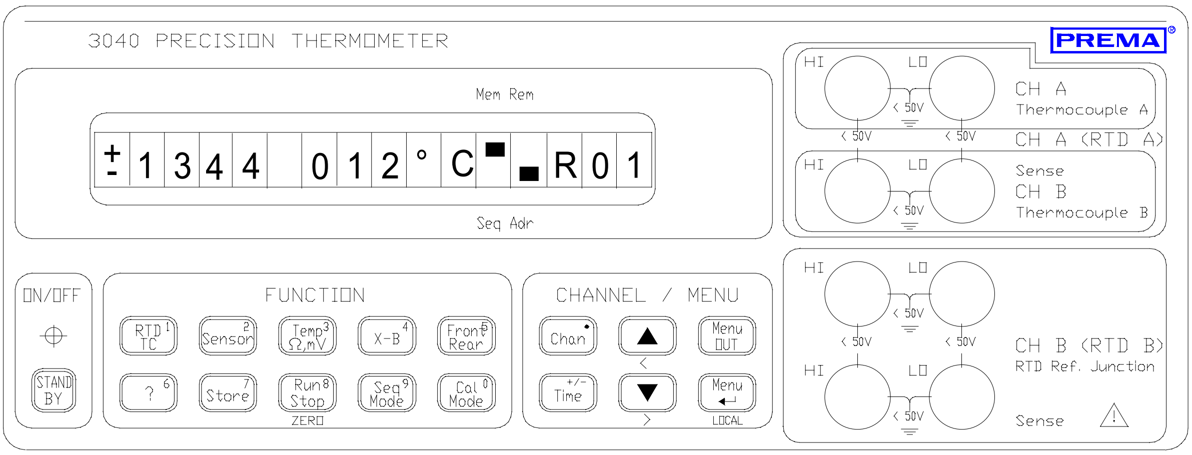


Fig. Front view of the 3040

The legend which is present under some keys refers to a functional meaning which is activated only in certain operating states.
Some keys also have a numerical second assignment in addition to their primary functional assignment. This second assignment is activated when numerical entries are expected, for example to enter the constant or during calibration.

The Function Field

KEY	Key Function
STANDBY	Switches the processor section of the instrument on and off. In standby status the analog electronic circuitry is still powered, so that the instrument is sooner ready with full accuracy after switching-on again.
RTD / TC	Switchover from RTD to TC or conversely (numerical: 1)
Sensor	Open/closes the menu for sensor setting (numerical: 2)
Temp / Ω, mV	Switch-over from temperature to the basic unit or conversely (numerical: 3)
X - B	Difference measurement between Channel X and Channel B (numerical: 4)
Front / Rear	Switchover between front and rear channel sockets (numerical: 5)
?	Status display of sensor settings with cursor keys (numerical: 6)
Store	Start / Stop of storing (saving) (numerical: 7)
Run / Stop	Start / Stop of the sequencer (numerical: 8)
Seq Mode	Open/closes the menu for sequencer setting (numerical 9)
Cal Mode	Open/closes the menu for calibration and sensor linearisation (numerical: 0)

Table: Keys in the Function Field

The Channel / Menu Field

Key	Function
CHAN	Selection of a measuring channel with the numerical keys (function field) (numerical: dot)
TIME	In conjunction with the cursor keys it is possible to change the measuring time and thus the resolution (numerical: "+/-").
⇧	Switches to the next higher channel. The cursor keys control the entry within the operator control menu. The character to the left of the cursor is selected for making numerical entries.
⇩	Switches to the next lower channel: The cursor keys control the entry within the operator control menu. The character to the right of the cursor is selected for making numerical entries.
Menu OUT	Switches back by one menu level.
Menu IN ↵	activates menu control, Enter to confirm, or goes one menu level deeper.
LOCAL (Menu IN ↵)	When in remote control status, pressing this key switches the instrument back to local mode.

Table: Keys in the Channel / Menu Field

4.2 The Display Field

The alphanumeric liquid crystal display (LCD) shows the measurement reading, the measuring unit, the currently active channel and the sensor type (RTD or TC).

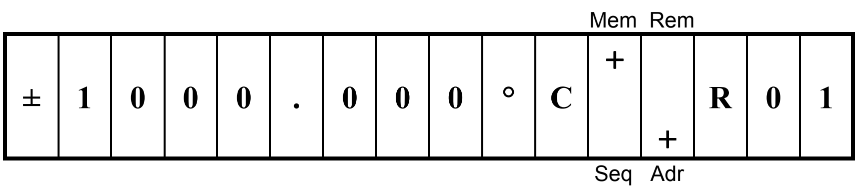


Fig. The Display of the 3040

Display Elements

The display elements have the following meaning:

											Mem	Rem			
											+				
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
												+			
											Seq	Adr			

Fig. Numbers of the display elements

1 to 9 — For displaying the 5½- to 7½ digit measurement reading together with the sign or error messages.

10 to 11 — Display of the measuring unit (°C, °F, K or V, Ω or kΩ)

12	Mem	Memory switched-on (storing of measurement readings is running).
	Seq	The sequencer is switched-on.
13	Rem	Fo remote control ON.
	Adr	For operating the instrument as talker or listener.
14	T	Thermocouple selected.
	R	Resistance thermometer sensor selected.
15 to 16	A	Front channel A
	B	Front channel B
	AB	X-B activated with channel A
	01 to 32	channel 01 to 32
	AZ	Auto-zero channel
14 to 16	CJ	Cold junction channel
	D01 to D32	X-B activated with channel 01 to 32

The chapter headed "Quick Start" contains further information concerning the display.

4.3 Measuring Inputs

For connecting the sensors, the 3040 is equipped on the front panel with low thermoelectric emf safety sockets for banana plugs. Two 50-pole subminiature D plug connectors are located on the rear. The adapter card or the isothermal block can bee connected here (see also the chapter headed "Accessories").

Connecting the Measuring Cables

The sensor should always be connected such that the measuring lead closest to ground potential is connected to the black input socket (LO) and the measuring lead with the higher potential with respect to ground is connected to the red input socket (HI).

Please read the chapter "Quick start" for the instructions for connecting the measuring leads of the respective sensors.

The pinout of the measuring input connectors on the rear of the instrument is contained in the chapter "Technical Specifications".

Overload Limits of the Measuring Inputs

The stipulated overload limits must be observed when connecting the sensors. These limits are marked on the front panel in red legend adjacent to the respective functions. A maximum voltage of 50 Vpeak or 50V DC must not be exceeded at any measuring input.

4.4 The Rear Panel

The interface socket connectors for IEEE488 interface, for the RS232 interface and the trigger socket digital I/O are located on the rear of the instrument.
The voltage selector switch in the black block at the top right is provided for setting the instrument to the available mains input voltage. The fuse and the socket connector for the mains cable are located adjacent thereto (see also the chapter "Getting Started").

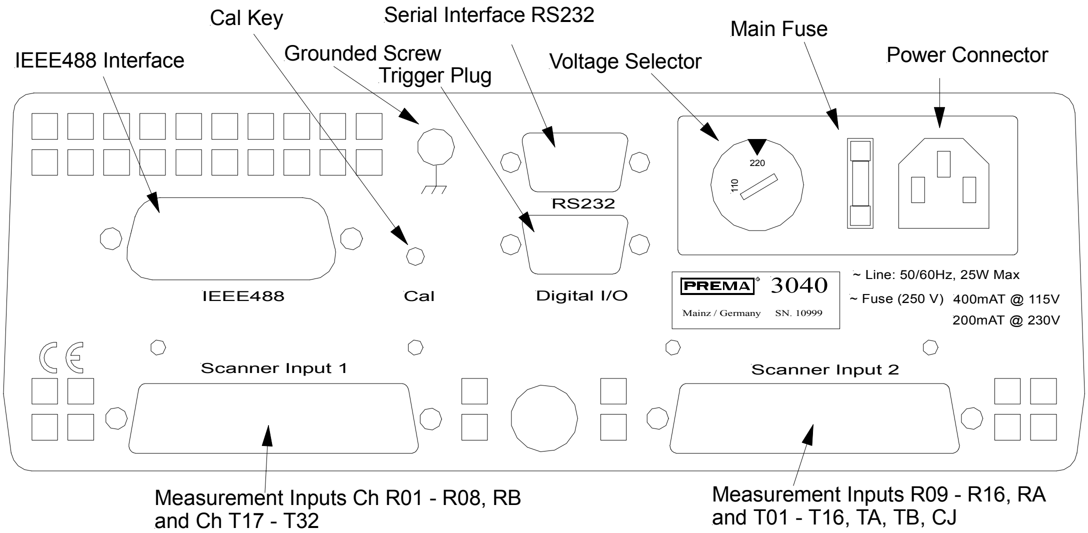


Fig.: Rear panel of the 3040

4.5 Navigating in the Menu Structure

Four different keys are provided for menu selection:

Menu in key	For making general settings such as filter, auto-zero, temperature unit, memory, interface and time settings, etc. Main Menu.
Sensor key	For making sensor-specific settings such as sensor selection, measuring ranges, difference measurements and true Ohm measurements, Sensor Menu.
Seq Mode key	For making sequencer settings, Sequencer Menu.
Cal Mode key	For calibration and sensor linearisation, Calibration Menu.

Dots appear at the end of the line containing a menu option if a deeper level menu exists. Manual operation using the menu structure is as follows:

Keypress	Display / Action
MENU IN KEY SENSOR KEY SEQ MODE KEY CAL MODE KEY	Activates the settings menu. Activates the sensors menu. Activates the sensor menu. Activates the calibration menu.
⇧ KEY	Switches within a menu level to the previous menu option.
⇩ KEY	Switches within a menu level to the menu option lying beyond.
MENU IN KEY	Selects the desired menu option, goes one menu level deeper or activates an option in the final menu level.
MENU OUT KEY	Terminates the entry, takes over the settings made. Goes one menu level higher. Takeover of the former setting while making numerical entries.

Table: General menu control

The menu is structured as described below:

SENSOR (SENSOR KEY) 1)	**CALIBRATION (CAL KEY)**	**MAIN MENU (MENU-IN KEY)**	**SEQUENCER (SEQ KEY)**
For PRT active: 1 Pt10 2 Pt25 3* Pt100 4 Pt500 5 Pt1000 6 Ranges (depends on sen-sor) 400Ω/0.1mA, 400Ω/0.3mA 100Ω / 3 mA, 300Ω / 1mA 1kΩ / 0.3mA, 3kΩ / 0.1mA 1kΩ / 3mA, 3kΩ / 1mA 10kΩ/0.3mA, 30kΩ/0.1mA 7* True Ohm ... 1*True O. active 2 Time / s = xxxx 8* X - B ... 1*X - B active 2 Time / s = xxxx or for TC active 1 Type J 2 Type K 3 Type T 4 Type E 5 Type R 6 Type S 7 Type B 8 Type L 9 Type U A Type N B X - B 1* X - B active 2 Time / s = xxxx 1) all settings for selected channel only	1 Enter Values ... 1 Data Pairs [2] No. of pairs = T0= , X0=.... T5= , X5= 2 Polynomial [2] C0= C1= .. C5= 3 R0, A, B, C... [3] 1 Ro=, 2 A =, 3 B = 4 C = 2 Enter Limits [2] 1 Xmin = 2 Tmin = 3 Xmax = 4 Tmax = 2/3 Store Cal. 3/4 Load Cal. 4/5 Load Fact. Cal 5/6 No. of Sensors ... 1 No. RTDxx (max. 16) 2 No. TC xx (max. 32) 6/7 Cal Ranges ... 300mV 400Ω/0.1mA, 400Ω/0.3mA 300Ω / 1 mA, 100Ω / 3 mA 1kΩ / 0.3mA, 3kΩ / 0.1mA 3kΩ / 1mA, 1kΩ / 3mA 30kΩ/0.1mA, 10kΩ/0.3mA 1 MΩ (True Ohm) 2) for temperature and selected channel only 3) for temperature with RTD and selected channel only	1 Filter ... 1 Auto Filter 2*Fast Auto Filt 3 Avrg. Filter 2 Auto Zero 1*Auto Z. active 2 Time / s = xxxxx s 3 Temp. Unit ... 1 * °C 2 °F 3 K 4 Memory ... 1 N = 100 000 2 Recall ... 1 Ch No. xx 2 Rd No. xxxxxx 3 Date 1970 01 01 4 T 00:00:00.000 (time) M 1303.723°C R01 (reading) 5 Interface ... 1*IEEE488... 1 Address 2*RS233 ... 1 Xon/Xoff 2*RTS / CTS 3 no Handshake 6 Contrast: N 7* Beeper 8 Settings ... 1 Save Settings 2 Load Fact. Set 3 Copy Channel 4 Paste Channel 9 Set Date&Time 1 Year = 1998 4 Hour = 09 2 Month = 09 5 Minutes = 17 3 Day = 17 6 Seconds= 00 A*Cold Junction (only for TC) 1 Auto CJ 1* Auto CJ active 2 Time / s = xxxx 3 * Front 4 Rear 2 Fixed value.. T/°C=+0000.000	1*Channel Active [4] 2 Trigger Delay Time [4] 1 Time / ms = xxxxxx 3 Switch-on Time [4] 1 Time / ms = xxxxxx 4 Interval Time Time / s = xxxxxxx 4) for selected channel only

Table: The Menus

4.6 Setting Informations with the ? Key

Most settings of the instrument can be requested with pressing the ? key on the front panel. You can scroll with cursor keys until the desired information appears.
A repeated press of the ? key brings again the measurement display.

The following information can be displayed:

- Sensor type
- Measurement range / current
- Integration time
- Channel no.
- True Ohm on / off (not for thermocouples)
- measured thermal voltage (EMF) with True-Ohm on (not for thermocouples or True Ohm off)
- Auto Zero on / off
- Filter on / off
- X - B on / off
- last value of channel RB or TB (not for X - B off)
- last value of the Cold Junction on Channel RB or CJ (not for RTD)
- elapsing intervall time for switched-on sequencer (not for Seq off)
- Date and Time

4.7 Setting of the Sensors

First select the desired kind of sensor with the RTD / TC key (RTD for platinum resistance sensors or TC for thermocouples). Then press the sensor key and set the desired sensor type (e.g. Pt100 or type J) in the menu.

	Keypress	Display / Action
1.	RTD-TC KEY	0.003°C RA if TA or T01 is displayed TC is active, if RA or R01 is displayed RTD sensor is active, this key toggles between RTD and TC
2.	SENSOR KEY	3*Pt100 Select the desired sensor with the ⇧⇩ KEYS.
3.	MENU IN KEY	5*Pt1000 Activates the selected sensor.
4.	MENU OUT KEY	Takes over the entry and then returns to measurement reading display more.

Table: Setting the Sensor

4.8 Setting the Measuring Current for Platinum Sensors

A selection between various measuring ranges and measuring currents for platinum sensors can be made on the 3040. Proceed as follows to change the measuring range:

	Keypress	Display / Action
1.	SENSOR KEY	7 Ranges... If this display does not appear, press the ⇧⇩-KEYS until it does appear (if necessary, first press the RTD/TC key).
2.	MENU IN KEY	4*3kΩ/1mA Select the desired measuring range with the ⇧⇩ KEYS.
3.	MENU IN KEY	Activates the selected measuring range.
4.	MENU OUT KEY	Takes over the entry and then returns to measurement reading display mode.

Table: Setting the measuring current

The following table gives an overview of the measuring ranges which can be set:

Range	Measuring Current	Sensor Type
400 Ω	0.1 mA	Pt10, Pt25, Pt100
400 Ω	0.27 mA	Pt10, Pt25, Pt100
300 Ω	1 mA	Pt10, Pt25, Pt100*)
100 Ω	2.7 mA	Pt10, Pt25
3 kΩ	0.1 mA	Pt500, Pt1000*)
1 kΩ	0.27 mA	Pt500, Pt1000
3 kΩ	1 mA	Pt100, Pt500, Pt1000*)
1 kΩ	2.7 mA	Pt100, Pt500**)
30 kΩ	0.1 mA	Pt1000
10 kΩ	0.27 mA	Pt1000

*) up to 560 °C　　**) up to 330 °C

Table: Possible ranges for RTDs

4.9 Selecting True Ohm Function

The True Ohm function can be selected for platinum sensors and for resistance measurements. This function eliminates disturbing thermoelectric emf's on the measuring leads. For this purpose switchover is made to the 1 MΩ resistance measuring range. The difference between the resistance value found there and the value measured normally is used to calculate and eliminate thermoelectric emf's.

An additional switching operation is necessary for the true Ohm measurement, therefore the adjustable repetition period should not be chosen too short. A value of 30 seconds is recommended, because thermoelectric emf's usually follow the time characteristic of the ambient temperature so that fast changes are hardly ever encountered.

RTD must be activated before True Ohm can be switched on.

	Keypress	Display / Action
1.	SENSOR KEY	`7 True Ohm ...` If this display does not appear, press the ⇧⇩ KEYS until it does appear (if necessary, first press the RTD/TC key).
2.	MENU IN KEY	`1*True O. active` If this display does not appear. press the ⇧ KEY until it does appear.
3.	MENU IN KEY	`1*True O. active` Activates the true Ohm measuring mode.
4.	⇩ KEY	`2 Time/s = 0030` Press the Enter key. The time after which the true Ohm reading is taken can then be set. Terminate the entry by pressing Enter again.
5.	MENU OUT KEY	Takes over the entry and then goes one menu level higher. Press again until measurement reading display mode reappears.

Table: Selecting True-Ohm Function

The accuracy of the measurement can be getting worse with switched-on True-Ohm because of additional channel switching. The accuracy is getting better only if real thermoelectric emfs are generated on the cables or connectors that can be eliminated by the True-Ohm function.
The measurement time for the True-Ohm function is two times higher than the measurement time of the actual channel.

4.10 Setting of X-B

The function X-B is used to determine the difference with respect to the measurement reading in channel B. For this purpose switchover to channel B takes place at regular intervals (can be defined). The measurement reading obtained there is subtracted from the actual reading in channel X and the resulting difference is displayed.

If thermocouples are activated, channel B is measured on TB. otherwise on RB (RTD). It is therefore important to activate the right kind of sensor before switching to X-B. It is also possible to switch X-B on and off by pressing the X-B KEY.

	Keypress	Display / Action
1.	SENSOR KEY	`9 X - B ...` If this display does not appear. press the ⇧⇩ KEYS until it does appear (id necessary, first press the RTD/TC key).
2.	MENU IN KEY	`1*X - B active` If this display does not appear, press the ⇧ KEY until it does appear.
4.	MENU IN KEY	`1*X - B active` activates the X-B measurement.
5.	⇩ KEY	`2 Time/s = 0030` After pressing the Enter key, the time after which the X-B reading is taken can be set. Press Enter again to terminate.
6.	MENU OUT KEY	Takes over the entry and then goes one menu level higher. Press again until the measurement reading display mode is reached.

Table: Setting X - B Function

4.11 Configure Alarm Outputs

Different upper and lower limits can be set for each channel. An output at the digital I/O interface is activated when the measurement value passes this limits.
Please first select the desired channel where the alarm outputs have to be configured and then proceed as follows:

	Keypress	Display / Action
1.	SENSOR KEY	`A Alarm Hi - Lo.` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
2.	MENU-IN KEY	`1 Alarm active` Acitvating the alarm outputs
3.	MENU-IN KEY	`1*Alarm active` Alarm outputs are ctivated
4.	⇩ KEY	`2 Alarm Hi ...` Entry of the upper limit
5.	MENU-IN KEY	`x/°C= +0000.000` upper limit in °C
6.	MENU IN KEY	`x/°C= +0000.00░` Editing the upper limit, blue description on or under the keys is active now
7.	MENU-IN KEY	Confirm the entry or quit without changing with the MENU-OUT KEY
8.	MENU-OUT KEY	Goes one menu level higher. Press again until the measurement reading display mode is reached.

Please see chapter "Technical Specifications, Trigger Interface" for the PINs.
Crossing the Hi-limit is marked with a ">" sign and crossing the Lo limit is marked by a "<" sign in the adress/remote field in the display. Is the reading within the limits no sign is marked.

											Mem	Rem			
±	1	0	0	0	.	0	0	0	°	C		>	R	0	1
											Seq	Adr			

4.12 Setting the Cold Junction Compensation

Cold junction compensation is usually necessary when connecting thermocouples. This means that the terminal temperature of the sensors is measured ("Auto CJ") and an amount corresponding to the terminals temperature is added to the measured thermo voltage
When working with an ice bath or a reference point thermostat, a fixed value can be specified. See the chapter "Operating Instructions" for further details.

Activating the Automatic Cold Junction Compensation

	Keypress	Display / Action
1.	MENU IN KEY	`9 Cold Junction.` If this display does not appear, press the ⇧⇩ KEYS until it does appear (if necessary, first press the RTD/TC key).
2.	MENU IN KEY	`1 Auto CJ...` Selects automatic cold junction compensation.
3.	MENU IN KEY	`1 Auto CJ active` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
4.	MENU IN KEY	`1*Auto CJ active` Activates the automatic cold junction compensation.
5.	⇩ KEY	`2 Time/s = 0040` After pressing the Enter key, the time after which the measurement of the cold junction is made can be set. Press Enter again to terminate.
6.	⇩ KEY	`3*Front Ch B, RTD` The measurement of the connecting point is made at the front connection B (RTD) when this item is activated. Press Enter to activate.
7.	⇩ KEY	`4 Rear Ch CJ` The measurement of the connecting point is made at the CJ channel on the rear when this point is activated. Press Enter to activate.
8.	MENU OUT KEY	Takes over the entry and then goes one menu level higher. Press again until the measurement reading display mode is reached.

Table: Setting Cold Junction Compensation

Activating the Cold Junction Compensation with fixed Value

	Keypress	Display / Action
1.	MENU IN KEY	`9 Cold Junction.` If this display does not appear, press the ⇧⇩ KEYS until it does appear (if necessary, first press the RTD/TC key).
2.	MENU IN KEY	`2 Fixed Value...` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
3.	MENU IN KEY	`T/°C= +0000.000` After pressing the Enter key, the magnitude for the cold junction compensation can be entered with the numerical keys.
4.	MENU OUT KEY	Terminates the entry without taking over the numerical entry just made.
5.	MENU IN KEY	Takes over the entry and then goes to measurement reading display mode.

Table: Cold Junction Compensation with fixed value

Automatic cold junction compensation is switched-off when cold junction compensation with a fixed value is switched-on. The measurement reading of the connecting point is then taken-over into the fixed value if automatic cold junction compensation was activated previously.

4.13 Filter

The measurement readings can be passed through a digital filter to increase the interference suppression factor and to improve readability of the display. The filter function operates as gliding average filter taking the mean of the last ten readings.
After the first ten readings reaching the filter loop, each new further reading discards the oldest reading in the filter loop.
Three filters are available:

- Automatic averaging filter (Auto Filter)
- Fast automatic averaging filter (Fast Auto Filter)
- Moving average filter (Avrg. Filter)

Automatic Averaging Filter (Auto Filter)

The **automatic averaging filter function** generates the moving average over ten measurement readings, but also calculates the difference between the last two successive measurements readings and compares the result with a factory-set difference value (depending on the sensor and measuring time). The filter function is restarted if the difference exceeds the factory-set value.
The filter function is restarted for channel and measuring time switchover too.

Fast Automatic Averaging Filter (Fast Auto Filter)

The fast automatic averaging filter stabilises the first measurement reading after a switchover (e.g. channel or measuring rang e switching). This filter ensures a more accurate measurement result when working with the sequencer. In contrast to the automatic averaging filter, this fast filter requires no transient settle-down time.

Moving Average Filter (Avrg. Filter)

The **moving average filter** operates according to the principle described above and permits no signal-dependent modification of the filter loop.
The filter loop is restarted by a function, range or measuring time changeover switching operation or on start by pressing the FILTER KEY.
This kind of filter operation achieves additional disturbance suppression by a factor of 20 dB.

Selecting the Filter

	Keypress	Display / Action
1.	MENU IN KEY	1 Filter... If this display does not appear, press the ⇧ KEY until it does appear.
2.	MENU IN KEY	1*Auto Filter The MENU IN KEY activates/deactivates the automatic averaging filter.
3.	⇩ KEY	2*Fast Auto Filt The MENU IN KEY activates/deactivates the averaging filter.
4.	⇩ KEY	3*Avrg. Filter The MENU IN KEY activates/deactivates the averaging filter.
5.	MENU OUT KEY	Takes over the entry and then goes one menu level higher. Press again until the measurement reading display mode is reached.

Table: Filter selection

4.14 Auto Zero Function

The Auto Zero function is provided for stabilising the internal zero point of the instrument. One zero measurement per day is recommended (T/s = 68400), or more often if higher accuracy is demanded or the ambient temperature fluctuates.

	Keypress	Display / Action
1.	MENU IN KEY	`2 Auto Zero...` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
2.	MENU IN KEY	`1 Auto Z. active` If this display does not appear, press the ⇧ KEY until it does appear.
3.	MENU IN KEY	`1*Auto Z. active` Activates the auto zero function.
4.	⇩ KEY	`1 Time/s = 68400` Press the Enter key to set the time after which the zero measurement is made. Terminate the entry with Enter.
5.	MENU OUT KEY	Takes over the entry and then switches to one menu level higher. Press again until the measurement reading display mode is reached.

Table: Selecting Auto-Zero Function

If the Autozero function is switched on, the display shows RAZ or TAZ in the last three digits after elapsing of the repeating time that is entered. RAZ is displayed when RTD is active, TAZ is displayed when TC is active.
The Autozero measurements are not carried out when True-Ohm function is activated. The accuracy of the measurements can be decreased because additional switching is necessary.

The integration time for the autozero measurement is set to 1 s as standard, this can be changed.
Please switch with the FRONT-REAR-KEY to rear inputs and then proceed as follows:

	Tastendruck	Display / Aktion
1.	⇧KEY	000.0003 Ω RAZ If this display does not appear, press the ⇧ KEY until it does appear.
2.	TIME KEY	the channel RAZ and TAZ switch the measurement unit to an internal short circuit. This channels can be worked with like other channels, this means the integration time can be entered and is stored after switching to another channel.
3.	MENU-OUT KEY	Takes over the entry and the reading is displayed

Select with the cursor keys the desired channel.

If the sequencer is running, please set the interval time long enough, so that the Autozero measurements can be carried out.
Please be aware that for thermocouples as well as for each different range of RTDs (only as far as they are activated) one autozero measurement is performed.

4.15 Setting the Temperature Unit

The measuring unit for temperature can be set with this menu option. Possible settings are °Celsius (°C) , ° Fahrenheit (°F) or Kelvin (K).

	Keypress	Display / Action
1.	MENU IN KEY	3 Temp. Unit... If this display does not appear, press the ⇧⇩ KEYS until it does appear.
2.	MENU IN KEY	1*°C Pressing the MENU IN KEY again activates °C .
3.	⇩ KEY	2 °F Confirm (change of the measuring unit) with the MENU IN KEY.
4.	MENU OUT KEY	Takes over the entry and then goes one menu level higher. Press again until measurement reading display mode is reached.

Table: Setting the temperature unit

4.16 Memory

The 3040 has a large memory capacity for measurement readings in addition to which the channel number and the time of day are stored here. The data are retained even in the case of mains voltage failure.
The data memory can be used to store the measurement data of a single channel or of several channels (in conjunction with the sequencer). This provides you with a powerful measurement data administration system.

Starting the Memory

Press the STORE KEY to **Start** the memory.
The message "Overwrite?" then appears if the memory is not empty. Press the MENU IN KEY to overwrite the existing data. If you do not want to overwrite already stored data, press any other key. New data are then not stored.
The data in memory can be read-out under remote control via the RS232 or IEEE488 interface.
The MEM flag in the 12th segment indicates that the measurement readings memory is currently active. No functions can be switched-over while the memory function is running.
All keys except the ? KEY and the MENU IN KEY respond only with the message STOP Storage!".
Measurement readings can be read-out with the MENU IN KEY even while the measurement readings are being stored.

Terminating Storage of Measurement Readings

Storage of measurement readings is **terminated** either when the predefined number of measurement readings is reached or when the STORE KEY is pressed again. The message "STOP Storage!" appears. If you are sure you want to stop storing measurement readings to memory, confirm this intention by pressing the MENU IN KEY again, otherwise press any other key.

Start / Stop of the Memory via the Trigger Interface

The sequencer can be started by trigger pulse on the Digital I/O interface on the rear side of the isntrument independant of a manual operation on front panel. The sequencer stops with the next trigger pulse. Warnings and messages are not displayed when the memory is started or stopped by the trigger.

You find more information in the chapter "Technical Specification" concerning the trigger signal and the meaning of the pins on the digital I/O interface.

Setting the Number of Readings

Proceed as follows to set the number of measurement readings:

	Keypress	Display / Action
1.	MENU IN KEY	5 Memory... If this display does not appear, press the ⇧⇩ KEYS until it does appear.
2.	MENU IN KEY	1 N=000010 After pressing the Enter key, the number of measurement readings can be set. Press Enter again to terminate the entry.
3.	MENU OUT KEY	Takes over the entry and then goes one menu level higher. Press again until the measurement readings display mode is reached.

Table: Setting the number of readings to be stored

Recalling Measurement Values

To read-out the measurement values on the instrument, press the following keys:

1.	MENU IN KEY	5 Memory... If this display does not appear, press the ⇧⇩ KEYS until it appears.
2.	MENU IN KEY	2 Recall... If this display does not appear, press the ⇩ KEY until it does appear.
3.	MENU IN KEY	1 Ch No. R01 If this display does not appear, press the ⇧ KEY until it does appear. After pressing the MENU IN KEY the desired channel can be selected with the ⇩ KEY. Press the MENU IN KEY to terminate.
4.	⇩ KEY	2 Rd No. 0000002 After pressing the MENU IN KEY, a certain measurement reading number can be selected with the ⇩ KEY, or entered. Confirm with MENU IN and terminate with the MENU OUT KEY.
5.	⇩ KEY	3 Date1998 07 28 After pressing the MENU IN KEY a certain date can be selected with the ⇩ KEY. Confirm with MENU IN.
6.	⇩ KEY	4 T 16:12:54.120 After pressing the MENU IN KEY a certain time can be selected with the ⇩ KEY. Conform with MENU IN.
7.	⇩ KEY	M 24.928°C R01 Stored measurement reading with set channel, predefined measurement reading number and set data and time.
8.	MENU IN KEY	β 24.928 °C R01 Quick browsing of the measurement readings (⇧ KEY or. ⇩ KEY). The associated measurement reading number, date and time for the displayed measurement reading can be recalled under steps 4 to 6.
9.	MENU OUT KEY	Goes one menu level higher. Press again until the measurement readings display mode is reached.

Table: Recall measurement values

The assignment of the time values is no longer correct if an overflow takes place, because this message is written into memory much sooner than expiry of the measuring time. In such cases the sequencer can be used because it provides well defined times.

4.17 Setting the Remote Control Interface

The 3040 in standard version is equipped with a serial data communication interface RS232 and a parallel data communication interface IEEE488.
Which one of these two interfaces shall be active must be defined in the main menu.

Activating the IEEE488 Interface

Proceed as follows to activate the IEEE488 interface for remote control:

	Keypress	Display / Action
1.	MENU IN KEY	5 Interface.. If this display does not appear, press the ⇧⇩ KEYS until it does appear
2.	MENU IN KEY	1 IEEE488.. If this display does not appear, press the ⇧⇩ KEYS until it does appear. Pressing the MENU IN KEY activates the IEEE488 interface.
3.	MENU IN KEY	1 Address 14 Enter the device address. confirm with MENU IN and terminate with the MENU OUT KEY.
4.	MENU OUT KEY	Takes over the entry and then goes one menu level higher. Press again until the measurement reading display mode is reached.

Table: Activating the IEEE488 interface

Activating the RS232 Interface

Proceed as follows to activate the RS232 interface for remote control:

	Keypress	Display / Action
1.	MENU IN KEY	`5 Interface..` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
2.	MENU IN KEY	`2 RS232 ..` If this display does not appear, press the ⇧⇩ KEYS until it does appear. Press the MENU IN KEY to activate the RS232 interface.
3.	MENU IN KEY	`2*RTS/CTS` Select the desired handshake mode with the ⇧⇩ KEYS and activate it by pressing the MENU IN KEY.
4.	MENU OUT KEY	Takes over the entry and then goes one menu level higher. Press again until the measurement reading display mode is reached.

Table: Activating the RS232 interface

The possible handshake modes for the RS232 interface are:

- Xon / Xoff Software handshake
- RTS / CTS Hardware handshake
  This requires a special cable, e.g. accessory item No. 3017.
- no handshake

Error-free data transmission cannot be guaranteed when working without handshake.

The settings of the interface are saved when the instrument is switched-off with standby key, and they become active again after the next start-up of the instrument.

4.18 Adjusting the Display Contrast

The contrast of the display can be set depending on the position of the operator.

	Keypress	Display / Action
1.	MENU IN KEY	6 Contrast: 6 If this display does not appear, press the ⇧⇩ KEYS until it does ap-pear.
2.	MENU IN KEY	Entry mode is activated. Pressing the MENU IN KEY again enables direct numerical entry.
3.	⇧ KEY	Increases display contrast by one unit.
4.	⇩ KEY	Decreases display contrast by one unit.
5.	MENU OUT KEY	Takes over the entry and then goes to measurement reading display mode.

Table: Adjusting the display contrast

The display contrast can be adjusted in steps from 1 to 9.

4.19 Activating the Beeper

The beeper can be activated, if a beep with every keystroke is desired.

	Keypress	Display / Action
1.	MENU IN KEY	7 Beeper If this display does not appear, press the ⇧⇩ KEYS until it does appear.
2.	MENU IN KEY	7*Beeper The beeper is now active and sounds a tone in response to every keypress. Proceed in the same way to deactivate the loudspeaker again.
3.	MENU OUT KEY	Takes over the entry and then goes to the measurement reading display mode.

Table: Activating the beeper

4.20 Storing and Recalling Device Settings

With the main menu option „Settings“ it is possible to store a device configuration which is to be the power-on status, and factory settings can be loaded.

	Keypress	Display / Action
1.	MENU IN KEY	`8 Settings..` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
2.	MENU IN KEY	`1 Save Settings` Stores the current device configuration as power-on status when the MENU IN KEY is pressed.
3.	⇩ KEY	`2 Load Fact. Set` Loads the factory settings when the MENU IN KEY is pressed.
4.	⇩ KEY	`3 Copy Channel` copies the settings of the actual channel into the clipboard
5.	⇩ KEY	`4 Paste Channel` copies the settings from the clipboard into the actual channel

Table: Storing device settings and loading factory settings

To load the stored device configuration, switch the instrument off and on again.

Transfer of settings to another channel

You can transfer channel specific settings to another channel with the main menu options „Settings, Copy Channel“ and „Settings, Paste Channel“.

Most device settings are specific for every channel and are stored specific for every channel (s. also "Power-on status" furtheron). This are mainly the settings configured in the sensor menu and partly in the sequencer menu. If this settings are the same for more than two channels the functions "Copy channel" and "Paste channel" in the main menu can tranfer the settings from one channel to another. The sensor type (RTD or TC) of both channels has to be the same type.

Please proceed as follows to copy and paste the settings:

	Keypress	Display / Action
1.	⇧⇩ KEY	Select the desired channel, carry out all the settings that are to be transferred to another channel
2.	MENU-IN KEY	8 Settings.. If this display does not appear, press the ⇧⇩ KEYS until it does appear.
3.	MENU-IN KEY	3 Copy Channel If this display does not appear, press the ⇧⇩ KEYS until it does appear.
4.	MENU-IN KEY	-0.001°C R01 copies the settings into the clipboard and the measurement reading is displayed
5.	⇧⇩ KEY	select the channel where the settings shall be transferred
6.	MENU-IN KEY	8 Settings.. If this display does not appear, press the ⇧⇩ KEYS until it does appear.
7.	MENU-IN KEY	4 Paste Channel If this display does not appear, press the ⇧⇩ KEYS until it does appear.
8.	MENU-IN KEY	-0.001°C R02 copies the settings from the clipboard into this channel and the measurement reading is displayed again Please repeat step No. 5. to 8. if you want to copy the settings in the clipboard to another channel.

Table: Tranfer of settings to another channel

Transfer of sensor calibration to another channel

The Cal key on the rear side has to be pressed and the right PIN must be entered before a sensor calibration can be transferred from one channel to another.

In the display you see "Cal" and the measurement reading alternating. If the sensor types are not different the sensor calibration (f. e. "Cal Pt100") and the channel specific settings can be copied to another channel.

Please proceed as follows to transfer the sensor calibration to another channel:

	Keypress	Display / Action
1.	CAL KEY (ON THE REAR SIDE)	Please press the Cal key on the rear side of the instrument to copy a sensor calibration. The display shows alternatingly "CAL" and the measurement reading, if the PIN has been entered correctly (s. Chapter "Calibration")
2.	⇧⇩ KEY	select the channel with the sensor calibration that must be copied.
3.	MENU-IN KEY	`8 Settings..` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
4.	MENU-IN KEY	`3 Copy Channel` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
5.	MENU-IN KEY	`-0.001°C  R01` copies the calibration into the clipboard and the measurement reading is displayed again.
6.	⇧⇩ KEY	select the channel where the calibration must be copied to.
7.	MENU-IN KEY	`8 Settings..` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
8.	MENU-IN KEY	`4 Paste Channel` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
9.	MENU-IN KEY	`-0.001°C  R02` copies the calibration and settings from the clipboard into this channel and the measurement reading is displayed again. Please repeat step No. 6. to 9. if you want to copy the settings in the clipboard to another channel.
10.	CAL-MODE KEY	`3 Store Cal.` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
11.	MENU-IN KEY	`-0.001°C  R02` The calibration for all channels is stored now.
12.	CAL KEY (ON THE REAR SIDE)	Please enter the cal key on the rear side of the instrument to terminate the entry.

Table: Transfer the sensor calibration to other channels

4.21 Set Date and Time

Date and Time information are stored with every reading in the memory. Please be sure that date and time are set correctly before using the memory.
Date or time can be displayed with the Info key (? KEY) and the ⇩ KEY.

	Keypress	Display / Action
1.	MENU-IN KEY	`9 Set Date&Time..` If this display does not appear, press the ⇧⇩ KEYS until it does appear
2.	MENU-IN KEY	`1 Year = 1999` If this display does not appear, press the ⇧⇩ KEYS until it does appear
3.	MENU-IN KEY	`1 Year = 1999` enter the year with the numerical keys, terminate with the MENU-IN KEY
4.	⇩ KEY	`2 Month = 05` confirm with the MENU-IN KEY and enter the month with the numerical keys, terminate with the MENU-IN KEY
5.	⇩ KEY	`3 Day = 05` confirm with the MENU-IN KEY and enter the day with the numerical keys, terminate with the MENU-IN KEY
6.	⇩ KEY	`4 Hour = 09` confirm with the MENU-IN KEY and enter the hour with the numerical keys, terminate with the MENU-IN KEY
7.	⇩ KEY	`5 Minutes = 35` confirm with the MENU-IN KEY and enter the minutes with the numerical keys, terminate with the MENU-IN KEY
8.	⇩ KEY	`6 Seconds = 02` confirm with the MENU-IN KEY and enter the seconds with the numerical keys, terminate with the MENU-IN KEY
9.	MENU-OUT KEY	Goes one menu level higher. Press again until the measurement reading display mode is reached.

Table: Setting of Date and Time

4.22 Power-on Status

The following parameters are stored in the power-on status:

- Sensor and measuring range for each channel
- Measuring time (resolution) for each channel
- X-B, true Ohm for each channel
- Alarm settings for each channel
- Filter setting
- Auto-zero settings
- Temperature measuring unit
- Cold junction settings
- Sequencer setting for each channel
- Display contrast setting

The currently set device configuration can be stored as power-on status with the menu option "Settings, Save Settings".

4.23 Automatic Switchover with the Sequencer

With the 3040 it is possible to interrogate and store all channels without any need for a connected computer.
This is achieved with the built-in sequencer (SEQ MODE KEY) and the data memory described above in another section.

The sequences successively (sequentially) switches to the channels specifies by the operator. Since the specific channel settings are stored in the instrument, an individual action sequence can be programmed for each channel.

The following keys are important here:

Run / Stop	Starts and stops the sequencer.
Seq Mode	Calls the sequencer menu for the sequencer configuration.

Run / Stop the Sequencer via the Trigger Interface

The sequencer can be started by trigger pulse on the Digital I/O interface on the rear side of the isntrument independant of a manual operation on front panel. The sequencer stops with the next trigger pulse.

You find more information in the chapter "Technical Specification" concerning the trigger signal and the meaning of the pins on the digital I/O interface.

The Scan Diagram of the Sequencer

In the sequencer menu it is possible to activate a channel and then to enter the channel-specific times such as channel switch-on duration and the trigger delay time.
The following diagram shows the significance of these times schematically.

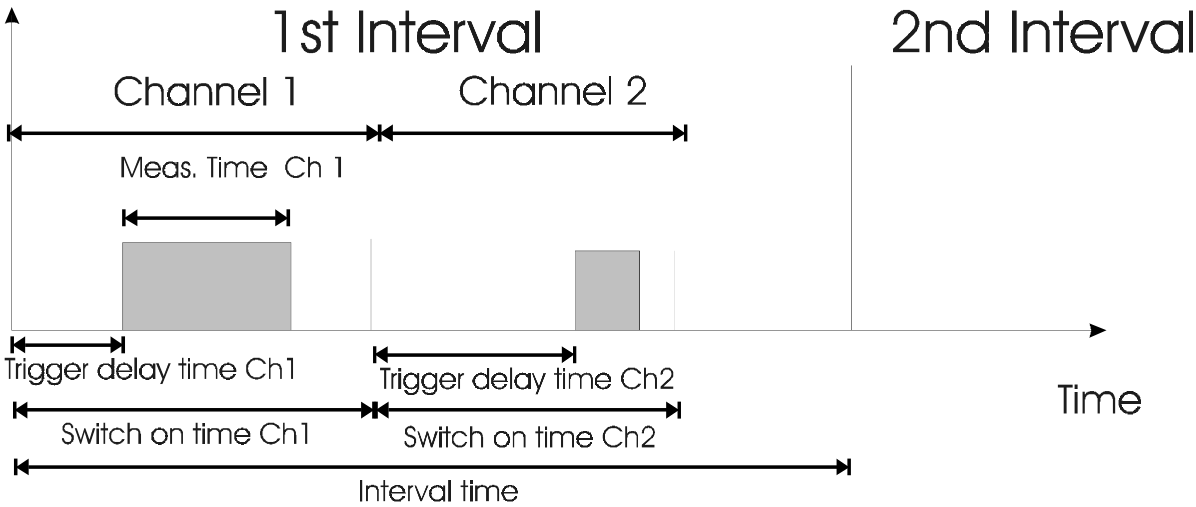


Fig. Scanning Diagram

All activated channels are switched-on successively. After the last channel has been switched, elapse of the interval time is awaited and then the sequencer starts over again.
The time for each one of these pauses is called the interval time. The time for which a channel is switched-on is called the channel switch-on duration. Furthermore, a third characteristic time, the trigger delay time, can be configured. This is the time delay between switch-on of a channel and start of the measurement in this channel. The measuring time is determined by the configured integration time constant (which can be set via the TIME KEY.

Furthermore, measurements are made in the interval pause for cold junction compensation, true Ohm, X-B and auto-zero. The interval time should be chosen to be somewhat longer than the total of the channel switch-on durations when one of these functions is activated.

The Sequencer Menu

Channel Active

Activates the selected channel.

Trg.Delay Time

the time elapse between switch-on of a channel and start of the actual measurement. (min. 0 ms, max. 099990 ms = approx. 100 s in 10ms steps)

Switch-on Time

The time for which a channel is switched-on.
The switch-on time consists of the trigger delay time, the integration time and a waiting time. The minimum switch-on duration is 300ms with the Fast Auto Filter switched on
(min. 300 ms, max. 999900 ms = approx. 16 min, 40 s in 100ms steps).
One measurement value per channel is stored if the memory is active.

Interval Time

The duration of a measuring interval: This is the time required for interrogating all activated channels, plus a waiting time until the activated channels are interrogated again. The interval time consists of the switch-on time of the activated channels and a waiting time (the time between interrogation of the last channel, a wait interval and interrogation of the first channel of the next cycle).

Attention: The interval time is not channel-specific. It must only be configured once and then applies for all channels. (min. 0 s, max. 9999999 s = more than 3 months in 1s steps).

Activating a Channel

The channel to be activated must be selected with the ⇩⇧ KEYS before calling the sequencer menu.

	Keypress	Display / Action
1.	SEQ MODE KEY	1 Channel Active If this display does not appear, press the ⇧ KEY until it does appear.
2.	MENU IN KEY	1*Channel Active The asterisk appears to show that the channel has been switched to the activated state.
3.	MENU OUT KEY	Takes over the entry and then goes to the measurement reading display mode.

Table: Activating a channel

Alternatively, the SEQ MODE KEY can be pressed again to exit from the menu.
All channels which have been activated in this manner are automatically scanned successively when the sequencer is started.

Setting the Trigger Delay Time

First select the desired channel, because the trigger delay time is specific for each channel.

	Keypress	Display / Action
1.	SEQ MODE KEY	2 Trg.Delay Time If this display does not appear, press the ⇧⇩ KEYS until it does appear.
2.	MENU IN KEY	1 Time/ms=000120 This is the standard setting.
3.	MENU IN KEY	This goes to Entry mode.
4.	⇧ KEY	This increases the time by 10 ms.
5.	⇩ KEY	This decreases the time by 10 ms.
6.	MENU IN KEY	Manual entry of the trigger delay time.
7.	MENU OUT KEY	This takes over the entry and then goes one menu level higher. Press again until the measurement reading display mode is reached.

Table: Setting the trigger delay time

Setting the Channel Switch-on Duration

Here too it is important to first of all select the channel for which the switch-on duration is to be configured, because this setting too is individual for each channel.

	Keypress	Display / Action
1.	SEQ MODE KEY	3 Switch-on Time If this display does not appear, press the ⇧⇩ KEYS until it does appear.
2.	MENU IN KEY	1 Time/ms=000600 This is the standard setting
3.	MENU IN KEY	This goes to Entry mode.
4.	⇧ KEY	This increases the time by 100 ms.
5.	⇩ KEY	This decreases the time by 100 ms.
6.	MENU IN KEY	Manual entry of the channel switch-on duration.
7.	MENU OUT KEY	Takes over the entry and then goes one menu level higher. Press again until the measurement reading display mode is reached.

Table: Setting the channel switch-on duration

Setting the Interval Time

The interval time is not channel-specific, therefore it can be configured with any arbitrary channel.

	Keypress	Display / Action
1.	SEQ MODE KEY	4 Interval Time If this display does not appear, press the ⇧ KEY until it does appear.
2.	MENU IN KEY	1 Time/s= 0000030 This is the standard setting.
3.	MENU IN KEY	This goes to Entry mode.
4.	⇧ KEY	This increases the interval time by 1 s.
5.	⇩ KEY	This decreases the interval time by 1 s.
6.	MENU IN KEY	Manual entry of the interval time value.
7.	MENU-OUTKEY	Takes over the entry and then goes one menu level higher. Press again until the measurement reading display mode is reached.

Table: Setting the interval time

Starting the Sequencer and Storing the Measurement Readings

To start the sequencer, press the RUN/STOP KEY.
The SEQ flag appears in the 12th segment to indicate that the sequencer is switched-on. The sequencer switches itself off if functions are switched-over while the sequencer is running.
If the measurement readings are to be recorded, press the STORE KEY after starting the sequencer, in order to start the memory for measurement readings.
Always **one** measurement reading per channel is stored in each cycle (duration of one interval time), even if the channel switch-on duration is longer than the measuring time.

Example:
It is required to measure the temperature of an engine in three different places at half-hourly intervals.
For this purpose the platinum sensors must be connected in four-wire configuration to the channels 01 to 03 on the rear of the instrument. The channels must then be configured successively:

1. Activate RTD (press the RTD-TC KEY)
2. Activate the rear connections (press the FRONT-REAR KEY)
3. Select the channel (e.g. channel R01) with the ⇧⇩ KEYS.
4. Select Pt100 in the sensor menu (SENSOR KEY).
5. Set the measuring time with the TIME KEY, e.g. 1s.
6. Press the SEQ MODE KEY to activate the channel (if necessary ⇧⇩ KEYS and MENU IN KEY for „1*Channel Active“.
7. Press the ⇩ KEY and the MENU IN KEY (switch-on time) twice in order to define the channel switch-on duration with the ⇧⇩ KEYS (e.g. 2s = 2000 ms) and terminate with the MENU OUT KEY. Repeat steps 3 to 7 for all further channels.
8. Press the ⇩ KEY and the MENU IN KEY (interval time) twice in order to define the interval time with the ⇧⇩ KEYS (e.g. 30min = 1800 s) and terminate with the MENU OUT KEY.
9. Press the RUN-STOP KEY to start the sequencer.
10. Press the STORE KEY To start the memory store function for measurement readings. Acknowledge the "Overwrite!" prompt message by pressing the MENU IN KEY.

If the settings for all channels are the same, you can transfer the settings from one channel to the other by using the Copy and Paste function in the main menu „Settings“.

4.24 Error Messages

Error Message	Meaning
Auto-Z.?	Auto-zero channel (RAZ or TAZ) cannot be measured (if necessary, make zero point measurement).
Br. wires	Open source line in 4-wire resistance measurement or RTD mode.
Cal. Error	Calibration error.
Check Sum Error	Wrong program or error in the instrument software (might possibly be curable by "Load Factory Settings" and then "Save Settings" in the main menu).
Clock not set	The internal clock has not been set.
Cold-J.?	Channel B RTD or channel CJ cannot be measured (no sensor connected or wrong sensor selected).
Error Scanner	Hardware fault! Get in touch with PREMA .
invalid PIN	Invalid PIN-No. for calibration.
no Cal. Mode	The "Cal key“ on the rear of the instrument has not been pressed for calibration.
Offset too high	Offset too large after pressing the zero key.
Overflow	Measuring range overflow.
Overwrite!	Measurement readings in memory will be overwritten when thereafter the MENU IN KEY is pressed.
Polarity?	Source or Sense are not connected with the right polarity.
Read. B?	Channel B RTD cannot be measured (no sensor connected, wrong sensor selected or menu setting incorrect).
reading too low	Measurement reading too small.
Sensor?	Sensor resistance under-/overshoots the defined range.
STOP Storage!	Storing is discontinued when the MENU IN KEY is pressed.
True-O.?	True Ohm measurement cannot be carried out (1MΩ range not calibrated or wrong offset).
value too high	entered value is too large.
value too low	entered value is too low.

5 Remote Control

This chapter describes operation of the 5017 via the IEEE-488 and RS232 interface in remotely controlled measuring systems.
This instrument supports both interface types: IEEE-488 and RS232

5.1 Configuration

Some manual configurations must be made to enable operation of the 5017 via one of the two interfaces IEEE-488 or RS232.
All necessary settings are made in the main menu „Interface“:

- Select interface (RS232, IEEE-488)
- Assign device address for IEEE-488
- Set handshake mode for RS232

Select Interface

Select the interface with which the instrument is to be controlled in the main menu „Interface“ (see chapter "Manual Operation").
The 3040 is equipped in the standard version with the two most common interfaces used in measuring systems, namely IEEE-488 and RS232.

Configuring the RS232 Interface

Transmission via the RS232 interface takes place with 8N1 format, i.e. a data word has 8 bits, no parity bit and one stop bit. The transmission speed is fixed at 9600 Bd.

Handshake Mode

The 3040 permits setting of various handshake modes so that this instrument can communicate with numerous RS232 control programs. Many programing languages and the Windows terminal program use XON/XOFF handshake. A special RS232 cable (zero modem cable, see chapter ‘Accessories’ No. 3017) is required for RTS/CTS handshake, but very fast and reliable data transmission is possible then.

Terminator Detection under RS232

The end of a transmitted or received message is designated with a line feed character "LF" in RS232 data transmission.

Configuring the IEEE-488 Interface

The device address and the terminator character of the messages (ASCII strings) are of importance for programing and data transmission in communication between the control computer and the 3040. The IEEE address can be assigned by the user, but the terminator is fixed and defined by the 488.2 standard.

Setting the IEEE-488, Device Address

The device address is set in the main menu "Interface, IEEE488" (see chapter "Manual Operation") and is saved in the power-on status, when switching of the instrument.
The device address set in the factory is 7.

Terminator Detection in the IEEE-488, Message Transmission

When operating with the IEEE488 interface, the standard string terminators are used for reception and transmission of messages (ASCII strings), namely "LF+EOI". "LF" stands for "Line Feed" and "EOI" designates an interface line which is set by hardware control.

5.2 General Information concerning Remote Control

All functions which can be manually controlled via the keyboard can also be remotely controlled, except for the device address assignment which can only be set via the keyboard.

The instrument understands up to 30 characters in a command. All characters are ASCII characters. Several commands can be combined in and executed from a single string of characters sent as one message (e.g. "X3R5T5"), but some commands must be sent as a single string. This are all commands with four letters such as SQA1, the calibration strings (NVxxxxxxxxx), ‘CNx’, ‘D1...’ and the ‘?-commands’.

Any space characters (SPACE, ASCII code 20H) contained in the character string sent by the computer are ignored.
The instrument can receive commands and it can also send device messages concerning its status. In this status the indication "ADR" appears in the display.

5.3 Special Features for the RS232 Interface

The 3040 is directly sending measurement values when opening the RS232 interface. If this is not wanted, the command ‘CN1’ can be send from the PC. Then the instrument sends only a measurement value, if ‘RD?’ comes from the PC.

5.4 Capabilities of the IEEE-488 Bus Interface

As soon as the instrument has received the first command via the interface, the keyboard is disabled for manual control of the instrument functions. Manual control via the keyboard is thereafter possible again after pressing the LOCAL-BUTTON.
In remote control mode the designator “Rem" is lit in the display.
The specific commands for controlling data transmission via the interface are contained in the manual for the utilized IEEE bus interface and some are specific to the programing language used.

The time when the instrument transmits messages can be defined by the computer. One possibility is for the computer to address the instrument as TALKER, and then read-out the device message. The second possibility is to operate the instrument in SRQ (service request) mode. It then requests service from the computer when a status change has taken place. Switchover to SRQ mode can be made with a command. The basic status of the instrument after power-up is without SRQ

The IEEE computer interface has the following capabilities defined by the IEEE-488 standard:

SH 1	Handshake source function
AH 1	Handshake sink function
T6	TALKER function
L3	LISTENER function
RL1	Remote control
DC1	Reset function
DT1	Initiate function
SR1	Service request function

General IEEE-488.1 Messages

The instrument understands the universal commands DCL, SPE and SPD. The command DCL (device clear) brings the instrument into its basic state (V dc, 300V). Of the addressed commands it understands GET, GTL, LLO and SDC.
The commands have the following effects:

DCL	Device Clear	Sets the instrument to the basic state
SDC	Selected Device Clear	Sets the instrument to the basic state
GTL	Go To Local	Terminates remote control status
LLO	Local Lock Out	The instrument cannot be switched to manual control via the local button (keyboard lockout)
SPE	Serial Poll Enable	Prepares for serial polling
SPD	Serial Poll Disable	Terminates serial polling
UNT	UnTalk	Addressing cancellation - is not displayed
UNL	UnListen	Addressing - is not displayed

PPC, PPU, TCT, GET not supported

5.5 RS232 / IEEE-488.2 Common Commands

In addition to the 488.1 commands, the 3040 also understands common commands according to the IEEE-488.2 standard that can be used with both interfaces RS232 and IEEE-488.

The common commands are transmitted to the 3040 as ASCII character string which must always start with an asterisk "*".

The following commands are implemented in the 3040:

*CLS	Clear Status Byte (command)
*ESE	Standard Event Status Enable (command)
*ESE?	Standard Event Status Enable (query)
*ESR?	Standard Event Status Register (query)
*IDN?	Identification (query)
*OPC	Operation Completed (command)
*OPC?	Operation Completed (query)
*RST	Reset (command)
*SRE	Service Request Enable (command)
*SRE?	Service Request Enable (query)
*STB?	Read Status Byte (query) *see description*
*TST?	Self Test (query)
*WAI	Wait To Continue (command)

*CLS, Clear Status Command

The command *"*CLS"* resets the status byte and the error queue. The Enable, Event, ESE and SRE registers are not reset.

*ESE Standard Event Status Enable Command

The command *"*ESE <Number> "* sets the contents of the Standard Event Enable Register (event register mask). The parameters thereby have no effect.

Number	Meaning for the Standard Event Enable Register
0	Resets the register
1	(Bit 1) Service Request
2	(Bit 0) Operation Completed (OPC) is set
4	(Bit 2) Query Error (QYE) is set
8	(Bit 3) Device Dependent Error (DDE) is set
16	(Bit 4) Execution Error (EXE) is set
32	(Bit 5) Command Error (CME) is set
64	(Bit 6) User Request (URQ) is set
128	(Bit 7) Power On (PON) is set

*ESE? Standard Event Status Enable Query

The command *"*ESE?"* reads out the mask set in the Standard Event Enable Register.
The reply is a decimal value whose binary meaning is as stated above.

*ESR? Standard Event Status Register Query

The command *"*ESR?"* reads the current contents of the Standard Event Status Register. The contents of this register are written directly by the instrument according to a certain event. After read-out this register is reset to 0.

*IDN? Identification Query

The command *"*IDN?"* queries the identification designation of the 3040. Read-out produces a character string with the following format:

"PREMA GmbH,3040 PRECISION THERMOMETER,0,<year>-<week>-<no.>"

with	<year>	=	Year of software version
	<week>	=	Week of software version
	<no.>	=	No. of software version

For example:
"PREMA GmbH, 3040 PRECISION THERMOMETER,0,97-10-01"

*OPC Operation Completed Command

The command *"*OPC"* sets the Operation Completed bit (Bit 0) of the Standard Event Status Register after all currently running command sequences have been executed completely.

*OPC? Operation Completed Query

The command *"*OPC?"* makes the instrument write an ASCII 1 into the output buffer if all currently running operations have been completed.

*RST Reset Command

The command *"*RST"* executes a reset of the 3040. The instrument thereby takes the default setting (*RST). All still running internal operations are aborted, but no registers are reset.

*SRE Service Request Enable Command

The command *"*SRE <Number>"* sets the mask for the Service Request Enable Register. The individual numbers here have the following meaning:

Decimal value	Contents of the Service Request Enable Register
0	Resets the register.
1	(Bit 0), sets measurement value
2	(Bit 1), sets Error message like "Overflow", "Sensor?"...
4	(Bit 2), sets Error Available (EAV)
16	(Bit 4), sets Message Available (MAV)
32	(Bit 5), sets Event Summary Bit (ESB)
128	(Bit 7), sets button pressed

Bit 3 and 6 are not assigned.

*SRE? Service Request Enable Query

The command *"*SRE?"* reads the contents of the Service Request Enable Register. The meaning of the contents of this register is as described above for the *SRE command.

*STB? Read Status Byte Query

The command *"*STB?"* reads out the status byte of the 3040. The value of the Status Byte is always 0, because the measurement value is set back after a new command. Use SRQ if you want to check when a maeasurement value is available.

Decimal value	Meaning in the status byte register
1	(Bit 0), Measurement Value available
2	(Bit 1), Error like "Overflow", "Sensor?", "Div/0" occured
4	(Bit 2), Error Queue.
16	(Bit 4), Message Queue.
32	(Bit 5), Event Summary Bit (ESB).
64	(Bit 6), Master Summary Status (MSS)/ Request Service (RQS)
128	(Bit 7), Button pressed

Bit 3 is not assigned.

To determine exactly what events have taken place, query the corresponding status registers. For example, if Bit 5 (ESB) is set, the cause can be determined with the command*"*ESR?"*.
For the IEEE488 interface, setting of Bit 6 activates the SRQ line so that the controller card in the computer can respond.

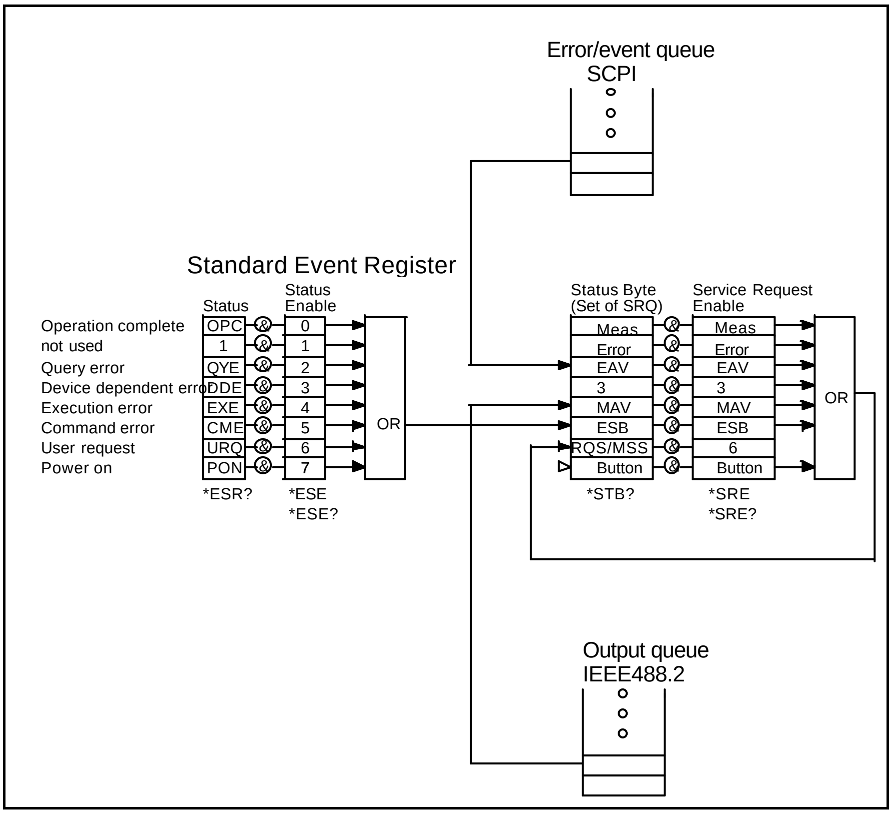
*TST?   Self Test Query

The command *"*TST?"* interrogates the result of the power-up self test of the instrument. The reply is *"0"* if the self test was completed without error. If any other value is obtained, please contact PREMA GmbH.

*WAI   Wait-to-Continue Command

The command *"*WAI"* prevents execution of further commands until the operations of a previous command have been completed.

5.6 Structure of the Registers



5.7 Instrument Commands

The instrument understands the following commands:

MR Measuring mode. The measurement reading is selected and appears in the display.

VD Direct Voltage, Basic unit for measuring thermocouples

O4 4-wire resistance, basic unit for measuring RTDs

Ux Basic unit on / off U1 = basic unit on U0 = basic unit off
query basic unit: U?

TC Temperature measurement in °Celsius
TF Temperature measurement in °Fahrenheit
TK Temperature measurment in Kelvin

UNIT? returns the unit of the reading, "VOLT", "OHM4", "DEGREE CELSIUS", "DEGREE FAHRENHEIT" or "KELVIN"

Xx Selection of the temperature sensor with

X1	Pt10	XE	Type E
X2	Pt25	XR	Type R
X3	Pt100	XS	Type S
X4	Pt500	XB	Type B
X5	Pt1000	XL	Type L
XJ	Type J	XU	Type U
XK	Type K	XN	Type N
XT	Type T	XC	User calibrated Sensor

Rx Range Selection with

R1	300mV(TC), 400 Ω, 0.1mA (Pt10, Pt25, Pt100)
R2	400Ω, 0.3 mA (Pt10, Pt25, Pt100)
R3	300Ω, 1 mA (Pt10, Pt25, *Pt100 to 60°C*)
R4	100 Ω, 3 mA (Pt10, Pt25)
R5	3kΩ, 0.1mA (Pt500, *Pt1000 to 560°C*)
R6	1kΩ, 0.3mA (*Pt500 to 330°C*)
R7	3kΩ, 1mA (Pt100, Pt500, *Pt1000 to 60°C*)
R8	1kΩ, 3mA (Pt100, *Pt500 to 330°C*, Pt1000)
R9	30 kΩ, 0.1mA (Pt1000)
RA	10 kΩ, 0.3mA (Pt1000)
RB	1 MΩ, 1 µA (True Ohm)

Tx Integration- / Measurement time selection with

T0	20ms	T6	2 s
T1	40ms	T7	4 s
T2	100ms	T8	10 s
T3	200ms	T9	20 s
T4	400ms	TA	40 s
T5	1 s	TB	100 s

D0 (D/Zero) Display mode off

D1“text“ Display mode switch-on. A text sent after “D1“ is output to the display of the 3040. The internal display is switched off.
The text sent must be enclosed between quote characters.
The D1"text" string is used to fasten the multimeter

F0 (F/zero) switches off the additional filter.

F1 Switches on the average value filter (Avg. Filter).

F2 Switches on the automatic filter (Auto Filter).

F3 Switches on the fast automatic filter (Fast Auto Filter).

Q0 (Q/zero) switches off SRQ mode.

Q1 Switches on SRQ mode, please set the SRE Register (see *SRE command)

EQ? Read the Error-Queue

S0 (S/zero) start mode off, continuous sequence of measurements on

S1 Start mode on; every S1 command starts a measurement

S2 Start mode on, start with trigger line or trigger button

A reading is started after expiration of the periodical measurements like Auto Cold Junction, True Ohm, X - B or Auto Zero.
To avoid this the user can reactivate the periodical measurements before a trigger signal is expected.
Starting a measurement is not possible when the sequencer is active.

L0 (L/zero) short format; the instrument outputs only the first message unit (measurement data and text messages).

L1 Long format; the instrument outputs both message units (measurement data/text messages and programing data).

ZO (**Z**eppelin/**O**tto**)** Offset correction on
only possible in Cal mode for basic units (volt and resistance measurement) or when the auto zero channel (RAZ or TAZ) is active.

MxxY selects a channel
with xxT = 01 to 32 for thermocouples, rear inputs
with xxR = 01 to 16 for RTDs, rear inputs
AT or BT for front input with thermocouples
AR or BR for front inputs with RTDs
CJ for Cold Junction channel (rear input)
AZ for Auto Zero channel (rear input)

The kind of sensor (T=TC or R=RTD) has to be send with the channel number because some channel numbers are existing for both kinds the thermocouples and the resistance sensors.
For example, you have set the „Number of sensors“ in the Cal Menu to RTD = 8, then the number of TCs is 16. So Ch 1 to Ch 8 is existing as well as for RTDs and also for TCs.

Calibration (N)

Setting the number of sensors (NT)

NTxx Number of thermocouples with xx = 01 to 32
NRxx Number of RTDs with xx = 01 to 16
Query: NT?, NR?

NV“ppppppp“ Entry of the calibration PIN
Starts the calibration mode, pressing the cal key is
not necessary for remote control.
the PIN is needed for all calibrations and also for
setting the number of channels.

Calibration of the Basic Units (mV, W)

NVxxxxxxxxx Calibration, Transmission of the calibration string

After NV the instruments expects a 9-digit unsigned integer decimal number as nominal value for the calibration via the interface. A nominal value must be transmitted alone, i.e. no other command from the table above may be contained in the same string. The instrument starts the calibration after transmission of the nominal value.

Temperature Linearisation

Linearisation via Data Pairs (ND)

NDNx Number of data pairs with x = 1 to 6,
x=0 delets all calibrations for the active channel
NDT1±x.xxxxxxxxE±x
NDX1±x.xxxxxxxxE±x data pair No. 1
NDT2±x.xxxxxxxxE±x
NDX2±x.xxxxxxxxE±x data pair No. 2 ...
Query: all parameters can be questioned with „ND_?“, for example „NDT1?“ delivers the value temperature of data pair No. 1

Linearisation via Polynomials (NP)

NPC0±x.xxxxxxxxE±x
NPC1±x.xxxxxxxxE±x ...
NPC5±x.xxxxxxxxE±x
Query: all parameters can be questioned with „NPC_?“, for example „NPC0“ delivers the coefficient C0.

Linearisation via Coefficients (CO)

NCOR±x.xxxxxxxxE±x	R_0 Constant
NCOA±x.xxxxxxxxE±x	A Constant
NCOB±x.xxxxxxxxE±x	B Constant
NCOC±x.xxxxxxxxE±x	C Constant

Query: all parameters can be questioned with „NCO_?“, for example „NCOR“ delivers the constant R_0.

Entry of the limits (NL)

{NLX1±x.xxxxxxxxE±x	lower limit voltage or resistance}
NLT1±x.xxxxxxxxE±x	lower limit temperature
{NLX2±x.xxxxxxxxE±x	upper limit voltage or resistance }
NLT2±x.xxxxxxxxE±x	upper limit temperature

Query: all parameters can be questioned with „NL_?“, for example „NCOR“ delivers the value of the constant R_0.

Delete the Linearisation

NDN0 deletes the linearisation for the actual channel

Query of the sensor calibration

CAL? Result with existing calibrated sensor:

"Cal <Sensortype>, <X>"
<Sensortype> = "Pt10",.., "Pt1000",
"Type J", .., "Type N"
<X> = "ND" for calibration with data pairs
"NP" for calibration with polynomial
"NC" for calibration with coefficients

Result with no calibrated sensor:
"No Cal Sensor"

Memory (ST)

STAx Start / Stop memory with x = 1 Start x = 0 Stop

STNxxxxx Number of readings with xxxxx = 1 to 100,000

STRx Recall x = 1 on x = 0 off (read with RD?)

Query: all functions can be questioned with „ST_?", for example „STR?" delivers 1 (=recall mode is on) or 0 (=recall mode is off)

Sequencer (SQ)

SQCx Channel active with x = 1 on x = 0 off

SQOxxx.x Channel Switch-On Time with xxx.x = time in sec

SQTxx.xx Trigger Delay Time with xx.xx = time in sec

SQIxxxxxx Interval time with xxxxxx = time in sec

SQAx Start / Stop Sequencer with x = 1 on x = 0 off

Query: all functions can be questioned with „SQ_?", for example „SQA?" delivers 1 (= sequencer is running) or 0 (=sequencer is not running)

Cold Junction Compensation (CJ)

CJAx **C**ompensation active with x = 0 off
x = 1 on, with time, measured on front input Ch B
x = 2 on, with time, measured on rear input Ch CJ
x = 3 on, with a fixed value

CJTxxxxx switching time for CJ with xxxxx = time in sec

CJV±x.xxxxxxxxE±x fixed value for CJ

Query: all functions can be questioned with „CJ_?", for example „CJV" delivers the value for the cold junction constant

True Ohm (TO)

TOAx True Ohm active with x = 0 off**,** x = 1 on

TOTxxxx switching time for True Ohm with xxxx = time in sec

Query: all functions can be questioned with „TO_?", for example „TOA?" delivers 1 (=True Ohm is on) or 0 (=True Ohm is off)

Differencial measurement X-B (DF)

DFAx X-B active with x = 0 off
x = 1 on, with B is RTD,
x = 2 on, with B is TC

DFTxxxx switching time for X-B, with xxxx = time in sec

Query: all functions can be questioned with „DF_?", for example „DFA?" delivers 1 (=X-B is on) or 0 (=X-B is off)

Autozero (AZ)

AZAx Autozero active with x = 1 on x = 0 off

AZTxxxx switching time for Autozero with xxxx = time in sec
Query: all functions can be questioned with „AZ_?“, for example „AZA?“ delivers 1 (=Autozero is on) or 0 (=Autozero is off)

RTCyyyymmddhhmmss
Setting of the internal real time clock (RTC)
f.e. : „RTC19980428180123“ sets the clock to 18:01 and 23 seconds on the 28th of April 1998
Query: RTC?

Ix Sets the contrast of the front panel display with x = 0 9

SV Save Settings, stores the actual device setting in the instrument

RD? READ?, reads the actual measurement value from the instrument

CNx x = 0 Continuous-Mode off (for RS232 Control)
x = 1 Continuous-Mode on

INFO? Status information about the actual channel, read-out is possible also during measurements and during back ground measurements
You get the following information after read-out:
f.e. „NO VALUE MRXJP00G1R6F0T2H0S0Q0M01B00“
(status information of the string)

5.8 Read-out the Memory

The readings stored in the memory can be transferred by a computer with the command "STR1" and read-out with "RD?" or respective read-out routine.
Such file is formatted as follows:

```
;R02;R04;RA ;RB
;     0.200;     2.160;     4.260;     4.500
36238.73443287;100.086;   -0.011;   23.292;108.6084
36238.73450579;100.108;    0.036;   23.286;108.6100
36238.73457870;100.113;    0.023;   23.272;108.6118
36238.73465162;100.045;    0.041;   23.258;108.6118
36238.73472454;100.156;    0.038;   23.256;108.6094
36238.73479745;100.097;    0.023;   23.251;108.6109
36238.73487037;100.070;    0.000;   23.224;108.6113
```

The data file is formatted as follows if only one channel is stored:

```
;RA
;     0.150
36238.74528935;   23.254
36238.74530093;   23.256
36238.74531250;   23.256
36238.74532407;   23.255
36238.74533565;   23.255
36238.74534722;   23.255
36238.74535880;   23.255
36238.74537037;   23.254
36238.74538194;   23.254
```

the first two lines are headers, the first line shows the channel numbers, the second line shows the time offset for each channel in seconds.
The first row displays the time in days since 1900. Other windows programs like Excel are able to read this and to convert it into date and time.

5.9 Display Mode

In display mode the computer can output text messages to the display of the instrument irrespective of other functions of the instrument.
Display mode is switched on with D1. The ASCII characters following thereafter are written to the display. All ASCII characters for which a segment code is defined in the ASCII segment table are displayed. All other characters produce a blank (dark) character position. All superfluous characters present after D1 and the output text are ignored. If D1"text" is sent together with other commands in the same character string, it must be the last command in the character chain.

The display mode can also be used to fasten the sequencer. The maximum switching rate is possible when the measurement reading is not displayed.

D0 switches display mode off again and the display according to the active operating mode and function appears.

5.10 String Length Selection

The Thermometer can send different length messages to the computer whereby the desired message length is selected with L0 or L1. The latest measurement reading is returned if the computer sends the command L0. The status information is not output in response to L0. In response to L1 the instrument sends the most recent data including the status information.

5.11 SRQ Mode

If the Thermometer is not to be continually interrogated by the computer but instead the meter is to request service from the computer when a status change has taken place, SRQ mode (service request) must be switched on with the command Q1.
The SRE register defines when an SRQ is sent, for example, when keyboard input has been made, when error messages appear.
The SRQ mode is only possible via the IEEE488 interface.

5.12 Instrument Message String

The instrument sends a message string containing its present status and the most recent measurement reading. If you are operating via the IEEE488 interface the computer must address the instrument as TALKER. The instructions how to do this are contained in the manual of the IEEE488 interface card in your PC. The message ‘ADR’ is lit in the display when the instrument has been addressed as TALKER.

The transmitted message consists of a character string and a line feed sign at the end of each character string enabling the computer to recognize the end of the transmission.
The message consists of two message units. The first unit contains the data of the most recent measurement reading, and the second unit contains data concerning the programing status. The two message units are transmitted as a complete data
record. The string terminator is fixed and defined with IEEE-488.2 standard as "LF + EOI".
The ASCII (ISO 7 bit) code is used for the transmission.
The length of the second message unit is fixed and always consists of 27 characters plus the terminator character. The length of the first message unit is 13 characters for output of measurement readings and calculation results.
Only the first message unit is transmitted when the short string is requested (command “L0"). The status information (2nd message unit) is not sent in this case.

Description of the Message String

The following table gives an overview of the possible lengths of the message string depending on the selected operating mode.
A message string consists of one (short string format) or of two (long string format) message units, followed by a line feed sign. The second message unit is called the status information.

40 characters + Line Feed

Example1: +01.298764E+0MRX3P00G0R3F2T5H0S0Q0MARB00 + Line Feed

or in short string format (13 characters)
"+01.298764E+0" + Line Feed

Example2:

ERROR 01	MRXJP00G1R6F1T2H0S0Q0M01B00 + Line Feed
ERROR 01	+ Terminator

The measurement reading or a text message appears in the first message unit.
Text messages are ERROR x, NULL, CAL.
Character positions not required are filled with blanks.
The second message unit (status information) commences at the 14th character.

Always the whole string has to be read-out, this are 41 characters with long string and 14 characters with short string.

Table of Device Messages sent by the Thermometer

The device message outputs the following characters to designate the instrument status or the instrument settings:

```
1st character 14th character          40.character+LF
!             !                         !
+x.xxxxxxxxE+xMRVDP00GxRxFxTxHxSxQxMxxBxx
-0000000000 -0  O4    0 1 0 0 0 0 0 01 00
0.........  :   X1    1 : 1 : 1 1 1 :  01
..........  :   X2    : : 2 : : 2   :   :
..........  :   X3    F :   : F     :   :
9999999999  9   X4      B   9       32 17
ERROR xx        X5          A       AR
                XJ          B       AT
                XK                  BR
                XT                  BT
                XE                  AZ
                XR                  CJ
                XS
                XB
                XL
                XU
                XN
                XC

(-----------)(---------------------------)
1st message   2nd meassage unit
    unit
```

Meaning of the transmitted Characters

Position (first, last character) of the message

(1, 1)	"+"	positive sign of the reading
	"-"	negatives sign of the reading or first character of the reading
(2, 10)	"x"	reading or text message
(11, 11)	"E"	designates exponents
(12, 12)	"+"	positive sign of the exponent
	"-"	negative sign of the exponent
(13, 13)	"x"	exponent
(14, 15)	MR	measurement reading is output
(16, 17)	VD	Direct voltage measurement
	O4	4-wire resistance measurement

X1	Pt10	XE	Type E
X2	Pt25	XR	Type R
X3	Pt100	XS	Type S
X4	Pt500	XB	Type B
X5	Pt1000	XL	Type L
XJ	Type J	XU	Type U
XK	Type K	XN	Type N
XT	Type T	XC	User calibrated sensor

(21, 22) "Gx" x is a hex integer number from 0 to F with the following meaning:

Memory on	1 LSB G-String	(G1)
Sequencer on	1	(G2)
Cal Sensor existing	1	(G4)
Calibration on	1 MSB G-String	(G8)

(23, 24) "Rx" measurement range "x" is active

x = 1	300mV(TC), 400 Ω / 0.1mA (Pt10, Pt25, Pt100)
x = 2	400Ω, 0.3 mA (Pt10, Pt25, Pt100)
x = 3	300Ω, 1 mA (Pt10, Pt25, *Pt100 up to 560°C*)
x = 4	100 Ω, 3 mA (Pt10, Pt25)
x = 5	3kΩ, 0.1mA (Pt500, *Pt1000 up to 560°C*)
x = 6	1kΩ, 0.3mA (Pt500)
x = 7	3kΩ, 1mA (Pt100, Pt500, *Pt1000 up to 560°C*)
x = 8	1kΩ, 3mA (Pt100, *Pt500 up to 330°C*, Pt1000)
x = 9	30 kΩ, 0.1mA (Pt1000)
x = A	10 kΩ, 0.3mA (Pt1000)
x = B	1 MΩ, 1 µA (True Ohm)

(25, 26) "Fx" Filter status
x = 0 Filter off
x = 1 Average Filter on
x = 2 Automatic Filter on
x = 3 Fast Auto Filter on, for fast scanning

(27, 28) "Tx" Integration time "x" is set

		for Vdc and Ω	for temp. meas.
T0	20 msec	5 1/2 digit	-
T1	40 msec	5 1/2 digit	-
T2	100 msec	5 1/2 digit	10 mK resolution
T3	200 msec	6 1/2 digit	10 mK resolution
T4	400 msec	6 1/2 digit	10 mK resolution
T5	1 sec	6 1/2 digit	1 mK resolution
T6	2 sec	7 1/2 digit	1 mK resolution
T7	4 sec	7 1/2 digit	1 mK resolution
T8	10 sec	7 1/2 digit	1 mK resolution
T9	20 sec	7 1/2 digit	1 mK resolution
TA	40 sec	7 1/2 digit	1 mK resolution
TB	100 sec	7 1/2 digit	1 mK resolution

(29, 30) "Hx" x is a hex integer number from 0 to F
with the following meaning
Cold junction compensation on 1 LSB H-String

	True Ohm on	1
	X-B on	1
	Autozero on	1 MSB H-String

(31, 32) "Sx" Start Mode
x=0 Start Mode switched off
x=1 Start Mode switched on (Start with „S1“ string)
x=2 Start Mode switched on via the digital I/O plug

(33, 34) "Qx" Service Request Function (only via the IEEE488 interface)
x=0 SERVICE-REQUEST Function switched off
x=1 SRQ switched on, SRQ is send after measurement value, error message, error available, message available, event summary bit (ESB) and key stroke (can be defined with SRE register)

(35, 37) "Mxx" Scanner
Channel "xx" is switched

Front plugs:	MAR	front channel A for RTDs
	MAT	front channel A for thermocouples
	MBR	front channel B for RTDs
	MBT	front channel B for thermocouples
Rear Inputs	MCJ	cold junction channel
	MAZ	Auto Zero channel

(38, 40) "Bxx", key no. xx is pressed, 00 means ‘no button is pressed’.
Numbers of the buttons on the front panel:

	1	2	3	4	5	11	12	13
17	6	7	8	9	10	14	15	16

5.13 Error Messages

Error 01	Overflow	Measuring range overflow
	Sensor?	Resistance / voltge of the sensor overshoots the defined range
Error 03	Br. wires	in four-wire measurement: open source line
Error 04	Offset too high	Offset too high after zero (302)
Error 05	Cal. Error	calibration error (341-343)
Error 06	Overload	system overload
Error 07	Polarity?	for RTD or Ω, sense or source wrong polarity
Error 11	not temperature	not for temperature measurement (304)
Error 14	invalid PIN	invalid PIN for calibration (307)

Values in brackets appear when reading out the error queue. Error message 01, 03 and 07 are send instead of the measurement value.

6 Calibration and Sensor Linearisation

6.1 General Information concerning Calibration

Primary Calibration of the Basic Units

In the state as delivered, the Precision Thermometer 3040 has already been calibrated in the factory using the basic units of measurement for the individual ranges and measuring currents, i.e. for direct voltage, 300 mV and for resistance measurements. Temperature values are determined from these variables by converting the basic variable into temperature measuring units using the standard formula according to the DIN specification.
This calibration is called the primary calibration in the further explanations and instructions given below.

Temperature Calibration

If you want a calibration for a temperature measuring unit, **it is essential that a temperature sensor must be delivered with the instrument.** This is so because the characteristics of the particular temperature sensor play an essential role in determining the calibration factor.
This calibration is called temperature calibration.

Only Calibration, or Adjustment too?

For any calibration procedure, a distinction must be made between the calibration itself, which only determines nominal and actual values, on the one hand, and a corresponding readjustment on the other hand.
The primary calibration of the 3040 in the PREMA factory always includes the readjustment too. If the instrument is calibrated with the sensor, the readjustment normally only involves the correction of the Ro value (e.g. for a Pt100 sensor, setting for the actual value, for example Ro=99.3Ω instead of Ro=100 Ω).
The 3040 permits entry of many more data items (pairs of values, polynomials or Ro, A, B, C values according to DIN).
The customer must specify the calibration point temperatures for calibrating temperature sensors. The corresponding resistance or voltage values are determined and noted for these temperature values in measurements with thermostatic baths or fixed point reference temperature devices. When the sensor calibration is carried out together with the instrument, these determined values can be entered directly into the 3040.
Up to six pairs of values can be stored.

6.2 Calibration Periods

PREMA recommends recalibration of the instruments after elapse of **one year**.
Two-year specifications are given too in the "Technical data" section of this manual, so that the customer can decide for himself whether recalibration at intervals of two years would suit his purposes.

6.3 Number of Sensors

In the standard version the number of sensors is set to 8 platinum resistance sensors and 16 thermocouples. Measurements with platinum sensors are made in 4-wire circuit configuration, in contrast to the 2-wire circuit configurations for thermocouples. Therefore corresponding numbers of relays must be reserved respectively in the scanner.

This number can be changed in the calibration menu, for which purpose the "Cal." key must be pressed on the rear of the instrument and then the PIN number must be entered. This legitimisation is enforced as a safety measure because sensor-specific data such as calibration values and settings can be deleted when the number of channels is changed.

How to change the number of sensors is explained in the "Quick start" chapter.

6.4 PREMA Calibration Service

Of course, you can let us calibrate your instrument in our factory.
Just call the phone number at the front of this manual and ask for the latest price information and how long factory calibration will take.
We make every effort to return your instrument to you as quickly as possible and we will provide you with a factory certificate for the complete calibration. PREMA can also negotiate and provide calibrations with DKD-certificate (certificate of the German calibration service).

6.5 Required Equipment

The following equipment must be available for complete calibration of the instrument:

- Multifunctional calibrator for direct voltage and resistance up to at least 1 MΩ and at least 6 1/2 digits resolution (e.g. Datron 4800), or

- Standard reference resistors and standard reference voltages.

- Shorting plug (3 shorting plugs, e.g. PREMA 3016 shorting plug set) for setting the zero point.

- Connecting cables with gold-plated banana plugs (e.g. PREMA 3014 or 3015, set of precision cables).

Alternatively you can work with less accurate reference sources having good short-term stability and use the 8 1/2 digit DMM 6048 from PREMA to check the actual values of the reference sources. In this case you must enter the reading of the DMM 6048 into the 3040 as calibration value.
In this so-called joint measuring procedure, it is also possible to use 5 1/2 digit calibrators for calibrating 7 1/2 digit measuring instruments.

6.6 Automated Calibration

Calibration of the 3040 can be automated with a computer and a multifunctional calibrator.
All measuring functions can be remotely controlled from computers; see the "Remote control" chapter for further details.
Normally calibration can be carried out completely under remote control without any need for manual adjustment of potentiometers or capacitors.

For a complete calibration the following measuring functions must be calibrated:

Direct voltage	300mV
Resistance, 4-wire	100Ω/3 mA, 300Ω/1 mA, 400Ω/0,1 mA 400Ω/0.3 mA, 1kΩ/0.3 mA, 1kΩ/3 mA 3kΩ/0.1 mA, 3kΩ/1 mA, 10kΩ/0.3 mA 30kΩ/0.1 mA, True Ohm (1MΩ)

All ranges and measuring currents of the individual measuring functions must be calibrated separately. **It is important to make the offset correction or adjust the zero point in each measuring function and for each measuring range before the calibration.**

The offset correction should be made regularly at least once a month and also after calibration.

6.7 Important Steps before Calibration

It is essential to observe and ensure the following points before calibration:

1. The ambient temperature should be at least 18°C and at most 28°C, ideally 23 ±1°C, and it should be stable. To avoid false measurement readings due to temperature fluctuations, a heat-insulating cloth can be wrapped around the terminals of the instrument.

2. Allow a warm-up time of at least 2 hours to elapse before commencing calibration.

3. An offset correction must be made for each measuring range of every measuring function.
   If you are working with a multifunctional calibrator, the offset calibration is made while the instrument is already connected to the calibrator, whereby the latter is switched to "Zero" (i.e. calibrator zero point).
   However, it is important that after calibration the genuine instrument zero point is set with shorting plugs connected to the front panel sockets.

4. Preferably use shielded leads which are kept as short as possible and have gold-plated plugs. This ensures that thermoelectric emf's at the measuring sockets are kept as small as possible.

5. After connecting a cable or switching-over the measuring function or measuring range, wait at least 1 minute before taking the first reading.

6.8 Secret Code Protection and Calibration Switch

The stored calibration data can be protected by the calibration switch on the rear of the instrument and a PIN number, against unintentional or incorrect recalibration.

The calibration key is located on the rear of the instrument and can be actuated with a pointed object (pencil, ball pen, etc.).
This key will respond to actuation after selecting the calibration module. At the same time a prompt appears in the window, requesting you to enter the secret code number.

6.9 Changing the PIN Number

The 7-digit PIN number is set to 0000000 in the state of the instrument as delivered from the factory. To change this number, proceed as follows:

	Keypress	Display / Action
1.	Press the "Cal" key on the rear of the instrument.	PIN:0000000 Enter the PIN number (0000000 in the state as delivered from the factory). After entering the correct PIN number, the display alternatingly shows "CAL" and the measurement reading.
2.	Press the "Cal" key on the rear of the instrument.	To terminate the calibration.
3.	Press the "Cal" key on the rear of the instrument.	PIN:0000000 The desired 7-digit PIN number can now be entered.
4.	Press the "Standby" key	Switch off the instrument, now the new PIN is stored.

Table: Changing the PIN number

6.10 Calibrating the Basic Units in mV and W

Proceed as follows to calibrate the basic units:

	Keypress	Display / Action
1.	"TEMP/Ω,mV" KEY	To switch to the basic unit Ω or mV.
2.	Press the "Cal" key on the rear of the instrument.	1 PIN:0000000 Enter a PIN number (0000000 in the state as delivered from the factory). After entering the correct PIN number, the display alternatingly shows "CAL" and the measurement reading.
3.	"CAL MODE" KEY	7 Cal.Ranges... If this display does not appear, press the ⇧⇩ KEYS until it does appear.
4.	"MENU IN" KEY	1 300mV If this display does not appear, press the ⇧ KEY until it does appear. With the "MENU IN" KEY select the desired measuring range and then press the "MENU OUT" KEY to terminate.
5.	⇧ KEY	1 Enter Value.. This selects value entry mode.
6.	"MENU IN" KEY	V +.1000000 Enter the nominal calibration value and then press the "MENU IN" KEY to terminate. This returns to the measurement reading display mode.
7.	"CAL MODE" KEY	7 Cal.Ranges.. Repeat steps 3 to 6 until all desired measuring ranges have been calibrated.
8.	"CAL MODE" KEY	2 Store Cal. This, followed by pressing the "MENU IN" KEY , stores the calibration result permanently.
9.	Press the "Cal" key on the rear of the instrument	This terminates the calibration procedure.

Table: Calibrating the basic units

Step 8 is very important. If storing (saving) the calibration result is omitted, the calibration made by the customer is lost and the factory calibration is restored when the instrument is next switched-off (even with the "STANDBY" KEY).
Proceed in the same manner as described above to calibrate all measuring ranges.

6.11 Offset Correction for the Basic Units

An offset correction (zero point in the basic units) must be carried out in each measuring range to correct the zero point.
The offset correction for the instrument offset always has to be proceeded on the front channel A.
Offset correction is only possible in calibration mode, this means after pressing the cal key on the rear of the panel and entering the right PIN No.
In this operation mode the RUN-STOP key can be used as ZERO button.

The zero point can be corrected provided that the existing deviation is less than 5% of the range end value (see also the chapter headed "Instructions for making measurements").
If the existing deviation is greater than this, the message "offset too high" will appear.

Note: A warm-up time of at least two hours should be allowed to elapse also before making a zero point correction.
After range switching please wait two measurements before the offset correction is proceeded.

Offset Correction on the Channels

A sensor or channel specific zero point on the different channels the elimination of thermoelectric emf's and resistance of the connecting leads and will be stored as offset to the zero point of channel A. It is not necessary to proceed the offset correction for all ranges, we recommend the range **100 W / 3mA.**
The following channels can be corrected: R01 - R16, RB, T01 - T32, TB, CJ.

Offset Correction for Autozero Function

If you want to use the Autozero function it is recommended to make zero also on the channels RAZ and TAZ. This channels are closed when auto zero is performed.
The offset that is measured with the autozero function changes directly the instrument offset as if the correction has been performed on channel A.

6.12 Calibrating the Direct Voltage Measuring Function

Offset Correction for Direct Voltage

Connect a shorting plug (accessory item No. 3016) to the TC sockets of **channel A** to make the offset correction for the direct voltage measuring range.
Press the cal key on the rear panel, enter your PIN and press the "ZERO" KEY (RUN/STOP) to start the zero point correction. An offset measurement is made in the set measuring range and the reading obtained is then compensated to zero.

Note: If the calibration is made with a calibrator, set the calibrator to zero with connected measuring leads and then correct the offset on the front panel sockets of the 3040.
Important! After making the calibration, again adjust the zero point as described above with a short circuit at the input of the 3040.

Calibrating Direct Voltage

Connect an exactly known positive or negative reference voltage source (between 100mV and 300mV) to the front panel sockets. An error message is displayed if the actual voltage does not lie in this range.
Now proceed as described under "Calibrating the basic units". The 3040 now shows a measurement reading which should correspond to the value of the connected reference voltage. Recalibration is necessary if the reading differs too much from the reference value.

6.13 Calibrating the Resistance Measuring Ranges

Offset Correction

In four-wire resistance measuring mode the true offset is determined on **channel A** by first shorting the Sense-Hi and Sense-Lo sockets and then the two source sockets, using two shorting plugs (accessory item No. 3016). Then connect together the sense sockets and the source sockets with a third shorting plug.

Here it is important that the "shortest" short circuit is made via the sense sockets to avoid including contact or series resistances in the measurement.

Note: If calibration is made with a calibrator, the calibrator must be set to zero with the leads connected, and then the offset must be compensated. Important! After calibration, correct the zero point again with a short circuit as described above.

Calibration

Proceed as described under "Calibrating the basic units".
Before doing this, the zero point should be compensated with the "ZERO" KEY (RUN-STOP).
Furthermore, observe the chapter "Instructions for making measurements", especially the instructions for compensating the resistance of the measuring leads.

6.14 Linearisation of a Temperature Sensor

Various linearisation modes are available for correcting a connected temperature sensor. Up to **six data pairs**, which are usually specified on calibration certificates or which have been determined using the 3040, can be entered.

Furthermore, **additive polynomials** are available and can be entered as C_0, C_1, C_2, C_3, C_4 and C_5 .
The formula is

$$X = C_0 + C_1*t + C_2*t^2 + C_3*t^3 + C_4*t^4 + C_5*t^5$$

with t = temperature, X = resistance or voltage, depending on the sensor

For platinum resistance thermometer sensors it is also possible to enter the constants R_0, A, B and C as defined by DIN / IEC / EN.

Entering Data Pairs

Proceed as follows to enter pairs of values:

	Keypress	Display / Action
1.	"TEMP/Ω,mV" KEY	To switch-over to temperature display, select the desired sensor type (e.g. Pt100).
2.	Press the "Cal" key on the rear of the instrument.	1 PIN:0000000 Enter the PIN number (0000000 in the state of the instrument as delivered from the factory). When the correct PIN number has been entered, the display alternatingly shows "CAL" and the measurement reading.
3.	"CAL MODE" KEY	1 Enter Values.. If this display does not appear, press the ⇧⇩ KEYS until it does appear.
4.	"MENU IN" KEY	1 Data Pairs.. If this display does not appear, press the ⇧ KEY until it does appear.
5.	"MENU IN" KEY	No. of pairs= Press the "MENU IN" KEY and then enter the number of pairs of values. Press the "MENU OUT" KEY to terminate the entry.
6.	⇩ KEY	T1= Enter the temperature corresponding to the first pair of values.
7.	"MENU IN" KEY	°C +0027.000 Enter the value with the numerical keys. Press the " MENU IN" KEY to terminate the entry.
8.	⇩ KEY	X1= Enter the resistance value / the voltage for the first pair of values.
9.	"MENU IN" KEY	Ω 0110.0000 The value can now be entered with the numerical keys. Press the "MENU IN" KEY to terminate the entry. Then repeat points 8 and 9 until all pairs of values have been entered. Press the "MENU OUT" KEY twice to terminate the sequence.
10.	⇩ KEY	3 Store Cal. Press this key and then the "MENU IN" KEY to store the calibration values permanently.
11.	Press the "Cal" key on the rear of the instrument.	To terminate the calibration procedure.

Table: Enter data pairs for linearisation

Step No. 10 is very important. If you forget to save the calibration values, they are lost and the factory calibration is restored when you next switch-off the instrument (even with the "STANDBY" KEY).
This linearisation procedure is based on the DIN-linearisation of the currently active sensor, therefore the pairs of values can differ therefrom only within certain limits.

A new menu option, e.g. "Cal.Pt100", now appears in the sensor menu. The entered pairs of values are active only for **this sensor and only in this channel**.

If more than two pairs of values are entered, the validity limits of this linearisation must be entered in the menu option "Limits". The DIN-linearisation is still valid beyond these limit values.

Entering an additive Polynomial

	Keypress	Display / Action
1.	"TEMP/Ω,mV" KEY	To switch to temperature display mode, select the desired sensor type (e.g. Pt100) or
2.	Press the "Cal" key on the rear of the instrument.	`1 PIN:0000000` enter the PIN number (0000000 in the state of the instrument as delivered from the factory) When the correct PIN number has been entered, the display alternatingly shows "CAL" and the measurement reading.
3.	"CAL MODE" KEY	`1 Enter Values..` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
4.	"MENU IN" KEY	`1 Polynomial..` If this display does not appear, press the ⇧ KEY until it does appear.
5.	"MENU IN" KEY	`1 C0 =` Press the "MENU IN" KEY and then enter the constant C0. Press the "MENU IN" KEY to terminate the entry (entry in V or Ω).
6.	⇩ KEY	`2 C1=` Enter the constant C1. Repeat steps 5 and 6 until all constants have been entered. Press the "MENU OUT" KEY twice to terminate the sequence.
7.	⇩ KEY	`3 Store Cal.` Press this key and then the "MENU IN" KEY to store the calibration values permanently.
8.	Press the "Cal" key on the rear of the instrument.	To terminate the calibration procedure.

Table: Entering a polynomial

Step No. 7 is very important. If you forget to store your calibration values, they are lost and the factory calibration is restored the next time the instrument is switched-off (even with the "STANDBY" KEY).

A new menu option, e.g. "Cal.Pt100", now appears in the sensor menu. The entered polynomial is active only for **this sensor and only in this channel**.

The entered constants are added to the constants of the respective FIN polynomial.

To define the limits of this polynomial, upper and lower limit values can be entered in the menu option "Limits". The DIN linearisation is still valid beyond these limits.

Entering the Coefficients Ro, A, B and C

	Keypress	Display / Action
1.	"TEMP/Ω,mV" KEY	To switch to temperature display, select the desired sensor type (only platinum sensors).
2.	Press the "Cal" key on the rear of the instrument.	1 PIN:0000000 Enter the PIN number (0000000 in the state of the instrument as delivered from the factory). When the correct PIN number has been entered, the display alternatingly shows "CAL" and the measurement reading.
3.	"CAL MODE" KEY	1 Enter Values.. If this display does not appear, press the ⇧⇩ KEYS until it does appear.
4.	"MENU IN" KEY	3 R0, A, B, C .. If this display does not appear, press the ⇧ KEY until it does appear.
5.	"MENU IN" KEY	1 R0 = Press the "MENU IN" KEY and then enter the R0 value of your sensor. Press the "MENU IN" KEY to terminate the entry.
6.	⇩ KEY	2 A = Enter the constant A. Repeat steps 5 and 6 to enter the constants B and C too. All constants must be entered! Press the "MENU OUT" KEY twice to terminate the sequence.
7.	⇩ KEY	3 Store Cal. Press this key and then the "MENU IN" KEY to store the calibration values permanently.
8.	Press the "Cal" key on the rear of the instrument.	To terminate the calibration procedure.

Table: Entering coefficients for linearisation

Step No. 7 is very important. If you forget to store the calibration values, they are lost and the factory calibration is restored the next time the instrument is switched off (even with the "STANDBY" KEY).

A new menu option, e.g. "Cal.Pt100", now appears in the sensor menu. The entered pairs of values are active only for **this sensor and only in this channel.**

This linearisation is calculated independently of the DIN polynomial, but it is necessary **to enter all the constants**, even if only Ro differs from the DIN polynomial.

To define the limits of this polynomial, an upper and a lower limit value can be entered in the menu option "Limits". The DIN linearisation is still valid beyond these limits.

6.15 Entering the Limits

Limits has to be entered if more than one data pair is active. The standard linearisation for the active type of sensor is valid outside the limitation set by the user.
Inside of the entered limits the actual linearization (data pairs, polynomial or coefficients) is valid.
The limits can be set either as a temperature value (Tmin and Tmax, as shown in the table) or in the basic unit as Volt or Ohms (Xmin and Xmax).

	Keypress	Display / Action
1.	"TEMP/Ω,mV" KEY	To switch to temperature display, select the channel in which sensor linearisation has been entered.
2.	Press the "Cal" key on the rear of the instrument.	`1 PIN:0000000` Enter the PIN number (0000000 in the state of the instrument as delivered from the factory). When the correct PIN number has been entered, the display alternatingly shows "CAL" and the measurement reading.
3.	"CAL MODE" KEY	`1 Enter Limits..` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
4.	"MENU IN" KEY	`Tmin =` If this display does not appear, press the ⇧⇩ KEYS until it does appear.
5.	"MENU IN" KEY	`°C -00200.000` Enter the lower limit value and press the "MENU IN" KEY to terminate the entry.
6.	2 X ⇩ KEY	`Tmax =` Press the "MENU IN" KEY and then enter the upper limit value. Press the "MENU OUT" KEY to terminate the entry. Under Xmin and Xmax you can view the corresponding resistance or voltage values recalculated with the entered polynomial or pairs of values.
7.	⇩ KEY	`3 Store Cal.` Press this key and then the "MENU IN" KEY to store the calibration values permanently.
8.	Press the "Cal" key on the rear of the instrument.	To terminate the calibration procedure.

Table: Entering the limits

6.16 Storing the Calibration Values

It is absolutely essential to save the calibration valuesand the limits, in order to store them permanently in memory. Otherwise every calibration result is stored only temporarily until the next time the instrument is switched-off.
It is also permissible to interrupt a calibration procedure and then switch the instrument off, provided that you first store the calibration values with the menu option "Store Cal". You can then continue later where you left off.

6.17 Reloading the Factory Calibration Data

If a false calibration has been made inadvertently, the factory calibration values can be reloaded with the menu option "5 Load Fact.Cal".

7 Operating Instructions for Measuring

7.1 Temperature Measurements with Platinum Sensors

Various platinum resistance thermometer sensors (Pt10, Pt25, Pt100, Pt500 and Pt 1000) can be used to make temperature measurements.

The temperature measurements are made as resistance measurements in four-wire circuit configuration with subsequent conversion to temperature values by calculation. The resistance of the connecting leads does not affect the measurement reading in four-wire circuit configuration, because only the voltage drop across the sensor is measured (see the description of the resistance measuring procedure in four-wire circuit configuration given in this chapter).

When connecting the sensors, it is important to observe correct polarity Hi-Hi and Lo-Lo of the measuring leads (Ω-Sense) and of the current source (Ω-Source).

Ready to use Pt100 sensors with handle and gold plated banana plugs for four-pole connection to the 3040 are available from PREMA too (see chapter „Accessories“).
Other customised sensors are available on request.

Principles of temperature measurements with platinum sensors

The temperature readings displayed in temperature measuring mode are determined using a 4-wire circuit configuration. The temperatures shown in the display of the 3040 are calculated from the measured resistance values according to the specification EN 60751 (DIN IEC 751).

$$R_T = R_0\ [1 + At + Bt^2 + C\ (t\text{-}100°C)\ t^3\ ] \text{ for } -200°C < t < 0°C$$

or

$$R_T = R_0\ (1 + At + Bt^2) \text{ for } 0°C < t < 850°C$$

with $R_0 = 100\ \Omega$ for Pt100

$A = 3{,}9083 \times 10^{-3}\ °C^{-1}$

$B = -5{,}775 \times 10^{-7}\ °C^{-2}$

$C = -4{,}183 \times 10^{-12}\ °C^{-4}$

The accuracy of the displayed temperature values depends on the basic accuracy of the measuring instrument (see the chapter „Technical Specifications“), but above all on the precision class of the utilised platinum resistance thermometers.
Pairs of values determined in the course of the calibration procedure can be entered for calibrated sensors (see the chapter „Calibration and Sensor Linearisation“).

7.2 Resistance Measurement

Resistance measurements with the 3040 are made by the direct current method in 4-wire circuit configuration. The voltage drop across the resistance R is measured and the ratio with respect to the voltage drop across the internal range resistor is determined. Therefore ageing or drift of the reference voltage source does not affect the resistance measurements.

The four-wire circuit configuration (see circuit diagram below) is used to eliminate the effect of the resistance of the connecting leads when measuring small resistance values.

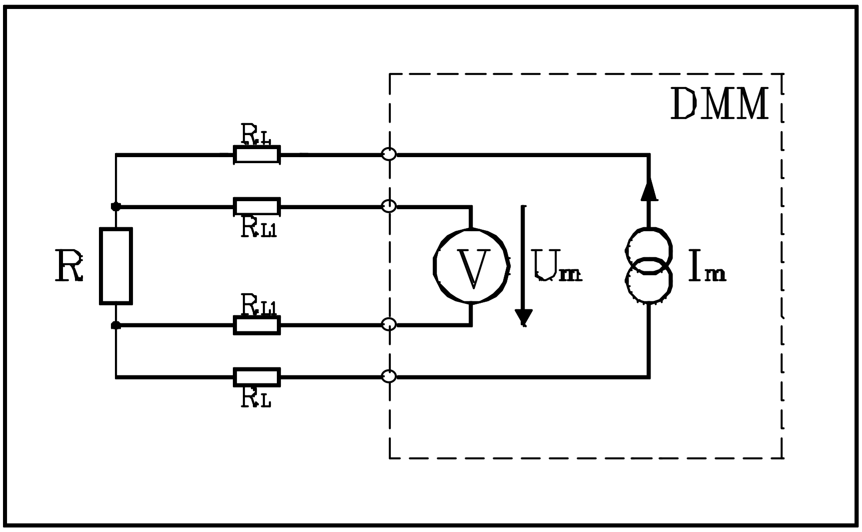


Fig. Principle of resistance measurement in 4-wire circuit configuration

The "outer" connections of the four-wire resistance measuring circuit impress the measuring current I_m via the lead resistance R_L through the resistance R which is to be measured.
The "inner" measuring leads with resistance R_{L1} are connected to the "Sense input" of the measuring instrument which has a high impedance input stage so that the voltage drop across R_{L1} is negligible. The voltage reading is therefore accurately proportional to the resistance value R.

Power Dissipation in the Resistors

A frequently overlooked source of error when making measurements with resistance sensors (e.g. temperature sensors) is the power dissipation in the resistances which are to be measured, and the resulting self-heating.
This can severely falsify the measurement result especially with sensors which have a large temperature coefficient. Disturbance of this kind is reduced by appropriate range-dependent choice of measuring current.

The following table gives an overview of the power dissipation at full scale reading for the respective resistance measuring ranges.

Range	**Measuring current**	**Power dissipation at full scale reading**
100Ω	2.7 mA	729 µW
300Ω	1 mA	300 µW
400Ω	0.1 mA	4 µW
400Ω	0.3 mA	36 µW
1kΩ	0.3 mA	90 µW
1kΩ	2.7 mA	7.29 mW
3kΩ	0.1 mA	30 µW
3kΩ	1 mA	3 mW
10kΩ	0.3 mA	900 µW
30kΩ	0.1 mA	300 µW

7.3 Temperature Measurement with Thermocouples

Thermocouples consist of junctions of two wires made of different materials. One of the junctions is the actual temperature sensor. When the junction is heated, a corresponding thermoelectric emf appears between the open ends of the two wires. This emf, which is approximately proportional to the temperature, is the measured parameter.

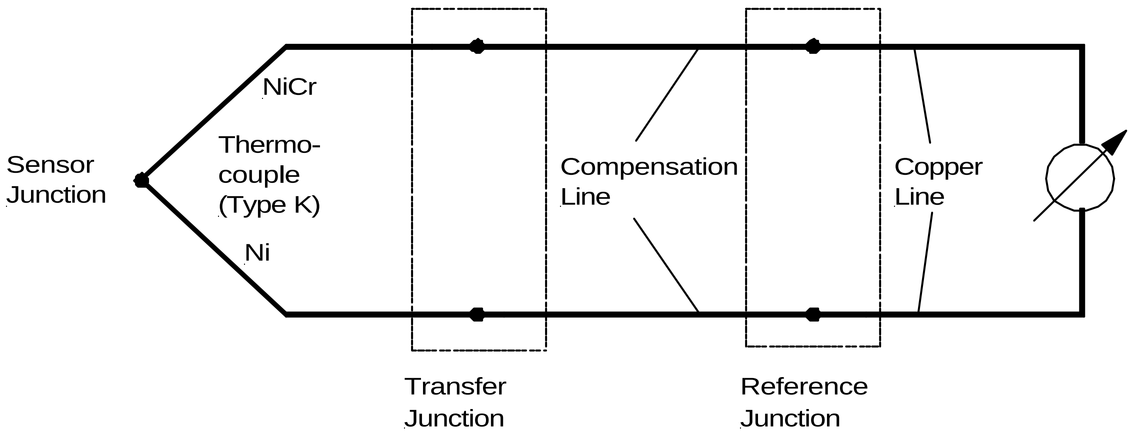


Fig. The structure of a thermocouple, taking type K (NiCr-Ni) as example

When the ends of the thermocouple pair of wires are connected to copper wires, this junction is called the reference junction.
The thermoelectric emf measured at the reference junction is proportional to the temperature difference between the measuring junction and the reference junction.
If the temperature of the reference junction is 0°C, the thermoelectric emf depends only on the measuring junction temperature. The reference junction temperature can be held constant at 0°C in an ice bath, but for many practical applications this is not convenient.
Therefore the 3040 provides an electronic reference junction compensation function with which the temperature of the connecting terminals, measured in channel CJ or B, is converted by calculation to a corresponding voltage which is added to the measured thermoelectric emf.
To keep the error as small as possible, the temperature difference between the individual terminals must be kept small. Therefore it is appropriate to locate the reference junction outside the measuring instrument. An isothermal terminal block is provided for this purpose (see under accessories) to which up to 30 thermocouples can be connected. The reference junction temperature is measured in the massive aluminium block using a Pt100 platinum resistance thermometer sensor.

Temperature measurements with thermocouples entail larger measuring errors than are encountered with platinum sensors. This is so because thermocouples deliver rather small thermoelectric emf's, ranging from max. 80 µV/K (type E) to only 0 to 11µV/K for type B, depending on the kind of thermocouple.

Direct voltages up to max. 300mV can be measured with the 3040. Thermocouple voltages lie around 60 mV maximum (Type E).
The voltage measurement reading is converted by calculation according to the respective DIN standard to the corresponding temperature. The temperature calculation is made according to DIN IEC 584 or EN 60584 for all thermocouple types except type U and L for which DIN 43710 is used.
The calculation for platinum sensors is relatively simple (a polynomial of maximum degree 4 suffices), but the calculation for thermocouples is very complicated. In some cases polynomials up to 14th degree are necessary for up to 6 different temperature subrange to describe the temperature/emf characteristic of the thermocouples.

7.4 Direct Voltage Measurement

Input resistance for Direct Voltage

The input resistance for voltage measurements has been made very large (>10GΩ) in order to exploit the high linearity of the measuring method. In this range the instrument still permits accurate measurements with maximum 1 ppm load error for measured objects with 1 kOhm source resistance.

The following diagram explains the effect of the source resistance.

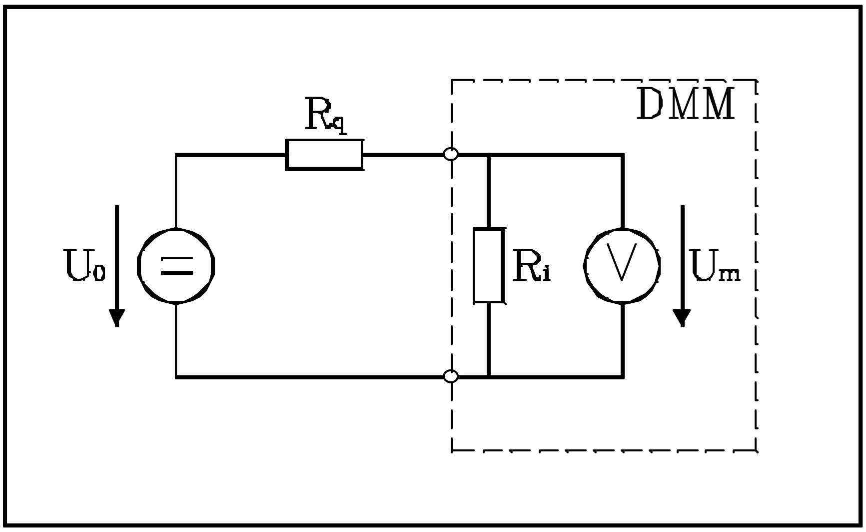


Fig. The effect of the source resistance on the measurement result

R_i = Input resistance of the 3040 (> 10 GΩ)
Rq = Source resistance of the measured object
U_0 = Voltage of the measured object

The percentage error of a measurement is given by the following expression:

$$\text{Error}(\%) = \frac{100 \times R_q}{R_q + R_i}$$

Example: Ri >= 10 GΩ; Rq = 10 kΩ
Measurement error = 0.0001 % (1 ppm)

The error is often expressed as ppm (parts per million). This form is obtained by multiplying the percentage error by ten thousand:

Error (ppm) = Error (%) x 10,000

Suppression of series alternating voltage

One of the chief advantages of integrating measuring methods for direct voltages is their large suppression factor for series alternating voltages (e.g. mains frequency disturbance) superimposed on the wanted signal voltage. Theoretically complete suppression is obtained for frequencies satisfying the condition that the measuring time is an integer multiple of their period.
If constant measuring times were to be used, any short-term fluctuations of the mains frequency would still produce measuring errors.

Therefore in the 3040 the measuring time is synchronised to the mains voltage period with the help of a PLL (phase locked loop) circuit. This ensures that the measuring time is always an integer multiple of the mains voltage period. The full integration measuring method then ensures that the disturbing effects of mains ripple exactly cancel out for the positive and negative half-periods. Mains ripple pickup is thus compensated completely.
The 3040 achieves series alternating voltage suppression factors >100 dB for mains frequencies of 50/60Hz ± 5%.

Common mode suppression

The common mode suppression factor expresses the capability of a measuring instrument to respond only to the wanted difference signal between the "Hi" and the "Lo" input terminals, while not being affected by any common voltage which both terminals have with respect to ground. Common mode voltage would not produce any errors in an ideal system, but in practice stray capacitance, insulation resistance and resistive asymmetry convert a part of the common mode voltage into differential mode disturbing voltage.
The common mode rejection factor of the 3040 is greater than 160 dB with an asymmetry of 1 kOhm in the connecting leads.

The True-Ohm Function and Thermoelectric EMF

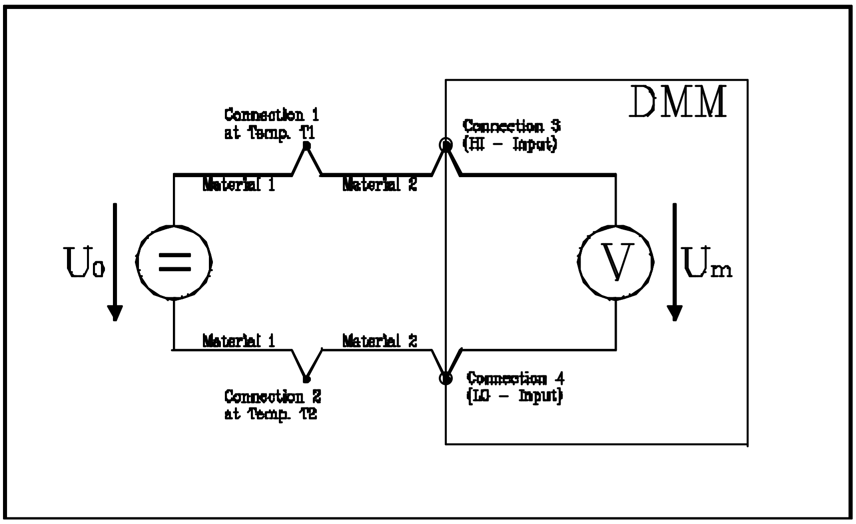


Diagram: Thermal Voltage sources in a measurement circuit

Thermoelectric emfs are one of the commonest sources of error when making direct voltage measurements in the small signal range.
They arise at contact junctions between dissimilar metals which are at the same or different temperatures.
The diagram shows the possible sources of thermoelectric emf's in a measuring circuit which can lie at an external junction (contact 1/2) as well as in the sockets of the measuring instrument.
Therefore always make sure that connections are made with the same material on both sides, or that at least materials producing small thermoelectric emf's are used.

The following table lists the various thermoelectric emf's obtained with various material combinations.

Contact materials	Approx. thermoelectric emf	
Cu - Cu	< 0.3µV/°C	
Cu - Ag (Silver)	0.4µV/°C	
Cu - Au (Gold)	0.4µV/°C	
Cu - Sn (Tin)	2-4µV/°C	(depending on the composition)

For example, if material 1 is a silver connecting lead and material 2 is a copper cable, a temperature difference of only 1°C between contacts 1 and 2 already produces a thermoelectric emf of 400 nV. This would correspond to an error of ±40 digits in the smallest measuring range with 7 1/2 digits resolution (10 nV sensitivity).

The function "True Ohm" can be switched-on for temperature measurements with platinum sensors and for resistance measurements, specially to suppress these thermoelectric emf's. In this function a much smaller measuring current is passed through the resistance to be measured, using the 1 MΩ range, and the difference with respect to the resistance reading obtained with normal measuring current is used to determine and eliminate the thermoelectric emf's by calculation.

Disturbance by inductive Interference

If the measuring leads are close to magnetic fields which vary in time, for example magnetic fields produced by neighbouring electric power lines, a corresponding disturbance voltage is induced in the leads in series with the wanted measuring voltage. Injection of inductive disturbance in the vicinity of a magnetic field can be reduced considerably by using twisted pair measuring leads. Also make sure that the measuring leads do not hang loose and move during the measurements, because this too can produce disturbing voltages.
Further measures to reduce disturbance are to increase the distance away from disturbing fields and/or to shield the leads.

8 Construction

The 3040 is roughly divided into two components:

- Analog Component
- Digital Component

The bottom of the unit's case is occupied by the analog multimeter board, as well as by the scanner board. The top of the case is occupied by the digital board, including the CPU and its peripherals and the IEEE488 interface.

A metal plate between the two hardware groups serves to provide support and shielding.

8.1 Input Circuit

The input circuit for DC values is implemented with a high-impedance operational amplifier, which guarantees an input resistance greater than 10 GΩ. It is therefore suited for highly precise DC voltage and resistance measurements.

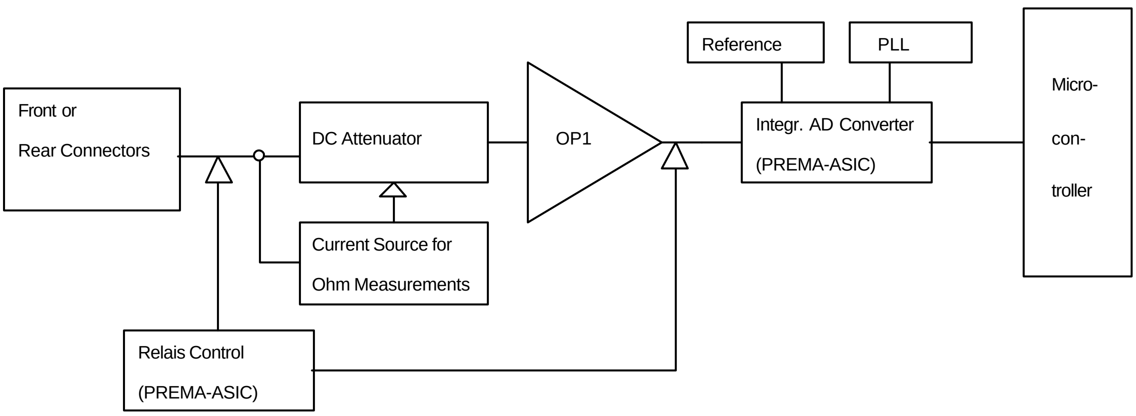


Diagram: Input Circuit

In order to be able to switch measurement ranges, the input circuit is also equipped with resistors and shunts.

8.2 Integrating A to D Converter

For the highest possible resolutions, the AD converter is an integrating converter whereby the direct voltage is converted to a sequence of pulses.
The PREMA Multiple Ramp Technique for analog to digital conversion (GPD #2114141, US Patent 3765012) is the basis for a dependable measurement instrument with exceptional linearity and extraordinary long-term accuracy using continuous integration of the measured signal without distorting interruptions.

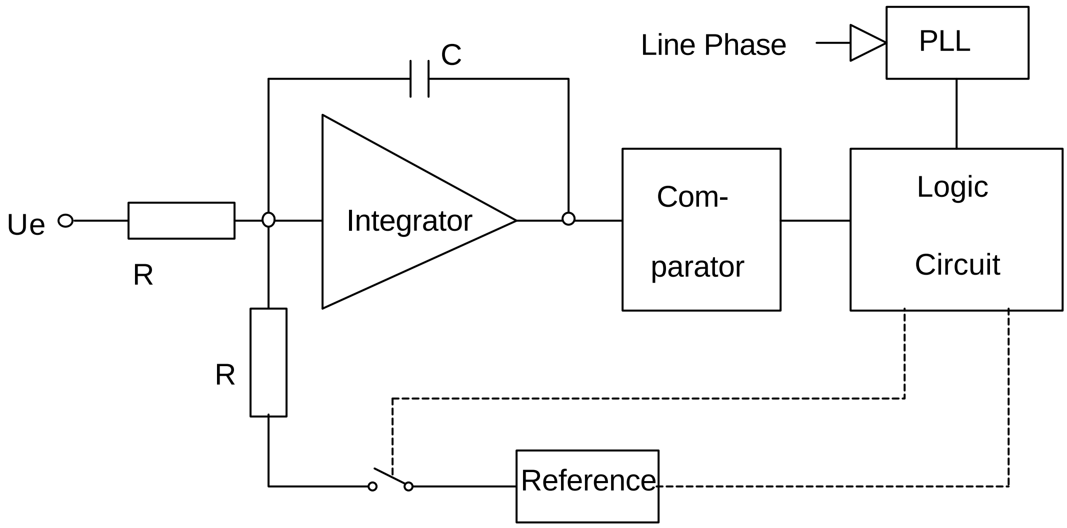


Diagram: Conceptual Circuit Diagram for "Integrating Converter"

The input current which is to be measured is applied continuously to the integrator. At periodic intervals the current from the reference voltage source with opposite polarity discharges the capacitor C.
During the discharge time the pulses of a clock oscillator are counted until the comparator detects the passage through zero and then switches off the reference current.
This method of A/D conversion has high linearity, because it is not necessary to switch the measured current. Methods requiring switching of the input voltage are disturbed by the stray capacitances of the switch which cause an error depending on the input voltage and thus produce nonlinearity.

The total of all pulses counted during the entire measuring time is proportional to the average value of the input voltage.
In this kind of voltage to time conversion the result is not falsified by the loss factor of the capacitor or by drift of its capacitance value.

The result is also independent of the frequency of the clock oscillator because the times for up and down integration are determined with the same frequency.
The precision of this method essentially depends on two circuit components, the resistor in the input and the reference voltage source U ref.
For the reference voltage source it is not the absolute accuracy which is important but the long term stability and low noise performance which can be optimized by selection and long term tests (aging).

The converter is composed of PREMA's customized IC, the external reference, the series resistors, and the integration capacitor.
The use of ASICs represents an important advantage here, since space is saved on the one hand, and the possibility of component failure is further reduced on the other hand.

Mains Synchronisation

With an integrating converter, the synchronisation between the measurement time and the period length of mains frequency is of great importance.
The reason is that, at resolutions of more than 4½ digits, power line noise becomes noticeable in the measurement result.
With sampling converters, this line noise is often eliminated by averaging over a number of measurement results. This method greatly increases the measurement time, however, and also suppresses short-time changes in the measurement signal.

In PREMA's patented Multiple-Ramp Technique, the duration of the measurement time, as well as the phase position, is coupled to the mains voltage. This coupling is effected through a PLL Circuit (Phase-Locked-Loop), which insures that phase position and length of measurement time are always adapted to the frequency and period length of the mains voltage.
This process forms the basis for optimal suppression of power line frequency in the measurement signal.

Reference

The integrating AD converter must be wired up with an external reference. The properties of this reference ultimately determine the long-term stability of the unit.
That is why only selected components, which have been tested, and aged, over a long period of time, are put to use in the 3040.
The reference is composed of a voltage-regulating Z-Diode, heated by a resistor. Unfortunately, references of this kind have the tendency to drift at the beginning of their operational life. After an aging process of two months, the most stable components are selected and put to use in the 3040. The absolute value of the reference voltage is of no significance, since the unit is calibrated during production.

8.3 Application of Microprocessors

A variety of microprocessors come into use in the 3040.
In order to support a certain level of modularity in the individual systems, it is desirable to make the modules as autonomous as possible.
This is achieved through diverse microprocessors of varying capacities. Each module, equipped with its own processor, is therefore tested independently of other modules, through its own set of test routines.

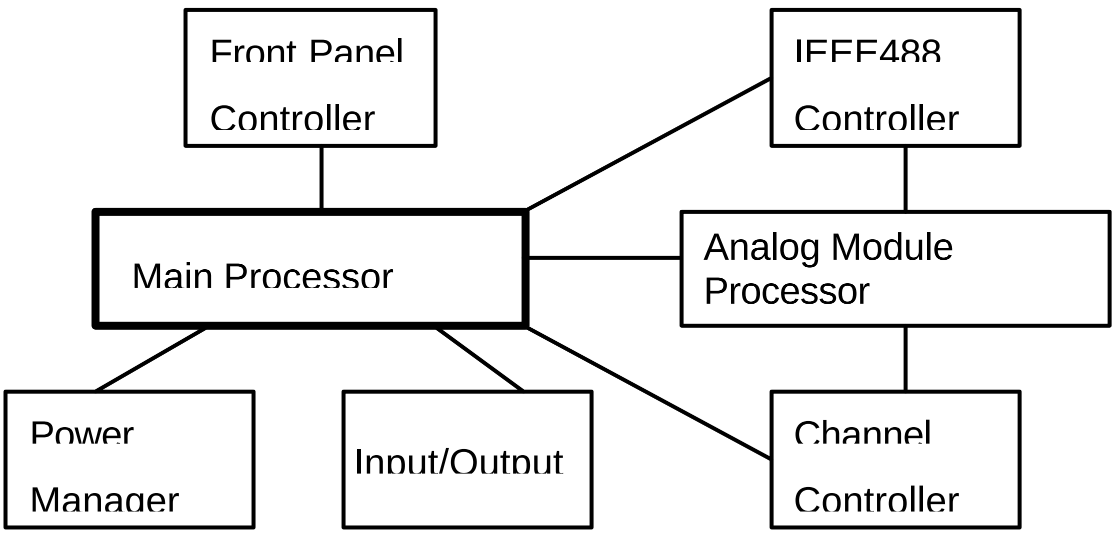


Diagram: Application of Microprocessors

This allows the error rate to be kept as small as possible, since each module has its own, independent test programs, which can operate independently from other modules, guaranteeing optimal functional security.

Another consequence of such a level of modularity is that updates are easy to carry out, and it is easier to make modifications that suit specific customer needs.

Main Processor

The main processor is a powerful 32-Bit CPU, which takes over the coordination of the various modules, as well as communication between them and supervision over them.

Power Management

The Power Management processor is directly responsible for all the functions that have to do with the incoming power voltage, as well as with the voltage supply to the individual modules.
The Standby switch has to be monitored to prevent data loss. The power manager makes sure, that all actual settings are stored in the EEPROM after switch-off the 3040 with the Standby.

In addition, the power manager organizes the activation and deactivation of the LCD and the adjustment of the LCD's contrast.

Other Processors

The **Front Panel Controller** assigns the appropriate functions to key presses on the front panel.

The **Analog Module's Processor** collects the accumulated measurement values, accounts for calibration and offset factors, takes care of filtering signals, and finally passes the data on to the main processor.

Switching of measurement points is carried out by the **Controller on the Scanner Board**. This processor receives its information about activation/deactivation of relays, and especially about timing, in part from the main processor, in part from the controller of the Analog Board.

8.4 Ports

You will find information about the connectors and their pin assignments in chapter 9, "Technical Specifications".

Display

The built-in display is an alphanumerical LC display with 16 easy to read characters. In order to improve the contrast, the display is backlighted. The contrast can be set in the menu.

Memory

The complete firmware is stored into two 1Mbit EPROMS. Furtheron the measurement values that are stored in the memory are kept in an EEPROM with a capacity of 100,000 readings. This values are stored even after switch-off of the instument.

Serial Port

The Serial communications port is implemented as an RS232 interface with a rear panel 9-pin connector.
Using the 3040 Command Set, the unit can be controlled over this interface by any PC. Functions and Ranges can be switched, and measurement data can be transferred.
You will find more on this topic in the chapter “Remote Control.”

IEEE-488 Port

This parallel interface can also be used to control the unit from a computer. In contrast to the serial RS232 interface, up to 30 units can be operated and controlled in parallel through a single IEEE-488 interface card in the PC.

Trigger Port

This port allows measurements to be started by an external trigger pulse.
The port’s configuration is outlined in chapter "Technical Specifications".

8.5 Measurement Inputs

The 3040’s front is equipped with eight safety connectors, to which measurement signals on two inputs can be connected. In order to reduce thermoelectric voltage and contact resistance, the connectors are composed of high-grade copper-tellur.

For precise measurements of even the smallest voltages and resistances, you should also use measurement leads with connectors composed of copper-tellur (see Accessories).

Front / Rear Measurement Connectors

Generally, the front measurement inputs are to be connected through appropriate banana plugs. If the measurement connectors on the rear panel are needed please press the FRONT-REAR button on the front panel.
The rear plugs are consructed as 50-pole Sub-D plugs with gold-plated pins. These plugs can be assemblied with an isothermal connection block (mainly used for thermocouples), with an adaptercard or with a SUB-D mating plug (please see chapter „Accessories“).

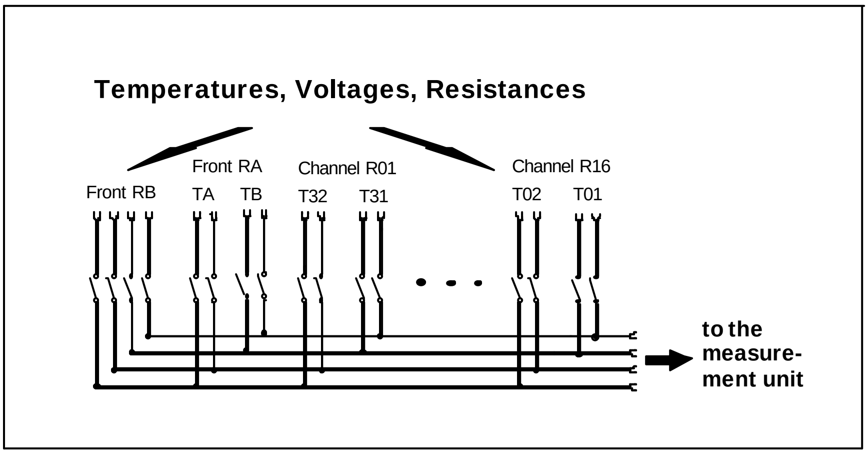
8.6 Power

A high-performance power filter connects the incoming AC mains voltage with the unit’s power supply. This filter prevents any influence on measurement results from power line interference, while preventing the unit itself from causing interference to the power line, which could affect other measurement units.

8.7 Scanner

The 3040 is equipped with a channel scanner, that allows to connect up to 32 thermocouples or 16 RTDs on the rear and additionally two thermocouples or RTDs on the front panel.
Please refer to chapter, "Technical Specifications" for the pin assignments of the rear inputs.

The scanner operates with bistable 4-pole relays for all the switching of 20 4-pole or 40 2-pole or 80 1-pole channels.



Channel Scanner with low-thermal voltage relays

The number of channels to be used for TCs and RTDs can be defined in the calibration menu (press the CAL MODE button, then menu „No of Sensors“).

The cal key on the rear panel has to pressed before the no. of sensors can be changed.

9 Technical Specifications

All error limits and stability specifications are given according to a calibration standard traceable to the “Physikalisch Technische Bundesanstalt (PTB)” (German National Bureau of Standards). The ambient temperature at the time of calibration was 23°C ± 1°C .

Technical Specifications provided are valid when the Automatic Filter is active and when a proper offset correction has been done in the basic functions voltage DC and resistance measurement.

9.1 Temperature (Platinum Sensors)

MEASURING METHOD	4-wire resistance measurement with DC current measurement bridge linearisation according to EN 60751 for Pt10, Pt25, Pt100, Pt500, Pt1000	
TEMPERATURE SENSOR	Pt10-, Pt25-, Pt100-, Pt500-, Pt1000- resistance sensors	
DISPLAY RANGE	**Full Scale**	**Resolution from 1s**
° Celsius	- 200°C to +850°C	0.001°C
° Fahrenheit	- 328°F to +1562°F	0.001°F
Kelvin	+73 K to +1123 K	0.001 K
VOLTAGE ON OPEN CLAMPS	about 5V	
MEASUREMENT TIMES	100ms to 100s	
MEASUREMENT PAUSES after range, function and channel switches	about 100ms	

ACCURACY *1), 4)*

± (ppm of reading + °C)

Sensor	Range / Current	24 h, 23±1°C	1 year, 23 ± 5°C
Pt 10	400Ω / 0.1 mA	10 + 0.230	30 + 0.310
	400Ω / 0.3 mA	10 + 0.077	30 + 0.110
	300Ω / 1 mA	10 + 0.023	30 + 0.031
	100Ω / 3 mA	10 + 0.008	30 + 0.011
Pt 25	400Ω / 0.1 mA	10 + 0.092	30 + 0.120
	400Ω / 0.3 mA	10 + 0.031	30 + 0.040
	300Ω / 1 mA	10 + 0.009	30 + 0.020
	100Ω / 3 mA	10 + 0.006	30 + 0.012
Pt 100	400Ω / 0.1 mA	10 + 0.026	30 + 0.038
	400Ω / 0.3 mA	10 + 0.011	30 + 0.018
	300Ω / 1 mA 3)	10 + 0.004	30 + 0.011
	3kΩ / 1 mA	4 + 0.016	30 + 0.038
	1kΩ / 3mA	4 + 0.006	30 + 0.018
Pt 500	3kΩ / 0.1 mA	10 + 0.006	30 + 0.014
	1kΩ / 0.3 mA 2)	10 + 0.004	30 + 0.010
	10kΩ / 0.3 mA	4 + 0.011	30 + 0.028
	3kΩ / 1 mA	4 + 0.004	30 + 0.014
	1kΩ / 3mA 2)	4 + 0.002	30 + 0.010
Pt 1000	3kΩ / 0.1 mA 3)	10 + 0.004	30 + 0.009
	30kΩ / 0.1 mA	4 + 0.016	30 + 0.038
	10kΩ / 0.3 mA	4 + 0.006	30 + 0.018
	3kΩ / 1 mA 3)	4 + 0.003	30 + 0.011

Specifications without sensor tolerance

TEMPERATURE COEFFICIENTS

(10°C-18°C, 28°C-40°C)	0.009°C/°C
(0°C-10°C, 40°C-50°C)	0.018°C/°C

1) ±0.03°C are to be added for measurement times < 1s, values are valid after offset correction for resistance

2) up to max. 330 °C 3) up to max. 560 °C 4) ppm = parts per million, 1ppm = 0.0001%

9.2 Temperature (Thermocouples)

MEASURING METHOD .... Measurement of voltage DC in 300mV range with linearisation according to DIN IEC 584 (EN 60584)

DISPLAY RANGE ....

Thermocouple	Range in °C
Type J (Fe-CuNi)	-210 to 1200
Type K (NiCr-Ni)	-270 to 1372
Type T (Cu-CuNi)	-270 to 400
Type E (NiCr-CuNi)	-270 to 1000
Type R (Pt13Rh-Pt)	-50 to 1760
Type S (Pt10Rh-Pt)	-50 to 1760
Type B (Pt30Rh-Pt6Rh)	42 to 1820
Type L (Fe-CuNi)	0 to 600
Type U (Cu-CuNi)	0 to 600
Type N (NiCrSi-NiSi)	-270 to 1300

RESOLUTION 0.001°C / °F / K for meas. time > 1s
0.01°C / °F / K for meas. time < 1s

MEASUREMENT TIMES 100ms to 100s

CONNECTION **via additional isothermal connection block**

(see chapter „Accessories“)
(measurement and automatic compensation of the connection temperature) or
via entry of the reference temperature
(any temperature between 273.16°C and 1999°C)

MEASUREMENT PAUSES
after function, range and channel switching: about 100 ms

ACCURACY *1), 2)*

in ± (ppm of reading + °C)

Sensor	Range °C	24h, 23 ± 1 °C	1 year, 23 ± 5 °C
Type K	-270 to 1370	8 + 0.016	30 + 0.016
Type J	-210 to 1200	8 + 0.011	30 + 0.011
Type T	-270 to 400	8 + 0.015	30 + 0.015
Type E	-270 to 1370	8 + 0.009	30 + 0.009
Type R / S	-50 to 1760	8 + 0.058	30 + 0.058
Type B	42 to 800	8 + 0.124	30 + 0.124
	800 to 1820	8 + 0.075	30 + 0.068
Type N	-270 to 1300	8 + 0.018	30 + 0.018
Type L	0 to 600	8 + 0.020	30 + 0.020
Type U	0 to 600	8 + 0.020	30 + 0.020

1) ±0.03°C are to be added for measurement times < 1s, values are valid after offset correction for voltage measurement

2) ppm = parts per million, 1ppm = 0.0001%

9.3 Resistance

MEASURING METHOD	4-wire measurement with selectable DC current	
RANGES	100Ω/300Ω/400Ω/1kΩ/3 kΩ/10kΩ/30 kΩ	
RANGE SELECTION	manual	
MEASUREMENT TIMES	**Digits**	**max. Resolution**
20ms / 40ms / 100ms	5 ½	1 mΩ
0.2s / 0.4s / 1s	6 ½	100 µΩ
2 / 4 / 10 / 20 / 40 / 100 s	7 ½	10 µΩ

ACCURACY *1), 2), 3)*
± (ppm of reading + ppm of full scale)

Range Full Scale	**Current**	**24 h** *23°C ± 1°C*	**1 year** *23°C ± 5°C*	**2 years** *4)* *23°C ± 5°C*
100Ω	2.7 mA	10 + 3	30 + 4	60 + 4
300Ω	1 mA	10 + 3	30 + 4	60 + 4
400Ω	0.1 mA	10 + 23	30 + 30	60 + 30
400Ω	0.3 mA	10 + 8	30 + 10	60 + 10
1kΩ	0.3 mA	10 + 2	30 + 4	60 + 4
1kΩ	2.7 mA	4 + 2	30 + 4	60 + 4
3kΩ	0.1 mA	10 + 2	30 + 4	60 + 4
3kΩ	1 mA	4 + 2	30 + 4	60 + 4
10kΩ	0.3 mA	4 + 2	30 + 4	60 + 4
30kΩ	0.1 mA	4 + 2	30 + 4	60 + 4

TEMPERATURE COEFFICIENTS
±(ppm of reading + ppm of full scale)/°C 3)

Range	**10°C-18°C and 28°C-40°C**	**0°C-10°C and 28°C-50°C**
100Ω / 300Ω / 400Ω	3 + 3	6 + 6
1kΩ / 3kΩ	2 + 2	4 + 4
10kΩ / 30kΩ	2 + 2	4 + 4

VOLAGE ON OPEN CLAMPS	about 5 V max.
MEASUREMENT PAUSES after function, range and channel switching	about 100ms
OVERLOAD LIMITS	± 50 Vpk

1) all specifications ± 1 Digit and after offset correction
2) valid for constant input signal; ± 5 ppm of full scale must be added after signal change
3) ppm = parts per million, 1ppm = 0.0001 %
4) max. values, typ values correspond to 1-year accuracy

9.4 Voltage DC

RANGE.................... ± 300mV

MEASUREMENT TIMES	**Full Scale**	**Digits**	**max. Resolution**
20ms / 40ms / 100ms	301 000	5 ½	1 µV
0.2s / 0.4s / 1s	3 010 000	6 ½	100 nV
2 / 4 / 10 / 20 / 40 / 100s	30 100 000	7 ½	10 nV

ACCURACY *1), 2), 3), 4)*
± (ppm of reading + ppm of full scale)

24 h, 23°C±1°C	8 + 2
1 year, 23°C ± 5°C	30 + 2
2 years, 23°C ± 5°C	42 + 2 *6)*

The values specified above assume that the measuring time dependent readout span is set large enough to permit readout with the accuracy stated.
A rounding error of ± 1 digit must be added to the error specified as a percentage of the maximum reading.

TEMPERATURE COEFFICIENTS
± (ppm of reading + ppm of full scale) / °C

(10°C - 18°C / 28°C - 40°C)	3 + 1.5
(0°C - 10°C / 40°C - 50°C)	6 + 3

ZERO POINT
Offset Voltage (1 h warm-up time)

Temperature Coefficient	better than 0.3 µV/°C
Long Term Stability	better than 5 µV after 90 days

INPUT BIAS CURRENT < about 20 pA at 23°C ± 1°C

INPUT RESISTANCE > 10 GΩ 5)

NOISE SUPPRESSION

(measured by increasing the interference peak value
up to the error Reading of 1 digit, measurement time: 400ms)

Series Mode Rejection

50 Hz Mains	> 100 dB
46 Hz to 56Hz	> 50 dB The peak value of the superimposed AC Voltage must be smaller than the DC Voltage Portion.

Common Mode Rejection

DC Voltage	160 dB
50Hz Mains	160 dB Low-Ohm connection from Shield to black "V, Ω–Lo" connector, with 1kΩ in the "Lo" Lead.

MEASUREMENT PAUSES

after Range, Function, or
Channel switch — about 100ms

MEASURING METHOD — fully integrating PREMA Multiple Ramp Method (DBP.Nr.2114141, US-Pat. No. 3765012)

POLARITY CHANGE — automatic, without measurement pause

OVERLOAD LIMITS — 50 Vpk or ± 50 V DC

1) All values ± 1 Digit and after Offset Correction
2) ppm = parts per million, 1 ppm = 0.0001 %
3) Values are valid for constant input signal; ± 5 ppm F.S. is to be added within 100 ms of a signal change.
4) ppm of full scale is related to a Reading Span of 301 000 00
5) Valid for input Voltage up to full scale.
6) max. values, typ. values correspond to the 1-year accuracy

9.5 Scanner

CHANNELS	34 Channels 2-pole (Thermocouples), or 18 Channels 4-pole (RTDs) or mixed, can be set in calibration mode (CAL MODE key) "No. of Sensors..." Autozero Channel 4-pole, Cold Junction Channel 4-pole
SWITCHING METHOD	bi-stable mechanical relays
THERMO VOLTAGE	typ. ± 1µV, max. 2µV after 1.5h warm-up
MAX. VOLTAGE BETWEEN 2 CONTACTS	±50 V or 50 Vpk
MAX. CONTINUITY RESISTANCE (PER LEAD)	approx. 1 Ω
LIFETIME	2 * 100 000 000 Alternations (0.1A, 10Vdc)
ISOLATION RESISTANCE BETWEEN 2 CONTACTS	3 GΩ at relative ambient humidity < 60%
ISOLATION RESISTANCE AGAINST CASE	3 GΩ at relative ambient humidity < 60%
CAPACITANCE	smaller than 100 pF between the contacts
ACTIVATE SCANNER	FRONT-REAR key on the front panel

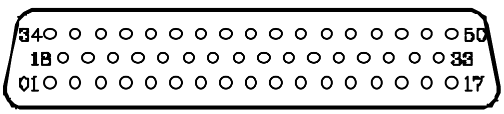
9.6 Pin Assignment of the Scanner

Scanner Input 1

Ch. No. RTD	Ch. No. TC	PIN No.	Ch. No. RTD	Ch. No. TC	PIN No.
01 SHi	32 Hi	19	06 SHi	22 Hi	25
01 SLo	32 Lo	18	06 SLo	22 Lo	24
01 Hi	31 Hi	35	06 Hi	21 Hi	9
01 Lo	31 Lo	34	06 Lo	21 Lo	8
02 SHi	30 Hi	4	07 SHi	20 Hi	27
02 SLo	30 Lo	3	07 SLo	20 Lo	26
02 Hi	29 Hi	2	07 Hi	19 Hi	11
02 Lo	29 Lo	1	07 Lo	19 Lo	10
03 SHi	28 Hi	21	08 SHi	18 Hi	29
03 SLo	28 Lo	20	08 SLo	18 Lo	28
03 Hi	27 Hi	37	08 Hi	17 Hi	13
03 Lo	27 Lo	36	08 Lo	17 Lo	12
04 SHi	26 Hi	5	RB SHi		31
04 SLo	26 Lo	22	RB SLo		30
04 Hi	25 Hi	39	RB Hi		15
04 Lo	25 Lo	38	RB Lo		14
05 SHi	24 Hi	7	RAZ SHi	TAZ Hi	33
05 SLo	24 Lo	6	RAZ SLo	TAZ Lo	32
05 Hi	23 Hi	40	RAZ Hi		17
05 Lo	23 Lo	23	RAZ Lo		16

Ground = 41, 42, 43, 44, 45, 50
Not connected = 50
RAZ = Autozero - Channel for RTDs
TAZ = Autozero - Channel for TCs
Output Channel = 46 (Hi), 47 (Lo), 48 (SHi), 49 (SLo) *)

SHi = Sense Hi
SLo = Sense Lo
RB = Channel B, RTD Front



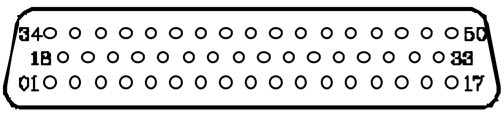
*) This lines are connected to the measurement unit. All lines remain connected in 2-pole arrangement.

Scanner Input 2

Ch. No. RTD	Ch. No. TC	PIN No.	Ch. No. RTD	Ch. No. TC	PIN No.
09 SHi	16 Hi	19	14 SHi	06 Hi	25
09 SLo	16 Lo	18	14 SLo	06 Lo	24
09 Hi	15 Hi	35	14 Hi	05 Hi	9
09 Lo	15 Lo	34	14 Lo	05 Lo	8
10 SHi	14 Hi	4	15 SHi	04 Hi	27
10 SLo	14 Lo	3	15 SLo	04 Lo	26
10 Hi	13 Hi	2	15 Hi	03 Hi	11
10 Lo	13 Lo	1	15 Lo	03 Lo	10
11 SHi	12 Hi	21	16 SHi	02 Hi	29
11 SLo	12 Lo	20	16 SLo	02 Lo	28
11 Hi	11 Hi	37	16 Hi	01 Hi	13
11 Lo	11 Lo	36	16 Lo	01 Lo	12
12 SHi	10 Hi	5	RA SHi	TA Hi	31
12 SLo	10 Lo	22	RA SLo	TA Lo	30
12 Hi	09 Hi	39	RA Hi	TB Hi	15
12 Lo	09 Lo	38	RA Lo	TB Lo	14
13 SHi	08 Hi	7	CJ SHi		33
13 SLo	08 Lo	6	CJ SLo		32
13 Hi	07 Hi	40	CJ Hi		17
13 Lo	07 Lo	23	CJ Lo		16

Ground = 41, 42, 43, 44, 45, 50
Not connected = 46, 47, 48, 49
CJ = Cold Junction
TA = Channel A, TC, Front
TB = Channel B, TC, Front

SHi= Sense Hi
SLo = Sense Lo

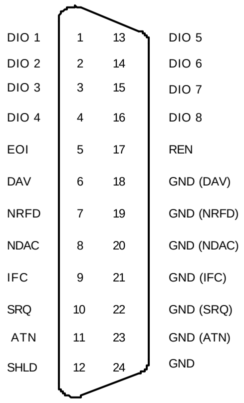


9.7 IEEE-488 Interface

Specifications

OUTPUT INFORMATION	measurement result, sensor, range, measurement time and other device settings.
INPUT INFORMATION	sensor, range, measurement time, start command, calibration set-point, constants and data pairs for linearisation, display text and other device settings.
ADDRESS	selectable from 0 to 30, in the main menu "Interface, IEEE488".
SERVICE REQUEST......	SRQ selectable with SRE mask.
TERMINATOR	EOI Line and Line Feed
KEYBOARD	can be de-activated over REN, can be activated over GTL and over LOCAL key (lockable over LLO)
COMPATIBILITY	IEEE-488.1 and IEEE-488.2
BUS CONNECTOR.........	24-pin as per IEEE-488

PIN ASSIGNMENTS IEEE-488 INTERFACE



GND = Signal Ground (µP Ground)
SHLD = Shielding

Data Bus: DIO 1-DIO 8	Data Bits 1-8	I/O
Data Transfer Control Bus DAV	Data Valid	I/O
NRFD	Not ready for Data	I/O
NDAC	No Data Accepted	I/O
Interface Control Bus: IFC	Interface Clear	I
ATN	Attention	I
SRQ	Service Request	O
REN	Remote Enable	I
EOI	End or Identify	I/O

Attention!
Avoid any discharge of electrostatic voltages over the IEEE-488 connector, since it can lead to damage or destruction of the unit.

9.8 RS232 Serial Interface

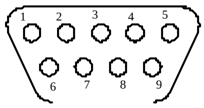
DATA FORMAT 8N1 (8 data bits, no parity, 1 stop bit)

BAUD RATE 9600 Bd

CONNECTOR TYPE 9-pin Sub-D connector

HANDSHAKE selectable:
- Xon/Xoff
- RTS/CTS
- no handshake

PIN ASSIGNMENTS:



PIN-No.	Orientation	Signal	Description
1	Input	DCD (Data Carrier Detect)	
2	Input	RD (Receive Data)	Received Data
3	Output	TD (Transmit Data)	Sent Data
4	Output	DTR (Data Terminal Ready)	
5		GND	Signal Ground
6	Input	DSR (Data Set Ready)	
7	Output	RTS (Request to Send)	
8	Input	CTS (Clear to Send)	
9	Input	RI (Ring Indicator)	

Table: PIN assignment RS232

9.9 Trigger Interface

CONNECTOR TYPE 9-pin SUB-D Connector

NUMBER OF LEADS 8 lines (4 used)

INPUT VOLTAGE Active Low

VIH Min. -0.5V

Max. 0.8V

VIL Min. 2.0V

Max. 5.5V

OUTPUT VOLTAGE VOH

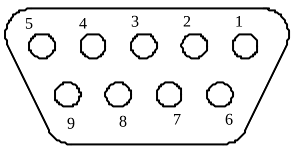
Max. 0,4V

IOH 2,5 mA

VOL Min. 3,0 V

IOL -2,5 mA

PIN Assignment of the TTL I/O interface



PIN	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**
Signal	In	In	In	In	Out	Out	Out	Out
	Trigger Reading	-	Mem Start/Stop	Seq Start/Stop	< Alarm	> Alarm	Mem on / off	Seq on / off

PIN 1 = Ground

There is no external voltage needed for a trigger. A short circuit between PIN1 and f.e. PIN 7 starts the memory.

9.10 EU Conformity

The EU Declaration of Conformity for the 3040 certifies that this instrument conforms to the pertinent requirements of the relevant EU directives and standards.

EMC Compliance Tests

The following EMC (EMC = Electromagnetic Compatibility) compliance tests have been carried out conforming to the EMC directive 89/336/EWG. The compliance has been documented.

Measurement of the EMI Emissions

EN 50081-1
Electromagnetic Compatibility
Generic Standard Class: Residential, Commercial and Light Industry

EN 55011
Class B, Limits and methods of measurement of Radio Interference Characteristics of Information Technology Equipment (ISM instruments), European Standard
Emission radiated, Frequency Range 30 MHz to 1 GHz.

EN 55022
Class B, Limits and methods of measurement of Radio Interference Characteristics of Information Technology Equipment (ISM instruments), European Standard
Emission conducted, Frequency Range 150 kHz to 30 MHz.

Measurement of EMI Immunity

Conforming EN 50082-1, **European Standard**,
Electromagnetic Compatibility - Generic Immunity Standard
Generic Standard Class: Residential, Commercial, or Light Industry.
Additional specifications under EMC test conditions

ENV 50140
EMC Immunity against radiated EMI (Electromagnetic Interference).
EMC Basic Directive, 30-1000MHz. Residential environment
EMI Radiation: 3V/m, 80%AM - f.e. Handy in a distance of 3-5m
3040 Specifications min. +/- 0.1 % F. S. (Full Scale)

ENV 50141
EMC Immunity against conducted EMI
EMC Basic Directive, 150 kHz - 80 MHz
EMI Source: $3V_{RMS}$ on open wires.
3040 Specifications min. +/- 0.1% F.S.

EN 61000-4-2
ESD Immunity Part 4-2
ESD: Air or Contact Discharge +/-8kV / 4 kV - Protection Class 2.
3040 Specifications min. +/- 0.1% F.S.

EN 61000-4-4
Burst and electrical fast transient immunity Part 4-4
Environment: Industrial Area 2kVpk - Protection Class 3.
3040 Specifications min. +/- 0.1% F.S.

EN 61000-4-5
Surge Immunity Test, Part 4-5
Environment: Industrial Area 2kV non symm. - Protection Class 3.
3040 Specifications min. +/- 0.1% F.S.

For the User´s safety:
The safety requirements according to the low voltage equipment directive 73/23/ECC have been fulfilled (product standard EN 61010).

9.11 General

SECURITY	complies with EN 61010, Ground is connected to the case.
WARM-UP TIME	20 min. to reach 1-year accuracy, 1h to reach 24h stability.
AMBIENT TEMPERATURE	
Operation......................	10°C to 45°C
Storage........................	-25°C to 60°C
RELATIVE HUMIDITY	
Operation at 0°C to 25°C	20% to 75%
Operation at 25°C to 45°C	20% to 65%
Storage	10% to 90% (40°C)
Transportation...........	5% to 95% (40°C) in each case excluding condensation
POWER SUPPLY	
Voltage	230V (switchable to 115V)
115V.................	+15%, -22% Mains Fuse with 0.4A
230V	+15%, -22% Mains Fuse with 0.2A
Power	typ. 20 VA /max. 50 VA
Frequency	47 to 63 Hz
WEIGHT	about 3.4 kg, 7.5 lbs
CASE	½-19” Case 2 HU Cast Aluminum Case

DIMENSIONS

Height	about 96 mm / 3.8 inch with feet
	about 89 mm / 3.5 inch without feet
Width	about 225 mm / 8.86 inch
Depth	about 375 mm / 14.7 inch

DIMENSIONS OF DELIVERED PACKAGE (CARTON)

Height	about 270 mm / 10.6 inch
Width	about 320 mm / 12.6 inch
Depth	about 460 mm / 18.1 inch

10 Accessories

10.1 Adaptercard (3110)

The adaptercard can be connected externally to the 50-wire Sub-D connector on the rear of the 3040. This card contains screw terminals for the incoming wires and so it is useful when you need to change the configurations of sources being scanned.
this card is mainly used for RTD sensors.

Two adaptercards are required for connecting all 80 channels.

Max. current: 2A
Max. voltage: 40V
Dimensions: approx.. 70 mm x 110 mm

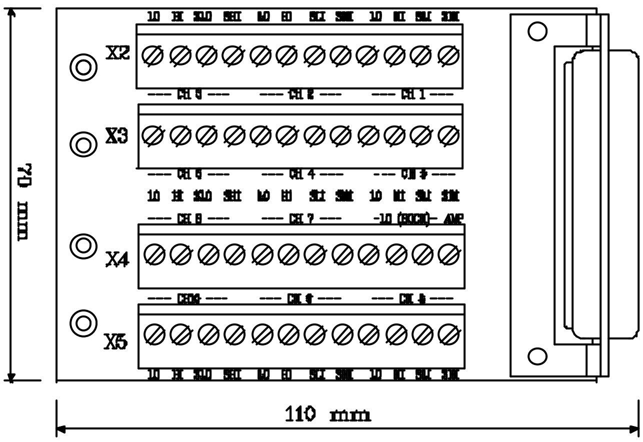


Fig.: Adaptercard 3110 for scanner input

Warning: Voltages **greater than 40V to ground should not** be connected to the adaptercard because the screw terminals are not protected against human touch.

10.2 Mating Plug for Sub-D (6000/03)

A 50-wire subminiature type D connector can be used for each set of 8 RTD channels (4-pole). This connector has solder connections for each wire and a cable outlet for round cables up to 12 mm diameter.

Two plugs are nessecary for connecting all channels.

10.3 Pt100 Temperature Probes (3011 and 3012)

Pt100-Temperature Probe in 4-wire connection with handle.
Connection to the DMM via a 1.5 m cable with 4 gold plated banana plugs.

Model	Surface Probe 3011	Immersion Probe 3012
Sensor	Pt100 (Platinum RTD100)	Pt100 (Platinum RTD100)
Connection	4-wire	4-wire
Temp. Range (Sensor)	-50°C to 220°C	-50°C to 500°C
max. Temp. (Handle)	-25°C to about 80°C	-25°C to about 80°C
Accuracy (Sensor)	1/3 DIN B	1/3 DIN B
Probe Length	160 mm without handle	160 mm without handle
Diameter	Contact Surface:ø 9 mm	Pipe: ø 5 mm
Cable Length	1.5 m	1.5 m
Connectors	4 Banana Plugs, 4 mm	4 Banana Plugs, 4 mm

Table: Pt100 Probe Specifications

10.4 Isothermal Box 3010

With the Isothermal Box 3010 it is possible to connect up to 34 different thermocouples at the scanner inputs of the Precision Thermometer 3040.
This can be used for cold junction compensation as the block temperature is measured with a Pt100 sensor.

10.5 Test Lead Set (3014)

The Test Lead Set consists of two, 1m long cables with shrouded, 4mm banana plugs and two probe tips. The contacts of the plugs have low thermal voltages, which is necessary for precise measurements.

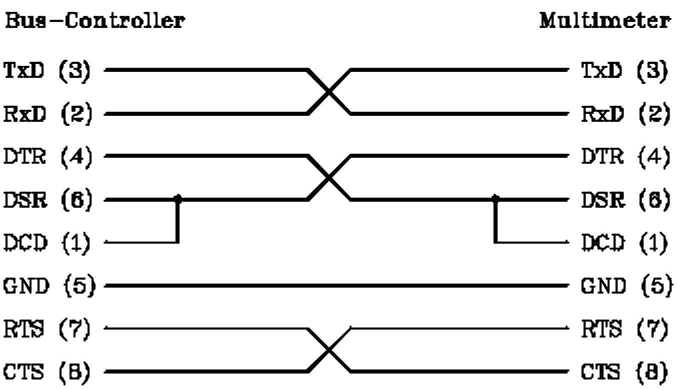
10.6 Set of Short Circuit Plugs (3016)

This set contains 3 gold plated short circuit plugs, which can be connected together. In this design it is possible to generate a very reliable short circuit for observing the zero point of the instrument. Three plugs can generate an excellent short circuit in 4-wire resistance measurement.

10.7 RS232 Cable (3018)

RS232 cable for controlling the 3040 from a PC with RS232 interface (Zero Modem Cable with RTS/CTS and SD/RD lines crossed).

PIN Assignment RS232 Cable



10.8 Carrying Case (4100)

Flexible carrying case for 3040 and accessories with handle and
shoulder strap.
Dimensions in cm : about 27 x 39 x 15 (W x H x D)

10.9 Accessories for the IEEE488 Bus

An interface card in the PC is necessary to remote control the 3040.
PREMA offers two IEEE488 interface cards for PC/AT/XT and compatibles:

5025	IEEE-488 Interface Card PC2A for PC XT/AT and DOS / Windows
5035	IEEE-488 Interface Card for PCI Bus
5023K	IEEE-488 Interface Cable, shielded, Length: 2m.

10.10 19-inch Rack Mounting Kit (5021 G)

Complete Slide-In module to mount a 3040 into a 19-inch rack.
Height 2 HU.

The rack mounting kit is delivered with all essential screws.
An extra shield is also delivered if there is only one 3040 in use.

10.11 Windows Software PREMA-Control

Reasonably priced software to control the 3040 via the RS232 or the IEEE488 interface from a windows PC. The software is delivered with RS232 interface cable (Accessory No. 3018).

Index