

# Device description \_v 1.0

## robusto control Series robusto slave RSC123



elrest Automationssysteme GmbH  
Leibnizstraße 10  
73230 Kirchheim unter Teck  
Germany  
Telefon: +49 (0) 7021 / 92025-0  
[www.elrest.de](http://www.elrest.de)

**elrest®**

# Table of contents

<b>1</b>	<b>General</b> .....	<b>6</b>
1.1	Preface.....	6
1.2	Liability.....	6
1.3	Security regulations and safety precautions.....	7
1.4	Copyright.....	7
1.5	Symbols.....	8
1.6	Safety instructions.....	9
1.7	Before you start.....	10
1.8	Storage, transport and packaging.....	10
1.9	Warranty.....	10
1.10	Application area.....	11
1.10.1	Intended use.....	11
1.10.2	Structure of the robusto control RSC123.....	12
1.10.3	Configuration.....	12
<b>2</b>	<b>Implementing</b> .....	<b>13</b>
2.1	Mechanical installation.....	13
2.1.1	Required space.....	13
2.1.2	Installation / Assembly.....	13
2.1.3	Cooling.....	16
2.1.4	Dimension drawing front view.....	17
2.1.5	Dimension drawing side view.....	17
2.2	Elektrical Installation.....	18
2.2.1	Supply voltage.....	18
2.2.2	EMC-compliant design.....	18
2.2.3	Connections to other CANopen devices.....	19
2.2.4	EGB / ESD- guidelines.....	20
2.2.5	Guidelines.....	21
2.2.6	Label.....	22
<b>3</b>	<b>System overview</b> .....	<b>23</b>
3.1	Products.....	23
3.1	Communication interfaces.....	24
3.1.1	Crosslinking with CANopen.....	24
<b>4</b>	<b>Device description</b> .....	<b>25</b>
4.1	Technical data RSC123.....	25
4.2	Interfaces.....	28

4.2.1	Frontview of the interfaces .....	28
4.2.2	Terminal assignment .....	29
4.2.3	Power- LED .....	34
4.2.4	Status - LED .....	34
4.2.5	HEX - Schalter (Modi).....	34
4.2.6	Reset- button.....	36
4.2.7	Download - plug .....	36
<b>5</b>	<b>Software .....</b>	<b>37</b>
5.1	Software dokumentations .....	37
5.1.1	General .....	37
5.1.2	EDS Datei .....	37
<b>6</b>	<b>CANopen .....</b>	<b>38</b>
6.1	CANopen introduction .....	38
6.1.1	Configuration and parametrisation.....	40
6.1.2	Network management .....	42
6.1.3	Prozess data objects (PDO) .....	46
6.1.4	Service data objects (SDO) .....	52
6.1.5	Identifier- distribution .....	56
6.2	CANopen object dictionary .....	57
6.2.1	Description of the objects and data.....	59
<b>7</b>	<b>CODESYS V3 .....</b>	<b>84</b>
7.1	Integrate EDS file .....	84
7.1	CANopen configuration .....	85
<b>8</b>	<b>Maintenance and service .....</b>	<b>87</b>
8.1	Maintenance.....	87
8.1.1	General .....	87
8.1.2	Function earth (FE) .....	87
8.1	Device failure.....	87
8.2	Accessories.....	88
8.3	Notice .....	89
<b>9</b>	<b>Troubleshooting .....</b>	<b>90</b>
9.1	Service and Support .....	90
<b>10</b>	<b>History .....</b>	<b>90</b>
<b>11</b>	<b>Appendix .....</b>	<b>91</b>
11.1	Resistance tables .....	91
11.1.1	Resistance characteristics for the temperature probe NTC-25-10k-100-680.....	91

11.1.2	Resistance characteristics for the temperature probe NTC-25-10k-100-970.....	92
11.1.3	KTY 110/130 Temperature range -50°C....+150°C All resistance value in $\Omega$ .....	93
11.1.4	KTY 81-1 Temperature range -55°C....+150°C All resistance value in $\Omega$ .....	94
11.1.5	KTY 81-2 Temperature range -55°C....+150°C All resistance value in $\Omega$ .....	94
11.1.6	NI1000 Temperature range -50°C....+690°C All resistance value in $\Omega$ .....	95
11.1.7	NI1000TK5000 Temperature range -50°C....+690°C All resistance value in $\Omega$ .....	97
11.1.8	PT100 Temperature range -200°C....+850°C All resistance value in $\Omega$ .....	99
11.1.9	PT500 Temperature range -200°C....+850°C All resistance value in $\Omega$ .....	102
11.1.10	PT1000 Temperature range -200°C....+850°C All resistance value in $\Omega$ .....	106
11.1.11	TC Typ B Temperature range 0°C....+1820°C All resistance value in mV .....	109
11.1.12	TC Typ E Temperature range -90°C....+780°C All resistance value in mV .....	112
11.1.13	TC Typ J Temperature range -100°C....+1020°C All resistance value in mV .....	114
11.1.14	TC Typ K (Ni-CrNi) Temperature range -150°C....+1370°C All resistance value in mV ...	116
11.1.15	TC Typ L (Fe-CuNi) Temperature range -105°C....+900°C All resistance value in mV ....	119
11.1.16	TC Typ N Temperature range -270°C....+1300°C All resistance value in mV .....	121
11.1.17	TC Typ R Temperature range 0°C....+1760°C All resistance value in mV .....	124
11.1.18	TC Typ S (Pt-RhPt) Temperature range 0°C....+1760°C All resistance value in mV.....	127
11.1.19	TC Typ T Temperature range -160°C....+400°C All resistance value in mV .....	130

# Imprint

©2015 by elrest Automationssysteme GmbH  
All rights reserved

## **elrest Automationssysteme GmbH**

Leibnizstraße 10  
732320 Kirchheim unter Teck  
Germany

Phone: + 49 (0) 7021 / 92025-0  
Fax: + 49 (0) 7021 / 92025-29

e-mail: [vertrieb@elrest.de](mailto:vertrieb@elrest.de)  
Web: <http://www.elrest.de>

## **Technical Support**

Phone: +49 (0) 7021 / 92025-33  
Fax: +49 (0) 7021 / 92025-29  
e-mail: [support@elrest.de](mailto:support@elrest.de)

This document was carefully created, in order to ensure the correctness and completeness of the documentation.  
Since, in spite of all the care taken, errors can never be completely avoided, we are always grateful for advice and suggestions.

# 1 General

## 1.1 Preface

This manual contains texts, illustrations and explanations for the correct installation and operation. This manual must be read and considered before installation and employment of the devices.

This documentation is mainly directed towards qualified personnel to control and automation technology. They must be well acquainted with the current standards and guidelines.

If you have any questions about the installation, application and operation, please contact the *elrest* customer hotline:

Phone: 07021/92025-33

Fax: 07021/92025-59

E-Mail: [hotline@elrest.de](mailto:hotline@elrest.de)

or contact your responsible agency.

This manual is published subject to any changes. Changes can be made without reference.

## 1.2 Liability

The documentation was carefully compiled.

All examples and illustrations in this manual serve only as assistance for understanding the text. Changes without references can be made. We do not assume any liability for the correctness of the represented operations. No claims for the modification of products that have already been supplied may be made on the base of the texts, explanations and illustrations in this documentation. *elrest* Automationssysteme GmbH takes on no responsibility for an application of products, which refers to the represented examples (e.g. in eStudio demo).

*elrest* Automationssysteme GmbH assumes under no circumstances the liability or responsibility for damage, which resulted from an inappropriate installation, respectively an application of the devices or the accessories.

The staff must ensure that the installation and the application of the products according all of the safety requirements, laws, regulations and standards

In each case the national regulations and the valid safety regulations have to be considered.

Interferences and changes in the devices automatically render the warranty void.

## 1.3 Security regulations and safety precautions

This manual was provided for trained and competent personnel. The qualification is defined by the European guidelines for machines, low-voltages and EMV. The connection and the assembly of the devices can be carried out only via an electrical specialist, if the voltages are higher than the Safety Extra Low Voltage (SELV).

In each case the national regulations and the valid safety regulations have to be considered. Interferences and changes in the devices automatically render the warranty void.

Due to the large number of different applications for these devices, you must adapt yourself for your particular application.

If circuit components should fail, appropriate safety devices must ensure that the attached periphery is stopped.

Do not try to repair the devices themselves or exchange electrical parts. Please turn exclusively to the elrest service department. You can contact us on the elrest-hotline.

Consider the local, national standards and regulations during the installation and the employment of the devices.

The relevant regulations (VDE etc.) while handling electrical system are to be considered:

- To activate
- Prevent unintentional restart
- The unit must be deenergized
- Ground and short-circuiting
- No ground-loops.
- Cover or shield nearby live electric parts.

## 1.4 Copyright

Copyright © 2015 elrest Automationssysteme GmbH (in further consequence “elrest” mentioned) all rights are reserved.

All parts of the software and the documentation are subject to copyright. The software described in this manual must be used exclusively in the context of the license terms.

No part of the documentation and software may be reproduced or assimilated by use an electronic data processing system, reproduced or spreaded in any form without a written permission of the company elrest (pressure, photocopy, microfilm or another procedure). The expressly exceptional cases, named in the paragraphs 53 und 54 UrhG, are not affected.

All measures have been taken to ensure the correctness and completeness of the information in this documentation. Nevertheless errors cannot be excluded. The company elrest cannot assume legal responsibility or any liability for damage, which results from the use of information from this manual or from the use of the program described in this documentation.

The product names mentioned in this manual are trade marks or registered trade marks of the respective manufacturing firms and are hereby accepted.

The information, contained in this document, may be changed without advance notice and represents no obligation on the part of elrest.

## 1.5 Symbols

In this manual different symbols are used for the emphasis of certain information. Hereby the service personnel receive necessary references to the safety and preventive measures. With each occurrence of the symbols the associated reference has to be read.



Indicates a directly threatening danger situation which may result in damage to persons or property.



Indicates a possibly arising danger, which may result in damage to persons or property.



Indicates notes, thereby the handling gets easier.

DANGER

Personal injury caused by electric current!



Indicates a high-risk, imminently hazardous situation which, if not avoided, will result in death or serious injury.

DANGER

Personal injury caused by electric current!



Indicates a high-risk, imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Warning of damage to persons



Indicate a possible danger with moderate risk that can result in death or (severe) bodily injury if it is not avoided.

CAUTION

Warning of damage to persons



Indicates a low-risk, potentially hazardous situation which, if not avoided, could result in slight to moderate injury.

CAUTION

Warning of damage to material



Indicates a possible danger which can result in material damage, when it cannot be avoided.

ESD

Damage to Property Caused by Electrostatic Discharge (ESD)!



Indicates a potentially hazardous situation which, if not avoided, may result in damage to property



NOTICE

Important Note!



Indicates a potential malfunction which, if not avoided, however, will not result in damage to property.

INFORMATION

Further information



Refers to further information, which is not a substantial component of this documentation (e.g. Internet)



ST

(\* comment to CoDeSys code lines \*)

```
a := a+1;
```

## 1.6 Safety instructions

For installing and operating purposes of the relevant device to your system the following safety precautions shall be observed:

DANGER

Don't assembly the devices under voltage!



Always switch off the power supply before assembling the device, eradicating defaults or carrying out maintenance operations.

DANGER

Take note of the general regulations on prevention of accidents!



Take note of the relevant regulations on prevention of accidents, e.g. the regulations during installation and commissioning of BGV A 3 "electrical installations and equipment" for mounting, installation and eradicating defaults.

DANGER

Take note of connection in compliance with the standard!



To avoid risks of the staff and the disturbances on the device, install the data- and the supply line conforming to standards. Take note of the correct assignment of connections. Observe the relevant EMC directives for your application.

ATTENTION

Replace defective or damaged device!



Replace defective or damaged device/module (e.g., in the event of deformed contacts), since the long-term functionality of fieldbus station involved can no longer be ensured.

ATTENTION

Shield the devices from creeping and isolating materials!



The components are not resistant against materials which have creeping and insulating properties such as: aerosols, silicones and triglycerides (found in some hand creams). If it cannot be excluded that this substances are in the environment of the device, incorporate the device in a cage which is resistant against the above-named substances. Always use proper tools and materials for the maintenance.

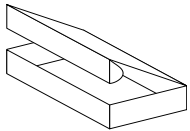
## 1.7 Before you start...

Before switching- on the supply voltage, please check definitely:

- The wiring
- Possible interference
- Free circulation around the heatsink

## 1.8 Storage, transport and packaging

The delivery has to be checked for completeness after the receipt. Possibly determined transport damages shall be notified to the shipping company and the manufacturer immediately. In the case of a possible temporary storage it is recommended to use the original packaging. The storage must be clean and dry. According the §BGB §446 and §448, the transfer of perils of the purchased product will pass to the buyer from invoicing. elrest does not assume any liability for the transport risk. If the carrier's liability of the transport enterprise does not cover the commodity value, it is incumbent on the buyer to conclude an additional transport insurance.



The devices are delivered in a suitable packing. To avoid damages please remove the packing before using the device. If the packing includes further accessories or descriptions, consider and keep them absolutely.

## 1.9 Warranty

A warranty claim presupposes a professional assembly and start-up, based on a valid assembly-, commissioning instruction and the operating instructions. The necessary assembly, start-up and maintenance work may be accomplished only by adept and authorized persons. See our EULA regulations too.

### Manufacturer

elrest  
Automationssysteme GmbH  
D-73230 Kirchheim unter Teck  
  
Leibnizstraße 10  
  
Phone: +49 (0) 7021/92025-0  
Fax: +49 (0) 7021/92025-29

### Trademark



### Country of origins

Germany

## 1.10 Application area

The CANopen Slave reads and sets analog and digital inputs. The relevant information is transferred via the CANopen protocol. The Slave can be set in any CANopen network.

### 1.10.1 Intended use

The devices are intended for the use in the ranges of the regulation, control and automatic control engineering.

Within all ranges, particularly when using inductive loads (e.g. engines and relay etc.), it must be guaranteed that arising voltage peaks don't exceed the maximum input voltages of the entrances and exits. If necessary, external protecting circuit parts must be installed.

The devices are exclusively intended for the installation in machines and plants. Start-up is forbidden until the conformity of the final product with the guideline 2006/42/EG „machine guideline “is determined.

With certain devices external measures (e.g. a special power supply) can be necessary, in order to achieve the required interference immunity against surge). In this case, it will be pointed out at the respective device.

It will be applied accordingly to the appropriate device, if external measures are necessary for the minimization of the radiated interference.

Further the environment can affect the radiated interference.

Fulfills a device the “higher” engineer standards (e.g. EN 61000-6-3:2007 generic standard emission: Living quarters, business and industrial areas and small enterprises), it will be applied accordingly to the appropriate device (see to chapter „data sheets “).



Warning!

This is a Class A product. In a domestic environment it may cause radio interference, in which case the user may be required to take adequate measures.

Designates a possibly arising danger, which can lead to a damage to property or person

### 1.10.2 Structure of the robusto control RSC123

Uniform structure of the robusto device:

- Robust aluminium heat sink housing
- Rail mounting
- Status LED for optical control of the operating status
- Plugs can be installed
- RJ45 sockets for interface connection

### 1.10.3 Configuration

A CANopen communication level is available.

The selected configuration of the hardware must be accord the setting of the peripheral components. Malfunctions may otherwise occur, if no safty prompts are programmed in the application.



A slave module can only be (dis-)connected to the system in the power-off state of all system components.

## 2 Implementing

### 2.1 Mechanical installation

Safety notes at the workplace:

Before installing and starting up, the manual must be read and followed carefully. The relevant EN and VDE regulations are valid.



Before starting up, adapt the device to the room temperature. By condensation you are allowed to switch on the device only after it is completely dry.

To prevent the device from overheating:

- avoid direct sun contact to the device,
- do not cover the vents
- ensure sufficient air circulation

#### 2.1.1 *Required space*

During installation, please ensure sufficient access to the device for the operator and maintenance work. Care must be taken for sufficient air ventilation.









#### 2.1.2 *Installation / Assembly*

The valid local, and in particular, electrical safety regulations must be kept.

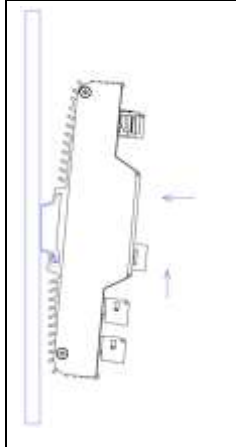
Safety notes at the workplace:

- The devices are intended for installation in switching cabinets;  
(in general switching cabinets made of steel)
- The protection rating IP20 has to be warranted;
- Unless otherwise indicated, the devices may only be installed perpendicular.
- The installation point has to be in a solid position with low vibration.

### 2.1.2.1 Assembly/Disassembly of the RSC123

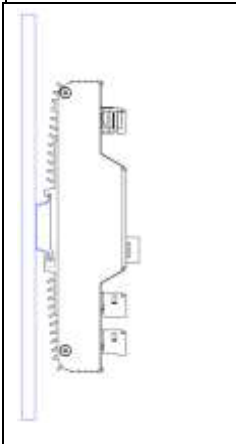
	<p>The RSC123 is mounted on a 35 mm top hat rail acc. DIN EN 60715</p> <p>Bring the system into a safe, de-energized state before starting installation, disassembly or wiring of the device!</p> <p><b>THE TOP HAT RAIL MUST BE CONNECTED TO THE PROTECTON EARTH (PE).</b></p>		
	<p><b>The device must be installed vertically</b></p>		
	<p>The ground from the RSC123 has to be connected with the PE on the switch cabinet. The device will be connected via X1 (power supply). When connecting and disconnecting cables, which require a great effort, the device must be hold in the top hat rail, so that no tear out of it is possible. The device must be connected via X1 and the fitting in the housing cover, corresponding low- resistance, to the PE.</p>		
	<p>The RSC123 must be included in the earth concept via its protective earth (PE) connection.</p> <p>Connect the top hat rail with PE power supply X1 and PIN3 with PE. The cable screens of the communications ports X27 /CAN IN, X28 /CAN OUT are connected with their mating connectors to the PE. The housing of the RSC123 must be connected via the screw connection (on the cover), corresponding low- resistance to the PE. The screws are tightened. The output current of 3 A must be protected. (max. 10 A for each terminal block)</p>		
 	<p>Do not connect the relays as a multi-phase use. Only 1 phase can be connected on a terminal block.</p> <p>Only connect low-voltage circuits <b>or</b> extra-low voltage circuits on a terminal block (never together). The stripping length of the cables according the terminal data must be strictly observed.</p>		

## Assembly:



Keep the RSC123 over the top hat rail, so that the top hat rail applies in a right angle to the rear side of the device.

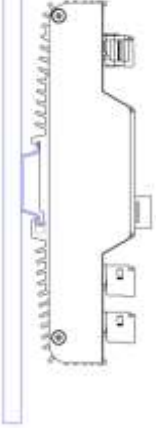

Put the device into the top hat rail and push against the spring force of the splay, till the upper part of the profile snaps over the upper part of the top hat rail.



Release the device; it must fit free and robust on the top hat rail.

Check the best fit by easy attempts at movement of the device.

## **Disassebly:**

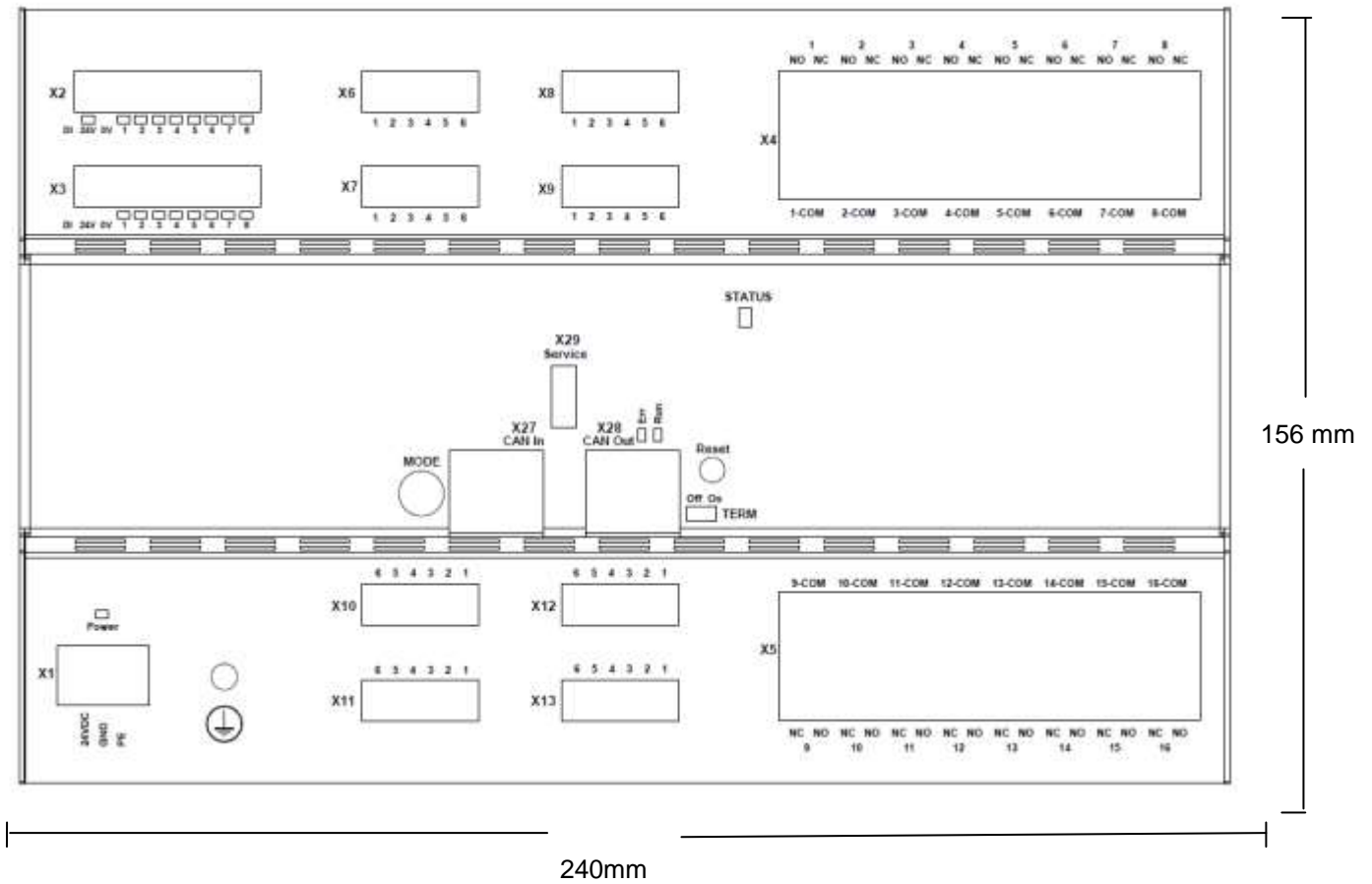
	<p>All connecting plugs must be removed before the disassembly.</p> <p>For the disassembly push up the device, till the device can be tipped forward for the release</p>
	<p>Push the device against the spring force of the splay till it can released from the upper part of the top hat rail.</p> <p>In this moment the device is no longer kept from the top hat rail, it must keep hold of you to avoid falling down.</p> <p>Lower the device and remove it from the top hat rail.</p>

### **2.1.3 Cooling**

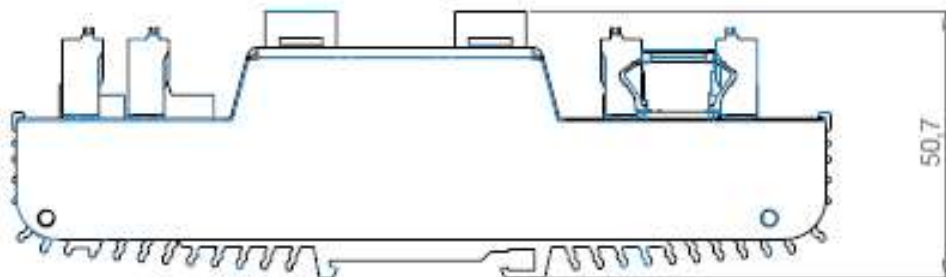
Passive heat sink: Cooling is achieved via the robusto heat in the backside of the device.



### 2.1.4 Dimension drawing front view



### 2.1.5 Dimension drawing side view



## 2.2 Elektrical Installation

### 2.2.1 Supply voltage

Proceed with start-up generally as follows:

- Attach the devices to the power supply.
- Attach the supply voltage for the device to X1.
- Turn the power supply on



The supply voltage connection of the control component from the device has polarity protection.

If several connection points are available for the identical potential, than no potential difference between them is allowed. Otherwise, the resulted compensation currents can lead to irreversible damages of the device. Therefore, provide a suitable equipotential bonding!



For the 24 V – supplier ensure a reliable electrical isolation of the low voltage. Only use power supply units manufactured to the standards IEC 364 - 4 - 41 / HD 384.04.41 (VDE 0100 Part 410).

Only use power supply units in accordance with SELV and PELV specifications!

The supply voltage may be intermediate within the specified voltage range! Otherwise this may cause malfunction on the device. See the technical specifications for the supply voltage requirements.



High frequency radiation, from mobile phones for example, can cause unintentional operating situations.

#### 2.2.1.1 Connectors for power supply

For the connectors X1, X2, X3, X6 – X13 und X29 only use the specified manufacturer types, not analog connectors can damage the pin connectors.

For the CAN interfaces can be used commercially connectors with good quality.



The connectors may not be separated while under load!

Faulty or incorrect connection may cause malfunction on the device

### 2.2.2 EMC-compliant design

The basis for an interference-free operation is an EMC-compliant hardware construction of the system, as well as the use of interference-free cables. The guidelines for interference-free installation of your system are accordingly to the installation of the RSCxxx devices.



For all signal connections are allowed only protected lines.

- All plug connectors must be screwed or locked;
- Signal lines and high-voltage cables are not allowed to lead both in the same cable duct;
- For malfunctions and damages caused by the use of unsuitable cable, no liability can be accepted;
- Unused signals (e.g. unused interfaces, battery connections, etc.) have to be adequate covered to avoid electrostatic influences (ETUC/ESD);
- Cables only plug in/off when the device is turned off.
- During the operation, all unit- connected cables must be connected to a remote peer.

### 2.2.3 Connections to other CANopen devices

Establish the connection as follows:

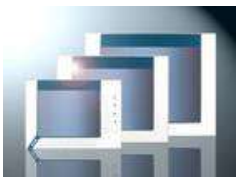
**Article number:** 25212.0000

MASTER Patch cable  
CM 1xx or 2xx or RJ-45 to RJ-45  
further Slave



**Artikelnummer:** 240020100 25212.0000

Visio control Cable D-Sub-9 to  
PMC4xx RJ-45



The individual accessory components can be gleaned from the chapter „[acesorries](#)“.

## 2.2.4 EGB / ESD- guidelines

### 2.2.4.1 What means EGB/ ESD

Nearly all modern modules are equipped with highly integrated chips or components in MOS technology. These electronic components are very sensitive to overvoltage and therefore to electrostatic discharge.

The international abbreviation for ESD means Electrostatic Sensitive Device.

This symbol is on cabinets, subtracks, or packing boxes and indicates the use of electrostatically sensitive devices and thereby sensitivity by touching the devices:



EGB /ESD sensitive components may be damaged by energies and voltages that are below the limit of human perception. This kind of voltages occurs when somebody, which is not electrostatically discharged, touches a module/chip/component. In most of the cases, the components exposed to such overvoltages can not immediately be detected as defective. Only after long operating of the device may an error occur.

An installation that conforms to EMC requirements as well as the use of interferencefree cables represents a basic requirement in ensuring trouble-free operation.

The directives for interference-free installation of your device also apply for the installation of the HMI device.

### 2.2.4.2 Protective measures against static charge

The most plastics are hard chargeable and therefore must be kept away from ESDs!

Ensure that operators, work area, and packaging have proper grounding when working with ESDs!

### 2.2.4.3 Handling of ESD-Modules

Basically, the electronic boards should be touched only when it's absolutely necessary. Never touch the chip connectors and live conductors of a flat electronic module.

Touch the electronic components **only**, if you are permanently grounded via the ESD wristband, ESD shoes, or shoes with protecting strip in constant touch with an ESD floor.

Discharge your body before touching any electronic module. For example, by touching electrically conductive and grounded material (e.g. grounded bare metal cabinet parts, water pipes...).

Electrostatic sensitive components or modules must not get in contact with materials which are chargeable including all standard types of plastic, desk top, and clothes with synthetical material and so on. Components must only be placed on conductive surfaces.(table with ESD- layer, ESD conductive cellular material, ESD packaging, ESD container)

Do not place the components near visual displays and monitors or television sets. (Keep a minimum distance of 10 cm)

### 2.2.5 Guidelines

The conformity of the above specified products with the provisions of the Directive 2006/42 /EG is supported by the respect of the following standards:

#### 2.2.5.1 Product standard

Household and similar electrical appliances - Safety - Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers (IEC 60335-2-40:2002, modifiziert + A1:2005, modifiziert + A2:2005, modifiziert + Korrigendum 1:2006)

#### 2.2.5.2 Immunity

Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments (IEC 61000-6-2:2005)

#### 2.2.5.3 Interference immunity

Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments

Suppression level according to EN EN 55011 Class A

## 2.2.6 Label

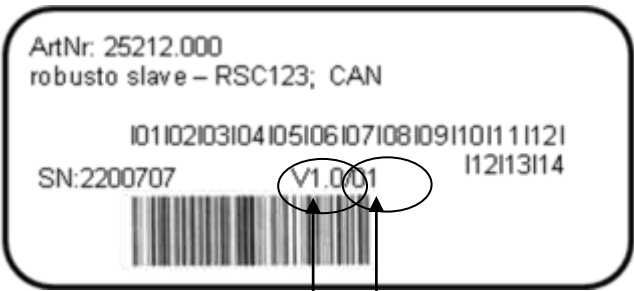
Each device has on the back side an individual series label, which identifies the device.

The serial label includes the following information:

- article number
- article description
- additional text
- serial number
- index
- month of delivery
- year of delivery

The index Vx.x/yy splits in

- x.x hardware status
- yy software status



Note for devices with the index = „ PROTOTYPE”.  
Prototypes are used only for test purposes.

## 3 System overview

### 3.1 Products

[elrest-products](#)



[combo](#)  
[robusto](#)



[visio terminal](#)  
[visio control](#)



[motion](#)



[Software](#)

### 3.1 Communication interfaces



CANopen is a widespread layer7 protocol for the automation. Serial interface for monitoring absolute position values of an encoder.

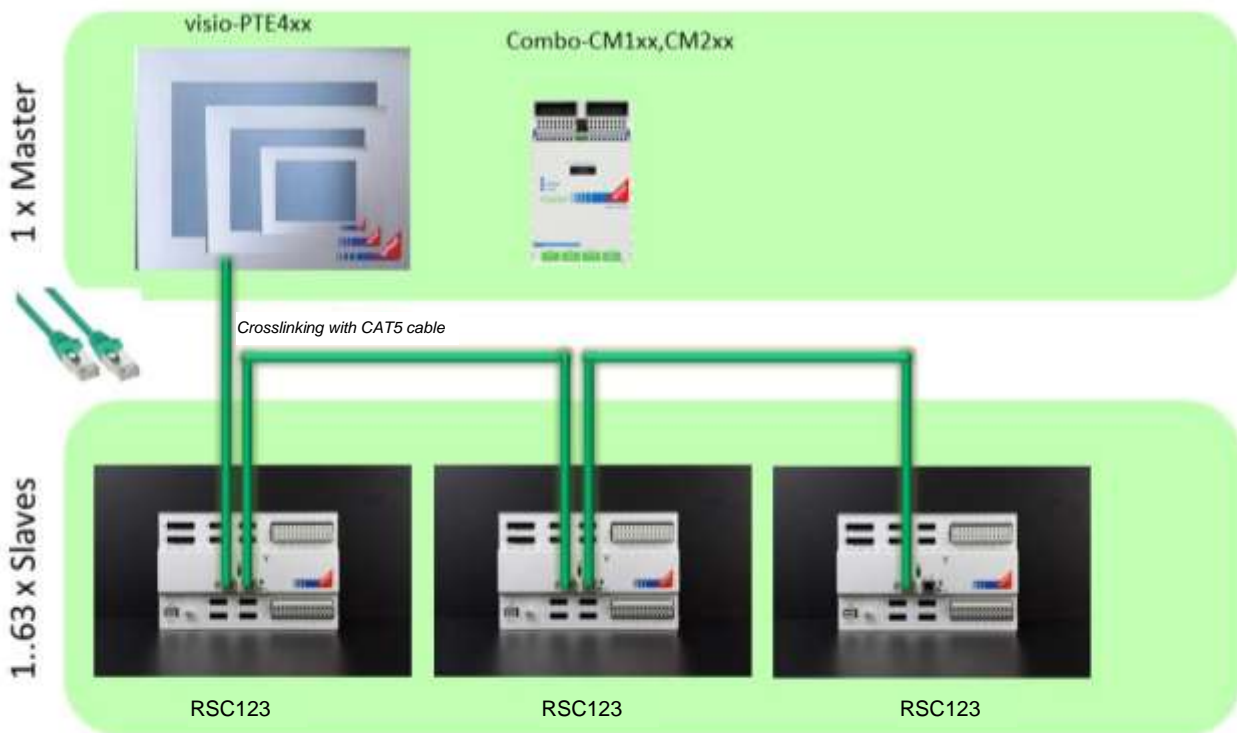


An open fieldbus interface to any CAN protocols, e.g. Truck-Norm J1939-base

#### Availability

The CAN interface is designed as a CANopen interface.

#### 3.1.1 Crosslinking with CANopen



A CAN- network can consist maximum of 127 participants, without a repeater 64 participants.  
The CAN physics allows a length of maximum 1000m @ 50 kBaud



## 4 Device description

### 4.1 Technical data RSC123

PRE-VIEW

robusto control

Data sheet robusto slave RSC123

**elrest**<sup>®</sup>  
Wir steuern  
Ihren Erfolg



symbolic illustration



- 16 digital In- and 16 digital Outputs (Relais)
- 16 analog In- or 16 analog Outputs

Specification	
Processor	32 Bit Cortex-M4 CPU 180 MHz with CAN
Memory	0,25 MByte RAM, 2 MByte Flash , 8 kByte Eeprom
Interface	
Field bus interface	1 x CAN acc. ISO 11898 with galvanically isolation (2 x RJ45 In/Out)
Functions	
CANopen Slave	Software implementation on one of the CAN interfaces
Bestell-Nr.:	
25212.0000	robusto slave - RSC123; 16DI, 16DO, 16AIO
Environment/ mechanical values	
Supply voltage	24 VDC (-15% / +20%) SELV with reverse polarity
Housing	robusto heat sink with device lid
Protection class	IP20, acc. EN 60529
Mounting	snap-in mounting on top-hat rail DIN50022
Outside dimensions in mm (w x h x d)	approx. 240 x 156 x 50
Weight app.	500 g
oper	0 °C...55 °C
Storage temperature	-20°C... 70°C
Relat	10%...85% non-condensing
Relat	5%...85% non-condensing
Cooling	Passive heat sink
Diagnostic	
LED's	LEDs for operating- and status reports; LED Power; LED status I/O
Digital Inputs	
Number	16
Input voltage	24 VDC without galvanically isolation, EN61131-2 type 3
Frequency max.	100 Hz +/- 20%, duty cycle high/low:1:1
Over voltage	33 V
Dissipation loss	0,2 watt per input
Connection	2 x socket 10-pole; contact spacing 3,5 mm, flexible: conductor cross section 0,5 ... 1,0 mm <sup>2</sup> rigid: conductor cross section 0,75... 1,5mm <sup>2</sup> WAGO: 250-716

Digital Outputs (Relais)																																																																																																	
Number	16 x relais, potential free																																																																																																
Output voltage	230 VAC, switching voltage																																																																																																
Output current	3 A (max. 10 A per terminal block), must be fused externally																																																																																																
Switching frequency Ohm/inductive	10 Hz																																																																																																
Connection	2 x socket 32-pole; contact spacing 5 mm, flexible: conductor crosssection 0,5 ... 1,0 mm <sup>2</sup> , starr: conductor cross section 0,75 ... 1,5 mm <sup>2</sup> , WAGO: 250-716																																																																																																
Analog In- and Outputs																																																																																																	
Number	16																																																																																																
Analog input types of sensors :	KTY81-1, KTY81-2 Ni1000, Ni1000-TK5000 PT100, PT1000, PT500 (2- oder 3-wire) TC (B,E,J,K,L,N,R,S,T) NTC Voltage : - 10...+ 10 VDC Current : 0...+ 20 mA Resistance: 0...200 kOhm																																																																																																
Analog output types of sensors :	Voltage : - 10...+ 10 VDC Current : 0...+ 20 mA																																																																																																
Accuracy	± 80 µA over input current 0..20 mA ± 40 mV over input voltage 0..10 V																																																																																																
Conversion time	100 ms of all analog channels																																																																																																
Current measuring range	Ain 0(4)...20 mA Aout 0(4)...20 mA																																																																																																
Voltage measuring range	Ain -10...10 V Vout -10...10 V																																																																																																
Temperature measuring range	-55...150°C *KTY81-1 -55...150°C *KTY81-2 -50...150°C *KTY110/130 -20...150°C NTC10K <sup>1</sup> -60...690°C *NI1000 -60...690°C *NI1000TK5000 -200...850°C PT100 -200...850°C *PT500 -200...850°C PT1000 0...1820°C *TC Typ B -90...780°C *TC Typ E -100...1020°C *TC Typ J -150...1370°C TC Typ K (Ni-CrNi) -105...1010°C *TC Typ L (Fe-CuNi) -270...1300°C *TC Typ N 0...1760°C *TC Typ R 0...1760°C *TC Typ S (Pt-RhPt) -160...400°C *TC Typ T 0...200 kOhm resistance																																																																																																
AD converter analog input	12-bit																																																																																																
D/A-converter analog output	12-bit																																																																																																
Current	0,1 A																																																																																																
Conversion time	100 ms of all analog channels																																																																																																
	<table border="1"> <thead> <tr> <th>Range:</th> <th>Type:</th> <th>Resolution:</th> <th>Genauigkeit</th> </tr> </thead> <tbody> <tr> <td>0(4)...20 mA</td> <td>Ampere</td> <td>11µA/digit</td> <td>± 80µA □</td> </tr> <tr> <td>0(4)...20 mA</td> <td>Ampere</td> <td>12µA/digit</td> <td>± 180µA □</td> </tr> <tr> <td>-10...10 V</td> <td>Volt</td> <td>6mV/digit</td> <td>± 40mV □</td> </tr> <tr> <td>-10...10 V</td> <td>Volt</td> <td>6mV/digit</td> <td>± 40mV □</td> </tr> <tr> <td>-55...150°C</td> <td>*KTY81-1</td> <td>0,21°C/digit</td> <td>± 1,5°C □</td> </tr> <tr> <td>-55...150°C</td> <td>*KTY81-2</td> <td>0,42°C/digit</td> <td>± 3°C □</td> </tr> <tr> <td>-50...150°C</td> <td>*KTY110/130</td> <td>0,42°C/digit</td> <td>± 3°C □</td> </tr> <tr> <td>-20...150°C</td> <td>NTC10K<sup>1</sup></td> <td>nicht linear</td> <td>tb.d. □</td> </tr> <tr> <td>-60...690°C</td> <td>*NI1000</td> <td>0,85°C/digit (at 1 mA)</td> <td>± 6°C □</td> </tr> <tr> <td>-60...690°C</td> <td>*NI1000TK5000</td> <td>0,85°C/digit (at 1 mA)</td> <td>± 6°C □</td> </tr> <tr> <td>-200...850°C</td> <td>PT100</td> <td>0,7°C/digit (bei 1 mA)</td> <td>± 4°C □</td> </tr> <tr> <td>-200...850°C</td> <td>*PT500</td> <td>0,65°C/digit</td> <td>± 4,5°C □</td> </tr> <tr> <td>-200...850°C</td> <td>PT1000</td> <td>0,59°C/digit</td> <td>± 4°C □</td> </tr> <tr> <td>0...1820°C</td> <td>*TC Typ B</td> <td>2,475°C/digit</td> <td>± 10°C □</td> </tr> <tr> <td>-90...780°C</td> <td>*TC Typ E</td> <td>0,255°C/digit</td> <td>± 1,5°C □</td> </tr> <tr> <td>-100...1020°C</td> <td>*TC Typ J</td> <td>0,33°C/digit</td> <td>± 2°C □</td> </tr> <tr> <td>-150...1370°C</td> <td>TC Typ K (Ni-CrNi)</td> <td>0,465°C/digit</td> <td>± 2,5°C □</td> </tr> <tr> <td>-105...1010°C</td> <td>*TC Typ L (Fe-CuNi)</td> <td>0,33°C/digit</td> <td>± 2°C □</td> </tr> <tr> <td>-270...1300°C</td> <td>*TC Typ N</td> <td>0,525°C/digit</td> <td>± 2°C □</td> </tr> <tr> <td>0...1760°C</td> <td>*TC Typ R</td> <td>1,575°C/digit</td> <td>± 7°C □</td> </tr> <tr> <td>0...1760°C</td> <td>*TC Typ S (Pt-RhPt)</td> <td>1,8°C/digit</td> <td>± 8°C □</td> </tr> <tr> <td>-160...400°C</td> <td>*TC Typ T</td> <td>0,375°C/digit</td> <td>± 2°C □</td> </tr> <tr> <td>0...200 kOhm</td> <td>resistance</td> <td>in preparation</td> <td></td> </tr> </tbody> </table>	Range:	Type:	Resolution:	Genauigkeit	0(4)...20 mA	Ampere	11µA/digit	± 80µA □	0(4)...20 mA	Ampere	12µA/digit	± 180µA □	-10...10 V	Volt	6mV/digit	± 40mV □	-10...10 V	Volt	6mV/digit	± 40mV □	-55...150°C	*KTY81-1	0,21°C/digit	± 1,5°C □	-55...150°C	*KTY81-2	0,42°C/digit	± 3°C □	-50...150°C	*KTY110/130	0,42°C/digit	± 3°C □	-20...150°C	NTC10K <sup>1</sup>	nicht linear	tb.d. □	-60...690°C	*NI1000	0,85°C/digit (at 1 mA)	± 6°C □	-60...690°C	*NI1000TK5000	0,85°C/digit (at 1 mA)	± 6°C □	-200...850°C	PT100	0,7°C/digit (bei 1 mA)	± 4°C □	-200...850°C	*PT500	0,65°C/digit	± 4,5°C □	-200...850°C	PT1000	0,59°C/digit	± 4°C □	0...1820°C	*TC Typ B	2,475°C/digit	± 10°C □	-90...780°C	*TC Typ E	0,255°C/digit	± 1,5°C □	-100...1020°C	*TC Typ J	0,33°C/digit	± 2°C □	-150...1370°C	TC Typ K (Ni-CrNi)	0,465°C/digit	± 2,5°C □	-105...1010°C	*TC Typ L (Fe-CuNi)	0,33°C/digit	± 2°C □	-270...1300°C	*TC Typ N	0,525°C/digit	± 2°C □	0...1760°C	*TC Typ R	1,575°C/digit	± 7°C □	0...1760°C	*TC Typ S (Pt-RhPt)	1,8°C/digit	± 8°C □	-160...400°C	*TC Typ T	0,375°C/digit	± 2°C □	0...200 kOhm	resistance	in preparation	
Range:	Type:	Resolution:	Genauigkeit																																																																																														
0(4)...20 mA	Ampere	11µA/digit	± 80µA □																																																																																														
0(4)...20 mA	Ampere	12µA/digit	± 180µA □																																																																																														
-10...10 V	Volt	6mV/digit	± 40mV □																																																																																														
-10...10 V	Volt	6mV/digit	± 40mV □																																																																																														
-55...150°C	*KTY81-1	0,21°C/digit	± 1,5°C □																																																																																														
-55...150°C	*KTY81-2	0,42°C/digit	± 3°C □																																																																																														
-50...150°C	*KTY110/130	0,42°C/digit	± 3°C □																																																																																														
-20...150°C	NTC10K <sup>1</sup>	nicht linear	tb.d. □																																																																																														
-60...690°C	*NI1000	0,85°C/digit (at 1 mA)	± 6°C □																																																																																														
-60...690°C	*NI1000TK5000	0,85°C/digit (at 1 mA)	± 6°C □																																																																																														
-200...850°C	PT100	0,7°C/digit (bei 1 mA)	± 4°C □																																																																																														
-200...850°C	*PT500	0,65°C/digit	± 4,5°C □																																																																																														
-200...850°C	PT1000	0,59°C/digit	± 4°C □																																																																																														
0...1820°C	*TC Typ B	2,475°C/digit	± 10°C □																																																																																														
-90...780°C	*TC Typ E	0,255°C/digit	± 1,5°C □																																																																																														
-100...1020°C	*TC Typ J	0,33°C/digit	± 2°C □																																																																																														
-150...1370°C	TC Typ K (Ni-CrNi)	0,465°C/digit	± 2,5°C □																																																																																														
-105...1010°C	*TC Typ L (Fe-CuNi)	0,33°C/digit	± 2°C □																																																																																														
-270...1300°C	*TC Typ N	0,525°C/digit	± 2°C □																																																																																														
0...1760°C	*TC Typ R	1,575°C/digit	± 7°C □																																																																																														
0...1760°C	*TC Typ S (Pt-RhPt)	1,8°C/digit	± 8°C □																																																																																														
-160...400°C	*TC Typ T	0,375°C/digit	± 2°C □																																																																																														
0...200 kOhm	resistance	in preparation																																																																																															

	*	in preparation
	†	further types, e.g. NTC1K, NTC2K... adjustable via parameter einstellbar, (see device dedescription)
<b>Standards</b>		
Product standard	EN61131-2	Programmable controllers - Part 2: Equipment requirements and tests (IEC 61131-2:2007); German version EN 61131-2:2007
Immunity and interference	EN61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Emission standard for industrial environments (IEC 61000-6-2:2005); German version EN 61000-6-2:2005
	EN61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments (IEC 61000-6-4:2006 + A1:2010); German version EN 61000-6-4:2007 + A1:2011
<b>Accessories</b>		
25001.0005		<p>Connector set composed of:</p> <p>2x socket 10-pole; contact spacing 3,5 mm, , conductor crossection up to 0,2 ... 1,0 mm², 8 A Serie 714-110</p> <p>8 x socket 10-pole; contact spacing 3,5 mm, , conductor crossection up to 0,2 ... 1,0 mm², 8 A Serie 714-106</p> <p>1 x socket 3-pole , Wago 734-103/037-000</p>
<b>Applications</b>		
		in many industries such as plastics, medical- and automation technology



Illustrations, descriptions, dimensions and specifications correspond to the circumstances or intentions at the time of printing this brochure. Changes of any kind, especially those resulting from technological progress, economic performance or a similar will be without notice. The external interconnection of equipment will be on your own responsibility

\*Remark: The use of standard memory card (e.g. CF-cards is generally possible. Anyhow elrest GmbH does not take any responsibility thereby.

elrest Automationssysteme GmbH • Leibnizstraße 10 • 73230 Kirchheim unter Teck • Tel.: +49 (0) 7021 92025-0

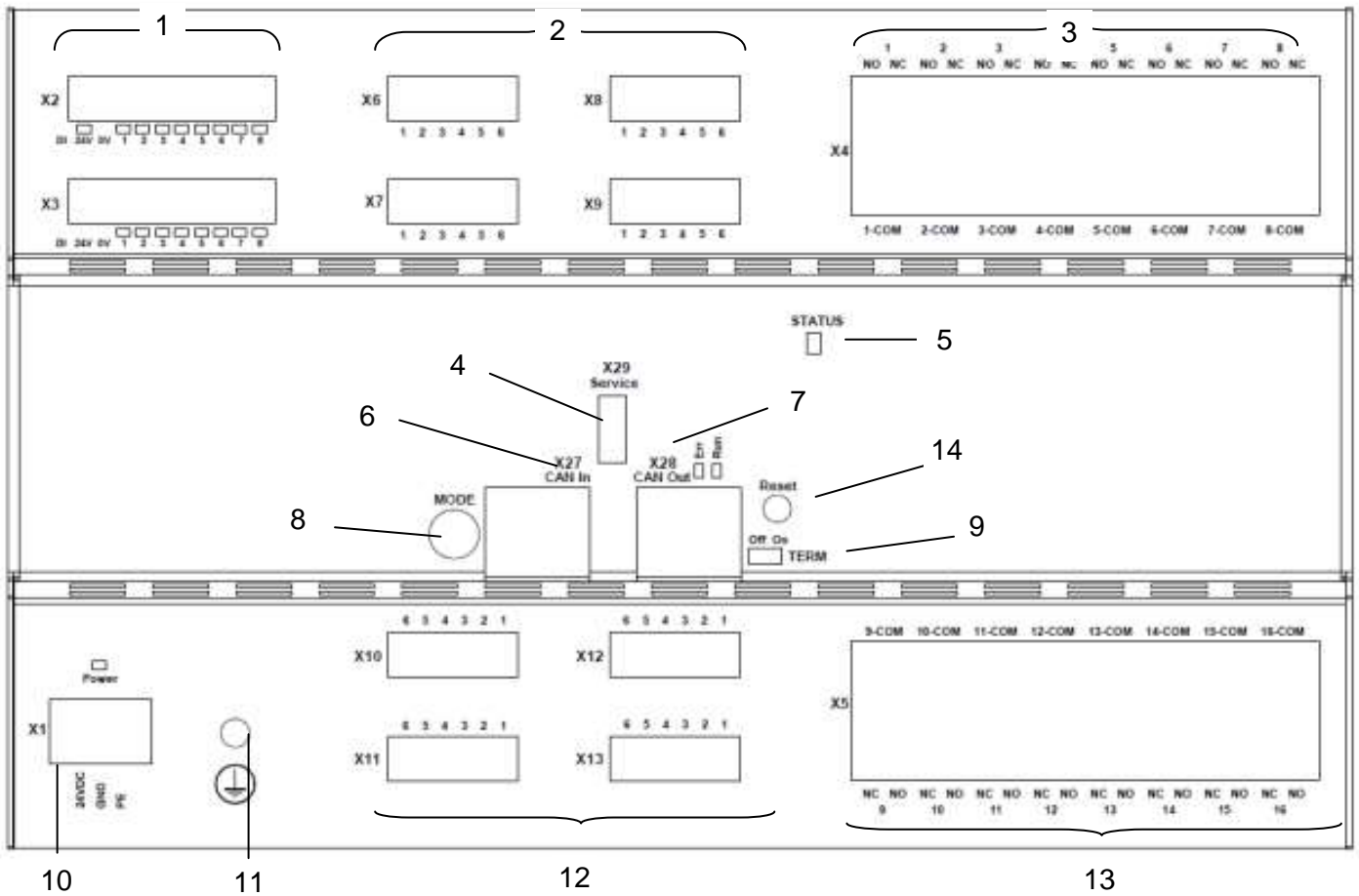
© 2014 • www.elrest.de • All rights reserved

EB01324-1/6



## 4.2 Interfaces

### 4.2.1 Frontview of the interfaces

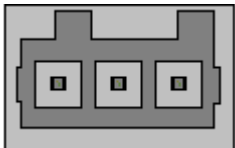



Nr.		Designation
1	X2-X3	Digital inputs
2	X6-X9	Analog in- or outputs
3	X4	Digital outputs (Relais)
4	X29	Service interface
5	STATUS	Status LED
6	X27	CAN IN
7	X28	CAN OUT with LEDs
8	MODE	Hex- switch
9	TERM	CAN terminal resistor 120 Ohm (switched on and off)
10	X1	Power supply with power control light
11	X10- X13	Analog in- or outputs
12	X12	Digital outputs (Relais)
13	Reset switch	After >8 sec. Hardware-Reset

## 4.2.2 Terminal assignment

### 4.2.2.1 X1: power supply

Via this connector the device will be supplied with the operating voltage. The connection is protected against polarity.

	PIN	Configuration
<b>X1</b> 1 2 3 	1	PS-24V
	2	PS-GND-IN
	3	PE 



The pins are additionally marked with its signal-name on the label of the lid.

The control-LEDs „24 V “light up, if the voltage systems are functioning properly.



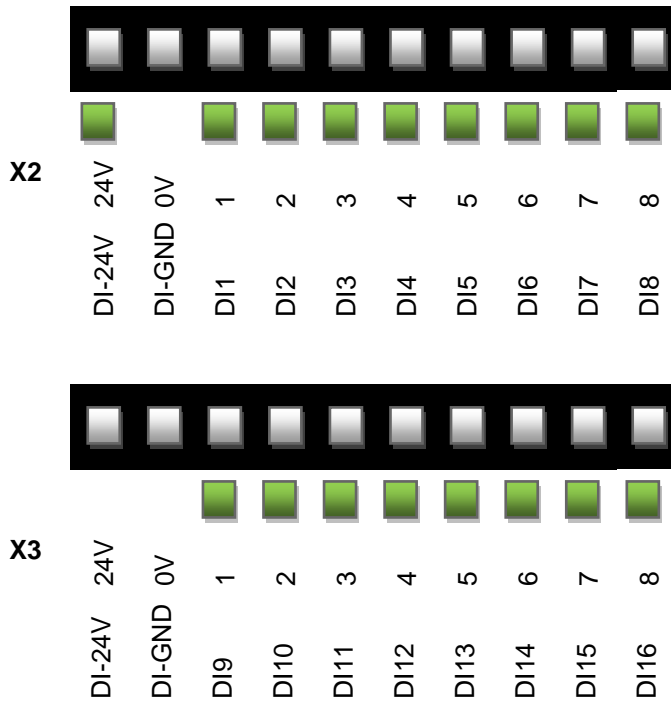
The RSC123 has to be included via its functional earth (FE) in the earthing concept.

- Connecting the top hat rail to FE
- Connecting the Power supply X1 / Pin3 to FE
- The cable screens of the communication ports, X27 /CAN IN, X28 /CAN OUT, are connected with their respective mating plug to FE.
- The housing of the RSC123 must be connected via the screw connection (on the cover), corresponding low- resistance to the PE.
- The lock washer must be located between the lid and loop of the protective earth, and has to be tightened with the screw.

#### 4.2.2.2 X2 – X3 Digital Inputs



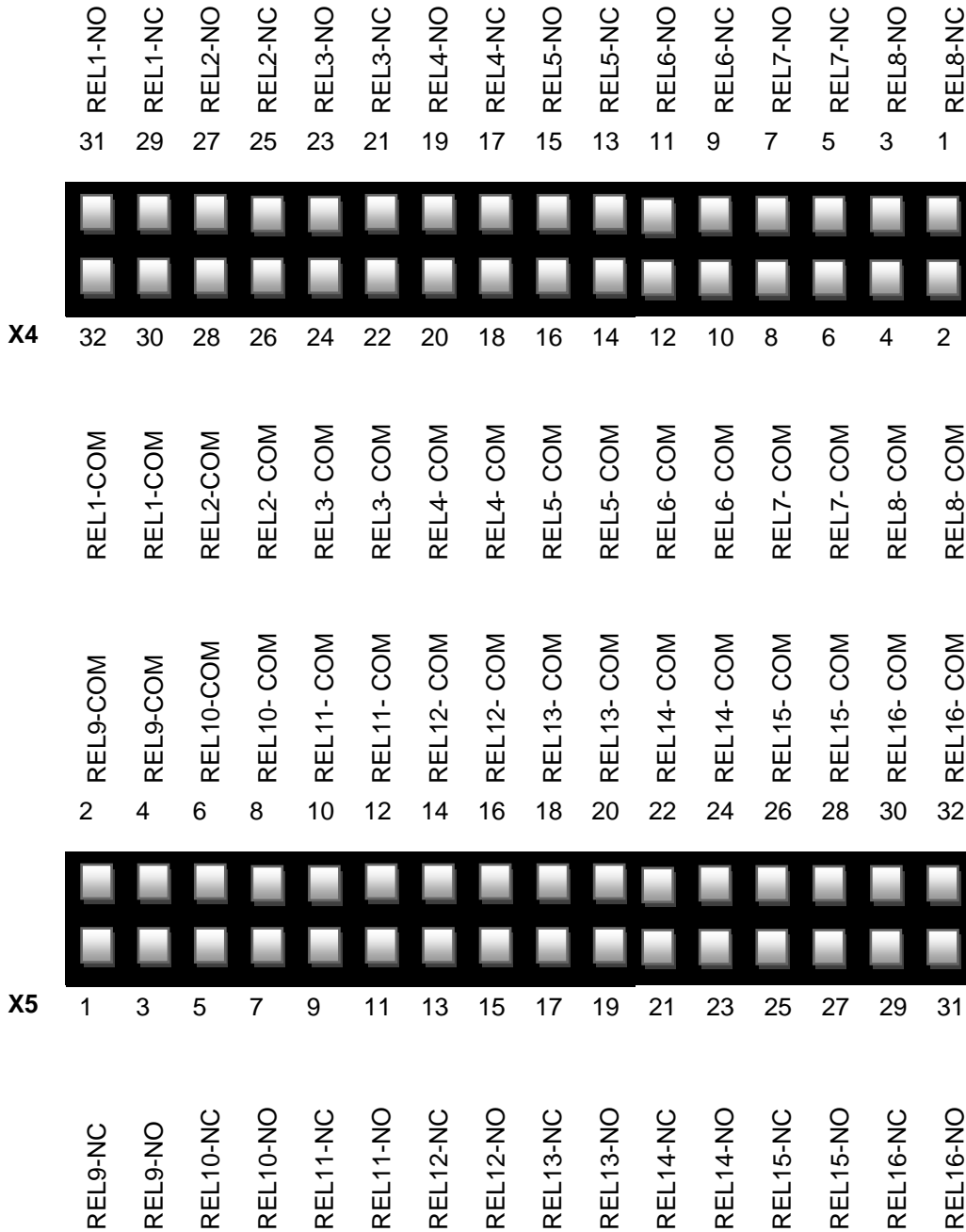
1 LED for power supply 24 V  
16 green LEDs for the inputs  
2 x 10-pole  
WAGO-714-140



### 4.2.2.3 X4 – X5 digital outputs(relais)



2 x 32-pole  
WAGO-250-716



NO = Normal Open (turnkey)  
NC = Normal Connected ( opener)



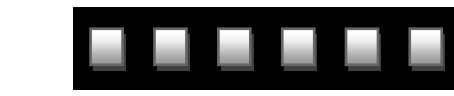
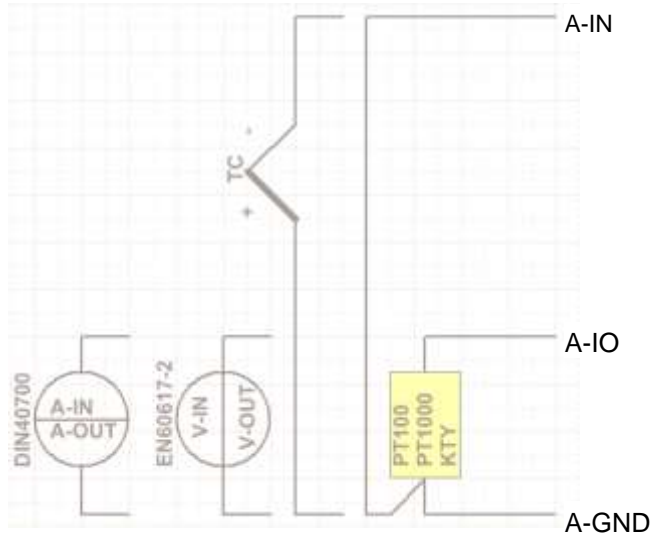
See chapter 2.1.2.1  
Assembly/Disassembly of the RSC123

4.2.2.4 X6– X13 analog in- or outputs  
 16 analog In- or Outputs  
 A 6-pole connector is required for. 2 channels



WAGO-714-136

Extern



**X6** 1 2 3 4 5 6  
 A-IO1 A-IN1 AGND1 A-IO2 A-IN2 AGND1



**X8** 1 2 3 4 5 6  
 A-IO5 A-IN5 AGND1 A-IO6 A-IN6 AGND1



**X7** 1 2 3 4 5 6  
 A-IO3 A-IN3 AGND1 A-IO4 A-IN4 AGND1



**X9** 1 2 3 4 5 6  
 A-IO7 A-IN7 AGND1 A-IO8 A-IN8 AGND1



**X10** 6 5 4 3 2 1  
 AGND2 A-IN9 A-IO9 AGND2 A-IN10 A-IO10



**X12** 6 5 4 3 2 1  
 AGND2 A-IN13 A-IO13 AGND2 A-IN14 A-IO14



**X11** 6 5 4 3 2 1  
 AGND2 A-IN11 A-IO11 AGND2 A-IN12 A-IO12



**X13** 6 5 4 3 2 1  
 AGND2 A-IN15 A-IO15 AGND2 A-IN16 A-IO16



#### 4.2.2.5 X27 CAN IN

This interface is led out via a 8-pole RJ45 connector, and is galvanically isolated from the supply voltage of the device.



PIN	Belegung
1	CAN-L
2	CAN-H
3	GND (Signal Ground für CAN)
4	NC
5	NC
6	NC
7	NC
8	NC

#### 4.2.2.6 X28 CAN OUT

This interface is led out via a 8-pole RJ45 connector, and is galvanically isolated from the supply voltage of the device.

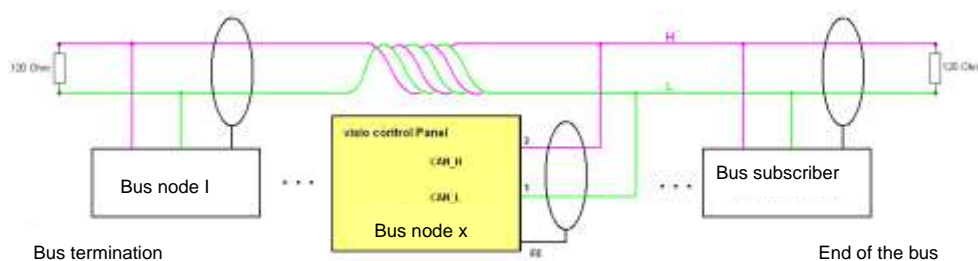


PIN	Belegung
1	CAN-L
2	CAN-H
3	GND (Signal Ground für CAN)
4	NC
5	NC
6	NC
7	NC
8	NC



The CAN interface will be internally supplied and is galvanically isolated. The RJ45 metal body is on the FE- potential (shield connection).

The device has an optionally terminating resistor (Switch „TERM“ = ON / OFF)





Tip for the connector socket on the cable:

Connect only the necessary pins for your application.

Check, if an external terminal resistor is necessary, because of the complete bus structure.

Usually are the termination resistors at the beginning and the end of the bus cable. The resistance value is characterised 120 Ohm.

#### 4.2.2.7 CAN LED

Access CIA Draft Recommendation 303 Part 3: Indicator specification

#### 4.2.3 Power- LED

1 x green:for the power supply of 24 V

#### 4.2.4 Status - LED

The status LED indicates various states by using the hex switch and in the run- modus. The description is given at the respective points of the document.

OFF: the device is off

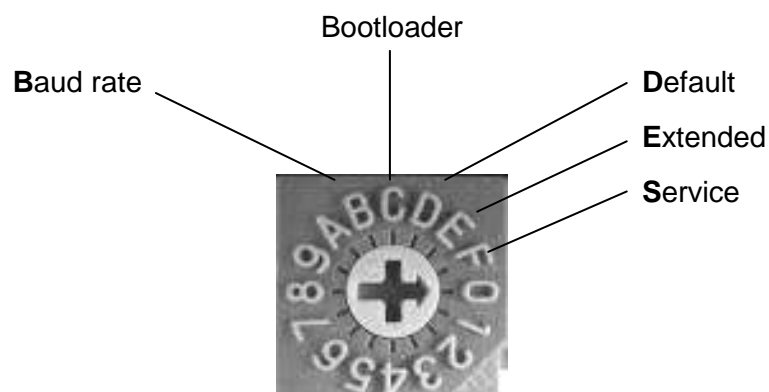
Fast flashing: the control is in the service-mode ,Run-/CAN –Modus

#### 4.2.5 HEX - Schalter (Modi)

The hex- rotary switch is used for the settings of different operation modes and device parameters. The switch position will be taken after a reset of the device.

The different switch positions have the following predefined functionality.

##### 4.2.5.1 Modi



Mode 0...9: Run-Mode:  
CANopen Stack runs  
The unit position of the NodeID corresponds to the switch setting

Mode A: Stop

Mode B: Advanced service-mode(CAN baud rate):  
CANopen Stack is stopped  
Run-LED flashes (ca. 1,2 Hz)

By changing the switch settings 0...5 and remaining for 3 s, the baud rate of the CAN interfaces will be set, after the expiration (3s) the device performs a reset.

Schalterstellung	Baudrate
0	1 MBd
1	500 kBd
2	250 kBd
3	125 kBd
4	100 kBd
5	50 kBd

Mode C Bootloader  
The device changes in the bootloader modus. The firmware can changed via the serial interface.

Mode D Default  
After 3 s all settings will be reset to factory defaults.

- baud rate is set to 125 kBd
- nodeID is zeroised

Mode E: Expanded service-mode (CAN NodeID):  
CANopen Stack is stopped  
Run-LED flashes (approx.. 1,25 Hz)  
By changing the switch settings 0...9 and remaining for 3 s, the tens digit of the CAN NodeID will be set.  
After 3 sec the device is performed a reset.

Mode F: Service-mode:  
CANopen Stack is stopped  
Run-LED flashes (approx. 1,2 Hz)

#### 4.2.5.2 Delivery status

The device is supplied in switch setting „F“. This correspond the service-mode.  
The CANopen stac is stoppped and the device is no active CAN bus device.

#### 4.2.6 *Reset- button*

Hardware: Funktionalität:  $t > 8$  s; hardware- reset

Software: If the reset-button will be pressed longer than 2 seconds during the restart, the firmware will be deleted and the device will be remained in theBootLoader mode.

#### 4.2.7 *Download - plug*

Behind the housing is a plug with a cover.

##### 4.2.7.1 Download - Adapter

With the download – adapter can be executed via CODESYS IDE a firmware-update.



# 5 Software

## 5.1 Software dokumentations

### 5.1.1 General

On our website can download further information:

The [customer link](#) will take you directly to the download area:

- Enter user name and password 
- Public 
- If not yet provided, please contact our [support](#):
- In der nachstehenden Tabelle finden sie weitere Informationen und Hilfe zur Installation.
- In the following table you find further information and help for the installation:

### 5.1.2 EDS Datei

Datei:	Bemerkung:	Download
RSC123.eds	EDS file for device configuration	<a href="#">customer-login</a>

# 6 CANopen

## 6.1 CANopen introduction

The CANopen application layer and communication profile specification was defined as a standardized application profile for industrial applications, initially based on CAN application layers (CAL). As CAL is only restricted on the definition communications services, CANopen goes beyond and offers a uniform description of the device functionality. With the passage of version four, all CAL services, which are necessary for CANopen, were integrated into the CANopen documents. The CANopen specification is updated by the CAN-in-Automation (CiA) and is since end of 2002 accepted as European standard EN 50325-4:2002 Industrial communications subsystem based on ISO 11898 (CAN) for controller-device interfaces -- Part 4: CANopen.



### Device model

The CANopen profile family is based on an communication profile, which specified the communication mechanisms and their description.

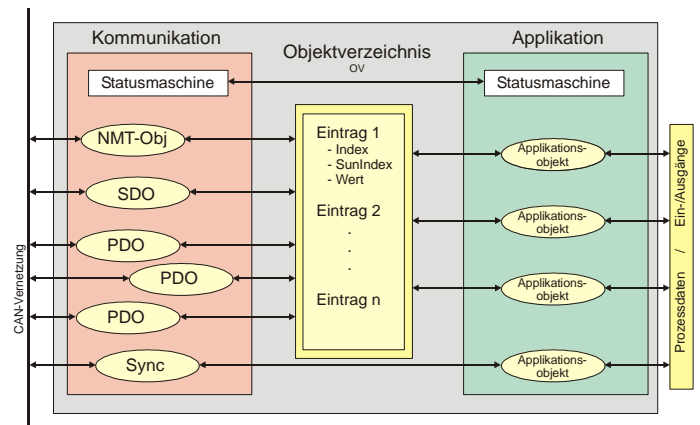
The most important types of device used in industrial automation technology, e.g. digital and analog I/Os (CiA 401), drives (CiA 402), controller (CiA 404), programmable controls (CiA 405) or encoder (CiA 406) are described in device profiles.

Service data objects (SDO) serve to fast data communication of the input and output data.

In the object dictionary (OV/OD) are structured the CANopen device parameters and the process data.

Via service data objects (SDO) can be accessed to any data of this object dictionary.

Further, some special objects (e.g. types of messages) are available for the network management (NMT), error messages, synchronization e.g.



Basic structure of the object dictionary:

Index (hex)	Object
0000	not used
0001-001F	Static Data Types
0020-003F	Complex Data Types
0040-005F	Manufacturer Specific Complex Data Types
0060-007F	Device Profile Specific Static Data Types
0080-009F	Device Profile Specific Complex Data Types
00A0-0FFF	Reserved for further use
1000-1FFF	Communication Profile Area
2000-5FFF	Manufacturer Specific Profile Area
6000-9FFF	Standardised Device Profile Area
A000-BFFF	Standardised Interface Profile Area
C000-FFFF	Reserved for further use

### Communication modes

CANopen defines several communication modes for the process data objects (input and output data):

#### Event driven:

Telegrams are sent as soon as their contents have changed. Not the whole process image will be transferred all the time, only the alterations of it.

#### Cyclic - synchronous:

A SYNC telegram causes the modules to accept the output data that was previously received, and to send new input data.

#### Requested (polled):

A CAN- data request telegram causes the modules to send the input data.

The desired mode of communication will be set with the parameter transmission type.

#### Device profile:

The robusto slave devices support all E/A communication modes and correspond to the device profile for input/output modules (DS401 Version 2).

#### Transfer rates

Seven transfer rates from 10 kBaud to 1 MBaud for different bus length are available. Short system reaction times and comparable low data rates achieves CANopen via an effective utilisation of the bus bandwidth.

#### Topology

CAN is based on a linear bus topology. CANopen logically limits the number of devices per net to 128, physically; the present driver generation permits 64 nodes in one net segment. With low data rates a maximum possible network can be increased by the use of repeaters, they also enable a construction of the tree structures.

## Bus access procedures

CAN operate on the basis of the Carrier-Sense-Multiple Access with Collision Avoidance (CSMA/CA) method. i.e. with regard to bus access each user is equal to the other and can access the bus as soon as the bus is free (Multi-Master-Bus Access). The exchange of information is not member related but message related. This means, that every message contains a unique identifier, which also defines the priority of the message. To exclude collisions on the bus by creating messages of various users, during the start of a data transmission a bit-wise bus arbitration will be carried out. The bus arbitration assigns the bus spread to the messages in order of priority; at the end of the arbitration phase only one bus subscriber occupies the bus. Collisions will be excluded and the range will be fully used.

## Configuration and parameterisation

For the parameterization of the robusto slave devices with configuration tools third-party, eds files (electronic data sheet) are available on the elrest homepage (<http://www.elrest.de>). You'll also find these eds- files on the current eStudio installation CD.

## Certification

The elrest CANopen devices have a powerful implementation in conformity with the CiA, the CAN in automation association.

### *6.1.1 Configuration and parametrisation*

The robusto Slave devices have several of configuration- and setting possibilities. The configuration The configuration effort is however very small, as for almost all parameters several default values are exist. This defaults are ensure the efforts of the most applications.

## Address (CAN NodeID)

Before commissioning of the robusto slave devices, the Node ID (CAN NodeID) must be set.

This setting is accomplished with the help of the rotary switch. The CAN NodeID is adjustable in the area of 1 to 127. The once digit of the NodeID can be determined directly from the setting of the rotary switch, the tens digit is explained in the following paragraphs. Please notice, that the switch is properly engaged. The change of the address will be valid, as soon as the slave device has switched on. Each Node ID must be assigned only once.

## CAN-baud rate

Before commissioning of the robusto slave devices, the CAN baud rate must be set. On instllation, the CAN baud rate will be set with the help of the rotary switch. All the nodes in a CANopen network must be set of the same baud rate.

## PDO parameter

### PDO-Indentifier

The default identifier distribution provides for up to 4 received process data objects (RxPDOs) and 4 transmit process data objects (TxPDOs). E.g., there are 32 digital and 12 analog In-/Outputs available



## PDO- communication modes

On which principle it communicates, can be set individual for each process data object:

- default,
- polled
- synchronized

## PDO-Mapping

By commissioning of the robusto slave devices, the data of the In- and Outputs will be mapped the process data objects. (Default-Mapping). When required, this mapping can be changed (see objects 0x1600 bzw. 0x1A00).

## Heartbeat/Guarding

If the devices should transmit the status informations autonomously, if the devices should response to the failure of the request telegrams or the master –heartbeats the respective, parameters have to be set (Guarding: Objekt 0x100C ; Heartbeat: Objekt 0x1016).

## SDO

The list of all parameters which can be achieved via CAN, are found in the object dictionary. The objects of the object dictionary are accessed via SDO.

## Configuration file

In the configuration files (electronic data sheet, eds), the parameters and the settings for the CANopen devices are listed. These eds-files can be read by the configuration tools. The structure (and syntax) of the eds-files are defined in CiA DSP 306.

## Configuration with external controllers

CANopen interfaces are for a large number of programmable logic controllers (PLCs), embedded controls and industrial-PCs.

The range of the configuration tools for the CANopen interfaces is wide. It extends from the graphical configuration tools right down to the easy interfaces to CAN-Layer 2, on which the user must be indicate CANopen and handle each CAN object.

In this description are all needed CAN objects described in details. So it's possible to address the robust slave device directly from an easy CAN interface.

The eds- files are available for the configuration with a general CANopen configuration tool. Usually it's sufficient to replicate the default mapping of the input /output modules

For more details of the configuration, it must be referenced to the manuals of the respective software and automation suppliers.

## 6.1.2 Network management

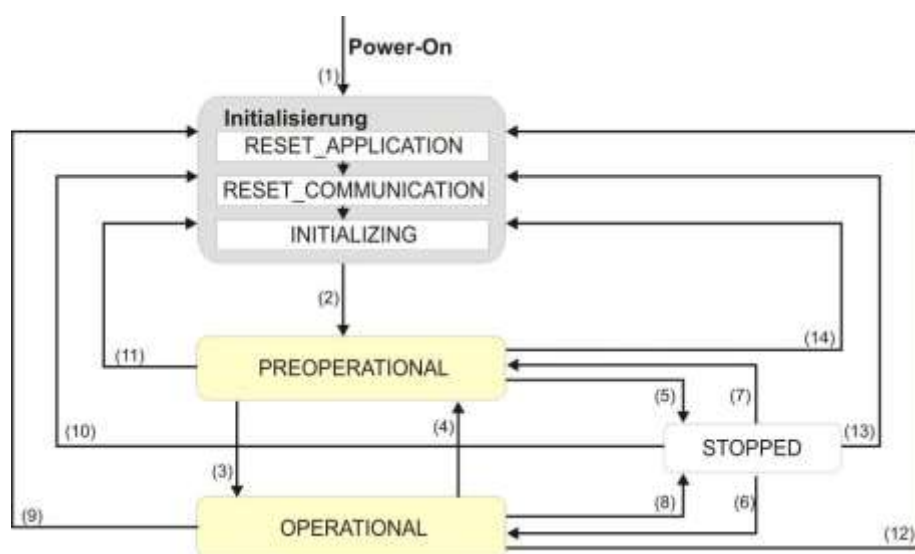
### Easy Boot-Up

CANopen allows a very easy boot-up of the distributed network. After the initialization, the modules are automatically in the state pre-operational. Already in this state can be accessed via service-data objects (SDOs) with default-identifier on the object directory, therefore, the modules can be configured.

For all entries in the object dictionary are default settings available, so in the most circumstances can be renounced of a configuration.

Only one CAN message is needed to start the modules: Start\_Remote\_Node: Identifier 0, two data bytes: 0x01, 0x00. They change the nodes into the state "OPERATIONAL"

State diagramm of a CANopen device:



- |                |                                 |
|----------------|---------------------------------|
| (1)            | Power-On                        |
| (2)            | Finished initialization         |
| (3),(6)        | Start-Remote-Node Indication    |
| (4),(7)        | Enter Preoperational Indication |
| (5),(8)        | Stop Remote Node Indication     |
| (9),(10),(11)  | Reset Communication Indication  |
| (12),(13),(14) | Reset Application Indication    |
| (3),(6)        | Start-Remote-Node Indication    |

### PREOPERATIONAL

After the initialization, the robusto Slave device changes without a command from outside, this means automatically, into the state PREOPERATIONAL. In this state it can be configured, because the service data objects (SDO) are already active. However, the process data objects are still off.

### OPERATIONAL

In the status operational are the process data objects active.

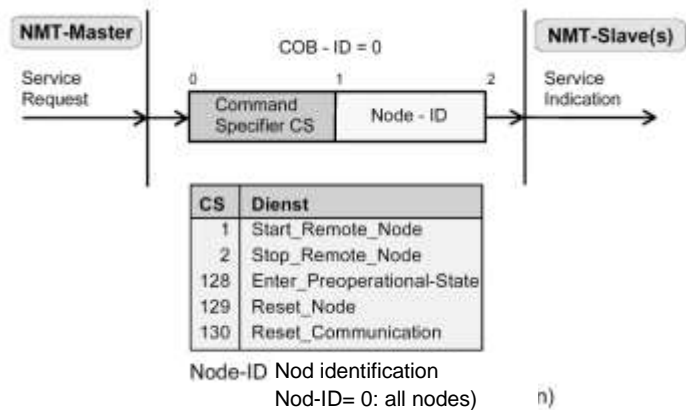
From the status operational can be restored a node in the status REOPERATIONAL. E.g. for additional configurations.

## Status transitions

Generally, in the CANopen specification is for NMT services to the nodes control the message identifier 0h reserved. Addressing of the individual nodes is performed via one Byte object within the user data area of the CAN telegrams.

The following NMT commands are available for the controlling of the node state:

- Stop\_Remote\_Node
- Start\_Remote\_Node
- Enter\_Preoperational
- Reset\_Node
- Reset\_Communication



## Protocol of the NMT services:

The following illustration gives an overview of all CANopen status transitions and the concerning command specifier (Command Specifier in the NMT master telegram)

Status transition	Command Specifier cs	Explanation
(1)	-	The initialization state is reached automatically at power-on.
(2)	-	After initialization the state PREOPERATIONAL is reached automatically the boot-up message is sent.
(3), (6)	cs = 1 = 0x01	<i>Start_Remote_Node</i> Starts the module, releases outputs and starts the PDO transmission.
(4), (7)	cs = 128 = 0x80	<i>Enter_Preoperational</i> Stops PDO transmission, SDO still active.
(5), (8)	cs = 2 = 0x02	<i>Stop_Remote_Node</i> Outputs are switching in error state and SDO and PDO are switched off.
(9), (10), (11)	cs = 129 = 0x81	<i>Reset_Node</i> Executes reset. All objects are set back to Power-On defaults..
(12), (13), (14)	cs = 130 = 0x82	<i>Reset_Communication</i> Executes reset of the communication functions. Objects 0x1000 - 0x1FFF are set back to Power-On defaults.

### Boot-Up-message

After the initialization sends the robusto Slave device the boot-up message.

The boot-up message is a CAN-message with a data byte (0) on the identifier of the guarding or heartbeat message: CAN-ID = 0x700 + Node-ID. Therefore can be observed reliable a subsequently activated device or a temporary loss of a device during the operation (e.g. voltage drop) without a node guarding.

The transmitter can be defined via the identifier of the message (see default identifier distribution). Additionally, this allows by the help of a CAN monitor, to recognize which nodes are in the network during starting without a write access on the bus (e.g. scanning network via reading parameters 0x1000)

Finally, via the boot-up message it will be communicated the end of the initialization phase. The device signalize that it can be configured or started.

### Nodes monitoring

For the default monitoring of the CANopen network are heartbeat and guarding-mechanism available.

These are most importantly in CANopen, because the devices sign not regularly in the event driven mode. When guarding, the participants will be polled cyclically via request telegrams (Remote Frame) of their status. When heartbeat, the nodes will be send their status themselves. (Node Guarding)

The following diagram shows the protocol of the cyclic node guarding.

The NMT Master polls each NMT Slave in specified time intervals (Node-Guard-Time) with a node specific remote-transmission-request-telegram. The NMT-Slave answers the request by sending its communication status.

The NMT Master send to the application a node-guarding-event,

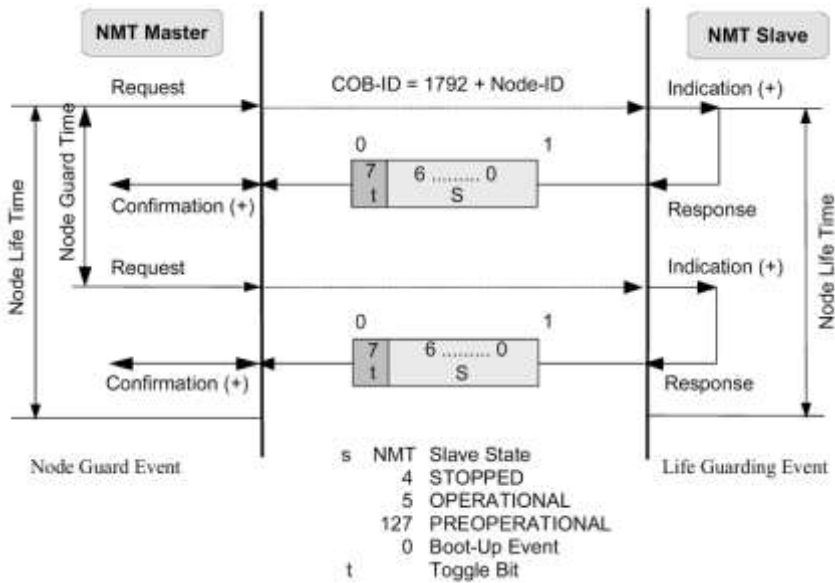
- If a node hasn't response a status request within its specific node-life-time
- or the sended status by a node is different then the available node of the NMT Master.

Otherwise a NMT-Slave sends a life-guarding-event to the application

- if the node status is not requested from the NMT Master longer as its life-time.
- node-guard- and node-life-time can be different for each NMT-Slave

For polling of the NMT- Slaves via the NMT-Master and the status message of the NMT- Slaves are 127 low-priority node-specific CAN-identifier reserved.

CANopen node-guarding protocol:



The Toggle-Bit (t) which is transmitted in the first guarding has the value 0.

Then the bit toggles in each guarding- telegram and signs thus, if a telegram was lost. In the other seven bit, the node displays it's network status (s):

The node life –time is calculated from the parameters guard-time (object 0x100C) and life-time-factor (object 0x100D):

$$\text{Life-Time} = \text{Guard-Time} \times \text{Life-Time-Factor}$$

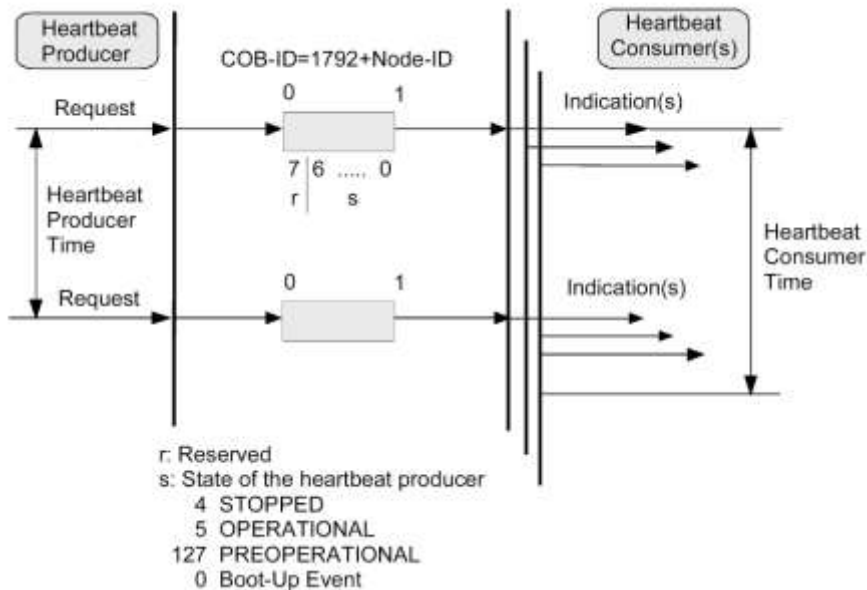
If one of the both parameters is "0" (default-setting), there is no monitoring of the Master (no life guarding).

Heartbeat:

The heartbeat method sends the nodes of their respective status message automatically. So remote frames can be ignored, and less bus load will be generated as guarding.

The Master sends its heartbeat-telegram also cyclic, so the slaves can recognize the loss of the master.

## CANopen heartbeat protocol:



The simultaneous implementation of both node monitoring methods is not allowed. If the heartbeat-producer-time is configured not zero, the heartbeat-protocol will be used.

### 6.1.3 Prozess data objects (PDO)

#### Introduction:

In many fieldbus systems the whole process image is transferred - mostly more or less cyclically. CANopen is not reduced to this communication principle, for CAN offers other possibilities due to the multi master bus access control.

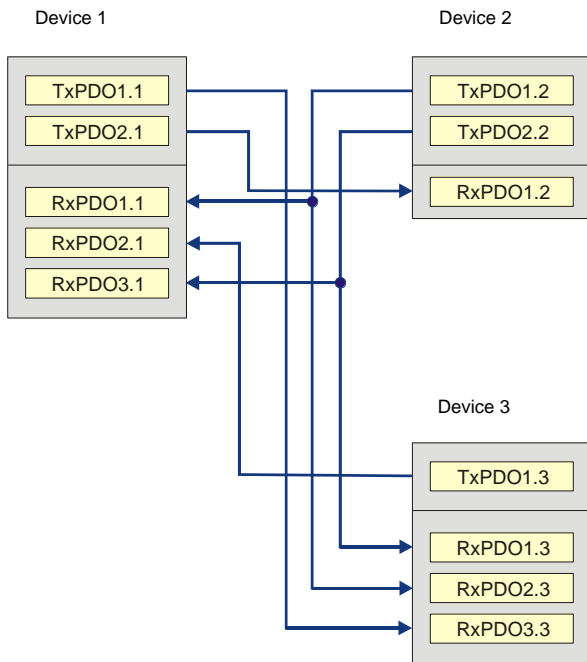
Process data objects are triggering the very mechanism for the transmission of process data (application objects). A PDO is send from a producer and can received from one or more consumers. The process data send from the PDO-producer could include max 8 byte. Transfer of PDOs is made without confirmation. A clearly assigned CAN message identifier for the PDO is necessary. The meaning of the transmitted data will be defined by the used CAN message identifier and the PDO-mapping. The PDO identification is done via the message identifier and the data contents consists only of user data, so the PDO transmission will be made without an additional protocol overhead.

Transfer of PDOs occurs in form of broadcast messages according to the CAN protocol. Via PDOs could be done easily any communication structures between the network devices.

The following figure shows an example of a communication structure with PDOs.

There is

- device 1: producer of TxPDO1.1 and TxPDO2.1
- and device 2 together with device 3: Consumer von TxPDO1.2 and TxPDO2.2.



The administration of PDOs is done from the PDO Producer and also from the PDO-Consumer, in two data structures per PDO (PDO Communication Parameter or PDO Mapping Parameter). These structures are within the object dictionary and will be configured generally during the system initialization via SDO.

### Communication parameters

The PDOs can be applied with communication parameters different according to the requirements of the application.

The transmission type of a PDO defines how the transmission of a PDO will be triggered at the PDO-Producer.

Besides the event driven or a requested transmission of PDOs will be required in the practically application of distributed systems, often a transfer after the expiration of a defined time interval. Also the possibility network synchronous capture and output will be required. CANopen supports these requirements by corresponding operation modes.

Basically it will be differenced between the *asynchronous* and *synchronous* mode.

#### *In asynchronous transmission:*

The transmission of a PDO and the data transfer to the application process will be made immediately after the occurrence of assigned events, and the receive of a PDO via a consumer.

#### *In synchronous transmission:*

Until a Sync object has been received, the corresponding PDO will be transmitted.

If a synchronous PDO will be transmitted just once after the occurrence of a synchronization object, it's named *acyclic – synchronous* PDO. ( Receipt of a SYNC object and the data content of a PDO object )

A PDO, which will be transmitted after a number of synchronization objects, it's named *cyclic – synchronous* PDO.

The CANopen parameters are in the object dictionary of the device. Via these can be accessed to the service data objects. The parameters for the RxPDOs are in Index 0x1400 (RxPDO1) and the following. Up to 512 RxPDOs can be available (in the range of Index 0x15FF). Accordingly the entries for the TxPDOs on index 0x1800 (TxPDO1) to 0x19FF (TxPDO512).

### PDO-Identifier

The most important communication parameter of a PDO is the CAN identifier (also called Communication Object Identifier, COB-ID).

It identifies the data and specifies their priority at the bus access. For every CAN data telegram there may be only one sending node (producer), but due to CAN, where the messages are sent in a broadcasting procedure, a telegram may be received from that many nodes you want (consumer).

Thus one node may place its input information at the disposal of several bus participants at the same time - even without the passing on by a logical bus master.

The Identifier is in the sets of communication parameters. It is coded as 32-Bit value, however the least significant 11 Bits (Bit 0...10) contains the actual identifier.

### CAN-Data telegram in Base Frame format

rezessiv															
		1	11	1	1	1	4	0...64	15	1	1	1	7	3	
dominant															
	Start of frame	Identifier-Feld	Remote Transmission Bit	Identifier Extension Bit	reserviert	Datenslangenfeld	Datenfeld	CRC-Prüfsumme	CRC Delimeter	Bestätigungs-Slot	Bestätigungs-Delimeter	End Of Frame	Intermission	Bus Idle	

combo Slave-devices don't support 29 Bit Identifier (acc. CAN 2.0B).



## PDO-communication modes: overview

CANopen offers different possibilities to transmit the process data.

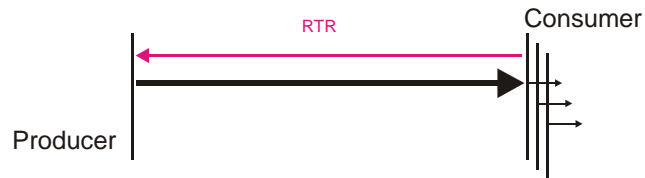
Event-driven:

(and/or Event Timer)



Polling

with Remote Frames



Sync

(cyclical / acyclical)



Transmission mode	cyclical	acyclical	synchronous	asynchronous	only RTR
0		X	X		
1-240	X		X		
241-251			- allocated -		
252			X		X
253				X	X
254, 255				X	

### Acyclic – synchronous

PDOs of the transmission mode 0 operate synchronously, but not cyclically.

A RxPDO is only evaluated after the receipt of the next SYNC telegram. For example axle groups can get successively new target position, which all will become valid for the next SYNC, without the continually need of sampling points.

A device, which TxPDO is configured of transmission mode 0, determines the input data by the receipt of the SYNC (synchronous process mapping) and transmits it, if the corresponding event occurs (modification of the inputs). The transmission mode 0 combined the reason of transmitting "event-driven" with the transmitting- / the processing- time "SYNC-receipt".

### Cyclic – synchronous

At the transmission - mode 1-240 will be sent the PDO cyclically. Every "nth" SYNC (n=1...240).

For the transmission type may not only be combined in the network but also at one coupler, you may thus define e.g. a fast cycle for the digital inputs (n=1), while the data of the analog inputs are transmitted in a slower cycle (e.g. n=10). RxPDOs are distinguished between the transmission mode 0...240:

A received PDO will be set to valid next time for the SYNC message. The cycle time (SYNC rate) may be monitored (Object 0x1006), The device response of SYNC failure according the definition of the device profile and sets its outputs in error state.

## RTR only

Process data objects which are only transmitted on requirements via a remote frame are the transmission types 252 and 253 valid.

252 is synchronously:

When SYNCs are received, process data will be determined, they just will be send on request.

253 is asynchronously:

The data will be determined continually and send on request.

It's not being advisable, because the retrieval of the input data are not supported entirely of some CAN-controllers. Because particularly the CAN controllers respond automatically to remote frames (without requesting input-data before), so the actuality of the polled data is maybe doubtful.

## Asynchronous

The transmission types 254 + 255 are asynchronous or also event triggered.

At the transmission type 254 the event is proprietary, at 255 it is defined in the device profile.

In the simplest case, the event is the change of the input. Each change of value will be transmitted.

The asynchronous transmission mode can be connected with the event timer and provides the input data, if actually no event has occurred.

## Inhibit time

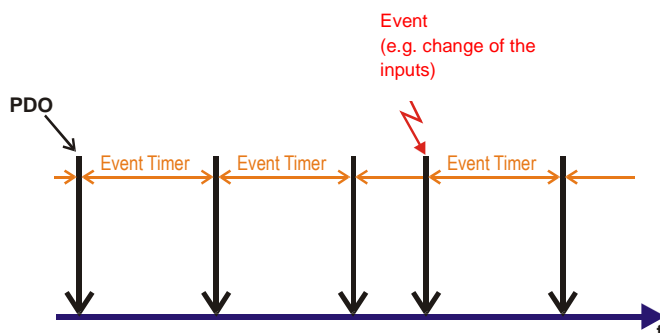
Via the parameter "inhibit time" a "send filter" may be activated that does not lengthen the reaction time of the relatively first input alteration, but that is active for the following changes. The inhibit time (send delay time) describes the time span has to passed between the sending of two identical telegrams. If you use the inhibit time, you may evaluate the maximum bus load and therefore the latent time in a "worst case" scenario.

## Event Timer

Via Sub-index 5 of the PDO communication parameters can be set the event timer for send PDO.

Expiration of this timer will be valued as an additionally event for the corresponding PDO, thus the PDO will be send.

If the application event occurs while a time period, it will be also send and the timer will be reset.



At reception PDOs, the event timer will be used to set the watch time for this PDO: If no corresponding PDO will be received during the programmed time, the application will be informed.

## PDO Mapping

The determination of the transmitted application objects in a process data object and the position within the PDOs is known as PDO-Mapping. Application objects are specified with index and Sub-index of the corresponding object dictionary, thus the arrangement of the application data can be described easily via a list of objects. This list represents each object via index, Sub-index and length of fields.

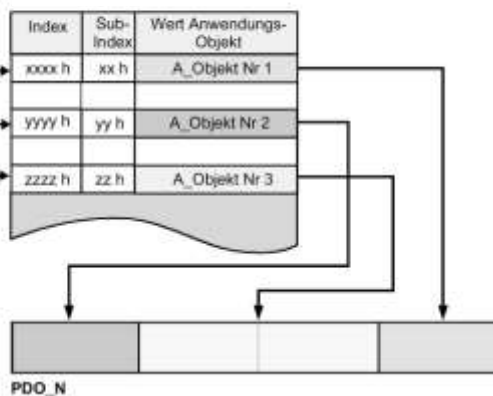
The CANopen- device profiles provides for each device type a default mapping This fits is for most application. The default mappings reproduce for digital in- / output modules the inputs or outputs acc. their physical sequence in the send- or receive process data objects. The current mapping can be read through the appropriate entries in the data object dictionary, so-called mapping tables. In first place of the mapping tables (Sub-index 0) contains the number of mapped objects, which are listed in the following. The tables are located in the object dictionary under index 0x1600. for RxPDOs, or 0x1A00 for TxPDOs.

## PDO mapping - basic representation:

**Mapping Parameter Record PDO\_N**

Eintrag Nr	Spezifikation Anwendungsobjekte
0	Anzahl Anwendungsobjekte = 3
	Index Sub-Index Länge / Bit
1	yyyy h yy h 8
2	zzzz h zz h 16
3	xxxx h xx h 8

**Device object directory**



## Reading the number of in- and outputs

Die Anzahl der digitalen und analogen Ein-/Ausgänge lässt sich durch Auslesen der entsprechenden Einträge im Objektverzeichnis ermitteln bzw. verifizieren:

The number of digital and analog in-/ outputs can be determined or verified via reading the corresponding entries in the object dictionary

### **Parameter**

Number of digital input bytes  
Number of digital output bytes  
Number of analog inputs  
Number of analog outputs

### **Adress in the object ditictory**

Index 0x6000, Sub-index 0  
Index 0x6200, Sub-index 0  
Index 0x6401, Sub-index 0  
Index 0x6411, Sub-index 0

### Variable mapping

In most cases, the default value of the process data objects (Default Mapping) satisfies the requirements of the application. For all other applications the values can be changed.

combo slave- devices support the variable mapping, the application objects (in- and output data) can be freely assigned to the PDOs. The mapping tables have to be configured.

As CANopen version 4 is only the following practice permitted, that absolutely must be complied with:

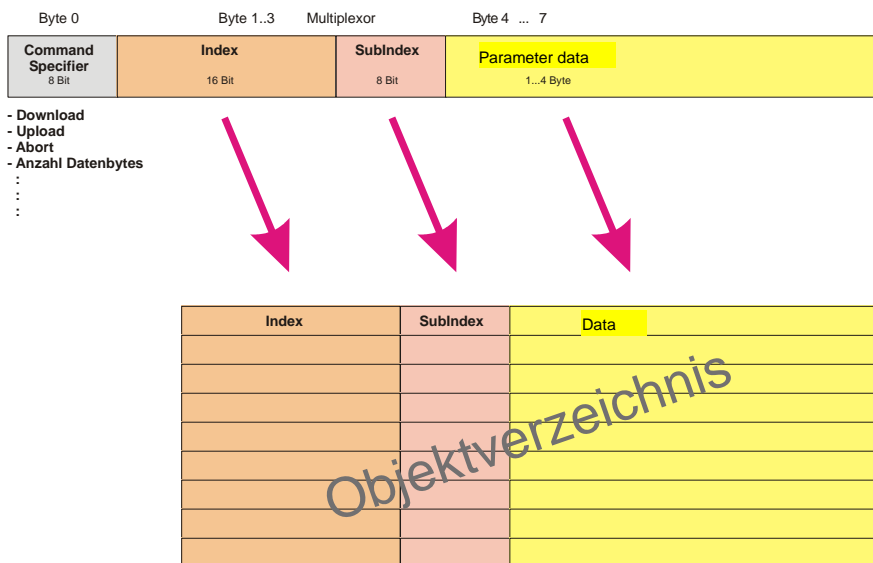
- Delete PDO (0x1400, or 0x1800, Sub-index 1, set bit 31 on "1")
- Set Sub-index 0 in the mapping-parameter (0x1600 bzw. 0x1A00) on "0"
- Change mapping entries (0x1600 bzw. 0x1A00, SI 1..8)
- Set valid value Sub-index 0 in mapping parameter.
- Check the device and the entries for consistency.
- Create PDO via enter the identifier (0x1400 or 0x1800 Sub-index 1).

### 6.1.4 *Service data objects (SDO)*

The confirmed transfer between data and two network users occurs via SDO services. The data transfer from one device to another is described in the client-server model. A SDO-client (user initiating) direct access to individual entries of the object dictionary of a SDO-server. Records in arbitrary lengths can be downloaded or loaded from a server. The transferred record will be specified by index and sub-index of the object dictionary input, which represents the record. Per one transmission direction is used one message identifier, thus the connection between a SDO client and a SDO server requires two CAN-identifiers. The connection between a client and a server is indicated as a SDO channel.

CANopen enables management of up to 128 client and server SDO connections per user. To ensure, that it's accessible for other devices, a CANopen device has to support minimum one SDO server- object, so-called default SDO. The listed parameters in the object dictionary will be read and flopped. These SDOs are multiplexed domains, this means data structures of any size which are provided with a multiplexor (address). The multiplexor consists of a 6-bit index and 8-bit-sub index. The entries will be addressed in the object dictionary.

## SDO-access of the object directory:



A single handshake satisfies, if the transmitted parameter up to 4 bytes contains. During the download the client send the data together with the index and the sub index. The server confirmed the receipt. By uploading the client queries the data via transmitting the index and the sub index of the desired parameters. The server sends the parameters (inc. index and sub index) in a reply telegram. For upload und download is used the same handshake. In the telegrams of 8 byte are coded in the first byte the different services. (Command Specifier). Except the objects 1008h, 1009h und 100Ah (name of device, hardware- or software version) are all parameters of the device 4 byte large. This description is limited only to the transfer of this data in the accelerated transfer (expedited transfer). The following describes the structure of the SDO tegrams:

### Client -> Server, Upload Request

11-bit identifier	8 byte user data							
0x600 (=1536dez) + Node-ID	0x40	Index0	Index1	SubIdx	0x00	0x00	0x00	0x00

Parameters	Explanation	
Index0	Index Low-Byte	(Unsigned16, LSB)
Index1	Index High-Byte	(Unsigned16, MSB)
SubIdx	Sub-index	(Unsigned8)

### Client -> Server, Upload Response

11-bit Identifier	8 Byte User data							
0x580 (=1408dez) + Node-ID	0x4x	Index0	Index1	SubIdx	Data0	Data1	Data2	Data3

Parameter	Explanation
Index0	Index Low-Byte (Unsigned16, LSB)
Index1	Index High-Byte (Unsigned16, MSB)
SubIdx	Sub-index (Unsigned8)
Data0	Daten Low-Low-Byte (LLSB)
Data3	Daten High-High-Byte (MMSB)

The parameters of the data types Unsigned8 are transmitted in Byte Data0, the parameters of the data types Unsigned16 in Data0 and Data1.

The number of the valid data bytes is coded in the first CAN-Datenbyte (0x4x) as follows:

Number of parameter-bytes	1	2	3	4
First CAN-Datenbyte	0x4F	0x4B	0x47	0x43

### Client -> Server, Download Request

11-bit Identifier	8 Byte user data							
0x600 (=1536dez) + Node-ID	0x22	Index0	Index1	SubIdx	Data0	Data1	Data2	Data3

Parameter	Explanation
Index0	Index Low-Byte (Unsigned16, LSB)
Index1	Index High-Byte (Unsigned16, MSB)
SubIdx	Sub-index (Unsigned8)
Data0	Daten Low-Low-Byte (LLSB)
Data3	Daten High-High-Byte (MMSB)

Optionally, it's possible to specify the number of the valid parameter data bytes in the first CAN- data byte:

Number of parameter bytes	1	2	3	4
First CAN data byte	0x2F	0x2B	0x27	0x23

Generally, it is not necessary, because only the least significant data bytes are evaluated up to the length of the the object directory input.

### Cancelling of parameter communication.

In case of a wrong parameter communication, it will be cancelled. Client or server sends a SDO telegram with the structure.

11-bit Identifier	8 Byte User data							
0x580(Client) oder 0x600(Server) + Node-ID	0x80	Index0	Index1	SubIdx	Error0	Error1	Error2	Error3

Parameter	Explanation
Index0	Index Low-Byte (Unsigned16, LSB)
Index1	Index High-Byte (Unsigned16, MSB)
SubIdx	Sub-index (Unsigned8)
Error0	SDO error-code Low-Low-Byte (LLSB)
Error3	SDO error-code High-High-Byte (MMSB)

### List of the SDO-error -codes (reason for the interrupt of the SDO-transfer)

SDO error-code	Explanation
0x05 03 00 00	Toggle Bit not alternated
0x05 04 00 01	SDO Command Specifier invalid or unknown.
0x06 01 00 00	Access to this object is not supported
0x06 01 00 02	Try, to write to a read-only parameter
0x06 02 00 00	Object not present in the object dictionary
0x06 04 00 41	Object cannot be mapped to the PDO
0x06 04 00 42	Number and/or length of mapped objects would exceed PDO length
0x06 04 00 43	General indication of incompatibility
0x06 04 00 47	General internal error in the device
0x06 06 00 00	Access is aborted, because of hardware error
0x06 07 00 10	Data type or parameter length does not correspond or unknown
0x06 07 00 12	Data type does not correspond, parameter length too large
0x06 07 00 13	Data type does not correspond, parameter length too small
0x06 09 00 11	Sub-index not existing
0x06 09 00 30	Common range mistake
0x06 09 00 31	Range mistake: parameter value too large
0x06 09 00 32	Range mistake: parameter value too small
0x06 0A 00 23	Resources are not available
0x08 00 00 21	Access not possible, because of local application
0x08 00 00 22	Access not possible, because of current device status

## 6.1.5 Identifier- distribution

### Default-identifier

CANopen provides for the important communications objects a default-identifier, they have been derived to the following scheme from the 7 bit node address (Node-ID) and a 4 bit function code:

For the broadcast-objects will be used the Node-ID 0. Thus, the following default identifier results:

### Broadcast Objects

Object	Function	Function Code	Resulting COB ID		Object for Comm. parameter / mapping
			hex	dez	
NMT	Boot-Up	0	0x00	0	- / -
SYNC	Synchronization	1	0x80	128	0x1005 + 0x1006 / -

### Peer-to-Peer-Objects

Object	Function	Function Code	Resulting COB ID		Object for Comm. parameter / mapping
			hex	dez	
Emergency	Status / error	1	0x81 - 0xFF	129 - 255	- / -
PDO1 (tx)	digital inputs	11	0x181 - 0x1FF	385 - 511	0x1800 / 0x1A00
PDO1 (rx)	digital outputs	100	0x201 - 0x27F	513 - 639	0x1400 / 0x1600
PDO2 (tx)	analog inputs	101	0x281 - 0x2FF	641 - 767	0x1801 / 0x1A01
PDO2 (rx)	analoge outputs	110	0x301 - 0x37F	769 - 895	0x1401 / 0x1601
PDO3 (tx)	analoge outputs *	111	0x381 - 0x3FF	897 - 1023	0x1802 / 0x1A02
PDO3 (rx)	analoge outputs *	1000	0x401 - 0x47F	1025 - 1151	0x1402 / 0x1602
PDO4 (tx)	analoge inputs *	1001	0x481 - 0x4FF	1153 - 1279	0x1803 / 0x1A03
PDO4 (rx)	analoge outputs *	1010	0x501 - 0x57F	1281 - 1407	0x1403 / 0x1603
SDO (tx)	Parameter	1011	0x581 - 0x5FF	1409 - 1535	- / -
SDO (rx)	Parameter	1100	0x601 - 0x67F	1537 - 1663	- / -
Guarding	Life-/Node-guarding, Heartbeat, Boot-Up message	1110	0x701 - 0x77F	1793 - 1919	(0x100C, 0x100D, 0x100E, 0x1016, 0x1017)



## 6.2 CANopen object dictionary

### Object directory - structure

In the CANopen object directory will be entered all CANopen objects, which are relevant for the robusto slave devices. The object directory is subdivided into three separate areas:

Communication specific profile area (0x1000 - 0x1FFF)

Contains the description of all relevant parameters for the communication.

Vendor specific profil area (Index 0x2000 - 0x5FFF).

Contains the description of vendor specific entries

Device profile segment (0x6000 - 0x9FFF).

Contains the objects for the device profile acc. DS-401.

### Basic structure of the object dictionary

Index	Beschreibung
0000h	Nicht verwendet
0001h - 001Fh	Statische Datentypen
0020h - 003Fh	Komplexe Datentypen
0040h - 005Fh	Herstellerspezifische komplexe Datentypen
0060h - 007Fh	Geräteprofil-spezifische statische Datentypen
0080h - 009Fh	Geräteprofil-spezifische komplexe Datentypen
00A0h - 025Fh	Reserviert für weitere Geräteprofil-spezifische Datentypen
0260h - 0FFFh	Reserviert
1000h - 1FFFh	Kommunikationsprofil
2000h - 5FFFh	Hersteller-spezifischer Bereich
6000h - 9FFFh	Standardisierte Geräteprofile
A000h - BFFFh	Standardisierte Interfaceprofile
C000h - FFFFh	Reserviert

The entries of the object directory are addressed by a 16-bit index. If an object exists of several components (e.g. object type Array or Record), the components are marked via an 8Bit sub-index. The object name describes its function. The data type attribute specifies the data type of the input. Via the access attribute it is specified, if an input may only be read, only be written or read and written.

### Communication specific profile area

In this area are all necessary parameters and objects for the communication of the device available. In the area 0x1000 - 0x1018 are the different, general communication specific parameters available (e.g. name of device).

The communication parameters (e.g. identifier) of the receive PDOs are in the area 0x1400 - 0x140F available (plus Sub-index) The mapping parameters of the receive PDOs are in the area up to 0x1600 - 0x160F (plus Sub-index) available.

The mapping parameters contain the references to the application objects, which are mapped in the PDOs and the data width corresponding the objects (see chapter PDO-Mapping).

The communication- and mapping parameters of the transmit-PDOs are in the areas 0x1800 - 0x180F or 0x1A00 - 0x1A0F available.

### Vendor specific area

The entires are in this area, specifically for the combo Slave devices, e.g. data objects for thandling the values of the analog in-/ outputs.

### Standardized device profile segment

In the standardized device profile segment will be supported the CANopen device profile DS-401 version 1. For analog inputs are functions available for fitting the communication of the event-controlled modes to the application requirements and to minimize the bus loading:

- Delta function
- Activate/deactivate the event control

### Objects

Below the list of the objects, which will be supported of the robusto Slave devices:

Parameter	Index
Device type	0x1000
Error register	0x1001
Error memory	0x1003
Sync-identifier	0x1005
Name of device	0x1008
Hardware-version	0x1009
Software-version	0x100A
Node number	0x100B
Guard time	0x100C
Life time factor	0x100D
Emergency identifier	0x1014
Producer heartbeat time	0x1017
Device identification (identity object)	0x1018
State changes of error	0x1029
Server SDO parameters	0x1200
Communication parameter 1.- 8. RxPDO	0x1400 - 0x1407
Mapping 1.- 8. RxPDO	0x1600 - 0x1607
Communication parameter 1.- 8. TxPDO	0x1800 - 0x1807
Mapping 1.- 8. TxPDO	0x1A00 - 0x1A07
Firmwareinfo	0x2010
Hardwareinfo	0x2020
Analog Channels	0x2101 – 0x2110
Digital inputs	0x6000
Digital outputs	0x6200
Error mode digital outputs	0x6206
Error value digital outputs	0x6207
Analog inputs 16 bit	0x6401
Analog outputs 16 bit	0x6411
Event control analog inputs	0x6423
Delta function analoge inputs	0x6426
Error mode analog outputs	0x6443
Error value analog outputs	0x6444

## 6.2.1 Description of the objects and data

### Device type

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1000	0	Device Type	Unsigned32	RO	N	0	Specification of the device type

The 32Bit value is divided in two 16Bit fields:

MSB	LSB
Additional information	Device profil-number
0000 0000 0000 wxyz	0x191 (401dez)

The "Additional Information" contains information about the signal types of the I/O device:

z = 1 means: the device has hat digital inputs,

y = 1 means: he device has digital outputs,

x = 1 means: the device has analog inputs,

w = 1 means: the device has analog outputs.

The type of device gives only a rough classification of the device. Each combo Slave device supports all kinds of in- and outputs, because the devices can be added with an extension module to expand the system as needed. => immer 0x00 0F 01 91

### Error register

Index	Sub-index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1001	0	Error Register	Unsigned8	RO	N	0	Error register

The 8 Bit value is coded as follows:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ManufSpec.	reserved	reserved	Comm.	reserved	reserved	reserved	generic

ManufSpec. Manufacturer-specific error will be more exactly specified.in object 1003.

Comm Communication error (Overrun CAN)

Generic A not more precisely specified error occurred (flag is set at every error message)

## Error memories

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1003	0	Predefined error field	Unsigned8	RO	N	0	Object 1003h contains a description, errors that have occurred on this device. - Sub-index 0 the number of errors saved.
	1	Actual error	Unsigned32	RO	N	--	Last occurred error
	...	...	--	--	...	...	...
	10	Standard error field	Unsigned32	RO	N	--	Maximum 10 failure signals will be stored

The 32 bitvalue is divided in two 16 bit fields:

MSB	LSB
Additional Information	Error Code

As usual, the LSB will be at first, and the MSB at last transmitted.

The additional code contains the error trigger (see emergency object) and thus a detailed error description.

New New errors are always saved at subindex 1; all other subindices are incremented accordingly. By means of writing a "0" to subindex 0, the complete error memory is deleted. If there were no error since power-on, the object 0x1003 only exists of a subindex 0 with entered "0". The fault memory will be deleted by a reset.

## Sync-Identifier

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1005	0	COB-ID Sync Message	Unsigned32	RW	N	0x80000008	Identifier for the SYNC message

The lower 11 bit of the 32-bit value contain the Identifier (0x80=128dez). Bit 30 indicates whether the device receives the SYNC telegram (1) or not (0). The CANopen- I/O devices receive the SYNC telegram, accordingly, Bit 30=0. Bit 31 is due to downward-compatibility irrelevant.

### Device name

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1008	0	Manufacturer device name	Visible string	RO	N	Visible string	Device name of the bus node

For the returned value is larger than 4Byte, the segmented SDO protocol is used for transmission.

### Software-Version

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x100A	0	Manufacturer software-version	Visible String	RO	N		Software version number of the device.

For the returned value is larger than 4Byte, the segmented SDO protocol is used for transmission.

### Guard-Time

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x100C	0	Guard-time [ms]	Unsigned16	RO	N	0	The distance between two guard telegrams will be set by an NMT master or the configuration tool.

### Life Time Factor

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x100D	0	Life time factor	Unsigned8	RO	N	0	Life time factor x guard time = life time (watchdog for life guarding)

If a guarding telegram is not received within the life time, the node enters the error state.

If life time factor and/or guard time are = 0, the node doesn't handle lifeguarding, but may however be monitored by the master (node guarding).

## Emergency Identifier

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1014	0	COB-ID Emergency	Unsigned32	RO	N	0x00000000 + NodeID	Identifier of the emergency-telegramm

The lower 11Bit of the 32Bit value contain the identifier (0x80=128dez). Via the MSBit can be set, if the emergency telegram is sent SYNC telegram (1) or not (0).

## Producer Heartbeat Time

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1017	0	Producer heartbeat time [ms]	Unsigned16	RW	N	0	Time (in ms) between 2 transmitted heartbeat- telegramms

## Identity Object

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1018	0	Number of elements identity object	Unsigned8	RO	N	4	The „identity object“ contains general information for the type and design of the device.
	1	Vendor ID	Unsigned32	RO	N	0x00000032	Manufacturerer code: elrest => 50
	2	Product code	Unsigned32	RO	N	0	device identification, depending on the design
	3	Revision number	Unsigned32	RO	N	0	Version number
	4	Serial number	Unsigned32	RO	N	0	Serial numner

The 32 bit value of the product code is divided in two 16Bit fields:

MSB			LSB		
Product code CE1xx			Product code CS1xx		
Produkt Code CE1xx	dez	hex	Product code CS1xx	Dez	Hex
CE100	100	0x64	CS100	100	0x64
CE101	101	0x65	CS101	101	0x65
CE150	150	0x96	CS110	110	0x6E
CS152	152	0x98	CS111	111	0x6F

### Change of state in case of error:

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1029	0	Number of elements	Unsigned8	RO	N	1	Number of elements
	1	Change of state	Unsigned8	RW	N	1	Configured the set value, the status of the stack will be changed in case of error, acc. the norm.

### Server SDO parameters

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1200	0	Number of elements	Unsigned8	RO	N	2	Number of elements
	1	COB ID client=> server	Unsigned32	RO	N	0x00000600 + node-ID of the clientt	COB-ID RxSDO (client => server)
	2	COB ID server=> client	Unsigned32	RO	N	0x00000600 + Node-ID	COB-ID TxSDO (client => server)

For reasons of the backward compatibility, it will be contained in the object dictionary.

### Communication parameters 1: RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1400	0	Number of elements	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N	0x00000200 + Node-ID	COB-ID (communication object identifier) RxPDO1
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	Irrelevant for RxPDOs
	4	--	Unsigned8	RW	N	-	Unused
	5	Event timer	Unsigned16	RW	N	0	Event timer: Time for monitoring (watchdog) of the receive PDOs

#### Sub-index 1 (COB-ID):

The lower 11 bit of the 32-bit value (Bits 0-10) contain the CAN-Identifier,

the MSBit (Bit 31) shows, if the PDO is active (1) or not (0),

Bit 30 monitors, if a RTR access to this PDO is allowed (0) or not (1).

It is not permitted to change the identifier (bit 0-10) while the object exists (Bit 31=0).

The Subindex 2 contains the transmission type (see introduction PDOs).

### Communication parameter 2. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1401	0	Number of elements	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N	0x00000300 + Node-ID	COB-ID (communication object identifier) RxPDO2
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	Irrelevant for RxPDOs
	4	--	Unsigned8	RW	N	-	Unused
	5	Event timer	Unsigned16	RW	N	0	Event timer: Time for monitoring (watchdog) of the receive PDOs

### Communication parameter 3. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1402	0	Number of elements	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N	0x00000300 + Node-ID	COB-ID (communication object identifier) RxPDO2
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	Irrelevant for RxPDOs
	4	--	Unsigned8	RW	N	-	Unused
	5	Event timer	Unsigned16	RW	N	0	Event timer: Time for monitoring (watchdog) of the receive PDOs

### Communication parameter 4. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1403	0	Number of elements	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N	0x00000500 + Node-ID	COB-ID (communication object identifier) RxPDO4
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	Irrelevant for RxPDOs
	4	--	Unsigned8	RW	N	-	Unused
	5	Event timer	Unsigned16	RW	N	0	Event timer: Time for monitoring (watchdog) of the receive PDOs



### Communication parameter 5. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1404	0	Number of elements	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N		COB-ID (communication object identifier) RxPDO4
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	Irrelevant for RxPDOs
	4	--	Unsigned8	RW	N	-	Unused
	5	Event timer	Unsigned16	RW	N	0	Event timer: Time for monitoring (watchdog) of the receive PDOs

### Communication parameter 6. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1405	0	Number of elements	Unsigned8	RO	N	5	Communication parameters of the 4. reception PDOs (RxPDO4). Sub-index0: Number of elements
	1	COB ID	Unsigned32	RW	N		COB-ID (communication object identifier) RxPDO4
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	Irrelevant for RxPDOs
	4	--	Unsigned8	RW	N	-	Unused
	5	Event timer	Unsigned16	RW	N	0	Event timer: Time for monitoring (watchdog) of the receive PDOs

### Communication parameter 7. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1406	0	Number of elements	Unsigned8	RO	N	5	Communication parameters of the 4. reception PDOs (RxPDO4). Sub-index0: Number of elements
	1	COB ID	Unsigned32	RW	N		COB-ID (communication object identifier) RxPDO4
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	Irrelevant for RxPDOs

	4	--	Unsigned8	RW	N	-	Unused
	5	Event timer	Unsigned16	RW	N	0	Event timer: Time for monitoring (watchdog) of the receive PDOs

### Communication parameter 8. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1407	0	Number of elements	Unsigned8	RO	N	5	Communication parameters of the 4. reception PDOs (RxPDO4). Sub-index0: Number of elements
	1	COB ID	Unsigned32	RW	N		COB-ID (communication object identifier) RxPDO4
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	Irrelevant for RxPDOs
	4	--	Unsigned8	RW	N	-	Unused
	5	Event timer	Unsigned16	RW	N	0	Event timer: Time for monitoring (watchdog) of the receive PDOs

### Mapping-parameter 1. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1600	0	Number of elements	Unsigned8	RO	N	4	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0x62000108	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	Transmission type	Unsigned8	RW	N	0x62000208	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	Inhibit time	Unsigned16	RW	N	0x62000308	3 mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	--	Unsigned8	RW	N	0x62000408	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

The first receive-PDO is per default planned for digital outputs.

#### Mapping-changes

For changing the mapping, the following sequence must be observed (since CANopen Version 4 required):

Delete PDO (set bit 31 to 0 in the identifier entry (Sub-index1) of the communication parameter)

Deactivate mapping (set sub-index 0 of the mapping entries to 0)

Change mapping entries (Subindices 1...8)

Activate mapping (set sub index 0 of the mapping entry to the correct number of the mapped objects)

Create PDO (set bit 31 in the identifier entry of the communication parameter (Sub-index 1) to 0.

#### Mapping-parameter 2. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1601	0	Number of elements	Unsigned8	RO	N	4	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0x64110110	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	2. mapped object	Unsigned32	RW	N	0x64110210	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0x64110310	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0x64110410	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

The second receive-PDO (RxPDO1) is per default planned for digital outputs.

To change the mapping, a certain order has to be observed (see object Index 0x1600).

#### Mapping-parameter 3. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1602	0	Number of elements	Unsigned8	RO	N	4	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0x64110510	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

	2	2. mapped object	Unsigned32	RW	N	0x64110610	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0x64110710	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0x64110810	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

The third receipt PDO is per default planned fo analog output 5 to 8.

To change the mapping, a certain order has to be observed (see object Index 0x1600).

#### Mapping-parameter 4. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1603	0	Number of elements	Unsigned8	RO	N	4	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0x64110910	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	2. mapped object	Unsigned32	RW	N	0x64110A10	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0x64110B10	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0x64110C10	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

The fourth receipt PDO is per default planned fo analog output 9 to 12.

To change the mapping, a certain order has to be observed (see object Index 0x1600).

### Mapping-parameter 5. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1604	0	Number of elements	Unsigned8	RO	N	0	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	2. mapped object	Unsigned32	RW	N	0	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

### Mapping-parameter 6. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1605	0	Number of elements	Unsigned8	RO	N	0	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	2. mapped object	Unsigned32	RW	N	0	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

### Mapping-parameter 7. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1606	0	Number of elements	Unsigned8	RO	N	0	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	2. mapped object	Unsigned32	RW	N	0	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

### Mapping-parameter 8. RxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1607	0	Number of elements	Unsigned8	RO	N	0	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	2. mapped object	Unsigned32	RW	N	0	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

### Communication parameter 1. TxPDO

Index	Sub Index	Name	Type	Attr b.	Map.	Default-value	Importance
0x1800	0	Number of elements	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N	0x00000180 + Node-ID	COB-ID (communication object identifier) TxPDO1
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	repetition delay time [value x 100µs]
	4	--	Unsigned8	RW	N	-	unused
	5	Event timer	Unsigned16	RW	N	0	Event timer

#### Sub-index 1 (COB-ID):

The lower 11 bit of the 32-bit value (Bits 0-10) contain the CAN-Identifier, the MSBit (Bit 31) shows, if the PDO is active (1) or not (0),

Bit 30 monitors, if a RTR access to this PDO is allowed (0) or not (1).

It is not permitted to change the identifier (Bit 0-10) during the object exists (Bit 31=0).

### Communication parameter 2. TxPDO

Index	Sub Index	Name	Type	Attr b.	Map.	Default-value	Importance
0x1801	0	Number of elements	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N	0x00000280 + Node-ID	COB-ID (communication object identifier) TxPDO2
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	repetition delay time [value x 100µs]
	4	--	Unsigned8	RW	N	-	unused
	5	Event timer	Unsigned16	RW	N	0	Event timer

The second send-PDO (RxPDO1) is per default planned for analog inputs 1 to 4 and configured for event driven transmission (Transmission Type 255).

The event control must first be activated (see object 0x6423).

### Communication parameter 3. TxPDO

Index	Sub Index	Name	Type	Attr b.	Map.	Default-value	Importance
0x1802	0	Number of elements	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N	0x00000380 + Node-ID	COB-ID (communication object identifier) TxPDO3
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs

	2	Transmission Type	Unsigned8	RW	N	255	Übertragungsart des PDOs
	3	Inhibit Time	Unsigned16	RW	N	0	Wiederholungs- verzögerung [Wert x 100µs]
	4	--	Unsigned8	RW	N	-	nicht benutzt
	5	Event Timer	Unsigned16	RW	N	0	Event Timer

The third send-PDO is per default planned for analog inputs 5 to 8 and configured for event driven transmission (Transmission Type 255).

The event control must first be activated (see object 0x6423).

#### Communication parameter 4. TxPDO

Index	Sub Index	Name	Type	Attr b.	Map.	Default-value	Importance
0x1803	0	Number of elements	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N	0x00000480 + Node-ID	COB-ID (communication object identifier) TxPDO4
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	repetition delay time [value x 100µs]
	4	--	Unsigned8	RW	N	-	unused
	5	Event timer	Unsigned16	RW	N	0	Event timer

#### Communication parameter 5. TxPDO

Index	Sub Index	Name	Type	Attr b.	Map.	Default-value	Importance
0x1804	0	Number of elements	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N	0	COB-ID (communication object identifier) TxPDO4
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	repetition delay time [value x 100µs]
	4	--	Unsigned8	RW	N	-	unused
	5	Event timer	Unsigned16	RW	N	0	Event timer



### Communication parameter 6. TxPDO

Index	Sub Index	Name	Type	Attr b.	Map.	Default-value	Importance
0x1805	0	Number of elements	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N	0	COB-ID (communication object identifier) TxPDO4
	2	Transmission type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit time	Unsigned16	RW	N	0	repetition delay time [value x 100µs]
	4	--	Unsigned8	RW	N	-	unused
	5	Event timer	Unsigned16	RW	N	0	Event timer

### Communication parameter 7. TxPDO

Index	Sub Index	Name	Type	Attr b.	Map.	Default-value	Importance
0x1806	0	Anzahl Elemente	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N	0	COB-ID (communication object identifier) TxPDO4
	2	Transmission Type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit Time	Unsigned16	RW	N	0	repetition delay time [value x 100µs]
	4	--	Unsigned8	RW	N	-	unused
	5	Event Timer	Unsigned16	RW	N	0	Event timer

### Communication parameter 8. TxPDO

Index	Sub Index	Name	Type	Attr b.	Map.	Default-value	Importance
0x1807	0	Anzahl Elemente	Unsigned8	RO	N	5	Number of available sub-index numbers
	1	COB ID	Unsigned32	RW	N	0	COB-ID (communication object identifier) TxPDO4
	2	Transmission Type	Unsigned8	RW	N	255	Transmission type of the PDOs
	3	Inhibit Time	Unsigned16	RW	N	0	repetition delay time [value x 100µs]
	4	--	Unsigned8	RW	N	-	unused
	5	Event Timer	Unsigned16	RW	N	0	Event timer

## Mapping parameter 1. TxPDO

Index	Sub Index	Name	Type	Attr b.	Map.	Default-value	Importance
0x1A00	0	Number of elements	Unsigned8	RO	N	4	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0x60000108	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	2. mapped object	Unsigned32	RW	N	0x60000208	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0x60000308	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0x60000408	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

The first send-PDO is per default planned for digital inputs.

For changing the mapping, the following sequence must be observed (see object index 0x1600).

## Mapping parameter 2. TxPDO

Index	Sub Index	Name	Type	Attrb .	Map.	Default-value	Importance
0x1A01	0	Number of elements	Unsigned8	RO	N	4	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0x64010110	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	2. mapped object	Unsigned32	RW	N	0x64010210	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0x64010310	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0x64010410	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

The second send-PDO is per default planned for analog inputs 1 to 4.

To change the mapping, a certain order has to be observed (see object Index 0x1600)

### Mapping parameter 3. TxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1A02	0	Number of elements	Unsigned8	RO	N	4	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0x64010510	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	2. mapped object	Unsigned32	RW	N	0x64010610	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0x64010710	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0x64010810	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

The third send-PDO is per default planned for analog inputs 5 to 8.

To change the mapping, a certain order has to be observed (see object Index 0x1600).

### Mapping parameter 4. TxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1A03	0	Number of elements	Unsigned8	RO	N	4	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0x64010910	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	2. mapped object	Unsigned32	RW	N	0x64010A10	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0x64010B10	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0x64010C10	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

The fourth send-PDO is per default planned for analog inputs 8 to 12.

To change the mapping, a certain order has to be observed (see object Index 0x1600).

## Mapping Parameter 5. TxPDO

Index	Sub Index	Name	Typ	Attrb.	Map.	Default-Wert	Bedeutung
0x1A04	0	Anzahl Elemente	Unsigned8	RO	N	0	Anzahl der verfügbaren SubIndexe
	1	1. gemapptes Objekt	Unsigned32	RW	N	0	1. gemapptes Applikationsobjekt: 2 Byte: Index 1 Byte: SubIndex 1 Byte: Bitbreite
	2	2. gemapptes Objekt	Unsigned32	RW	N	0	2. gemapptes Applikationsobjekt: 2 Byte: Index 1 Byte: SubIndex 1 Byte: Bitbreite
	3	3. gemapptes Objekt	Unsigned32	RW	N	0	3. gemapptes Applikationsobjekt: 2 Byte: Index 1 Byte: SubIndex 1 Byte: Bitbreite
	4	4. gemapptes Objekt	Unsigned32	RW	N	0	4. gemapptes Applikationsobjekt: 2 Byte: Index 1 Byte: SubIndex 1 Byte: Bitbreite

## Mapping Parameter 6. TxPDO

Index	Sub Index	Name	Typ	Attrb.	Map.	Default-Wert	Bedeutung
0x1A05	0	Anzahl Elemente	Unsigned8	RO	N	0	Anzahl der verfügbaren SubIndexe
	1	1. gemapptes Objekt	Unsigned32	RW	N	0	1. gemapptes Applikationsobjekt: 2 Byte: Index 1 Byte: SubIndex 1 Byte: Bitbreite
	2	2. gemapptes Objekt	Unsigned32	RW	N	0	2. gemapptes Applikationsobjekt: 2 Byte Index 1 Byte: SubIndex 1 Byte: Bitbreite
	3	3. gemapptes Objekt	Unsigned32	RW	N	0	3. gemapptes Applikationsobjekt: 2 Byte: Index 1 Byte: SubIndex 1 Byte: Bitbreite
	4	4. gemapptes Objekt	Unsigned32	RW	N	0	4. gemapptes Applikationsobjekt: 2 Byte: Index 1 Byte: SubIndex 1 Byte: Bitbreite

### Mapping parameter 7. TxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1A06	0	Number of elements	Unsigned8	RO	N	0	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	2. mapped object	Unsigned32	RW	N	0	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

### Mapping Parameter 8. TxPDO

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x1A07	0	Number of elements	Unsigned8	RO	N	0	Number of available sub-index numbers
	1	1. mapped object	Unsigned32	RW	N	0	1. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	2	2. mapped object	Unsigned32	RW	N	0	2. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	3	3. mapped object	Unsigned32	RW	N	0	3. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width
	4	4. mapped object	Unsigned32	RW	N	0	4. mapped application object: 2 Byte: Index 1 Byte: Sub-index 1 Byte: bit width

## Firmware info

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x2010	0	Number of elements	Unsigned8	RO	N	1	Number of available sub-index numbers
	1	Firmware version	Unsigned32	RO	N		Firmware version

## Hardware info

Index	Sub Index	Name	Type	Attr b.	Map.	Default-value	Importance
0x2020	0	Number of elements	Unsigned8	RO	N	8	Number of available sub-index numbers
	1	Firmware version	Unsigned32	RO	N		Firmware version
	2	Number of IO channels	Unsigned32	RO	N		Number of IO channels
	3	Current temperature	Unsigned32	RO	N		Current temperature
	4	Maximum temperature	Unsigned32	RO	N		Maximum temperature
	5	Minimum temperature	Unsigned32	RO	N		Minimum temperature
	6	Reboot counter	Unsigned32	RO	N		Reboot counter
	7	Calibration data	Unsigned32	RO	N		Data of the latest calibration
	8	Operating hours counter	Unsigned32	RO	N		Operating hours counter

## Analog channel

Index	Sub Index	Name	Type	Attr b.	Map.	Default-value	Importance
0x2101 ... 0x2110	0	Number of elements	Unsigned8	RO	N	11	Number of available sub-index numbers
	1	Type	Unsigned8	RW	N	55	Type of channel
	2	Value	Signed16	RW	N		Current value of the channel
	3	Status	Unsigned8	RO	N		Status display of the channel
	4	Elements of the averaging	Unsigned8	RW	N	5	Number of grid points for the averaging between 5 and 10
	5	MinDigit	Unsigned16	RO	N		Value of calibration for the setting type
	6	MinValue	Signed16	RO	N		Value of calibration for the setting type
	7	MaxDigit	Unsigned16	RO	N		Value of calibration for the setting type
	8	MaxValue	Signed16	RO	N		Value of calibration for the setting type

	9	DAC value	Unsigned16	RW	N		Value is created on DAC between 0...4095
	10	ADC- value 1	Unsigned16	RO	N		ADC value for A-IO
	11	ADC- value 2	Unsigned16	RO	N		ADC value for A-IN
	12	NTC B-value	Float	RW	N	3987.75	Coefficient, results of the resistance at 25 °C and 100°C
	13	NTC resistance at 25°C	Float	RW	N	10000	Resistance at 25°C
	14	NTC resistance at 100°C	Float	RW	N	680	Resistance at 100°C
	15	Parallel resistance via clamb	Float	RW	N	10000	Parallel resistance, switched via the input clamb

### Digital Inputs

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x6000	0	Number of elements	Unsigned8	RO	N	4	Number of available digital 8 Bit – Input blocks
	1	1. Input block	Unsigned8	RO	Y	0	1. Input block (DI1...DI8)
	2	2. Input block	Unsigned8	RO	Y	0	2. Input block (DI9...DI16)
	3	3. Input block	Unsigned8	RO	Y	0	3. Input block (DI17...DI24)
	4	4. Input block	Unsigned8	RO	Y	0	4. Input block (DI25...DI32)

Via default each change of a value in the event triggered PDO leads to the sending of a telegram.

### Digital Outputs

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x6200	0	Number of elements	Unsigned8	RO	N	4	Number of available digital 8 Bit – Output block
	1	1. Output block	Unsigned8	RW	Y	0	1. Output block (DO1...DO8)
	2	2. Output block	Unsigned8	RW	Y	0	2. Output block (DO9...DO16)
	3	3. Output block	Unsigned8	RW	Y	0	3. Output block (DO17...DO24)
	4	4. Output block	Unsigned8	RW	Y	0	4. Output block (DO25...DO32)

### Error mode of the digital outputs

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x6206	0	Number of elements	Unsigned8	RO	N	4	Number of available digital 8 Bit – Output block
	1	1. Output block	Unsigned8	RW	N	0	1. Output block (DO1...DO8)
	2	2. Output block	Unsigned8	RW	N	0	2. Output block (DO9...DO16)
	3	3. Output block	Unsigned8	RW	N	0	3. Output block (DO17...DO24)
	4	4. Output block	Unsigned8	RW	N	0	4. Output block (DO25...DO32)

When guarding error, the setting value in object 0x6207 will be created in DOx equal ONE at the output. When DOx equal ZERO, the old value is retained.

### Error value of digital outputs

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x6207	0	Number of elements	Unsigned8	RO	N	4	Number of available digital 8 Bit – Output block
	1	1. Output block	Unsigned8	RW	N	0	1. Output block (DO1...DO8)
	2	2. Output block	Unsigned8	RW	N	0	2. Output block (DO9...DO16)
	3	3. Output block	Unsigned8	RW	N	0	3. Output block (DO17...DO24)
	4	4. Output block	Unsigned8	RW	N	0	4. Output block (DO25...DO32)

When guarding error and setting object 0x6206, the setting value will be set on the output.

### Analog inputs

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x6401	0	Number of elements	Unsigned8	RO	N	16	Number of available analog input channels
	1	1. Input channel	Signed16	RO	Y	0	1. analog input AI1
	2	2. Input channel	Signed16	RO	Y	0	2. analog input AI2
	...						
	15	15. Input channel	Signed16	RO	Y	0	15. analog input AI15
	16	16. Input channel	Signed16	RO	Y	0	16. analog input AI16



Depending on the chosen sensor type, it results different range of values

Sensor-type	Input	Range of values
AIN_M10_10VOLT	-10V ... 10V	-10000 ... 10000
AIN_0_20mA	0mA ... 20 mA	0 ... 20000
AIN_PT100_2WIRE	-30,0 ... 500,0 °C	-300 ... 5000

### Analog Outputs

Index	Sub Index	Name	Typ	Attrb.	Map.	Default-Wert	Bedeutung
0x6411	0	Anzahl Elemente	Unsigned8	RO	N	16	Anzahl vorhandener analoger Ausgänge
	1	1. Eingangskanal	Signed16	RW	Y	0	1. analoger Ausgang AO1
	2	2. Eingangskanal	Signed16	RW	Y	0	2. analoger Ausgang AO2
	...						
	15	15. Eingangskanal	Signed16	RW	Y	0	15. analoger Ausgang AO15
	16	16. Eingangskanal	Signed16	RW	Y	0	16. analoger Ausgang AO16

Depending on the chosen sensor type, it results different range of values

Sensor-type	Input	Range of values
AOUT_M10_10VOLT	-10V ... 10V	-10000 ... 10000
AOUT_0_20mA	0mA ... 20 mA	0 ... 20000

### Event control of analog inputs

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x6423	0	Global interrupt Enable	Boolean	RW	N	0	Activate the event-driven sending of PDOs with analog inputs

According CANopen the analog inputs in TxPDO2.4 are configured event driven (255) via default to the transmission type. But the event (changing of the input value) is deactivated via the event control in the object 0x6423 to avoid a submergence of the bus with analog signals.

It is advisable to control the data volume of the analog PDOs via synchronous communication or via the use of the event timer. In the event driven operation the transmission of the analog PDOS can be parameterized before the activating via adjust the inhibit time (object 0x1800ff, Sub-index 3) and/or the delta function (object 0x6426).

## Delta function of analog inputs

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x6426	0	Number of elements	Unsigned8	RO	N	16	Number of available analog input channels
	1	1. Delta Input channel	Signed16	RW	N	0	Delta 1. analog input
	2	2. Delta Input channel	Signed16	RW	N	0	Delta 2. analog input
	...						
	15	15. Delta Input channel	Signed16	RW	N	0	Delta 15. analog input
	16	16. Delta Input channel	Signed16	RW	N	0	Delta 16. analog input

Values unequal to zero are activating the delta function for the assigned channel. A PDO is then transmitted when the value has been changed for more than the delta value since the last transmission. In addition, the event trigger has to be active (object 0x6423). The data format corresponds to the analog inputs. (The delta function accepts only positive values).

### Sensor type analog inputs

The analog inputs of the robusto slave devices are configurable. This means, each analog input channel has to be assigned a sensor type.

## Error mode of the analog outputs

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x6443	0	Number of elements	Unsigned8	RO	N	16	Number of available analog input channels
	1	1. Output channel	Unsigned8	RW	N	0	1. analog outputs AO1
	2	2. Output channel	Unsigned8	RW	N	0	2. analog outputs AO2
	...						
	15	15. Output channel	Unsigned8	RW	N	0	15. analog outputs AO15
	16	16. Output channel	Unsigned8	RW	Y	0	16. analog outputs AO16

If guarding error, the output will be set according the parameterized value.

If parameter value ONE, the value which is written in the object 0x6444 will be created at the output.

If value ZERO, the output remains unchanged.

## Error value of the analog outputs

Index	Sub Index	Name	Type	Attrb.	Map.	Default-value	Importance
0x6444	0	Number of elements	Unsigned 8	RO	N	16	Number of available analog input channels
	1	1. Output channel	Signed32	RW	N	0	1. analog outputs AO1
	2	2. Output channel	Signed32	RW	N	0	2. analog outputs AO2
	...						
	15	15 Output channel	Signed32	RW	N	0	15. analog outputs AO15
	16	16. Output channel	Signed32	RW	N	0	16. analog outputs AO16

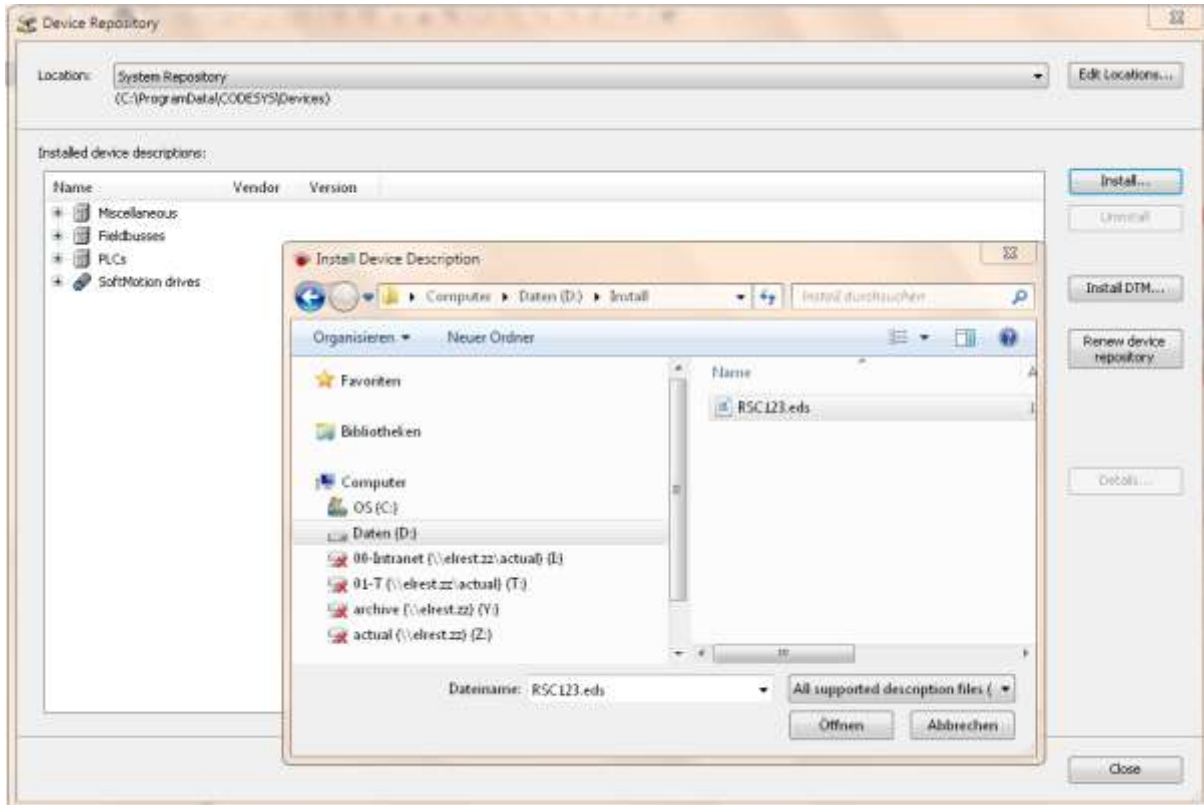
If guarding error and the setting object 0x6443, the setting value will be created at the output.

## 7 CODESYS V3

### 7.1 Integrate EDS file

In CODESYS V3, the RSC123 will be notified by installing of the EDS file in the development system and can be integrated in the configuration.

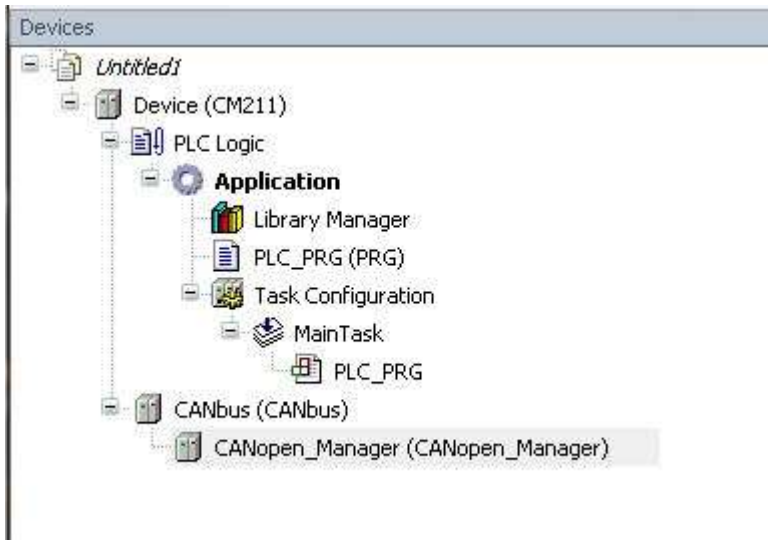
Installation is carried out via the menu item „Tools\Device-Repository“ in the CODESYS DIE”



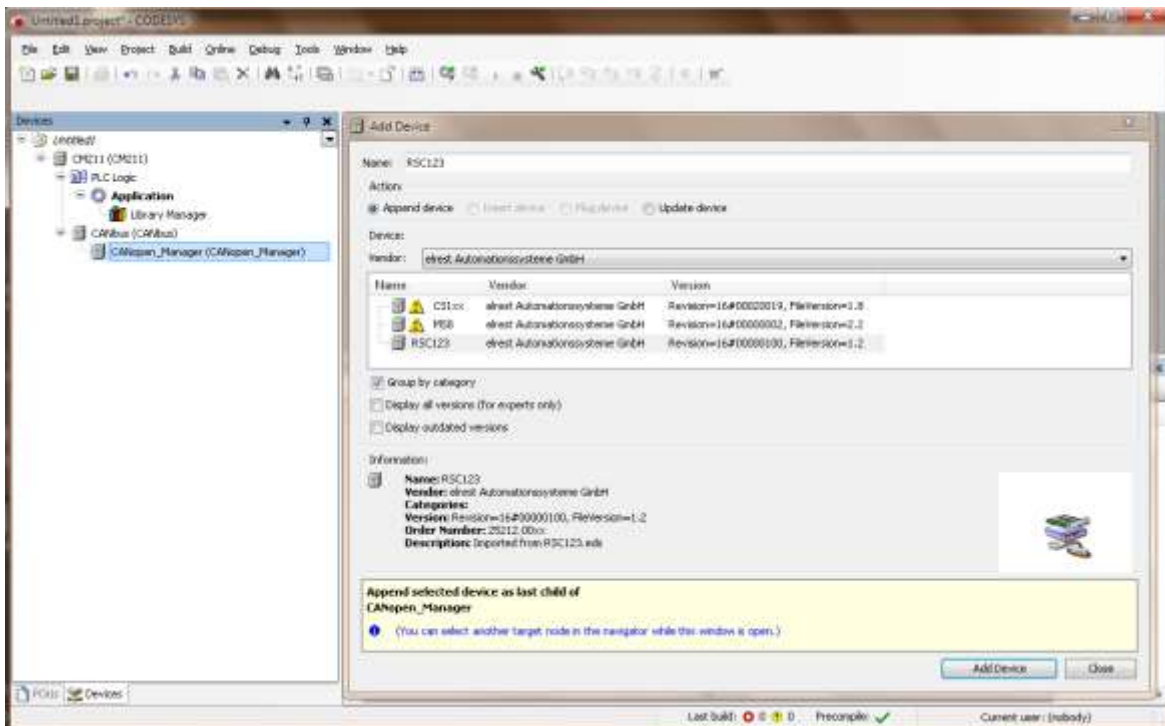
After pressing the button „install“, the choice will be taken for the corresponding EDS file. Its will be selected with “Open” and transmitted in the system repository via the CODESYS DIE. Now, the RSC123 can be integrated in a CANopen configuration.

## 7.2 CANopen configuration

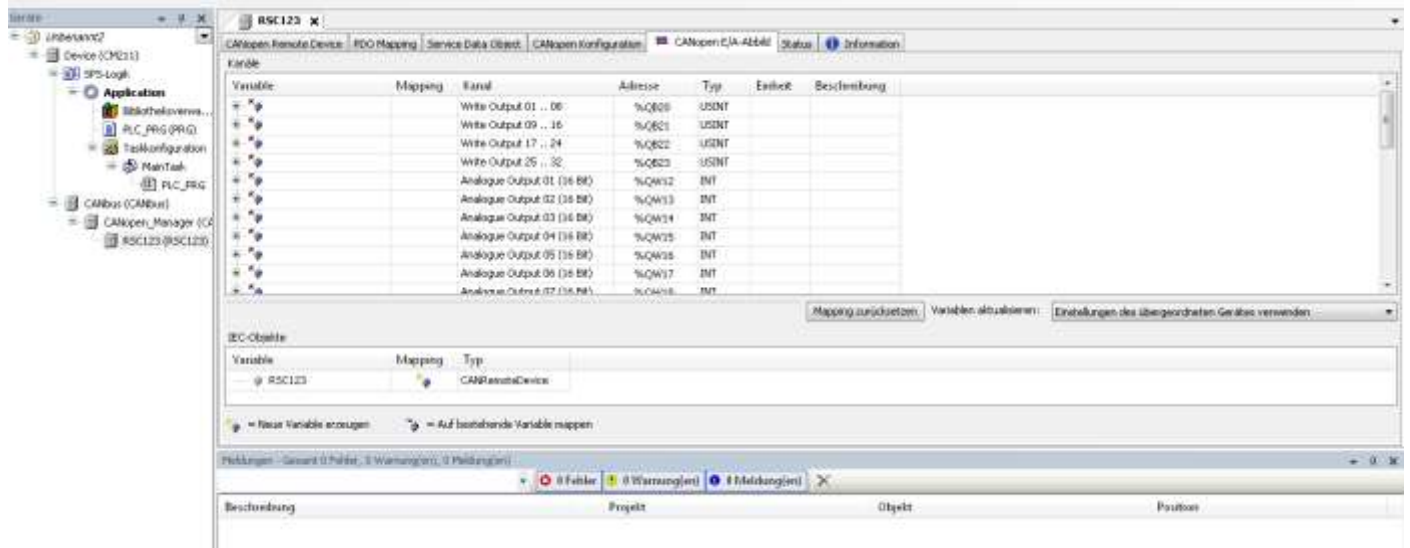
In the CODESYS application, the CANbus will be integrated with CANopen\_Manager via „taching device“.



Via „taching device“ the used RSC 102 node can be added to the configuration.



The included RSC123 node can now in the expert mode be configured and parameterized. The setting Node ID has to be configured, the supervision type of the node, properties of the PDOs and if necessary to configure the used analog channels.



If using analog channels, in the tab „Service Data Object“ the type of the used channel has to be set in the analog channel.



The object type of the used channel has to be added and the value for the type has to be registered.

```

AIN_O_1VOLT           := 1,    (* Wertebereich: 0 .. 1000 *)
AIN_O_20MA            := 3,    (* Wertebereich: 0 .. 20000 *)
AIN_TC_TYPE_K        := 15,   (* NiCrNi C° Kalibrierung auf die physikalischen Größe mV *)
AIN_PT100_2WIRE      := 21,   (* C° Kalibrierung auf die physikalischen Größe Ohm *)
AOUT_M10_10VOLT      := 51,   (* Wertebereich: -10000 .. 10000 *)
AOUT_O_20MA          := 52,   (* Wertebereich: 0 .. 20000 *)
AIN_M10_10VOLT       := 100,  (* Wertebereich: -10000 .. 10000 *)
AIN_500_OHM          := 103,  (* Wertebereich: 0 .. 500 *)
AIN_NTC_10KOHM       := 104,  (* Wertebereich: 0 .. 500 *)
AOUT_AI08_OFF        := 55

```



For further information please contact our application department.  
[Service and support](#)

## 8 Maintenance and service

### 8.1 Maintenance

#### 8.1.1 General

Please ensure you observe and check the following points:

- The ambient conditions must be assured.
- Is the housing temperature unusually high?

##### 8.1.1.1 Device temperature



**The device temperature** of the robusto RSC123 during the operation should not be lower than 0°C and not higher than 50 °C sein.

Otherwise all warranty claims and the device can be destroyed).

#### 8.1.2 Function earth (FE)

Power plug X1



The cable screens of the communication ports X27 /CAN-IN and X28 /CAN-OUT are connected with FE:



The housing has to be connected, with low-resistance, via the screw connections (sideways of the housing) to the PE.

### 8.1 Device failure

The RSCxxx device was tested before delivery and has left our premises in good order and conditions. Should an error occur, on our website [„service/ redelivery“](#) you can fill out the RMA form and send us. We'll attend to it directly and answer as soon as possible.

## 8.2 Accessories

Designation	Artikle number	Description	
Patch cable	commercial	Connection to CM1xx or 2xx und further slaves.	
Cable D-Sub-9 to RJ-45	240020100	Connection to visio control PMC4xx and further slaves.	
Connector set	25001.0005	<p>2x socket 10-pole; contact spacing 3,5 mm, conductor crosssection up to 0,2 ... 1,0 mm<sup>2</sup>, 8 A Serie 714-110</p> <p>8 x socket 10-pole; contact spacing 3,5 mm, conductor crosssection up to 0,2 ... 1,0 mm<sup>2</sup>, 8 A Serie 714-106</p> <p>1 x socket 3-pole , WAGO 734-103/037-000</p>	  
Download- adapter	25002.0000		
Cable for adapter	commercial	USB A on USB-Micro-B	



## 8.3 Notice

Note for devices with the index = „PROTOTYPE”.

Chapter

Prototypes are used only for test purposes.

[Security regulations and safety precautions](#)

Interface X26: this interface is not assigned.

[Frontview of the interfaces](#)

Firmware Info:

[Firmware Info: INDEX 2010](#)

## 9 Troubleshooting

### 9.1 Service and Support

#### Hotline

For additional support and information contact our hotline with the following times:

Mon-Fri: 8.00- 12.00 and 13.00 - 16.30

Phone: +49 (0) 7021 / 92025-33

Besides, you can of course always contact us by mail or fax.

Fax.: +49 (0) 7021 / 92025-29

e-mail: [support@elrest.de](mailto:support@elrest.de)

#### Training und Workshops

We offer education or project-based workshops for the elrest products.

Please contact our sales department for further information.

Phone: +49 (0) 7021/92025-0

Fax: +49 (0) 7021/92025-29

E-mail: [vertrieb@elrest.de](mailto:vertrieb@elrest.de)

## 10 History

<i>Date</i>	<i>Name</i>	<i>Chapter</i>	<i>Changing</i>
03.08.2015	Hm	1.0	Created

2015 elrest Automationssysteme GmbH. All rights reserved.

The information in this document is subject to change without notice and does not represent a commitment on the part of elrest GmbH. The software and/or databases described in this document are made available subject to a License Agreement and a Nondisclosure Agreement. The software and/or databases may only be used or copied strictly in accordance with the terms of the Agreement. Unless explicitly permitted under the terms of the License or Non-Disclosure Agreement; it is illegal to copy the software to another medium. Reproduction or dissemination of this manual in whole or in part for any purpose, in any form and by any means – electronic, mechanical, photocopying or recording – without the express written permission of elrest Automationssysteme GmbH is prohibited. All illustrations, descriptions, dimensions and technical data correspond to the conditions or intentions at the time of printing of this brochure. The company reserves the right to make any changes, particularly where such changes are the result of technical development, more economic design or similar factors. Customers are solely responsible for the external connection of the devices.

E602023-1.0

# 11 Appendix

## 11.1 Resistance tables

Below are the measuring range for the temperature of analog in- and outputs. The tables show each type and its measuring range.

### 11.1.1 Resistance characteristics for the temperature probe NTC-25-10k-100-680

°C	
-50,00	667,83
-40,00	335,67
-30,00	176,68
-20,00	96,97
-10,00	55,30
0,00	32,65
10,00	19,90
20,00	12,49
25,00	10,00
30,00	8,06
40,00	5,32
50,00	3,60
60,00	2,49
70,00	1,75
80,00	1,26
90,00	0,92
100,00	0,68
110,00	0,51
120,00	0,39
130,00	0,30
140,00	0,23
150,00	0,18

11.1.2 Resistance characteristics for the temperature probe  
NTC-25-10k-100-970

°C	
-50,00	329,50
-40,00	188,50
-30,00	111,30
-20,00	67,77
-10,00	42,47
0,00	27,28
10,00	17,96
20,00	12,09
25,00	10,00
30,00	8,31
40,00	5,83
50,00	4,16
60,00	3,02
70,00	2,23
80,00	1,67
90,00	1,27
100,00	0,97
110,00	0,76
120,00	0,59
130,00	0,48
140,00	0,39
150,00	0,31

### 11.1.3 KTY 110/130

Temperature range  $-50^{\circ}\text{C} \dots +150^{\circ}\text{C}$

All resistance value in  $\Omega$

$^{\circ}\text{C}$	$\Omega$
-50	1036,000
-40	1140,000
-30	1250,000
-20	1370,000
-10	1496,000
0	1630,000
10	1772,000
20	1922,000
25	2000,000
30	2080,000
40	2246,000
50	2418,000
60	2600,000
70	2788,000
80	2984,000
90	3188,000
100	3400,000
110	3620,000
120	3846,000
130	4082,000
140	4256,000
150	4470,000

#### 11.1.4 KTY 81-1

Temperature range -55°C....+150°C

All resistance value in  $\Omega$

°C	$\Omega$
-55	490,000
-50	515,000
-40	567,000
-30	624,000
-20	684,000
-10	747,000
0	815,000
10	886,000
20	961,000
25	1000,000
30	1040,000
40	1122,000
50	1209,000
60	1299,000
70	1392,000
80	1490,000
90	1591,000
100	1696,000
110	1805,000
120	1915,000
125	1970,000
130	2023,000
140	2124,000
150	2211,000

#### 11.1.5 KTY 81-2

Temperature range -55°C....+150°C

All resistance value in  $\Omega$

°C	$\Omega$
-55	980,000
-50	1030,000
-40	1135,000
-30	1247,000
-20	1367,000
-10	1495,000
0	1630,000
10	1772,000
20	1922,000
25	2000,000
30	2080,000
40	2245,000
50	2417,000
60	2597,000
70	2785,000
80	2980,000
90	3182,000
100	3392,000
110	3607,000
120	3817,000
125	3915,000
130	4008,000
140	4166,000
150	4280,000

### 11.1.6 NI1000

Temperature range  $-50^{\circ}\text{C} \dots +690^{\circ}\text{C}$

All resistance value in  $\Omega$

$^{\circ}\text{C}$ in steps of 10	$^{\circ}\text{C}$ tended to zero in step of one									
	0	1	2	3	4	5	6	7	8	9
-50	742,550	747,360	752,190	757,030	761,890	766,760	771,640	776,540	781,450	786,370
-40	791,310	796,260	801,230	806,210	811,210	816,210	821,230	826,270	831,320	836,380
-30	841,460	846,550	851,650	856,770	861,900	867,040	872,200	877,370	882,560	887,750
-20	892,960	898,190	903,430	908,680	913,340	919,220	924,510	929,820	935,140	940,470
-10	945,820	951,170	956,550	961,930	967,330	972,740	978,170	983,600	989,060	994,520

$^{\circ}\text{C}$ in steps of 10	$^{\circ}\text{C}$ ascending in step of one									
	0	1	2	3	4	5	6	7	8	9
0	1000,000	1005,490	1011,000	1016,510	1022,050	1027,590	1033,150	1038,720	1044,310	1049,900
10	1055,520	1061,140	1066,780	1072,430	1078,090	1083,770	1089,460	1095,170	1100,890	1106,620
20	1112,360	1118,120	1123,900	1129,680	1135,480	1141,290	1147,120	1152,960	1158,810	1164,680
30	1170,560	1176,450	1182,360	1188,280	1194,210	1200,160	1206,130	1212,100	1218,090	1224,090
40	1230,110	1236,140	1242,190	1248,250	1254,320	1260,410	1266,510	1272,620	1278,750	1284,890
50	1291,050	1297,220	1303,410	1309,610	1315,820	1322,050	1328,290	1334,550	1340,820	1347,100
60	1353,400	1359,720	1366,050	1372,290	1378,750	1385,120	1391,510	1397,910	1404,330	1410,760
70	1417,210	1423,670	1430,150	1436,640	1443,150	1449,670	1456,210	1462,760	1469,330	1475,950
80	1482,510	1489,130	1495,760	1502,400	1509,070	1515,740	1522,440	1529,140	1535,870	1542,610
90	1549,370	1556,140	1562,930	1569,730	1576,550	1583,390	1590,240	1597,110	1604,000	1610,900
100	1617,830	1624,760	1631,720	1638,690	1645,670	1652,680	1659,700	1666,740	1673,790	1680,870
110	1687,960	1695,070	1702,190	1709,330	1716,490	1723,670	1730,870	1738,080	1745,320	1772,570
120	1759,840	1767,120	1774,430	1781,750	1789,090	1796,460	1803,840	1811,230	1818,650	1826,090
130	1833,540	1841,020	1848,510	1856,020	1863,560	1871,110	1878,680	1886,270	1893,880	1901,510
140	1909,170	1916,840	1924,530	1932,240	1939,970	1947,730	1955,500	1963,259	1971,110	1978,950
150	1986,800	1994,680	2002,580	2010,500	2018,440	2026,410	2034,400	2042,400	2050,430	2058,480
160	2066,560	2074,650	2082,770	2090,910	2099,080	2107,270	2115,480	2123,710	2131,960	2140,240
170	2148,550	2156,870	2165,220	2173,590	2181,990	2190,410	2198,860	2207,330	2215,820	2224,340
180	2232,890	2241,450	2250,050	2258,670	2267,310	2275,980	2284,670	2293,390	2302,140	2310,910
190	2319,710	2328,540	2337,390	2346,260	2355,170	2364,100	2373,060	2382,040	2391,050	2400,090

°C in steps of 10 ↓	°C ascending in steps of two →				
	0	2	4	6	8
200	2409,160	2427,380	2445,710	2464,150	2482,710
210	2501,380	2520,170	2539,080	2558,110	2577,260
220	2596,540	2615,930	2635,460	2655,110	2674,880
230	2694,790	2714,830	2735,000	2755,310	2775,750
240	2796,330	2817,040	2837,900	2858,900	2880,040
250	2901,330	2922,760	2944,350	2966,080	2987,960
260	3010,000	3032,190	3054,540	3077,050	3099,720
270	3122,550	3145,550	3168,710	3192,040	3215,540
280	3239,210	3263,050	3287,070	3311,270	3335,650
290	3360,200	3384,940	3409,870	3434,990	3460,590
300	3485,790	3511,000	3537,360	3563,440	3589,730
310	3616,210	3642,900	3669,800	3696,910	3724,230
320	3751,760	3779,510	3807,480	3835,670	3864,080
330	3892,720	3921,580	3950,680	3980,010	4009,570
340	4039,380	4069,420	4099,710	4130,250	4161,030
350	4192,070	4223,350	4254,900	4286,710	4318,770
360	4351,110	4383,710	4416,580	4449,730	4483,150
370	4516,850	4550,840	4585,110	4619,660	4654,510
380	4689,660	4725,100	4760,840	4796,890	4833,250
390	4869,910	4906,890	4944,180	4981,800	5019,740
400	5058,000	5096,590	5135,520	5174,790	5214,390
410	5254,340	5294,640	5335,290	5376,290	5417,650
420	5459,370	5501,460	5543,910	5586,740	5629,950
430	5673,540	5717,510	5761,860	5806,610	5851,760
440	5897,310	5943,260	5689,610	6036,380	6083,570
450	6131,180	6179,210	6227,660	6276,560	6325,880
460	6375,650	6425,870	6476,530	6527,650	6579,230
470	6631,270	6683,780	6736,760	6790,200	6844,160
480	6898,580	6953,500	7008,910	7064,820	7121,240
490	7178,170	7235,610	7293,570	7352,060	7411,070
500	7470,630	7530,720	7591,350	7652,540	7714,280
510	7776,580	7839,450	7902,890	7966,900	8031,500
520	8096,680	8162,460	8228,830	8295,810	8363,400
530	8431,600	8500,430	8569,880	8639,960	8710,680
540	8782,050	8854,060	8926,730	9000,060	9074,060
550	9148,740	9224,090	9300,130	9376,870	9454,300
560	9532,440	9611,280	9690,850	9771,140	9852,160
570	9933,920	10016,430	10099,680	10183,690	10268,470
580	10354,010	10440,330	10527,440	10615,340	10704,040
590	10793,550	10883,860	10975,000	11066,960	11159,760
600	11253,400	11347,890	11443,230	11539,440	11636,520
610	11734,480	11833,330	11933,070	12033,710	12135,260
620	12237,730	12341,120	12445,450	12550,720	12656,940
630	12764,110	12872,250	12981,370	13091,460	13202,550
640	13314,640	13427,730	13541,840	13656,980	13773,140
650	13890,350	14008,610	14127,930	14248,320	14369,780
660	14492,330	14615,980	14740,730	14866,690	14993,570
670	15121,690	15250,950	15381,360	15512,930	15645,670
680	15779,590	15914,690	16051,000	16188,510	16327,240
690	16467,210				



### 11.1.7 NI1000TK5000

Temperature range -50°C....+690°C

All resistance value in  $\Omega$

°C in steps of 10 ↓	°C tended to zero in step of one →									
	0	1	2	3	4	5	6	7	8	9
-50	790,880	794,840	798,800	802,780	806,760	810,750	814,750	818,760	822,780	826,800
-40	830,840	834,880	838,940	843,000	847,070	851,150	855,240	859,340	863,450	867,570
-30	871,690	875,830	879,980	884,130	888,300	892,470	896,650	900,850	905,050	909,260
-20	913,480	917,720	921,960	926,210	930,470	934,740	939,020	943,310	947,610	951,920
-10	956,240	960,570	964,910	969,260	973,620	977,990	982,370	986,770	991,170	995,580

°C in steps of 10 ↓	°C ascending in step of one →									
	0	1	2	3	4	5	6	7	8	9
0	1000,000	1004,430	1008,870	1013,330	1017,790	1022,260	1026,750	1031,240	1035,750	1040,270
10	1044,790	1049,330	1053,880	1058,440	1063,010	1067,590	1072,180	1076,780	1081,390	1086,020
20	1090,650	1095,300	1099,960	1104,620	1109,300	1113,990	1118,700	1123,410	1128,130	1132,870
30	1137,620	1142,370	1147,140	1151,920	1156,720	1161,520	1166,340	1171,160	1176,000	1180,850
40	1185,710	1190,590	1195,470	1200,370	1205,280	1210,200	1215,130	1220,070	1225,030	1230,000
50	1234,980	1239,970	1244,970	1249,990	1255,020	1260,060	1265,110	1270,180	1275,250	1280,340
60	1285,450	1290,560	1295,690	1300,830	1305,980	1311,140	1316,320	1321,510	1326,710	1331,920
70	1337,150	1342,390	1347,640	1352,910	1358,180	1363,470	1368,780	1374,090	1379,420	1384,770
80	1390,120	1395,490	1400,870	1406,260	1411,600	1417,090	1422,530	1427,970	1433,430	1438,910
90	1444,390	1449,900	1455,410	1460,940	1466,480	1472,030	1477,600	1483,180	1488,770	1494,380
100	1500,010	1505,640	1511,290	1516,950	1522,630	1528,320	1534,030	1539,750	1545,480	1551,220
110	1556,980	1562,760	1568,550	1574,350	1580,170	1586,000	1591,840	1597,700	1603,580	1609,470
120	1615,370	1621,280	1627,220	1633,160	1639,120	1645,100	1651,080	1657,090	1663,110	1669,140
130	1675,190	1681,250	1687,330	1693,420	1699,520	1705,650	1711,780	1717,930	1724,100	1730,280
140	1736,480	1742,690	1748,910	1755,150	1761,410	1767,680	1773,970	1780,270	1786,590	1792,920
150	1799,270	1805,630	1812,010	1818,410	1824,820	1831,240	1837,680	1844,140	1850,610	1857,100
160	1863,600	1870,120	1876,650	1883,200	1889,770	1896,350	1902,950	1909,560	1916,190	1922,840
170	1929,500	1936,180	1942,870	1949,580	1956,310	1963,050	1969,810	1976,580	1983,370	1990,180
180	1997,000	2003,840	2010,700	2017,570	2024,460	2031,370	2038,290	2045,230	2052,190	2059,160
190	2066,150	2073,150	2080,170	2087,210	2094,270	2101,340	2108,430	2115,540	2122,660	2129,800
200	2139,960	2145,645	2151,330	2158,545	2165,760	2173,010	2180,260	2187,550	2194,840	2202,160
210	2209,480	2216,835	2224,190	2231,580	2238,970	2246,395	2253,820	2261,280	2268,740	2276,235
220	2283,730	2291,265	2298,800	2306,365	2313,930	2321,535	2329,140	2336,775	2344,410	2352,085
230	2359,760	2367,380	2375,000	2382,840	2390,680	2398,460	2406,240	2414,060	2421,880	2429,735
240	2437,590	2445,485	2453,380	2461,310	2469,240	2477,205	2485,170	2493,175	2501,180	2509,225
250	2517,270	2525,345	2533,420	2541,540	2549,660	2557,810	2565,960	2574,155	2582,350	2590,580
260	2598,810	2607,080	2615,350	2623,655	2631,960	2640,305	2648,650	2657,030	2665,410	2673,835
270	2682,260	2690,720	2699,180	2707,680	2716,180	2724,720	2733,260	2741,835	2750,410	2759,030
280	2767,650	2776,305	2784,960	2793,655	2802,350	2811,085	2819,820	2828,600	2837,380	2846,195
290	2855,010	2863,865	2872,720	2881,615	2890,510	2899,450	2908,390	2917,365	2926,340	2935,360
300	2944,380	2953,435	2962,490	2971,590	2980,690	2989,830	2998,970	3008,155	3017,340	3026,560
310	3035,780	3045,045	3054,310	3063,615	3072,920	3082,270	3091,620	3101,010	3110,400	3119,830
320	3129,260	3138,735	3148,210	3157,725	3167,240	3176,800	3186,360	3195,960	3205,560	3215,205
330	3224,850	3234,535	3244,220	3253,950	3263,680	3273,455	3283,230	3293,045	3302,860	3312,720
340	3322,580	3332,480	3342,380	3352,325	3362,270	3372,260	3382,250	3392,285	3402,320	3412,400

°C in steps of 10	°C ascending in step of one									
	0	1	2	3	4	5	6	7	8	9
350	3422,480	3432,600	3442,720	3452,885	3463,050	3473,260	3483,470	3493,730	3503,990	3514,285
360	3524,580	3534,925	3545,270	3555,660	3566,050	3576,485	3586,920	3597,400	3607,880	3618,405
370	3628,930	3639,505	3650,080	3660,695	3671,310	3681,970	3692,630	3703,340	3714,050	3724,805
380	3735,560	3746,360	3757,160	3768,005	3778,850	3789,745	3800,640	3811,580	3822,520	3833,505
390	3844,490	3855,520	3866,550	3877,630	3888,710	3899,840	3910,970	3922,145	3933,320	3944,540
400	3955,760	3967,030	3978,300	3989,615	4000,930	4012,295	4023,660	4035,075	4046,490	4057,950
410	4069,410	4080,915	4092,420	4103,980	4115,540	4127,145	4138,750	4150,405	4162,060	4173,760
420	4185,460	4197,215	4208,970	4220,770	4232,570	4244,420	4256,270	4268,165	4280,060	4292,010
430	4303,960	4315,955	4327,950	4340,000	4352,050	4364,145	4376,240	4388,390	4400,540	4412,735
440	4424,930	4437,180	4449,430	4461,725	4474,020	4486,370	4498,720	4511,115	4523,510	4535,960
450	4548,410	4560,910	4573,410	4585,965	4598,520	4611,120	4623,720	4636,375	4649,030	4791,640
460	4674,440	4687,195	4699,950	4712,760	4725,570	4738,430	4751,290	4764,200	4777,110	4790,075
470	4803,040	4816,055	4829,070	4842,135	4855,200	4868,325	4881,450	4894,620	4907,790	4921,020
480	4934,250	4947,525	4960,800	4974,135	4987,470	5000,855	5014,240	5027,675	5041,110	5054,605
490	5068,100	5081,645	5095,190	5108,790	5122,390	5136,040	5149,690	5163,395	5177,100	5190,865
500	5204,630	5218,440	5232,250	5246,120	5259,990	5273,915	5287,840	5301,820	5315,800	5329,830
510	5343,860	5357,950	5372,040	5386,180	5400,320	5414,520	5428,720	5442,975	5457,230	5471,535
520	5485,840	5500,205	5514,570	5528,990	5543,410	5557,885	5572,360	5586,895	5601,430	5616,015
530	5630,600	5645,245	5659,890	5674,590	5689,290	5704,045	5718,800	5733,615	5748,430	5763,300
540	5778,170	5793,100	5808,030	5823,010	5837,990	5853,035	5868,080	5883,175	5898,270	5913,425
550	5928,580	5943,795	5959,010	5974,280	5989,550	6004,880	6020,210	6035,595	6050,980	6066,425
560	6081,870	6097,375	6112,880	6128,440	6144,000	6159,620	6175,240	6190,920	6206,600	6222,340
570	6238,080	6253,875	6269,670	6285,525	6301,380	6317,295	6333,210	6349,185	6365,160	6381,190
580	6397,220	6413,315	6429,410	6445,560	6461,710	6477,925	6494,140	6510,410	6526,680	6543,010
590	6559,340	6575,735	6592,130	6608,585	6625,040	6641,550	6658,060	6674,635	6691,210	6707,845
600	6724,480	6741,175	6757,870	6774,625	6791,380	6808,200	6825,020	6841,900	6858,780	6875,720
610	6892,660	6909,660	6926,660	6943,725	6960,790	6977,915	6995,040	7012,230	7029,420	7046,670
620	7063,920	7081,230	7098,540	7115,915	7133,290	7150,730	7168,170	7185,665	7203,160	7220,725
630	7238,290	7255,915	7273,540	7291,230	7308,920	7326,670	7344,420	7362,235	7380,050	7397,930
640	7415,810	7433,750	7451,690	7469,695	7487,700	7505,770	7523,840	7541,975	7560,110	7578,305
650	7596,500	7614,760	7633,020	7651,350	7669,680	7688,070	7706,460	7724,915	7743,370	7761,890
660	7780,410	7798,995	7817,580	7836,230	7854,880	7873,595	7892,310	7911,090	7929,870	7948,715
670	7967,560	7986,475	8005,390	8024,365	8043,340	8062,385	8081,430	8100,535	8119,640	8138,820
680	8158,000	8177,240	8196,480	8215,785	8235,090	8254,465	8273,840	8293,285	8312,730	8332,235
690	8351,740									

### 11.1.8 PT100

Temperature range -200°C....+850°C

All resistance value in  $\Omega$

°C in steps of 10 ↓	°C tended to zero in step of one →									
	0	1	2	3	4	5	6	7	8	9
-200	18,493	18,926	19,358	19,790	20,221	20,653	21,083	21,514	21,944	22,374
-190	22,803	23,232	23,661	24,089	24,517	24,945	25,372	25,799	26,226	26,652
-180	27,078	27,504	27,929	28,354	28,779	29,203	29,627	30,051	30,474	30,897
-170	31,320	31,742	32,165	32,587	33,008	33,429	33,850	34,271	34,691	35,111
-160	35,531	35,951	36,370	36,789	37,208	37,626	38,044	38,462	38,879	39,297
-150	39,714	40,130	40,547	40,963	41,379	41,795	42,210	42,625	43,040	43,455
-140	43,869	44,283	44,697	45,111	45,524	45,937	46,350	46,763	47,175	47,587
-130	47,999	48,411	48,822	49,234	49,645	50,055	50,466	50,876	51,286	51,696
-120	52,106	52,515	52,924	53,333	53,742	54,151	54,559	54,967	55,375	55,783
-110	56,190	56,598	57,005	57,412	57,818	58,225	58,631	59,037	59,443	59,849
-100	60,254	60,659	61,065	61,469	61,874	62,279	62,683	63,087	63,491	63,895
-90	64,299	64,702	65,105	65,508	65,911	66,314	66,717	67,119	67,521	67,923
-80	68,325	68,727	69,128	69,530	69,931	70,332	70,733	71,134	71,534	71,934
-70	72,335	72,735	73,135	73,534	73,934	74,333	74,733	75,132	75,531	75,930
-60	76,328	76,727	77,125	77,523	77,921	78,319	78,717	79,115	79,512	79,910
-50	80,307	80,704	81,101	81,498	81,894	82,291	82,687	83,083	83,479	83,875
-40	84,271	84,667	85,063	85,458	85,853	86,248	86,643	87,038	87,433	87,828
-30	88,222	88,617	89,011	89,405	89,799	90,193	90,587	90,980	91,374	91,767
-20	92,160	92,553	92,946	93,339	93,732	94,125	94,517	94,910	95,302	95,694
-10	96,086	96,478	96,870	97,262	97,653	98,045	98,436	98,827	99,218	99,609

°C in steps of 10	°C ascending in step of one									
	0	1	2	3	4	5	6	7	8	9
0	100,000	100,391	100,781	101,172	101,562	101,953	102,343	102,733	103,123	103,513
10	103,902	104,681	104,681	105,071	105,460	105,849	106,238	106,627	107,016	107,404
20	107,793	108,181	108,570	108,958	109,346	109,734	110,122	110,509	110,897	111,284
30	111,672	112,059	112,446	112,833	113,220	113,607	113,994	114,380	114,767	115,153
40	115,539	115,925	116,311	116,697	117,083	117,469	117,854	118,240	118,625	119,010
50	119,395	119,780	120,165	120,550	120,934	121,319	121,703	122,087	122,471	122,855
60	123,239	123,623	124,007	124,390	124,774	125,157	125,540	125,923	126,306	126,689
70	127,072	127,454	127,837	128,219	128,602	128,984	129,366	129,748	130,130	130,511
80	130,893	131,274	131,656	132,037	132,418	132,799	133,180	133,561	133,941	134,322
90	134,702	135,083	135,463	135,843	136,223	136,603	136,982	137,362	137,741	138,121
100	138,500	138,879	139,258	139,637	140,016	140,395	140,773	141,152	141,530	141,908
110	142,286	142,664	143,042	143,420	143,797	144,175	144,552	144,930	145,307	145,684
120	146,061	146,438	146,814	147,191	147,567	147,944	148,320	148,696	149,072	149,448
130	149,824	150,199	150,575	150,950	151,326	151,701	152,076	152,451	152,826	153,200
140	153,575	153,950	154,324	154,698	155,072	155,446	155,820	156,194	156,568	156,941
150	157,315	157,688	158,061	158,435	158,808	159,180	159,553	159,926	160,298	160,671
160	161,043	161,415	161,787	162,159	162,531	162,903	163,274	163,646	164,017	164,388
170	164,760	165,131	165,501	165,872	166,243	166,614	166,984	167,354	167,724	168,095
180	168,465	168,834	169,204	169,574	169,943	170,313	170,682	171,051	171,420	171,789
190	172,158	172,527	172,895	173,264	173,632	174,000	174,368	174,736	175,104	175,472
200	175,840	176,207	176,575	176,942	177,309	177,676	178,043	178,410	178,777	179,143
210	179,510	179,876	180,242	180,609	180,975	181,340	181,706	182,072	182,438	182,803
220	183,168	183,534	183,899	184,264	184,628	184,993	185,358	185,722	186,087	186,451
230	186,815	187,179	187,543	187,907	188,271	188,634	188,998	189,361	189,724	190,088
240	190,451	190,813	191,176	191,539	191,901	192,264	192,626	192,988	193,350	193,712
250	194,074	194,436	194,798	195,159	195,521	195,882	196,243	196,604	196,965	197,326
260	197,686	198,047	198,407	198,768	199,128	199,488	199,848	200,208	200,568	200,927
270	201,287	201,646	202,006	202,365	202,724	203,083	203,442	203,800	204,159	204,517
280	204,876	205,234	205,592	205,950	206,308	206,666	207,024	207,381	207,739	208,096
290	208,453	208,810	209,167	209,524	209,881	210,237	210,594	210,950	211,307	211,663
300	212,019	212,375	212,731	213,086	213,442	213,797	214,153	214,508	214,863	215,218



### 11.1.9 PT500

Temperature range -200°C....+850°C

All resistance value in  $\Omega$

°C in steps of 10 ↓	°C tended to zero in step of one →									
	0	1	2	3	4	5	6	7	8	9
-200	92,600	94,761	96,920	99,077	101,230	103,390	105,540	107,690	109,840	111,980
-190	114,130	116,270	118,410	120,550	122,690	124,830	126,960	129,090	131,220	133,350
-180	135,480	137,610	139,730	141,860	143,980	146,100	148,220	150,330	152,450	154,560
-170	156,680	158,790	160,900	163,000	165,110	167,210	169,320	171,420	173,520	175,620
-160	177,720	179,810	181,910	184,000	186,090	188,180	190,270	192,360	194,450	196,530
-150	198,620	200,700	202,780	204,860	206,940	209,020	211,090	213,170	215,240	217,310
-140	219,380	221,450	223,520	225,590	227,650	229,720	231,780	233,840	235,910	237,970
-130	240,020	242,080	244,140	246,190	248,250	250,300	252,350	254,400	256,450	258,500
-120	260,550	262,600	264,640	266,690	268,730	270,770	272,810	274,850	276,890	278,930
-110	280,970	283,000	285,040	287,070	289,100	291,130	293,170	295,200	297,220	299,250
-100	301,280	303,310	305,330	307,360	309,380	311,400	313,420	315,440	317,460	319,480
-90	321,500	323,520	325,530	327,550	329,560	331,570	333,590	335,600	337,610	339,620
-80	341,630	343,640	345,640	347,650	349,660	351,660	353,660	355,670	357,670	359,670
-70	361,670	363,670	365,670	367,670	369,670	371,670	373,660	375,660	377,650	379,650
-60	381,640	383,630	385,620	387,610	389,610	391,590	393,580	395,570	397,560	399,550
-50	401,530	403,520	405,500	407,490	409,470	411,450	413,430	415,410	417,390	419,370
-40	421,350	423,330	425,310	427,290	429,260	431,240	433,210	435,190	437,160	439,140
-30	441,110	443,080	445,050	447,020	448,990	450,960	452,930	454,900	456,870	458,830
-20	460,800	462,770	464,730	466,700	468,660	470,620	472,590	474,550	476,510	478,470
-10	480,430	482,390	484,350	486,310	488,270	490,220	492,180	494,140	496,090	498,050

°C in steps of 10 ↓	°C ascending in step of one →									
	0	1	2	3	4	5	6	7	8	9
0	500,000	501,950	503,910	505,860	507,810	509,760	511,720	513,670	515,620	517,560
10	519,510	521,460	523,410	525,360	527,300	529,250	531,190	533,140	535,080	537,030
20	538,970	540,910	542,850	544,790	546,730	548,670	550,610	552,550	554,490	556,430
30	558,370	560,300	562,240	564,170	566,110	568,040	569,980	571,910	573,840	575,770
40	577,700	579,640	581,570	583,500	585,420	587,350	589,280	591,210	593,130	595,060
50	596,990	598,910	600,840	602,760	604,680	606,610	608,530	610,450	612,370	614,290
60	616,210	618,130	620,050	621,970	623,880	625,800	627,720	629,630	631,550	633,460
70	635,380	637,290	639,200	641,110	643,030	644,940	646,850	648,760	650,670	652,580
80	654,480	656,390	658,300	660,210	662,110	664,020	665,920	667,830	669,730	671,000
90	673,540	675,440	677,340	679,240	681,140	683,040	684,940	686,840	688,730	690,630
100	692,530	694,420	696,320	698,210	700,110	702,000	703,900	705,790	707,680	709,570
110	711,460	713,350	715,240	717,130	719,020	720,910	722,800	724,680	726,570	728,460
120	730,340	732,230	734,110	735,990	737,880	739,760	741,640	743,520	745,400	747,280
130	749,160	751,040	752,920	754,790	756,670	758,550	760,420	762,300	764,170	766,050
140	767,920	769,800	771,670	773,540	775,410	777,280	779,150	781,020	782,890	784,760
150	786,630	788,490	790,360	792,230	794,090	795,960	797,820	799,680	801,550	803,410
160	805,270	807,130	808,990	810,860	812,710	814,570	816,430	818,290	820,150	822,000
170	823,860	825,720	827,570	829,430	831,280	833,130	834,990	836,840	838,690	840,540
180	842,390	844,240	846,090	847,940	849,790	851,640	853,480	855,330	857,180	859,020
190	860,870	862,710	864,550	866,400	868,240	870,080	871,920	873,760	875,600	877,440
200	879,280	881,120	882,960	884,790	886,630	888,470	890,300	892,140	893,970	895,800
210	897,640	899,470	901,300	903,130	904,970	906,800	908,620	910,450	912,280	914,110
220	915,940	917,760	919,590	921,420	923,240	925,070	926,890	928,710	930,540	932,360
230	934,180	936,000	937,820	939,640	941,460	943,280	945,100	946,920	948,730	950,550
240	952,360	954,180	955,990	957,810	959,620	961,440	963,250	965,060	966,870	968,680
250	970,490	972,300	974,110	975,920	977,730	979,530	981,340	983,150	984,950	986,760
260	988,560	990,360	992,170	993,970	995,770	997,570	999,370	1001,200	1003,000	1004,800
270	1006,600	1008,400	1010,200	1012,000	1013,800	1015,600	1017,400	1019,100	1020,900	1022,700
280	1024,500	1026,300	1028,100	1029,900	1031,700	1033,500	1035,300	1037,100	1038,800	1040,600
290	1042,400	1044,200	1046,000	1047,800	1049,600	1051,300	1053,100	1054,900	1056,700	1058,500
300	1060,300	1062,000	1063,800	1065,600	1067,400	1069,200	1070,900	1072,700	1074,500	1076,300







### 11.1.10 PT1000

Temperature range -200°C....+850°C

All resistance value in  $\Omega$

°C in steps of 10 ↓	°C tended to zero in step of one →									
	0	1	2	3	4	5	6	7	8	9
-200	185,201	189,522	193,840	198,154	202,465	206,772	211,076	215,376	219,672	223,965
-190	228,255	232,541	236,824	241,103	245,379	249,651	253,920	258,186	262,449	266,708
-180	270,964	275,217	279,467	283,713	287,956	292,197	296,434	300,667	304,898	309,126
-170	313,350	317,572	321,791	326,006	330,219	334,429	338,635	342,839	347,040	351,238
-160	355,433	359,626	363,815	368,002	372,186	376,367	380,545	384,721	388,894	393,064
-150	397,232	401,397	405,559	409,719	413,876	418,030	422,182	426,331	430,478	434,622
-140	438,764	442,904	447,040	451,175	455,307	459,436	463,563	467,688	471,810	475,930
-130	480,048	484,163	488,276	492,386	496,495	500,601	504,705	508,806	512,906	517,003
-120	521,098	525,191	529,281	533,370	537,456	541,540	545,622	549,702	553,780	557,856
-110	561,930	566,002	570,072	574,139	578,205	582,269	586,331	590,391	594,448	598,504
-100	602,558	606,611	610,661	614,709	618,756	622,800	626,843	630,884	634,923	638,960
-90	642,996	647,030	651,062	655,092	659,120	663,147	667,172	671,195	675,217	679,236
-80	683,254	687,271	691,286	695,299	699,310	703,320	707,328	711,335	715,340	719,344
-70	723,345	727,346	731,344	735,341	739,337	743,331	747,324	751,315	755,304	759,292
-60	763,278	767,263	771,247	775,229	779,210	783,189	787,166	791,143	795,117	799,091
-50	803,063	807,033	811,003	814,970	818,937	822,902	826,865	830,828	834,789	838,748
-40	842,707	846,663	850,619	854,573	858,526	862,478	866,428	870,377	874,325	878,271
-30	882,217	886,160	890,103	894,044	897,985	901,923	905,861	909,797	913,732	917,666
-20	921,599	925,530	929,461	933,390	937,317	941,244	945,169	949,093	953,016	956,938
-10	960,859	964,778	968,696	972,613	976,529	980,444	984,358	988,270	992,181	996,091

°C in steps of 10	°C ascending in step of one									
	0	1	2	3	4	5	6	7	8	9
	500,000	501,950	503,910	505,860	507,810	509,760	511,720	513,670	515,620	517,560
10	1039,025	1042,921	1046,816	1050,710	1054,603	1058,495	1062,385	1066,274	1070,162	1074,049
20	1077,935	1081,820	1085,703	1089,585	1093,467	1097,347	1101,225	1105,103	1108,980	1112,855
30	1116,729	1120,602	1124,474	1128,345	1132,215	1136,083	1139,950	1143,817	1147,681	1151,545
40	1155,408	1159,270	1163,130	1166,989	1170,847	1174,704	1178,560	1182,414	1186,268	1190,120
50	1193,971	1197,821	1201,670	1205,518	1209,364	1213,210	1217,054	1220,897	1224,739	1228,579
60	1232,419	1236,257	1240,095	1243,931	1247,766	1251,600	1255,432	1259,264	1263,094	1266,923
70	1270,751	1274,578	1278,404	1282,228	1286,052	1289,874	1293,695	1297,515	1301,334	1305,152
80	1308,968	1312,783	1316,597	1320,411	1324,222	1328,033	1331,843	1335,651	1339,458	1343,264
90	1347,069	1350,873	1354,676	1358,477	1362,277	1366,077	1369,875	1373,671	1377,467	1381,262
100	1385,055	1388,847	1392,638	1396,428	1400,217	1404,005	1407,791	1411,576	1415,360	1419,143
110	1422,925	1426,706	1430,485	1434,264	1438,041	1441,817	1445,592	1449,366	1453,138	1456,910
120	1460,680	1464,449	1468,217	1471,984	1475,750	1479,514	1483,277	1487,040	1490,801	1494,561
130	1498,319	1502,077	1505,833	1509,589	1513,343	1517,096	1520,847	1524,598	1528,347	1532,096
140	1535,843	1539,589	1543,334	1547,078	1550,820	1554,562	1558,302	1562,041	1565,779	1569,516
150	1573,251	1576,986	1580,719	1584,451	1588,182	1591,912	1595,641	1599,368	1603,095	1606,820
160	1610,544	1614,267	1617,989	1621,709	1625,429	1629,147	1632,864	1636,580	1640,295	1644,009
170	1647,721	1651,433	1655,143	1658,852	1662,560	1666,267	1669,972	1673,677	1677,380	1681,082
180	1684,783	1688,483	1692,181	1695,879	1699,575	1703,271	1706,965	1710,658	1714,349	1718,040
190	1721,729	1725,418	1729,105	1732,791	1736,475	1740,159	1743,842	1747,523	1751,203	1754,882
200	1758,560	1762,237	1765,912	1769,587	1773,260	1776,932	1780,603	1784,273	1787,941	1791,609
210	1795,275	1798,940	1802,604	1806,267	1809,929	1813,590	1817,249	1820,907	1824,564	1828,220
220	1831,875	1835,529	1839,181	1842,832	1846,483	1850,132	1853,779	1857,426	1861,072	1864,716
230	1868,359	1872,001	1875,642	1879,282	1882,921	1886,558	1890,194	1893,830	1897,463	1901,096
240	1904,728	1908,359	1911,988	1915,616	1919,243	1922,869	1926,494	1930,117	1933,740	1937,361
250	1940,981	1944,600	1948,218	1951,835	1955,450	1959,065	1962,678	1966,290	1969,901	1973,510
260	1977,119	1980,726	1984,333	1987,938	1991,542	1995,145	1998,746	2002,347	2005,946	2009,544
270	2013,141	2016,737	2020,332	2023,925	2027,518	2031,109	2034,699	2038,288	2041,876	2045,463
280	2049,048	2052,632	2056,215	2059,798	2063,378	2066,958	2070,537	2074,114	2077,690	2081,265
290	2084,839	2088,412	2091,984	2095,554	2099,123	2102,692	2106,259	2109,824	2113,389	2116,953
300	2120,515	2124,076	2127,636	2131,195	2134,753	2138,310	2141,865	2145,419	2148,972	2152,524



### 11.1.11 TC Typ B

Temperature range 0°C....+1820°C

All resistance value in mV

°C in steps of 10 ↓	°C ascending in step of one →									
	0	1	2	3	4	5	6	7	8	9
0	0,000	0,000	0,000	-0,001	-0,001	-0,001	-0,001	-0,001	-0,002	-0,002
10	-0,002	-0,002	-0,002	-0,002	-0,002	-0,002	-0,002	-0,002	-0,003	-0,003
20	-0,003	-0,003	-0,003	-0,003	-0,003	-0,002	-0,002	-0,002	-0,002	-0,002
30	-0,002	-0,002	-0,002	-0,002	-0,002	-0,001	-0,001	-0,001	-0,001	0,001
40	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,001	0,001	0,002
50	0,002	0,002	0,003	0,003	0,004	0,004	0,004	0,005	0,005	0,006
60	0,006	0,007	0,007	0,008	0,008	0,009	0,009	0,010	0,010	0,011
70	0,011	0,012	0,012	0,013	0,014	0,014	0,015	0,015	0,016	0,017
80	0,017	0,018	0,019	0,020	0,020	0,021	0,022	0,022	0,023	0,024
90	0,025	0,026	0,026	0,027	0,028	0,029	0,030	0,031	0,031	0,032
100	0,033	0,034	0,035	0,036	0,037	0,038	0,039	0,040	0,041	0,042
110	0,043	0,044	0,045	0,046	0,047	0,048	0,049	0,050	0,051	0,052
120	0,053	0,055	0,056	0,057	0,058	0,059	0,060	0,062	0,063	0,064
130	0,065	0,066	0,068	0,069	0,070	0,072	0,073	0,074	0,075	0,077
140	0,078	0,079	0,081	0,082	0,084	0,085	0,086	0,088	0,089	0,091
150	0,092	0,094	0,095	0,096	0,098	0,099	0,101	0,102	0,104	0,106
160	0,107	0,109	0,110	0,112	0,113	0,115	0,117	0,118	0,120	0,122
170	0,123	0,125	0,127	0,128	0,130	0,132	0,134	0,135	0,137	0,139
180	0,141	0,142	0,144	0,146	0,148	0,150	0,151	0,153	0,155	0,157
190	0,159	0,161	0,163	0,165	0,166	0,168	0,170	0,172	0,174	0,176
200	0,178	0,180	0,182	0,184	0,186	0,188	0,190	0,192	0,195	0,197
210	0,199	0,201	0,203	0,205	0,207	0,209	0,212	0,214	0,216	0,218
220	0,220	0,222	0,225	0,227	0,229	0,231	0,234	0,236	0,238	0,241
230	0,243	0,245	0,248	0,250	0,252	0,255	0,257	0,259	0,262	0,264
240	0,267	0,269	0,271	0,274	0,276	0,279	0,281	0,284	0,286	0,289
250	0,291	0,294	0,296	0,299	0,301	0,304	0,307	0,309	0,312	0,314
260	0,317	0,320	0,322	0,325	0,328	0,330	0,333	0,336	0,338	0,341
270	0,344	0,347	0,349	0,352	0,355	0,358	0,360	0,363	0,366	0,369
280	0,372	0,375	0,377	0,380	0,383	0,386	0,389	0,392	0,395	0,398
290	0,401	0,404	0,407	0,410	0,413	0,416	0,419	0,422	0,425	0,428
300	0,431	0,434	0,437	0,440	0,443	0,446	0,449	0,452	0,455	0,458
310	0,462	0,465	0,468	0,471	0,474	0,478	0,481	0,484	0,487	0,490
320	0,494	0,497	0,500	0,503	0,507	0,510	0,513	0,517	0,520	0,523
330	0,527	0,530	0,533	0,537	0,540	0,544	0,547	0,550	0,554	0,557
340	0,561	0,564	0,568	0,571	0,575	0,578	0,582	0,585	0,589	0,592
350	0,596	0,599	0,603	0,607	0,610	0,614	0,617	0,621	0,625	0,628
360	0,632	0,636	0,639	0,643	0,647	0,650	0,654	0,658	0,662	0,665
370	0,669	0,673	0,677	0,680	0,684	0,688	0,692	0,696	0,700	0,703
380	0,707	0,711	0,715	0,719	0,723	0,727	0,731	0,735	0,738	0,742
390	0,746	0,750	0,754	0,758	0,762	0,766	0,770	0,774	0,778	0,782
400	0,787	0,791	0,795	0,799	0,803	0,807	0,811	0,815	0,819	0,824
410	0,828	0,832	0,836	0,840	0,844	0,849	0,853	0,857	0,861	0,866
420	0,870	0,874	0,878	0,883	0,887	0,891	0,895	0,900	0,904	0,909
430	0,913	0,917	0,922	0,926	0,930	0,935	0,939	0,944	0,948	0,953
440	0,957	0,961	0,966	0,970	0,975	0,979	0,984	0,988	0,993	0,997
450	1,002	1,007	1,011	1,016	1,020	1,025	1,029	1,034	1,039	1,043
460	1,048	1,053	1,057	1,062	1,067	1,071	1,076	1,081	1,086	1,090
470	1,095	1,100	1,105	1,109	1,114	1,119	1,124	1,128	1,133	1,138
480	1,143	1,148	1,153	1,158	1,162	1,167	1,172	1,177	1,182	1,187
490	1,192	1,197	1,202	1,207	1,212	1,217	1,222	1,227	1,232	1,237
500	1,242	1,247	1,252	1,257	1,262	1,267	1,272	1,277	1,282	1,288
510	1,293	1,298	1,303	1,308	1,313	1,318	1,323	1,329	1,334	1,339
520	1,344	1,350	1,355	1,360	1,365	1,371	1,376	1,381	1,386	1,392
530	1,397	1,402	1,408	1,413	1,418	1,424	1,429	1,434	1,440	1,445
540	1,451	1,456	1,461	1,467	1,472	1,478	1,483	1,489	1,494	1,500
550	1,505	1,511	1,516	1,522	1,527	1,533	1,539	1,544	1,550	1,555
560	1,561	1,566	1,572	1,578	1,583	1,589	1,595	1,600	1,606	1,612
570	1,617	1,623	1,629	1,634	1,640	1,646	1,651	1,657	1,663	1,669
580	1,675	1,680	1,686	1,692	1,698	1,704	1,709	1,715	1,721	1,727
590	1,733	1,739	1,745	1,750	1,756	1,762	1,768	1,774	1,780	1,786

°C in steps of 10	°C ascending in step of one									
	0	1	2	3	4	5	6	7	8	9
600	1,792	1,797	1,804	1,810	1,816	1,822	1,828	1,834	1,840	1,846
610	1,852	1,858	1,864	1,870	1,876	1,882	1,888	1,894	1,901	1,907
620	1,913	1,919	1,925	1,931	1,937	1,944	1,950	1,956	1,962	1,968
630	1,975	1,981	1,987	1,993	1,999	2,006	2,012	2,018	2,025	2,031
640	2,037	2,043	2,050	2,056	2,062	2,069	2,075	2,082	2,088	2,094
650	2,101	2,107	2,113	2,120	2,126	2,133	2,139	2,146	2,152	2,158
660	2,165	2,171	2,178	2,184	2,191	2,197	2,204	2,210	2,217	2,224
670	2,230	2,237	2,243	2,250	2,256	2,263	2,270	2,276	2,283	2,289
680	2,296	2,303	2,309	2,316	2,323	2,329	2,336	2,343	2,350	2,356
690	2,363	2,370	2,376	2,383	2,390	2,397	2,403	2,410	2,417	2,424
700	2,431	2,437	2,444	2,451	2,458	2,465	2,472	2,479	2,485	2,492
710	2,499	2,506	2,513	2,520	2,527	2,534	2,541	2,548	2,555	2,562
720	2,569	2,576	2,583	2,590	2,597	2,604	2,611	2,618	2,625	2,632
730	2,639	2,646	2,653	2,660	2,667	2,674	2,681	2,688	2,696	2,703
740	2,710	2,717	2,724	2,731	2,738	2,746	2,753	2,760	2,767	2,775
750	2,782	2,789	2,796	2,803	2,811	2,818	2,825	2,833	2,840	2,847
760	2,854	2,862	2,869	2,876	2,884	2,891	2,898	2,906	2,913	2,921
770	2,928	2,935	2,943	2,950	2,958	2,965	2,973	2,980	2,987	2,995
780	3,002	3,010	3,017	3,025	3,032	3,040	3,047	3,055	3,062	3,070
790	3,078	3,085	3,093	3,100	3,108	3,116	3,123	3,131	3,138	3,146
800	3,154	3,161	3,169	3,177	3,184	3,192	3,200	3,207	3,215	3,223
810	3,230	3,238	3,246	3,254	3,261	3,269	3,277	3,285	3,292	3,300
820	3,308	3,316	3,324	3,331	3,339	3,347	3,355	3,363	3,371	3,379
830	3,386	3,394	3,402	3,410	3,418	3,426	3,434	3,442	3,450	3,458
840	3,466	3,474	3,482	3,490	3,498	3,506	3,514	3,522	3,530	3,538
850	3,546	3,554	3,562	3,570	3,578	3,586	3,594	3,602	3,610	3,618
860	3,626	3,634	3,643	3,651	3,659	3,667	3,675	3,683	3,692	3,700
870	3,708	3,716	3,724	3,732	3,741	3,749	3,757	3,765	3,774	3,782
880	3,790	3,798	3,807	3,815	3,823	3,832	3,840	3,848	3,857	3,865
890	3,873	3,882	3,890	3,898	3,907	3,915	3,923	3,932	3,940	3,949
900	3,957	3,965	3,974	3,982	3,991	3,999	4,008	4,016	4,024	4,033
910	4,041	4,050	4,058	4,067	4,075	4,084	4,093	4,101	4,110	4,118
920	4,127	4,135	4,144	4,152	4,161	4,170	4,178	4,187	4,195	4,204
930	4,213	4,221	4,230	4,239	4,247	4,256	4,265	4,273	4,282	4,291
940	4,299	4,308	4,317	4,326	4,334	4,343	4,352	4,360	4,369	4,377
950	4,387	4,396	4,404	4,413	4,422	4,431	4,440	4,448	4,457	4,466
960	4,475	4,484	4,493	4,501	4,510	4,519	4,528	4,537	4,546	4,555
970	4,564	4,573	4,582	4,591	4,599	4,608	4,617	4,626	4,635	4,643
980	4,653	4,662	4,671	4,680	4,689	4,698	4,707	4,716	4,725	4,733
990	4,743	4,753	4,762	4,771	4,780	4,789	4,798	4,807	4,816	4,825
1000	4,834	4,843	4,853	4,862	4,871	4,880	4,889	4,898	4,908	4,917
1010	4,926	4,935	4,944	4,954	4,963	4,972	4,981	4,990	5,000	5,009
1020	5,018	5,027	5,037	5,046	5,055	5,065	5,074	5,083	5,092	5,102
1030	5,111	5,120	5,130	5,139	5,148	5,158	5,167	5,176	5,186	5,195
1040	5,205	5,214	5,223	5,233	5,242	5,252	5,261	5,270	5,280	5,289
1050	5,299	5,308	5,318	5,327	5,337	5,346	5,356	5,365	5,375	5,384
1060	5,394	5,403	5,413	5,422	5,432	5,441	5,451	5,460	5,470	5,480
1070	5,489	5,499	5,508	5,518	5,528	5,537	5,547	5,556	5,566	5,576
1080	5,585	5,595	5,605	5,614	5,624	5,634	5,643	5,653	5,663	5,672
1090	5,682	5,692	5,702	5,711	5,721	5,731	5,740	5,750	5,760	5,770
1100	5,780	5,789	5,799	5,809	5,819	5,828	5,838	5,848	5,858	5,868
1110	5,878	5,887	5,897	5,907	5,917	5,927	5,937	5,947	5,956	5,966
1120	5,976	5,986	5,996	6,006	6,016	6,026	6,036	6,046	6,055	6,065
1130	6,075	6,085	6,095	6,105	6,115	6,125	6,135	6,145	6,155	6,165
1140	6,175	6,185	6,195	6,205	6,215	6,225	6,235	6,245	6,256	6,266
1150	6,276	6,286	6,296	6,306	6,316	6,326	6,336	6,346	6,356	6,367
1160	6,377	6,387	6,397	6,407	6,417	6,427	6,438	6,448	6,458	6,468
1170	6,478	6,488	6,499	6,509	6,519	6,529	6,539	6,550	6,560	6,570
1180	6,580	6,591	6,601	6,611	6,621	6,632	6,642	6,652	6,663	6,673
1190	6,683	6,693	6,704	6,714	6,724	6,735	6,745	6,755	6,766	6,776



### 11.1.12 TC Typ E

Temperature range -90°C....+780°C

All resistance value in mV

°C in steps of 10 ↓	°C tended to zero in step of one →									
	0	1	2	3	4	5	6	7	8	9
-90	-4,777	-4,731	-4,684	-4,636	-4,589	-4,542	-4,494	-4,446	-4,398	-4,350
-80	-4,360	-4,254	-4,205	-4,156	-4,107	-4,058	-4,009	-3,960	-3,911	-3,861
-70	-3,811	-3,761	-3,711	-3,661	-3,611	-3,561	-3,510	-3,459	-3,408	-3,357
-60	-3,306	-3,255	-3,204	-3,152	-3,100	-3,048	-2,996	-2,944	-2,892	-2,840
-50	-2,787	-2,735	-2,682	-2,629	-2,576	-2,523	-2,469	-2,416	-2,362	-2,309
-40	-2,255	-2,201	-2,147	-2,093	-2,038	-1,984	-1,929	-1,874	-1,820	-1,765
-30	-1,709	-1,654	-1,599	-1,543	-1,488	-1,432	-1,376	-1,320	-1,264	-1,208
-20	-1,152	-1,095	-1,039	-0,982	-0,925	-0,868	-0,811	-0,754	-0,697	-0,639
-10	-0,582	-0,524	-0,466	-0,408	-0,350	-0,292	-0,234	-0,176	-0,117	-0,059
°C in steps of 10 ↓	°C ascending in step of one →									
	0	1	2	3	4	5	6	7	8	9
0	0,000	0,059	0,118	0,176	0,235	0,294	0,354	0,413	0,472	0,532
10	0,591	0,651	0,711	0,770	0,830	0,890	0,950	1,010	1,071	1,131
20	1,192	1,252	1,313	1,373	1,434	1,495	1,556	1,617	1,678	1,740
30	1,801	1,862	1,924	1,986	2,047	2,109	2,171	2,233	2,295	2,357
40	2,420	2,482	2,545	2,607	2,670	2,733	2,795	2,858	2,921	2,984
50	3,048	3,111	3,174	3,238	3,301	3,365	3,429	3,492	3,556	3,620
60	3,685	3,749	3,813	3,877	3,942	4,006	4,071	4,136	4,200	4,265
70	4,330	4,395	4,460	4,526	4,591	4,656	4,722	4,788	4,853	4,919
80	4,985	5,051	5,117	5,183	5,249	5,315	5,382	5,448	5,514	5,581
90	5,648	5,714	5,781	5,848	5,915	5,982	6,049	6,117	6,184	6,251
100	6,319	6,386	6,454	6,522	6,590	6,658	6,725	6,794	6,862	6,930
110	6,998	7,066	7,135	7,203	7,272	7,341	7,409	7,478	7,547	7,616
120	7,685	7,754	7,823	7,892	7,962	8,031	8,101	8,170	8,240	8,309
130	8,379	8,449	8,519	8,589	8,659	8,729	8,799	8,869	8,940	9,010
140	9,081	9,151	9,222	9,292	9,363	9,434	9,505	9,576	9,647	9,718
150	9,789	9,860	9,931	10,003	10,074	10,145	10,217	10,288	10,360	10,432
160	10,503	10,575	10,647	10,719	10,791	10,863	10,935	11,007	11,080	11,152
170	11,224	11,297	11,369	11,442	11,514	11,587	11,660	11,733	11,805	11,878
180	11,951	12,024	12,097	12,170	12,243	12,317	12,390	12,463	12,537	12,610
190	12,684	12,757	12,831	12,904	12,978	13,052	13,126	13,199	13,273	13,347
200	13,421	13,495	13,569	13,644	13,718	13,792	13,866	13,941	14,015	14,090
210	14,164	14,239	14,313	14,388	14,463	14,537	14,612	14,687	14,762	14,837
220	14,912	14,987	15,062	15,137	15,212	15,287	15,362	15,438	15,513	15,588
230	15,664	15,739	15,815	15,890	15,966	16,041	16,117	16,193	16,269	16,344
240	16,420	16,496	16,572	16,648	16,724	16,800	16,876	16,952	17,028	17,104
250	17,181	17,257	17,333	17,409	17,486	17,562	17,639	17,715	17,792	17,868
260	17,945	18,021	18,098	18,175	18,252	18,328	18,405	18,482	18,559	18,636
270	18,713	18,790	18,867	18,944	19,021	19,098	19,175	19,252	19,330	19,407
280	19,484	19,561	19,639	19,716	19,794	19,871	19,948	20,026	20,103	20,181
290	20,259	20,336	20,414	20,492	20,569	20,647	20,725	20,803	20,880	20,958
300	21,036	21,114	21,192	21,270	21,348	21,426	21,504	21,582	21,660	21,739
310	21,817	21,895	21,973	22,051	22,130	22,208	22,286	22,365	22,443	22,522
320	22,600	22,678	22,757	22,835	22,914	22,993	23,071	23,150	23,228	23,307
330	23,386	23,464	23,543	23,622	23,701	23,780	23,858	23,937	24,016	24,095
340	24,174	24,253	24,332	24,411	24,490	24,569	24,648	24,727	24,806	24,885



°C in steps of 10	°C ascending in step of on									
350	24,964	25,044	25,123	25,202	25,281	25,360	25,440	25,519	25,598	25,678
360	25,757	25,836	25,916	25,995	26,075	26,154	26,233	26,313	26,392	26,472
370	26,552	26,631	26,711	26,790	26,870	26,950	27,029	27,109	27,189	27,268
380	27,348	27,428	27,507	27,587	27,667	27,747	27,827	27,907	27,986	28,066
390	28,146	28,226	28,306	28,386	28,466	28,546	28,626	28,706	28,786	28,866
400	28,946	29,026	29,106	29,186	29,266	29,346	29,427	29,507	29,587	29,667
410	29,748	29,827	29,908	29,988	30,068	30,148	30,229	30,309	30,389	30,470
420	30,550	30,630	30,711	30,791	30,871	30,952	31,032	31,112	31,193	31,273
430	31,354	31,434	31,515	31,595	31,676	31,756	31,837	31,917	31,998	32,078
440	32,159	32,239	32,320	32,400	32,481	32,562	32,642	32,723	32,803	32,884
450	32,965	33,045	33,126	33,207	33,287	33,368	33,449	33,529	33,610	33,691
460	33,772	33,852	33,933	34,014	34,095	34,175	34,256	34,337	34,418	34,498
470	34,579	34,660	34,741	34,822	34,902	34,983	35,064	35,145	35,226	35,307
480	35,387	35,468	35,549	35,630	35,711	35,792	35,873	35,954	36,034	36,115
490	36,196	36,277	36,358	36,439	36,520	36,601	36,682	36,763	36,846	36,925
500	37,005	37,086	37,167	37,248	37,329	37,410	37,491	37,572	37,653	37,734
510	37,815	37,896	37,977	38,058	38,139	38,220	38,300	38,381	38,462	38,534
520	38,624	38,705	38,786	38,867	38,948	39,029	39,110	39,191	39,272	39,353
530	39,434	39,515	39,596	39,677	39,758	39,839	39,920	40,001	40,082	40,163
540	40,243	40,324	40,405	40,486	40,567	40,648	40,729	40,810	40,891	40,972
550	41,053	41,134	41,215	41,296	41,377	41,457	41,538	41,619	41,700	41,781
560	41,862	41,943	42,024	42,105	42,185	42,266	42,347	42,428	42,509	42,590
570	42,671	42,751	42,832	42,913	42,994	43,075	43,156	43,236	43,317	43,398
580	43,479	43,560	43,640	43,721	43,802	43,883	43,963	44,044	44,125	44,206
590	44,286	44,367	44,448	44,529	44,609	44,690	44,771	44,851	44,932	45,013
600	45,093	45,174	45,255	45,335	45,416	45,497	45,577	45,658	45,738	45,819
610	45,900	45,980	46,061	46,141	46,222	46,302	46,383	46,463	46,544	46,624
620	46,705	46,785	46,866	46,946	47,027	47,107	47,188	47,268	47,349	47,429
630	47,509	47,590	47,670	47,751	47,831	47,911	47,992	48,072	48,152	48,233
640	48,313	48,393	48,474	48,554	48,634	48,715	48,795	48,875	48,955	49,035
650	49,116	49,196	49,276	49,356	49,436	49,517	49,597	49,677	49,757	49,837
660	49,917	49,997	50,077	50,157	50,238	50,318	50,398	50,478	50,558	50,638
670	50,718	50,798	50,878	50,958	51,038	51,118	51,197	51,277	51,357	51,437
680	51,517	51,597	51,677	51,757	51,837	51,916	51,996	52,076	52,156	52,236
690	52,315	52,395	52,475	52,555	52,634	52,714	52,794	52,873	52,953	53,033
700	53,112	53,192	53,272	53,351	53,431	53,510	53,590	53,670	53,749	53,829
710	53,908	53,988	54,067	54,147	54,226	54,306	54,385	54,465	54,544	54,624
720	54,703	54,782	54,862	54,941	55,021	55,100	55,179	55,259	55,338	55,417
730	55,497	55,576	55,655	55,734	55,814	55,893	55,972	56,051	56,131	56,210
740	56,289	56,368	56,447	56,526	56,606	56,685	56,764	56,843	56,922	57,001
750	57,080	57,159	57,238	57,317	57,396	57,475	57,554	57,633	57,712	57,791
760	57,870	57,949	58,028	58,107	58,186	58,265	58,343	58,422	58,501	58,580
770	58,659	58,738	58,816	58,895	58,974	59,053	59,131	59,210	59,289	59,367
780	59,446									

### 11.1.13 TC Typ J

Temperature range -100°C....+1020°C

All resistance value in mV

°C in steps of 10	°C tended to zero in step of one									
	0	1	2	3	4	5	6	7	8	9
-100	-4,633	-4,591	-4,550	-4,509	-4,467	-4,425	-4,384	-4,342	-4,300	-4,257
-90	-4,215	-4,173	-4,130	-4,088	-4,045	-4,002	-3,959	3,916	-3,872	-3,829
-80	-3,786	-3,742	-3,698	-3,654	-3,610	-3,566	-3,522	-3,478	-3,434	-3,389
-70	-3,344	-3,300	-3,255	-3,210	-3,165	-3,120	-3,075	-3,089	-2,984	-2,938
-60	-2,893	-2,847	-2,801	-2,755	-2,709	-2,663	-2,617	-2,571	-2,524	-2,478
-50	-2,431	-1,865	-1,818	-1,770	-1,722	-1,674	-1,626	-1,578	-2,055	-2,008
-40	-1,961	-1,913	-1,865	-1,818	-1,770	-1,722	-1,674	-1,626	-1,578	-1,530
-30	-1,482	-1,433	-1,385	-1,336	-1,288	-1,239	-1,190	-1,142	-1,093	-1,044
-20	-0,995	-0,946	-0,896	-0,847	-0,798	-0,749	-0,699	-0,650	-0,600	-0,550
-10	-0,501	-0,451	-0,401	-0,351	-0,301	-0,251	-0,201	-0,151	-0,101	-0,050
0	0,000	0,050	0,101	0,151	0,202	0,253	0,303	0,354	0,405	0,456

°C in steps of 10	°C ascending in step of one									
	0	1	2	3	4	5	6	7	8	9
0	0,000	0,050	0,101	0,151	0,202	0,253	0,303	0,354	0,405	0,456
10	0,507	0,558	0,609	0,660	0,711	0,762	0,814	0,865	0,916	0,968
20	1,019	1,071	1,122	1,174	1,226	1,277	1,329	1,381	1,433	1,485
30	1,537	1,589	1,641	1,693	1,745	1,797	1,849	1,902	1,954	2,006
40	2,059	2,111	2,164	2,216	2,269	2,322	2,374	2,427	2,480	2,532
50	2,585	2,638	2,691	2,744	2,797	2,850	2,903	2,956	3,009	3,062
60	3,116	3,169	3,222	3,275	3,329	3,382	3,436	3,489	3,543	3,596
70	3,650	3,703	3,757	3,810	3,864	3,918	3,971	4,025	4,079	4,133
80	4,187	4,240	4,294	4,348	4,402	4,456	4,510	4,564	4,618	4,672
90	4,726	4,781	4,835	4,889	4,943	4,997	5,052	5,106	5,160	5,215
100	5,269	5,323	5,378	5,432	5,487	5,541	5,595	5,650	5,705	5,759
110	5,814	5,868	5,923	5,977	6,032	6,087	6,141	6,196	6,251	6,306
120	6,360	6,415	6,470	6,525	6,579	6,634	6,689	6,744	6,799	6,854
130	6,909	6,964	7,019	7,074	7,129	7,184	7,239	7,294	7,349	7,404
140	7,459	7,514	7,569	7,624	7,679	7,734	7,789	7,844	7,900	7,955
150	8,010	8,065	8,120	8,175	8,231	8,286	8,341	8,396	8,452	8,507
160	8,562	8,618	8,673	8,728	8,783	8,839	8,894	8,949	9,005	9,060
170	9,115	9,171	9,226	9,282	9,337	9,392	9,448	9,503	9,559	9,614
180	9,669	9,725	9,780	9,836	9,891	9,947	10,002	10,057	10,113	10,168
190	10,224	10,279	10,335	10,390	10,446	10,501	10,557	10,612	10,668	10,723
200	10,779	10,834	10,890	10,945	11,001	11,056	11,112	11,167	11,223	11,278
210	11,334	11,389	11,445	11,501	11,556	11,612	11,667	11,723	11,778	11,834
220	11,889	11,945	12,000	12,056	12,111	12,167	12,222	12,278	12,334	12,389
230	12,445	12,500	12,556	12,611	12,667	12,722	12,778	12,833	12,889	12,944
240	13,000	13,056	13,111	13,167	13,222	13,278	13,333	13,389	13,444	13,500
250	13,555	13,611	13,666	13,722	13,777	13,833	13,888	13,944	13,999	14,055
260	14,110	14,166	14,221	14,277	14,332	14,388	14,443	14,499	14,554	14,609
270	14,665	14,720	14,776	14,831	14,887	14,942	14,998	15,053	15,109	15,164
280	15,219	15,275	15,330	15,386	15,441	15,496	15,552	15,607	15,663	15,718
290	15,773	15,829	15,884	15,940	15,995	16,050	16,106	16,161	16,216	16,272
300	16,327	16,383	16,438	16,493	16,549	16,604	16,659	16,715	16,770	16,825
310	16,881	16,936	16,991	17,046	17,102	17,157	17,212	17,268	17,323	17,378
320	17,434	17,489	17,544	17,599	17,655	17,710	17,765	17,820	17,876	17,931
330	17,986	18,041	18,097	18,152	18,207	18,262	18,318	18,373	18,428	18,483
340	18,538	18,594	18,649	18,704	18,759	18,814	18,870	18,925	18,980	19,035



### 11.1.14 TC Typ K (Ni-CrNi)

Temperature range -150°C....+1370°C

All resistance value in mV

°C in steps of 10 ↓	°C tended to zero in step of one →									
	0	1	2	3	4	5	6	7	8	9
-150	-4,912	-4,889	-4,865	-4,841	-4,817	-4,792	-4,768	-4,743	-4,719	-4,694
-140	-4,669	-4,644	-4,618	-4,593	-4,567	-4,541	-4,515	-4,489	-4,463	-4,437
-130	-4,410	-4,384	-4,357	-4,330	-4,303	-4,276	-4,248	-4,221	-4,193	-4,166
-120	-4,138	-4,110	-4,082	-4,053	-4,025	-3,997	-3,968	-3,939	-3,910	-3,881
-110	-3,852	-3,823	-3,793	-3,764	-3,734	-3,704	-3,674	-3,644	-3,614	-3,584
-100	-3,553	-3,523	-3,492	-3,461	-3,430	-3,399	-3,368	-3,337	-3,305	-3,274
-90	-3,242	-3,211	-3,179	-3,147	-3,115	-3,082	-3,050	-3,018	-2,985	-2,953
-80	2,920	-2,887	-2,854	-2,821	-2,788	-2,754	-2,721	-2,687	-2,654	-2,620
-70	-2,586	-2,552	-2,518	-2,484	-2,450	-2,416	-2,381	-2,347	-2,312	-2,277
-60	-2,243	-2,208	-2,173	-2,137	-2,102	-2,067	-2,032	-1,966	-1,961	-1,925
-50	-1,889	-1,853	-1,817	-1,781	-1,745	-1,709	-1,673	-1,636	-1,600	-1,563
-40	-1,527	-1,490	-1,453	-1,416	-1,379	-1,342	-1,305	-1,268	-1,231	-1,193
-30	-1,156	-1,118	-1,081	-1,043	-1,005	-0,968	-0,930	-0,892	-0,854	0,816
-20	-0,777	-0,739	-0,701	-0,662	-0,623	-0,585	0,547	-0,508	-0,469	-0,431
-10	-0,392	-0,353	-0,314	-0,275	-0,236	-0,197	-0,157	-0,118	-0,079	-0,039

°C in steps of 10 ↓	°C ascending in step of one →									
	0	1	2	3	4	5	6	7	8	9
0	0,000	0,039	0,079	0,119	0,158	0,198	0,238	0,277	0,317	0,357
10	0,397	0,437	0,477	0,517	0,557	0,597	0,637	0,677	0,718	0,758
20	0,798	0,838	0,879	0,919	0,960	1,000	1,041	1,081	1,122	1,162
30	1,203	1,244	1,285	1,325	1,366	1,407	1,448	1,489	1,529	1,570
40	1,611	1,652	1,693	1,734	1,776	1,817	1,858	1,899	1,940	1,981
50	2,022	2,064	2,105	2,146	2,188	2,229	2,270	2,312	2,353	2,394
60	2,436	2,477	2,519	2,560	2,601	2,643	2,684	2,726	2,767	2,809
70	2,850	2,892	2,933	2,975	3,016	3,058	3,100	3,141	3,183	3,224
80	3,266	3,307	3,349	3,390	3,432	3,473	3,515	3,556	3,598	3,639
90	3,681	3,722	3,764	3,805	3,847	3,888	3,930	3,971	4,012	4,054
100	4,095	4,137	4,178	4,219	4,261	4,302	4,343	4,384	4,426	4,467
110	4,508	4,549	4,590	4,632	4,673	4,714	4,755	4,796	4,837	4,878
120	4,919	4,960	5,001	5,042	5,083	5,124	5,164	5,205	5,246	5,287
130	5,327	5,368	5,409	5,450	5,490	5,531	5,571	5,612	5,652	5,693
140	5,733	5,774	5,814	5,855	5,895	5,936	5,976	6,016	6,057	6,097
150	6,137	6,177	6,218	6,258	6,298	6,338	6,378	6,419	6,459	6,499
160	6,539	6,579	6,619	6,659	6,699	6,739	6,779	6,819	6,859	6,899
170	6,939	6,979	7,019	7,059	7,099	7,139	7,179	7,219	7,259	7,299
180	7,338	7,378	7,418	7,458	7,498	7,538	7,578	7,618	7,658	7,697
190	7,737	7,777	7,817	7,857	7,897	7,937	7,977	8,017	8,057	8,097
200	8,137	8,177	8,216	8,256	8,296	8,336	8,376	8,416	8,456	8,497
210	8,537	8,577	8,617	8,657	8,697	8,737	8,777	8,817	8,857	8,898
220	8,938	8,978	9,018	9,058	9,099	9,139	9,179	9,220	9,260	9,300
230	9,341	9,381	9,421	9,462	9,502	9,543	9,583	9,624	9,664	9,705
240	9,745	9,786	9,826	9,867	9,907	9,948	9,989	10,029	10,070	10,111
250	10,151	10,192	10,233	10,274	10,315	10,355	10,396	10,437	10,478	10,519
260	10,560	10,600	10,641	10,682	10,723	10,764	10,805	10,846	10,887	10,928
270	10,969	11,010	11,051	11,093	11,134	11,175	11,216	11,257	11,298	11,339
280	11,381	11,422	11,463	11,504	11,546	11,587	11,628	11,669	11,711	11,752
290	11,793	11,835	11,876	11,918	11,959	12,000	12,042	12,083	12,125	12,166
300	12,207	12,249	12,290	12,332	12,373	12,415	12,456	12,498	12,539	12,581
310	12,623	12,664	12,706	12,747	12,789	12,831	12,872	12,914	12,955	12,997
320	13,039	13,080	13,122	13,164	13,205	13,247	13,289	13,331	13,372	13,414
330	13,456	13,497	13,539	13,581	13,623	13,665	13,706	13,748	13,790	13,832
340	13,874	13,915	13,957	13,999	14,041	14,083	14,125	14,167	14,208	14,250

°C in steps of 10	°C ascending in step of one									
	0	1	2	3	4	5	6	7	8	9
350	14,292	14,334	14,376	14,418	14,460	14,502	14,544	14,586	14,628	14,670
360	14,712	14,754	14,796	14,838	14,880	14,922	14,964	15,006	15,048	15,090
370	15,132	14,174	15,216	15,258	15,300	15,342	15,384	15,426	15,468	15,510
380	15,552	15,594	15,636	15,679	15,721	15,763	15,805	153,847	15,889	15,931
390	15,974	16,016	16,058	16,100	16,142	16,184	16,227	16,269	16,311	16,353
400	16,395	16,438	16,480	16,522	16,564	16,607	16,649	16,691	16,733	16,776
410	16,818	16,86	16,902	16,945	16,987	17,029	17,072	17,114	17,156	17,199
420	17,241	17,283	17,326	17,368	17,41	17,453	17,495	17,537	17,580	17,622
430	17,664	17,707	17,749	17,792	17,834	17,876	17,919	17,961	18,004	18,046
440	18,088	18,131	18,173	18,216	18,258	18,301	18,343	18,385	18,428	18,47
450	18,513	18,555	18,598	18,640	18,683	18,725	18,768	18,810	18,853	18,895
460	18,938	18,980	19,023	19,065	19,108	19,150	19,193	19,235	19,278	19,320
470	193,363	19,405	19,448	196,490	19,533	196,576	19,618	19,661	19,703	17,746
480	19,788	19,831	19,873	19,916	19,959	20,001	20,044	20,086	20,129	20,172
490	20,214	20,257	20,299	20,342	20,385	20,427	20,470	20,512	20,555	20,598
500	20,640	20,683	20,725	20,768	20,811	20,853	20,896	20,938	20,981	21,024
510	21,066	21,109	21,152	21,194	21,237	21,28	21,322	21,365	21,407	21,450
520	21,493	21,535	21,578	21,621	21,663	21,706	21,749	21,791	21,834	21,876
530	21,919	21,962	22,004	22,047	22,090	22,132	22,175	22,218	22,260	22,303
540	22,346	22,388	22,431	22,473	22,516	22,559	22,601	22,644	22,687	22,729
550	22,772	22,815	22,857	22,900	22,942	22,985	23,028	23,070	23,117	23,156
560	23,198	23,241	23,284	23,326	23,369	23,411	23,454	23,497	23,539	23,582
570	23,624	23,667	23,710	23,752	23,795	23,837	23,880	23,923	23,965	24,008
580	24,050	24,093	24,136	24,178	24,221	24,263	24,306	24,348	24,391	24,434
590	24,476	24,519	24,561	24,604	24,646	24,689	24,731	24,774	24,817	24,859
600	24,902	24,944	24,987	25,029	25,072	25,114	25,157	25,199	25,242	25,284
610	25,327	25,369	25,412	25,454	25,497	25,539	25,582	25,624	25,666	25,709
620	25,751	25,794	25,836	25,879	25,921	25,964	26,006	26,048	26,091	26,133
630	26,176	26,218	26,260	26,303	26,345	26,387	26,430	26,472	26,515	26,557
640	26,599	26,642	26,684	26,726	26,769	26,811	26,853	26,896	26,938	26,980
650	27,022	27,065	27,107	27,149	27,192	27,234	27,276	27,318	27,361	27,403
660	27,445	27,487	27,529	27,572	27,614	27,656	27,698	27,740	27,783	27,825
670	27,867	27,909	27,951	27,993	28,035	28,078	28,120	28,162	28,204	28,246
680	28,288	28,330	28,372	28,414	28,456	28,498	28,540	28,593	28,625	28,667
690	28,709	28,751	28,793	28,835	28,877	28,919	28,961	29,002	29,044	29,086
700	29,128	29,170	29,212	29,254	29,296	29,338	29,380	29,422	29,464	29,505
710	29,547	29,589	29,631	29,673	29,715	29,756	29,798	29,840	29,882	29,924
720	29,965	30,007	30,049	30,091	30,132	30,174	30,216	30,257	30,299	30,341
730	30,383	30,427	30,466	30,508	30,549	30,591	30,632	30,674	30,716	30,757
740	30,799	30,840	30,882	30,924	30,965	31,007	31,048	31,090	31,131	31,173
750	31,214	31,256	31,297	31,339	31,380	31,422	31,463	31,504	31,546	31,587
760	31,629	31,670	31,712	31,753	31,794	31,856	31,877	31,918	31,960	32,001
770	32,042	32,084	32,125	32,166	32,207	32,249	32,290	32,331	32,372	32,414
780	32,455	32,496	32,537	32,578	32,619	32,661	32,702	32,743	32,784	32,825
790	32,866	32,907	32,948	32,990	33,031	33,072	33,113	33,154	33,195	33,236
800	33,277	33,318	33,359	33,400	33,441	33,482	33,523	33,564	33,604	33,645
810	33,686	33,727	33,768	33,809	33,850	33,891	33,931	33,972	34,013	34,054
820	34,095	34,136	34,176	34,217	34,258	34,299	34,339	34,380	34,421	34,461
830	34,502	34,543	34,583	34,624	34,665	34,705	34,746	34,787	34,827	34,868
840	34,909	34,949	34,990	35,030	35,071	35,111	35,152	35,192	35,233	35,273
850	35,314	35,354	35,395	35,435	35,476	35,516	35,557	35,597	35,637	35,678

°C in steps of 10	°C ascending in step of one									
860	35,718	35,758	35,799	35,839	35,880	35,920	35,960	36,000	36,041	36,081
870	36,121	36,162	36,202	36,242	36,282	36,323	36,363	36,403	36,443	36,483
880	36,524	36,564	36,604	36,644	36,684	36,724	36,764	36,804	36,844	36,885
890	36,925	36,965	37,005	37,045	37,085	37,125	37,165	37,205	37,245	37,285
900	37,325	37,365	37,405	37,445	37,484	37,524	37,564	37,604	37,644	37,684
910	37,724	37,764	37,803	37,843	37,883	37,923	37,963	38,002	38,042	38,082
920	38,122	38,162	38,201	38,241	38,281	38,320	38,360	38,400	38,439	38,479
930	38,519	38,558	38,598	38,638	38,677	38,717	38,756	38,796	38,836	38,875
940	38,915	38,954	38,994	39,033	39,073	39,112	39,152	39,191	39,231	39,270
950	39,310	39,349	39,388	39,428	39,467	39,507	39,546	39,585	39,625	39,664
960	39,703	39,743	39,782	39,821	39,861	39,900	39,939	39,979	40,018	40,057
970	40,096	40,136	40,175	40,214	40,253	40,262	40,332	40,710	40,410	40,449
980	40,488	40,527	40,566	40,605	40,645	40,684	40,723	40,762	40,801	40,840
990	40,879	40,918	40,957	40,996	41,035	41,074	41,113	41,151	41,191	41,230
1000	41,269	41,308	41,347	41,385	41,424	41,463	41,502	41,541	41,580	41,619
1010	41,657	41,696	41,735	41,774	41,813	41,851	41,890	41,929	41,968	42,006
1020	42,045	42,084	42,123	42,161	42,200	42,239	42,277	42,316	42,355	42,393
1030	42,432	42,470	42,506	42,548	42,586	42,625	42,663	42,702	42,740	42,779
1040	42,817	42,856	42,894	42,933	42,971	43,010	43,048	43,087	43,125	43,164
1050	43,202	43,240	43,279	43,317	43,356	43,394	43,432	43,471	43,509	43,547
1060	43,585	43,624	43,662	43,700	43,739	43,777	43,815	43,853	43,891	43,930
1070	43,968	44,006	44,044	44,082	44,121	44,159	44,197	44,235	44,273	44,311
1080	44,349	44,387	44,425	44,463	44,501	44,539	44,577	44,615	44,653	44,691
1090	44,729	44,767	44,805	44,843	44,881	44,919	44,957	44,995	45,033	45,070
1100	45,108	45,146	45,184	45,222	45,260	45,297	45,335	45,373	45,411	45,448
1110	45,486	45,524	45,561	45,599	45,637	45,675	45,712	45,750	45,787	45,825
1120	45,863	45,900	45,938	45,975	46,013	46,051	46,088	46,126	46,163	46,201
1130	46,238	46,275	46,313	46,350	46,388	46,425	46,463	46,500	46,537	46,575
1140	46,612	46,649	46,687	46,724	46,761	46,799	46,836	46,873	46,910	46,948
1150	46,985	47,022	47,059	47,096	47,134	47,171	47,208	47,245	47,282	47,319
1160	47,356	47,393	47,430	47,468	47,505	47,542	47,579	47,616	47,653	47,689
1170	47,726	47,763	47,800	47,837	47,874	47,911	47,948	47,985	48,021	48,058
1180	48,095	48,132	48,169	48,205	48,242	48,279	48,316	48,352	48,389	48,426
1190	48,462	48,499	48,536	48,572	48,609	48,645	48,682	48,718	48,755	48,792
1200	48,828	48,865	48,901	48,937	48,974	49,010	49,047	49,083	49,120	49,156
1210	49,192	49,229	49,265	49,301	49,338	49,374	49,410	49,446	49,483	49,519
1220	49,555	49,591	49,627	49,663	49,700	49,736	49,772	49,808	49,844	49,880
1230	49,916	49,952	49,988	50,024	50,060	50,096	50,132	50,168	50,204	50,240
1240	50,276	50,311	50,347	50,383	50,419	50,455	50,491	50,526	50,562	50,598
1250	50,633	50,669	50,705	50,741	50,776	50,812	50,847	50,883	50,919	50,954
1260	50,990	51,025	51,061	51,096	51,132	51,167	51,203	51,238	51,274	51,309
1270	51,344	51,380	51,415	51,450	51,486	51,521	51,556	51,592	51,627	51,662
1280	51,697	51,733	51,768	51,803	51,838	51,873	51,908	51,943	51,979	52,014
1290	52,049	52,084	52,119	52,154	52,189	52,224	52,259	52,294	52,329	52,364
1300	52,398	52,433	52,468	52,503	52,538	52,573	52,608	52,642	52,677	52,712
1310	52,747	52,781	52,816	52,851	52,886	52,920	52,955	52,989	53,024	53,059
1320	53,093	53,128	53,162	53,197	53,232	53,266	53,301	53,335	53,370	53,404
1330	53,439	53,473	53,507	53,542	53,576	53,611	53,645	53,679	53,714	53,748
1340	53,782	53,817	53,851	53,885	53,920	53,954	53,988	54,022	54,057	54,091
1350	54,125	54,159	54,193	54,228	54,262	54,296	54,330	54,364	54,398	54,432
1360	54,466	54,501	54,535	54,569	54,603	54,637	54,671	54,705	54,739	54,773
1370	54,807									

### 11.1.15 TC Typ L (Fe-CuNi)

Temperature range -105°C....+900°C

All resistance value in mV

°C in steps of 10 ↓	°C tended to zero in step of one →									
	0	1	2	3	4	5	6	7	8	9
-110						-4,950	-4,910	-4,870	-4,830	-4,790
-100	-4,750	-4,710	-4,660	-4,620	-4,580	-4,540	-4,500	-4,450	-4,410	-4,370
-90	-4,330	-4,280	-4,240	-4,200	-4,150	-4,110	-4,060	-4,020	-3,980	-3,930
-80	-3,890	-3,840	-3,800	-3,750	-3,710	-3,660	-3,620	-3,570	-3,530	-3,480
-70	-3,440	-3,390	-3,350	-3,300	-3,250	-3,210	-3,160	-3,120	-3,070	-3,020
-60	-2,980	-2,930	-2,880	-2,840	-2,790	-2,740	-2,700	-2,650	-2,600	-2,560
-50	-2,510	-2,460	-2,410	-2,360	-2,320	-2,270	-2,220	-2,170	-2,120	-2,080
-40	-2,030	-1,980	-1,930	-1,880	-1,830	-1,780	-1,730	-1,680	-1,630	-1,580
-30	-1,530	-1,480	-1,430	-1,380	-1,320	-1,270	-1,220	-1,170	-1,120	-1,070
-20	-1,020	-0,970	-0,920	-0,870	-0,810	-0,760	-0,710	-0,660	-0,610	-0,560
-10	-0,510	-0,460	-0,410	-0,360	-0,310	-0,250	-0,200	-0,150	-0,100	-0,050

°C in steps of 10 ↓	°C ascending in step of one →									
	0	1	2	3	4	5	6	7	8	9
0	0,000	0,050	0,100	0,160	0,210	0,260	0,310	0,360	0,420	0,470
10	0,520	0,570	0,630	0,680	0,730	0,780	0,840	0,890	0,940	1,000
20	1,050	1,100	1,160	1,210	1,260	1,310	1,370	1,420	1,470	1,530
30	1,580	1,630	1,690	1,740	1,790	1,840	1,900	1,950	2,000	2,060
40	2,110	2,160	2,220	2,270	2,330	2,380	2,430	2,490	2,540	2,600
50	2,650	2,700	2,760	2,810	2,870	2,920	2,970	3,030	3,080	3,140
60	3,190	3,240	3,300	3,350	3,410	3,460	3,510	3,570	3,620	3,680
70	3,730	3,780	3,840	3,890	3,950	4,000	4,050	4,110	4,160	4,220
80	4,270	4,320	4,380	4,430	4,490	4,540	4,600	4,650	4,710	4,770
90	4,820	4,870	4,930	4,980	5,040	5,090	5,150	5,200	5,260	5,320
100	5,370	5,420	5,480	5,530	5,590	5,640	5,700	5,750	5,810	5,870
110	5,920	5,970	6,030	6,080	6,140	6,190	6,250	6,300	6,360	6,420
120	6,470	6,530	6,580	6,640	6,690	6,750	6,810	6,860	6,920	6,970
130	7,030	7,090	7,140	7,200	7,250	7,310	7,370	7,420	7,480	7,530
140	7,590	7,650	7,700	7,760	7,810	7,870	7,930	7,980	8,040	8,090
150	8,150	8,210	8,260	8,320	8,370	8,430	8,490	8,540	8,600	8,650
160	8,710	8,770	8,820	8,880	8,930	8,990	9,050	9,100	9,160	9,210
170	9,270	9,330	9,380	9,440	9,490	9,550	9,610	9,660	9,720	9,770
180	9,830	9,890	9,940	10,000	10,050	10,110	10,170	10,220	10,280	10,330
190	10,390	10,450	10,500	10,560	10,631	10,670	10,730	10,780	10,840	10,890
200	10,950	11,010	11,060	11,120	11,170	11,230	11,290	11,340	11,400	11,450
210	11,510	11,570	11,620	11,680	11,730	11,790	11,850	11,900	11,960	12,010
220	12,070	12,130	12,180	12,240	12,290	12,350	12,410	12,460	12,520	12,570
230	12,630	12,690	12,740	12,800	12,850	12,910	12,970	13,020	13,080	13,130
240	13,190	13,250	13,300	13,360	13,410	13,470	13,530	13,580	13,640	13,690
250	13,750	13,810	13,860	13,920	13,970	14,030	14,090	14,140	14,200	14,250
260	14,310	14,370	14,420	14,480	14,540	14,590	14,650	14,710	14,760	14,820
270	14,880	14,940	14,990	15,050	15,100	15,160	15,220	15,270	15,330	15,380
280	15,440	15,500	15,550	15,610	15,660	15,720	15,780	15,830	15,890	15,940
290	16,000	16,060	16,110	16,170	16,220	16,280	16,340	16,390	16,450	16,500
300	16,560	16,620	16,670	16,730	16,780	16,840	16,900	16,950	17,010	17,060
310	17,120	17,180	17,230	17,290	17,340	17,400	17,460	17,510	17,570	17,620
320	17,680	17,740	17,790	17,850	17,900	17,960	18,020	18,070	18,130	18,180
330	18,240	18,300	18,350	18,410	18,460	18,520	18,580	18,630	18,690	18,740
340	18,800	18,860	18,910	18,970	19,020	19,085	19,140	19,190	19,250	19,300
350	19,360	19,420	19,470	19,530	19,580	19,640	19,700	19,750	19,810	19,850

°C in steps of 10 ↓	°C ascending in step of one →									
	0	1	2	3	4	5	6	7	8	9
360	19,920	19,980	20,030	20,090	20,140	20,200	20,260	20,310	20,370	20,420
370	20,480	20,540	20,590	20,650	20,700	20,760	20,820	20,870	20,930	20,980
380	21,040	21,100	21,150	21,210	21,260	21,320	21,380	21,430	21,490	21,540
390	21,600	21,660	21,710	21,770	21,820	21,880	21,940	21,990	22,050	22,100
400	22,160	22,220	22,270	22,330	22,380	22,440	22,500	22,550	22,610	22,660
410	22,720	22,780	22,830	22,890	22,950	23,000	23,060	23,120	23,180	23,230
420	23,290	23,350	23,400	23,460	23,520	23,570	23,630	23,690	23,740	23,800
430	23,860	23,920	23,970	24,030	24,090	24,140	24,200	24,260	24,320	24,370
440	24,430	24,490	24,540	24,600	24,660	24,710	24,770	24,830	24,890	24,940
450	25,000	25,060	25,110	25,170	25,230	25,280	25,340	25,400	25,460	25,510
460	25,570	25,630	25,680	25,740	25,800	25,850	25,910	25,970	26,030	26,080
470	26,170	26,200	26,250	26,310	26,370	26,420	26,480	26,540	26,600	26,650
480	26,710	26,770	26,820	26,880	26,940	26,990	27,050	27,110	27,170	27,220
490	27,280	27,340	27,390	27,450	27,510	27,560	27,620	27,680	27,740	27,790
500	27,850	27,910	27,970	28,020	28,080	28,140	28,200	28,260	28,310	28,370
510	28,430	28,490	28,550	28,600	28,660	28,720	28,780	28,840	28,890	28,950
520	29,010	29,070	29,130	29,180	29,240	29,300	29,360	29,420	29,470	29,530
530	29,590	29,650	29,710	29,760	29,820	29,880	29,940	30,000	30,050	30,110
540	30,170	30,230	30,290	30,340	30,400	30,460	30,520	30,580	30,630	30,690
550	30,750	30,810	30,870	30,920	30,980	31,040	31,100	31,160	31,210	31,270
560	31,330	31,390	31,450	31,500	31,560	31,620	31,680	31,740	31,790	31,850
570	31,910	31,970	32,030	32,080	32,140	32,200	32,260	32,320	32,370	32,430
580	32,490	32,550	32,610	32,660	32,720	32,780	32,840	32,900	32,960	33,020
590	33,080	33,140	33,200	33,260	33,320	33,380	33,430	33,490	33,550	33,610
600	33,670	33,730	33,790	33,850	33,910	33,970	34,020	34,080	34,140	34,200
610	34,260	34,320	34,380	34,440	34,500	34,560	34,610	34,670	34,730	34,790
620	34,850	34,910	34,970	35,030	35,090	35,150	35,200	35,260	35,320	35,380
630	35,440	35,500	35,560	35,620	35,680	35,740	35,800	35,860	35,920	35,980
640	36,040	36,100	36,160	36,220	36,280	36,340	36,400	36,460	36,520	36,580
650	36,640	36,700	36,760	36,820	36,880	36,950	37,010	37,070	37,130	37,190
660	37,250	37,300	37,360	37,420	37,480	37,550	37,610	37,670	37,730	37,790
670	37,850	37,910	37,970	38,040	38,100	38,160	38,220	38,280	38,350	38,410
680	38,470	38,530	38,590	38,660	38,720	38,780	38,840	38,900	38,970	39,030
690	39,090	39,150	39,220	39,280	39,340	39,410	39,470	39,530	39,590	39,660
700	39,720	39,780	39,850	39,910	39,970	40,040	40,100	40,160	40,220	40,290
710	40,350	40,410	40,480	40,540	40,600	40,670	40,730	40,800	40,860	40,930
720	40,980	41,040	41,110	41,170	41,230	41,300	41,360	41,430	41,490	41,560
730	41,620	41,690	41,750	41,820	41,880	41,950	42,010	42,080	42,140	42,210
740	42,270	42,340	42,400	42,470	42,530	42,600	42,660	42,730	42,790	42,860
750	42,920	42,990	43,050	43,120	43,180	43,250	43,310	43,380	43,440	43,510
760	43,570	43,640	43,700	43,770	43,830	43,900	43,970	44,030	44,100	44,160
770	44,230	44,300	44,360	44,430	44,490	44,560	44,630	44,690	44,760	44,820
780	44,890	44,960	45,020	45,090	45,150	45,220	45,290	45,350	45,420	45,480
790	45,550	45,620	45,680	45,750	45,820	45,890	45,950	46,020	46,090	46,150
800	46,220	46,290	46,350	46,420	46,490	46,560	46,620	46,690	46,760	46,820
810	46,890	46,960	47,030	47,090	47,160	47,230	47,300	47,370	47,430	47,500
820	47,570	47,640	47,710	47,770	47,840	47,910	47,980	48,050	48,110	48,180
830	48,250	48,320	48,390	48,460	48,530	48,600	48,660	48,730	48,800	48,870
840	48,940	49,010	49,080	49,150	49,220	49,290	49,350	49,420	49,490	49,560
850	49,630	49,700	49,770	49,840	49,910	49,980	50,040	50,110	50,180	50,250
860	50,320	50,390	50,460	50,530	50,600	50,670	50,740	50,810	50,880	50,950
870	51,020	51,090	51,160	51,230	51,300	51,370	51,440	51,510	51,580	51,650
880	51,720	51,790	51,860	51,930	52,000	52,080	52,150	52,220	52,290	52,360
890	52,430	52,500	52,570	52,640	52,710	52,790	52,860	52,930	53,000	53,070
900	53,140									





### 11.1.16 TC Typ N

Temperature range -270°C....+1300°C

All resistance value in mV

°C in steps of 10 ↓	°C tended to zero in step of one →									
	0	1	2	3	4	5	6	7	8	9
-270	-4,345	-4,345	-4,344	-4,344	-4,343	-4,342	-4,341	-4,340	-4,339	-4,337
-260	-4,336	-4,334	-4,332	-4,330	-4,328	-4,326	-4,324	-4,321	-4,319	-4,316
-250	-4,313	-4,310	-4,307	-4,304	-4,300	-4,297	-4,293	-4,289	-4,285	-4,281
-240	-4,277	-4,273	-4,268	-4,263	-4,259	-4,254	-4,248	-4,243	-4,238	-4,232
-230	-4,227	-4,221	-4,215	-4,209	-4,202	-4,196	-4,189	-4,183	-4,176	-4,169
-220	-4,162	-4,155	-4,147	-4,140	-4,132	-4,124	-4,116	-4,108	-4,100	-4,091
-210	-4,083	-4,074	-4,066	-4,057	-4,048	-4,038	-4,029	-4,020	-4,010	-4,000
-200	-3,990	-3,980	-3,970	-3,960	-3,950	-3,929	-3,928	-3,918	-3,907	-3,896
-190	-3,884	-3,873	-3,862	-3,850	-3,838	-3,827	-3,815	-3,803	-3,790	-3,778
-180	-3,766	-3,753	-3,740	-3,727	-3,715	-3,701	-3,688	-3,675	-3,661	-3,648
-170	-3,634	-3,620	-3,607	-3,592	-3,578	-3,564	-3,550	-3,535	-3,521	-3,506
-160	-3,494	-3,476	-3,461	-3,446	-3,430	-3,415	-3,399	-3,384	-3,368	-3,352
-150	-3,336	-3,320	-3,304	-3,288	-3,271	-3,255	-3,238	-3,221	-3,204	-3,187
-140	-3,170	-3,153	-3,136	-3,118	-3,101	-3,083	-3,066	-3,048	-3,030	-3,012
-130	-2,994	-2,976	-2,957	-2,939	-2,921	-2,902	-2,883	-2,864	-2,846	-2,827
-120	-2,807	-2,788	-2,769	-2,750	-2,730	-2,711	-2,691	-2,671	-2,651	-2,632
-110	-2,612	-2,591	-2,571	-2,551	-2,531	-2,510	-2,490	-2,469	-2,448	-2,427
-100	-2,407	-2,386	-2,365	-2,343	-2,322	-2,301	-2,280	-2,258	-2,237	-2,215
-90	-2,193	-2,171	-2,150	-2,128	-2,106	-2,084	-2,061	-2,039	-2,017	-1,995
-80	-1,972	-1,950	-1,927	-1,904	-1,882	-1,859	-1,836	-1,813	-1,790	-1,767
-70	-1,744	-1,721	-1,697	-1,674	-1,651	-1,627	-1,604	-1,580	-1,556	-1,533
-60	-1,509	-1,485	-1,461	-1,437	-1,413	-1,389	-1,365	-1,341	-1,317	-1,293
-50	-1,268	-1,244	-1,220	-1,195	-1,171	-1,146	-1,121	-1,097	-1,072	-1,047
-40	-1,023	-0,998	-0,973	-0,948	-0,923	-0,898	-0,873	-0,848	-0,823	-0,797
-30	-0,772	-0,747	-0,722	-0,696	-0,671	-0,646	-0,620	-0,595	-0,569	-0,544
-20	-0,518	-0,492	-0,467	-0,441	-0,415	-0,390	-0,364	-0,338	-0,312	-0,286
-10	-0,260	-0,234	-0,208	-0,183	-0,157	-0,130	-0,104	-0,078	-0,052	-0,026

°C in steps of 10 ↓	°C ascending in step of one →									
	0	1	2	3	4	5	6	7	8	9
0	0,000	0,026	0,052	0,078	0,104	0,130	0,156	0,182	0,208	0,235
10	0,261	0,287	0,313	0,340	0,366	0,393	0,419	0,446	0,472	0,499
20	0,525	0,552	0,578	0,605	0,632	0,659	0,685	0,712	0,739	0,766
30	0,793	0,820	0,847	0,874	0,901	0,928	0,955	0,983	1,010	1,037
40	1,065	1,092	1,119	1,147	1,174	1,202	1,229	1,257	1,284	1,312
50	1,340	1,368	1,395	1,423	1,451	1,479	1,507	1,535	1,563	1,591
60	1,619	1,647	1,675	1,703	1,732	1,760	1,788	1,817	1,845	1,873
70	1,902	1,930	1,959	1,988	2,016	2,045	2,074	2,102	2,131	2,160
80	2,189	2,218	2,247	2,276	2,305	2,334	2,363	2,392	2,421	2,450
90	2,480	2,509	2,538	2,568	2,597	2,626	2,656	2,685	2,715	2,744
100	2,774	2,804	2,833	2,863	2,893	2,923	2,953	2,983	3,012	3,042
110	3,072	3,102	3,133	3,163	3,193	3,223	3,253	3,283	3,314	3,344
120	3,374	3,405	3,435	3,466	3,496	3,527	3,557	3,588	3,619	3,649
130	3,680	3,711	3,742	3,772	3,803	3,834	3,865	3,896	3,927	3,958
140	3,989	4,020	4,051	4,083	4,114	4,145	4,176	4,208	4,239	4,270
150	4,302	4,333	4,365	4,396	4,428	4,459	4,491	4,523	4,554	4,586
160	4,618	4,650	4,681	4,713	4,745	4,777	4,809	4,841	4,873	4,905
170	4,937	4,969	5,001	5,033	5,066	5,098	5,130	5,162	5,195	5,227
180	5,259	5,292	5,324	5,357	5,389	5,422	5,454	5,487	5,520	5,552
190	5,585	5,618	5,650	5,683	5,716	5,749	5,782	5,815	5,847	5,880

°C in steps of 10 	°C ascending in step of one 									
	0	1	2	3	4	5	6	7	8	9
200	5,913	5,946	5,979	6,013	6,046	6,079	6,112	6,145	6,178	6,211
210	6,245	6,278	6,311	6,345	6,378	6,411	6,445	6,478	6,512	6,545
220	6,579	6,612	6,646	6,680	6,713	6,747	6,781	6,814	6,848	6,882
230	6,916	6,949	6,983	7,017	7,051	7,085	7,119	7,153	7,187	7,221
240	7,255	7,289	7,323	7,357	7,392	7,426	7,460	7,494	7,528	7,563
250	7,597	7,631	7,666	7,700	7,734	7,769	7,803	7,838	7,872	7,907
260	7,941	7,976	8,010	8,045	8,080	8,114	8,149	8,184	8,218	8,253
270	8,288	8,323	8,358	8,392	8,427	8,462	8,497	8,532	8,567	8,602
280	8,637	8,672	8,707	8,742	8,777	8,812	8,847	8,882	8,917	8,953
290	8,988	9,023	9,058	9,094	9,129	9,164	9,200	9,235	9,270	9,306
300	9,341	9,377	9,412	9,448	9,483	9,519	9,554	9,590	9,625	9,661
310	9,696	9,732	9,768	9,803	9,839	9,875	9,910	9,946	9,982	10,018
320	10,054	10,089	10,125	10,161	10,197	10,233	10,269	10,305	10,341	10,377
330	10,413	10,449	10,485	10,521	10,557	10,593	10,629	10,665	10,701	10,737
340	10,774	10,810	10,846	10,882	10,918	10,955	10,991	11,027	11,064	11,100
350	11,136	11,173	11,209	11,245	11,282	11,318	11,355	11,391	11,428	11,464
360	11,501	11,537	11,574	11,610	11,647	11,683	11,720	11,757	11,793	11,830
370	11,867	11,903	11,940	11,977	12,013	12,050	12,087	12,124	12,160	12,197
380	12,234	12,271	12,308	12,345	12,382	12,418	12,455	12,492	12,529	12,566
390	12,603	12,640	12,677	12,714	12,751	12,788	12,825	12,862	12,899	12,937
400	12,974	13,011	13,048	13,085	13,122	13,159	13,197	13,234	13,271	13,308
410	13,346	13,383	13,420	13,457	13,495	13,532	13,569	13,607	13,644	13,682
420	13,719	13,756	13,794	13,831	13,869	13,906	13,944	13,981	14,019	14,056
430	14,094	14,131	14,169	14,206	14,244	14,281	14,319	14,356	14,394	14,432
440	14,469	14,507	14,545	14,582	14,620	14,658	14,695	14,733	14,771	14,809
450	14,846	14,884	14,922	14,960	14,998	15,035	15,073	15,111	15,149	15,187
460	15,225	15,262	15,300	15,338	15,376	15,414	15,452	15,490	15,528	15,566
470	15,604	15,642	15,680	15,718	15,756	15,794	15,832	15,870	15,908	15,946
480	15,984	16,022	16,060	16,099	16,137	16,175	16,213	16,251	16,289	16,327
490	16,366	16,404	16,442	16,480	16,518	16,557	16,595	16,633	16,671	16,710
500	16,748	16,786	16,824	16,863	16,901	16,939	16,978	17,016	17,054	17,093
510	17,131	17,169	17,208	17,246	17,285	17,323	17,361	17,400	17,438	17,477
520	17,515	17,554	17,592	17,630	17,669	17,707	17,746	17,784	17,823	17,861
530	17,900	17,938	17,977	18,016	18,054	18,093	18,131	18,170	18,208	18,247
540	18,286	18,324	18,363	18,401	18,440	18,479	18,517	18,556	18,595	18,633
550	18,672	18,711	18,749	18,788	18,827	18,865	18,904	18,943	18,982	19,020
560	19,059	19,098	19,136	19,175	19,214	19,253	19,292	19,330	19,369	19,408
570	19,447	19,485	19,524	19,563	19,602	19,641	19,680	19,718	19,757	19,796
580	19,835	19,874	19,913	19,952	19,990	20,029	20,068	20,107	20,146	20,185
590	20,224	20,263	20,302	20,341	20,379	20,418	20,457	20,496	20,535	20,574
600	20,613	20,652	20,691	20,730	20,769	20,808	20,847	20,886	20,925	20,964
610	21,003	21,042	21,081	21,120	21,159	21,198	21,237	21,276	21,315	21,354
620	21,393	21,432	21,471	21,510	21,549	21,588	21,628	21,667	21,706	21,745
630	21,784	21,823	21,862	21,901	21,940	21,979	22,018	22,058	22,097	22,136
640	22,175	22,214	22,253	22,292	22,331	22,370	22,410	22,449	22,488	22,527
650	22,566	22,605	22,644	22,684	22,723	22,762	22,801	22,840	22,879	22,919
660	22,958	22,997	23,036	23,075	23,115	23,154	23,193	23,232	23,271	23,311
670	23,350	23,389	23,428	23,467	23,507	23,546	23,585	23,624	23,663	23,703
680	23,742	23,781	23,820	23,860	23,899	23,938	23,977	24,016	24,056	24,095
690	24,134	24,173	24,213	24,252	24,291	24,330	24,370	24,409	24,448	24,487
700	24,527	24,566	24,605	24,644	24,684	24,723	24,762	24,801	24,841	24,880
710	24,919	24,959	24,998	25,037	25,076	25,116	25,155	25,194	25,233	25,273
720	25,312	25,351	25,391	25,430	25,469	25,508	25,548	25,587	25,626	25,666
730	25,705	25,744	25,783	25,823	25,862	25,901	25,941	25,980	26,019	26,058
740	26,098	26,137	26,176	26,216	26,255	26,294	26,333	26,373	26,412	26,451
750	26,491	26,530	26,569	26,608	26,648	26,687	26,726	26,766	26,805	26,844
760	26,883	26,923	26,962	27,001	27,041	27,080	27,119	27,158	27,198	27,237
770	27,276	27,316	27,355	27,394	27,433	27,473	27,512	27,551	27,591	27,630
780	27,669	27,708	27,748	27,787	27,826	27,866	27,905	27,944	27,983	28,023
790	28,062	28,101	28,140	28,180	28,219	28,258	28,297	28,337	28,376	28,415

°C in steps of 10 ↓	°C ascending in step of one →									
	0	1	2	3	4	5	6	7	8	9
800	28,455	28,494	28,533	28,572	28,612	28,651	28,690	28,729	28,769	28,808
810	28,847	28,886	28,926	28,965	29,004	29,043	29,083	29,122	29,161	29,200
820	29,239	29,279	29,318	29,357	29,396	29,436	29,475	29,514	29,553	29,592
830	29,632	29,671	29,710	29,749	29,789	29,828	29,867	29,906	29,945	29,985
840	30,024	30,063	30,102	30,141	30,181	30,220	30,259	30,298	30,337	30,376
850	30,416	30,455	30,494	30,533	30,572	30,611	30,651	30,690	30,729	30,768
860	30,807	30,846	30,886	30,925	30,964	31,003	31,042	31,081	31,120	31,160
870	31,199	31,238	31,277	31,316	31,355	31,394	31,433	31,473	31,512	31,551
880	31,590	31,629	31,668	31,707	31,746	31,785	31,824	31,863	31,903	31,942
890	31,981	32,020	32,059	32,098	32,137	32,176	32,215	32,254	32,293	32,332
900	32,371	32,410	32,449	32,488	32,527	32,566	32,605	32,644	32,683	32,722
910	32,760	32,799	32,838	32,877	32,916	32,955	32,993	33,032	33,071	33,110
920	33,149	33,188	33,227	33,266	33,305	33,344	33,382	33,421	33,460	33,499
930	33,538	33,577	33,616	33,655	33,693	33,732	33,771	33,810	33,849	33,888
940	33,926	33,965	34,004	34,043	34,082	34,121	34,159	34,198	34,237	34,276
950	34,315	34,353	34,392	34,431	34,470	34,508	34,547	34,586	34,625	34,663
960	34,702	34,741	34,780	34,818	34,857	34,896	34,935	34,973	35,012	35,051
970	35,089	35,128	35,167	35,205	35,244	35,283	35,321	35,360	35,399	35,437
980	35,476	35,515	35,553	35,592	35,631	35,669	35,708	35,747	35,785	35,824
990	35,862	35,901	35,940	35,978	36,017	36,055	36,094	36,132	36,171	36,210
1000	36,248	36,287	36,325	36,364	36,402	36,441	36,479	36,518	36,556	36,595
1010	36,633	36,672	36,710	36,749	36,787	36,826	36,864	36,903	36,941	36,980
1020	37,018	37,057	37,095	37,134	37,172	37,210	37,249	37,287	37,326	37,364
1030	37,402	37,441	37,479	37,518	37,556	37,594	37,633	37,671	37,710	37,748
1040	37,786	37,825	37,863	37,901	37,940	37,978	38,016	38,055	38,093	38,131
1050	38,169	38,208	38,246	38,284	38,323	38,361	38,399	38,437	38,476	38,514
1060	38,552	38,590	38,628	38,667	38,705	38,743	38,781	38,819	38,858	38,896
1070	38,934	38,972	39,010	39,049	39,087	39,125	39,163	39,201	39,239	39,277
1080	39,315	39,354	39,392	39,430	39,468	39,506	39,544	39,582	39,620	39,658
1090	39,696	39,734	39,772	39,810	39,848	39,886	39,924	39,962	40,000	40,038
1100	40,076	40,114	40,152	40,190	40,228	40,266	40,304	40,342	40,380	40,418
1110	40,456	40,494	40,532	40,570	40,607	40,645	40,683	40,721	40,759	40,797
1120	40,835	40,872	40,910	40,948	40,986	41,024	41,062	41,099	41,137	41,175
1130	41,213	41,250	41,288	41,326	41,364	41,401	41,439	41,477	41,515	41,552
1140	41,590	41,628	41,665	41,703	41,741	41,778	41,816	41,854	41,891	41,929
1150	41,966	42,004	42,042	42,079	42,117	42,154	42,192	42,229	42,267	42,305
1160	42,342	42,380	42,417	42,455	42,492	42,530	42,567	42,605	42,642	42,680
1170	42,717	42,754	42,792	42,829	42,867	42,904	42,941	42,979	43,016	43,054
1180	43,091	43,128	43,166	43,203	43,240	43,278	43,315	43,352	43,389	43,427
1190	43,464	43,501	43,538	43,576	43,613	43,650	43,687	43,725	43,762	43,799
1200	43,836	43,873	43,910	43,948	43,985	44,022	44,059	44,096	44,133	44,170
1210	44,207	44,244	44,281	44,318	44,355	44,393	44,430	44,467	44,504	44,541
1220	44,577	44,614	44,651	44,688	44,725	44,762	44,799	44,836	44,873	44,910
1230	44,947	44,984	45,020	45,057	45,094	45,131	45,168	45,204	45,241	45,278
1240	45,315	45,352	45,388	45,425	45,462	45,498	45,535	45,572	45,609	45,645
1250	45,682	45,719	45,755	45,792	45,828	45,865	45,902	45,938	45,975	46,011
1260	46,048	46,085	46,121	46,158	46,194	46,231	46,267	46,304	46,340	46,377
1270	46,413	46,449	46,486	46,522	46,559	46,595	46,631	46,668	46,704	46,741
1280	46,777	46,813	46,850	46,886	46,922	46,959	46,995	47,031	47,067	47,104
1290	47,140	47,176	47,212	47,249	47,285	47,321	47,357	47,393	47,430	47,466
1300	47,502									

### 11.1.17 TC Typ R

Temperature range 0°C....+1760°C

All resistance value in mV

°C in steps of 10 ↓	°C ascending in step of one →									
	0	1	2	3	4	5	6	7	8	9
0	0,000	0,005	0,011	0,016	0,021	0,027	0,032	0,038	0,043	0,049
10	0,054	0,060	0,065	0,071	0,077	0,082	0,088	0,094	0,100	0,105
20	0,111	0,117	0,123	0,129	0,135	0,141	0,147	0,153	0,159	0,165
30	0,171	0,177	0,183	0,189	0,195	0,201	0,207	0,214	0,220	0,226
40	0,232	0,239	0,245	0,251	0,258	0,264	0,271	0,277	0,284	0,290
50	0,296	0,303	0,310	0,316	0,323	0,329	0,336	0,343	0,349	0,356
60	0,363	0,369	0,376	0,383	0,390	0,397	0,403	0,410	0,417	0,424
70	0,431	0,438	0,445	0,452	0,459	0,466	0,473	0,480	0,487	0,494
80	0,501	0,508	0,516	0,523	0,530	0,537	0,544	0,552	0,559	0,566
90	0,573	0,581	0,588	0,595	0,603	0,610	0,618	0,625	0,632	0,640
100	0,647	0,655	0,662	0,670	0,677	0,685	0,693	0,700	0,708	0,715
110	0,723	0,731	0,738	0,746	0,754	0,761	0,769	0,777	0,785	0,792
120	0,800	0,808	0,816	0,824	0,832	0,839	0,847	0,855	0,863	0,871
130	0,879	0,887	0,895	0,903	0,911	0,919	0,927	0,935	0,943	0,951
140	0,959	0,967	0,976	0,984	0,992	1,000	1,008	1,016	1,025	1,033
150	1,041	1,049	1,058	1,066	1,074	1,082	1,091	1,099	1,107	1,116
160	1,124	1,132	1,141	1,149	1,158	1,166	1,175	1,183	1,191	1,200
170	1,208	1,217	1,225	1,234	1,242	1,251	1,260	1,268	1,277	1,285
180	1,294	1,303	1,311	1,320	1,329	1,337	1,346	1,355	1,363	1,372
190	1,381	1,389	1,398	1,407	1,416	1,425	1,433	1,442	1,451	1,460
200	1,469	1,477	1,486	1,495	1,504	1,513	1,522	1,531	1,540	1,549
210	1,558	1,567	1,575	1,584	1,593	1,602	1,611	1,620	1,629	1,639
220	1,648	1,657	1,666	1,675	1,684	1,693	1,702	1,711	1,720	1,729
230	1,739	1,748	1,757	1,766	1,775	1,784	1,794	1,803	1,812	1,821
240	1,831	1,840	1,849	1,858	1,868	1,877	1,886	1,895	1,905	1,914
250	1,923	1,933	1,942	1,951	1,961	1,970	1,980	1,989	1,998	2,008
260	2,017	2,027	2,036	2,046	2,055	2,064	2,074	2,083	2,093	2,102
270	2,112	2,121	2,131	2,140	2,150	2,159	2,169	2,179	2,188	2,198
280	2,207	2,217	2,226	2,236	2,246	2,255	2,265	2,275	2,284	2,294
290	2,304	2,313	2,323	2,333	2,342	2,352	2,362	2,371	2,381	2,391
300	2,401	2,410	2,420	2,430	2,440	2,449	2,459	2,469	2,479	2,488
310	2,498	2,508	2,518	2,528	2,538	2,547	2,557	2,567	2,577	2,587
320	2,597	2,607	2,617	2,626	2,636	2,646	2,656	2,666	2,676	2,686
330	2,696	2,706	2,716	2,726	2,736	2,746	2,756	2,766	2,776	2,786
340	2,796	2,806	2,816	2,826	2,836	2,846	2,856	2,866	2,876	2,886
350	2,896	2,906	2,916	2,926	2,937	2,947	2,957	2,967	2,977	2,987
360	2,997	3,007	3,018	3,028	3,038	3,048	3,058	3,068	3,079	3,089
370	3,099	3,109	3,119	3,130	3,140	3,150	3,160	3,171	3,181	3,191
380	3,201	3,212	3,222	3,232	3,242	3,253	3,263	3,273	3,284	3,294
390	3,304	3,315	3,325	3,335	3,346	3,356	3,366	3,377	3,387	3,397
400	3,408	3,418	3,428	3,439	3,449	3,460	3,470	3,480	3,491	3,501
410	3,512	3,522	3,533	3,543	3,553	3,564	3,574	3,585	3,595	3,606
420	3,616	3,627	3,637	3,648	3,658	3,669	3,679	3,690	3,700	3,711
430	3,721	3,732	3,742	3,753	3,764	3,774	3,785	3,795	3,806	3,816
440	3,827	3,838	3,848	3,859	3,869	3,880	3,891	3,901	3,912	3,922
450	3,933	3,944	3,954	3,965	3,976	3,986	3,997	4,008	4,018	4,029
460	4,040	4,050	4,061	4,072	4,083	4,093	4,104	4,115	4,125	4,136
470	4,147	4,158	4,168	4,179	4,190	4,201	4,211	4,222	4,233	4,244
480	4,255	4,265	4,276	4,287	4,298	4,309	4,319	4,330	4,341	4,352
490	4,363	4,373	4,384	4,395	4,406	4,417	4,428	4,439	4,449	4,460
500	4,471	4,482	4,493	4,504	4,515	4,526	4,537	4,548	4,558	4,569
510	4,580	4,591	4,602	4,613	4,624	4,635	4,646	4,657	4,668	4,679
520	4,690	4,701	4,712	4,723	4,734	4,745	4,756	4,767	4,778	4,789
530	4,800	4,811	4,822	4,833	4,844	4,855	4,866	4,877	4,888	4,899
540	4,910	4,922	4,933	4,944	4,955	4,966	4,977	4,988	4,999	5,010
550	5,021	5,033	5,044	5,055	5,066	5,077	5,088	5,099	5,111	5,122
560	5,133	5,144	5,155	5,166	5,178	5,189	5,200	5,211	5,222	5,234
570	5,245	5,256	5,267	5,279	5,290	5,301	5,312	5,323	5,335	5,346
580	5,357	5,369	5,380	5,391	5,402	5,414	5,425	5,436	5,448	5,459

°C in steps of 10 ↓	°C ascending in step of one →									
	0	1	2	3	4	5	6	7	8	9
600	5,583	5,595	5,606	5,618	5,629	5,640	5,652	5,663	5,674	5,686
610	5,697	5,709	5,720	5,731	5,743	5,754	5,766	5,777	5,789	5,800
620	5,812	5,823	5,834	5,846	5,857	5,869	5,880	5,892	5,903	5,915
630	5,926	5,938	5,949	5,961	5,972	5,984	5,995	6,007	6,018	6,030
640	6,041	6,053	6,065	6,076	6,088	6,099	6,111	6,122	6,134	6,146
650	6,157	6,169	6,180	6,192	6,204	6,215	6,227	6,238	6,250	6,262
660	6,273	6,285	6,297	6,308	6,320	6,332	6,343	6,355	6,367	6,378
670	6,390	6,402	6,413	6,425	6,437	6,448	6,460	6,472	6,484	6,495
680	6,507	6,519	6,531	6,542	6,554	6,566	6,578	6,589	6,601	6,613
690	6,625	6,636	6,648	6,660	6,672	6,684	6,695	6,707	6,719	6,731
700	6,743	6,755	6,766	6,778	6,790	6,802	6,814	6,826	6,838	6,849
710	6,861	6,873	6,885	6,897	6,909	6,921	6,933	6,945	6,956	6,968
720	6,980	6,992	7,004	7,016	7,028	7,040	7,052	7,064	7,076	7,088
730	7,100	7,112	7,124	7,136	7,148	7,160	7,172	7,184	7,196	7,208
740	7,220	7,232	7,244	7,256	7,268	7,280	7,292	7,304	7,316	7,328
750	7,340	7,352	7,364	7,376	7,389	7,401	7,413	7,425	7,437	7,449
760	7,461	7,473	7,485	7,498	7,510	7,522	7,534	7,546	7,558	7,570
770	7,583	7,595	7,607	7,619	7,631	7,644	7,656	7,668	7,680	7,692
780	7,705	7,717	7,729	7,741	7,753	7,766	7,778	7,790	7,802	7,815
790	7,827	7,839	7,851	7,864	7,876	7,888	7,901	7,913	7,925	7,938
800	7,950	7,962	7,974	7,987	7,999	8,011	8,024	8,036	8,048	8,061
810	8,073	8,086	8,098	8,110	8,123	8,135	8,147	8,160	8,172	8,185
820	8,197	8,209	8,222	8,234	8,247	8,259	8,272	8,284	8,296	8,309
830	8,321	8,334	8,346	8,359	8,371	8,384	8,396	8,409	8,421	8,434
840	8,446	8,459	8,471	8,484	8,496	8,509	8,521	8,534	8,546	8,559
850	8,571	8,584	8,597	8,609	8,622	8,634	8,647	8,659	8,672	8,685
860	8,697	8,710	8,722	8,735	8,748	8,760	8,773	8,785	8,798	8,811
870	8,823	8,836	8,849	8,861	8,874	8,887	8,899	8,912	8,925	8,937
880	8,950	8,963	8,975	8,988	9,001	9,014	9,026	9,039	9,052	9,065
890	9,077	9,090	9,103	9,115	9,128	9,141	9,154	9,167	9,179	9,192
900	9,205	9,218	9,230	9,243	9,256	9,269	9,282	9,294	9,307	9,320
910	9,333	9,346	9,359	9,371	9,384	9,397	9,410	9,423	9,436	9,449
920	9,461	9,474	9,487	9,500	9,513	9,526	9,539	9,552	9,565	9,578
930	9,590	9,603	9,616	9,629	9,642	9,655	9,668	9,681	9,694	9,707
940	9,720	9,733	9,746	9,759	9,772	9,785	9,798	9,811	9,824	9,837
950	9,850	9,863	9,876	9,889	9,902	9,915	9,928	9,941	9,954	9,967
960	9,980	9,993	10,006	10,019	10,032	10,046	10,059	10,072	10,085	10,098
970	10,111	10,124	10,137	10,150	10,163	10,177	10,190	10,203	10,216	10,229
980	10,242	10,255	10,268	10,282	10,295	10,308	10,321	10,334	10,347	10,361
990	10,374	10,387	10,400	10,413	10,427	10,440	10,453	10,466	10,480	10,493
1000	10,506	10,519	10,532	10,546	10,559	10,572	10,585	10,599	10,612	10,625
1010	10,638	10,652	10,665	10,678	10,692	10,705	10,718	10,731	10,745	10,758
1020	10,771	10,785	10,798	10,811	10,825	10,838	10,851	10,865	10,878	10,891
1030	10,905	10,918	10,932	10,945	10,958	10,972	10,985	10,998	11,012	11,025
1040	11,039	11,052	11,065	11,079	11,092	11,106	11,119	11,132	11,146	11,159
1050	11,173	11,186	11,200	11,213	11,227	11,240	11,253	11,267	11,280	11,294
1060	11,307	11,321	11,334	11,348	11,361	11,375	11,388	11,402	11,415	11,429
1070	11,442	11,456	11,469	11,483	11,496	11,510	11,524	11,537	11,551	11,564
1080	11,578	11,591	11,605	11,618	11,632	11,646	11,659	11,673	11,686	11,700
1090	11,714	11,727	11,741	11,754	11,768	11,782	11,795	11,809	11,822	11,836
1100	11,850	11,863	11,877	11,891	11,904	11,918	11,931	11,945	11,959	11,972
1110	11,986	12,000	12,013	12,027	12,041	12,054	12,068	12,082	12,096	12,109
1120	12,123	12,137	12,150	12,164	12,178	12,191	12,205	12,219	12,233	12,246
1130	12,260	12,274	12,288	12,301	12,315	12,329	12,342	12,356	12,370	12,384
1140	12,397	12,411	12,425	12,439	12,453	12,466	12,480	12,494	12,508	12,521
1150	12,535	12,549	12,563	12,577	12,590	12,604	12,618	12,632	12,646	12,659
1160	12,673	12,687	12,701	12,715	12,729	12,742	12,756	12,770	12,784	12,798
1170	12,812	12,825	12,839	12,853	12,867	12,881	12,895	12,909	12,922	12,936
1180	12,950	12,964	12,978	12,992	13,006	13,019	13,033	13,047	13,061	13,075
1190	13,089	13,103	13,117	13,131	13,145	13,158	13,172	13,186	13,200	13,214

°C in steps of 10	°C ascending in step of one									
	0	1	2	3	4	5	6	7	8	9
1200	13,228	13,242	13,256	13,270	13,284	13,298	13,311	13,325	13,339	13,353
1210	13,367	13,381	13,395	13,409	13,423	13,437	13,451	13,465	13,479	13,493
1220	13,507	13,521	13,535	13,549	13,563	13,577	13,590	13,604	13,618	13,632
1230	13,646	13,660	13,674	13,688	13,702	13,716	13,730	13,744	13,758	13,772
1240	13,786	13,800	13,814	13,828	13,842	13,856	13,870	13,884	13,898	13,912
1250	13,926	13,940	13,954	13,968	13,982	13,996	14,010	14,024	14,038	14,052
1260	14,066	14,081	14,095	14,109	14,123	14,137	14,151	14,165	14,179	14,193
1270	14,207	14,221	14,235	14,249	14,263	14,277	14,291	14,305	14,319	14,333
1280	14,347	14,361	14,375	14,390	14,404	14,418	14,432	14,446	14,460	14,474
1290	14,488	14,502	14,516	14,530	14,544	14,558	14,572	14,586	14,601	14,615
1300	14,629	14,643	14,657	14,671	14,685	14,699	14,713	14,727	14,741	14,755
1310	14,770	14,784	14,798	14,812	14,826	14,840	14,854	14,868	14,882	14,896
1320	14,911	14,925	14,939	14,953	14,967	14,981	14,995	15,009	15,023	15,037
1330	15,052	15,066	15,080	15,094	15,108	15,122	15,136	15,150	15,164	15,179
1340	15,193	15,207	15,221	15,235	15,249	15,263	15,277	15,291	15,306	15,320
1350	15,334	15,348	15,362	15,376	15,390	15,404	15,419	15,433	15,447	15,461
1360	15,475	15,489	15,503	15,517	15,531	15,546	15,560	15,574	15,588	15,602
1370	15,616	15,630	15,645	15,659	15,673	15,687	15,701	15,715	15,729	15,743
1380	15,758	15,772	15,786	15,800	15,814	15,828	15,842	15,856	15,871	15,885
1390	15,899	15,913	15,927	15,941	15,955	15,969	15,984	15,998	16,012	16,026
1400	16,040	16,054	16,068	16,082	16,097	16,111	16,125	16,139	16,153	16,167
1410	16,181	16,196	16,210	16,224	16,238	16,252	16,266	16,280	16,294	16,309
1420	16,323	16,337	16,351	16,365	16,379	16,393	16,407	16,422	16,436	16,450
1430	16,464	16,478	16,492	16,506	16,520	16,534	16,549	16,563	16,577	16,591
1440	16,605	16,619	16,633	16,647	16,662	16,676	16,690	16,704	16,718	16,732
1450	16,746	16,760	16,774	16,789	16,803	16,817	16,831	16,845	16,859	16,873
1460	16,887	16,901	16,915	16,930	16,944	16,958	16,972	16,986	17,000	17,014
1470	17,028	17,042	17,056	17,071	17,085	17,099	17,113	17,127	17,141	17,155
1480	17,169	17,183	17,197	17,211	17,225	17,240	17,254	17,268	17,282	17,296
1490	17,310	17,324	17,338	17,352	17,366	17,380	17,394	17,408	17,423	17,437
1500	17,451	17,465	17,479	17,493	17,507	17,521	17,535	17,549	17,563	17,577
1510	17,591	17,605	17,619	17,633	17,647	17,661	17,676	17,690	17,704	17,718
1520	17,732	17,746	17,760	17,774	17,788	17,802	17,816	17,830	17,844	17,858
1530	17,872	17,886	17,900	17,914	17,928	17,942	17,956	17,970	17,984	17,998
1540	18,012	18,026	18,040	18,054	18,068	18,082	18,096	18,110	18,124	18,138
1550	18,152	18,166	18,180	18,194	18,208	18,222	18,236	18,250	18,264	18,278
1560	18,292	18,306	18,320	18,334	18,348	18,362	18,376	18,390	18,404	18,417
1570	18,431	18,445	18,459	18,473	18,487	18,501	18,515	18,529	18,543	18,557
1580	18,571	18,585	18,599	18,613	18,627	18,640	18,654	18,668	18,682	18,696
1590	18,710	18,724	18,738	18,752	18,766	18,779	18,793	18,807	18,821	18,835
1600	18,849	18,863	18,877	18,891	18,904	18,918	18,932	18,946	18,960	18,974
1610	18,988	19,002	19,015	19,029	19,043	19,057	19,071	19,085	19,098	19,112
1620	19,126	19,140	19,154	19,168	19,181	19,195	19,209	19,223	19,237	19,250
1630	19,264	19,278	19,292	19,306	19,319	19,333	19,347	19,361	19,375	19,388
1640	19,402	19,416	19,430	19,444	19,457	19,471	19,485	19,499	19,512	19,526
1650	19,540	19,554	19,567	19,581	19,595	19,609	19,622	19,636	19,650	19,663
1660	19,677	19,691	19,705	19,718	19,732	19,746	19,759	19,773	19,787	19,800
1670	19,814	19,828	19,841	19,855	19,869	19,882	19,896	19,910	19,923	19,937
1680	19,951	19,964	19,978	19,992	20,005	20,019	20,032	20,046	20,060	20,073
1690	20,087	20,100	20,114	20,127	20,141	20,154	20,168	20,181	20,195	20,208
1700	20,222	20,235	20,249	20,262	20,275	20,289	20,302	20,316	20,329	20,342
1710	20,356	20,369	20,382	20,396	20,409	20,422	20,436	20,449	20,462	20,475
1720	20,488	20,502	20,515	20,528	20,541	20,554	20,567	20,581	20,594	20,607
1730	20,620	20,633	20,646	20,659	20,672	20,685	20,698	20,711	20,724	20,736
1740	20,749	20,762	20,775	20,788	20,801	20,813	20,826	20,839	20,852	20,864
1750	20,877	20,890	20,902	20,915	20,928	20,940	20,953	20,965	20,978	20,990
1760	21,003									

11.1.18 TC Typ S (Pt-RhPt)  
 Temperature range 0°C....+1760°C  
 All resistance value in mV

°C in steps of 10 ↓	°C ascending in step of one →									
	0	1	2	3	4	5	6	7	8	9
0	0,000	0,005	0,011	0,016	0,022	0,027	0,033	0,038	0,044	0,050
10	0,055	0,061	0,067	0,072	0,078	0,084	0,090	0,095	0,101	0,107
20	0,113	0,119	0,125	0,131	0,137	0,143	0,149	0,155	0,161	0,167
30	0,173	0,179	0,185	0,191	0,197	0,204	0,210	0,216	0,222	0,229
40	0,235	0,241	0,248	0,254	0,260	0,267	0,273	0,280	0,286	0,292
50	0,299	0,305	0,312	0,319	0,325	0,332	0,338	0,345	0,352	0,358
60	0,365	0,372	0,378	0,385	0,392	0,399	0,405	0,412	0,419	0,426
70	0,433	0,440	0,446	0,453	0,460	0,467	0,474	0,481	0,488	0,495
80	0,502	0,509	0,516	0,523	0,530	0,538	0,545	0,552	0,559	0,566
90	0,573	0,580	0,588	0,595	0,602	0,609	0,617	0,624	0,631	0,639
100	0,646	0,653	0,661	0,668	0,675	0,683	0,690	0,698	0,705	0,713
110	0,720	0,727	0,735	0,743	0,750	0,758	0,765	0,773	0,780	0,788
120	0,795	0,803	0,811	0,818	0,826	0,834	0,841	0,849	0,857	0,865
130	0,872	0,880	0,888	0,896	0,903	0,911	0,919	0,927	0,935	0,942
140	0,950	0,958	0,966	0,974	0,982	0,990	0,998	1,006	1,013	1,021
150	1,029	1,037	1,045	1,053	1,061	1,069	1,077	1,085	1,094	1,102
160	1,110	1,118	1,126	1,134	1,142	1,150	1,158	1,167	1,175	1,183
170	1,191	1,199	1,207	1,216	1,224	1,232	1,240	1,249	1,257	1,265
180	1,273	1,282	1,290	1,298	1,307	1,315	1,323	1,332	1,340	1,348
190	1,357	1,365	1,373	1,382	1,390	1,399	1,407	1,415	1,424	1,432
200	1,441	1,449	1,458	1,466	1,475	1,483	1,492	1,500	1,509	1,517
210	1,526	1,534	1,543	1,551	1,560	1,569	1,577	1,586	1,594	1,603
220	1,612	1,620	1,629	1,638	1,646	1,655	1,663	1,672	1,681	1,690
230	1,698	1,707	1,716	1,724	1,733	1,742	1,751	1,759	1,768	1,777
240	1,786	1,794	1,803	1,812	1,821	1,829	1,838	1,847	1,856	1,865
250	1,874	1,882	1,891	1,900	1,909	1,918	1,927	1,936	1,944	1,953
260	1,962	1,971	1,980	1,989	1,998	2,007	2,016	2,025	2,034	2,043
270	2,052	2,061	2,070	2,078	2,087	2,096	2,105	2,114	2,123	2,132
280	2,141	2,151	2,160	2,169	2,178	2,187	2,196	2,205	2,214	2,223
290	2,232	2,241	2,250	2,259	2,268	2,277	2,287	2,296	2,305	2,314
300	2,323	2,332	2,341	2,350	2,360	2,369	2,378	2,387	2,396	2,405
310	2,415	2,424	2,433	2,442	2,451	2,461	2,470	2,479	2,488	2,497
320	2,507	2,516	2,525	2,534	2,544	2,553	2,562	2,571	2,581	2,590
330	2,599	2,609	2,618	2,627	2,636	2,646	2,655	2,664	2,674	2,683
340	2,692	2,702	2,711	2,720	2,730	2,739	2,748	2,758	2,767	2,776
350	2,786	2,795	2,805	2,814	2,823	2,833	2,842	2,851	2,861	2,870
360	2,880	2,889	2,899	2,908	2,917	2,927	2,936	2,946	2,955	2,965
370	2,974	2,983	2,993	3,002	3,012	3,021	3,031	3,040	3,050	3,059
380	3,069	3,078	3,088	3,097	3,107	3,116	3,126	3,135	3,145	3,154
390	3,164	3,173	3,183	3,192	3,202	3,212	3,221	3,231	3,240	3,250
400	3,259	3,269	3,279	3,288	3,298	3,307	3,317	3,326	3,336	3,346
410	3,355	3,365	3,374	3,384	3,394	3,403	3,413	3,423	3,432	3,442
420	3,451	3,461	3,471	3,480	3,490	3,500	3,509	3,519	3,529	3,538
430	3,548	3,558	3,567	3,577	3,587	3,596	3,606	3,616	3,626	3,635
440	3,645	3,655	3,664	3,674	3,684	3,694	3,703	3,713	3,723	3,732
450	3,742	3,752	3,762	3,771	3,781	3,791	3,801	3,810	3,820	3,830
460	3,840	3,850	3,859	3,869	3,879	3,889	3,898	3,908	3,918	3,928
470	3,938	3,947	3,957	3,967	3,977	3,987	3,997	4,006	4,016	4,026
480	4,036	4,046	4,056	4,065	4,075	4,085	4,095	4,105	4,115	4,125
490	4,134	4,144	4,154	4,164	4,174	4,184	4,194	4,204	4,213	4,223
500	4,233	4,243	4,253	4,263	4,273	4,283	4,293	4,303	4,313	4,323
510	4,332	4,342	4,352	4,362	4,372	4,382	4,392	4,402	4,412	4,422
520	4,432	4,442	4,452	4,462	4,472	4,482	4,492	4,502	4,512	4,522
530	4,532	4,542	4,552	4,562	4,572	4,582	4,592	4,602	4,612	4,622
540	4,632	4,642	4,652	4,662	4,672	4,682	4,692	4,702	4,712	4,722
550	4,732	4,742	4,752	4,762	4,772	4,782	4,793	4,803	4,813	4,823
560	4,833	4,843	4,853	4,863	4,873	4,883	4,893	4,904	4,914	4,924
570	4,934	4,944	4,954	4,964	4,974	4,984	4,995	5,005	5,015	5,025
580	5,035	5,045	5,055	5,066	5,076	5,086	5,096	5,106	5,116	5,127
590	5,137	5,147	5,157	5,167	5,178	5,188	5,198	5,208	5,218	5,228





°C in steps of 10	°C ascending in step of one									
	0	1	2	3	4	5	6	7	8	9
1300	13,159	13,171	13,183	13,195	13,208	13,220	13,232	13,244	13,256	13,268
1310	13,280	13,292	13,305	13,317	13,329	13,341	13,353	13,365	13,377	13,390
1320	13,402	13,414	13,426	13,438	13,450	13,462	13,474	13,487	13,499	13,511
1330	13,523	13,535	13,547	13,559	13,572	13,584	13,596	13,608	13,620	13,632
1340	13,644	13,657	13,669	13,681	13,693	13,705	13,717	13,729	13,742	13,754
1350	13,766	13,778	13,790	13,802	13,814	13,826	13,839	13,851	13,863	13,875
1360	13,887	13,899	13,911	13,924	13,936	13,948	13,960	13,972	13,984	13,996
1370	14,009	14,021	14,033	14,045	14,057	14,069	14,081	14,094	14,106	14,118
1380	14,130	14,142	14,154	14,166	14,178	14,191	14,203	14,215	14,227	14,239
1390	14,251	14,263	14,276	14,288	14,300	14,312	14,324	14,336	14,348	14,360
1400	14,373	14,385	14,397	14,409	14,421	14,433	14,445	14,457	14,470	14,482
1410	14,494	14,506	14,518	14,530	14,542	14,554	14,567	14,579	14,591	14,603
1420	14,615	14,627	14,639	14,651	14,664	14,676	14,688	14,700	14,712	14,724
1430	14,736	14,748	14,760	14,773	14,785	14,797	14,809	14,821	14,833	14,845
1440	14,857	14,869	14,881	14,894	14,906	14,918	14,930	14,942	14,954	14,966
1450	14,978	14,990	15,002	15,015	15,027	15,039	15,051	15,063	15,075	15,087
1460	15,099	15,111	15,123	15,135	15,148	15,160	15,172	15,184	15,196	15,208
1470	15,220	15,232	15,244	15,256	15,268	15,280	15,292	15,304	15,317	15,329
1480	15,341	15,353	15,365	15,377	15,389	15,401	15,413	15,425	15,437	15,449
1490	15,461	15,473	15,485	15,497	15,509	15,521	15,534	15,546	15,558	15,570
1500	15,582	15,594	15,606	15,618	15,630	15,642	15,654	15,666	15,678	15,690
1510	15,702	15,714	15,726	15,738	15,750	15,762	15,774	15,786	15,798	15,810
1520	15,822	15,834	15,846	15,858	15,870	15,882	15,894	15,906	15,918	15,930
1530	15,942	15,954	15,966	15,978	15,990	16,002	16,014	16,026	16,038	16,050
1540	16,062	16,074	16,086	16,098	16,110	16,122	16,134	16,146	16,158	16,170
1550	16,182	16,194	16,205	16,217	16,229	16,241	16,253	16,265	16,277	16,289
1560	16,301	16,313	16,325	16,337	16,349	16,361	16,373	16,385	16,396	16,408
1570	16,420	16,432	16,444	16,456	16,468	16,480	16,492	16,504	16,516	16,527
1580	16,539	16,551	16,563	16,575	16,587	16,599	16,611	16,623	16,634	16,646
1590	16,658	16,670	16,682	16,694	16,706	16,718	16,729	16,741	16,753	16,765
1600	16,777	16,789	16,801	16,812	16,824	16,836	16,848	16,860	16,872	16,883
1610	16,895	16,907	16,919	16,931	16,943	16,954	16,966	16,978	16,990	17,002
1620	17,013	17,025	17,037	17,049	17,061	17,072	17,084	17,096	17,108	17,120
1630	17,131	17,143	17,155	17,167	17,178	17,190	17,202	17,214	17,225	17,237
1640	17,249	17,261	17,272	17,284	17,296	17,308	17,319	17,331	17,343	17,355
1650	17,366	17,378	17,390	17,401	17,413	17,425	17,437	17,448	17,460	17,472
1660	17,483	17,495	17,507	17,518	17,530	17,542	17,553	17,565	17,577	17,588
1670	17,600	17,612	17,623	17,635	17,647	17,658	17,670	17,682	17,693	17,705
1680	17,717	17,728	17,740	17,751	17,763	17,775	17,786	17,798	17,809	17,821
1690	17,832	17,844	17,855	17,867	17,878	17,890	17,901	17,913	17,924	17,936
1700	17,947	17,959	17,970	17,982	17,993	18,004	18,016	18,027	18,039	18,050
1710	18,061	18,073	18,084	18,095	18,107	18,118	18,129	18,140	18,152	18,163
1720	18,174	18,185	18,196	18,208	18,219	18,230	18,241	18,252	18,263	18,274
1730	18,285	18,297	18,308	18,319	18,330	18,341	18,352	18,362	18,373	18,384
1740	18,395	18,406	18,417	18,428	18,439	18,449	18,460	18,471	18,482	18,493
1750	18,503	18,514	18,525	18,535	18,546	18,557	18,567	18,578	18,588	18,599
1760	18,609									

### 11.1.19 TC Typ T

Temperature range -160°C....+400°C

All resistance value in mV

°C in steps of 10 ↓	°C tended to zero in step of one →									
	0	1	2	3	4	5	6	7	8	9
-160	-4,865	-4,844	-4,823	-4,802	-4,780	-4,759	-4,737	-4,715	4,693	-4,671
-150	-4,648	-4,626	-4,604	-4,581	-4,558	-4,535	-4,512	-4,489	-4,466	-4,443
-140	-4,419	-4,395	-4,372	-4,348	-4,324	-4,300	-4,275	-4,251	-4,226	-4,202
-130	-4,177	-4,152	-4,127	-4,102	-4,077	-4,052	-4,260	-4,000	-3,975	-3,949
-120	-3,923	-3,897	-3,871	-3,844	-3,818	-3,791	-3,765	-3,738	-3,711	-3,684
-110	-3,675	-3,629	-3,602	-3,574	-3,547	-3,519	-3,491	-3,463	-3,435	-3,407
-100	-3,379	-3,350	-3,322	-3,293	-3,264	-3,235	-3,206	-3,177	-3,148	-3,118
-90	-3,089	-3,059	-3,030	-3,000	-2,970	-2,940	-2,910	-2,879	-2,849	-2,818
-80	-2,788	-2,757	-2,726	-2,695	-2,664	-2,633	-2,602	-2,571	-2,539	-2,507
-70	-2,476	-2,444	-2,412	-2,380	-2,348	-2,316	-2,283	-2,251	-2,218	-2,186
-60	-2,153	-2,120	-2,087	-2,054	-2,021	-1,987	-1,954	-1,920	-1,887	-1,853
-50	-1,819	-1,785	-1,751	-1,717	-1,683	-1,648	-1,614	-1,579	-1,545	-1,510
-40	-1,475	-1,440	-1,405	-1,370	-1,335	-1,299	-1,264	-1,228	-1,192	-1,157
-30	-1,121	-1,085	-1,049	-1,013	-0,976	0,940	-0,904	-0,867	-0,830	-0,794
-20	-0,757	-0,720	-0,683	-0,646	-0,608	-0,571	-0,534	-0,496	-0,459	-0,421
-10	-0,383	-0,345	-0,307	-0,269	-0,231	-0,193	-0,154	-0,116	-0,077	-0,039

°C in steps of 10 ↓	°C in steps of 10 →									
	0	1	2	3	4	5	6	7	8	9
0	0,000	0,039	0,078	0,117	0,156	0,195	0,234	0,273	0,312	0,352
10	0,391	0,431	0,470	0,510	0,549	0,589	0,629	0,669	0,709	0,749
20	0,790	0,830	0,870	0,911	0,951	0,992	1,033	1,074	1,114	1,155
30	1,196	1,238	1,279	1,320	1,362	1,403	1,445	1,486	1,528	1,570
40	1,612	1,654	1,696	1,738	1,780	1,823	1,865	1,908	1,950	1,993
50	2,036	2,079	2,122	2,165	2,208	2,251	2,294	2,338	2,381	2,425
60	2,468	2,512	2,556	2,600	2,643	2,687	2,732	2,776	2,820	2,864
70	2,909	2,953	2,998	3,043	3,087	3,132	3,177	3,222	3,267	3,312
80	3,358	3,403	3,448	3,494	3,539	3,585	3,631	3,677	3,722	3,768
90	3,814	3,860	3,907	3,953	3,999	4,046	4,092	4,138	4,185	4,232
100	4,279	4,325	4,372	4,419	4,466	4,513	4,561	4,608	4,655	4,702
110	4,750	4,798	4,845	4,893	4,941	4,988	5,036	5,084	5,132	5,180
120	5,228	5,277	5,325	5,373	5,422	5,470	5,519	5,567	5,616	5,665
130	5,714	5,763	5,812	5,861	5,910	5,959	6,008	6,057	6,107	6,156
140	6,206	6,255	6,305	6,355	6,404	6,454	6,504	6,554	6,604	6,654
150	6,704	6,754	6,805	6,855	6,905	6,956	7,006	7,057	7,107	7,158
160	7,209	7,260	7,310	7,361	7,412	7,463	7,515	7,566	7,617	7,668
170	7,720	7,771	7,823	7,874	7,926	7,977	8,029	8,081	8,133	8,185
180	8,237	8,289	8,341	8,393	8,445	8,497	8,550	8,602	8,654	8,707
190	8,759	8,812	8,865	8,917	8,970	9,023	9,076	9,129	9,182	9,235
200	9,288	9,341	9,395	9,448	9,501	9,555	9,608	9,662	9,715	9,769
210	9,822	9,876	9,930	9,984	10,038	10,092	10,146	10,200	10,254	10,308
220	10,362	10,417	10,471	10,525	10,580	10,634	10,689	10,743	10,798	10,853
230	10,907	10,962	11,017	11,072	11,127	11,182	11,237	11,292	11,347	11,403
240	11,458	11,513	11,569	11,624	11,680	11,735	11,791	11,846	11,902	11,958
250	12,013	12,069	12,125	12,181	12,237	12,293	12,349	12,405	12,461	12,518
260	12,574	12,630	12,687	12,743	12,799	12,856	12,912	12,969	13,026	13,082
270	13,139	13,196	13,253	13,310	13,366	13,423	13,480	13,537	13,595	13,652
280	13,709	13,766	13,823	13,881	13,938	13,995	14,053	14,110	14,168	14,226
290	14,283	14,341	14,399	14,456	14,514	14,572	14,630	14,688	14,746	14,804
300	14,862	14,920	14,978	15,036	15,095	15,153	15,211	15,270	15,328	15,386
310	15,445	15,503	15,562	15,621	15,679	15,738	15,797	15,856	15,914	15,973
320	16,032	16,091	16,150	16,209	16,268	16,327	16,387	16,446	16,505	16,564
330	16,624	16,683	16,742	16,802	16,861	16,921	16,980	17,040	17,100	17,159
340	17,219	17,279	17,339	17,399	17,458	17,518	17,578	17,638	17,698	17,759
350	17,819	17,879	17,939	17,999	18,060	18,120	18,180	18,241	18,301	18,362
360	18,422	18,483	18,543	18,604	18,665	18,725	18,786	18,847	18,908	18,969
370	19,030	19,091	19,152	19,213	19,274	19,335	19,396	19,457	19,518	19,579
380	19,641	19,702	19,763	19,825	19,886	19,947	20,009	20,070	20,132	20,193
390	20,255	20,317	20,378	20,440	20,502	20,563	20,625	20,687	20,748	20,810
400	20,872									