RESISTRON

ROPEX

RES-406

Operating instructions

Important features

- Complete control via PROFIBUS-DP interface
- Automatic zero calibration (AUTOCAL)
- Automatic optimization (AUTOTUNE)
- Automatic configuration of the secondary voltage and current ranges (AUTORANGE, as of February 2006)
- Automatic phase angle compensation (AUTOCOMP, as of February 2006)
- Automatic frequency adjustment
- Booster connection as standard
- 0…10VDC analog output for ACTUAL temperature
- Alarm function with fault diagnosis
- Heatsealing band alloy and temperature range selectable

Version 1
3.3.20

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Contents

1 General information

This RESISTRON® temperature controller is manufactured according to EN 61010-1. In the course of its manufacture it passed through quality assurance, whereby it was subjected to extensive inspections and tests. As a result of this, the product left our factory in perfect condition.
Please carefully read through the operating manual before using the RESISTRON® temperature controller. Keep the operating manual for later reference and make sure that information and functions important for the user are available.
The recommendations and warning notes contained in these operating instructions must be complied with, in order to guarantee safe operation.
The device can be operated within the limits indicated in the "Technical Data" without impairing its operational safety. Installation and maintenance may only be performed by technically trained, skilled persons who are familiar with the associated risks and warranty provisions.

1.1 Copyright

1.2 Intended use

RESISTRON® temperature controllers may only be used for heating and temperature control of heatsealing bands which are expressly approved for them, and providing the regulations, notes and warnings contained in these instructions are observed.
In case of non-observance or use contrary to the intended purpose, there is a risk that safety will be impaired or that the heatsealing band, electrical wiring, transformer etc. will overheat. This is the personal responsibility of the user.

1.3 Heatsealing band

The use of suitable heatsealing bands is a basic prerequisite for reliable and safe operation of the system.
The resistance of the heatsealing band which is used must have a positive minimum temperature coefficient in order to guarantee trouble-free operation of the RESISTRON® temperature controller.
The temperature coefficient must be specified as follows:

$$TCR = 10\text{x}10^{-4}\text{K}^{-1} \text{ or } \text{K}^{-1} \text{ or } \text{ppm/K}$$

e.g. Alloy A20: TCR = 1100 ppm/K
LEX3500: TCR = 3500 ppm/K
Vacodil: TCR = 1100 ppm/K

The RESISTRON® temperature controller must be set and coded according to the temperature coefficient of the heatsealing band.
The temperature coefficient must be taken from the ROPEX application report and must be set accordingly.

The use of incorrect alloys with a too low temperature coefficient and incorrect coding of the RESISTRON® temperature controller leads to uncontrolled heating of the heatsealing band, which will ultimately burn out!

The original heatsealing bands must be clearly identified by means of suitable markings as well as the connector geometry, length, or other means to ensure that replacement bands are identical.

1.4 Impulse transformer

A suitable impulse transformer is necessary in order to guarantee trouble-free operation of the control loop. This transformer must be designed according to EN 61558 or UL 5058 (isolating transformer with reinforced insulation) and have a one section bobbin. When the impulse transformer is installed, suitable touch protection must be provided in accordance with the national installation regulations for electrical equipment. In addition to this, water, cleaning solutions and conductive fluids must be prevented from seeping into the transformer.
Incorrect installation of the impulse transformer impairs electrical safety.

1.5 Current transformer PEX-W4/-W5

The current transformer supplied with the RESISTRON® temperature controller is an integral part of the control system.
Only the original ROPEX PEX-W4 or PEX-W5 current transformer may be used. Other transformers may cause the equipment to malfunction.
The current transformer may only be operated if it is correctly connected to the RESISTRON® temperature controller (see section "Startup and operation"). The relevant safety instructions contained in section "Power supply", must be observed. External monitoring modules can be used in order to additionally increase operating safety. They are not included in the scope of supply of the standard control system and are described in a separate document.

1.6 Line filter

ROPEX provides line filters in different power classes. The ROPEX application report lists the suitable line filter which can be ordered accordingly.
The use of an original ROPEX line filter is mandatory in order to comply with the directives mentioned in section "DECLARATION OF CONFORMITY" on page 6. This device must be installed and connected according to the instructions contained in section "Power supply" as well as the separate documentation enclosed with the line filter.

1.7 Maintenance

The controller requires no special maintenance. Regular inspection and / or tightening of the terminals – including the terminals for the winding connections on the impulse transformer – is recommended. Dust deposits on the controller can be removed with dry compressed air.

Dust deposits and dirt from liquids result in a loss of function. Accordingly, installation in a switch cabinet or terminal cabined with IP54 is recommended.

1.8 Transportation

Store and transport the device in its original carton.
After transport, perform a visual inspection for possible damage.

1.9 Disposal

This device is subject to Directive 2012/19/EU concerning the reduction of the increasing amount of waste electrical and electronic equipment and the disposal of such waste in an environmentally sound way.
To guarantee proper disposal and / or the recover of reusable material, please take the device to a designated municipal collection point and observe local regulations.
Careless, uncontrolled disposal can cause damage to the environment and human health. By ensuring that your product is disposed of or recycled in a responsible way, you can help protect the environment and human health.

This device must not be disposed of as residual waste!

DECLARATION OF CONFORMITY

We hereby declare that the following device has been developed and manufactured in conformance with the directives cited below:

Designation:	RESISTRON temperature controller with accessories
Type:	RES-406 with line filter and current transformer
Operating principle:	Impulse sealing of films and plastics

Compliant with following standards and directives:

EN 61010-1	Safety requirements for electrical equipment, control, and laboratory use
2014/35/EU	low voltage directive
2014/30/EU	electromagnetic compatibility directive
2011/65/EU	RoHS directive

Note:

This declaration of conformity certifies that the device/electronic itself complies with the above-mentioned directives. The CE mark on the device/electronic does not relieve the machinery manufacturer of his duty to verify the conformity of the completely installed, wired and operationally ready system in the machine with the EMC directive.

Comments:

RESISTRON/CIRUS temperature controllers are not independently operable devices. They are used by the machinery manufacturer to form a sealing system by adding EMC-relevant components such as filters, transformers, heatsealing bands and wiring. The final configuration may vary significantly in terms of performance and physical dimensions. All information provided by us in connection with the line filter is merely intended as a guide and is based on a typical measuring setup. It serves to demonstrate that compliance with the EMC directive can be achieved by using a line filter that is suitable for the overall system. The line filter and current transformer must, however, be determined on the basis of the respective application. We also wish to point out that the transformer which is used must be designed in accordance with VDE 0551/EN 61558 or UL 5058 for safety reasons.

July 12, 2020

J. Kühner (CEO)

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2 Application

This RESISTRON® temperature controller is an integral part of the "Series 400", the outstanding feature of which is its microprocessor technology. All RESISTRON temperature controllers are used to control the temperature of heating elements (heatsealing bands, beaded bands, cutting wires, heatsealing blades, solder elements etc.), as required in a variety of heatsealing processes.
The controller is most commonly used for impulse-heatsealing PE films in:

- Vertical and horizontal f/f/s machines
- Pouch, filling and sealing machines
- Film wrapping machines
- Pouch-making machines
- Group packaging machines
- etc.

3 Principle of operation

The resistance of the heatsealing band, which is temperature-sensitive, is monitored 50x per second (60x at 60 Hz) by measuring the current and voltage. The temperature calculated with the help of these measurements is displayed and compared with the set point.
The primary voltage of the impulse transformer is adjusted by phase-angle control, if the measured values deviate from the set point. The resulting change in the current through the heatsealing band leads to a change in the band temperature and thus also its resistance. This change is measured and evaluated by the RESISTRON® temperature controller.
The control loop is closed: ACTUAL temperature = SET temperature. Even minute thermal loads on the heatsealing band are detected and can be corrected quickly and precisely.
A highly high response thermo-electric control loop is formed which is highly accurate because purely electrical variables are measured at a high sampling rate. A high secondary current can be controlled because power is controlled on the primary side of the transformer. This allows optimum adaptation to the load and to the required dynamic range despite the exceptionally compact dimensions of the controller.

4 Traits of the controller

- Very simple operation thanks to AUTOCAL, the automatic zero calibration function.
- Good dynamic response of the control system thanks to AUTOTUNE, which adapts automatically to the controlled system.
- High precision thanks to further improved control accuracy and linearization of the heatsealing band characteristic.
- High flexibility: The AUTORANGE function (as of February 2006) covers a secondary voltage range from 0.4 V to 120 V and a current range from 30 A to 500 A.
- Automatic adjustment to the line frequency in the range from 47 Hz to 63 Hz.
- Increased protection against dangerous conditions, such as overheating of the heatsealing band.

The RESISTRON® temperature controller RES-406 is equipped with a PROFIBUS-DP interface. This interface can be used to control all the controller functions and interrogate controller information.
The ACTUAL temperature of the heatsealing band is supplied to the PROFIBUS interface and to an analog 0 to 10 V DC output. The real heatsealing band temperature can thus be displayed on an external temperature meter (e.g. ATR-x).

The RES-406 features an integrated fault diagnosis function, which tests both the external system (heatsealing band, wiring etc.) and the internal electronics and outputs a selective error message in case of a fault.
To increase operational safety and interference immunity, all PROFIBUS signals are electrically isolated from the controller and the heating circuit.
Either coding switches on the temperature controller itself or the PROFIBUS interface can be used to adapt to different heatsealing band alloys (Alloy A20, LEX3500 etc.) and set to the required temperature range (0…300 °C, 0…500 °C etc.).
The compact design of the RESISTRON® temperature controller RES-406 and the plug-in connections make this controller easy to install.

5 Installation

See also section 1 "General information" on page 3.

Installation and startup may only be performed by technically trained, skilled persons who are familiar with the associated risks and warranty provisions.

5.1 Installation procedure

Proceed as follows to install the RESISTRON® temperature controller RES-406:

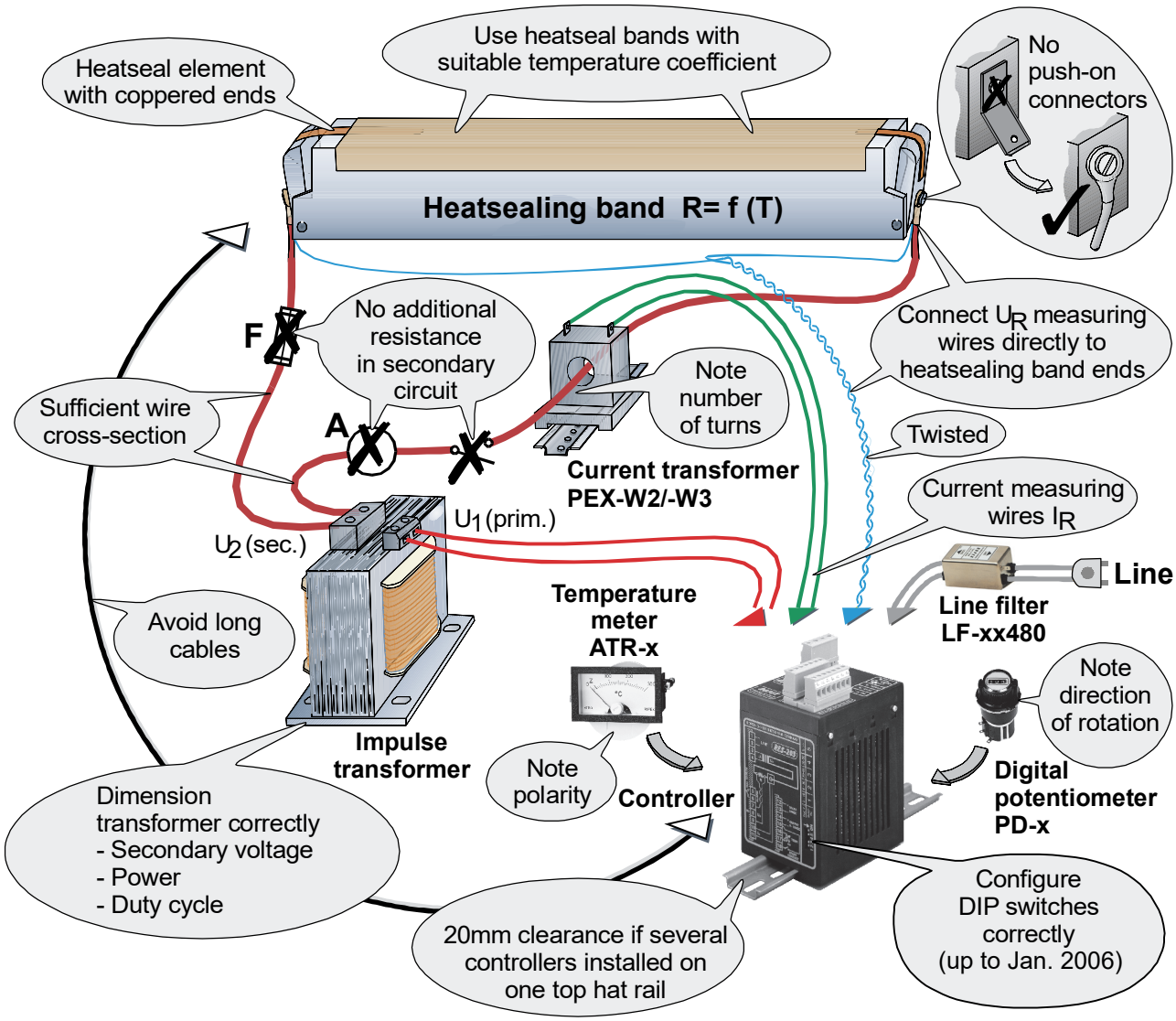
1. Switch off the line voltage and verify that the circuit is de-energized.
2. The supply voltage specified on the nameplate of the RESISTRON® temperature controller must be identical to the line voltage that is present in the plant or machine. The line frequency is automatically detected by the RESISTRON® temperature controller in the range from 47 Hz...63 Hz.
3. Install the RESISTRON® temperature controller in the electrical cabinet on a standard top hat rail (DIN TS35 rail, according to DIN EN 50022). If several controllers are installed on one top hat rail, the minimum clearance specified in section 9 "Technical data" on page 57 must be allowed between them.
4. Wire the system in accordance with the instructions in section 5.3 "Power supply" on page 11, section 5.6 "Wiring diagram (standard)" on page 14 and the ROPEX Application Report. The information provided in section 5.2 "Installation steps" on page 10 must also be heeded.
   An overcurrent protective device (e.g. a fuse) must be fitted when the controller is installed. The minimum possible specification for this device must be entered in the ROPEX Application Report based on the calculated currents. If a larger overcurrent protective device is fitted, you must match the current carrying capacity of the other components accordingly (e.g. cables, impulse transformer etc.).

5. Connect the RESISTRON® temperature controller to the PROFIBUS master using a cable according to IEC 61158.

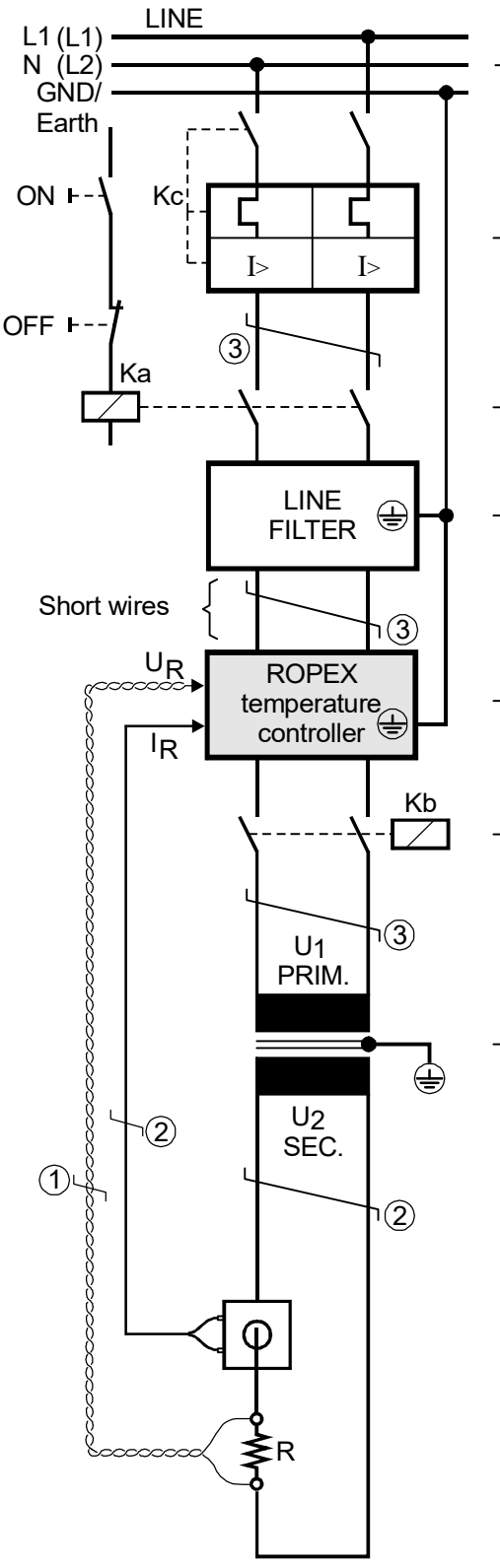
Check the tightness of all the system connections, including the terminals for the impulse transformer windings.

6. Make sure that the wiring conforms to the relevant national and international installation regulations.

5.2 Installation steps



5.3 Power supply



Line

Over-current protection
Double-pole circuit-breaker or fuses,
(↳ ROPEX Application Report)

Short-circuit protection only. RESISTRON® temperature controller not protected.

Relay Ka
For "HEAT ON - OFF" function (all-pole) or "EMERGENCY STOP".

Line filter
The filter type and size must be determined according to the load, the transformer and the machine wiring (↳ ROPEX Application Report).

Do not run the filter supply wires (line side) parallel to the filter output wires (load side).

RESISTRON® temperature controller

Relay Kb
Load break (all-pole), e.g. in combination with the alarm output of the temp. controller (ROPEX recommendation).

When using a series resistor RV-....-1 the relay Kb shall be installed.

Impulse Transformer
Designed according to EN 61558 (isolating transformer with reinforced insulation). Connect core to ground.

Use transformers with a one section bobbin. The power, duty cycle and voltage values must be determined individually according to the application (↳ ROPEX Application Report and "Accessories" leaflet for impulse transformers).

Wiring
The wire cross-sections depend on the application (↳ ROPEX Application Report).

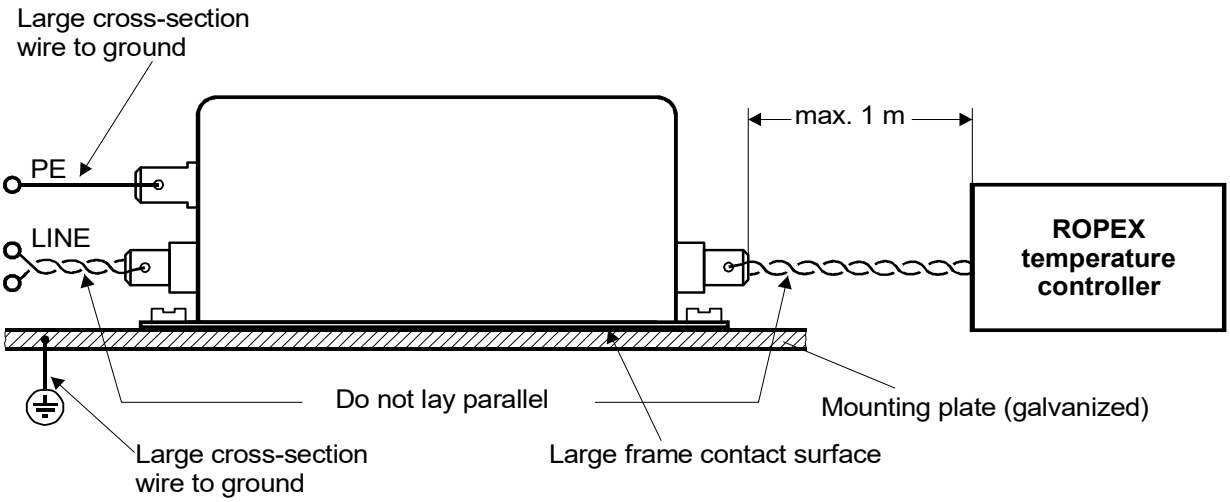
① Wires must always be twisted (min. 20 turns/meter).
② These wires must be twisted (min. 20 turns/meter) if several control loops are laid together ("crosstalk").
③ Twisting (min. 20 turns/meter) is recommended to improve EMC.

5.4 Line filter

To comply with EMC directives – corresponding to EN 50081-1 and EN 50082-2 – RESISTRON control loops must be operated with line filters.
These filters damp the reaction of the phase-angle control on the line and protect the controller against line disturbances.

The use of a suitable line filter is part of the standards conformity and a prerequisite of the CE mark.

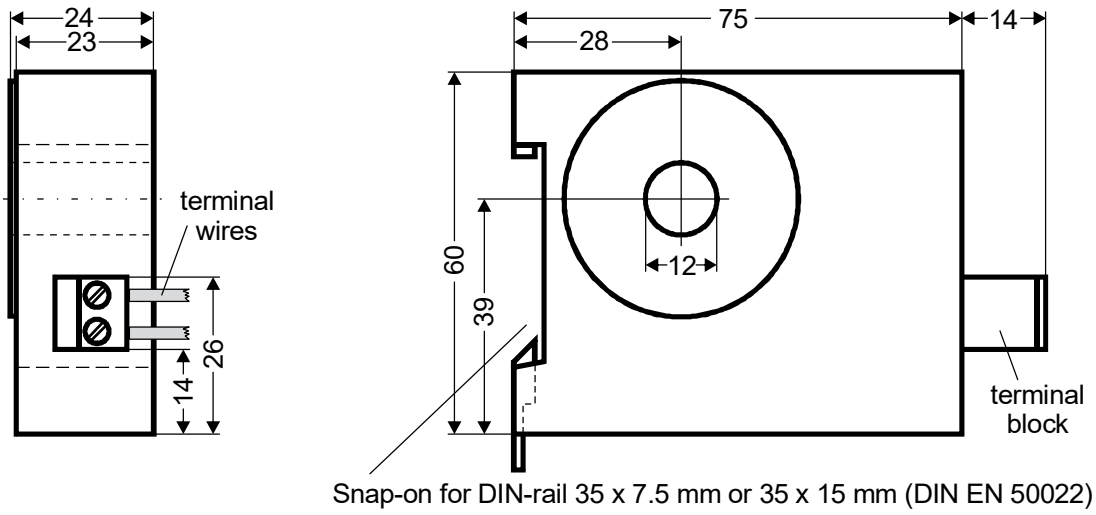
ROPEX line filters are specially optimized for use in RESISTRON control loops. Providing that they are installed and wired correctly, they guarantee compliance with the EMC limit values.
You can find the exact specification of the line filter in the ROPEX Application Report calculated for your particular heatsealing application.
For more technical information: "Line filter" documentation.
It is permissible to supply several RESISTRON control loops with a single line filter, providing the total current does not exceed the maximum current of the filter.
The wiring instructions contained in section 5.3 "Power supply" on page 11 must be observed.
Example drawing for LF-06480:



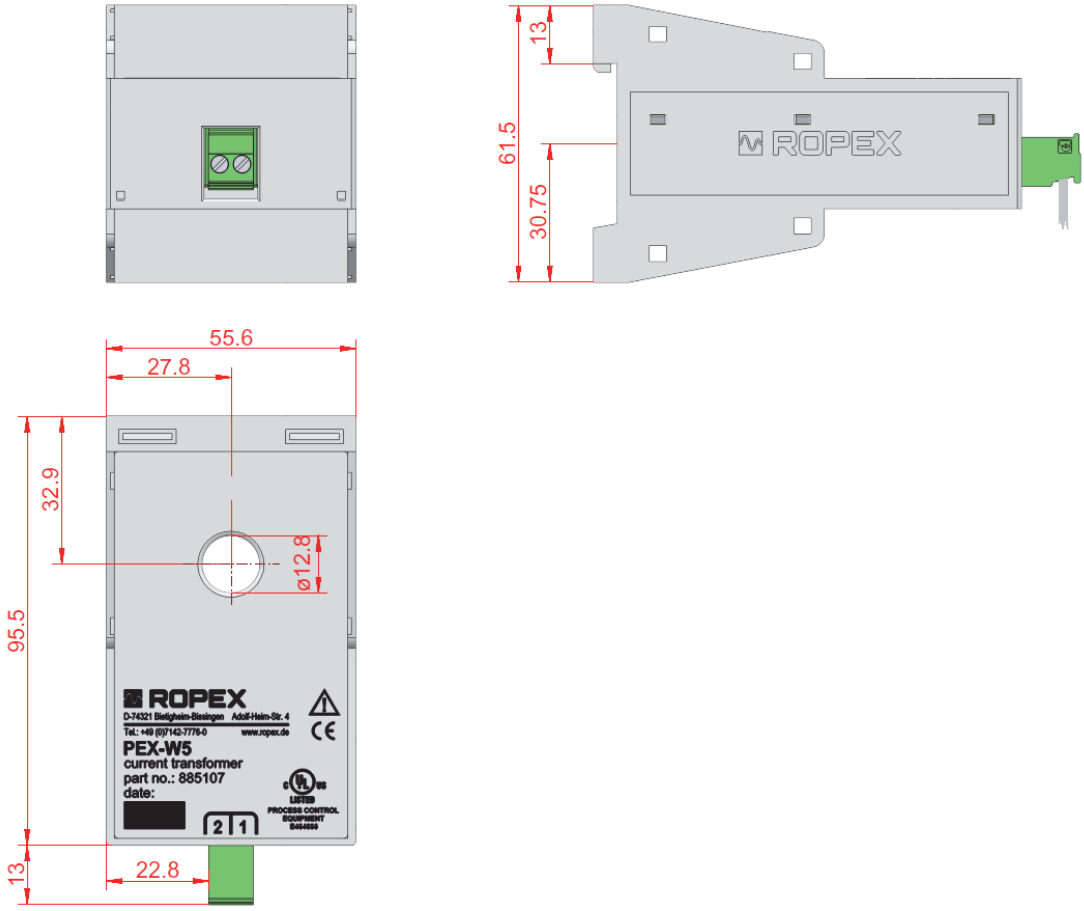
5.5 Current transformer PEX-W4/-W5

The PEX-W4/-W5 current transformer supplied with the RESISTRON® temperature controller is an integral part of the control system. The current transformer may only be operated if it is connected to the temperature controller correctly (section 5.3 "Power supply" on page 11).

5.5.1 PEX-W4

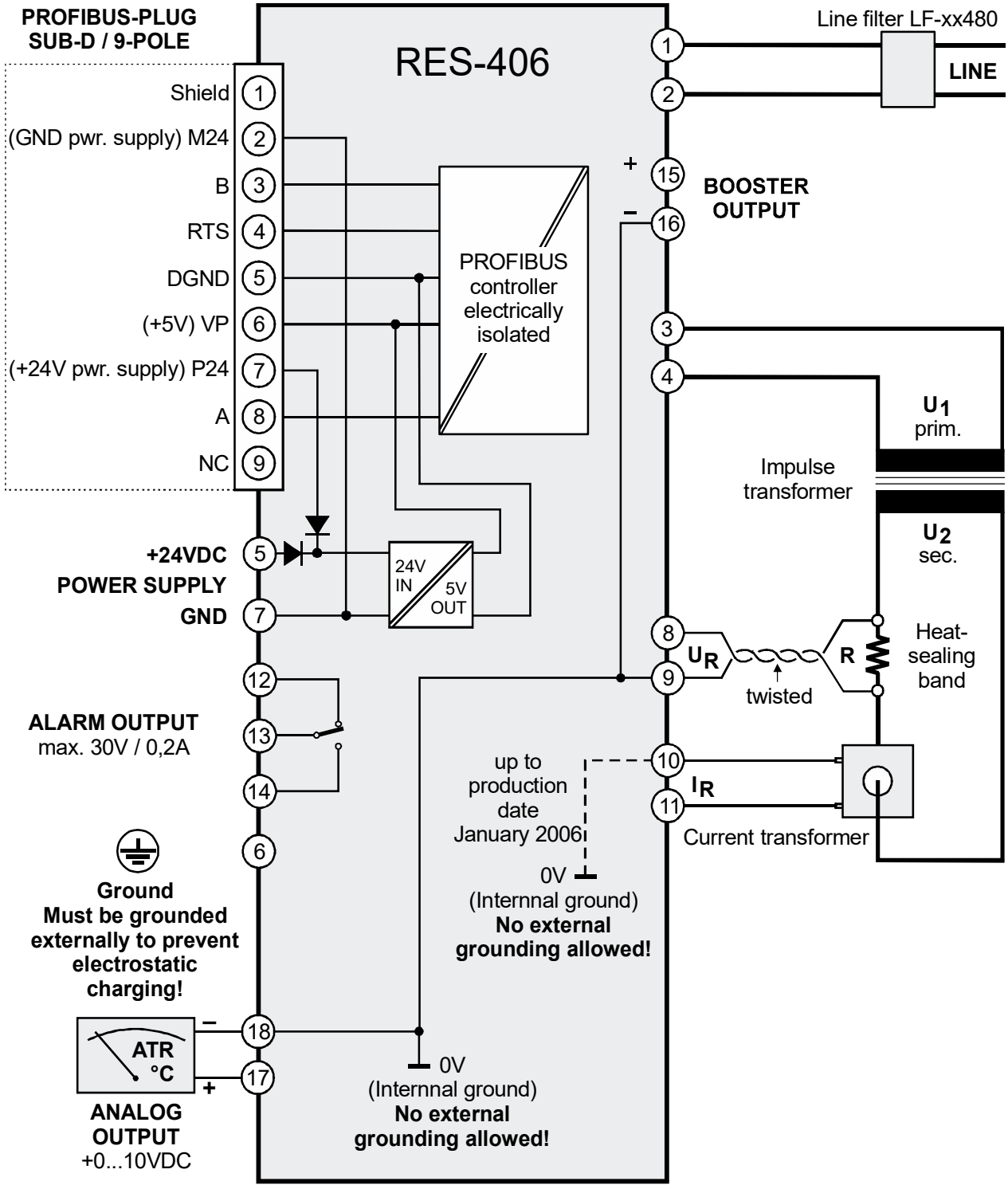


5.5.2 PEX-W5

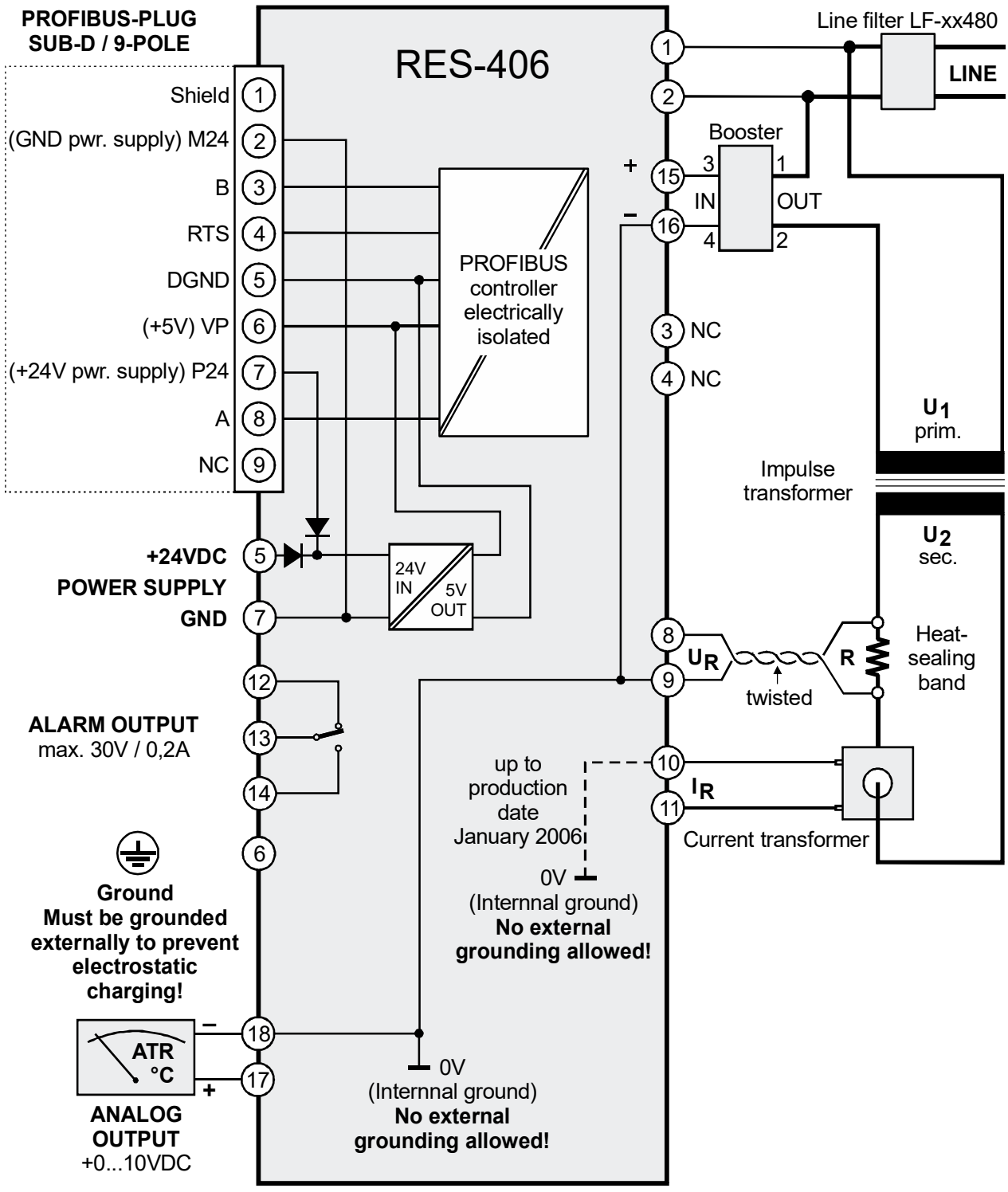


Mounting on DIN-rail 35 x 7.5 mm or 35 x 15 mm (DIN EN 50022).

5.6 Wiring diagram (standard)

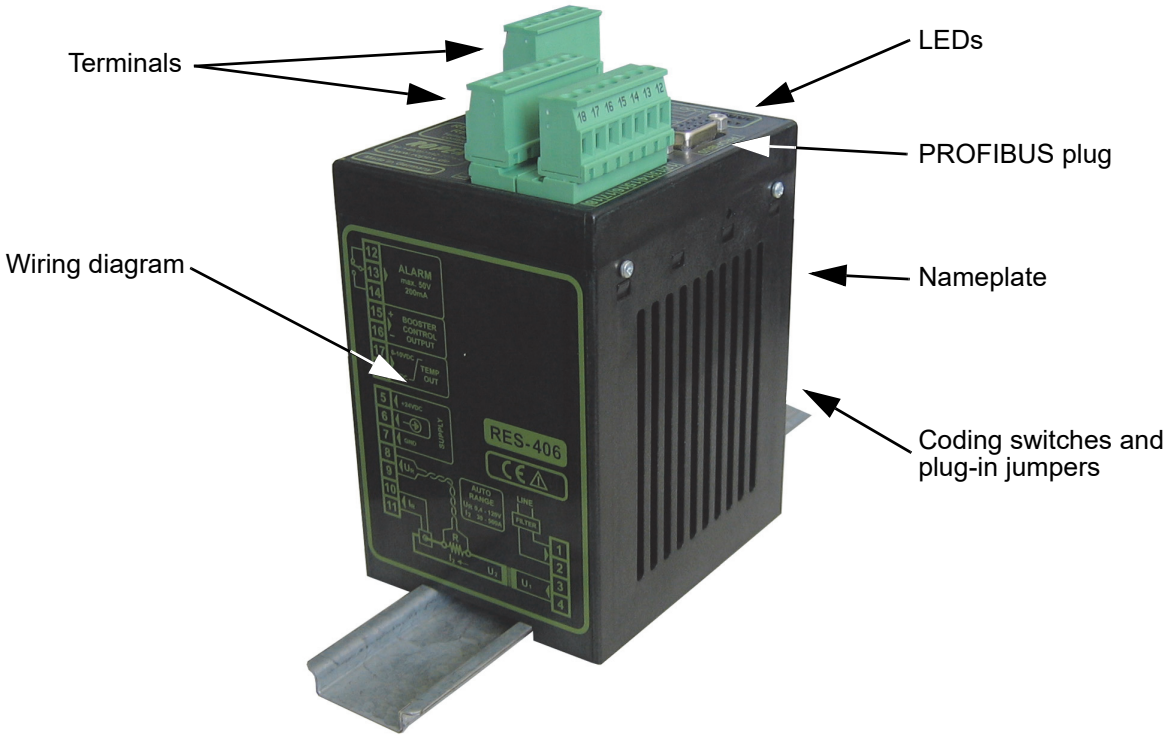


5.7 Wiring diagram with booster connection



6 Startup and operation

6.1 View of the controller



6.2 Controller configuration

The controller must be switched off in order to configure the coding switches and plug-in jumpers.

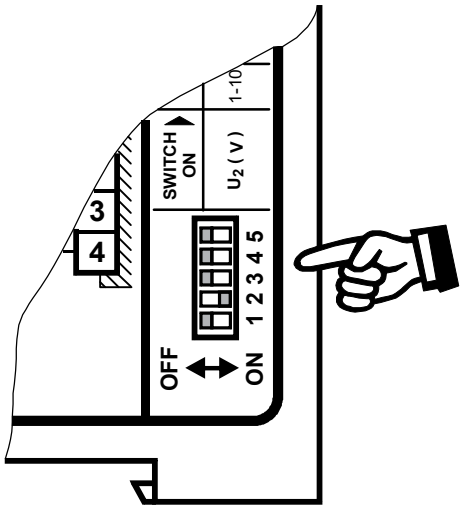
6.2.1 Configuration of the DIP switches for secondary voltage and current

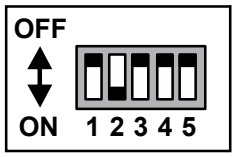
Automatic configuration (AUTORANGE)
(as of February 2006)

The secondary voltage and current ranges are automatically configured by the automatic calibration function (AUTOCAL). The voltage is configured in the range from 0.4VAC to 120VAC and the current in the range from 30A to 500A. If the voltage and/or the current is outside the permissible range, a detailed error message appears on the controller (see section 7.16 "Error messages" on page 49).

Configuration with coding switches
(up to January 2006)

Set the DIP switches for matching the secondary voltage U_2 and the secondary current I_2 to the correct position for **your** application.
You can find the exact configuration of the DIP switches in the ROPEX Application Report calculated for your particular application.





⇨ Factory settings

U_2 ⇩	DIP switch 1	2	3	I_2 ⇩	DIP switch 4	5
1...10V	ON	OFF	OFF	30...100A	OFF	OFF
6...60V	OFF	ON	OFF	60...200A	ON	OFF
20...120V	OFF	OFF	ON	120...400A	ON	ON

If the secondary current I_2 is less than 30 A, the secondary high-current wire must be laid twice (or several times) through the PEX-W3 or PEX-W4 current transformer (↳ ROPEX Application Report).

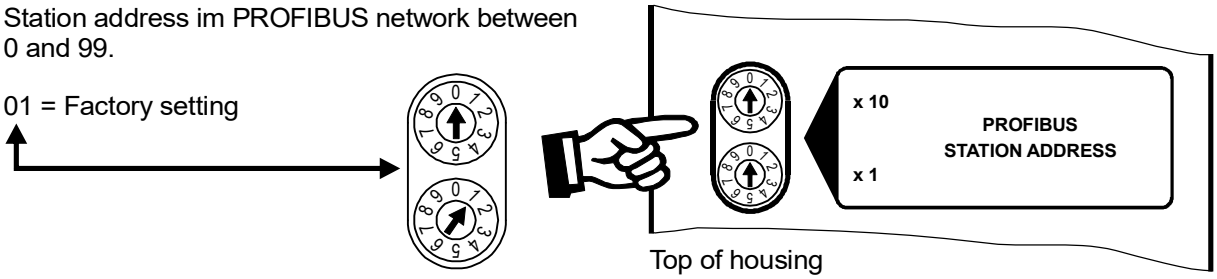
6.2.2 Configuration of the rotary coding switch for the temperature range and alloy

Switch position	Temp. range	Temp. coefficient	Band alloy
0	300°C	1100ppm/K	e.g. A20
1	300°C	780ppm/K	e.g. L
4	500°C	1100ppm/K	e.g. A20
5	500°C	780ppm/K	e.g. L
8	300°C	3500ppm/K	
9	PC-CONFIGURATION		

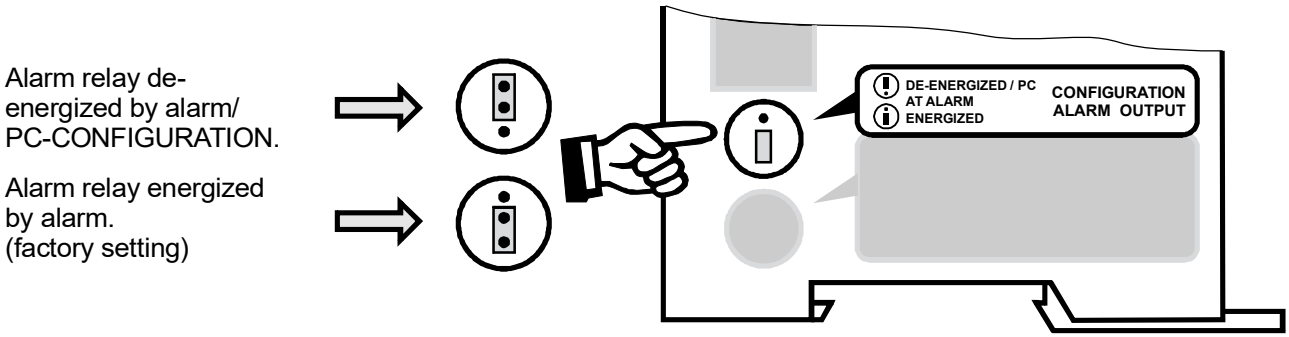
The settings for a temperature coefficient of 780 ppm (switch position 1 and 5) are only available on controllers manufactured as of October 2003.
The setting of the rotary coding switch for the temperature range and alloy can be overwritten with the parameter data (↳section 7.7 "Parameter data" on page 34).
If the switch is set to "9" (as of February 2006), more temperature ranges and alloys can be selected by means of the ROPEX visualization software (↳ see section 7.11 "Diagnostic interface/visualization software (as of February 2006)" on page 47).

6.2.3 Configuration of the rotary coding switches for the station address

The station address of the RES-406 in the PROFIBUS network can be set between 0 and 99 with these coding switches. A new setting does not take effect until the next time the controller is switched on.



6.2.4 Configuration of the alarm relay



If the jumper is not inserted, the alarm relay is permanently energized when using a controller up to production date January 2006. The other functions of the controller (e.g. heating, AUTOCAL etc.) are not impaired by this.
If the plug-jumper is not inserted when using a controller as of production date February 2006 - or if it is incorrectly inserted - an error message appears when the controller is switched on (↳ section 7.16 "Error messages" on page 49).

If the "Alarm relay deenergized by alarm/PC CONFIGURATION" position is selected (as of February 2006), the behavior of the alarm output can be configured in more detail by means of the ROPEX visualization software (↳ see section 7.11 "Diagnostic interface/visualization software (as of February 2006)" on page 47).

6.3 Replacing and "burning in" the heatsealing band

6.3.1 "Burning in" the heatsealing band

The heatsealing band is a key component in the control loop, since it is both a heating element and a sensor. The geometry of the heatsealing band is too complex to be discussed at length here. We shall therefore only refer to a few of the most important physical and electrical properties:
The measuring principle applied for this system necessitates a heatsealing band alloy with a suitable temperature coefficient TCR. Too low a TCR leads to oscillation or uncontrolled heating.
When heatsealing bands with a higher TCR are used, the controller must be calibrated for this.
The first time the heatsealing band is heated to approximately 200…250 °C, the standard alloy undergoes a once-only resistance change (burn-in effect). The cold resistance of the heatsealing band is reduced by approximately 2…3 %. However, this at first glance slight resistance change results in a zero point error of 20…30 °C. The zero point must therefore be corrected after a few heating cycles, i.e. the AUTOCAL function must be repeated.

The burn-in effect described here does not occur if the heatsealing band has already been thermally pretreated by the manufacturer.

An overheated or burned-out heatsealing band must no longer be used because the TCR has been altered irreversibly.

One very important design feature is the copper or silver-plating of the heatsealing band ends. Cold ends allow the temperature to be controlled accurately and increase the life of the teflon coating and the heatsealing band.

6.3.2 Replacing the heatsealing band

All power supply leads must be disconnected from the RESISTRON® temperature controller in order to replace the heatsealing band.

The heatsealing band must be replaced in accordance with the instructions provided by the manufacturer.

Each time the heatsealing band is replaced, the zero point must be calibrated with the AUTOCAL function while the band is still cold, in order to compensate production-related resistance tolerances. The burn-in procedure described above should be performed for all new heatsealing bands.

6.4 Startup procedure

Please also refer to section 1 "General information" on page 3 and section 2 "Application" on page 7.

Installation and startup may only be performed by technically trained, skilled persons who are familiar with the associated risks and warranty provisions.

6.4.1 Initial startup

Prerequisites: The controller must be correctly installed and connected (↳ section 5 "Installation" on page 8).
Proceed as follows to start up the controller for the first time:

1. Switch off the line voltage and verify that all circuits are de-energized.
2. The supply voltage specified on the nameplate of the controller must be identical to the line voltage that is present in the plant or machine. The line frequency is automatically detected by the temperature controller in the range from 47…63 Hz.
3. In the case of controllers manufactured up to January 2006, the settings of the DIP switches on the controller are indicated in the ROPEX Application Report and depend on the heatsealing band that is used.
   The settings of the coding switches on the controller depend on the required station address in the PROFIBUS network (↳ section 6.2 "Controller configuration" on page 16).
4. Link the device master file into the PROFIBUS master (↳ section 7.3), select the required communication module ("compact" or "extended" protocol) and start the communication.
5. Make sure that the "ST" bit is not set.
6. Switch on the line voltage and the 24 VDC auxiliary supply (the order is arbitrary).
7. When the voltage is switched on, the yellow "AUTOCAL" LED lights up for approximately 0.3 seconds to indicate that the controller is being powered up correctly. This LED blinks slowly (1 Hz) as long as no PROFIBUS communication is active. It does not go out again until it detects an active communication.

All controllers manufactured as of February 2006:
If the red "ALARM" LED lights up for 0.3 s in addition to the yellow "AUTOCAL" LED when the voltage is switched on, the configuration of this controller has been changed in the visualization software

(↳ section 7.11 "Diagnostic interface/visualization software (as of February 2006)" on page 47). In order to avoid malfunctions, please check the controller configuration before continuing the startup procedure.

8. The green "DATA EXCHANGE" LED lights up to indicate an active PROFIBUS communication.
9. One of the following states then appears:

Up to production date January 2006:

"ALARM" LED	"OUTPUT" LED	ACTION
OFF	Short pulses every 1.2s	Go to 10
BLINKS fast (4Hz)	OFF	Go to 10
Lit continuously	OFF	Fault diagnosis (↳ section 7.16)

As of production date February 2006:

"ALARM" LED	"OUTPUT" LED	ACTION
OFF	Short pulses every 1.2s	Go to 10
BLINKS fast (4Hz)	OFF	Go to 10
Lit continuously	OFF	Fault no. 901: (Fault group: 7): Supply voltage/ Sync-Signal missing (↳ section. 7.2) Otherwise: Fault diagnosis (↳ section. 7.16)

10. Activate the AUTOCAL function while the heatsealing band is still cold by setting the "AC" bit (**A**UTO**C**AL) in the PROFIBUS protocol (↳ section 7.4 "PROFIBUS protocol" on page 26). The yellow "AUTOCAL" LED lights up for the duration of the calibration process (approx. 10…15s). The "AA" bit (**A**UTOCAL **a**ctive) is set in addition and a voltage of app. 0V appears at the actual value output (terminals 17+18). If an ATR-x is connected, it indicates 0…3°C.
    When the zero point has been calibrated, the "AUTOCAL" LED goes out and a voltage of 0.66VDC (300°C range) or 0.4VDC (500°C range) appears at the actual value output instead. If an ATR-x is connected, it must be set to "Z".
    If the zero point has not been calibrated successfully, the "AL" bit (**al**arm active) is set and the red "ALARM" LED blinks slowly (1Hz). In this case the controller configuration is incorrect (↳ section 6.2 "Controller configuration" on page 16 and ROPEX Application Report). Repeat the calibration after the controller has been configured correctly.
11. When the zero point has been calibrated successfully, specify a defined temperature by means of the

PROFIBUS protocol (set point) and set the "ST" bit. The "RA" bit (**c**ontroller **a**ctive) is then activated and the "HEAT" LED lights up. The heating and control process can be observed at the actual value output:
The controller is functioning correctly if the temperature (which corresponds to the signal change at the analog output or the actual value in the PROFIBUS protocol) has a harmonious motion, in other words it must not jump abruptly, fluctuate or deviate temporarily in the wrong direction. This kind of behavior would indicate that the U_R measuring wire have been wired incorrectly.
If an error code is displayed, please proceed as described in section 7.16 "Error messages" on page 49.

12. Burn in the heatsealing band (↳ section 6.3 "Replacing and "burning in" the heatsealing band" on page 18) and repeat the AUTOCAL function.

The controller is now ready

6.4.2 Restart after replacing the heatsealing band

To replace the heatsealing band, proceed as described in section 6.3 "Replacing and "burning in" the heatsealing band" on page 18.

Always use a heatsealing band with the correct alloy, dimensions and copper-plating in order to avoid malfunctions and overheating.

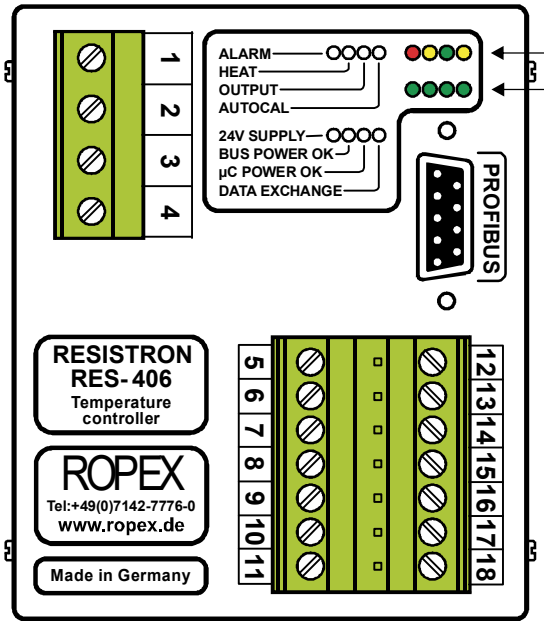
Continue with section 6.4 steps 5 to 12.

7 Controller functions

See also section 5.6 "Wiring diagram (standard)" on page 14.

7.1 Indicators and controls

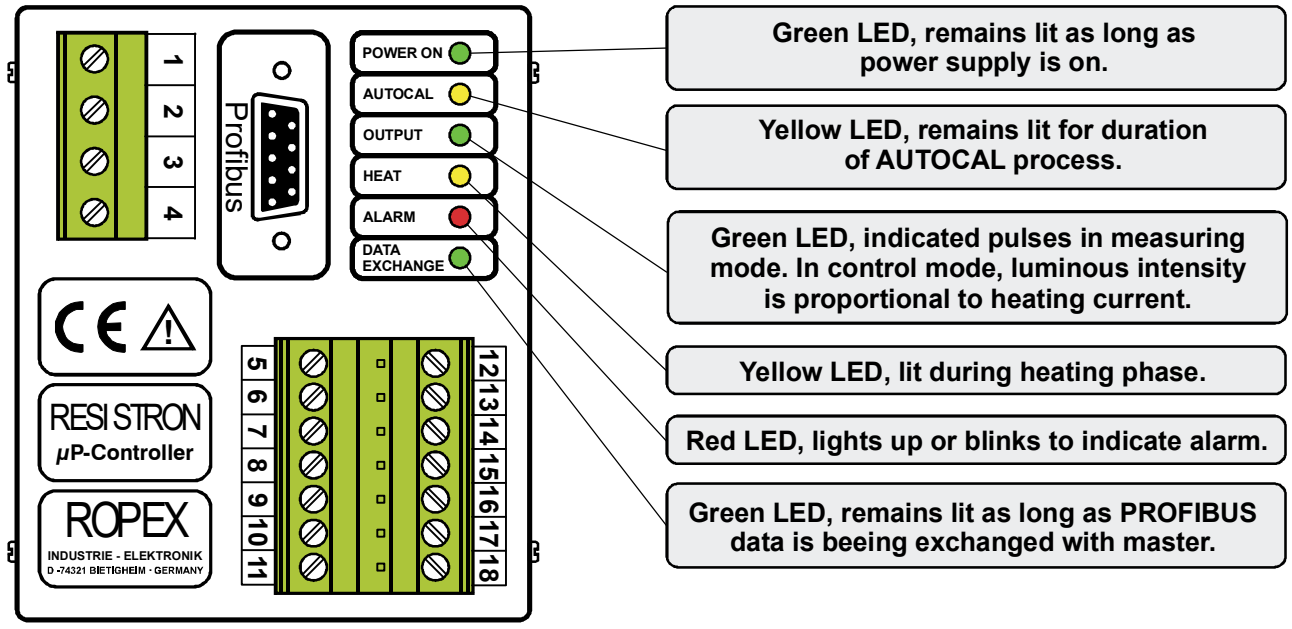
Manufactured as of February 2006



ALARM (red LED)	**Lights up or blinks to indicate an alarm.**
HEAT (yellow LED)	**Lit during heating phase.**
OUTPUT (green LED)	**Indicates pulses in measurement mode. In control mode, luminous intensity is proportional to heating current.**
AUTOCAL (yellow LED)	**Remains lit for duration of AUTOCAL process.**

24V SUPPLY (green LED)	**Lit if external 24VDC power supply is present.**
BUS PWR OK (green LED)	**Lit if internal 5VDC power supply for Profibus interface is OK.**
µC PWR OK (green LED)	**Lit if internal 5VDC power supply for microcontroller is OK.**
DATA EXC (green LED)	**Remains lit while Profibus data is exchanged with master.**

Manufactured up to January 2006



In addition to the functions shown in the diagram above, various controller operating states are indicated by the LEDs. These states are described in detail in the table below:

LED	Blinks slowly (1 Hz)	Blinks fast (4 Hz)	Lit continuously
AUTOCAL (yellow)	No PROFIBUS communication or RS-Bit is activated (Reset)	AUTOCAL requested, but function disabled	AUTOCAL executing
	LED blinks with a different frequency: Supply voltages incorrect (too low)		
HEAT (yellow)	—	START requested, but function disabled	START executing
OUTPUT (green)	In control mode the luminous intensity is proportional to the heating current.		
ALARM (red)	Configuration error, AUTOCAL not possible	Controller calibrated incorrectly, run AUTOCAL	Fault, ↳ section 7.16
DATA EXCHANGE (green)	—	—	Communication with PROFIBUS master active

The following sections describe only controller-specific functions. For general information about PROFIBUS and the system configuration, please refer to the description of your PLC.

7.2 PROFIBUS communication “up to Jan. 2006“/“as of Feb. 2006“

On controllers manufactured up to January 2006, PROFIBUS communication is only assured if the 24 VDC power supply (terminals 5+7 and PROFIBUS connector pins 7+2) and the line voltage are present. If the line voltage is switched off (e.g. for safety reasons in order to open a door), the PROFIBUS master indicates a bus fault because PROFIBUS communication is not possible on the RES-406.

This problem has been rectified on controllers manufactured as of February 2006. PROFIBUS communication is always possible on these controllers as long as the 24 VDC power supply is present, i.e. switching off the line voltage no longer results in a bus fault.

If the line voltage is not present however (e.g. if it is switched off in order to open a door), error code 901 (error group 7, no line voltage/sync signal) appears on controllers manufactured as of February 2006 and the alarm relay is switched. This error can be reset by switching on the line voltage again and activating the "RS" bit (section 7.5.3 "Reset (RS)" on page 29).

The error code that appears if the line voltage is switched off can be easily processed, and switching of the alarm relay suppressed, in the PLC program.

If controllers manufactured as of February 2006 are installed in an older machine (e.g. in order to carry out repairs), this new controller function can lead to unwanted error codes when the line voltage is switched off, depending on the PLC program.
Permanently disconnecting the 24 VDC power supply (terminals 5+7 and PROFIBUS connector pins 7+2) results in the same behavior as on older controllers (manufactured up to January 2006), i.e. a bus fault in the PROFIBUS master.

7.3 Device master file (GSD)

Configuring tools for the PROFIBUS-DP master that must be configured interpret the contents of the slave device master files and use them to create a master parameter set for the PROFIBUS master, which is responsible for useful data communication. The *ROxy0613.GSD* file (*xy*: GSD Version; e.g „15“ for version „v1.5“) of the RES-406 contains all the controller information needed for the configuration, e.g. the possible baud rates, parameter descriptions, error messages etc. The device master files and the associated display files (.DIB, for visualizing states) are supplied with the controller in German (.GSG) and English (.GSD or .GSE) on a diskette. They can also be requested by E-Mail (support@ropex.de) or they can be downloaded from our Homepage (www.ropex.de).
After the required device master file has been linked into the configuring tool, you must select one of the two communication modules ("compact" or "extended"). This determines which protocol will be used by the RES-406 to communicate with the PROFIBUS master.

If you want to use all features of the controller make sure that the appropriate version of the device master file is used. Since production date 06.02 the required device master file version is printed on the housing of the temperature controller.

7.4 PROFIBUS protocol

The PROFIBUS protocol can be configured either as "compact" (16bits for input data and 16bits for output data) or as "extended" (2x16bits for input data and 2x16bits for output data). The protocol is determined at the configuring stage by selecting a module ("compact" or "extended"). The compact protocol is sufficient for efficient communication with the RES-406. The extended protocol separates the set point and the actual value of the RES-406 from the status information and the control functions, to enable it to be decoded more easily by the PROFIBUS master.

Bits 0…7 form the low byte and bits 8…15 the high byte ("INTEL format").

7.4.1 "Compact" protocol with 4-Bit error code

The 16-bit **input data** from the PROFIBUS master to the RES-406 contains the set point and the control functions and has the following structure:

	Control function				Spare			Set point / AC temperature								
Name:	RS	ST	AC	MP	0	0	0									
Bit no.:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

The 16-bit **output data** from the RES-406 to the PROFIBUS master contains the actual value or the error code and the status information and has the following structure:

													Error code if AL = 1			
	Status information							Actual value (compact) if AL = 0								
Name:	AA	AG	AL	TE	TO	RA	VZ						A3	A2	A1	A0
Bit no.:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

7.4.2 "Compact" protocol with 10-Bit error code

The 10-Bit error codes are available on all controllers manufactured as of July 24,2006 and supplied with GSD Version v1.6. These error codes must be activated in the parameter data (↳ section 7.7.9 "Error code format" on page 38).

The 16-bit **input data** from the PROFIBUS master to the RES-406 contains the set point and the control functions and has the following structure:

	Control function				Spare			Set point / AC temperature								
Name:	RS	ST	AC	MP	0	0	0									
Bit no.:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

The 16-bit **output data** from the RES-406 to the PROFIBUS master contains the actual value or the error code and the status information and has the following structure:

														Error code if AL = 1		
	Status information							Actual value (compact) if AL = 0								
Name:	AA	AG	AL	TE	TO	RA	VZ/A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
Bit no.:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

7.4.3 "Extended" protocol with 4-Bit error code

The extended protocol transfers 2x16bits. The 2x16-bit **input data** contains the set point in word ① and the control functions in word ②:

①	Spare							Set point / AC temperature								
Name:	0	0	0	0	0	0	0									
Bit no.:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

②	Spare												Control function			
Name:	0	0	0	0	0	0	0	0	0	0	0	0	MP	RS	ST	AC
Bit no.:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

The 2x16-bit **output data** contains the actual value in word ① and the error code and status information in word ②:

①	Actual value (signed)															
Name:	VZ															
Bit no.:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

②	Spare				Error code				Spare		Status information					
Name:	0	0	0	0	A3	A2	A1	A0	0	0	AA	AG	AL	TE	TO	RA
Bit no.:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

7.4.4 "Extended" protocol with 10-Bit error code

The 10-Bit error codes are available on all controllers manufactured as of July 24,2006 and supplied with GSD Version v1.6. These error codes must be activated in the parameter data (↳ section 7.7.9 "Error code format" on page 38).

The extended protocol transfers 2x16bits. The 2x16-bit **input data** contains the set point in word ① and the control functions in word ②:

①	Spare							Set point / AC temperature								
Name:	0	0	0	0	0	0	0									
Bit no.:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

②	Spare												Control function			
Name:	0	0	0	0	0	0	0	0	0	0	0	0	MP	RS	ST	AC
Bit no.:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

The 2x16-bit **output data** contains the actual value in word ① and the error code and status information in word ②:

①	Actual value (signed)															
Name:	VZ															
Bit no.:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

②	Error code										Status information					
Name:	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	AA	AG	AL	TE	TO	RA
Bit no.:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

7.5 Input data

The term "input data" refers to the data that is transferred from the PROFIBUS master to the RES-406. It contains the set point and the control functions, such as START or AUTOCAL for the RES-406. These functions are explained in the following.

7.5.1 Automatic zero calibration "AUTOCAL" (AC)

Because of the automatic zero calibration (AUTOCAL) function, there is no need to adjust the zero point manually on the controller. This function matches the controller to the resistance of the system and calibrates it to the value which is predefined in the parameter data (section 7.7.4 "Variable calibration temperature" on page 36). If no parameter data is transferred by the PROFIBUS master, the default value is 20 °C.

Some PROFIBUS masters do not allow the parameter data to be changed during operation. It is therefore not possible to adapt the calibration temperature to the prevailing ambient conditions in the machine.
As of GSD Version v1.6, the calibration temperature can be specified by means of the "Set point/AC temperature" input data whenever the zero point is calibrated, providing this setting is selected in the parameter data (↳ section 7.7.4 "Variable calibration temperature" on page 36). It can be specified in the 0…+40 °C range. The value selected for the calibration temperature must be entered in the "Set point/AC temperature" input data when the "AUTOCAL" function is activated ("AC" bit = 1). This selected value must remain entered until the "AUTOCAL" function has finished.
If the specified temperature is too high (greater than 40 °C) or if the selected value varies, an error message appears (error codes 115 and 116; ↳ section 7.16 "Error messages" on page 49).

The AUTOCAL request ("AC" bit = 1) is executed by the controller providing the AUTOCAL function is not disabled.
The automatic calibration process takes about 10…15 seconds. The heatsealing band is not heated during this process. The yellow LED on the front panel lights up while the AUTOCAL function is active and the controller reports "AUTOCAL active" ("AA" bit = 1) in the output data. The actual value output (terminals 17+18) is 0…3 °C (corresponds to app. 0 VDC).
If the temperature of the heatsealing band varies on controllers manufactured as of February 2006, the "AUTOCAL" function is executed a maximum of three times. If the function still cannot be terminated successfully, an error message appears (↳ section 7.16 "Error messages" on page 49).

You should always wait for the heatsealing band and the bar to cool down (to ambient temperature) before activating the AUTOCAL function.

Reasons for disabled AUTOCAL function:

1. The AUTOCAL function cannot be activated until 10 seconds after the controller is switched on. During this time the controller reports "AUTOCAL disabled" ("AG" bit = 1) in the output data.
2. The AUTOCAL function is not activated if the heatsealing band is cooling down at a rate of more than 0.1K/sec. If the "AC" bit is activated, the function is executed automatically providing the cooling rate has fallen below the above-mentioned value.
3. If the "START" bit ("ST" bit = 1) is activated, the AUTOCAL function is not executed ("HEAT" LED lit).
4. If the "RESET" bit ("RS" bit = 1) is activated, the AUTOCAL function is not executed.
5. AUTOCAL cannot be activated if error codes 1…3, 5…7 (As of February 2006 also: 101…103, 201…203, 801, 9xx) occur at start-up. AUTOCAL cannot be activated with error codes 5…7 (As of February 2006 also: 201…203, 801, 9xx) if the controller has operated correctly, at least one time, after start-up (↳ section 7.16 "Error messages" on page 49).

If the AUTOCAL function is disabled ("AG" bit = 1) and if you attempt to activate it ("AC" bit = 1) then the "AUTOCAL" LED blinks fast (4Hz).

7.5.2 Start (ST)

When the "START" bit is activated ("ST" bit = 1), the controller-internal set/actual comparison is enabled and the heatsealing band is heated up to the SET temperature. It remains at this temperature either until the "ST" bit is reset or until the actual heating time exceeds the preset heating time limit (↳ section 7.7.5 "Heating time limit" on page 37).
The "HEAT" LED on the front panel of the RES-406 lights up continuously for the duration of the heating phase.
A start request is not processed if the AUTOCAL function is active, the controller has reported an alarm, the set point is less than 20°C higher than the calibration temperature or the "RS" bit is set. In all these cases the "HEAT" LED blinks.
The heating process is terminated if the "ST" bit is reset or if a PROFIBUS fault occurs.

The "ST" bit is only accepted if the AUTOCAL function is deactivated and there are no alarms.

The alarm relay is switched if the "ST" bit is activated while a warning message is indicating error codes 8...12 (as of February 2006 also: 104…106, 111…114, 211, 302 oder 303) (↳ section 7.16 "Error messages" on page 49). The heatsealing band is no longer heated up.

7.5.3 Reset (RS)

This bit resets the controller if the controller reports an alarm.
No AUTOCAL or START requests are accepted as long as the "RS" bit is set. From then on, only fault nos. 5 and 7 (As of February 2006: 201…203, 901, 913) are evaluated and output by the fault diagnosis function. The power section is not activated in this state and no measuring impulses are generated. Consequently, the actual value is no longer updated. The reset request is not processed until the "RS" bit is reset. The PROFIBUS communication is not interrupted by a controller reset. The controller simply requests the parameter data from the PROFIBUS master again.
As of production date February 2006, the controller actual value output changes to 0…3°C (i.e. approximately 0VDC) while the "RS" bit is being activated. This may be interpreted by the higher-level controller (e.g. a PLC) as feedback.
The "AUTOCAL" function is not aborted if the "RS" bit is activated while it is still executing.

The controller performs an internal initialization run lasting approximately 500ms after the "RESET" bit is deactivated. The next heatsealing process cannot be started until it has finished.

If a contactor Kb is used to deactivate the control loop (↳ section 5.3 "Power supply" on page 11), it must be reliably energized again 200 ms at the latest after the "RS" bit is reset (note the contactor switching and delay times). If it is energized too late, an error message will be output by the controller.

7.5.4 Measurement pause (MP)

No more measuring impulses are generated by the controller as soon as the "MP" bit is set. From then on, only fault nos. 5 and 7 (As of February 2006: 201…203, 901, 913) are evaluated and output by the fault diagnosis function. In addition, the actual value is no longer updated. The last valid value before the bit was set is output. As soon as the bit is reset, new measuring impulses are generated, all error messages are evaluated and the actual value is updated again.
This bit is only active in measuring mode. "ST", "RS" and "AC" take priority. The bit is suitable for all applications in which the electrical connections of the heatsealing band need to be disconnected during normal operation without triggering an alarm (e.g. sliding rail contacts).
In contrast with the "RS" bit (RESET), the "MP" bit does not reset any error message when it is set. The controller is activated again as soon as the bit is reset, in other words there is no initialization phase.

When the controller is started, it only evaluates the "MP" bit if the system test (including the functional test of the heating circuit) is successful. This can take several 100 ms.

The "MP" bit is available on all controllers manufactured as of July 14, 2003 and supplied with GSD Version v1.3.

7.5.5 Set point

A set point of up to 300 °C or 500 °C is allowed, depending on the selected temperature range (↳ section 7.7.1 "Temperature range and alloy" on page 36). If you attempt to enter a higher set point, it is limited to 300 °C or 500 °C internally.

7.6 Output data

The term "output data" refers to the data that is transferred from the RES-406 to the PROFIBUS master. It contains the current actual value and all important information about the momentary status of the controller. If an alarm is signaled, the fault can be diagnosed accurately with the help of the error code.

7.6.1 AUTOCAL active (AA)

The "AA" bit indicates that the AUTOCAL function is currently executing.

7.6.2 AUTOCAL disabled (AG)

If the "AG" bit is set, the AUTOCAL function is temporarily disabled. This is the case if "START" is active or if the heatsealing band is still in the cooling-down phase.

7.6.3 Alarm active (AL)

If the "AL" bit is set, an alarm has been triggered but not yet reset. The error code provides information about the exact cause of the fault (↳ section 7.16 "Error messages" on page 49).

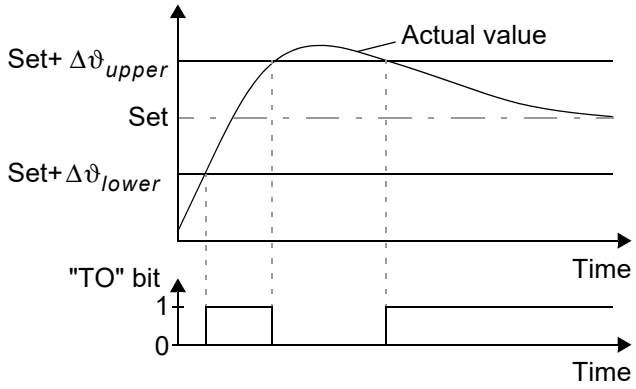
7.6.4 Temperature reached (TE)

The "TE" bit is set if the actual temperature exceeds 95% of the set temperature. As soon as the control mode is exited ("ST" bit = 0) or an alarm is signaled ("AL" bit = 1), this status bit is reset again.

7.6.5 Temperature OK (TO)

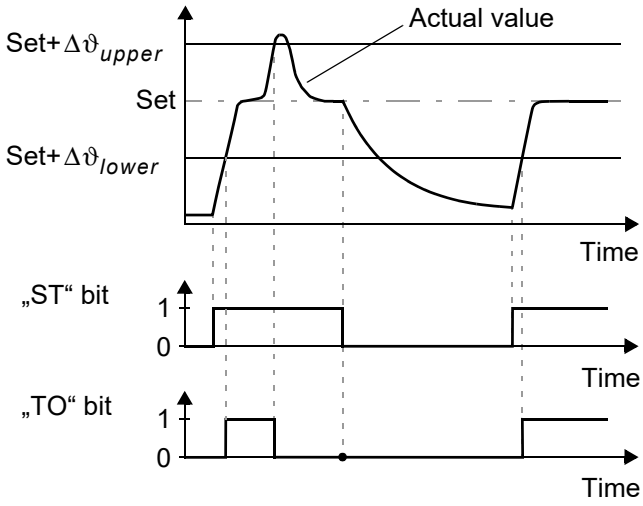
The RES-406 checks whether the actual temperature is within a settable tolerance band ("OK" window) on either side of the set temperature. The lower ($\Delta\vartheta_{lower}$) and upper ($\Delta\vartheta_{upper}$) limits of the tolerance band can be changed independently of one another by means of the parameter data (↳ section 7.7 "Parameter data" on page 34). The following settings are possible:

1. **„off“**
   The „TO“ bit is always deactivated.
2. **„Active if Tact = Tset“**
   (Factory setting up to software revision 017
   and as of software revision 103
   The „TO“ bit is activated if the actual value is inside the specified temperature tolerance band. If the actual temperature is outside the tolerance band the „TO“ bit is deactivated (see graph below).

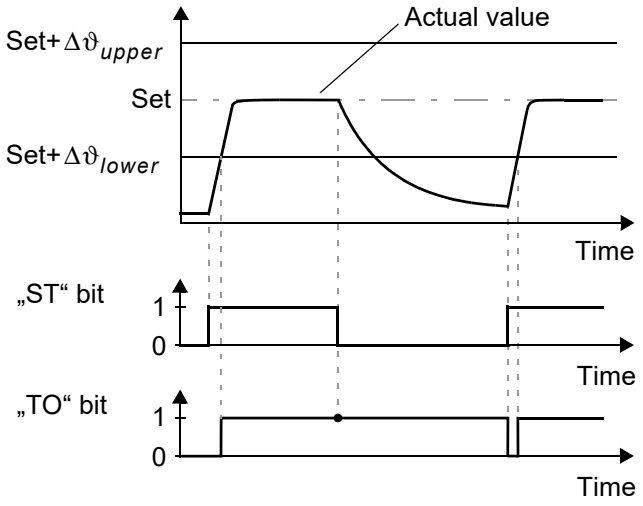


   Unlike the "Temperature reached" status bit ("TE" bit), the actual temperature is evaluated independently of the control mode.
3. **„Active if Tact = Tset, with latch function**
   (as of software revision 100 available)
   (Factory setting for software revision 100…102)
   A heatsealing cycle starts when the "ST" bit is set. The "TO" bit is set when the actual temperature reaches the temperature tolerance band for the first time during a heatsealing cycle. If the actual temperature leaves the tolerance band again - while the "ST" bit is still set - the "TO" bit is reset (refer to Fig. a.). If the actual temperature does not leave the tolerance band again - while the "ST" bit is still set - the "TO" bit is not reset until the start of the next heatsealing cycle (latch function, refer to Fig. b.). The switching state of the "TO" bit can thus be queried after the "ST" bit has been reset and before the start of the next heatsealing cycle.

a.) Temperature *not* OK



b.) Temperature OK



For controllers with software revision 100, 101 and 102 the configuration for the „TO“ bit can be set via the ROPEX visualization software. As of software revision 103 the configuration for the „TO“ bit is set in the PROFIBUS parameter data (or the DPV1 protocoll extension). A configuration with the ROPEX visualization software is no more possible.

The limits of the tolerance band are adjustable to max. ±99K on controllers manufactured as of February 2006 and supplied with GSD Version v1.5 (On older controllers the limits are adjustable to max. ±20K).

7.6.6 Controller active (RA)

The RES-406 has processed the "START" request successfully and entered the control mode if the "RA" bit = 1.

7.6.7 Sign (VZ)

In the compact protocol, the sign bit indicates whether the actual value is positive or negative.

7.6.8 Actual value

If you are using the *compact* protocol, the actual value itself is always positive. The sign bit (VZ) then indicates whether the amount of the actual value is positive or negative. If an alarm is signaled, the actual value contains the error code.
If you are using the *extended* protocol, all 16 bits of the first word must be interpreted as a signed number (twos complement notation). During the calibration procedure or if an alarm is signaled, the actual value is 0. The error code is contained in separate bits.

7.6.9 Error codes

If a fault is signaled („AL“ bit = 1), the error code allows the exact cause to be determined. The "Error code format" parameter determines whether two or three-digit error codes are output. If two-digit error codes are specified, some faults are grouped together; three-digit error codes enable a fault to be identified more precisely.
In the compact protocol, the error code appears instead of the actual value in bits 0…3 (error code format = 4-bit) or 0…9 (error code format = 10-bit).
In the extended protocol, the error code appears in the second word at bit positions 8…11 (error code format = 4-bit) or 6…15 (error code format = 10-bit) (↳ section 7.16 "Error messages" on page 49).

10-bit error codes are available on all controllers manufactured as of July 24, 2006 and supplied with GSD Version v1.6. Older controllers only show 4-bit error codes.

In addition to the error codes, the PROFIBUS diagnostics function also sends error messages to the PROFIBUS master. The error messages corresponding to each error code are already stored in the device master file (GSD), so that they automatically appear in plain text on the PROFIBUS master whenever the device diagnosis for the RES-406 is interrogated there. The language in which the error messages are displayed depends on the selected device master file.

The PROFIBUS diagnostics function always transfers 4-bit error codes regardless of the setting of the "Error code format" parameter (↳ section 7.7.9 "Error code format" on page 38).

7.7 Parameter data

The parameter data contains values for selecting the heatsealing band alloy, the temperature range, the upper and lower tolerance band limits for temperature monitoring, the calibration temperature and the optional heating time limit. It is transferred from the PROFIBUS master to the RES-406 each time the system is started up. If the parameter data is changed during operation, the RES-406 performs a reset. The PROFIBUS communication is not interrupted. The parameter data has the following structure:

No.	Function	Default value [1]	Possible values
0…3	Reserved, set to 0	0	0
4	Temperature range / alloy	10	0, 1, 4, 5, 8, 10
5	Lower temperature OK threshold	10K	3…99K
6	Upper temperature OK threshold	10K	3…99K
7	Calibration temperature	20°C	-1, 0…40°C
8	Heating time limit (100ms units)	0	0…250 (0…25.0s)
9	Extended controller dignostis	activated	deactivated, activated
10	Measuring impulse duration (as of 14.07.03 and GSD Version v1.3)	17	17…30 (1.7…3.0ms)
11	Data format (as of 23.07.04 and GSD Version v1,4)	High/Low byte (Intel)	High/Low byte (Intel), Low/High byte (Motorola)
12	Error code format (as of 24.07.06 and GSD Version v1.6)	4 bit	4 bit, 10 bit

No.	Function	De-fault value [1]	Possible values
13/ 14	Temperature coefficient (as of Feb. 2006 and GSD Version v2.0)	1100 ppm	400…4000 ppm
15	Temperature range (as of Feb. 2006 and GSD Version v2.0)	300° C	200, 300, 400, 500°C
16/ 17	Maximum temperature (as of Feb. 2006 and GSD Version v2.0)	300° C	200…500° C
18	Temperature diagnosis (as of Feb. 2006 and GSD Version v2.0)	de-acti-vated	deactivated, activated
19	Temperature diag-nosis delay time (100 ms steps) (as of Feb. 2006 and GSD Version v2.0)	0 s	0…99 (0…9.9 s)
20/ 21	Heatup timeout (100 ms steps) (as of Feb. 2006 and GSD Version v2.0)	0 s	0…999 (0…99.9 s)
22	AUTOCOMP (as of Feb. 2006 and GSD Version v2.0)	off	off, on, AUTO
23	„TO“ bit (Temperatur OK) (as of Feb. 2006 and GSD Version v2.0)	active if Tact = Tset	off, active if Tact=Tset, active if Tact=Tset with latch
24	Hold mode (as of Feb. 2006 and GSD Version v2.0)	off	off, on, 2 s

1. The default value is stored in the device master file and transferred from the PROFIBUS master to the RES-406 when the system is started up.

7.7.1 Temperature range and alloy

This parameter selects both the temperature range and the heatsealing band alloy. You can overwrite the setting of the rotary coding switch by changing the default value (10).

Value	Temperature range	Alloy
0	300°C	TCR = 1100 ppm, e.g. Alloy A20
1	300 °C	TCR = 780 ppm, e.g. Alloy L
4	500°C	TCR = 1100 ppm, e.g. Alloy A20
5	500 °C	TCR = 780 ppm, e.g. Alloy L
8	300°C	TCR = 3500 ppm, e.g. LEX3500
9	PC configuration (ROPEX visualization software)	PC configuration (ROPEX visualization software)
10	Rotary coding switch setting	Rotary coding switch setting

The settings for a temperature coefficient of 780 ppm (values 1 and 5) are only available on controllers manufactured as of October 2003.

The setting „ROPEX visualization software“ (value 9) is available on controllers manufactured as of March 2007 and supplied with GSD Version v2.0.

You must always execute the AUTOCAL function after changing this parameter.

7.7.2 Lower temperature OK threshold

Lower threshold value for the "OK" window.
Refer section 7.6.5 "Temperature OK (TO)" on page 31 and section 7.7.11 "Temperature diagnosis (as of GSD Version v2.0)" on page 39).

7.7.3 Upper temperature OK threshold

Upper threshold value for the "OK" window.
Refer section 7.6.5 "Temperature OK (TO)" on page 31 and section 7.7.11 "Temperature diagnosis (as of GSD Version v2.0)" on page 39).

7.7.4 Variable calibration temperature

The calibration temperature is set to 20 °C as default. You can change it to another value between 0 °C and 40 °C in order to adapt it to the temperature of the cooled-down heatsealing band.
Some PROFIBUS masters do not allow the parameter data to be changed during operation. It is therefore not possible to adapt the calibration temperature to the prevailing ambient conditions in the machine.

As of GSD Version v1.6, the calibration temperature can be activated for setting by means of the input data by selecting the value "-1" in the parameter data. The calibration temperature can then be specified via the "Set point/ AC temperature input data (↳ section 7.5.1 "Automatic zero calibration "AUTOCAL" (AC)" on page 28).

You do not need to execute the AUTOCAL function after changing the calibration temperature.

7.7.5 Heating time limit

The heating time limit provides additional protection against unwanted permanent heating. The controller automatically deactivates the heating impulse after the set heating time limit has elapsed if the start bit remains set for longer than the time specified by this limit. The start bit must be reset before the controller can be started up again. The heating time limit is deactivated as default (0), but can be set to any value between 0 s and 25.0 s (0 and 250).

7.7.6 Extended controller diagnosis

The extended controller diagnosis uses the diagnostic function of the PROFIBUS protocol to display several faults of the RES-406 on the PROFIBUS master directly. For each fault there is a text message stored in the device master file so the error codes appear on the PROFIBUS master in plain text if the master has the capability to display text messages.
With the help of parameter No. 9 the extended controller diagnosis can be activated or deactivated. The default setting is "activated".
Although the extended controller diagnosis ist deactivated, there is the fault diagnosis which is coded in the protocol.

This paramter is available on all controllers manufactured as of June 17, 2002 and supplied with GSD Version v1.2.

DPV1 protocol extension (alarm model):
The extended device diagnostic functionality is not available with the DPV1 protocol extension and GSD Version v2.0 or higher (↳ section 7.8 "DPV1 protocol extension (as of GSD Version v2.0)" on page 42. The DPV1 alarm model (↳ section 7.8.2 "DPV1 alarm model" on page 42) must be used in this configuration instead. In this case, parameter no. 9 in the GSD file switches the so-called DPV1 diagnostic interrupt on and off.
If you want to keep the old extended device diagnostics (e.g. for reasons of software compatibility), you must use a GSD version previous to v2.0. The DPV1 functionality for the RES-406 is then automatically deactivated in the PROFIBUS master.

7.7.7 Measuring impulse duration

The length of the measuring impulses generated by the controller can be set with parameter no. 10. It may be necessary to set a measuring impulse that is longer than the default 1.7 ms for certain applications.

This parameter is available on all controllers manufactured as of July 14, 2003 and supplied with GSD Version v1.3.

7.7.8 Data format

This parameter specifies the order of the bytes (Intel: "high/low byte", Motorola: "low/high byte") in the cyclic data for both input and output data (↳ section 7.4 "PROFIBUS protocol" on page 26). We recommend setting "low/high byte (Motorola)" for Siemens controllers.

This parameter is available on all controllers manufactured as of July 23, 2004 and supplied with GSD Version v1.4.

7.7.9 Error code format

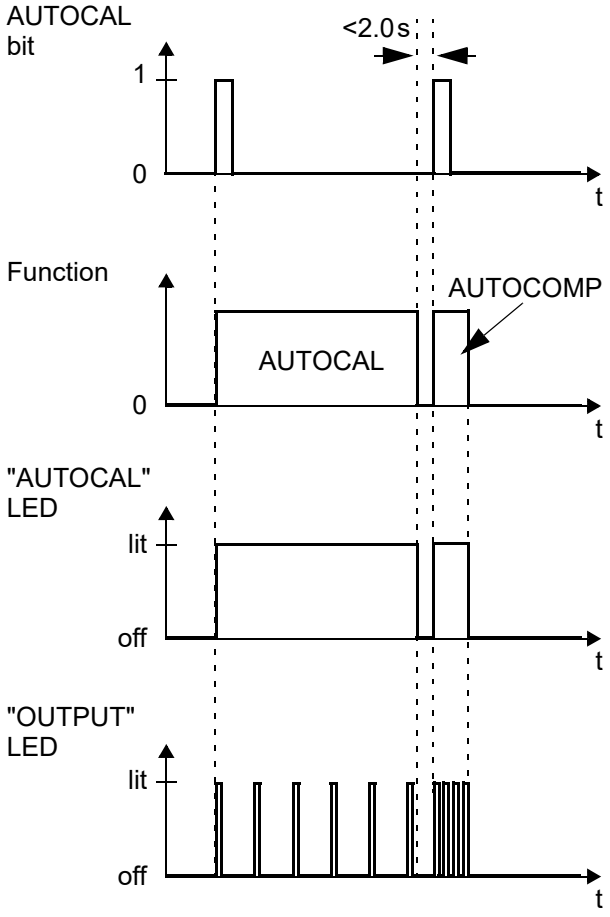
This parameter specifies the length of the error codes in the cyclic data. You can choose between a 4-bit and a 10-bit format (section 7.4 "PROFIBUS protocol" on page 26). "4-bit" generates two-digit error codes in the range 1…3 and is the default setting. "10-bit" generates more detailed three-digit error codes (section 7.16 "Error messages" on page 49).

This parameter is available on all controllers manufactured as of July 24, 2007 and supplied with GSD Version v1.6.

7.7.10 Automatic phase angle compensation (AUTOCOMP) (as of GSD Version v2.0)

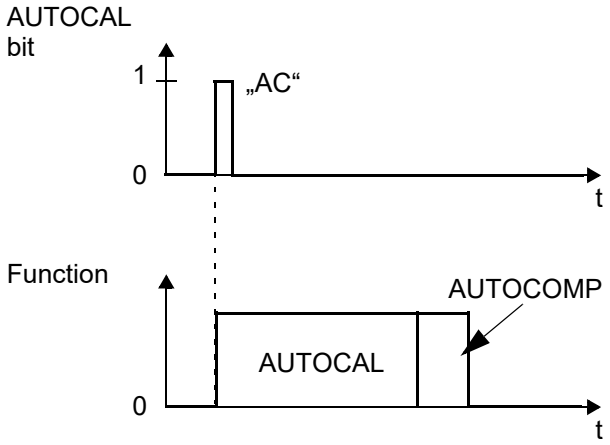
It may be necessary to compensate the phase angle displacement between the U_R and I_R measuring signals for special heatsealing applications (ROPEX Application Report). The "AUTOCOMP" function is provided for this purpose. The follwing settings are possibe:

1. **„off“** (Factory setting)
   The „AUTOCOMP“ function is switched off.
2. **„on“**
   It is executed whenever the "AUTOCAL" function (section 7.16 "Error messages" on page 49) is run twice in quick succession. The interval between the end of the first "AUTOCAL" function and the start of the second "AUTOCAL" must be shorter than 2.0s. The second "AUTOCAL" function only takes around 2.0s and incorporates the "AUTOCOMP" function.
   If the interval between the two "AUTOCAL" functions is longer than 2.0s, "AUTOCAL" is executed normally again the second time.



The "OUTPUT" LED blinks repeatedly when the "AUTOCOMP" function is executed and the actual value output (terminals 17+14) is set to 0…3 °C (i.e. app. 0 VDC).

3. **„AUTO“ (as of software revision 105)**
   With this setting the „AUTOCOMP“ function is activated automatically after the "AUTOCAL" function has been successfully executed.

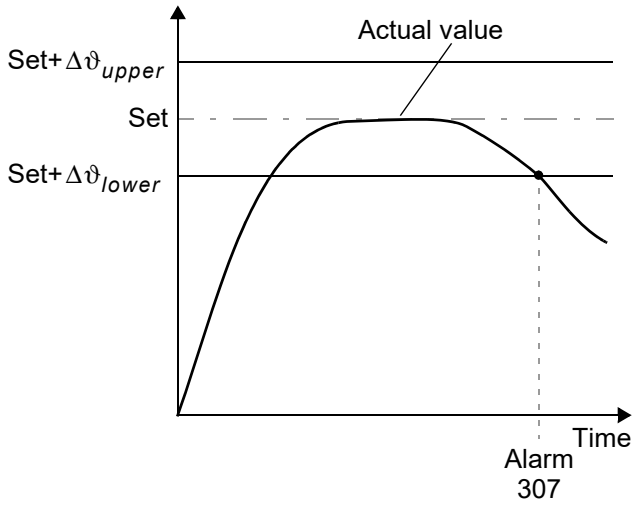


The "OUTPUT" LED blinks repeatedly when the "AUTOCOMP" function is executed and the actual value output (terminals 17+14) is set to 0…3 °C (i.e. app. 0 VDC).

The "AUTOCOMP" function must be activated by means of the PROFIBUS parameter data (↬ section 7.7 "Parameter data" on page 34) or the DPV1 protocol extension (↬ section 7.8 "DPV1 protocol extension (as of GSD Version v2.0)" on page 42).
(default setting: AUTOCOMP off)

7.7.11 Temperature diagnosis (as of GSD Version v2.0)

An additional temperature diagnosis can be activated by means of the PROFIBUS parameter data or the DPV1 protocol extension.. The RES-406 checks whether the ACTUAL temperature is within a settable tolerance band ("OK" window) on either side of the SET temperature. The lower ($\Delta\vartheta_{lower}$) and upper ($\Delta\vartheta_{upper}$) tolerance band limits are the same like in the „Temperature OK“ function (↬ section 7.6.5 "Temperature OK (TO)" on page 31). The limits are configured in the factory to -10 K and +10 K.
If the actual temperature is inside the specified tolerance band when the "START" signal is activated, the temperature diagnosis is activated as well. If the ACTUAL temperature leaves the tolerance band, the corresponding error code (307 or 308) is indicated and the alarm relay is switched (↬ section 7.16 "Error messages" on page 49).

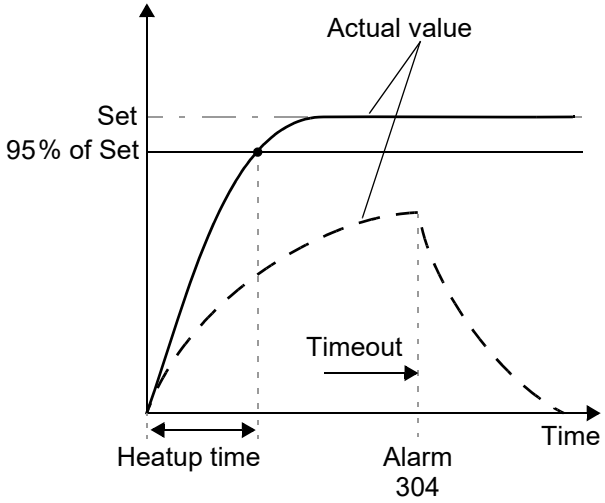


If the temperature diagnosis is not activated by the time the "START" bit is deactivated (i.e. if the ACTUAL temperature does not exceed the upper or lower tolerance band limit), the corresponding error code (309, 310) is indicated and the alarm relay is switched.
An additional delay time (0…9.9s) can be set by means of the PROFIBUS parameter data or the DV1 protocol extension. The first time the lower tolerance band limit is exceeded, the temperature diagnosis is not activated until the parameterized delay time has elapsed. The temperature diagnosis function can thus be explicitly suppressed, e.g. if the temperature drops temporarily owing to the closure of the sealing jaws.

The lower and upper tolerance band limits cannot be set in the ROPEX visualization software. The same limits apply as for the TO bit. They can only be set by means of the PROIBUS parameter data (↳ section 7.7 "Parameter data" on page 34) or the DPV1 protocol extension (↳ section 7.8 "DPV1 protocol extension (as of GSD Version v2.0)" on page 42).

7.7.12 Heatup timeout (as of GSD Version v2.0)

An additional heatup timeout can be activated by means of the PROFIBUS parameter data or the DPV1 protocol extension.
This timeout starts when the „START“ bit is activated. The RES-406 then monitors the time required for the ACTUAL temperature to reach 95% of the SET temperature. If this time is longer than the parameterized time, the corresponding error code (304) is indicated and the alarm relay is switched (↳ section 7.16 "Error messages" on page 49).



The "Heatup timeout" function must be activated by means of the PROFIBUS parameter data (↳ section 7.7 "Parameter data" on page 34) or the DPV1 protocol extension (↳ section 7.8 "DPV1 protocol extension (as of GSD Version v2.0)" on page 42).
(default setting: Heatup timeout off)

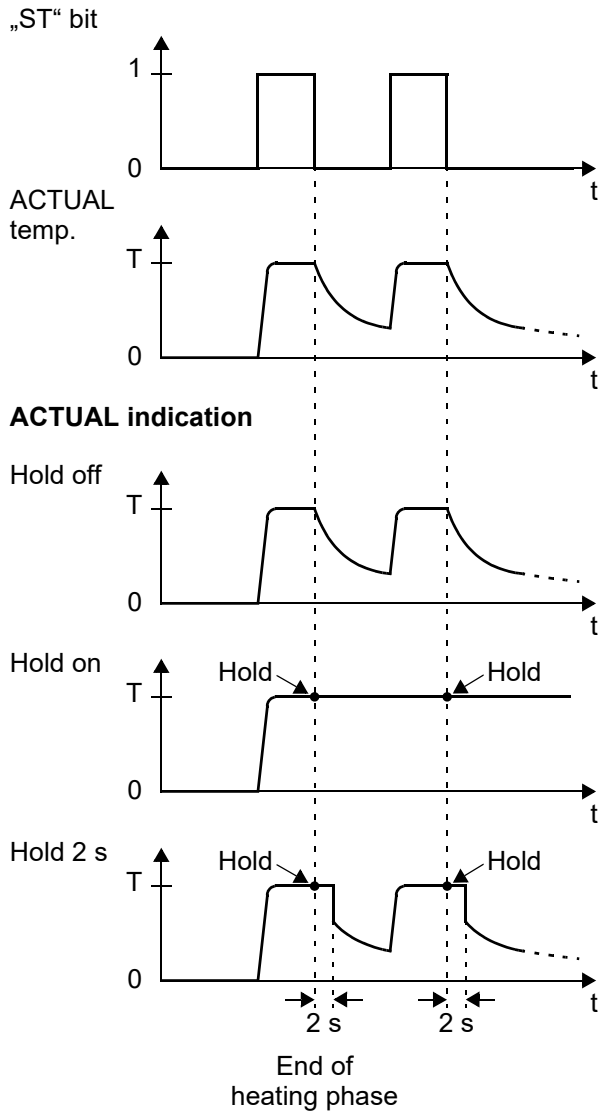
7.7.13 Hold mode (as of GSD Version v2.0)

The behavior of the digital indication of the ACTUAL temperature via the PROFIBUS communication is set by means of the paramters data or the DPV1 protocol extension as followed:

1. **"off" (Factory setting)**
   The real ACTUAL temperature is always indicated.
2. **"on"**
   The ACTUAL temperature that was valid at the end of the last heatsealing phase is always indicated as a digital value. When the controller is switched on, the real ACTUAL temperature is indicated until the end of the first heating phase.
3. **"2 s"**
   It causes the current ACTUAL temperature to be displayed as a digital value for an additional 2 seconds at the end of a heatsealing phase. This temperature is then indicated again in real time until the end of the next heating phase.

Hold mode affects the digital value of the real temperature in the PROFIBUS communiction and the numeric temperature display in the ROPEX visualization software only. The output of the real temperature on the actual value output and the data record in the graphics window of the ROPEX visualization software is not affected.

The various hold modes are shown below:



The "Holde mode" function must be activated by means of the PROFIBUS parameter data (↳ section 7.7 "Parameter data" on page 34) or the DPV1 protocol extension (↳ section 7.8 "DPV1 protocol extension (as of GSD Version v2.0)" on page 42).
(default setting: Hold mode off).

7.8 DPV1 protocol extension (as of GSD Version v2.0)

Text in preparation.

7.8.1 Identification and maintenance (I&M functions)

Text in preparation.

7.8.2 DPV1 alarm model

Text in preparation.

7.8.3 DPV1 parameter data

The basic controller settings and functions can be set with the parameter data in the device master file (GSD file, ↳ section 7.7 "Parameter data" on page 34).
Some PLC systems only allow you to change the settings in the GSD file when you create a new project. The settings cannot be changed while the machine or system is operating.
The DPV1 protocol extension makes it possible to change these settings and functions without interrupting the operation of the controller. The temperature coefficient for the heatsealing band, for instance, can be altered on the PLC control unit during the validation process.
This acyclic service supports both reading and writing of the controller parameters. The parameter data can optionally be accessed by addressing the slot indexes. Since the controller does not store parameters transferred to it in this way, you must remember to transfer all parameters that deviate from the static configuration again after restarting the controller or the bus.

Please contact the manufacturer for more information about how your PLC system supports the DPV1 protocol extension.

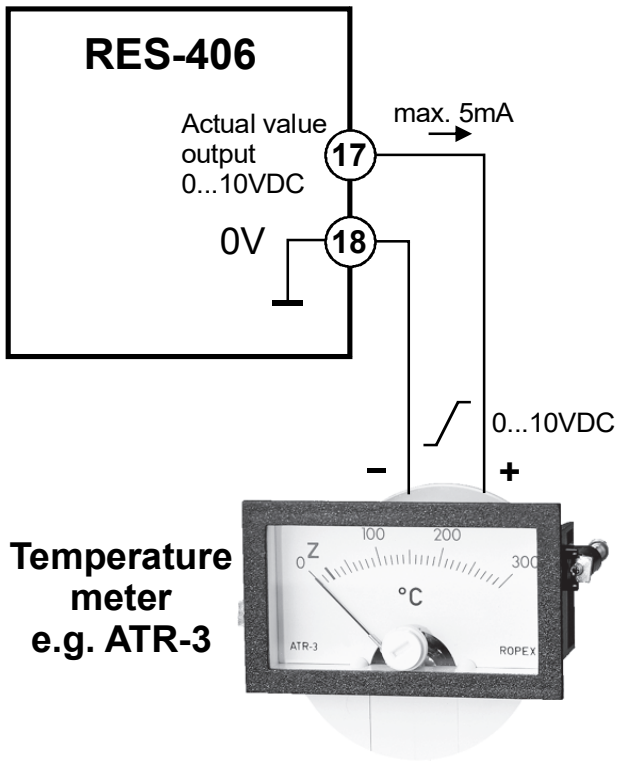
DPV1 parameter table of the RES-406
Default values are printed ***bold/cursive***.

Slot	Index	Parameter	Value range
x	255	I&M functions (IM0)	Article number, serial number, version index, manufacturer ID
0	0	Cyclic data	↳ section 7.4 "PROFIBUS protocol" on page 26
1	4	Alloy/range	0: 1100 ppm/K, 300 °C 1: 780 ppm/K, 300 °C 4: 1100 ppm/K, 500 °C 5: 780 ppm/K, 500 °C 8: 3500 ppm/K, 300 °C 9: PC configuration *10: Rotary coding switch* 11: variable
1	5	Lower temperature limit [K]	3…99 ***(10)***
1	6	Upper temperature limit [K]	3…99 ***(10)***
1	7	Calibration temperature [°C]	-1: variable with cyclic data 0…40 ***(20)***
1	8	Heating time limit [0.1 s steps]	0…250 ***(0=without limit)***
1	9	Extended controller diagnosis	0: deactivated *1: activated*
1	10	Measuring pulse length [0.1 ms steps]	17…30 ***(17)***
1	11	Data format	*0: Intel* 1: Motorola
1	12	Error code format	*0: 4 bit (2 digits)* 1: 10 bit (4 digits)
1	13	Temperature coefficient [ppm/K]	400…4000 ***(1100)***

Slot	Index	Parameter	Value range
1	15	Temperatur range	0: 200 °C *1: 300 °C* 2: 400 °C 3: 500 °C
1	16	Maximum temperature [°C]	200…500 ***(300)***
1	18	Temperature diagnosis	*0: deactivated* 1: activated
1	19	Temperature diagnosis delay time [0.1 s steps]	0…99 ***(0)***
1	20	Heatup timeout [0.1s steps]	0…999 ***(0)***
1	22	AUTOCOMP	*0: off* 1: on 2: AUTO (as of software revision 105)
1	23	„TO“ bit (Temperature OK)	0: off *1: active if Tact=Tset* 2: active if Tact=Tset, with latch
1	24	Hold mode	*0: off* 1: on 2: 2 s

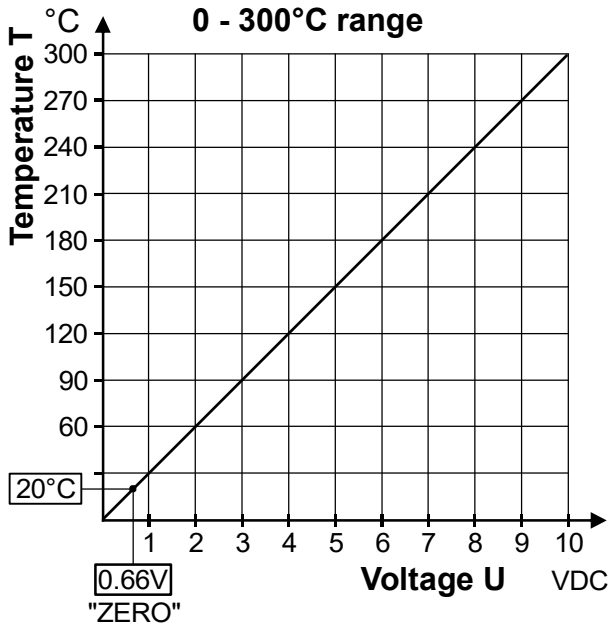
7.9 Temperature indication (actual value output)

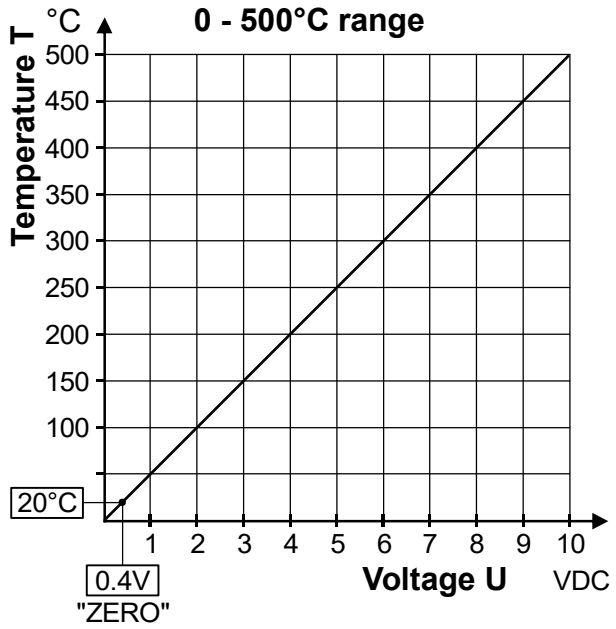
The RES-406 supplies an analog 0…10VDC signal, which is proportional to the real ACTUAL temperature, at terminals 17+18.



Voltage values:
0VDC → 0°C
10VDC → 300°C (ATR-3) or 500°C (ATR-5)
(depending on the controller configuration)

The relationship between the change in the output voltage and the ACTUAL temperature is linear.





An indicating instrument can be connected to this output in order to visualize the temperature of the heatsealing band.
The characteristics of the ROPEX ATR-x temperature meter (size, scaling, dynamic response) are ideally suited to this application and this instrument should therefore always be used (section 12 "How to order" on page 60). It not only facilitates SET-ACTUAL comparisons, but also enables other criteria such as the heating rate, set point reached within the specified time, cooling of the heatsealing band etc. to be evaluated.
This meter moreover permits disturbances in the control loop (loose connections, contacting or wiring problems) as well as any line disturbances to be observed extremely effectively and interpreted accordingly. The same applies if mutual interference occurs between several neighboring control loops.

This output is not potential-free and might have the potential of the secondary voltage of the impulse transformer.

External grounding is not allowed. If this warning is ignored, the controller will be damaged by frame currents.

Contact-voltage protection must be installed at the terminals of the external temperature meter.

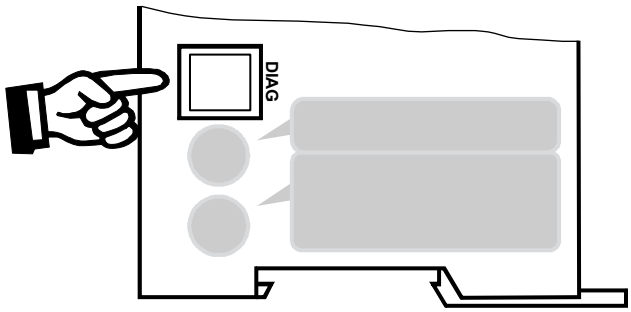
If an alarm is signaled, the analog output at terminals 14+18 is used to display a selective error message (section 7.16 "Error messages" on page 49).

7.10 Booster connection

The RES-406 controller has a connection for an external switching amplifier (booster) as standard. This connection (at terminals 15+16) is necessary for high primary currents (continuous current > 5A, pulsed current > 25A). The switching amplifier should be connected as described in section 5.7 "Wiring diagram with booster connection" on page 15.

7.11 Diagnostic interface/visualization software (as of February 2006)

An interface with a 6-pole Modular Jack (RJ-12) is provided for systemdiagnostics and process visualization. This interface allows a data connection to be set up to the ROPEX visualization software using the ROPEX communication interface CI-USB-1.



Only a ROPEX comunication interface is allowed to be connected to the diagnostic interface. Connecting another device (e.g. a telephone cable) could result in malfunctions or damage to the controller.

The ROPEX visualization software is described in a separate document.

7.12 Total cycle counter (as of February 2006)

The number of heatsealing cycles executed since the controller was first delivered is stored internally (ST bit = 1). This counter can only be displayed and not reset. It can only be displayed in the ROPEX visualization software (section 7.11 "Diagnostic interface/visualization software (as of February 2006)" on page 47).

7.13 Operating hours counter (as of February 2006)

The number of operating hours since the controller was first delivered is stored internally. This counter works with a resolution of six minutes. It can only be displayed and not reset. It can only be displayed in the ROPEX visualization software (section 7.11 "Diagnostic interface/visualization software (as of February 2006)" on page 47).

7.14 Log function (as of software revision 107)

As of software revision 107, the RES-406 has a storage function for logging error messages (↳ section 7.16 "Error messages" on page 49) and zero calibrations (AUTOCAL function, ↳ section 7.5.1 "Automatic zero calibration "AUTOCAL" (AC)" on page 28). The log shows the 30 most recent messages. The message log is stored together with the total cycle counter and the operating hours counter. This log can only be displayed and not deleted. It can only be displayed in the ROPEX visualization software (↳ section 7.11 "Diagnostic interface/visualization software (as of February 2006)" on page 47).
The log function for error messages and zero calibrations (AUTOCAL function) allows you to evaluate operating states at a later point in time, simplifying fault analyses.

7.15 System monitoring/alarm output

To increase operating safety and to avoid faulty heatsealing, this controller incorporates special hardware and software features that facilitate selective fault detection and diagnosis. Both the external wiring and the internal system are monitored.
These features assist the operator in identifying the cause of abnormal operations.
A system fault is reported or differentiated by means of the following indications.

A.) Red "ALARM" LED on the controller with three states:

1. **Blinks fast (4 Hz)**
   The AUTOCAL function should be executed (error codes 8+9; as of February 2006 also: 104…106, 211, 302, 303).
2. **Blinks slowly (1 Hz)**
   The system configuration is incorrect and the zero calibration (AUTOCAL function) was unsuccessful (↳ section 6.2 "Controller configuration" on page 16). It corresponds to error codes 10…12 (as of February 2006 also: 111…114).
3. **Lit continuously:**
   This indicates that a fault is preventing the controller from being started (error codes 1…7; as of February 2006 also: 101…103,107, 108, 201…203, 307, 308, 801, 9xx).
   As a rule, it refers to an external wiring fault.

B.) Alarm relay (relay contact terminals 12+13+14):

This relay is set in the factory as follows:

- **DE-ENERGIZED** in operating states A.1 and A.2, but energized if the "ST" bit is activated in one of these states.
- **ENERGIZED** in operating state A.3.

If the alarm relay is configured opposite to the factory setting (↳ section 6.2.4 "Configuration of the alarm relay" on page 18), these states are reversed.

C.) Error code indication via the PROFIBUS protocol

If a fault occures the "AL" bit is set and in the compact protocol the error code appears instead of the actual value in bits 0…3, while in the extended protocol it is contained at bit positions 8…11 in the second word (↳ section 7.6.9 "Error codes" on page 33).

D.) Error code output via the 0…10VDC analog output (terminals 17+18):

Since a temperature indication is no longer necessary if a fault occurs, the analog output is used to display error messages in the event of an alarm.

13 voltage levels (up to January 2006: 12 voltage levels) are offered for this purpose in the 0…10VDC range, each of which is assigned an error code (section 7.16 "Error messages" on page 49).
If a state that requires AUTOCAL occurs – or if the controller configuration is not correct – (error codes 8…12;as of February 2006 also: 104…106, 111…114, 211, 302, 303), the signal at the analog output jumps back and forth at 1Hz between the voltage value which corresponds to this error and the end of the scale (10VDC, i.e. 300°C or 500°C). If the "ST" bit is activated in one of these states, the voltage value does not change any more.

An alarm can only be reset by activating the „RS“ bit or by switching the controller off and then on again.

If an error message is reset using the "RS" bit, the "RS" bit must be deactivated first.

Invalid error messages may appear when the controller is switched off owing to the undefined operating state. This must be taken into account when they are evaluated by the higher-level controller (e.g. a PLC) in order to avoid false alarms.

7.16 Error messages

In addition to the fault diagnosis which is coded in the protocol, you can also access the PROFIBUS diagnostics function (extended controller diagnosis). The error codes appear in the configuring tool in plain text, because they are stored in the device master file.
The table below shows how the analog voltage values correspond with the faults that have occurred. It also describes the fault and the required corrective action.
The error messages are listed in two separate tables for controllers "up to January 2006" and "as of February 2006". The block diagram in section 7.17 "Fault areas and causes" on page 54 permits each fault to be cleared quickly and efficiently.
13 voltage levels for fault diagnostics appear at the actual value output of all controllers manufactured as of February 2006. The error messages are differentiated even more finely in the controller. The 3-digit error codes described in brakets below can be displayed with the ROPEX visualization software (section 7.11 "Diagnostic interface/visualization software (as of February 2006)" on page 47) to facilitate troubleshooting.

If the actual value output is evaluated in order to identify an error message - in the higher-level controller, for instance - the tolerance window must be adjusted to prevent it from being incorrectly interpreted. Please note the tolerances of the actual value output (section 9 "Technical data" on page 57).

Part 1 of 3: Error messages as of February 2006 (faults)

NOTE: The error messages shown here are output as faults (constant error voltage at actual value output, alarm LED lit continuously, alarm relay energized).

Error code		Act. val. output voltage [V]	Cause	Action if machine started for first time	Action if machine already operated, HS band not changed
1	101	0.66	No current signal	Fault area ①	Fault area ①
2	102	1.33	No voltage signal	Fault area ③	Fault area ③
3	103	2.00	No current / voltage signals	Fault area ②	Fault areas ②⑨
4	107	2.66	Temperature step, down	Fault areas ④⑤⑥ ("loose contact")	Fault areas ④⑤⑥ ("loose contact")
	108		Temperature step, up		
	307 308 309 310		Temperature too high / low (↳ section 7.7.11)	-	-
5	201	3.33	No line frequency / line frequency fluctuates	Check power supply	Check power supply
	202		Line frequency too high / fluctuates		
	203		Line frequency too low / fluctuates		
6	304	4.00	Heatup time too long (↳ section 7.7.12)	Perform **RESET**	Perform **RESET**
7	901	4.66	No line voltage / sync signal	Check line voltage / Replace device	Check line voltage / Replace device
	913		Triac defective	Replace device	Replace device
	914 915 916		Internal fault, device defective	Replace device	Replace device
	917 918		Jumper for alarm output incorrect	Check jumper	Check jumper

Part 2 of 3: Error messages as of February 2006 (warnings)

NOTE: The specified error messages are initially output as warnings (actual value output jumps back and forth between two values, alarm LED blinks, alarm relay de-energized). When the "START" signal is activated, the warning changes to a fault (actual value output no longer jumps back and forth, see bold italic values, alarm LED lit continuously, alarm relay energized).

Error code		Act. val. output voltage [V]	Cause	Action if machine started for first time	Action if machine already operated, HS band not changed
8	104	***5.33*** ↔ 10	Current signal incorrect, incorrect impulse transformer specification	Perform **AUTOCAL** , check transformer specification, fault areas⑦⑧	Fault areas ④⑤⑥ ("loose contact")
	105		Voltage signal incorrect, incorrect impulse transformer specification		
	106		Current and voltage signals incorrect, incorrect impulse transformer specification		
	302		Temperature too low, calibration not performed, loose contact, ambient temp. fluctuates	Perform **AUTOCAL** and / or fault areas ④⑤⑥ ("loose contact")	
	303		Temperature too high, calibration not performed, loose contact, ambient temp. fluctuates		
9	211	***6.00*** ↔ 10	Data error	Perform **AUTOCAL**	Perform **AUTOCAL**

Part 3 of 3: Error messages as of February 2006 (warnings)

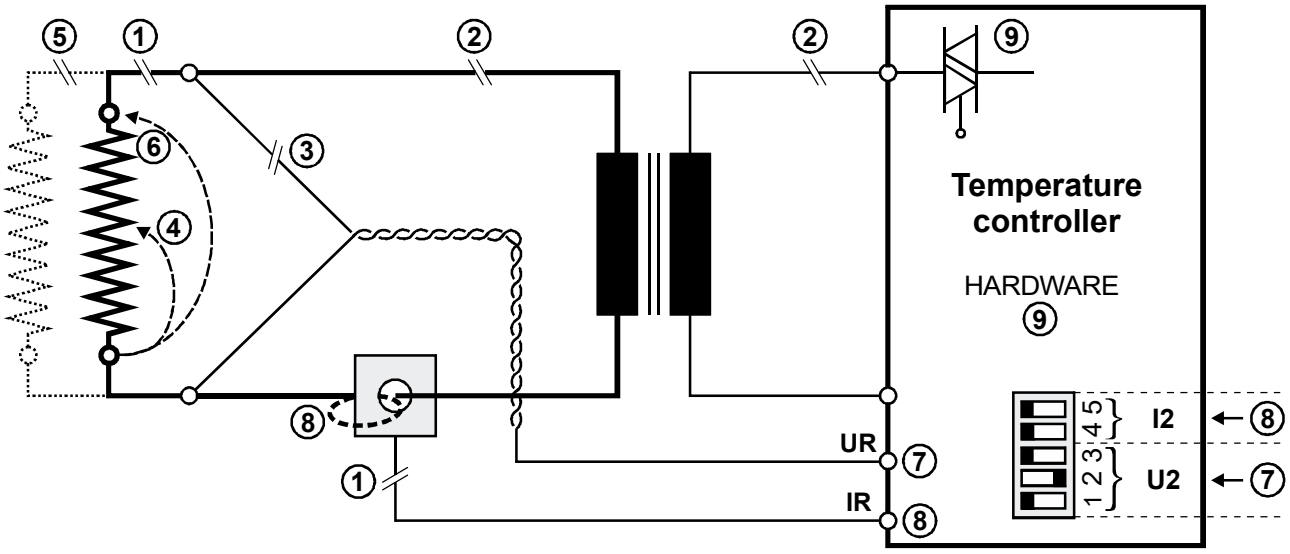
NOTE: The specified error messages are initially output as warnings (actual value output jumps back and forth between two values, alarm LED blinks, alarm relay de-energized). When the "START" signal is activated, the warning changes to a fault (actual value output no longer jumps back and forth, see bold italic values, alarm LED lit continuously, alarm relay energized).

Error code		Act. val. output voltage [V]	Cause	Action if machine started for first time	Action if machine already operated, HS band not changed
10	111	***6.66*** ↔ 10	Current signal incorrect, no calibration possible	Fault area ⑧, check configuration	Fault areas ④⑤⑥ ("loose contact")
11	112	***7.33*** ↔ 10	Voltage signal incorrect, no calibration possible	Fault area ⑦, check configuration	Fault areas ④⑤⑥ ("loose contact")
12	113	***8.00*** ↔ 10	Current / voltage signals incorrect, no calibration possible	Fault area ⑦⑧, check configuration	Fault areas ④⑤⑥ ("loose contact")
13	114	***8.66*** ↔ 10	Temperature fluctuates, no calibration possible	Perform **AUTOCAL** and / or fault areas ④⑤⑥ ("loose contact")	Perform **AUTOCAL** and / or fault areas ④⑤⑥ ("loose contact")
	115		Ext. calibration temp. too high, no calibration possible	Perform **AUTOCAL** with ext. calibration temperature ≤40°C	Perform **AUTOCAL** with ext. calibration temperature ≤40°C
	116		Ext. calibration temp. fluctuates, no calibration possible	Perform **AUTOCAL** with stable ext. calibration temperature	Perform **AUTOCAL** with stable ext. calibration temperature

Error messages up to January 2006

Error code	Act. value output ; Voltage [V]	Temp. 300°C [°C]	Temp. 500°C [°C]	ALARM LED	STATUS of alarm relay (factory set.)	Cause	Action if machine started for first time	Action if machine already operating, HS-band not chang.
1	0.66	20	33	Lit Continuously	Energized	I_R signal missing	Fault area ①	Fault area ①
2	1.33	40	66			U_R signal missing	Fault area ③	Fault area ③
3	2.00	60	100			U_R and I_R signals missing	Fault area ②	Fault areas ②⑨
4	2.66	80	133			Temperature step	Fault areas ④⑤⑥ (loose contact)	Fault areas ④⑤⑥ (loose contact)
5	3.33	100	166			Frequency fluctuation, inadmissible line frequency	Check power supply	Check power supply
6	4.00	120	200			Internal fault	**Run** RESET	**Run** RESET
7	4.66	140	233			Internal fault, controller defective	Replace controller	Replace controller
8	5.33 ↔ 10	160 ↔ 300	266 ↔ 500	Blinks fast (4 Hz)	De-Energized, gets energized with"START" signal (voltage value at analog output then no longer changes)	U_R and/or I_R signal incorrect	**Run** AUTOCAL	Fault areas ④⑤⑥
9	6.00 ↔ 10	180 ↔ 300	300 ↔ 500			Data error	**Run** AUTOCAL	---
10	6.66 ↔ 10	200 ↔ 300	333 ↔ 500	Blinks slowly (1 Hz)		I_R signal incorrect, calibration not possible	Fault area ⑧, check configuration	---
11	7.33 ↔ 10	220 ↔ 300	365 ↔ 500			U_R signal incorrect, calibration not possible	Fault area ⑦, check configuration	---
12	8.00 ↔ 10	240 ↔ 300	400 ↔ 500			U_R and I_R signals incorrect, calibration not possible	Fault areas ⑦⑧, check configuration	---

7.17 Fault areas and causes



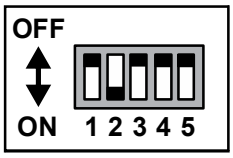
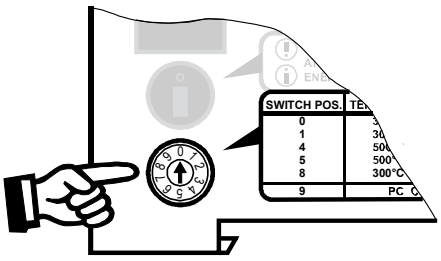
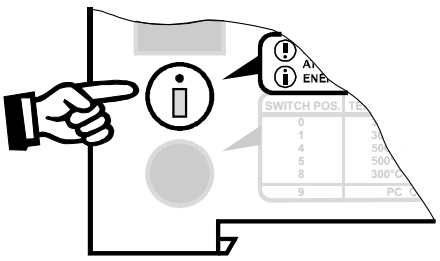
The table below explains the possible fault causes.

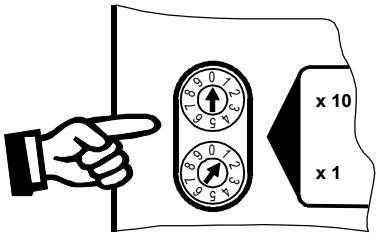
Fault area	Explanation	Possible causes
①	Load circuit interrupted after U_R pickoff point	- Wire break, heatsealing band break - Contact to heatsealing band is defective
	current transformer signal interrupted	- I_R measuring wires from current transformer interrupted
②	Primary circuit interrupted	- Wire break, triac in controller defective - Primary winding of impulse transformer interrupted
	Secondary circuit interrupted before U_R-pickoff point	- Wire break - Secondary winding of impulse transformer interrupted
③	U_R signal missing	- Measuring wires interrupted
④	Partial short-circuit (delta R)	- Heatsealing band partially bypassed by conducting part (clamp, opposite heatsealing bar etc.)
⑤	Parallel circuit interrupted	- Wire break, heatsealing band break - Contacting to heatsealing band defective
⑥	Total short-circuit	- Heatsealing band installed incorrectly, insulation at heatsealing bar ends missing or incorrectly installed - Conducting part bypasses heatsealing band completely
⑦	U_R signal incorrect	- Up to Jan. 2006: DIP switches 1 - 3 configured incorrectly (U_2 range) - As of Feb. 2006: U_2 outside permissible range from 0.4…120VAC

Fault area	Explanation	Possible causes
⑧	I_R signal incorrect	- Up to Jan. 2006: DIP switches 4 + 5 configured incorrectly (I_2 range) - As of Feb. 2006: I_2 outside permissible range from 30…500A
	Turns through current transformer incorrect	- Check number of turns (two or more turns required for currents < 30A)
⑨	Internal controller fault	- Hardware fault (replace controller) - Plug-in jumper for alarm output not connected or incorrectly connected

8 Factory settings

The RESISTRON® temperature controller RES-406 is configured in the factory as follows:

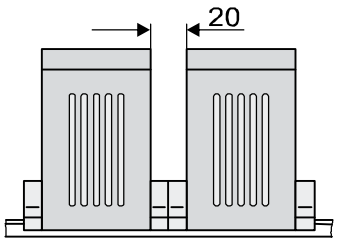
DIP switches for secondary voltage U_2 and current I_2 (up to January 2006)		U_2 = 6…60VAC I_2 = 30…100A DIP switches: 2 ON 1, 3, 4, 5 OFF These switches are automatically set by the AUTORANGE function on all controllers manufactured as of February 2006.
Rotary coding switch for heatsealing band alloy and temperature range		Heatsealing band alloy: Alloy A20 Temperature range: 300°C Rotary coding switch: "0" position
Plug-in jumper for alarm relay		Alarm relay is energized at alarm

Rotary coding switches for station address	 Top of housing	Station address = 01_{dec}
Automatic phase angle compensation (AUTOCOMP) [X]		AUTOCOMP: off
Temperature diagnosis [X]		Temperature diagnosis: deactivated
Heatup timeout [X]		Heatup timeout: deactivated

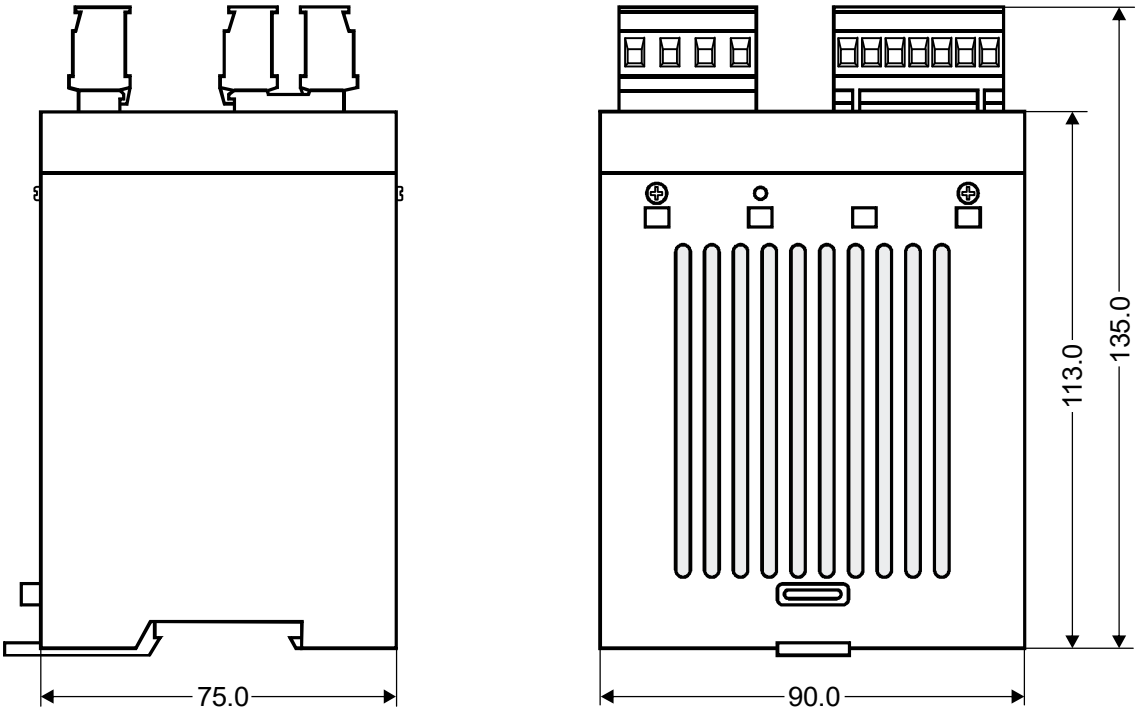
[X] As of February 2006 and GSD Version v2.0:
Setting by means of the PROFIBUS parameter data or the DPV1 protocol extension.

9 Technical data

Type of construction	Housing for installation in the electrical cabinet Snaps onto a standard top hat rail (DIN TS35 rail, 35 mm) acc. to DIN EN 50022 Dimensions: 90 x 75mm; height: 135mm (incl. terminals)
Line voltage	All controllers manufactured as of February 2006: 115VAC version: 110VAC -15%…120VAC +10% (equivalent to 94…132VAC) 230VAC version: 220VAC -15%…240VAC +10% (equivalent to 187…264VAC) 400VAC version: 380VAC -15%…415VAC +10% (equivalent to 323…456VAC) All controllers manufactured as of January 2004 up to January 2006: 115VAC version: 115VAC -15%…120VAC +10% (equivalent to 98…132VAC) 230VAC version: 230VAC -15%…240VAC +10% (equivalent to 196…264VAC) 400VAC version: 400VAC -15%…415VAC +10% (equivalent to 340…456VAC) All controllers manufactured up to December 2003: 115VAC, 230VAC or 400VAC, tolerance: +10% / -15% depending on version selected (↳ section 12 "How to order" on page 60)
Line frequency	47…63Hz, automatic adjustment to frequencies in this range
24VDC-Supply voltage Terminals 5+7 or PROFIBUS plug, pins 2+7	24VDC, Imax = 100mA Tolerance: +10 / -10% The 24VDC-Supply voltage can be fed either via terminals 5 and 7 or via the PROFIBUS plug at pins 2 and 7.
PROFIBUS-DP interface	Baud rates: 9.6kbaud; 19.2kbaud; 45.45kbaud; 93.75kbaud; 187.5kbaud; 500kbaud; 1.5Mbaud; 3Mbaud; 6Mbaud; 12Mbaud Plug acc. to IEC 61158
Heatsealing band type and temperature range	All controllers manufactured as of February 2006: The temperature range and temperature coefficient settings can also be specified by means of the ROPEX visualization software (↳ section 7.11 "Diagnostic interface/visualization software (as of February 2006)" on page 47) in addition to the rotary coding switch (see below): Temperature range: 200°C, 300°C, 400°C or 500°C Temperature coefficient: 400…4000ppm (variable setting range) All controllers manufactured as of start of production: Five different ranges can be set with the rotary coding switch or via the PROFIBUS interface: Temperature coefficient 1100ppm, 0…300°C (e.g. Alloy A20) Temperature coefficient 780ppm, 0…300°C (e.g. Alloy L) Temperature coefficient 1100ppm, 0…500°C (e.g. Alloy A20) Temperature coefficient 780ppm, 0…500°C (e.g. Alloy L) Temperature coefficient 3500ppm, 0…300°C (e.g. LEX3500) The settings for a temperature coefficient of 780ppm are only available on controllers manufactured as of October 2003.

Analog output (actual value) Terminals 17+18	0…10V DC, Imax = 5mA Equivalent to 0…300°C or 0…500°C Accuracy: ±1% add. 50mV
Alarm relay Terminals 12, 13, 14	U_{max} = 30V (DC/AC), I_{max} = 0.2A, changeover contact, potential-free
Maximum load (primary current of impulse transformer)	I_{max} = 5A (duty cycle = 100%) I_{max} = 25A (duty cycle = 20%)
Power dissipation	max. 20W
Ambient temperature	+5…+45°C
Degree of protection	IP20
Installation	If several controllers are installed on one top hat rail (DIN TS35 rail), a clearance of at least 20mm should be allowed between them. The moving clip required for fastening must be facing down for mounting on a horizontal top hat rail.  End holders to mechanical fix the controller must be fitted at both ends for mounting on a vertical top hat rail.
Weight	Approx. 0.7kg (incl. connector plug-in parts)
Housing material	Plastic, polycarbonate, UL-94-V0
Connecting cables Type / cross-sections	Rigid or flexible; 0.2…2.5mm² (AWG 24…12) Plug-in connectors **If ferrules are used, they must be crimped in accordance with DIN 46228 and IEC/EN 60947-1.** **This is essential for proper electrical contact in the terminals.**

10 Dimensions



11 Modifications (MODs)

Owing to its universal design, the RESISTRON® temperature controller RES-406 is suitable for a very wide range of heatsealing applications.
One modification (MOD) is available for the RESISTRON® temperature controller RES-406 for implementing special applications.
The modifications must be ordered separately.

MOD 01

Amplifier for low secondary voltages (U_R = 0.25…16VAC). This modification is necessary, for example, for very short or low-resistance heatsealing bands.

12 How to order

Pictures exemplary.

	**Contr. RES - 406 / . . . VAC** **115**: Power supply 115VAC, P/N 740601 **230**: Power supply 230VAC, P/N 740602 **400**: Power supply 400VAC, P/N 740603 Scope of supply: Controller includes connector plug-in parts (without current transformer) **Modification MOD . . (optional, if required)** e.g. **01**: MOD 01, P/N 800001 (Amplifier for low voltage) Please indicate the article numbers of the controller and the required modifications (optional) in all orders, e.g. RES-406/400VAC + MOD 01 (controller for 400VAC power supply with amplifier for low voltage) P/N 740603 + 800001 must be ordered
	**Current transformer PEX-W4** P/N 885106
	**Line filter LF- . . 480** **06**: Continuous current 6A, 480VAC, P/N 885500 **35**: Continuous current 35A, 480VAC, P/N 885506
	**Impulse transformer** See ROPEX Application Report for design and ordering information
	**Communiction interface CI-USB-1** P/N 885650
	**Temp. meter ATR- .** **3**: 300°C range, P/N 882130 **5**: 500°C range, P/N 882150
	**Booster B- . . .** **075415**: Max. pulse load 75A, 415VAC, P/N 885302 **100415**: Max. pulse load 100A, 400VAC, P/N 885304

For more accessories: "Accessories" leaflet

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