TOSS
VERPACKUNGSSYSTEME

PIREG®-C2 PROFINET™

Resistance-temperature controller with PROFINET™ interface

Device description

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1. General, safety and warning instructions

1.1 Notes on device description

This devices description serves to ensure the optimal assembly, start-up, operation and maintenance of PIREG-C_2 and must be read before performing these actions. Keep the device description close at hand and accessible to every user for consultation as needed. Hand over this device description to the future user of the PIREG-C_2. All required settings are described in the present device description. Nevertheless, please do not attempt any unauthorised manipulations in case of difficulties during start-up and operation. In doing so you can put yourself and others at risk and jeopardize your warranty claim. In this case, please contact us immediately:

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1.2 Icons and symbols

Danger: Indicates a hazard which can result in personal injuries. Where this symbol is used you must consult the device description and observe and follow the instructions provided therein to avoid hazards.

Danger: Indicates a hazard due to electric current. Disregarding safety instructions can lead to the risk of serious or deadly injuries.

Danger: Indicates a hazard which can result in personal injuries up to burn up due to hot surfaces.

Note: Indicates a particularly important information disregarding of which can result in e.g. property damage.

1.3 General safety instructions

Caution: Instructions and warnings contained in this description must be observed in order to ensure safe operation. The device can be operated under the conditions specified in the **??** without impairing its operational safety.

Caution: This device may be installed and operated only by trained electricians! Maintenance and repairs must be performed exclusively by technically trained experts who are familiar with associated hazards and warranty provisions.

Note: Please make sure to familiarise yourself with the device by reading this device description fully and carefully before you start to operate it.

1.4 Application

Note: The resistance-temperature controller PIREG-C_2 may be used only for heating and temperature control of heating conductors expressly suitable for this purpose using isolating transformers in compliance with regulations, instructions and maintenance listed in this description. Disregarding the above instructions or improper use may result in impairment of safety or overheating of the heating conductor, the electrical wiring, the transformers and other components.

1.5 Notes on heating conductor

An essential requirement for the function and safety of the overall heating system is the use of suitable heating conductor. The positive temperature coefficient of the heating conductor used must be equal or greater than the positive temperature coefficient set at the PIREG-C_2. The temperature suitable for the temperature coefficient must be set at the PIREG-C_2 via the interfaces (see 13 and 16.7.8) The temperature coefficient of the heating conductor must be positive over the entire temperature range.

Table 1: Predefined temperature coefficients

Alloy	Tk_1	Tk_2	Tk_3
Alloy L	$7.46 \cdot 10^{-4}\,K^{-1}$	$0.00 \cdot 10^{-6}\,K^{-2}$	$0.00 \cdot 10^{-9}\,K^{-3}$
Alloy M	$8.62 \cdot 10^{-4}\,K^{-1}$	$0.00 \cdot 10^{-6}\,K^{-2}$	$0.00 \cdot 10^{-9}\,K^{-3}$
Alloy A20	$10.80 \cdot 10^{-4}\,K^{-1}$	$0.00 \cdot 10^{-6}\,K^{-2}$	$0.00 \cdot 10^{-9}\,K^{-3}$
Norex	$48.30 \cdot 10^{-4}\,K^{-1}$	$-6.12 \cdot 10^{-6}\,K^{-2}$	$2.80 \cdot 10^{-9}\,K^{-3}$
Alloy A20C	$12.65 \cdot 10^{-4}\,K^{-1}$	$0.00 \cdot 10^{-6}\,K^{-2}$	$-0.70 \cdot 10^{-9}\,K^{-3}$
Alloy A20D	$12.55 \cdot 10^{-4}\,K^{-1}$	$0.00 \cdot 10^{-6}\,K^{-2}$	$0.00 \cdot 10^{-9}\,K^{-3}$

Table 2: Limit values for the user defined temperature coefficients

	Lower limit	Upper limit
Tk_1	$3.00 \cdot 10^{-4}\,K^{-1}$	$99.99 \cdot 10^{-4}\,K^{-1}$
Tk_2	$-99.99 \cdot 10^{-6}\,K^{-2}$	$99.99 \cdot 10^{-6}\,K^{-2}$
Tk_3	$-99.99 \cdot 10^{-9}\,K^{-3}$	$99.99 \cdot 10^{-9}\,K^{-3}$

Caution: Using a heating conductor with temperature coefficients that is too low or setting the temperature coefficient at the controller too high, can result in an uncontrolled heating and even burn up of the heating conductor.

When correcting setpoint voltage you can also use lower temperature coefficients (see 9.1.3). Heating conductors connected in parallel can be regulated more precisely to the same temperature than those in series connection. However, cabling must be strictly symmetrical and designed in such a way that no overcurrent results when two opposing heating conductors come into contact. If heating conductors in series are to be used, take into account the effect on the overcurrent reaction when two opposing sealing bands touch when choosing the type of connection.

1.6 Notes on sealing transformer

The sealing transformer must be designed according to EN 61558 (VDE 0570) or UL 5085 (Isolating transformer with reinforced insulation) and designed in a single-chamber construction. All standard-compliant types and designs can be used as sealing transformer. The induction in the iron core of the transformer must not be lowered, as is otherwise generally common for primary-side thyristor operation. A transformer with fewer losses is disrupted less on the secondary side than a low inrush current transformer. Therefore, use stiff and rather larger transformers for applications with shorter heating and sealing time. For large sealing operations a transformer with a primary voltage of 400 V is advantageous, because switching capacity of the internal actuator of the PIREG-C_2 is more than sufficient and there is no need to use external actuators (semiconductor relay).

Caution: If the transformer is to be placed in the machine body, a sufficient contact protection must be provided. In addition, you must prevent water, cleaning solutions or conducting fluids from coming into contact with the transformer. Cable cross-sections must be designed according to the actually occurring currents. Disregarding these instructions impair the electrical safety.

For better results the transformer power and the secondary voltage must match the heating conductor. A high transformer output voltage achieves a short heating time. However, the voltage should not be selected too high, so that no fewer than 12 measurements of the controller are required during heating for a temperature setpoint jump of 300 °C (heating time ≥ 240 ms). For lower heating curves correspondingly, fewer measurements are required. (PIREG-C_2 performs a measurement every 20 ms during the heating). The greater the secondary voltage of the transformer for a given heating conductor, the more energy is used in the heating conductor, even in OFF state. This takes place through the temperature measuring pulse sent continuously to the heating conductor by the controller. That is why the rest temperature deviates more from the ambient temperature in the OFF state the higher is the secondary voltage of the transformer.

1.7 Notes on current transformer

Caution: The current transformer is part of the control system. Use only original Toss® current transformer. The current transformer must be operated only with a ballast resistance. The ballast resistance is built-in in the PIREG-C_2. The current transformer must be installed such that the magnetic stray field of the sealing transformer or other stray field does not influence the measurement.

Caution: The cable used to connect the heating conductor can heat up the current transformer.

1.8 General assembly instructions

The PIREG-C_2 resistance-temperature controller is intended exclusively for the switch cabinet installation. Open operation is not allowed. The controller as well as the current transformer are snapped on a 35 mm support rail according to EN 60715 (EN 50022). Maintain a distance of at least 20 mm to the neighbouring devices when installing the controller on the support rail. Take into account the heat radiation of the neighbouring devices when mounting the controller (observe the permissible ambient temperature!).

Note: Before installing the connectors make sure that all supply and connection cables are voltage-free. Make sure to comply with the five safety rules of electrical engineering.

1.9 Maintenance

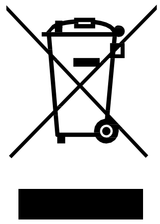
The PIREG-C_2 resistance-temperature controller does not require any special maintenance. Occasional checking and tightening of the connection terminals are recommended. Dust deposits on the controller can be removed with dry, compressed air when disconnected from power supply.

1.10 Validity

The first delivered device version (vvv) was the 1.00 with the program version 1.01 for the galvanically isolated side (ggg) and 1.01 for the measuring equipment side (mmm). Additions to this device description, which are valid as of the later version, contain the version specifications, abbreviated Vvvv/ggg/mmm, e.g. V1.00/1.01/1.01, as of which they are valid. The device and program version can be read via the interfaces using the command (VERS).

1.11 Disposal

Note: Do not dispose of the device in household waste!
The PIREG-C_2 and its components must be disposed of through local collection points for waste electronic equipment in accordance with the WEEE Directive 2012/19/EU on waste electrical and electronic equipment.



Incorrect disposal can result in hazards for the environment.
The PIREG-C_2, its components and packaging materials must be disposed of in an environmentally friendly manner in accordance with country-specific waste treatment and disposal regulations.

2. Scope of delivery

Temperature controller **PIREG-C2**
current transformer **PIREG-CT-50**

3. Accessories

Set-point potentiometer
0 **…** 300 °C

Analogue actual value display
0 **…** 300°

4. Brief description

PIREG-C_2 resistance-temperature controller with a PROFINET™ interface as bus system is used for temperature control of the heating conductor for the thermal pulse sealing of films. The sealing transformer is switched by the PIREG-C_2 on the primary side. Either the internal actuator or an external semiconductor relay, which is activated by PIREG-C_2, can be used. The heating conductor is fed from the secondary side of the transformer. The measuring signals are received directly at the heating conductor and provided to the controller.

The temperature coefficient Tc is a material constant of the metal alloy used for the heating conductor and must be positive. This increases the resistance of the heating conductor when heated. This effect is used for purposes of temperature control. The temperature controller measures and controls the resistance of the heating conductor. The temperature actual value is determined through voltage and current measurement.

PIREG-C_2 operates as a proportional controller, which itself determines the optimal P-factor, i.e. the control amplification, for the controlled system during the calibration. The controlled system consists of the sealing transformer and the heating conductor. The P-factor determined during calibration can be subsequently corrected with command or via the setpoint value input (see command reference of the serial interfaces and 16.7.15). An additional compensation function minimises the residual control deviation typical for a proportional controller.

The PIREG-C_2 is operated either in the classic manner with setpoint potentiometer or setpoint voltage, actual value instrument, LEDs and switches or digital signals (10, 11, 12), via the PROFINET™ interface (16), as well as via the RS232-, RS485- or USB interface (13.1, 13.2) with which the PIREG-C_2 is equipped. The PIREG-C_2 can be set exclusively via the PROFINET™ interface or the RS232-, RS485 or USB interface. Combinations of operating modes are also possible.

The PIREG-C_2 is set to temperature coefficients (see 13 and 16.7.8). In case of deviating values of the temperature coefficients the setpoint voltage must be corrected. The PIREG-C_2 can also determine the actual temperature coefficients of a heating conductor through a temperature coefficient correction, Tc correction (see command `KPFK` and 16.7.15). To simplify the temperature coefficient correction, Tc correction, the PIREG-C_2 can be connected to an external thermometer via the RS232 interface which measures the actual temperature of the heating conductor.
Depending on the setting, the PIREG-C_2 operates up to a temperature range of 500° C.

The controller automatically adjusts to the secondary voltage of the transformer during calibration and current through the heating conductor. The secondary voltage of the transformer can be within a range of 1 … 120 V. The current measured with a current transformer can be within a range of 20 … 500 A. The calibration values can be stored in the controller, so that after switching on the power, under the same requirements, the recalibration and the start-up time is saved. The PIREG-C_2 can perform the calibration both at a fixed room temperature of 20° C as well as at a variable ambient temperature between 0 … 500°C. The actual reference temperature is transmitted to the controller from outside. This is advantageous for constant sealing temperatures with different ambient conditions (see command `EIPA` and 16.7.9).

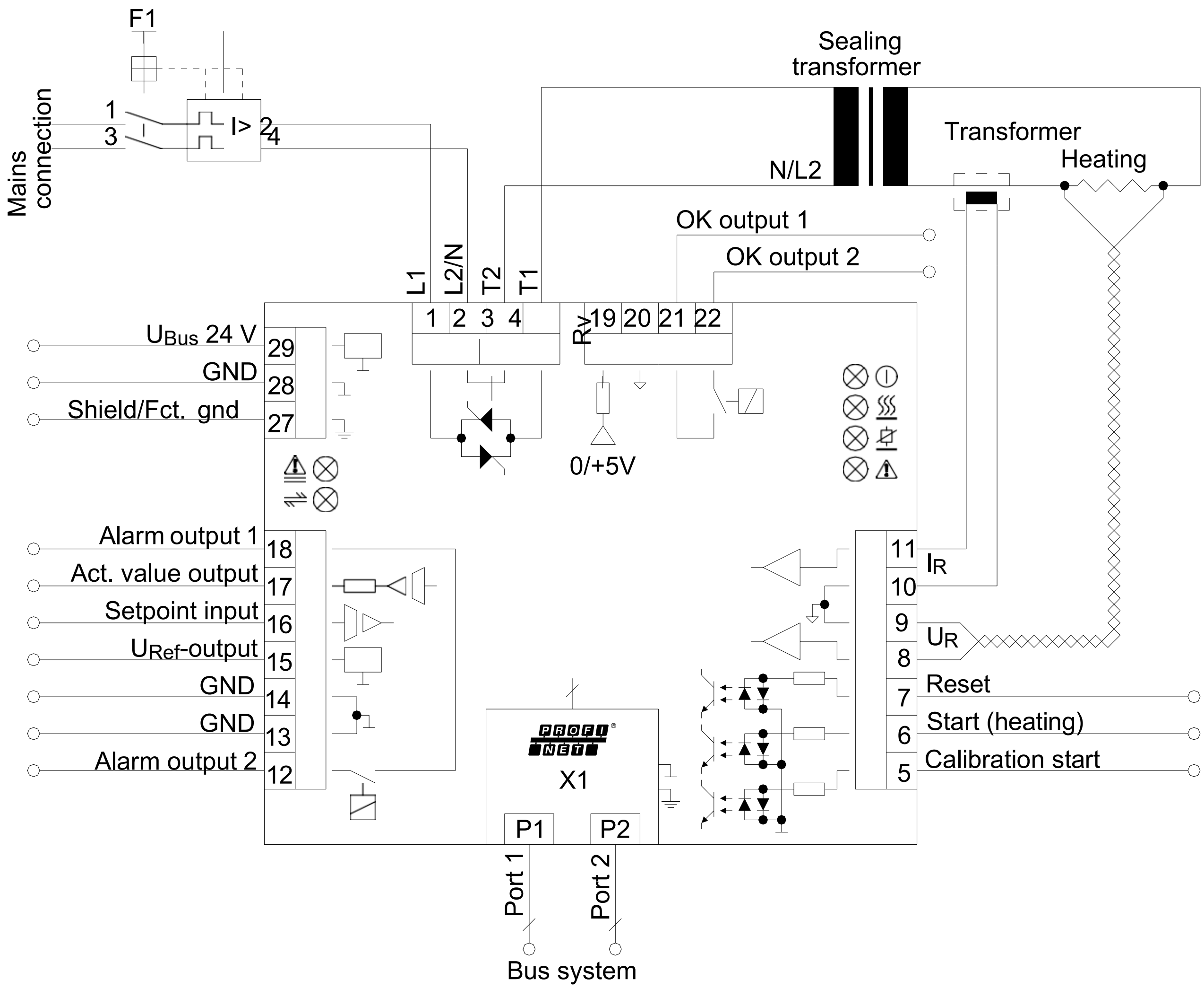
The PIREG-C_2 also switches on high-quality sealing transformers, e.g. toroidal transformers, on the primary side without a power surge. A soft-switch procedure is used with which the remanence takes into account and influences the sealing transformer. Remanence is the residual magnetisation in the iron core of the transformer.

An initialisation setting of the remanence is performed automatically once the power is switched on. The heating conductor is inevitably heated to approx. 40 … 70 °C for a short time. Only a short remanence setting with a duration of 40 ms for EI and 80 ms for toroidal transformers is used for each sealing process. If the pause between two sealing processes for toroidal transformers is greater than 10 min, the duration is increased to 160 ms.

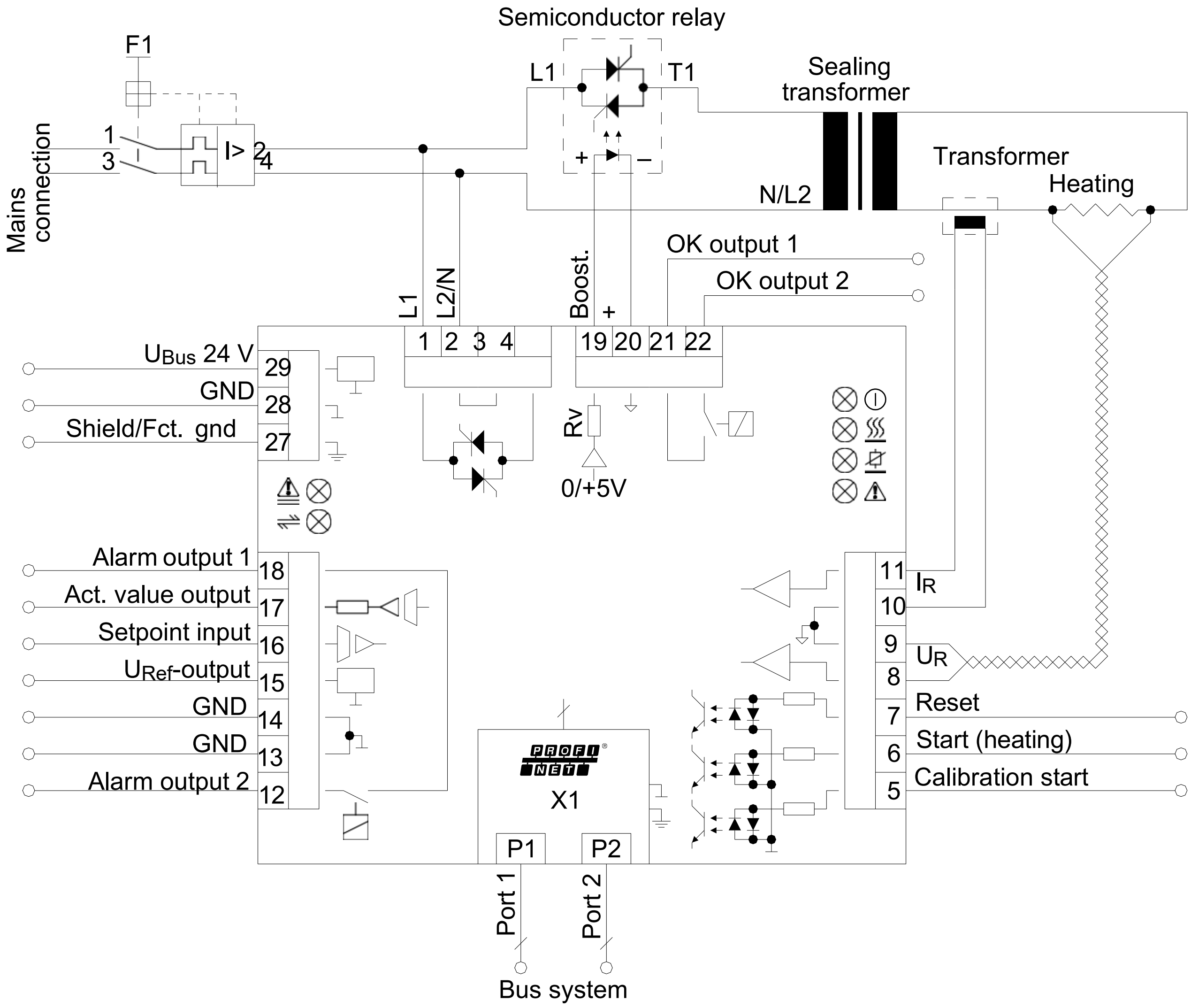
For the temperature control itself the PIREG-C_2 uses a phase angle control.

5. Connection diagrams

5.1 Control with internal actuator



5.2 Control with external solid-state relay



6. Assembly and start-up

First it must be checked whether the connection voltage specified on the resistance-temperature controller matches the mains voltage used and that the transformer primary current does not exceed the maximum permissible load current of the controller.

Caution: For a secure operation, the PIREG-C_2 resistance-temperature controller must be operated only on symmetrical TN and TT networks.
During installation, a correctly dimensioned overcurrent protection device must be provided before the PIREG-C_2 mains input.

Caution: The PIREG-C_2 must be connected to the mains voltage via an easily accessible and marked isolating device (e.g. switch or circuit breaker).

Note: The Terminal 27 must be earthed so as to ensure that the shielding of the Ethernet cable is effective in accordance with the requirements of the PROFINET™ (Functional Earthing).

6.1 Assembly

The PIREG-C_2 resistance-temperature controller is intended exclusively for fixed installation. Open operation is not allowed.

As per its intended application the PIREG-C_2 must be used only in a safety enclosure, which complies with the requirements against spread of fire, against electrical shock, against mechanical hazards and has an adequate strength in accordance with UL61010-1. The controller as well as the current transformer are snapped on a 35 mm support rail according to EN 60715 (EN 50022).

During the assembly of the controller, maintain a minimum distance of at least 20 mm to the neighbouring devices and wiring to all sides. Take into account the heat radiation of the neighbouring devices when mounting the controller (observe the permissible ambient temperature!).

6.2 Mains voltage selection

The types PIREG-C2-2xx of the resistance-temperature controller have a manual 120/240V mains voltage switching. The mains voltage is switched with a slide switch which is activated from the outside using a screw driver. The access to the slide driver is located on the underside of the PIREG-C_2 between the ventilation slots.

Depending on the setting, the resistance-temperature controller of the type PIREG-C2-2xx can be operated with the mains switch both at a mains voltage of 100 … 127 V as well as a mains voltage of 200 … 240 V. The type PIREG-C2-2xx of the resistance-temperature controller is factory set for a mains voltage of 200 … 240 V.

The resistance-temperature controller of the type PIREG-C2-4xx has no mains voltage switch.

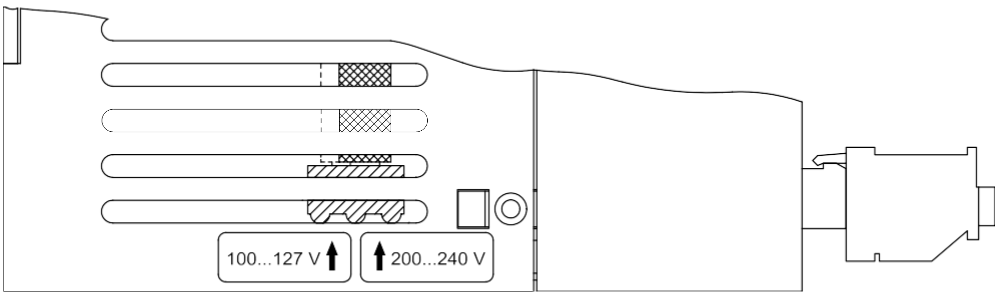


Figure 1: View of the underside of the PIREG-C_2. Switch in left position: Mains voltage 100 … 127 V.
Switch in right position: Mains voltage 200 … 240 V.

6.3 Connection

The resistance-temperature controller must be connected according to the connection diagram of the actuator variant used. No need to take into account the polarity of the measuring leads for the current IR and the voltage UR on the heating conductor as well as the connections of the sealing transformer on the primary and secondary side.

Note: The measurement leads of the voltage measurement input U_R (terminals 8,9) and the current measurement input I_R (terminal 10,11) must not be interchanged, as an interchange can damage the current measurement input I_R. It is recommended to recheck the connections of the voltage measurement input U_R and current measurement input I_R before start-up.

When connecting a setpoint potentiometer make sure the direction of rotation is correct. In the 0° C position of the resistance between the terminals 13 and 16 must be 0 Ω. The measuring leads for the voltage measurement U_R are connected directly to the heating conductor and must be twisted (> 50 stocks/m). The supply lines from the sealing transformer must be connected to the heating conductor with cable lugs and not with plug-in connectors. The cables must have sufficient cable cross section. No additional components such as fuses, switches or resistive connections should be installed in the secondary circuit of the sealing transformer.

6.3.1 Transformer

Note the following when installing the current transformer:

- The current transformer must not be installed in areas where it exceeds 75% of the wiring space of a cross-sectional area.
- The installation of the current transformer must not block any ventilation openings.
- The current transformer must not be installed in the area of arc vents.
- The current transformer is not intended for the wiring method of Class 2 and the connection to devices of Class 2.
- The current transformer and the cables must be secured such that they do not come into contact with any live parts.

Caution: The PIREG-C_2 must always be activated before the installation or maintenance of the current transformer.

6.4 Set the mains voltage

Once the mains voltage is set the green LED *Mains* lights up.

If the calibration type “Recalibrate” is selected, the PIREG-C_2 switches directly to the calibration once the mains voltage is set and adapts the controller to the combination of sealing transformer and heating conductor. The blue LED *Calibrate* lights up and the yellow LED *Heating* starts flashing. After a successful calibration the PIREG-C_2 returns to the OFF state and is ready for operation (2)

If the calibration type “Saved calibration” is selected, the PIREG-C_2 switches to OFF or FAULT state once the mains voltage is set and waits for the signal *Calibration-Start*. The LED *Alarm* and *Calibrate* can be permanently Off or On and flashing. If there are no errors 1 … 3 (see 11), you can switch to calibration.

Caution: There should not be any High-Signal on the control inputs *Reset* and *Start* before switching the controller for the first time. If the calibration does not match a modified heating tape, it can overheat.

7. Heating conductor

The heating conductor is an important component of the controller circuit, as it is both a temperature sensor as well as a heating element at the same time. Due to their diversity, it is not possible to discuss the impact of the geometry of the heating conductor. Therefore, only a few remarks on physical and electrical properties are provided.

The measuring principle of the resistance-temperature controller requires a heating conductor with a positive temperature coefficient, which is set at the PIREG-C_2. When using a heating conductor with a lower temperature coefficient than at the controller, the heating conductor can overheat or even burn up. The actual value cannot be brought to the setpoint despite full heating output.

When heating the heating conductor for the first time at 250 … 300 °C, the cold-resistance of the heating conductor experiences a resistance change (Burn-in effect) of 2 … 3 %. This resistance change, in turn, leads to a zero point error if 20 … 30 °C. After a few heating cycles this zero point error must be corrected by the PIREG-C_2 with a recalibration.

Due to irreversible changes of the temperature coefficients an overheated or burnt-out heating conductor should no longer be used.

A constructive measure for improving the precise temperature control and increasing the service life of the heating conductor as well as the Teflon coating is the copper or silver plating of the heating conductor ends. This measure ensures conductor “cold ends” and enables the controller to measure the temperature only there where is also sealed. As a rule, the temperature of the heating conductor can be determined by the PIREG-C_2 only as the mean value of all sections of the heating conductor. If the individual sections of the heating conductor are exposed or are otherwise not in contact with the heat dissipating surfaces, they will be hotter than the sections of heating conductor when heated, which can release their heat. In this case, the heating temperature reached in these sections is lower than the temperature displayed by the controller, which negatively impacts the sealing result.

In order to offset the production-related tolerance of the heating conductor a recalibration must be performed after each heating conductor replacement. In case of brand new heating conductors, it is necessary to take the burn-in into account.

7.1 Burn-in of the heating conductor

The heating conductor is best burned in with open sealing tool in such a way that the *Start* signal is given and the temperature setpoint is slowly increased from zero up to the burn-in temperature. The burn-in end temperature must be at least 50° C above the maximum sealing temperature on the heating conductor. The heating conductor must be monitored. (Annealing colours, hot spots).

Perform a recalibration after the burn-in.

Note: It is also recommended to increase the setpoint slowly for the first time, if a thermal pretreated heating conductor is used, which must not be burned-in. This way, you can check the proper temperature control of the heating conductor. This way, you can detect errors in calibration or selection of temperature coefficients without overheating or burning up of the heating conductor.

8. Operating states

8.1 Calibration

The PIREG-C_2 adapts to the sealing transformer-heating conductor combination automatically during calibration. The voltage UR at the heating conductor and the current IR through the heating conductor are measured every second. In this state the blue LED lights up *Calibrate* and the message *Calibration-OK* is reset. The output *OK* is factory set to display the state of the message *Calibration-OK*. The analogue output *actual value* is used to display the individual steps. For this, the analogue output *actual value* is updated every second. The calibration process with individual states is available to the PROFINET™ interface and other interfaces. The controlling PLC can also monitor the calibration by observing the analogue output *actual value* at terminal 17, detect the end of the calibration with the *Calibration-OK* message and finally enable the operator to seal. During the calibration steps 1 to 7 no *Start* signal should be given, as otherwise the PIREG-C_2 aborts the calibration with Error 2.

8.1.1 Calibration process

8.1.1.1 Initialisation:

During the calibration the PIREG-C_2 collects the data required for the calibration. In addition, it checks the selected temperature coefficients for dynamics and consistency in the selected temperature range. Should the dynamics and consistency exceed the permissible limits, the PIREG-C_2 aborts the calibration with Error 13 (Parameter error). The set reference temperature T_{ref} is checked for the permissible range of 0 … 50° C. If the limit temperature lies outside this range, the PIREG-C_2 also aborts the calibration with Error 13 (Reference temperature is selected to high).

8.1.1.2 Calibrate input amplifier:

The input amplifier for U_R and I_R are gradually adjusted to the voltage and current on the heating conductor. In the first step the required modulation reserve for the sealing transformer-heating conductor combination is determined, if this has not been set manually with the `KASR` command. In this calibration step the analogue output *actual value* is subjected to different voltage values every second. The measured current or voltage measurement value is displayed alternately. The current is shown in the range of 0 … 5 V, the voltage in the range of 5 … 10 V. The zero point of the measurement value is at 5 V. The measurement amplifier for the voltage U_R and current I_R are initialised at the start of calibration with minimal amplification. With successful adjustment, the measurement value of the current is in the range of 1.66 … 3.33 V and the measurement value of the voltage in the range 6.66 … 8.33 V at the end of the calibration step.

8.1.1.3 Determine phase shift:

The transformer-related phase shifts between U_R and I_R are measured and correct in this step. The controller automatically sets the optimal sampling time for U_R and I_R. The analogue output *actual value* shows the phase shift. A signal of approximately 5 V corresponds to the optimal value.

8.1.1.4 Determine reference resistance:

The reference resistance R_{ref} of the heating conductor is determined in this step. A fixed reference temperature of T_{ref} = 20 °C is assumed for the calibration of the controller. Alternatively, the variable reference temperature of 0 … 50°C can be specified as setpoint value (50 °C = 1.66 V at 300 °C and 1.00 V at 500 °C). During the initialisation of the calibration the PIREG-C_2 reads the variable reference temperature based on the settings. The reference temperature must have been reached during the calibration so that the controller can operate precisely. By normalising the voltage signal U_R and current signal I_R, the reference resistance for various temperature coefficients always lies within the same resistance range. If 20° C is selected as reference temperature, then R_{20} of the heating conductor is directly determined as the reference resistance. If instead of 20° C another heating conductor temperature has been selected, the determined reference resistance is above or below the value for the R 20 according to the temperature coefficients. The reference resistance is displayed in the calibration step 4 for one second at the analogue output *actual value*. At a reference temperature of 20 °C the voltage at the analogue output *actual value* is 7 … 8 V and at a variable reference temperature it is within a range 6 … 10 V.

8.1.1.5 Wait for temperature comparison time:

The temperature comparison time is used to ensure that the reference resistance has been determined only when the heating conductor has cooled down completely. The signal at the analogue output *actual value* runs down from 10 V to 0 V during the comparison time. A time period of 15s or 30s can be selected for the temperature comparison time. (see `EINS` command and 16.7.8)

8.1.1.6 Check the reference resistance:

The reference resistance is checked after the expiry of the temperature comparison time. When calibrating to a heating conductor which cools down even further during the expiry of the temperature comparison time, the entire calibration is rejected and restarted automatically. In case of a successful reference resistance test, the PIREG-C_2 the PIREG-C2 calculates the R20 of the heating conductor (resistance at 20 °C) from the type of reference temperature coefficients T_{ref} set, the selected temperature coefficient Tc and the determined reference resistance R_{ref}.

8.1.1.7 Determine P-factor:

The P-factor of the sealing transformer-heating conductor combination is determined by a targeted heating with a constant control variable. The heating conductor is heated with a defined control variable by a maximum of approximately 60 K or is exposed to this temperature for a maximum of 120 mains periods. The total amplification of the control system is determined by measuring the power input in the heating conductor and measuring the temperature increase of the heating conductor. This calculates the P-factor for the PIREG-C_2. For very unfavourable conditions in case of sealing transformer-heating conductor combination or mains connection there is the option to manually correct the P-factor of the PIREG-C_2 in a range between 30 … 110 % (see `EIPA` command and 16.7.15). With the P-factor which is set by the `PFUE` command, the P-factor determined by the PIREG-C_2 can be monitored over a valid range (see 8.4 and 16.7.17).

8.1.2 8-Point Tc Correction

With the function of the 8-Point temperature coefficients correction, the tolerance of the temperature coefficients can be corrected. These result from the dispersion in the metallurgical composition of the heating conductor. In the calibration step 8 the heating conductor is gradually heated by the PIREG-C_2 in eight temperature steps. The PIREG-C_2 compares its actual value temperature with the actual temperature of the heating conductor, which is transmitted to it as setpoint or directly as temperature measurement value. The step size depends on the selected temperature range. The first temperature step is always 50° C. The temperature of the eight temperature steps lies 20% below the final value of the temperature range.

The six other temperature steps are equidistant in between:

- 300 °C temperature range: 50, 77, 104, 131, 159, 186, 213 and 240 °C.
- 500 °C temperature range: 50, 100, 150, 200, 250, 300, 350 and 400 °C.

The actual temperature of the heating conductor must be reported back to the PIREG-C_2 externally as setpoint or directly as measurement value of the external thermometer. Deviations of up to ±20 % between the actual value temperature calculated by the controller and the actual temperature of the heating conductor can be corrected (see 9.1.9, `EINS` command and 16.7.8). The correction procedure is controlled with the *Start* signal or the `STST` command. The 8-Point Tc Correction can be saved with the `STKA` command, so that it does not have to be performed again with a recalibration, but only if the heating conductor is replaced.

Operating the 8-Point Tc Correction:

- **Manual operation:** The manual operation of the heating conductor is reported back to the PIREG-C_2 via the analogue input *Setpoint*. The rising edge of the *Start* signal switches to the next temperature heating step. Once a balanced temperature of the heating conductor is set, the temperature set as setpoint is accepted as the actual temperature of the heating conductor with the falling edge of the *Start* signal. After the heating at the next temperature level, you have to wait a long time after the temperature is reached, until the heating conductor has actually reached the new temperature. The analogue output *actual value* shows the corresponding, not yet corrected actual temperature of the PIREG-C_2. At the start of the 8-Point Tc Correction the LED *Calibrate* starts to flash for the duration of the communication setup time with a clock rate of 1 Hz, while the PIREG-C_2 attempts to establish connection with the external thermometer.
- **Manual operation with external thermometer:** The 8-Point Tc Correction is also controlled with the *Start* signal, as described above. The actual temperature of the heating conductor is measured with the external thermometer which is connected to the RS232 interface of the PIREG-C_2.

At the start of the 8-Point Tc Correction, the PIREG-C_2 attempts to autonomously connect with the external thermometer for the duration of the communication setup time. The *Calibrate* LED flashes at a clock rate of 1 Hz during the connection setup and once there is connection to the external thermometer.

- **Automatic 8-Point Tc Correction:** For the automatic 8-Point Tc Correction the external thermometer must be connected to the PIREG-C_2 and the set value for the heating time must be greater than zero. The heating time is the time until the heating conductor has reached a balanced temperature in a temperature level. It can be adjusted by the user (see `KTKZ` command and 16.7.16). The PIREG-C_2 runs through the automatic 8-Point Tc Correction autonomously and remains at each temperature level according to the set heating time.

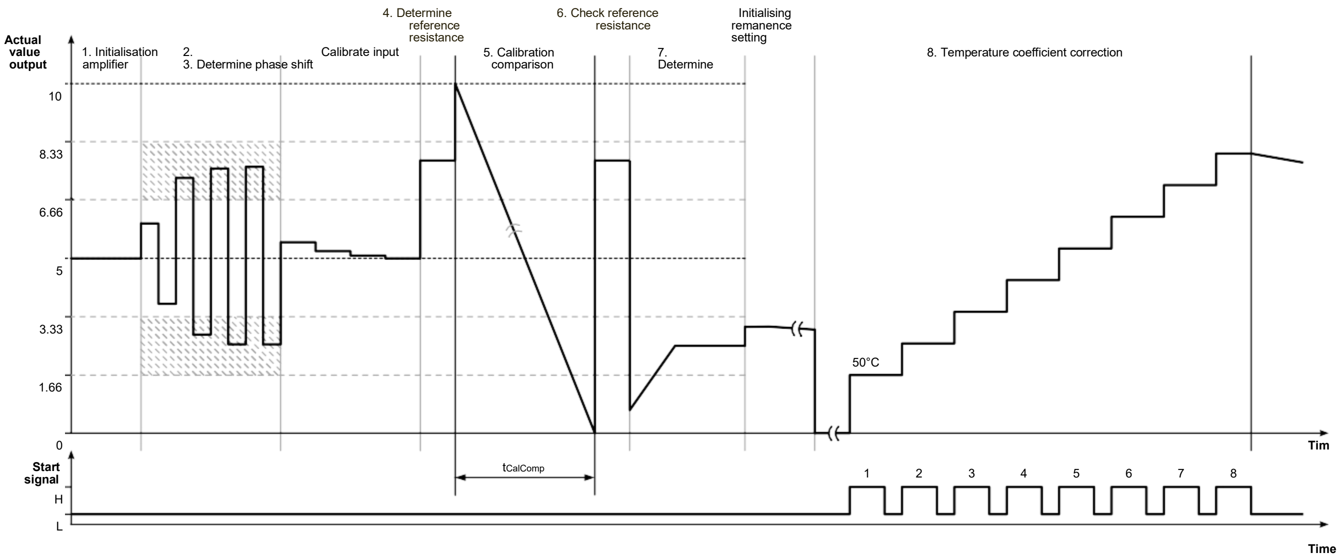


Figure 2: Calibration process

Calibration steps 1 to 7 must be performed by the controller during each calibration. Step 8 is a selectable calibration function (see 8.1.2). If an error occurs during the individual calibration steps the PIREG-C_2 aborts the calibration process and starts a new attempt. After the fifth attempt it aborts the calibration with a fault message. (see 8.4)

To make sure that the reference resistance R_{20} of the heating conductor is determined correctly, the calibration must be performed when the heating conductor has a temperature of approx. 20° C or the externally determined calibration temperature. Various factors influence the time for a calibration process. The voltage level on the heating conductor, the current through the heating conductor, the phase shift of the U_R and I_R and the P-factor of the sealing transformer-heating conductor combination determine the calibration time. The controller requires maximum 48s or 63s for a calibration process. If the calibration process is not successful, because e.g. the P-factor has been determined incorrectly, the controller makes four further attempts before reporting an error. In this case, the maximum calibration time is 240s or 315s, depending on the temperature comparison time.

In the calibration type “Recalibrate”, the controller switches to calibration every time after restarting the controller in order to perform a recalibration. The calibration can also be started in OFF and FAULT state with the *Calibration-Start* signal.

If the calibration type “Saved calibration” is selected, the controller switches to calibration only if the *start* signal is applied in the OFF and FAULT state or before the mains is switched on. With this calibration type the calibration values are saved in a non-volatile memory and are immediately available to the controller after the mains is switched on or after the *Reset* signal.

At the end of a successful calibration process the operator or the controlling PLC can detect as follows:

- **Without 8-Point Tc Correction:** By observing the actual value for the characteristic voltage curves (see 2 Step 5, 6 and 7 with subsequent remanence sets and cooling down of the heating conductor of approx. 50° C to about the ambient temperature).
- **With 8-Point Tc Correction:** As before, but with subsequent 8-Point Tc Correction. The controller is ready for operation after the last correction step. The PLC must then wait until the temperature of the heating conductor has cooled down.
- **With message *Calibration-OK*:** The message *Calibration-OK* is reset at the start of the calibration and reset at the end of the successful calibration. This is the factory set function of the *OK* output, which can be modified with the `KONF` command.

8.1.3 Single-point Tc correction

The single-point temperature coefficient correction makes it possible to correct the tolerance of the temperature coefficient of the heating conductor for only one operating point. For this operating point, the actual temperature of the heating conductor is reported back to the PIREG-C2 externally as setpoint or directly as measurement value of the external thermometer. The single-point Tc correction runs outside the normal calibration and is started in the OFF state. The single-point Tc correction has an OFF and an ON state. Once the single-point Tc correction has started, the PIREG-C2 is in the OFF state. In the ON state, the heating conductor is heated to the temperature set as setpoint in the OFF state. After the heating you have to wait a long time after the temperature is accepted, until the heating conductor has actually reached the new temperature. The analogue output *actual value* shows the not yet corrected actual temperature of the PIREG-C2. The single-point Tc correction ends when existing the ON state. The correction procedure is controlled with the *Start* signal or the `STST` command. Deviations of up to ±20 % between the actual value temperature calculated by the controller and the actual temperature of the heating conductor can be corrected. The single-point Tc correction can be performed only if the 8-Point Tc Correction has not been performed during the calibration. The single-point Tc correction is reset with every calibration. The end-point Tc correction can be saved with the `STKA` command, so that it does not have to be performed again after a recalibration, but only if the heating conductor is replaced.

Operating the single-point Tc correction:

- **Manual operation:** The single-point Tc correction is started with the `STKA` command. If the pulse-control for the Calibration-Start input (5) has been configured with the `KONF` command, the single-point Tc correction can also be started by applying a High Level for less than one second. As long as there is a Low Level at the *Start* signal input, the PIREG-C2 remembers the temperature set as setpoint as the operating point temperature. As soon as the *Start* signal is set, the PIREG-C2 heats the heating conductor at the remembered temperature of the operating point. Now the actual temperature of the heating conductor is set as setpoint. If the *Start* signal is deleted again, the PIREG-C2 calculates the correction factors for the end-point Tc correction and saves them, provided the calibration type “Saved Calibration” is selected.
- **manual operation with external thermometer:** Starting and controlling the single-point Tc correction is performed as described above. The actual temperature of the heating conductor is measured with the external thermometer which is connected to the RS232 interface of the PIREG-C2. The PIREG-C2 attempts to autonomously connect with the external thermometer at the start of the single-point. The *Calibration* LED flashes at a clock rate of 1 Hz if there is connection to the external thermometer.
- **automatic single-point Tc correction:** For the automatic single-point Tc Correction the external measurement device must be connected to the PIREG-C2 and the set value for the heating time must be greater than zero. The heating time is the time until the heating conductor has reached a balance temperature in the ON state of the single-point Tc correction and can be configured y the user (see `KTKZ` command and 16.7.16). The single-point Tc correction starts automatically as described above for the manual operation. The PIREG-C2 runs the automatic Sing-point Tc correction autonomously and remains in ON state according to the set heating time.

8.1.4 P-factor correction

The P-factor correction serves the subsequent manual correction of calibrated P-factor (see `KPFK` command 16.7.15) with very unfavourable conditions of the sealing transformer-heating conductor combination or mains connection. The correction range is 30 … 250 % (from V1.01/1.09/1.07). The P-factor correction can be set with the `KPFK` command. The P-factor correction value is not reset with a calibration, as it is system dependent.

8.2 OFF state

In the OFF state, the PIREG-C2 continuously measures the heating conductor resistance, determines its temperature and outputs it as the actual value. For these purposes, a truncated positive and negative mains half-wave with a fixed current flow angle (1.8 ms at a mains frequency of 50 Hz) is fed to the transformer for each resistance measurement. The time interval of the measurements is based on the heating conductor temperature. If the heating conductor has a temperature of 20° C the measurement interval is 1.5 s. With a temperature of 300°C the measurement interval is only 100 ms. Since energy is consumed for the measurement of the resistance in the heating conductor, the latter heats up in OFF state depending on the heating conductor voltage. The controller switches from the OFF state to ON state as soon as the *Start* is available. With the *Calibration-Start*, the PIREG-C_2 switches to calibration and returns to the OFF state in case of successful calibration. The PIREG-C_2 then remains in the OFF state, even if the *Calibration-Start* is still present (Evaluation of the rising edge). If the pulse-control for the calibration-start input (5) has been configured with the (KONF) command, the PIREG-C_2 switches to single-point Tc correction, when a high-signal is applied for less than one second.

8.2.1 Measurement pulse-pause

In the OFF state, the measurement pulse-pause can be switched On and Off with the I (MEPA) command. With the switched-on measurement pulse-pause, the PIREG-C_2 does not send any measurement pulse (for determining the heating conductor temperature) to the sealing transformer. The actual value output shows the last determined value. Thus, only the monitoring of the mains voltage and the device function is active. All other monitoring functions in relation to the measurement pulse are functionless.

8.2.2 Calibration switching

The PIREG-C_2 offers the option of saving eight calibrations and to switch between them using the `KANR` command or by setting the corresponding filed in the PROFINET™ output data (see 16.6.2),. This can happen, however, only in the OFF state. After switching on the mains or reset the Calibration 1 is always active. The heating conductor of the eight calibrations must be the same in terms of temperature coefficient, temperature range and other calibration settings. A possible temperature coefficient correction is performed for every calibration separately. The PIREG-C_2 performs a separate calibration for every heating conductor, which is saves separately.

8.3 ON state

In the ON state the PIREG-C_2 controls the temperature of the heating conductor according to the set setpoint. The control is performed via a phase angle control. As soon as the *Start* is removed, the controller returns to OFF state.

8.4 FAULT state

The PIREG-C_2 moves into the FAULT state when it detects an error. The controller monitors the mains voltage, the heating conductor temperature, the value of the current and voltage measurement on the heating conductor and the calibration parameters. The 12 lists remedies and error areas for the individual errors (11).

The alarm output is set in the FAULT state. In case of a mains failure (Error 3), the activation occurs only with a 2 s delay. In the FAULT state, the alarm and calibration LEDs are activated with different clock rates of 1 or 4 Hz depending on the error that has occurred (11). The actual value output is also clocked in some error cases. Then, the voltage at the actual value output changes every second between the voltages associated with the error. You can leave the FAULT state by switching the mains voltage off, the *Reset* and setting the *Start* signal. You cannot leave the FAULT state with *Calibration-Start* in case of Errors 1 and 3.

In the OFF state after the mains is switched on or after a reset, the errors 4 … 13 with the LEDS and the actual value output are only reported, but the alarm output is not factory set. In this way, a calibration error does not lead to a machine malfunction when switching on. The factory settings can be changed with a `KONF` command (PROFINET™ Parameter 16.7.14).

8.4.1 Temperature monitoring

The temperature monitoring is an additional monitoring function which is activated and controlled with the `TUEE` command via the PROFINET™ Parameter 16.7.22. The temperature actual value during the sealing process is monitored in the ON state to make sure it lies within the temperature OK range. If the actual value leaves the temperature OK range after the expiry of the stabilisation time during the sealing process, the PIREG-C_2 switches to the FAULT state with Error 8. The stabilisation time starts as soon as the temperature actual value has reached the temperature OK range. The stabilisation starts again in case of a change in the setpoint value of more than 2° C.

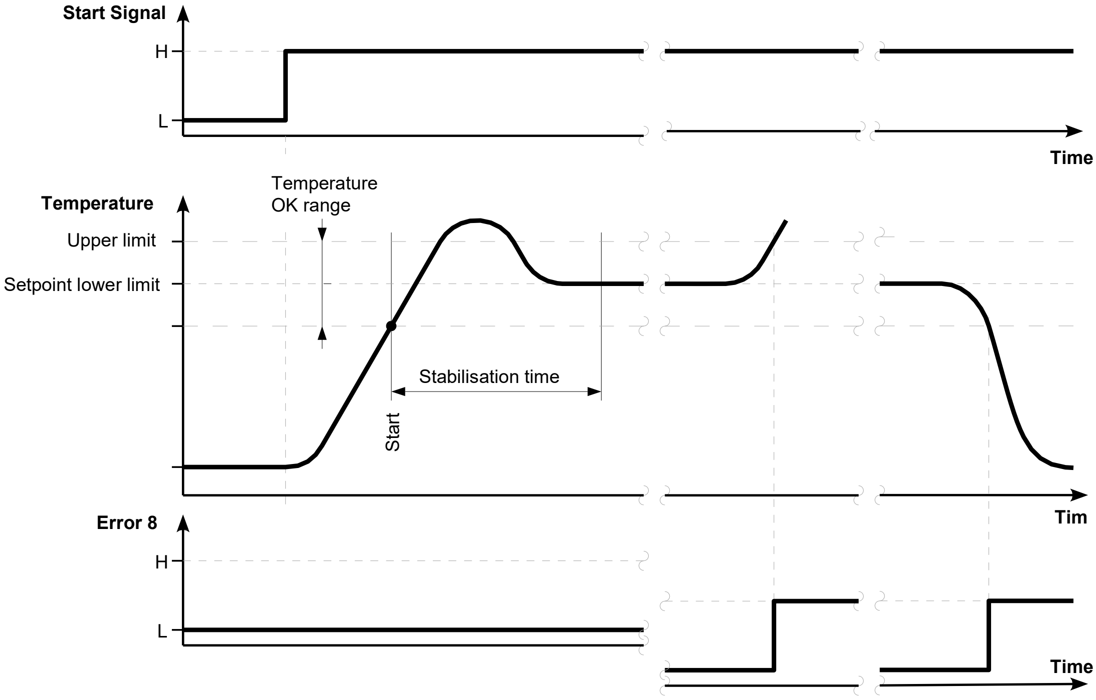


Figure 3: Temperature monitoring

8.4.2 Heating monitoring

The temperature monitoring is an additional monitoring function which is activated and set with `AHUE` command or via the PROFINET™ Parameter 16.7.6. With this function the rise in temperature after applying the *Start* signal is monitored.

Variant 1:

In case of Variant 1 the PIREG-C2 monitors the heating to a maxim value. If the temperature actual value does not reach the set temperature OK range within the set heating time the PIREG-C2 switches to the FAULT state with Error 8.

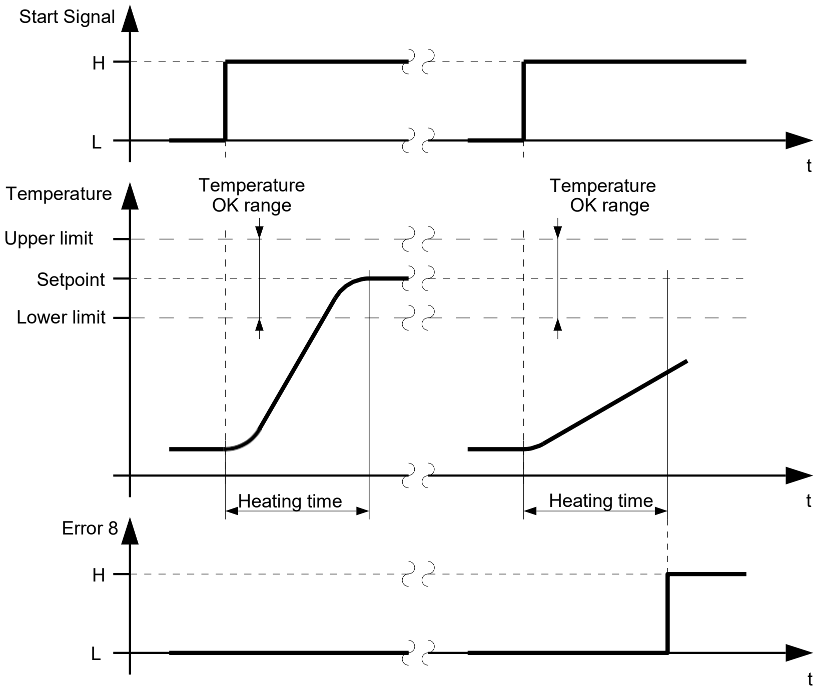


Figure 4: Heating monitoring (Variant 1)

Variant 2:

In case of Variant 2 the PIREG-C2 monitors the heating to a minimum and a maxim value. If the temperature actual value does not reach the set temperature OK range within the set time frame the PIREG-C2 switches to the FAULT state with Error 8.

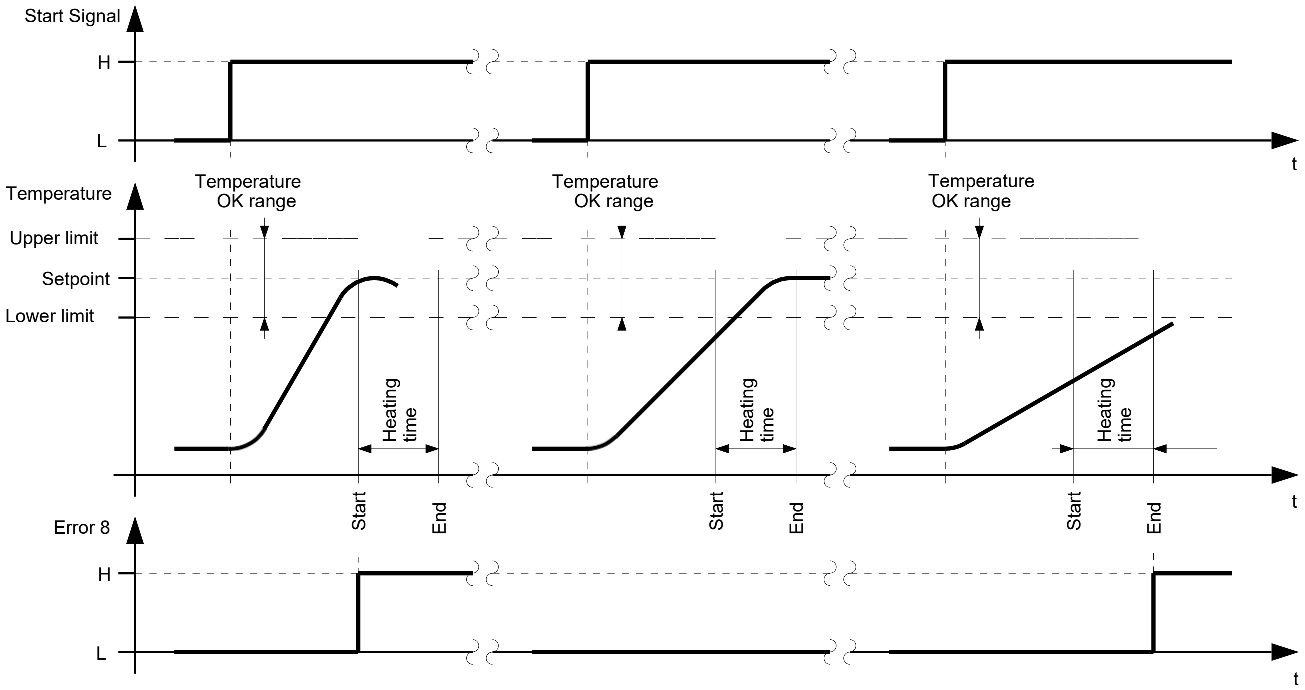


Figure 5: Heating monitoring (Variant 2)

8.4.3 Communication monitoring

The communication monitoring is an additional monitoring function for the three interfaces of the PIREG- C2 which is independently activated and set for each interface with the `KOUE` command. This function checks the communication via the interfaces for an interruption. If there is no communication via the interfaces for longer than the set downtime, the PIREG-C2 switches to Fault state with Error 9.

8.4.4 P-factor monitoring

The P-factor monitoring is an additional monitoring function for the P-factor calibration (see 8.1.1.7), which is set with the `PFUE` command or via the PROFINET™ Parameter 16.7.17. This function monitors the calibrated P-factor for a minimum and maximum value of an OK range. If the calibrated P-factor is outside the OK range, the PIREG-C2 switches to FAULT state with Error 10.

To determine the OK range of the P-factor monitoring, first a calibration with the provided sealing transformer-heating conductor combination must be performed. The calibrated P-factor of the PIREG-C2 can also be read back with the `PFUE` command. The lower and upper limits should be set according to this value. In addition to the sealing transformer heating conductor combination the level of the mains voltage also influences the calibrated P-factor of the PIREG-C2.

8.4.5 Heating time limit

The heating time limit is a monitoring function for preventing the unintended continuous heating of the PIREG-C2 through an operating error. The monitoring function is activated and maximum heating time is set with the `HZBG` command (PROFINET™ Parameter 16.7.5). If the maximum heating time is exceeded in the ON state the PIREG-C2 switches to FAULT state with Error 2 and terminates the heating.

8.4.6 R20 reference value monitoring

The R20 reference value monitoring is a monitoring function R20 value, which is determined during PIREG-C2 calibration (from V1.01/1.09/1.06). The changes of the R20 value, e.g. due to ageing or wear of the heating conductor during calibration, can be detected and monitored with the R20 reference value monitoring. In addition, the R20 reference value monitoring can be used to prevent the disturbances due to interruptions (e.g. with parallel connected heating conductors) from remaining undetected.

The R_{20} reference value monitoring functions only during calibration.

Using the `RHZL` command (PROFINET™ Parameter 16.7.19) the reference resistance R_{20} of the heating conductor is initially saved as reference R_{20} value, e.g. after the calibration of a new heating conductor. Using the `RRUE` command (PROFINET™ Parameter 16.7.19) you can activate the R_{20} reference value monitoring and set the OK range for the saved reference R_{20} value. If the current calibrated R_{20} value of the controller is outside the OK range, the PIREG-C_2 switches to FAULT state with Error 10.

9. Operation

The PIREG-C_2 offers two operating concepts. On the one hand, the classic operation with setpoint potentiometer or setpoint voltage, actual value instrument or actual value voltage, switch or digital signals and LEDs. On the other hand, the expanded operation via the PROFINET™ interface or the RS232- (1), RS485- (2) or USB interface (3) with which the PIREG-C_2 equipped.

Combinations of these operating modes are also possible.

9.1 Interfaces

The PIREG-C_2 can be set only via the PROFINET™ interface or the RS232-, RS485 or. USB-interface. The settings are made using various commands.

9.1.1 Setting commands

Table 3: Commands for Setting Settings

No.	Setting	Command
1	Heating ramp	EINS
2	Temperature coefficient	EINS EIPA TK
3	Calibration comparison time	EINS
4	Temperature range	EINS EIPA TB
5	Calibration type	EINS
6	Transformer type	EINS
7	Reference temperature	EINS EIPA BT
8	8-Point Tc Correction	STKA

9.1.2 Heating ramp

The time value in which the controller brings the temperature actual value up to the setpoint using a linear ramp, is set with the Setting 1. This makes the slow heating of the heating conductor possible.

9.1.3 Temperature coefficient

The temperature coefficient of the used heating conductor is set with Setting 2.

Caution: Using a heating conductor with temperature coefficients that is too low or the temperature coefficient set on the controller is too high, can result in an uncontrolled heating and even **burn up** of the heating conductor.

Then, the actual value can not reach the setpoint and the controller keeps heating up. For heating conductors that have a different temperature coefficient the setpoint voltage must be corrected or the single-point (see 8.1.3) or the 8-Point-Tc correction (see 8.1.2) performed.

Example:

The temperature coefficient of the heating conductor is $Tc = 4.3 \cdot 10^{-4}\ K^{-1}$ and can not be directly set with the `EIPA TK` command. The smallest temperature coefficient which can be set with the `EINS` command is $Tk_{min} = 7.46 \cdot 10^{-4}\ K^{-1}$.

To use the heating conductor the desired setpoint T_s must be adjusted accordingly. The adjusted setpoint T_a is determined as follows:

$$\frac{Tk}{Tk_{min}} = \frac{T_a}{T_s}$$

Hence:

$$T_a = \frac{Tk}{Tk_{min}} \cdot T_s$$
$$= \frac{4{,}3 \cdot 10^{-4}\,K^{-1}}{7{,}46 \cdot 10^{-4}\,K^{-1}} \cdot T_s$$
$$= 0.57 \cdot T_s$$

For a desired setpoint of T_s = 300° C only 5.7 V may be applied to the analogue input *Setpoint* instead of 10 V. With a control voltage of 10 V, the controller will attempt to control at 526° instead of at 300° C.

It is possible to precisely set the temperature coefficient of the heating conductor at the PIREG-C_2 via the interface with the `EIPA` and `KONF` command (PROFINET™ Parameter 16.7.9 16.7.14).

9.1.4 Calibration comparison time

The temperature comparison time is set with the Setting 3. The resistance of the heating conductor is determined at the reference temperature during the calibration. To ensure that the determined reference resistance is correct, the resistance of the heating conductor is once again measured after the expiry of the calibration comparison time and compared with previously determined reference resistance. If the difference of the two measurement values is greater than 1.2 % a new calibration process is started. This prevents the calibration from being conducted on a heating conductor which is still cooling down. The longer the calibration comparison time is selected, it would be more likely that resistance changes due to cooling of the heating conductor are detected during calibration.

9.1.5 Temperature range

The operating temperature range of the controller from 300° C or 500° C is selected with the Setting 4. The upper and lower temperature values apply accordingly.

9.1.6 Calibration type

Recalibration:

An automatic recalibration is performed each time after switching the controller on or the *Reset* signal. The calibration values are not saved. The calibration can also be started in OFF and FAULT state with the *Calibration-Start*.

Saved calibration:

The calibration sates only with the *Calibration-Start* signal. For this, the *Calibration-Start* signal can be applied in OFF and FAULT state or before switching the mains on. The calibrated values are saved in a non-volatile memory and are not lost in case of power supply failure or *Reset* signal. This means that with changes in the heating conductor configuration or a change of the transformer a recalibration must be performed. Then, the newly determined values overwrite the previous values in the memory.

9.1.7 Transformer type

The PIREG-C_2 is adapted to the transformer type with the Setting 6. After switching the controller on or the *Reset* signal the transformer is subjected to several uni-polar phase controls and the remanence in the iron core of the transformer is brought to a defined position. The current flow angle of the phase control for setting the remanence is adjusted to the transformer type. For every sealing process the quick-start procedure is used during which the transformer is subjected to only a few remanence setting pulses before full power on. If with the toroidal transformers the pause between two sealing processes is longer than 10 min., the number of remanence-setting pulses of the quick-start procedure is doubled. The soft-start-procedure used also serves for surge-free power on of the hight-quality transformers.

9.1.8 Reference temperature

The Setting 7 determines whether the calibration is performed with a fixed reference temperature of 20° C or a variable reference temperature between 0 … 50° C. With the variable reference temperature, a precise calibration of the heating conductor is possible even at ambient temperatures which deviates significantly from 20° C.

When the heating conductor temperature is measured with a temperature sensor before the start of calibration, the influence of the ambient temperature can be completely ignored during calibration.

The variable reference temperature must be specified as a setpoint for the PIREG-C_2 before the start of calibration. This can be done with a potentiometer on a PLC or with an external temperature sensor at *Setpoint* or via the interfaces with the (`EINS` and `KONF`, PROFINET™-Parameter 16.7.8 and 16.7.14) command. An error message appears when the limit of the reference temperature of 50° C is exceeded (Error 13). The PIREG-C_2 reads the variable reference temperature during the initialisation of calibration (2). A setpoint of 50° C corresponds to 1.66 V in 300° C temperature range or 1.0 V in 500° C temperature range at *Setpoint*.

9.1.9 8-Point Tc Correction

The 8-Point Tc Correction is activated with Setting 8. Alloy-related dispersions of the heating conductor materials can be corrected with this function. For the correction procedure the heating conductor is heated in eight temperature steps by the PIREG- C_2 during calibration. The first temperature step is always 50° C. The temperature of the eight temperature steps lies 20% below the final value of the temperature range. The six other temperature steps are equidistant in between:

- 300 °C temperature range: 50, 77, 104, 131, 159, 186, 213 and 240 °C
- 500 °C temperature range: 50, 100, 150, 200, 250, 300, 350 and 400 °C

In each step, the actual temperature of the heating conductor is reported back to the PIREG-C_2 by an external thermometer. The feedback can be done either automatically via compatible measurement device connected to the RS-232 interface or manually by setting the setpoint and via an external voltage at the *Setpoint* input, via the potentiometer or by setting the setpoint with the PLC. If an external voltage is used, the voltage of 0 V corresponds to a temperature of 0° C, a voltage of 10 V to the end value of the temperature range.

Each individual calibration point is checked immediately for a maximum deviation of ±20% during recording (error 13). Using the entered measurement points the PIREG-C_2 calculates seven best-fit lines for correcting its actual value according to the actual temperature of the heating conductor.

The correction procedure is controlled with the *Start* signal. With the rising edge of the signal the controller switches the system to the next temperature step (heating) and with the falling edge the setpoint is accepted by the controller as the externally measured temperature of the heating conductor. To ensure that the heating conductor reaches the temperature precisely after the setpoint jump a dwell time of a least 30s (depending on the system) is required after heating phase.

If a compatible external thermometer is used for the measurement of the heating conductor temperature and the heating time of the can perform the 8-Point correction autonomously (8.1.2).

The values calculated by the PIREG-C_2 during the 8-Point-Tc correction cab be read with the `TKEI` command (PROFINET™ Parameter 16.7.20).

9.1.10 Single-point Tc correction

In the OFF state, the single-point Tc correction can be started with the `STKA` command. This makes it possible to correct the tolerance of the temperature coefficient of the heating conductor for a specific operating point. For this operating point, the actual temperature of the heating conductor is reported back to the PIREG-C_2 externally as setpoint or directly as measurement value of the external thermometer. The single-point Tc correction runs outside the normal calibration and is started in the OFF state.

The single-point Tc correction has an OFF and an ON state. Following the start the PIREG-C_2 is in the OFF state. In the ON state, the heating conductor is heated to the temperature set as setpoint in the OFF state. To ensure that the heating conductor can reach the temperature precisely a dwell time of a least 30s (depending on the system) is required after heating phase. The single-point Tc correction ends when existing the ON state. The correction procedure is controlled with the *Start* signal. Deviations of up to ±20 % between the actual value temperature calculated by the controller and the actual temperature of the heating conductor can be corrected. The single-point Tc correction can be performed only if the 8-Point Tc Correction has not been performed during the calibration and every calibration process is reset.

The single-point Tc correction can be saved with the *Calibration- Start* command, so that it does not have to be performed again after a recalibration, but only if the heating conductor is replaced.

9.2 Time protocol functions

The PIREG-C2 offers the option of recording the time behaviour of a sealing process, in order to e.g. detect long-term changes (from V1.01/1.09/1.06). Using the time-protocol functions the time behaviour of the sealing system, essentially consisting of the sealing transformer and heating conductor, is recorded during a sealing process. The recording is performed separately for heating phase in ON state and the subsequent cooling phase in OFF state.

9.2.1 Heating phase

The values recorded for the previous heating phase of the previous ON state are read out in the OFF state with the `ZPFE` command (PROFINET™ Parameter 16.7.23). The following values are recorded for the heating phase:

- Temperature actual value before the heating
- Temperature setpoint before the heating
- Heating time; the heating time ends if the actual value exceeded the 95% of the setpoint
- Sealing time; the sealing time starts if the actual value exceeded 95% of the setpoint.
- Average value of the temperature actual value during the sealing time. Heating time; the heating time starts and ends with the application and removal of the Start signal.

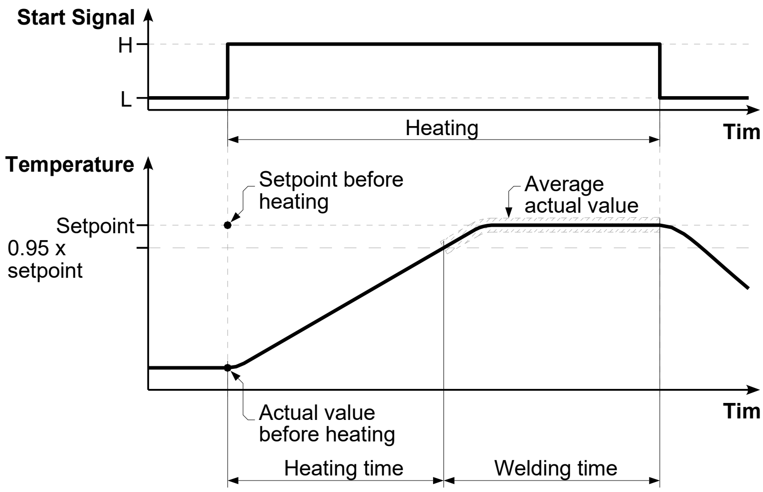


Figure 6: Time protocol functions - Heating phase

9.2.2 Cooling phase

The recorded values of the cooling phase should be read out with the `ZPFA` command (PROFINET™-Parameter 16.7.23) in the OFF state, as soon as the temperature actual value has exceeded 50° C or immediately before the next ON state. The following values are recorded for the cooling phase:

- Actual temperature value at the beginning of the OFF state
- Cooling time: The cooling time ends when the actual temperature falls below 50° C.

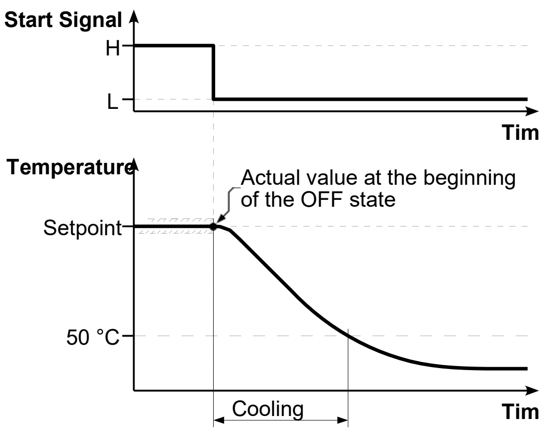
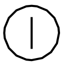
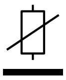


Figure 7: Time protocol functions - Cooling phase

10. Visual displays

The PIREG-C_2 has the following visual indicators:

Table 4: LED indicators on the PIREG-C_2

Designation.	Symbol	Colour	Description
Mains		Green	This display indicates the presence of mains voltage on the PIREG-C_2. After the switch-on or a reset, the LED flashes for 5s with 1 Hz, if the interface control is selected for the temperature setpoint or the setting control.
Heating		Yellow	Reflects the actuator control. Luminosity is proportional to the energy to the heating conductor. Is also used for error coding.
Calibration		Blue	Lights up continuously during a calibration. If a connection is established to an external thermometer during the calibration or single-point Tc correction, it flashes with a 1 Hz frequency.
Alarm		Red	Together with the heating indicator, shows the error state and type of the resistance temperature controller.
PROFINET™-Signal LED	PN	White	Indicates an existing connection with a PROFINET™ Controller. With the help of common project planning tools can be used for identifying the controller.
PROFINET™-Alarm LED	AL	Red	Shows an error in the PROFINET™ bus system (e.g.: connection interruption).

11. Inputs

11.1 Start

By applying a high level at the *Start* input (Terminal 6) the *Start* signal is set and a sealing process is stated. The controller starts to regulate the temperature of the heating conductor according to the setpoint and maintains the temperature constant as long as the high signal is present. If the 8-Point Tc Correction is selected for the calibration, the Start input also controls the correction procedure during manual operation. The single-point Tc correction is also controlled with the *Start* input.
During the calibration steps 1 to 7 no *Start* signal should be given, as otherwise the PIREG-C_2 aborts the calibration with Error 2.

11.2 Calibration start

By applying a high level to the input *Calibration-Start* (Terminal 5) in OFF or Fault state of the controller the *Calibration-Start* signal is set and switches to the calibration state. Here the controller is adapted to the combination of heating conductor and sealing transformer. The signal can move to Low during the calibration of the controller.
The input *Calibration-Start* can be configured for a pulse control with the `KONF` command
(PROFINET™-Parameter 16.7.14). This way the single-point Tc correction can start in OFF state, if a high level is present less than one second. As soon as the high level is present longer than one second, the PIREG-C_2 switches to the calibration state.

11.3 Reset

With a high level at *Reset* (Terminal 7) input the PIREG-C_2 and the bus system are reset into state after turning the mains power on. This way, the FAULT state can be exited without turning the mains power off.
This can also interrupt the running calibration.

11.4 Setpoint

The temperature *setpoint* of the controller is applied to the input *Setpoint* (Terminal 16) with an analogue voltage. When calibrating with variable reference temperature, the reference temperature is applied to the setpoint input and the actual temperature of the heating conductor is applied for the 8-Point and single-point Tc correction.
The permissible voltage range of the setpoint input is 0 … 10 V and is depicted linearly over the selected temperature range, i.e. a voltage of 10 V corresponds to 300° C or 500° C.

A potentiometer can also be used for the setpoint, whose wiper is connected to the *Setpoint* input, the CW connection to the URef output (Terminal 15) and the CCW connection to the corresponding GND connection (Terminal 13 or 14).
Pay attention to the rotational direction of the potentiometer when connecting the setpoint potentiometer. The voltage at the setpoint input should increase when turning the setpoint potentiometer clockwise (CW).

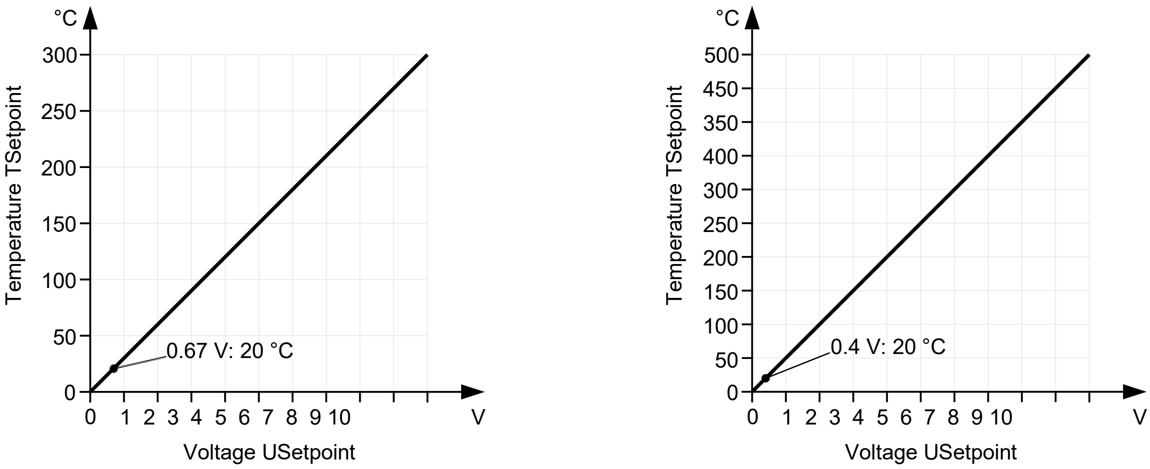


Figure 8: Linear scaling of the setpoint input voltage according to the temperature range

12. Outputs

12.1 Reference voltage

The reference voltage U_{ref} output (Terminal 15) provides a reference voltage of 10mV for the setpoint setting with a potentiometer. If the PIREG-C_2 should operate without additional power supply, the switches for the control input can also be connected to the Uref output. Maximum 20 mA can be applied to the Uref output.

12.2 Actual value

A voltage in the range of 0 … 10 V is present at the actual value output UIst (Terminal 17), which is proportional to the temperature of the heating conductor. The voltage range is based on the temperature range selected, i.e. 10 V at actual value output corresponds to 300° or 500° C. Maximum 5 mA can be applied to the actual value output.

Hold-Mode:

If the Hold mode is activated with the `KONF` command, the temperature measured at the end of the sealing process is also displayed in the OFF state on the actual value output. Here you can choose whether the measured temperature is displayed until the Start of the next sealing process or only for 2s.

12.3 Alarm

The alarm output (Terminal 12, 18) is a relay switch contact. Using the `KONF` command you can determine whether the alarm output is opened or closed in case of a malfunction. The relay contact is factory set to close in case of a malfunction. In case of a power failure (Error 3) it is set with a delay of 2s, in all other cases immediately. In addition, with the `KONF` command it can be determined as to whether the alarm output is immediately set in case of a failure or only after a sealing process has been completed. In this way, a calibration error does not lead to a machine malfunction when switching on.

12.4 OK

The OK output (Terminal 21, 22) is a relay switch contact. With the `KONF` command you can determine as to whether the OK output is opened or closed in when OK. The relay contact is factory set to close in OK-case. The OK output has the following control functions that can be set with the `KONF` command:

Calibration-OK message:

This is the factory setting. The OK output is reset during the calibration. It is reset after a successful calibration. The end of the calibration can be reported with the calibration-OK message. If the saved calibration values do not match the setting the OK output is also reset.

Temperature OK message:

The OK output is activated when the actual value is in the temperature OK range. The setting of the temperature OK range and an associated stabilisation time is done with the `KONF` command.

Combination of calibration and temperature- OK message:

This is the combination of the two above functions. This means that the calibration OK message is done after a Rest or a calibration and the temperature OK message is performed with the first *Start* signal.

Temperature reached message:

The OK output is activated if the actual value has reached 95% of the setpoint temperature in the ON state. Upon exiting the ON state, the OK output is reset.

12.5 External semiconductor relay

The ELR output (Terminal 19, 20) is used for activating an external semiconductor relay which is used as actuator instead of the internal actuator of the controller. With the external semiconductor relay the combination of heating conductor and sealing transformer can be activated which have a higher power than the maximum permissible power of the internal actuator.

13. Interfaces

The PIREG-C2 has three serial interfaces. This is an RS232 (1), an RS485
(2) and a USB interface (3).

The RS232- and USB interfaces are used for direct, text-based communication with the controller. The RS485 interface serves as an interface to higher-level controllers via communication using a binary protocol.

The RS232 and the RS485 interfaces use a joint connector.

The communication via the USB interface takes place via a virtual serial interface. For this, appropriate drivers might have to be installed.

13.1 RS232 and USB interface (text-based)

The RS232 and USB interface use the same command set, composed of alphanumeric characters. This provides a good comprehensibility for the user.

Each interface has a 64 B line buffer. The Baud rate for each interface is set separately with the `BRAT` command.

Table 5: Factory settings of the RS232 and USB interface

Baud rate:	9600 Bd
Start bits:	1
Data bits:	8
Stop bits:	1
Parity:	without
Flow control:	-

13.1.1 Protocol description

ASCII strings are used for the communication telegrams. Both lower and upper case alphabets can be used.

The PIREG-C2 itself does not establish communication with its communication partner; it remains passive. Each line from communication partner is acknowledged either with the requested reply, an error message or an OK message.

The PIREG-C2 uses only upper case alphabets and numbers for acknowledgement and reply.

A telegram always ends with the ASCII characters “Carriage return” (`13`, `0x0D`, `'\r'`). The names of the commands or acknowledgements are separated from the following data by a space. Data to be transferred are transmitted with a constant width and with leading zeros, if needed. If several data fields are transferred, they are separated with a space.

The complete command description is available in the annex.

13.1.2 Addressing

Communication via the RS232 interface can also be addressed. This allows the RS232 interfaces of up to three PIREG-C2 units to be connected in parallel, and thus up to three PIREG-C2 units can be addressed via a single RS232 interface.

The addressing of the RS232 communication is switched on and off with the `KOKO` command. The address of the RS232 communication is set with the `GADR` command and can also be used for the RS485 communication. The address space covers the range `0` … `255`. Device address `0` is configured at the factory.

13.2 RS485 Interface (binary)

The RS485 interface uses a binary command set in order to increase the communication speed. The interface has a 64-byte data storage. For the RS485 communication the PIREG-C2 has an address which is set with the `GADR` command. This address is also used for the addressed RS232 communication.

Using the addressing up to 31 PIREG-C2 can be operated on the same RS485 Bus. The address space covers the range 0 … 255, Address 0 is used as factory default set.

All PIREG-C2 connected to an RS485-Bus can be addressed under the address 255. The data and commands transferred with this address are accepted by all devices, there is no acknowledgement in most cases. However, the short set *Device-Detection* also becomes an acknowledgement with device address 255.

The Baud rate can be set with the BRAT command.

Table 6: Factory settings of the RS485 interface

Baud rate:	9600 Bd
Start bits:	1
Data bits:	8
Stop bits:	1
Parity:	even
Flow control:	-

13.2.1 Protocol description

The protocol used is based on DIN 19244. The PIREG-C2 itself does not establish communication with the master; it remains passive. The PIREG-C2 with a delay of 3ms for a secure direction switching of the RS485 communication.

The following telegram types are used:

- Short set:
  - Transmission of short commands to the PIREG-C2 (e.g., Reset).
  - Retrieval of important data from the PIREG-C2 with little overhead.
  - Acknowledgement for calls that do not require data.
- Control set:
  - Acknowledgement for calls that do not require response data.
- Long set:
  - Transfer of commands with parameters to the PIREG-C2.
  - Reading data from the PIREG-C2.

13.2.2 Telegram formats

Short set:

Table 7: Short set RS485 telegram format

Byte no.	Field		value	
			Decimal	Hexadecimal
1	SZ	Start character	16	0x10
2	GA	Device address	0 … 250, 255	0x00 … 0xfa, 0xff
3	FF	Function field	see command reference	
4	PS	Checksum	(GA + FF) mod 255	
5	EZ	Termination character	22	0x16

Control set:

The control sets are used by the master only on the call side. They are used to call up all commands that cannot be called up via short sets as they require a more detailed specification. The control set has a fixed length LG of three.

Table 8: Control set RS485 telegram format

Byte no.	Field		value	
			Decimal	Hexadecimal
1	`SZ`	Start character	`104`	`0x68`
2	`LG`	Length	`3`	`0x03`
3	`LG`	Length (repeated)		
4	`SZ`	Start character	`104`	`0x68`
5	`GA`	Device address	0 … 250, `255`	`0x00 … 0xfa, 0xff`
6	`FF`	Function field	see command reference	
7	`BI`	Command index	see command reference	
8	`PS`	Checksum	(`GA` + `FF` + `BI`) mod 255	
9	`EZ`	Termination character	`22`	`0x16`

Long set:

The length LG of the long set is the length of the data block n plus three.

Table 9: Long set RS485 telegram format

Byte no.	Field		value	
			Decimal	Hexadecimal
1	`SZ`	Start character	`104`	`0x68`
2	`LG`	Length	$n + 3$	
3	`LG`	Length (repeated)		
4	`SZ`	Start character	`104`	`0x68`
5	`GA`	Device address	0 … 250, `255`	`0x00 … 0xfa, 0xff`
6	`FF`	Function field	see command reference	
7	`BI`	Command index	see command reference	
9	`DB[0]`	Data block	see command reference	
⋮	`DB[…]`			
$N-2$	`DB[`$n-1$`]`			
$N-1$	`PS`	Checksum	$(GA + FF + BI + \sum_{i=0}^{n-1} DB[i]) \bmod 255$	
N	`EZ`	Termination character	`22`	`0x16`

The complete command description for the RS485 interface is available in the annex.

13.3 Communication with external thermometer

Using a special connection cable an external thermometer DTM3000 (from V1.01/1.16/1.10) or the former TM6[1], can be connected to the RS232 interface of the PIREG-C$_2$. The configuration is done with the `KOKO` command.

The communication to the DTM3000 thermometer is configured at the factory. At the start of the 8-Point Tc Correction, the PIREG-C$_2$ attempts to establish connection with the external thermometer for the duration of the calibration. When establishing communication the PIREG-C$_2$ transmits up to four times the query byte to the thermometer, in case the latter does not return a valid response beforehand. The maximum communication establishment time results from the transmission interval time. If no communication takes place, the PIREG-C$_2$ resets the former interface configuration.

The following data formats apply for communication with the external thermometer:

[1]The TM6 thermometer is no longer available.

Table 10: RS232 communication with an external thermometer

Model	Query byte (Unicode characters)	Transmission interval	Maximum communication establishment time	Baud rate	Configuration
DTM3000	`0x44 (D)`	333 ms	1.11 s	9600	1 Start bit 8 data bits 1 stop bit, no parity
TM6	`0xfc (ü)`	1.5 s	5 s	2400	

14. Error conditions

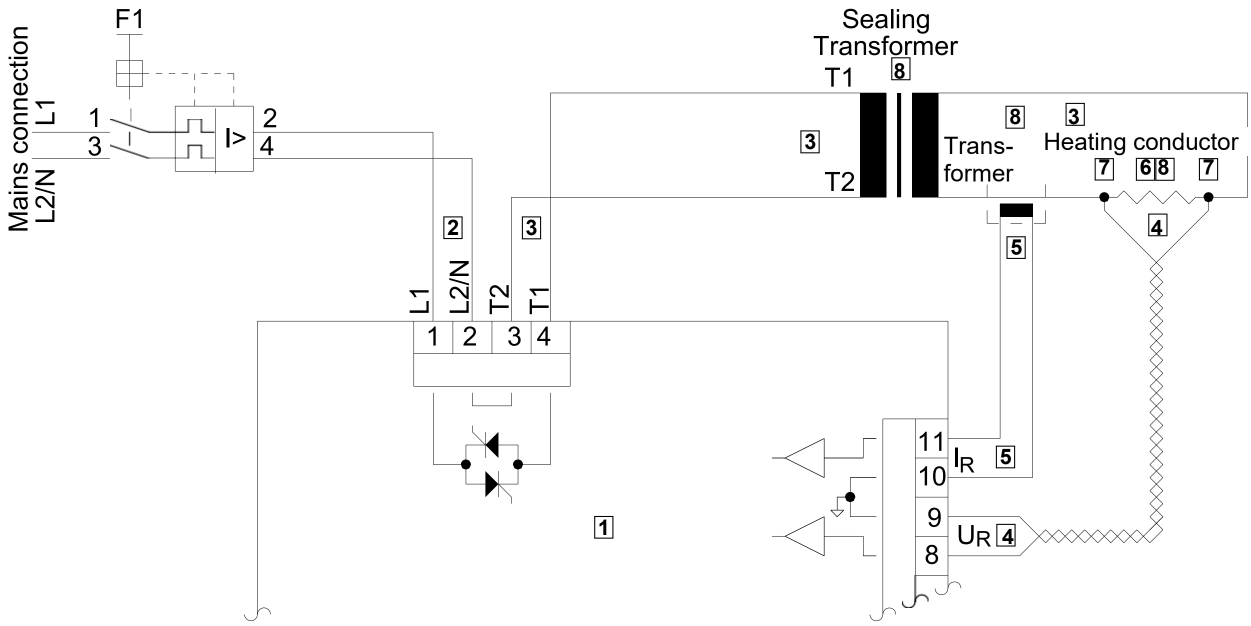


Figure 9: Error ranges during operation of the PIREG-C2

Table 11: Error indications

No.	Error	Actual value output [V]	Alarm LED	Cali-bration LED	Alarm output according to signal *Reset*	Alarm output according to signal *Start*
1	• Device error • Bus system supply voltage too low or too high	4.66 / 0.0	red	black	red	
2	• Internal error • Read/write error of the non-volatile. Memory • Signal *start* during calibration • Heating time limit	4.00	red	black	red	
3	• Mains error (under-/over voltage or power frequency error)	3.33	red	blue/black	red	
4	• Current signal IR and voltage signal UR too low	2.00	red	blue/black	black	red
5	• Voltage signal UR too low	1.33 / 0.0	red	blue/black	black	red
6	• Current signal IR too low	0.66	red	blue/black	black	red
7	• Current and/or voltage signal too large	5.33 / 10.0	red/black	blue/black	black	red
8	• Temperature too large or too small (heating conductor error) • Temperature monitoring • Heating monitoring or • Temperature jump upwards or downwards	2.66	red	red	black	red

Please turn over...

Table 11: Error indications (continued)

No.	Error	Actual value output [V]	Alarm LED	Cali-bration LED	Alarm output	
					according to signal *Reset*	according to signal *Start*
9	• Data error, stored calibration values do not match the settings • Communication monitoring	6.00 / 10.0	⊕	⊕	●	○
10	• Current signal I_R and voltage signal U_R too small or too large • R_{20} cannot be determined • R_{20}-reference value monitoring • Phase shift cannot be determined • P-factor cannot be determined • P-factor monitoring has addressed	8.00 / 10.0	◐	⊕	●	○
11	• Voltage signal U_R too small, too large, or unstable	7.33 / 10.0	◐	◐	●	○
12	• Current signal I_R too small, too large, or unstable	6.66 / 10.0	◐	◐	●	○
13	• Reference temperature selected too high • Temperature coefficient correction range exceeded • Parameter error: Consistency and dynamics of the selected temperature coefficients in reference to the temperature range	8.66 / 10.0	◐	⊕	●	○

Key:

● off / not set
○ permanently on
◐ slow flashing (approx. 1 Hz)
⊕ fast flashing (approx. 4 Hz)

Table 12: Troubleshooting measures

No.	Error	Remedy and error range: During installation	Remedy and error range: During operation
1	• Device error	Perform reset, check controller	
	• Bus system supply voltage too low or too high	Check bus system supply voltage Perform reset	
2	• Internal error • Read/write error of the non-volatile. Memory	Perform reset Check controller [1]	
	• Signal *start* during calibration	See 9.1.3	
	• Heating time limit	See 8.4.5	
3	• Mains error (under-/over voltage or power frequency error)	120/240V- Check mains voltage switchover (see 6.2) Check mains connection [2] Perform reset	Check mains connection [2] Perform reset
4	• Current signal IR and voltage signal UR too low	Perform calibration Check heating circuit [3]	Check heating circuit
5	• Voltage signal UR too low	Check voltage measurement connection UR [4] Perform calibration	Check heating circuit
6	• Current signal IR too low	Check current measurement connection IR [5] Perform calibration	Check current measurement connection IR [5]
7	• Current and/or voltage signal too large	Check heating conductor [6] Perform calibration	Check heating conductor [6]
8	• Temperature too large or too small (heating conductor error)	Check heating conductor [6] Perform calibration	Check heating conductor [6]
	• Temperature monitoring	See 8.4.1	
	• Heating monitoring	See 8.4.2	
	• Temperature jump upwards or downwards	Check heating conductor connection [7]	
9	• Data error (stored calibration values do not match the settings)	Perform calibration	
	• Communication monitoring	See command `KOUE`	
10	• Current signal IR or voltage signal UR too low or too high	Heating conductor connection [7] Check dimensioning [8]	
	• R_{20} cannot be determined	Check dimensioning [8]	
	• R_{20}-reference value monitoring	See 8.4.6	
	• Phase shift cannot be determined • P-factor cannot be determined	Check dimensioning [8]	
	• P-factor monitoring has addressed	See 8.4.4	
	• Voltage signal UR too small, too large, or unstable	Check voltage measurement connection UR [4] Check heating conductor [6] Check dimensioning [8]	
12	• Current signal IR too small, too large, or unstable	Current measurement connection IR [5] Check heating conductor [6] Check dimensioning [8]	

Please turn over...

Table 12: Troubleshooting measures (continued)

No.	**Error**	**Remedy and error range**	
		During installation	**During operation**
13	• Reference temperature selected too high • Temperature coefficient correction range exceeded • Parameter error: Consistency and dynamics of the selected temperature coefficients in reference to the temperature range	See 8.1.1.1	
	• Signal *start* during calibration	see 8.1.2 and 8.1.3	
	• Heating time limit	See 8.4.5	

14.1 Error memory

The PIREG-C_2 has an error log that stores the last 100 error events. The error log can be read using the FESP command and cleared using the FESL command. For chronological assignment, the respective error event is saved with the value of the operating hour counter at the time the error occurred. (see `BSTZ`, PROFINET™-Parameter 16.7.7).

15. Technical data

15.1 PIREG-C2 controller

15.1.1 Controller

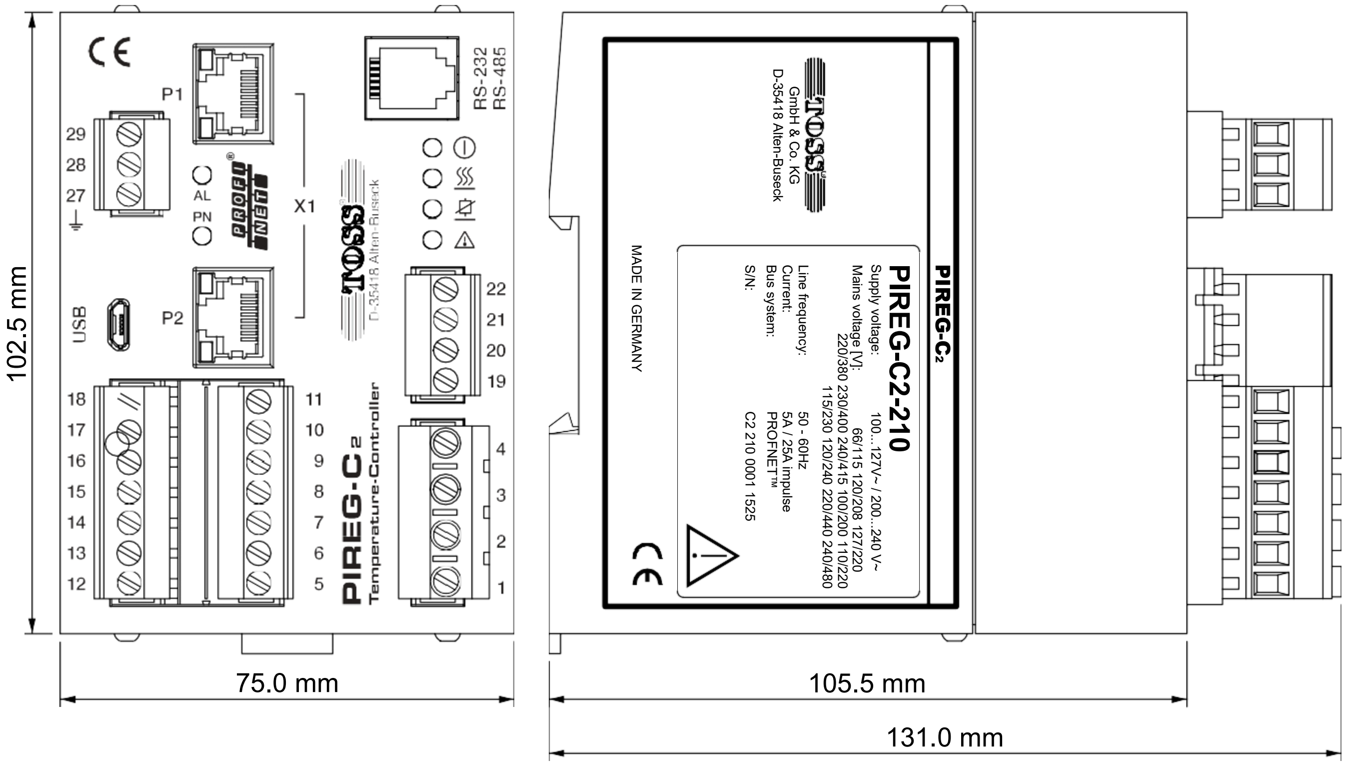


Figure 10: Dimensions of the PIREG-C2 with PROFINET™ interface. Scale 5:4

Table 13: Mains specifications

Variant		120 V	230 V	400 V
Model name:		PIREG-C2-2xx (switchable)		PIREG-C2-4xx
Rated voltage:		100 … 127 V	200 … 240 V	380 … 415 V
Permissible fluctuation:		−15 … 10 % (85 … 140 V)	−15 … 10 % (170 … 264 V)	−15 … 10 % (320 … 457 V)
Permissible mains systems and voltages:	Three-phase, four-wire system with grounded neutral conductor (symmetrical TN and TT mains)	66 V / 115 V 120 V / 208 V 127 V / 220 V	220 V / 380 V 230 V / 400 V 240 V / 415 V	220 V / 380 V 230 V / 400 V 240 V / 415 V
	Split single-phase, three-wire system:	100 V / 200 V 110 V / 220 V 115 V / 230 V 120 V / 240 V	220 V / 440 V 240 V / 480 V	
Mains connection:		Connection between the outer and neutral conductor or between two outer conductors, whereby the rated voltage between the outer conductor and earthing must not exceed 300 V.		
Surge category: (according to DIN EN 60664, VDE 0110-1)		III		
Mains frequency:	Rated frequency:	50 … 60 Hz		
	Permissible fluctuation:	± 5 Hz (45 … 65 Hz)		
Rated current consumption:		I_{max} = 5 A (internal actuator)		
Internal consumption:		3 W		
Overcurrent protection device:	Maximum rated current:	$I_{N,max}$ = 10 A		
	Fuse types:	• Circuit breaker according to EN 60898 (Characteristic B, C, D, K, or Z) • Circuit breaker according to UL 489 (Characteristic B, C, D, K, or Z) • Fuse gG according to IEC 60269 • Class CC or Class J fuse according to UL 248 (Characteristic Fast-acting or time-delay) For a UL-compliant installation, overcurrent protection devices according to UL 248 or UL 489 must be used.		

15.1.2 Actuators

Table 14: Internal actuator specifications

Internal actuator		
Description		Actuator with anti-parallel thyristors on a heat sink in the PIREG-C2
Maximum load current:	Continuous heating (100% duty-cycle)	$I_{L,max}$ = 5 A
	Pulse heating (Max. duty cycle 20% or max. 6 s)	$I_{L,max}$ = 25 A
Maximum peak current:	t_{Peak} = 10 ms	I_{TSM} = 500 A
Leakage current:	U_{Mains} = 240 V	I_D = 11 mA
	U_{Mains} = 415 V	I_D = 13 mA
Limit load integral:	t = 10 ms	I^2t = 1250 A^2s
Fuse:		Above defined current limit values must be complied with for the fuse.

Table 15: Specifications of the external semiconductor relay.

External actuator	
Description:	Instantaneous switching semiconductor relay
Galvanic isolation:	According to EN 61010 or UL 61010 the galvanic isolation between the control and load circuit of the semiconductor relay must be designed as double or reinforced isolation.
Required protective measures against electric shock: (Control circuit)	SELV or PELV circuit
Open-circuit control voltage: (PIREG-C2)	U_{HiLo} = 5 V (DC)
DC internal resistance: (PIREG-C2)	R_{vh} = 18
Maximum control current:	I_{HiLo} = 30 mA
Maximum permissible switch-on delay:	T_{on} = 0.2 ms
Maximum permissible switch-off delay:	T_{off} = 0.25 ms

15.1.3 Temperature ranges

Table 16: Specification of available temperature ranges

	Temperature range 1:	Temperature range 2:	User-defined:
Temperature range:	0 … 300 °C	0 … 500 °C	0 … T_{max} T_{max} = 100 … 500 °C
Undertemperature:	−10 °C		
Overtemperature:	360 °C	600 °C	T_{max} + 20 %

15.1.4 Time response (50 Hz)

Table 17: Time response specifications

Initialisation:	after power on and reset:	500 ms
Power failure:	In the event of a power failure, the PIREG-C2 enters a FAULT state or performs a reset after the power is restored	80 ms
Reset	Cancel heating	5 … 25 ms
Start (heating):	Switch-On delay:	7 … 27 ms
	Switch-Off delay:	17 … 44 ms
Set remanence:	after power on, reset, and calibration: EI transformer	80 ms
	after power on, reset, and calibration: Toroidal transformer	300 ms
	during the sealing process: EI transformers	40 ms
	during the sealing process: Toroidal transformers	80 ms
	during the sealing process: Toroidal transformers, sealing breaks longer than 10 minutes	160 ms
	Current flow angle of EI transformer:	3.1 ms
	Current flow angle of toroidal transformer:	1.8 ms
Calibration start:	Switch-On delay:	7 … 27 ms
Calibration	Max. calibration time: (Temperature comparison time = 15 s)	240 s
	Max. calibration time: (Temperature comparison time = 30 s)	315 s
	Temperature comparison time 1: (Setting 3)	15 s
	Temperature comparison time 2: (Setting 3)	30 s
Heating ramp:	The heating ramps are set using the following interfaces:	Without / 2 / 3 / 5 s

15.1.5 Digital control signals

Table 18: Specifications of the digital control inputs

Inputs		
Terminals:	Start	6
	Calibration start	5
	reset	7
Potential:		Isolated from the measurement technology side
Control voltage: (High level)		$U_{Contr.,Hi}$ = 4 … 32 V (DC) (polarity independent)
Max. control voltage:		$U_{Cont,max}$ = ±40 V
Input current:		I_{Cont} = 0.5 … 4.5 mA
Power supply:		SELV or PELV circuit

Table 19: Specifications of the digital control outputs

Outputs		
Terminals:	Alarm	12, 18
	OK	21, 22
Model:		Reed relay contact (normally open)
Potential:		potential-free
Max. switching capacity	ohmic load	10 W
Max. switching voltage:	DC:	60 V
	AC	30 V
Max. switching current:	DC	500 mA
	AC:	350 mA
Rated load		50 V / 100 mA
Service life	at rated load	$1 \cdot 10^7$ switching cycles
	5 V with 100 mA	$1 \cdot 10^9$ switching cycles
Power supply:		SELV or PELV circuit

15.1.6 Analogue control voltages

Table 20: Setpoint input specifications

Setpoint input		
Terminals:	USet	16
Potential:		Isolated from the measurement technology side
Rated voltage:		USetpoint = 0 … 10 V (DC)
Max. Voltage:		USetpoint,max = 11 V
Input resistance:		Rf = 1 M
Power supply:		SELV or PELV circuit

Table 21: Actual value output specifications

Actual value output		
Terminals:	UActual	17
Potential:		Isolated from the measurement side
Nominal voltage range:		UActual = 0 … 10 V (DC)
Max. output voltage:		UActual value max = 10.1 VDC
Max. output current:		IActual value max = 5 mA
Internal resistance:		Ri = 100
Circuit:		SELV or PELV circuit

Table 22: Reference voltage output specifications

Reference voltage output		
Terminals:	Uref	15
Potential:		Isolated from the measurement side
Rated voltage:		Uref = 9.9 … 10.1 V (DC)
Max. output current:		Irefmax = 20 mA
Internal resistance:		Ri = 51.1 Ω
Circuit:		SELV or PELV circuit

15.1.7 Measurement signals

Table 23: Voltage measurement input specifications

Voltage measurement		
Terminals:	U_R	8, 9
Nominal voltage range:		U_R = 0.4 … 120 V
Maximum signal voltage:		Urmax = 160 V
	Range 1: (U_R = 11 … 120 V)	P_{ure} = 105 ˛
Input resistance: [6]	Range 2: (U_R= 1.4 … 11 V)	P_{ure} = 13.1 ˛
	Range 3: (U_R= 0.4 … 1.4 V)	P_{ure} = 1.67 ˛
Measurement category: (According to IEC 61010-2-030)		CAT II
Power supply:		Secondary circuit supplied from the mains voltage (see above, overvoltage category III). The sealing transformer used must be designed according to EN 61558 (VDE 0570) or UL 5085 (Isolating transformer with reinforced insulation) and UL 61010.

Table 24: Specification of the current measurement inputs

Current measurement		
Terminals:	I_R	10, 11
Input resistance:		Pure = 5 Ω (ballast resistance)
Nominal current range:		I_R = 20 … 500 mA Uir = 0.1 … 2.5 V
Maximum signal current:		Irmax = 1500 mA Uirmax = 5 V
Measurement category: (According to IEC 61010-2-030)		CAT II
Circuit:		SELV or PELV circuit

15.1.8 RS-232 and RS-485 interfaces

Table 25: RS-232 interface specifications

RS-232 interface	
Supported Baud rates:	9600 Bd 19 200 Bd 38 400 Bd 57 600 Bd 115 200 Bd
RxD input voltage:	±25 V
TxD output voltage:	±5 V at 3 load
RxD input resistance:	3 … 7 ˛
TxD output resistance:	300
Power supply:	SELV or PELV circuit
Connection socket:	RJ-12, 6P6C

Table 26: RS-485 interface specifications

RS-485 interface		
Supported Baud rates:		9600 Bd 19 200 Bd 38 400 Bd 57 600 Bd 115 200 Bd
R input voltage:		±14 V
T output voltage:		1.5 … 3 V at 54
R input resistance:		24 ˛
Reference resistors:	+R/+T signal (A):	5.6 ˛ to +5 V
	-R/-T signal (B):	5.6 ˛ to GND
	+R/+T signal (A) to -R/-T signal (B):	2.7 ˛
Power supply:		SELV or PELV circuit
Connection socket:		RJ-12, 6P6C

15.1.9 Pin assignment of RS-232 and RS-485 interfaces

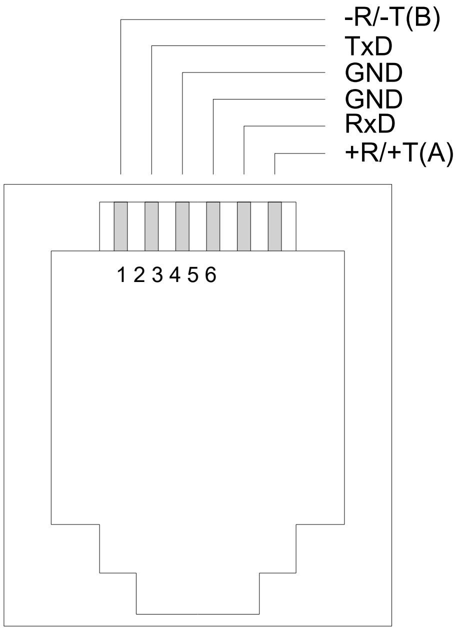


Figure 11: Pin assignment of the RJ-12 socket (6P6C, top view) of the serial interfaces.
TxD: PIREG-C_2 output
RxD PIREG-C_2 input

15.1.10 Virtual serial interface via USB

Table 27: USB interface specifications

USB interface	
USB standard:	USB 1.1 and 2.0
Connector:	Micro-USB type B
Interface type:	Virtual serial interface
Controller:	FDTI FT230XS
Supported Baud rates:	9600 Bd 19 200 Bd 38 400 Bd 57 600 Bd 115 200 Bd
Power supply:	SELV or PELV circuit

15.1.11 PROFINET™ bus system

Table 28: PROFINET™ bus system specifications

Rated voltage:	U_{Bus} = 24 V (DC)
Permissible fluctuation:	21.6 … 26.4 V (DC)
Permitted peak voltage:	30 V
Current consumption:	I_{Bus} = 120 mA
Required protective measures against electric shock:	SELV or PELV Circuit
Functional earthing:	The terminal 27 must be earthed so as to ensure that the shielding of the Ethernet cable is effective in accordance with the requirements of the PROFINET™.

15.1.12 Order code

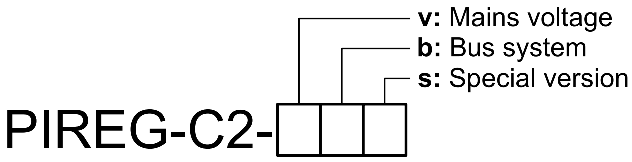


Figure 12: Order code

Table 29: Decoding of the order code

Field		Options	
v	Mains voltage variant	2	100 … 127 V / 200 … 240 V
		4	380 … 415 V
b	Bus system	0	without
		1	PROFINET™
		2	EtherNet/IP™
s	Special version	0	without
		*	Upon request

15.2 Current transformer

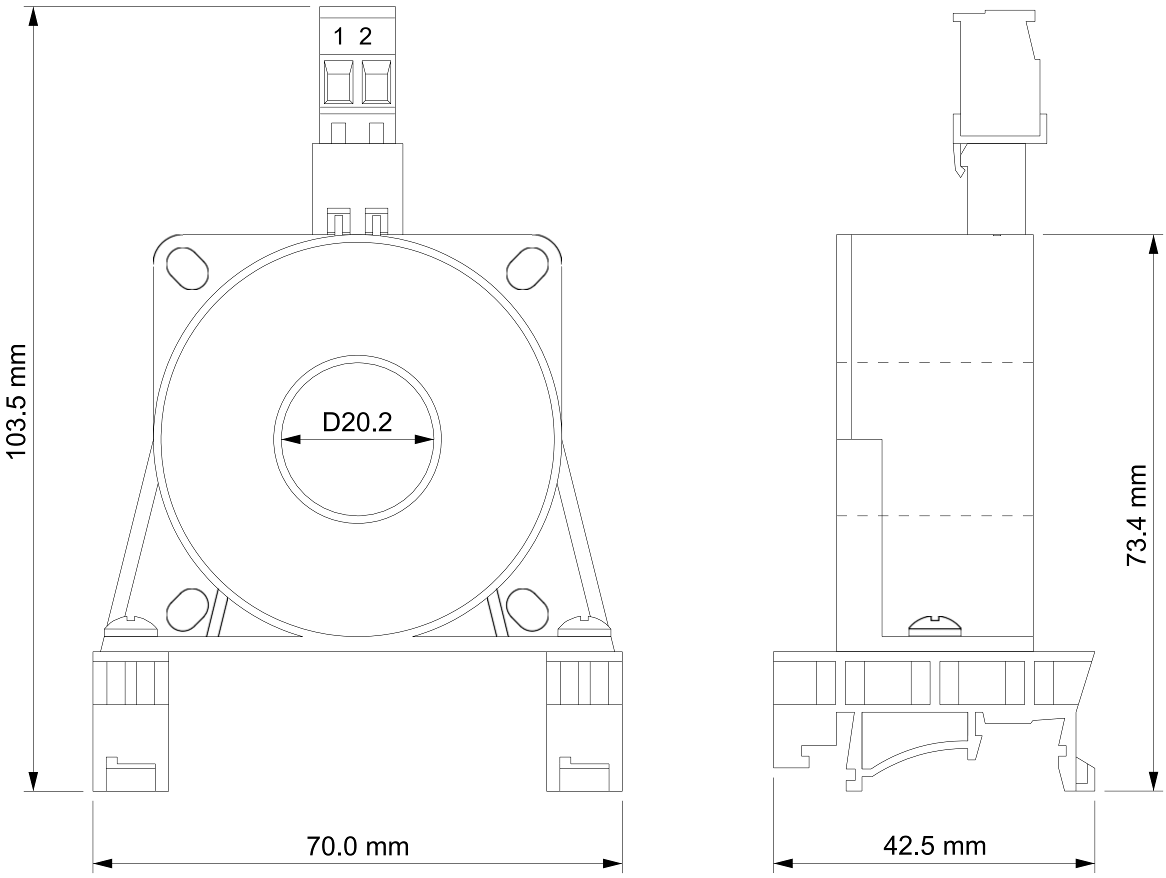


Figure 13: Dimensions of the PIREG-CT-50 current transformer

Table 30: Current transformer specifications

Model:	PIREG-CT-50
Max. rated current:	500 A
Power supply:	The secondary circuit is supplied from the mains voltage (see above, with overvoltage category III). The sealing transformer used must be designed according to EN 61558 (VDE 0570) or UL 5085 (Isolating transformer with reinforced insulation) and UL 61010.
Measurement category:	CAT II (IEC 61010-2-030)
Max. operating voltage:	160 V (Voltage between primary and secondary circuits with an uninsulated through-wire)
Mains frequency:	50 - 60 Hz
Max. rated voltage: (output side)	2.5 V
Max. rated current: (output side)	500 mA
Max. ballast resistance:	5 Ω
Transmission ratio:	1 : 1000
Connections:	plug-in screw terminals: Clamping range 0.2 … 2.5 mm² (AWG 24 … 12), Tightening torque 0.5 … 0.6 N m. Material: unreinforced polyamide, flammability class UL94 V0
Design:	Encapsulated in an insulated housing
Housing:	Material: fibre-reinforced polyamide PA-F, polyurethane potting compound, flammability class UL94 V0
Mounting rail holder:	Material: polyamide PA, flammability class UL94 V0
Soiling degree:	2
Protection class:	IP20 (not part of the UL 61010 approval)
Mounting:	Quick-mounting on a 35 mm rail according to EN 60715 (EN 50022)
Dimensions (W x H x D):	70 x 42.5 x 103.5 mm
Weight:	180 g
Impact resistance:	10 g
Altitude:	max. 2000 m
Humidity:	Up to +31°C: 80% maximum rel. humidity, decreasing linearly down to 50% rel. humidity at +40°C.
Operating temperature:	0 … 50 °C
Storage temperature:	−10 … 70 °C
UL File:	E509199

15.3 Potentiometer

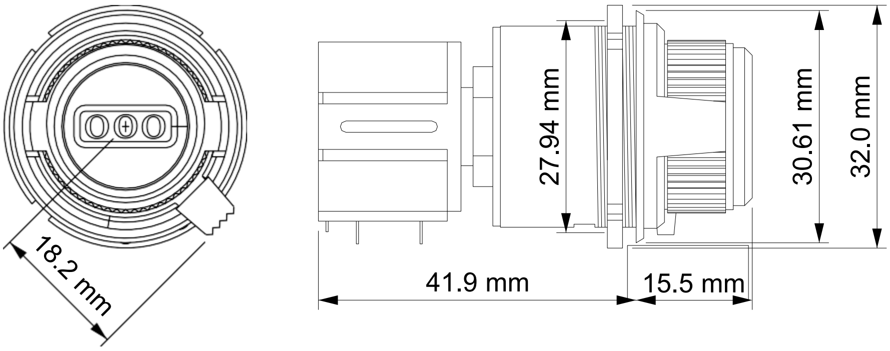


Figure 14: Potentiometer dimensions

Table 31: Potentiometer specifications

Model:	0 … 300 °C
Resistance value:	5 ˛ ±5 %, Linearity: ±0.25 %, Temperature coefficient: 50 ppm/K
Total load capacity:	1.0 W
Angle of rotation:	1080°
Connections:	Solder connection
Design:	open
Housing:	Glass-fibre reinforced plastic
Mounting hole:	28.45 … 28.90 mm
Soiling degree:	2
Protection class:	IP00
Dimensions (L x D):	57.4 x 32 mm
Weight:	51 g
Humidity:	95%, non-condensing
Altitude:	max. 2000 m
Operating temperature:	0 … 50 °C
Storage temperature:	−10 … 70 °C

15.4 Analogue display

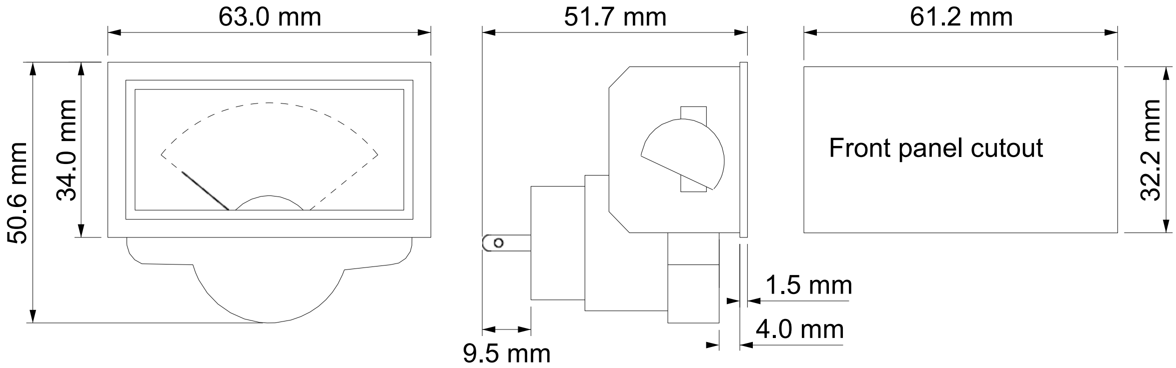


Figure 15: Analogue display dimensions

Table 32: Analogue temperature display specifications

Model:	Display 2060 0 … 300 °C
Scale:	0 … 300 °C, Accuracy: ±1.5%, nominal vertical position
Input voltage:	0 … 10 V (DC)
Input resistance:	10.3 ˛
Connections:	Solder connection
Design:	open
Housing:	Glass-fibre reinforced plastic
Front panel cutout:	61.2 x 32.2 mm
Soiling degree:	2
Protection class:	IP00
Dimensions (W x H x D):	63 x 50.6 x 51.7 mm
Weight:	65 g
Humidity:	95%, non-condensing
Altitude:	max. 2000 m
Operating temperature:	0 … 50 °C
Storage temperature:	−10 … 70 °C

15.5 Sealing transformer

The sealing transformer must be designed according to EN 61558 (VDE 0570) or UL 5085 (Isolating transformer with reinforced insulation). It need not be designed for reduced induction.

15.6 External thermometer DTM3000

Table 33: Specifications of the DTM3000 thermometer

Model:	DTM3000 for Thermocouples
Sensor:	Type K thermocouple (NiCr-Ni)
Measuring range:	−200 … 1370 °C
Accuracy:	< ± 0.5 K
Resolution:	0.1 °C
Measuring rate:	max. 4 s^{-1}
Display:	1-line LCD display
Connection:	Miniature flat connector
RS232 interface:	9600 Baud, 1 start bit, 8 data bits, 1 stop bit, no parity Connector: Binder Series 719, 4-pin
Supply voltage:	9 V block, size 6F22 Service life: approx. 125 h
Housing:	Plastic (ABS)
Dimensions (W x H x D):	60 x 120 x 26 mm
Weight:	130 g
Operating temperature:	0 … 60 °C

15.7 Spare parts

Table 34: Spare parts list

Part	Manufacturer	Model	Order No.
Connection terminals 1 … 4:	Phoenix Contact	GMVSTBW 2.5 HV/ 4-ST-7,62BD1-4	1711127
Connection terminals 5 … 11:	Phoenix Contact	MVSTBR 2.5/ 7-ST BD:5-11	1881998
Connection terminals 12 … 18:	Phoenix Contact	MVSTBW 2.5/ 7-ST BD:18-12	1882036
Connection terminals 19 … 22:	Phoenix Contact	MVSTBW 2.5/ 4-ST BD:19-22	1752094
Connection terminals 27 … 29:	Phoenix Contact	MVSTBW 2.5/ 3-ST BD:29-27 MQ	1065489
Connection terminals 1 … 2:	Phoenix Contact	MVSTBW 2.5/ 2-ST-5,08 BD:1-2	1722325
RJ-12 connector, 6P6C	MH Connectors	MHRJ12-6P6CR	6510-0104-04

16. PROFINET™ bus system

With the PROFINET™ variant of the PIREG-C_2 it can be integrated in a PROFINET™ network. It is possible to control the PIREG-C_2 (e.g. heating, calibration), query its state (e.g. Current temperature, error state) and set or read various settings.

The PIREG-C_2 operates in the PROFINET™ network as a field device of the conformity class A. To address the controller an properly projected PROFINET™ controller (e.g. a PLC with PROFINET™ interface) is needed.

Both cyclic process data as well as acyclic parameter data are used for data exchange with the PIREG-C_2.

16.1 Hardware description

The PROFINET™ bus system must be supplied with a rated voltage of 24 V via the corresponding terminal. The PIREG-C_2 is connection with the PROFINET™ network via Ports P1 and P2 of the network interface X1. The ports support the automatic connection negotiation for the following speed (MAU types):

- 100BASE-T, Full-duplex
- 100BASE-T, Semi-duplex
- 10BASE-T, Full-duplex
- 10BASE-T, Semi-duplex

The green LED of the Ethernet sockets show the link and the activity with flashing. The neighbouring orange colour LED shows a link with 100 Mbit s^{-1}.

The red LED AL lights up in case of an error, e.g. if the connection to the PLC is lost. It remains lit after a power ON until a PROFINET™ controller has established a connection.

As soon as the connection is established the white PROFINET™ LED lights up. Using the relevant configuration tools, it can also be made to flash, e.g. to identify a device.

16.2 GSD file

The “General Device Description” (GSD) file contains all information required by a project planning tool in order to integrate the PIREG-C_2 in a PROFINET™ network.

16.3 Addressing

The IPv4 address used by the PIREG-C_2 as well as the PROFINET™ name device are assigned to the controller via the DCP protocol. This can e.g. take place either with the project planning tool or by the PLC. If desired the assignment can be made persistent.

16.4 Command overview

The following tables provide an overview of the assignment of (used by the text-based serial interfaces) command to their PROFINET™ equivalent.

Table 35: Mapping of PIREG-C_2 commands to cyclic PROFINET™ IO data

Command	Description	Read	Write
FEZU	Query the error state	✓	-
ISTW	Query the current actual temperature value	✓	-
KANR	Set and query the calibration number (1 … 8) of the active calibration.	✓	✓
MEPA	Set and query the state of the measurement pulse-pause	✓	✓
SOLW	Set the temperature setpoint	-	✓
STEU	Query the states of the manual and interface control inputs	✓	-
STKA	Set the control states for calibration	-	✓

Please turn over...

Table 35: Mapping of PIREG-C2 commands to cyclic PROFINET™ IO data (continued)

Command	Description	Read	Write
STRS	Reset command	-	✓
STST	Set the signal start	-	✓
ZUST	Query the state of the PIREG-C2	✓	-

Table 36: Mapping of PIREG-C2 commands to PROFINET™ parameters

Command	Description	Read	Write	Index	Note
AHUE	Set and query the settings of the heating monitoring	✓	✓	14	16.7.6
BSTZ	Query the status of the operating hours counter	✓	-	15	16.7.7
EINS	Set and query the setting switches of the PIREG-C2	✓	✓	16	16.7.8
EIPA	Set and query the setting parameters reference temperature, temperature range and temperature coefficients	✓	✓	17 … 18	16.7.9
FEKO	Set and query of the settings of the error configuration of the controller	✓	✓	19	16.7.10
GWPA	Query the selected parameters to be used for the next calibration	✓	-	20	16.7.11
HZBG	Set and query the set maximum heating time	✓	✓	13	16.7.5
KAPK	Query the parameters of the calibrated calibration (1… 8)	✓	-	21 … 28	16.7.12
KASR	Set and query the calibration parameter and modulation reserve	✓	✓	29 … 30	16.7.13
KONF	Set and query the configuration of the PIREG-C2.	✓	✓	31	16.7.14
KPFK	Set and query the P-factor correction value	✓	✓	32	16.7.15
KTKZ	Set and query the heating time for the automatic execution of the Tc correction	✓	✓	33	16.7.16
PFUE	Set and query the parameter of the P-factor monitoring	✓	✓	34 … 35	16.7.17
RHZL	Set and query the reference resistance R20 of the heating conductor	✓	✓	36 … 38	16.7.19
RRUE	Set and query the parameters of the reference R20 value monitoring	✓	✓	39	16.7.19
TKEK	Query the settings of the 8-point Tc correction of the of the calibrated calibration (1 … 8)	✓	-	40 … 47	16.7.20
TOKG	Set and query the temperature limits and the stabilisation time of the temperature OK message	✓	✓	48	16.7.21
TUEE	Set and query the parameter of the temperature monitoring	✓	✓	49	16.7.22
VERS	Query the device and software versions of the PIREG-C2 controller	✓	-	1	16.7.1
WESE	Restore factory settings	-	✓	2	16.7.2
ZPFA	Query the values of the time log function OFF state	✓	-	50	16.7.23
ZPFE	Query the values of the time log function ON state	✓	-	51	16.7.23
ZYKL	Reset and query the sealing cycles counter	✓	✓	3 … 12	16.7.4

16.5 Reset bus system

The bus system is reset under the following conditions.

- After a power-on
- With a high level at *Reset* input
- By setting the *Reset* signal

The latter can be done either via one of the serial interfaces or via the cyclic PROFINET™ input data. If the Reset parameter is set to 3, only the bus system itself is reset.

16.6 Cyclic data (process data)

16.6.1 Input data

This is only-readable process data, which the controller sends to the PROFINET™ controller every 8 ms.

Table 37: Cyclic input data of the PROFINET™ bus system

Byte offset	Bit offset	Length [bits]	Data type	Description	see command (attr.)
0	0	32	Float	Actual value [°C]	ISTW
1					
2					
3					
4	0	1	Boolean	Status of the external *start* input	STEU (a)
	1	1	Boolean	Status of the external *calibration start* input	STEU (b)
	2	1	Boolean	Status of the external *reset* input	STEU (c)
	3	1	Boolean	Control state of the internal *bus system Reset* signal	-
	4	1	Boolean	Control state of the *start* signal	STEU (d)
	5	2	Enum	Control state of the *calibration start* signal	STEU (e)
	7	1	Boolean	Control state of the *reset* signal	STEU (f)
5	0	4	Unsigned	Currently selected calibration number	KANR
	4	1	Boolean	Activation state of the measurement pulse-pause	MEPA
	5	1	Boolean	State of the calibration OK message	KONF
	6	1	Boolean	State of the temperature OK message	KONF
	7	1	Boolean	State of the temperature reached message	KONF
6	0	4	Enum	Current operating state	ZUST (bb)
	4	4	Enum	Status of an ongoing calibration	ZUST (kk)
7	0	2	Enum	Error state - device error	FEZU (a)
	2	2	Enum	Error state - mains voltage error	FEZU (b)
	4	3	Enum	Error state - data error	FEZU (c)
	7	1	-	-	-
8	0	4	Unsigned	Error state - Active calibration number when the error occurs	FEZU (d)
	4	2	Enum	Error state - reference voltage	FEZU (e)
	6	2	Enum	Error state - reference current	FEZU (f)
9	0	4	Enum	Error state - temperature error	FEZU (g)
	4	4	Enum	Error state - Calibration error	FEZU (h)

Note: duplicate attribute MEPA

16.6.2 Output data

This is the writeable process data which must be sent to the PIREG-C_2 by the PROFINET™ controller every 8 ms.

Writing of invalid usage data (e.g., due to an incorrect value range) is ignored and the value is not accepted by the PIREG-C_2

Table 38: Cyclic output data of the PROFINET™ bus system

Byte offset	Bit offset	Length [bits]	Data type	Description	see command (attr.)
0	0	32	Float	Setpoint [°C]	SOLW
1					
2					
3					
4	0	1	Boolean	Start command	STST
	1	2	Enum	Calibration Start command	STKA
	4	1	Boolean	Control Reset command	STRS
	5	1	Boolean	Bus system Reset command	STRS
	5	1	Boolean	Bus system Reset command	STRS
	6	2	-	-	-
5	0	4	Unsigned	Current calibration number	KANR
	4	1	Boolean	Activation state of the measurement pulse pause[1]	MEPA
	5	3	-	-	-

[1] In the device description data (GSD), the attribute "measurement pulse pause" incorrectly appears twice, once at position 6 and once at position 12. The bit at position 6 is ignored by the controller and should not be used.

16.6.3 Standard value and behaviour in case of connection interruption

After a power-on or a reset of the bus system all fields of the PROFINET™ output data are reset to zero. In addition, the data are ignored by the controller as long as there is no connection.

If the connection to the PROFINET™ controller is interrupted in the ON state the controller switches to the FAULT state and the heating process is terminated.

16.7 Cyclic data (parameter)

Acyclic parameter data can be read and written by the PROFINET™ controller.

Writing of invalid usage data (e.g. due to an incorrect value range) is ignored and the values are not accepted by the PIREG-C2.

16.7.1 Basic configuration

Some parameters are discarded by the controller without feedback to the PLC in certain operating modes (e.g., calibration). If the PLC transmits a basic configuration after establishing a connection (e.g., immediately after the controller is switched on) while the controller is calibrating, this configuration will not be applied correctly.

To ensure smooth operation of the controller in PROFINET™ mode, it is therefore recommended to configure these parameters as follows during the project planning:

Table 39: PROFINET™ basic configuration

Index	Byte	Attribute Name	Value	Definition
16	**5**	Calibration mode	1: Load values	The controller does not automatically switch to calibration mode after being switched on..
31	**1**	Setpoint source	1: Data interface	The setpoint is determined by the input data of the PROFINET™ bus system.

16.7.2 Version format PROFINET parameters

Index:	1
Description:	Device Version Information
Total length:	6-byte(s)
Command reference:	`VERS`
Note:	Format: Three-digit decimal number, to be read as v.vv

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Unsigned	yes	0	-	General device version
2					
3	Unsigned	yes	0	-	Version of the isolated side
4					
5	Unsigned	yes	0	-	Version of the measurement side
6					

16.7.3 Factory state

Index:	2
Description:	Reset to Factory State
Total length:	1-byte(s)
Command reference:	`WESE`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Boolean	no	0	0, 1	Perform Reset

16.7.4 Total Heating Cycle Counter

Index:	3
Description:	Heating cycle counter (Total)
Total length:	4-byte(s)
Command reference:	`CYCLE 0`

Byte	Data type	R/O	Default.	Value range	Attribute description
1 2 3 4	Unsigned	yes	0	-	Total Number of Heating Cycles

16.7.5 Heating cycle counter for calibration numbers

Index:	4 … 11
Description:	Heating Cycle Counter for Calibration Numbers 1 … 8
Total length:	4-byte(s)
Command reference:	`CYCLE 0`

Byte	Data type	R/O	Default.	Value range	Attribute description
1 2 3 4	Unsigned	no	0	-	Number of heating cycles using Calibration number 0. Can be reset by writing 0.

Index:	12
Description:	Resetting a heating cycle counter
Total length:	1-byte(s)
Command reference:	`ZYKL`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Unsigned	no	0	0; 1 … 8	Calibration number for which the counter is to be reset. Evaluated when the parameter is changed.

16.7.6 Maximum heating time

Index:	12
Description:	Maximum heating time
Total length:	4-byte(s)
Command reference:	`HZBG`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Float	no	0.0	0.0 … 99.9	Maximum Duration of a Heating Phase [s]
2					
3					
4					

16.7.7 Heating monitoring

Index:	13
Description:	Heating time monitoring
Total length:	4-byte(s)
Command reference:	`AHUE`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Float	no	5.0	5.0 … 99.9	Lower limit of temperature deviation for temperature OK message [K]
2					
3					
4					
5	Float	no	99.0	5.0 … 99.9	Upper limit of temperature deviation for temperature OK message [K]
6					
7					
8					
9	Float	no	0.0	0.0 … 99.8	Lower limit of heat-up time [s]
10					
11					
12					
13	Float	no	99.0	0.1 … 99.9	Upper limit of heat-up time [s]
14					
15					
16					

16.7.8 Operating hours counter

Index:	15
Description:	Operating hours counter
Total length:	4-byte(s)
Command reference:	`BSTZ`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Float	yes	0	-	PIREG-C2 operating time [s]
2					
3					
4					

16.7.9 Controller settings

Index:	16
Description:	Settings
Total length:	8-byte(s)
Command reference:	`EINS`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Unsigned	no	0	0: without 1: 1 s 2: 3 s 3: 5 s	Heating ramp duration
2	Unsigned	no	0	0: Alloy L 1: Alloy A20 2: NOREX 3: Alloy M 4: User-defined. 5: Alloy A20 6: Alloy A20D	Temperature coefficient preset
3	Unsigned	no	0	0: 15 s 1: 30 s	Calibration comparison time
4	Unsigned	no	0	0: 300 °C 1: 500 °C 2: User-defined.	Temperature range
5	Unsigned	no	0	0: Calibrate 1: Load values	Calibration mode: Calibrate after power-up or use saved values
6	Unsigned	no	0	0: EI/UI laminated 1: Toroid core	Transformer type
7	Unsigned	no	0	0: 20 °C 1: Variable 2: User-defined.	Reference temperature
8	Boolean	no	false		Activation 8-Point Tc Correction

16.7.10 Custom calibration parameters

Index:	17
Description:	Custom calibration parameters (writeable)
Total length:	20-byte(s)
Command reference:	`EIPA`

Byte	Data type	R/O	Default.	Value range	Attribute description
1 **2** **3** **4**	Float	no	20.0	0.0 … 50.0	Reference Temperature [°C]
5 **6** **7** **8**	Float	no	200.0	100.0 … 500.0	Temperature Range [°C]
9 **10** **11** **12**	Float	no	$7.46 \cdot 10^{-4}$	$3.0 \cdot 10^{-4}$ … $9.999 \cdot 10^{-3}$	Temperature coefficient Tk_1 [K^{-1}]

Please turn over...

(continued)

Byte	Data type	R/O	Default.	Value range	Attribute description
13 14 15 16	Float	no	0.0	$-9.999 \cdot 10^{-5}$ … $9.999 \cdot 10^{-5}$	Temperature coefficient Tk_2 [K^{-2}]
17 18 19 20	Float	no	0.0	$-9.999 \cdot 10^{-8}$ … $9.999 \cdot 10^{-8}$	Temperature coefficient Tk_3 [K^{-3}]

Index:	18
Description:	User-defined calibration parameters (Read-Only)
Total length:	8-byte(s)
Command reference:	`EIPA TK`

Byte	Data type	R/O	Default.	Value range	Attribute description
1 2 3 4	Float	yes	0.0	-	Continuous Temperature Range [°C]
5 6 7 8	Float	yes	0.0	-	Dynamic Temperature Range [°C]

16.7.11 Error configuration

Index:	19
Description:	Error Configuration
Total length:	1-byte(s)
Command reference:	`FEKO`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Boolean	no	0	0, 1	Error message when a temperature jump occurs

16.7.12 Parameters of the next calibration process

Index:	20
Description:	Parameters of the next calibration process
Total length:	24-byte(s)
Command reference:	`GWPA`

Byte	Data type	R/O	Default.	Value range	Attribute description
1 2 3 4	Float	yes	20.0	0.0 … 50.0	Reference temperature [°C]

Please turn over...

(continued)

Byte	Data type	R/O	Default.	Value range	Attribute description
5 6 7 8	Float	yes	200.0	100.0 … 500.0	Temperature range [°C]
9 10 11 12	Float	yes	$7.46 \cdot 10^{-4}$	$3.0 \cdot 10^{-4}$ … $9.999 \cdot 10^{-3}$	Temperature coefficient Tk_1 [K^{-1}]
13 14 15 16	Float	yes	0.0	$-9.999 \cdot 10^{-5}$ … $9.999 \cdot 10^{-5}$	Temperature coefficient Tk_2 [K^{-2}]
17 18 19 20	Float	yes	0.0	$-9.999 \cdot 10^{-8}$ … $9.999 \cdot 10^{-8}$	Temperature coefficient Tk_3 [K^{-3}]
21	Unsigned	yes	0	0: 15 s 1: 30 s	Calibration comparison time
22	Unsigned	yes	0	0: Calibrate 1: Load values	Calibration mode: Calibrate after power-up or use saved values
23	Unsigned	yes	0	0: EI/UI laminated 1: Toroid core	Transformer type
24	Unsigned	yes	0	0: without 1: 8-Point-correction 2: 8-Point-correction (stored) 3: 1-Point-correction	Temperature coefficient correction

16.7.13 Calibration parameters

Index:	21 … 28
Description:	Calibration parameters for calibration numbers 1 to 8
Total length:	30-byte(s)
Command reference:	`KAPK 0`

Byte	Data type	R/O	Default.	Value range	Attribute description
1 2 3 4	Float	yes	20.0	0.0 … 50.0	Reference temperature [°C]
5 6 7 8	Float	yes	200.0	100.0 … 500.0	Temperature range [°C]
9 10 11 12	Float	yes	$7.46 \cdot 10^{-4}$	$3.0 \cdot 10^{-4}$ … $9.999 \cdot 10^{-3}$	Temperature coefficient Tk_1 [K^{-1}]

Please turn over...

(continued)

Byte	Data type	R/O	Default.	Value range	Attribute description
13 14 15 16	Float	yes	0.0	$-9.999 \cdot 10^{-5}$ … $9.999 \cdot 10^{-5}$	Temperature coefficient Tk_2 [K^{-2}]
17 18 19 20	Float	yes	0.0	$-9.999 \cdot 10^{-8}$ … $9.999 \cdot 10^{-8}$	Temperature coefficient Tk_3 [K^{-3}]
21 22 23 24	Float	yes	0.0	0 … 999	Heating time for automatic temperature coefficient correction [s]
25	Unsigned	yes	0	0: 15 s 1: 30 s	Calibration comparison time
26	Unsigned	yes	0	0: Calibrate 1: Load values	Calibration mode: Calibrate after power-up or use saved values
27	Unsigned	yes	0	0: EI/UI laminated 1: Toroid core	Transformer type
28	Unsigned	yes	0	0: without 1: 8-Point-Correction 2: 8-Point-Correction (stored) 3: 1-Point-Correction 4: 1-Point-Correction (stored)	Temperature coefficient correction
29	Unsigned	yes	0	0, 20 … 100	Modulation reserve [%] (0: automatic)
30	Unsigned	yes	0	0, 30 … 250	P-factor correction value [%] (0: value determined during calibration is used)

16.7.14 Modulation reserve

Index:	29
Description:	Modulation reserve (writeable)
Total length:	1-byte(s)
Command reference:	`KASR`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Unsigned	yes	0	0, 20 … 100	Modulation reserve [%] (0: automatic)

Index:	30
Description:	Modulation reserve (read-only)
Total length:	1-byte(s)
Command reference:	`KASR`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Unsigned	yes	0	20 … 100	Modulation reserve [%] (value determined during calibration)

16.7.15 Device configuration

Index:	31
Description:	Device configuration
Total length:	7-byte(s)
Command reference:	KONF

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Unsigned	no	1	0: Control voltage 1: Data interface	Setpoint source
2	Unsigned	no	0	0: Delayed 1: Instantaneous	Time behaviour of the alarm output
3	Unsigned	no	0	0: Normally open (NO) 1: Normally closed (NC)	Switch contact configuration of the alarm output
4	Unsigned	no	0	0: Cal. OK message 1: Temp. OK message 2: Temp. OK message (during calibration) 3: Temp. reached message	Configuration of the behaviour of the OK output
5	Unsigned	no	0	0: Normally open (NO) 1: Normally closed (NC)	Switch contact configuration of the OK output
6	Boolean	no	0	0, 1	The 1-point Tk correction is started by a rising edge (with dwell time at high level < 1 s) at the Calibration Start input.
7	Unsigned	no	0	0: Normal 1: Reference voltage 2: Hold-mode 3: Hold-Mode(2s)	Configuration of the actual value output

16.7.16 P-factor correction

Index:	32
Description:	P-factor correction
Total length:	1-byte(s)
Command reference:	KPFK

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Unsigned	no	0	0, 30 … 250	P-factor correction value (0: (The value determined during calibration is used)

16.7.17 Heating time (8-Point Tc correction)

Index:	33
Description:	Warm-up time for 8-point Tk correction.
Total length:	4-byte(s)
Command reference:	KTKZ

Byte	Data type	R/O	Default.	Value range	Attribute description
1 **2** **3** **4**	Float	no	0	0 … 999	Heat-up time for the 1-point temperature correction process

16.7.18 P-factor monitoring

Index:	34
Description:	P-factor monitoring
Total length:	3-byte(s)
Command reference:	`PFUE`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Unsigned	no	0	1 … 99	Lower limit of the P-factor [%]
2	Unsigned	no	0	2 … 100	Upper limit of the P-factor [%]
3	Boolean	no	0	0, 1	Activation of P-factor monitoring

16.7.19 Current P-factor

Index:	35
Description:	P-factor (current calibration number)
Total length:	4-byte(s)
Command reference:	`PFUE`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Float	yes	0.0	-	P-factor determined during calibration of the current calibration number
2					
3					
4					

16.7.20 R_{20} reference resistance

Index:	36
Description:	R_{20} I/O operation
Total length:	1-byte(s)
Command reference:	`RHZL`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Unsigned	no	0	0: None 1: Save current value 2: Delete saved value	Operation to be performed

Index:	37
Description:	R_{20} value (current calibration number)
Total length:	4-byte(s)
Command reference:	`RHZL`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Float	yes	0.0	-	R_{20} value of the current calibration number
2					
3					
4					

Index:	38
Description:	R_{20} reference value
Total length:	4-byte(s)
Command reference:	`RHZL`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Float	yes	0.0	-	R_{20} reference value of the current calibration number
2					
3					
4					

Index:	39
Description:	R_{20}-reference value monitoring
Total length:	3-byte(s)
Command reference:	`RRUE`

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Unsigned	no	0	5 … 100	Lower limit of the R_{20} reference value [%]
2	Unsigned	no	0	5 … 100	Upper limit of the R_{20} reference value [%]
3	Boolean	no	0	0, 1	Activation of R_{20}-reference value monitoring

16.7.21 Values of the 8-Point temperature coefficient correction

Index:	40 … 47
Description:	Values of the 8-Point temperature coefficient correction Calibration numbers 1 to 8
Total length:	64-byte(s)
Command reference:	`KPFK`
Note:	For the first of the nine points output by the KPFK command, the temperature of both the controller and the heating element is always 20 °C. This static point is not included here.

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Float	yes	0.0	-	Setpoint temperature point 1 [°C]
2					
3					
4					
5	Float	yes	0.0	-	Heating tape temperature point 1 [°C]
6					
7					
8					
9	Float	yes	0.0	-	Setpoint temperature point 2 [°C]
10					
11					
12					
13	Float	yes	0.0	-	Heating tape temperature point 2 [°C]
14					
15					
16					
17	Float	yes	0.0	-	Setpoint temperature point 3 [°C]
18					
19					
20					

Please turn over...

(continued)

Byte	Data type	R/O	Default.	Value range	Attribute description
21 22 23 24	Float	yes	0.0	-	Heating tape temperature point 3 [°C]
25 26 27 28	Float	yes	0.0	-	Setpoint temperature point 4 [°C]
29 30 31 32	Float	yes	0.0	-	Heating tape temperature point 4 [°C]
33 34 35 36	Float	yes	0.0	-	Setpoint temperature point 5 [°C]
37 38 39 40	Float	yes	0.0	-	Heating tape temperature point 5 [°C]
41 42 43 44	Float	yes	0.0	-	Setpoint temperature point 6 [°C]
45 46 47 48	Float	yes	0.0	-	Heating tape temperature point 6 [°C]
49 50 51 52	Float	yes	0.0	-	Setpoint temperature point 7 [°C]
53 54 55 56	Float	yes	0.0	-	Heating tape temperature point 7 [°C]
57 58 59 60	Float	yes	0.0	-	Setpoint temperature point 8 [°C]
61 62 63 64	Float	yes	0.0	-	Heating tape temperature point 8 [°C]

16.7.22 Temperature OK message configuration

Index:	48
Description:	Temperature OK message configuration
Total length:	6-byte(s)
Command reference:	`TOKG`

Byte	Data type	R/O	Default.	Value range	Attribute description
1 2 3 4	Float	yes	0.0	0.0 … 99.9	Stabilisation time [s]
5	Unsigned	no	0	5 … 99	Lower limit of the temperature OK range [K]
6	Unsigned	no	0	5 … 99	Upper limit of the temperature OK range [K]

16.7.23 Temperature monitoring configuration

Index:	49
Description:	Temperature monitoring
Total length:	7-byte(s)
Command reference:	`TUEE`

Byte	Data type	R/O	Default.	Value range	Attribute description
1 2 3 4	Float	yes	0.0	0.0 … 99.9	Stabilisation time [s]
5	Unsigned	no	0	5 … 99	Lower limit of the temperature OK range [K]
6	Unsigned	no	0	5 … 99	Upper limit of the temperature OK range [K]
7	Unsigned	no	0	0, 1	Temperature monitoring activation

16.7.24 Logging

Index:	50
Description:	Logged data of the OFF state
Total length:	8-byte(s)
Command reference:	`ZPFA`

Byte	Data type	R/O	Default.	Value range	Attribute description
1 2 3 4	Float	yes	0.0	0.0 … 665.53	Cooling time [s]
5 6 7 8	Float	yes	0.0	0.0 … 999.0	Actual temperature at the beginning of the OFF state [°C]

Index:	51
Description:	Logged data of the heating state
Total length:	20-byte(s)
Command reference:	ZPFE

Byte	Data type	R/O	Default.	Value range	Attribute description
1	Float	yes	0.0	0.0 … 665.53	Heating time [s]
2					
3					
4					
5	Float	yes	0.0	0.0 … 665.53	Sealing time [s]
6					
7					
8					
9	Float	yes	0.0	0.0 … 999.0	Actual temperature before heating [°C]
10					
11					
12					
13	Float	yes	0.0	0.0 … 999.0	Temperature setpoint before heating [°C]
14					
15					
16					
17	Float	yes	0.0	0.0 … 999.0	Average temperature setpoint during the sealing process [°C]
18					
19					
20					

17. Annex

Table 39: Annexes to this document

Numbering	Description
i)	Command reference for serial interfaces

i) Command Reference for Serial Interfaces

The PIREG-C2 has three serial interfaces. These are an RS232 (1), an RS485 (2), and a USB (3). The RS232 and the RS485 interfaces use a joint connector. The USB interface is used as a virtual RS232 interface.
The RS232 and USB interfaces are used for direct communication with the controller. The RS485 interface serves as an interface to a higher-level controller, e.g., a PLC.

i) 1. Communication

i) 1.1. RS232 and USB communication: The RS232 and USB interface use the same command set, composed of alphanumeric characters. This provides a good comprehensibility for the user. Each interface has a 64-byte data memory. The Baud rate can be set separately for each interface using a command (BRAT). Both interfaces have the following factory set data format:

9600 Baud	1 Start bit	8 data bits	1 stop bit	No parity

Log: ASCII strings are used for the communication telegrams. Both lower and upper case alphabets can be used. The PIREG-C2 itself does not establish communication with its communication partner; it remains passive. The PIREG-C2 acknowledges every communication from communication partners either with the requested reply or the OK acknowledgement. An error acknowledgement is issued in case of faulty communication. For its acknowledgement and reply the PIREG-C2 uses only upper case alphabets.
A telegram always ends with the ASCII character Number 13. The names of the commands or acknowledgements are separated from the following data by a space. Data to be transferred are transmitted with a constant width and with leading zeros, if needed. If several data are transferred, they are separated with a space.

i) 1.2. Addressed RS232 communication: The communication via the RS232 interface can also be addressed. This allows the RS232 interfaces of up to three PIREG-C2 to be connected in parallel. This way, a communication partner can communicate with up to PIREG-C2 via a RS232 interface. The addressing of the RS232 communication is switched on and off with the (KOKO) command. The address of the RS232 communication is set with the (GADR) command and can also be used for the RS485 communication. The address space covers the range 0 … 250. Address 0 is factor set.

Log: Addressed RS232 communication is used with the form described above. The address is placed before the command, the acknowledgement and the response and separated by a space. Three numbers are always used for the address.

i) 1.3. RS485 communication: The RS485 interface uses a binary command set in order to increase the communication speed. The interface has a 64-byte data storage. For the RS485 communication the PIREG-C2 has an address which is set with the (GADR) command. This address is also used for the addressed RS232 communication. Using the addressing up to 31 PIREG-C2 can be operated on the same RS485 Bus. The address space covers the range 0 … 250. The Baud rate can be set with the (BRAT) command. Address 0 is factor set and the interface has the following data format:

9600 Baud	1 Start bit	8 data bits	1 stop bit	even parity

Log: The protocol used is based on DIN 19244. The PIREG-C2 itself does not establish communication with the master in bus system; it remains passive. The PIREG-C2 replies with a delay of min. 3 ms for a secure direction switching of the RS485 communication. The following telegram formats are used:

Short set: Short sets are sent from the master to the PIREG-C2 on the call side:
➔ for transmitting short commands to the PIREG-C2 (e.g. reset).
➔ for shortened retrieval of important data from PIREG-C2.
Short sets are used on the answer side by the PIREG-C2:
➔ for acknowledgement for calls not requiring reply data.

SZ	GA	FF	PS	EZ

Control set: The control sets are used by the master only on the call side. They are used to call up all commands that cannot be called up via short sets as they require a more detailed specification. The control set has a fixed length LG of three.

SZ	LG	LG	SZ	GA	FF	BI	PS	EZ

Long set:

The long sets are used:

➔ to transfer commands with parameters to the PIREG-C2

➔ to transfer data from the PIREG-C2 by the master.

The length LG of the long set is the length of the data block plus three.

SZ	LG	LG	SZ	GA	FF	BI	DB0…n	PS	EZ

Start character SZ:

The Start-Sign identifies the telegram (1 byte)

➔ Start-Sign for short set: 10h

➔ Start-Sign for control and long set: 68h

Device address GA:

➔ 0...250, range for individual device addresses of the PIREG-C2. The address 0 is the factory setting.

➔ All PIREG-C2 connected to a Bus can be addressed under the address 255. The data and commands transferred with this address are accepted by all devices, but there is no acknowledgement to the Master.

In the short set with the function field AAh in the call direction, an acknowledgement is also performed at the device address GA 25i)

Function field d FF:

The function field contains

➔ with the short set, the actual information, predefined bit by bit and is different in the call and response direction.

➔ with control and long set the direction and control information for the transferred data block.

Function coding of the Function field (FF) in the call-up direction:

Call control:	Code:	Set type:	Remark:
Reset device.	09h	Short set	Only the specified codes are evaluated by the PIREG-C2; invalid codes are responded to with an error acknowledgement.
Detect device. The PIREG-C2 also sends an acknowledgement for device address 255.	AAh		
Send data to PIREG-C2.	69h	Control and long set	
Data from Query PIREG-C2.	89h		

Function coding of the function field (FF) in the response direction:

Bit no.	Function:	Value:	Assignment:
0…2	Reserved	000	Fixed
3	Command lock	0	Command executed, PIREG-C2 ready
		1	PIREG-C2 is not ready for this command
4	Command error	0	Command executed
		1	The function field FF or the command index BI is unknown.
5	Transmission error	0	Call telegram correct
		1	A parity error has occurred or the PS checksum is incorrect.
6	unused	0	0
7	Syntax or parameter error	0	No syntax or parameter error
		1	Syntax or parameter error

Command index BI:

The command to be executed is specified via the Command-Index. The PIREG-C2 acknowledges all Command-Indexes, that are not assigned to any commands as error.

Length LG:

The length of the data block DB is variable and depends on the Command-Index B and the function field FF. The control set has a fixed length of three. With the long set, the length LG is the length of the data block plus three.

Data block DB:

The data block DB can have parameters and data from and to PIREG-C2. Negative numbers are represented as 2's complements.

Checksum PS:

With the short set the checksum is the sum of the device address GA: and function filed FF without overflow summation. With the control set the checksum is the sum of the device address GA, function field FF and the command Index BI without overflow summation. With long set the checksum is the sum of all characters of the device-address GA up to and including the last characters of the device address GA, without overflow summation.

End character EZ:

The end character is for all set types 16h.

i) 1.4. External thermometer RS232 communication: Using a special connection cable an external thermometer DTM3000 (from V1.01/1.16/1.10) or the former TM6, can be connected to the RS232 interface of the PIREG-C2. The TM6 thermometer is no longer available. The configuration is done with the (KOKO) command. The communication to the DTM3000 thermometer is configured at the factory. At the start of the 8-Point Tc Correction during the calibration and at the start of the single-point Tc correction the PIREG-C2 attempts to establish connection with the external thermometer.
When establishing communication the PIREG-C2 transmits up to four times the query telegram to the thermometer, in case the latter does not return a valid response beforehand. The maximum communication establishment time results from the transmission interval time. If no communication takes place, the PIREG-C2 resets the former interface configuration.
The following data formats apply for communication with the external thermometer:

	Query telegram	Transmission interval time	Maximum communication setup time	Baud rate	Data format
DTM3000:	"D"	333 ms	1.11 s	9600 Baud	1 Start bit 8 data bits 1 stop bit, no parity
TM6:	"FCh"	1.5 s	5 s	2400 Baud	

If the communication takes place the PIREG-C2 transmits the query telegram to the thermometer with the transmission interval time. The communication with the thermometer is monitored. If three consecutive query telegrams are not responded or three consecutive responses are faulty the PIREG-C2 switches to the FAULT state with Error 9.
After the end of the 8-point and single-point Tc correction the PIREG-C2 ends the communication with the thermometer and resets the previous interfaces configuration.

i) 2. RS232 and USB interface acknowledgements

i) 2.1. OK acknowledgement

Syntax: **Acknowledgement: QOK00**

Description: With this acknowledgement the PIREG-C2 acknowledges an error-free communication where no response is transmitted.

Example **Report:** QOK00

Reference: Error acknowledgements

i) 2.2. Error 1 acknowledgement

Syntax: **Acknowledgement: QFE01**

Description: The PIREG-C2 sends this acknowledgement when the received command name is not known to the controller.

Example **Report:** QFE01

Reference: OK acknowledgement

i) 2.3. Error 2 acknowledgement

Syntax: **Acknowledgement: QFE02**

Description: The PIREG-C2 sends this acknowledgement when there is a syntax or parameter error in the telegram of the received command or if the telegram is incomplete.

Example **Report:** QFE02

Reference: OK acknowledgement

i) 2.4. Error 3 acknowledgement

Syntax: **Acknowledgement: QFE03**

Description: The PIREG-C2 sends this acknowledgement when the execution of the telegram is not enabled, or the entered code number is incorrect.

Example **Report:** QFE03

Reference: OK acknowledgement

i) 2.i) Error 4 acknowledgement

Syntax: **Acknowledgement: QFE04**

Description: The PIREG-C2 sends this acknowledgement when an error has occurred when saving in the EEPROM memory.

Example **Report:** QFE04

Reference: OK acknowledgement

i) 3. RS485 interface acknowledgements

The identification of the acknowledgement during communication via the RS485 interface is down via the function field FF in response telegram.

i) 3.1. OK acknowledgement

Syntax: **Acknowledgement: Function field FF = 00h in response telegram**

Description: The OK acknowledgement is executed when the function field FF is set to 00h. This takes place directly in response telegram as long or short set.

Example **Report:** 10 21 00 21 16 (Short set, GA = 21h)

Reference: Error acknowledgements

i) 3.2. Command lock

Syntax: **Acknowledgement: Short set, function field FF Bit 3=1**

Description: The PIREG-C2 sends this acknowledgement when the execution of the telegram is not enabled, or the entered code number is incorrect.
In addition, the PIREG-C2 sends this acknowledgement when an error has occurred when saving in the EEPROM memory.

Example **Report:** 10 21 08 29 16 (Short set, GA = 21h)

Reference: OK acknowledgements

i) 3.3. Command error

Syntax: **Acknowledgement: Short set, function field FF Bit 4=1**

Description: The PIREG-C2 sends this acknowledgement when the code for the function field FF or the command index BI is not known to the controller.

Example **Report:** 10 21 10 31 16 (Short set, GA = 21h)

Reference: OK acknowledgements

i) 3.4. Transmission error

Syntax: **Acknowledgement: Short set, function field FF Bit 5=1**

Description: The PIREG-C2 sends this acknowledgement if a parity error occurs or the checksum PS is faulty.

Example **Report:** 10 21 20 41 16 (Short set, GA = 21h)

Reference: OK acknowledgements

i) 3.5. Syntax or parameter error

Syntax: **Acknowledgement:**
Short set, function field FF Bit 7=1

Description: The PIREG-C2 sends this acknowledgement when there is a syntax or parameter error in the telegram of the received command or if the telegram is incomplete.

Example **Report:** 10 21 80 A1 16 (Short set, GA = 21h)

Reference: OK acknowledgements

i) 4. Interface commands

Write (S...) and read (L...) commands are available for setting the parameters and for the operation and control of the PIREG-C2. With this command the controller parameters can be set and sealing process started. Using a command (WESE) the factory settings can be restored.
For RS232 and the USB interface every command telegram starts with the character “S” or “L”, depending on the type of command. The response telegrams to read commands start with the character “A” followed by the command name. The response times to read commands are usually at 0-5 ms and maximum at 1 ms, unless stated otherwise. The response telegram data are separated by spaces.
With the addressed RS232 communication every telegram starts with the address consisting of three characters and is separated with a space from the above-described telegram structure of a command, an acknowledgement or a response.
With the RS485 interface the identification of the command for the Writing is done with 69h and for Reading with 89h in function filed FF. For the following example the device address GA 21h is used for the controller. The end character of every telegram of the RS485 interface is 16h.
The input values are monitored for their limits.

Command overview

L	S	Command	Description	BI	Item
X	X	**AHUE**	Setting and query of the heating monitoring settings	0Bh	**i) 4.1.**
X	X	**BRAT**	Setting and query of the set Baud rate of interfaces	0Ah	**i) 4.2.**
X		**BSMS**	Query of the MAC address and the serial number of AnyBus modules of the bus system of the PIREG-C2 controller. (EtherNet/IP variant only)	7Bh	**i) 4.3.**
X		**BSTZ**	Query of the operating hours counter	6Fh	**i) 4.4.**
X	X	**EINS**	Setting and query of the setting switch of the PIREG-C2 controller	02h	**i) 4.5.**
X	X	**EIPA**	Setting and query of the setting parameter reference temperature, temperature range and temperature coefficients.	03h	**i) 4.6.**
X	X	**FEKO**	Setting and query of the controller error configuration	14h	**i) 4.7.**
	X	**FESL**	Delete error memory	6Ch	**i) 4.8.**
X		**FESP**	Reading the error memory	76h	**i) 4.9.**
X		**FEZU**	Query of the error state	33h	**i) 4.10.**
X	X	**GADR**	Setting and query of the device address GA of the addressed RS232 and RS485 communication	07h	**i) 4.11.**
X		**GTYP**	Query of the device type of the PIREG-C2 controller	6Bh	**i) 4.12.**
X		**GWPA**	Query of the selected parameters used for the next calibration.	04h	**i) 4.13.**
X	X	**HZBG**	Setting and query of the heating time limit	70h	**i) 4.14.**
X		**ISTW**	Query of the current actual temperature value	34h	**i) 4.15.**
X	X	**KANR**	Setting and query of the calibration number (1…8) of the active calibration	3Ch	**i) 4.16.**
X		**KAPA**	Query of the parameters of the currently active calibration	05h	**i) 4.17.**
X		**KAPK**	query of the parameters of the calibrated calibrations (1…8)	13h	**i) 4.18.**
X	X	**KASR**	Setting and query of the selected and calibrated headroom	10h	**i) 4.19.**
X	X	**KOKO**	Setting and query of the controller's communication configuration	11h	**i) 4.20.**
X	X	**KONF**	Setting and query of the configuration of the PIREG-C2 controller.	06h	**i) 4.21.**
X	X	**KOUE**	Setting and query of the communication monitoring settings	0Dh	**i) 4.22.**
X	X	**KPFK**	Setting and query of the P-factor correction value	0Fh	**i) 4.23.**
X	X	**KTKZ**	Setting and query of the heating time for automatic Tc correction	0Eh	**i) 4.24.**
X	X	**MEPA**	Setting and query of of the state of the measurement pulse-pause	3Dh	**i) 4.25.**
X	X	**PFUE**	Setting and query of the P-factor monitoring settings	12h	**i) 4.26.**
X	X	**RHZL**	Setting and query of the reference resistance R20 of the heating conductor	80h	**i) 4.27.**
X	X	**RRUE**	Setting and query of the reference R20 value monitoring settings	15h	**i) 4.28.**
X	X	**SOLW**	Setting and query of the temperature setpoint used	35h	**i) 4.29.**
X		**STEU**	Query of the state of the manual and interface control inputs	36h	**i) 4.30.**
	X	**STKA**	Starting calibration via interface	38h	**i) 4.31.**
	X	**STRS**	Triggering a reset via interface	39h	**i) 4.32.**
	X	**STST**	Controlling heating via interface	3Ah	**i) 4.33.**
X		**TKEI**	Query of the 8-point Tc correction setting for the current calibration	72h	**i) 4.34.**
X		**TKEK**	Query of the 8-point Tc correction setting for the calibrated calibrations (1…8)	73h	**i) 4.35.**
X	X	**TOKG**	Setting and query of the temperature limits and the stabilisation time Temperature OK message	08h	**i) 4.36.**
X	X	**TUEE**	Setting and query of the temperature monitoring settings	09h	**i) 4.37.**
X		**UIMW**	Query of Ur and Uir at the sampling time and calculating the effective values of Ur and Ir.	71h	**i) 4.38.**
X		**VERS**	Query of the device and both program versions of the PIREG-C2 controller.	69h	**i) 4.39.**
	X	**WESE**	Setting the factory settings	0Ch	**i) 4.40.**
X		**ZPFA**	Reading the values of the time log function (OFF state)	78h	**i) 4.41.**
X		**ZPFE**	Reading the values of the time log function (ON state)	79h	**i) 4.42.**
X		**ZUST**	Query of the state of the PIREG-C2 controller	37h	**i) 4.43.**
X	X	**ZYKL**	Resetting and query of the sealing cycle counters	6Eh	**i) 4.44.**

Abbreviations: L: Read command; S: Write command; BI: Command index for RS485 interface

i) 4.1. AHUE Command

Syntax RS232/USB:

Read: **LAHUE**

Response:
- Variant 1: **AAHUE a uuu ooo ttt**
- Variant 2: **AAHUE a uuu ooo sss eee**

Write:
- Variant 1: **SAHUE a uuu ooo ttt**
- Variant 2: **SAHUE a uuu ooo sss eee**

Response: OK or error acknowledgement; Response time

Release: max. 6 ms, not in power-on or calibration state

Syntax: RS485:

Read: **Control set, BI = 0Bh**

Response: - Variant 1: **Long set with DB0…DB4**

DB4	DB3	DB2	DB1	DB0
H-byte	L-byte			
ttt		ooo	uuu	a

- Variant 2: **Long set with DB0…DB6**

DB6	DB5	DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte			
eee		sss		ooo	uuu	a

Write: - Variant 1: **Long set with DB0…DB4, BI = 0Bh**

DB4	DB3	DB2	DB1	DB0
H-byte	L-byte			
ttt		ooo	uuu	a

- Variant 2: **Long set with DB0…DB6, BI = 0Bh**

DB6	DB5	DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte			
eee		sss		ooo	uuu	a

Response: Short set, OK or error acknowledgement; response time max. 6 ms

Enable: not in power-on or calibration state

Description: Setting and query of the heating monitoring settings. The heating monitoring is a monitoring function in two variants. In Variant 1, a maximum time is monitored in which the heating must be performed. In Variant 2, a time range is monitored within which the heating must be performed.

The monitoring function is switched On (a=1) and Off (a=0) with “a”. A temperature OK range is set around the setpoint with the lower limit “uuu” (5…99K) and upper limit “ooo” (5…99K) in K. In Variant 1, the actual value of the PIREG-C2 must have reached the temperature OK range before the heating time “ttt” has elapsed in 0.1s (0…99.9s). In variant 2, the actual value must have reached the temperature-OK-range within the time window “sss”, in 0.1s (0…99.8s), to “eee”, in 0.1s (0.1…99.9s). If this doesn’t happen the PIREG-C2 switches to the Fault (Error 8).

If the setpoint increases by more than 5° C the heating monitoring is restarted.

Example RS232/USB:

Read: LAHUE

Response:
- Variant 1: AAHUE 1 010 010 010
- Variant 2: AAHUE 1 010 010 008 012

Write:
- Variant 1: SAHUE 1 010 010 010
- Variant 2: SAHUE 1 010 010 008 012

Response: QOK00

Example RS485:

Read: 68 03 03 68 21 89 0B B5 16 (GA=21h)

Response:
- Variant 1: 68 08 08 68 21 00 0B 01 0A 0A 0A 00 4B 16
- Variant 2: 68 0A 0A 68 21 00 0B 01 0A 0A 08 00 0C 00 55 16)

Write:
- Variant 1: 68 08 08 68 21 69 0B 01 0A 0A 0A 00 B4 16 (GA=21h)
- Variant 2: 68 0A 0A 68 21 69 0B 01 0A 0A 08 00 0C 00 BE 16

Response: 10 21 00 21 16

Reference: FEZU

i) 4.2. BRAT Command

Syntax RS232/USB:	**Read:**	**LBRAT**
	Response:	**ABRAT n bbbb**
	Write:	**SBRAT n bbbb**
	Response:	OK or error acknowledgement; response time max. 6 ms
	Enable:	not in power-on or calibration state

Syntax: RS485: **Read:** **Long set with DB0, BI = 0Ah**

DB0
n

Response: **Long set with DB0…DB2**

DB2	DB1	DB0
H-byte	L-byte	
bbbb		n

Write: **Long set with DB0…DB2, BI = 0Ah**

DB2	DB1	DB0
H-byte	L-byte	
bbbb		n

Response: short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Description: Setting and query of the Baud rate “bbbb”, in 0.1 kBaud, of the interface with number “n” (1=RS232, 2=RS485 and 3=USB). Values 9.6 kBaud, 19.2 kBaud, 38.4 kBaud, 57.6 kBaud and 115.2 kBaud are available for the Baud rate.
The acknowledgement is already sent with the new Baud rate.

Example RS232/USB:	**Read:**	LBRAT 1	
	Response:	ABRAT 1 0096	(RS232 interface, 9600 Baud)
	Write:	SBRAT 1 0096	(RS232 interface 9600 Baud)
	Response:	QOK00	

Example RS485:	**Read:**	68 04 04 68 21 89 0A 01 B5 16	(GA=21h)
	Response:	68 06 06 68 21 00 0A 01 60 00 8C 16	
	Write:	68 06 06 68 21 69 0A 01 60 00 F5 16	(GA=21h)
	Response:	10 21 00 21 16	(GA=21h)

Reference: --

i) 4.3. BRAT Command

Syntax RS232/USB:	**Read:**	**LBSMS**
	Response:	**ABSMS aa-aa-aa-aa-aa-aa ssssssss**
	Release:	only with device type x2x

Syntax: RS485: **Read:** **Control set, BI = 7Bh**
Response: **Long set with DB0…DB9**

DB5	DB4	DB3	DB2	DB1	DB0
aaaaaaaaaaaa					

DB9	DB8	DB7	DB6
ssssssss			

Release: only with device type x2x

Description: Query of the MAC-Address “aaaaaaaaaaaa” and the serial number “ssssssss” of the EtherNet/IP bus system of the PIREG-C2 controller. With the output via the RS232-/USB interface, the MAC address as well as the serial number is output in hexadecimal representation. In addition, with the MAC address the MAC address bytes are separated by a hyphen “-”. (from V1.01/1.18/1.14)

Example RS232/USB:	**Read:**	LBSMS
	Response:	ABSMS 00-30-11-26-12-2B A0393A23

Example RS485:	**Read:**	68 03 03 68 21 89 7B 25 16	(GA=21h)
	Response:	68 0D 0D 68 21 00 7B 2B 12 26 11 30 00 23 3A 39 A0 76 16	

Reference: --

i) 4.4. BSTZ Command

Syntax RS232/USB: **Read:** **LBSTZ**
Response: **ABSTZ hhhhhh:mm:ss**

Syntax: RS485: **Read:** **Control set, BI = 6Fh**
Response: **Long set with DB0…DB4**

DB4	DB3	DB2	DB1	DB0
H-byte	M-byte	L-byte		
hhhhhh			mm	ss

Description: The query of the state of the operating hours counter in hours “hhhhhh” (0...999999), minutes “mm” (0...59) and seconds “ss” (0…59). The time units are separated with a colon “:”.

Example RS232/USB: **Read:** LBSTZ
Response: ABSTZ 000176:34:15

Example RS485: **Read:** 68 03 03 68 21 89 6F 19 16 (GA=21h)
Response: 68 08 08 68 21 00 6F 2B 18 49 00 00 1C 16

Reference: ZYKL

i) 4.5. EINS Command

Syntax RS232/USB: **Read:** **LEINS**
Response: **AEINS abcd efgh**
Write: **SEINS abcd efgh**
Response: OK or error acknowledgement; response time max. 6 ms
Release: not in power-on or calibration state

Syntax: RS485: **Read:** **Control set, BI = 02h**
Response: **Long set with DB0 and DB1**

DB1								DB0							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
-	-	-	h	g1	g0	f	e	d1	d0	c	b2	b1	b0	a1	a0

Write: **Long set with DB0 and DB1, BI = 02h**

DB1								DB0							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
-	-	-	h	g1	g0	f	e	d1	d0	c	b2	b1	b0	a1	a0

Response: Short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Description: Setting and query of the PIREG-C2 setting switch. The setting switches have the same function as the ten DIP switches on the PIREG-C2 without bus system. Use the KONF command to select whether the DIP switch or the setting switch are used.

Assignment

a **Heating ramp of the heating conductor:**
0= without 1= 2 s 2= 3 s 3= 5 s

b **Temperature coefficient of the heating conductor:**
0= Tk1= $7.46x10^{-4}$ 1/K, Tk2= 0, Tk3=0 (Alloy L)
1= Tk1= $10.8x10^{-4}$ 1/K, Tk2= 0, Tk3=0 (Alloy A20)
2= Tk1= $48.3x10^{-4}$ 1/K, Tk2= $-6.12x10^{-6}$ 1/K², Tk3=$2.80x10^{-9}$ 1/K³ (NOREX)
3= Tk1= $8.62x10^{-4}$ 1/K, Tk2= 0, Tk3=0 (Alloy M)
4= Set with SEIPA TK command
5= Tk1= $12.65x10^{-4}$ 1/K, Tk2= 0, Tk3= $-0.70 x10^{-9}$ 1/K³ (Alloy A20C)
6= Tk1= $12.55x10^{-4}$ 1/K, Tk2= 0, Tk3= 0 (Alloy A20D)
(5 and 6 from V1.01/1.14/1.09)

c **Calibration comparison time:** 0= 15 s 1= 30 s

d **Temperature range:** 0= 0...300 °C 1= 0...500 °C
2= Set with SEIPA TB command

e **Calibration type:** 0= Recalibration upon power on or reset
1= Save calibration

f **Transformer type:** 0= Sealing transformer with EI or UI core
1= Sealing transformer with toroidal core

g **Reference temp:** 0= Reference temperature 20 °C for calibration
1= Variable reference temperature 0...50 °C for calibration.
2= Set with SEIPA BT command

h **8-Point Tc correction:** 0= without 8-Point Tc correction
1= with 8-Point Correction

Example RS232/USB:	**Read:**	LEINS	
	Response:	AEINS 0100 1000	
	Write:	SEINS 0100 1000	
	Response:	QOK00	
Example RS485:	**Read:**	68 03 03 68 21 89 02 AC 16	(GA=21h)
	Response:	68 05 05 68 21 00 02 20 01 44 16	
	Write:	68 05 05 68 21 69 02 04 01 91 16	(GA=21h)
	Response:	10 21 00 21 16	
Reference:	KONF, EIPA		

i) 4.6. EIPA Command

Syntax RS232/USB:

Read: **LEIPA BT** Read reference temperature
Response: **AEIPA BT ttt**
Write: **SEIPA BT ttt** Set reference temperature
Response: OK or error acknowledgement; response time max. 6 ms
Release: not in power-on or calibration state

Read: **LEIPA TB** Read temperature range
Response: **AEIPA TB ttt**
Write: **SEIPA TB ttt** Set temperature range response:
OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Read: **LEIPA TK** Read temperature coefficients
Response: **AEIPA TK ±aaaa ±bbbb ±cccc sss ddd** ; Response time max. 6 ms
Write: **SEIPA TK ±aaaa ±bbbb ±cccc** Set temperature coefficient
Response: AEIPA TK sss ddd ; Response time max. 26 ms
Release: not in power-on or calibration state

Syntax: RS485:

Read: **Long set with DB0, BI = 03h**

Index: Function:
01h Read reference temperature
02h Read temperature range
03h Read temperature coefficient

DB0
Index
xx

Response: Read reference temperature and temperature range
Long set with DB0…DB2

Index: Function:
01h Read reference temperature
02h Read temperature range

DB2	DB1	DB0
H-byte	L-byte	Index
ttt		xx

Read temperature coefficient, Index: 03h
Long set with DB0…DB10

DB6	DB5	DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte	H-byte	L-byte	Index
±cccc		±bbbb		±aaaa		xx

DB10	DB9	DB8	DB7
H-byte	L-byte	H-byte	L-byte
ddd		sss	

Write: Read reference temperature and temperature range
Long set with DB0…DB2, BI = 03h

Index: Function:
01h Set reference temperature
02h Set temperature range

DB2	DB1	DB0
H-byte	L-byte	Index
ttt		xx

Response: Short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Write: Set temperature coefficient, Index: 03h
Long set with DB0…DB6, BI = 03h

DB6	DB5	DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte	H-byte	L-byte	Index
±cccc		±bbbb		±aaaa		xx

Response: **Long set with DB0…DB4**

DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte	Index
ddd		sss		xx

response time max. 26 ms
Release: not in power-on or calibration state

Description: The function of the command is to set and query the following setting parameters which are saved and are released with the EINS command:

Reference temperature BT:

Setting and query of the reference temperature “ttt” (0…50) in 1° C for execution of calibration.

Temperature range TB:

Setting and query of the parameters only for the upper limit “ttt” (100…500) in 1° C of the temperature range. Each temperature range always starts at 0 °C. The value for the overtemperature limit always lies 20% higher than the upper limit of the temperature range. The value for the Undertemperature limit is fixed at -10° C.

Temperature coefficient TK:

Setting and query of the heating conductor coefficients:

- Tk1= “±aaaa” in 0.01×10^{-4} 1/K (+300…+9999)
- Tk2= “±bbbb” in 0.01×10^{-6} $1/K^2$ (-9999…+9999)
- Tk3= “±cccc” in 0.01×10^{-9} $1/K^3$ (-9999…+9999)

The PIREG-C2 simultaneously checks the resistance curve, given when using temperature coefficients, for consistency and dynamic in the temperature range -20…+600 °C. The PIREG-C2 responds with the temperature range for the consistency “sss” and for the dynamic “ddd” in °C. The temperature range of the PIREG-C2 must be lower or at the most equal to the limit temperatures for consistency and dynamics.

Example RS232/USB:	**Read:**	LEIPA BT	Read/write reference temperature
	Response:	AEIPA BT 030	
	Write:	SEIPA BT 030	
	Response:	QOK00	
	Read:	LEIPA TK	Read/write temperature coefficients
	Response:	AEIPA TK +5260 -0646 +0318 500 358	
	Write:	SEIPA TK +5260 -0646 +0318	
	Response:	AEIPA TK 500 358	

Example RS485:		Read/write reference temperature	
	Read:	68 04 04 68 21 89 03 01 AE 16	(GA=21h)
	Response:	68 06 06 68 21 00 03 01 1E 00 43 16	
	Write:	68 06 06 68 21 69 03 01 1E 00 AC 16	(GA=21h)
	Response:	10 21 00 21 16	
		Read/write temperature coefficients	
	Read:	68 04 04 68 21 89 03 03 B0 16	(GA=21h)
	Response:	68 0E 0E 68 21 00 03 03 8C 14 7A FD 3E 01 F4 01 66 01 D9 16	
	Write:	68 0A 0A 68 21 69 03 03 8C 14 7A FD 3E 01 E6 16	(GA=21h)
	Response:	68 08 08 68 21 00 03 03 F4 01 66 01 83 16	

Reference: EINS

i) 4.7. FEKO Command

Syntax RS232/USB:	**Read:**	**LFEKO**
	Response:	**AFEKO abcd efgh**
	Write:	**SFEKO abcd efgh**
	Response:	OK or error acknowledgement; response time max. 6 ms
	Enable:	not in power-on or calibration state

Syntax: **Read:** **Control set, BI = 14h**

RS485: **Long set with DB0**

DB0							
7	6	5	4	3	2	1	0
h	g	f	e	d	c	b	a

Write: **Long set with DB0, BI = 14h**

DB0							
7	6	5	4	3	2	1	0
h	g	f	e	d	c	b	a

Response: Short set, OK or error acknowledgement; response time max. 6 ms

Enable: not in power-on or calibration state

Description: Setting and query of the PIREG-C2 settings of the error configuration of the PIREG-C2. The following error messages can be activated and deactivated on the PIREG-C2 with the FEKO command. (from V1.01/1.06/1.06)

Assignment			
a	**Temperature jump:**	0 = active	1 = deactivated
b	Not occupied		
c	Not occupied		
d	Not occupied		
e	Not occupied		
f	Not occupied		
g	Not occupied		
h	Not occupied		

Example RS232/USB:	**Read:**	LFEKO	
	Response:	AFEKO 1000 0000	
	Write:	SFEKO 1000 0000	
	Response:	QOK00	
Example RS485:	**Read:**	68 03 03 68 21 89 14 BE 16	(GA=21h)
	Response:	68 04 04 68 21 00 14 01 36 16	
	Write:	68 04 04 68 21 69 14 01 9F 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: FEZU

i) 4.8. FESL Command

Syntax RS232/USB:	**Write:**	**SFESL z**
	Response:	OK or error acknowledgement; response time max. 225 ms
	Enable:	not in power-on or calibration state
Syntax: RS485:	**Write:**	**Long set with DB0, BI = 6Ch**

DB0							
7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	z

Response: Short set, OK or error acknowledgement; response time max. 225 ms
Enable: not in power-on or calibration state

Description: Clears the contents of the error log with the state z=1. The PIREG-C2 stores the last 100 error events. After clearing, all values in the memory locations are zero.

Example RS232/USB:	**Write:**	SFESL 1	
	Response:	QOK00	
Example RS485:	**Write:**	68 04 04 68 21 69 6C 01 F7 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: FESP

i) 4.9. FESP Command

Syntax RS232/USB:	**Read:**	**LFESP**	
	Response:	**nnn;hhhhhh:mm:ss;abcd efgh**	**(100 times)**
Syntax: RS485:	**Read:**	**Control set, BI = 76h**	
	Response:	**Long set with DB0…DB8**	**(100 times)**

DB8	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
					H-byte	M-byte	L-byte	
abcd efgh			ss	mm	hhhhhh			nnn

Note: For reasons of backward compatibility, bit “c2” of parameter “C” is located in data byte DB8 as bit 4 and bits “d2” and “d3” of parameter “D” are located in data byte DB8 as bits 5 and 6. (see command FEZU)

DB7								DB6							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
g3	g2	g1	g0	f1	f0	e1	e0	d1	d0	c1	c0	b1	b0	a1	a0

DB8							
7	6	5	4	3	2	1	0
-	d3	d2	c2	h3	h2	h1	h0

Description: Reading out the contents of the error memory of the PIREG-C2 controller. The PIREG-C2 stores the last 100 error events. The output is in CSV format. If memory locations are not occupied, all values are zero. The output is executed in 100 lines. The error with the number 1 is the newest error event, the error with number 100 is the oldest.
During the RS485 communication the hundred longitudinal sets are sent consecutively with a pause of 3ms.

Assignment	
nnn:	Memory location number (1…100)
hhhhhh:	Operating time hours (0…999999)
mm:	Operating time minutes (0…59)
ss:	Operating time seconds (0…59)

a **Device error:** 0= OK 1= Error

b **Mains failure:** 0= OK 1= Undervoltage
2= Overload 3= Mains frequency error

c **Data error:** 0= OK
1= Calibration values do not match the setting
2= Read/write error of the non-volatile memory
3= Communication monitoring
4= Heating time limit exceeded

d **Cal. Number:** Calculation number:
1…8, the error occurred when using this calibration

e **Voltage signal Ur:** 0= OK 1= Too small 2= too large 3= Unstable

f **Current signal Ir:** 0= OK 1= Too small 2= too large 3= Unstable

g **Heating conductor temperature:** 0= OK 1= Too small 2= too large

With temperature monitoring: 3= Too small 4= too large
With heating-up monitoring: 5= Heating time exceeded
6= Heating time not reached
Temperature jump: 7= Down 8= Up

h **Calibration error:**
0= OK
1= Parameter error
2= Voltage or current signal faulty (see above)
3= Error determining phase shift
4 = Determination of R20 not possible or
Reference R20 value monitoring (from V1.01/1.09/1.06)
5= Error when determining the P-factor or P-factor monitoring
6= Reference temperature selected too high
7= The range of the temperature coefficient correction exceeded
8= Start-Signal during calibration
9= Data error during access

Example RS232/USB:
Read: LFESP
Response:
001;000024:10:00;0001 0120
002;000024:09:47;0001 1120
…

Example RS485:
Read: 68 03 03 68 21 89 76 20 16 (GA=21h)
Response:
68 0C 0C 68 21 00 76 01 18 00 00 0A 00 40 24 00 1E 16
68 0C 0C 68 21 00 76 02 18 00 00 09 2F 40 25 00 4E 16
…

Reference: FEZU, FESL

i) 4.10. FEZU Command

Syntax RS232/USB:	**Read:** Response:	**LFEZU** **AFEZU abcd efgh**
Syntax: RS485:	**Read:** Response:	**Control set, BI = 33h** **Long set with DB0…DB2**

Note: For reasons of backward compatibility, bit “c2” of parameter “C” is located in data byte DB2 as bit 4 and bits “d2” and “d3” of parameter “D” are located in data byte DB2 as bits 5 and 6.

DB1								DB0							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
g3	g2	g1	g0	f1	f0	e1	e0	d1	d0	c1	c0	b1	b0	a1	a0

DB2							
7	6	5	4	3	2	1	0
-	d3	d2	c2	h3	h2	h1	h0

Description: Query of the error state of the PIREG-C2.

Assignment

a **Device error:** 0= OK 1= Error
2= Bus system supply undervoltage
3= Bus system supply overvoltage

b **Mains failure:** 0= OK 1= Undervoltage
2= Overload 3= Mains frequency error

c **Data error:** 0= OK
1= Calibration values do not match the setting
2= Read/write error of the non-volatile memory
3= Communication monitoring
4= Heating time limit exceeded

d **Cal. Number:** 1…8, the error occurred when using this calibration

e **Voltage signal Ur:** 0= OK 1= Too small 2= too large 3= Unstable

f **Current signal Ir:** 0= OK 1= Too small 2= too large 3= Unstable

g **heating conductor:**
temperature: 0= OK 1= Too small 2= too large
with temperature monitoring: 3= Too small 4= too large
with heating-up monitoring: 5= Heating time exceeded
6= Heating time not reached
Temperature jump: 7= downward 8= upward

h **Calibration error:**
0= OK
1= Parameter error
2= Voltage or current signal faulty (see above)
3= Error determining phase shift
4 = Determination of R20 not possible
Reference R20 value monitoring (from V1.01/1.09/1.06)
5= Error when determining the P-factor or P-factor monitoring
6= Reference temperature selected too high
7= The range of the temperature coefficient correction exceeded
8= Start-Signal during calibration
9= Data error during access

Example RS232/USB:	**Read:** Response:	LFEZU AFEZU 0001 1120	
Example RS485:	**Read:**	68 03 03 68 21 89 33 DD 16	(GA=21h)
	Response:	68 06 06 68 21 00 33 40 2A 00 BE 16	(GA=21h)

Reference: ZUST

i) 4.11. GADR Command

Syntax RS232/USB:	**Read:**	**LGADR**
	Response:	**AGADR aaa**
	Write:	**SGADR aaa**
	Response:	OK or error acknowledgement; response time max. 6 ms
	Enable:	not in power-on or calibration state

Syntax: RS485:	**Read:**	**Control set, BI = 07h**
	Response:	**Long set with DB0**

DB0
Adr.
aaa

	Write:	**Long set with DB0, BI = 07h**

DB0
Adr.
aaa

Response: Short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Description: Setting and query of the device address GA “aaa” (0...250) addressed RS232 and RS485 communication. The factory setting is “000”. If the device address is changed, the acknowledgement is still done with the old device address.

Example RS232/USB:	**Read:**	LGADR
	Response:	AGADR 033
	Write:	SGADR 033
	Response:	QOK00

Example RS485:	**Read:**	68 03 03 68 21 89 07 17 16	(GA=21h)
	Response:	68 04 04 68 21 00 07 21 49 16	
	Write:	68 04 04 68 00 69 07 21 91 16	(GA=00 ➔ 21h)
	Response:	10 21 00 21 16	

Reference: KOKO

i) 4.12. GTYP Command

Syntax RS232/USB:	**Read:**	**LGTYP**
	Response:	**AGTYP ttt**

Syntax: RS485:	**Read:**	**Control set, BI = 6Bh**
	Response:	**Long set with DB0 and DB1**

DB1	DB0
H-byte	L-byte
ttt	

Description: Query of the device type “ttt” (mains voltage, etc.) of the PIREG-C2 controller

Example RS232/USB:	**Read:**	LGTYP
	Response:	AGTYP 200

Example RS485:	**Read:**	68 03 03 68 21 89 6B 15 16	(GA=21h)
	Response:	68 05 05 68 21 00 6B C8 00 54 16	

Reference: VERS

i) 4.13. GWPA Command

Syntax RS232/USB:	**Read:**	**LGWPA**
	Response:	**AGWPA defg bbb ttt ±aaaa ±bbbb ±cccc**

Syntax: RS485:	**Read:**	**Control set, BI = 04h**
	Response:	**Long set with DB0…DB10**

DB6	DB5	DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte	H-byte	L-byte	
±aaaa		ttt		bbb		defg

DB10	DB9	DB8	DB7
H-byte	L-byte	H-byte	L-byte
±cccc		±bbbb	

DB0							
7	6	5	4	3	2	1	0
-	-	g3	g2	g1	f	e	d

Description: Query of the following parameters, which are used for the next calibration of the PIREG-C2:

- Settings “defg” (s.u.)
- Reference temperature “bbb” (0…50) in 1° C
- Temperature range “ttt” (100...500) in 1° C
- Heating conductor temperature coefficient: Tk1 “±aaaa” (+300…+9999) in 0.01×10^{-4} 1/K
- Heating conductor temperature coefficient: Tk2 “±bbbb” (-9999…+9999) in 0.01×10^{-6} $1/K^2$
- Heating conductor temperature coefficient: Tk3 “±cccc” (-9999…+ 9999) in 0.01×10^{-9} $1/K^3$

If variable reference temperature is selected for the calibration, the actual setpoint is output for the reference temperature “bbb”; in case the setpoint is greater than 50°C, the value “999” is output.

Assignment of settings:

d	**Calibration comparison time:**	0= 15 s	1= 30 s
e	**Calibration type:**	0= Recalibration upon power on or reset 1= Save calibration	
f	**Transformer type:**	0= Sealing transformer with EI or UI core 1= Sealing transformer with toroidal core	
g	**Temperature coefficient correction:** 0= without temperature coefficient correction 1= with 8-Point Tc Correction 3= 8-Point Tc Correction saved 4= Single-point Tc correction saved		

Example RS232/USB:	**Read:**	LGWPA	
	Response:	AGWPA 1100 020 300 +1080 +0000 +0000	
Example RS485:	**Read:**	68 03 03 68 21 89 04 AE 16	(GA=21h)
	Response:	68 0E 0E 68 21 00 04 03 14 00 2C 01 38 04 00 00 00 00 A5 16	

Reference: KAPA, EINS

i) 4.14. HZBG Command

Syntax RS232/USB:	**Read:**	**LHZBG**
	Response:	**AHZBG ttt**
	Write:	**SHZBG ttt**
	Response:	OK or error acknowledgement; response time max. 6 ms
	Enable:	not in power-on or calibration state

Syntax: RS485:

Read: **Control set, BI = 70h**

Response: **Long set with DB0 and DB1**

DB1	DB0
H byte	L byte
ttt	

Write: **Long set with DB0 and DB1, BI = 70h**

DB1	DB0
H byte	L byte
ttt	

Response: Short set, OK or error acknowledgement; response time max. 6 ms

Enable: not in power-on or calibration state

Description: Setting and query of set maximum heating time “ttt” (0…999), in 0.1 s, the heating time limit. With the value “000” for the heating time “ttt”, the heating time limit is switched off. If the set maximum heating time is exceeded in the Single-State the PIREG-C2 switches to FAULT state with Error 2 and terminates the heating.

Example RS232/USB:	**Read:**	LHZBG	
	Response:	AHZBG 100	
	Write:	SHZBG 050	
	Response:	QOK00	
Example RS485:	**Read:**	68 03 03 68 21 89 70 1A 16	(GA=21h)
	Response:	68 05 05 68 21 00 70 64 00 F5 16	
	Write:	68 05 05 68 21 69 70 32 00 2C 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: FEZU

i) 4.15. ISTW Command

Syntax RS232/USB:	**Read:**	**LISTW**
	Response:	**AISTW iii**
Syntax: RS485:	**Read:**	**Control set, BI = 34h**
	Response:	**Long set with DB0 and DB1**

DB1	DB0
H-byte	L-byte
iii	

Description: Query of the current actual temperature value “iii” in °C of PIREG-C2. The actual value “iii” is limited to maximum 999 and negative actual values are set as zero.

Example RS232/USB:	**Read:**	LISTW	
	Response:	AISTW 194	
Example RS485:	**Read:**	68 03 03 68 21 89 34 DE 16	(GA=21h)
	Response:	68 05 05 68 21 00 34 C4 00 19 16	

Reference: --

i) 4.16. KANR Command

Syntax RS232/USB:	**Read:**	**LKANR**
	Response:	**AKANR n**
	Write:	**SKANR n**
	Response:	OK or error acknowledgement; response time max. 1 ms
	Enable:	not in power-on or calibration state
Syntax: RS485:	**Read:**	**Control set, BI = 3Ch**
	Response:	**Long set with DB0**
	Write:	**Long set with DB0, BI = 3Ch**
	Response:	Short set, OK or error acknowledgement; response time max. 1 ms
	Enable:	not in power-on or calibration state

DB0
n

DB0
n

Description: Setting and query of the calibration number “n” (1…8) of the active calibration. Calibration number for use is activated with the calibration number and terminates any running measurement pulse-pause.
If the calibration type “Recalibration upon power on or reset” is selected, the PIREG-C2 always performs a calibration after calibration switching. After switching on the mains or reset the Calibration 1 is always active.

Example RS232/USB:	**Read:**	LKANR	
	Response:	AKANR 1	
	Write:	SKANR 1	
	Response:	QOK00	
Example RS485:	**Read:**	68 03 03 68 21 89 3C E6 16	(GA=21h)
	Response:	68 04 04 68 21 00 3C 01 5E 16	
	Write:	68 04 04 68 21 69 3C 01 C7 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: --

i) 4.17. KAPA Command

Syntax RS232/USB: **Read:** **LKAPA**
Response: **AKAPA defg bbb ttt ±aaaa ±bbbb ±cccc**

Syntax: RS485: **Read:** **Control set, BI = 05h**
Response: **Long set with DB0…DB10**

DB6	DB5	DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte	H-byte	L-byte	
±aaaa		ttt		bbb		defg

DB10	DB9	DB8	DB7
H-byte	L-byte	H-byte	L-byte
±cccc		±bbbb	

DB0							
7	6	5	4	3	2	1	0
-	-	g3	g2	g1	f	e	d

Description: Query of the following parameters, the currently active calibration (1…8) of the PIREG- C2:
- Settings "defg" (s.u.)
- Reference temperature "bbb" (0…50, 255 at variable reference temperature) in 1° C
- Temperature range "ttt" (100...500) in 1° C
- Heating conductor temperature coefficient: Tk1 "±aaaa" (+300…+9999) in $0.01x10^{-4}$ 1/K
- Heating conductor temperature coefficient: Tk2 "±bbbb" (-9999…+9999) in $0.01x10^{-6}$ $1/K^2$
- Heating conductor temperature coefficient: Tk3 "±cccc" (-9999…+9999) in $0.01x10^{-9}$ $1/K^3$

Assignment of settings:

d **Calibration comparison time:** 0= 15 s 1= 30 s

e **Calibration type:** 0= Recalibration upon power on or reset
1= Save calibration

f **Transformer type:** 0= Sealing transformer with EI or UI core
1= Sealing transformer with toroidal core

g **Temperature coefficient correction:**
0= without temperature coefficient correction
1= with 8-Point Tc Correction
2= with single-point Tc correction
3= 8-Point Tc Correction saved
4= Single-point Tc correction saved

Example RS232/USB: **Read:** LKAPA
Response: AGWPA 1100 020 300 +1080 +0000 +0000

Example RS485: **Read:** 68 03 03 68 21 89 05 AF 16 (GA=21h)
Response: 68 0E 0E 68 21 00 05 03 14 00 2C 01 38 04 00 00 00 00 A6 16

Reference: GWPA, EINS, STKA

i) 4.18. KAPK Command

Syntax RS232/USB: **Read:** **LKAPK n**
Response: **AKAPK n defg bbb ttt ±aaaa ±bbbb ±cccc rrr zzz ppp**

Syntax: RS485: **Read:** **Long set with DB0, BI = 13h**

DB0
n

Response: **Long set with DB0…DB15**

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte	H-byte	L-byte		
±aaaa		ttt		bbb		defg	n

DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8
	H-byte	L-byte		H-byte	L-byte	H-byte	L-byte
ppp	zzz		rrr	±cccc		±bbbb	

DB1							
7	6	5	4	3	2	1	0
-	-	g3	g2	g1	f	e	d

Description: Query of the following parameters, calibrated calibration “n” (1…8) of the PIREG- C2 controller:
- Settings “defg” (s.u.)
- Reference temperature “bbb” (0…50, 255 at variable reference temperature) in 1° C
- Temperature range “ttt” (100...500) in 1° C
- Heating conductor temperature coefficient: Tk1 “±aaaa” (+300…+9999) in $0.01x10^{-4}$ 1/K
- Heating conductor temperature coefficient: Tk2 “±bbbb” (-9999…+9999) in $0.01x10^{-6}$ $1/K^2$
- Heating conductor temperature coefficient: Tk3 “±cccc” (-9999…+9999) in $0.01x10^{-9}$ $1/K^3$
- Modulation reserve “rrr” (000= Auto. modulation reserve 20…100 %) in 1 %
- Heating time for the automatic Tc-correction “zzz” (0…999 s) in 1 s
- P-Facto correction value “ppp”“ (0, 30…250 % (from V1.01/1.09/1.07) in 1%

If the heating time “zzz” is zero, the Tc correction is controlled via the Start-Input. If the P-factor correction value “ppp” is zero, the controller operates with the calibrated P-factor.

Assignment of settings:

d	**Calibration comparison time:**	0= 15 s	1= 30 s
e	**Calibration type:**	0= Recalibration upon power on or reset 1= Save calibration	
f	**Transformer type:**	0= Sealing transformer with EI or UI core 1= Sealing transformer with toroidal core	
g	**Temperature coefficient correction:** 0= without temperature coefficient correction 1= with 8-Point Tc Correction 2= with single-point Tc correction 3= 8-Point Tc Correction saved 4= Single-point Tc correction saved		

Example RS232/USB:
Read: LKAPK 1
Response: AKAPK 1 0100 020 300 +1080 +0000 +0000 040 888 095

Example RS485:
Read: 68 04 04 68 21 89 13 01 BE 16 (GA=21h)
Response: 68 13 13 68 21 00 13 01 02 14 2C 2C 01 38 38 00 00 00 00 28 78 03 5F 16 16

Reference: GWPA, KAPA, EINS, STKA

i) 4.19. KASR Command

Syntax RS232/USB:
Read: **LKASR**
Response: **AKASR rrr kkk**
Write: **SKASR rrr**
Response: OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Syntax: RS485:
Read: **Control set, BI = 10h**
Response: **Long set with DB0 and DB1**

DB1	DB0
kkk	rrr

Write: **Long set with DB0, BI = 10h**

DB0
rrr

Response: Short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Description: Setting and query of the calibration parameters, modulation reserve “rrr” in % (000= automatic modulation reserve, 20…100%) of the input amplifier for UR and Ir for the current active calibration (1…8). A change in the manually set modulation reserve “rrr” results in Error 9 and a new calibration must be carried out. In addition, the calibrated modulation reserve “kkk” is output in % (20…100%) of the current active calibration during reading.
During the automatic modulation reserve determination (rrr=000) the controller determines the required modulation reserve during the calibration autonomously.

Example RS232/USB:
Read: LKASR
Response: AKASR 030 020
Write: SKASR 030
Response: QOK00

Example RS485:	**Read:**	68 03 03 68 21 89 10 BA 16	(GA=21h)
	Response:	68 05 05 68 21 00 10 1E 14 63 16	
	Write:	68 04 04 68 21 69 10 1E 4F 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: FEZU, factory settings

i) 4.20. KOKO Command

Syntax RS232/USB:
- **Read:** **LKOKO**
- Response: **AKOKO abcd efgh**
- **Write:** **SKOKO abcd efgh**
- Response: OK or error acknowledgement; response time max. 6 ms
- Enable: not in power-on or calibration state

Syntax: RS485:

Read: **Control set, BI = 11h**

Response: **Long set with DB0**

DB0							
7	6	5	4	3	2	1	0
h	g	f	e	d	c	b	a

Write: **Long set with DB0, BI = 11h**

DB0							
7	6	5	4	3	2	1	0
h	g	f	e	d	c	b	a

Response: Short set, OK or error acknowledgement; response time max. 6 ms

Enable: not in power-on or calibration state

Description: Setting and query of the configuration of the PIREG-C2 controller. With the communication configuration the following additional settings are made for the RS232, RS485, the USB and the bus system interfaces and the respective communication:

Assignment

a	**Addressed RS232 communication:**	0= Off	1= On
b	**External thermometer communication:** (from V1.01/1.16/1.10)	0= Off	1= On
c	**External thermometer communication type:** (from V1.01/1.16/1.10)	0= DTM3000	1= TM6
d	**Bus system PROFINET : N/A** **EtherNet/IP bus system: Reset execution, write process data (SPz):** 0= Reset of the PIREG-C2 only 1= Reset of the EtherNet/IP interface and the PIREG-C2 (from V1.01/1.20/1.14)		
e	Not occupied		
f	Not occupied		
g	Not occupied		
h	Not occupied		

Example RS232/USB:	**Read:**	LKOKO
	Response:	AKOKO 1000 0000
	Write:	SKOKO 1000 0000
	Response:	QOK00

Example RS485:	**Read:**	68 03 03 68 21 89 11 BB 16	(GA=21h)
	Response:	68 04 04 68 21 00 11 01 33 16	
	Write:	68 04 04 68 21 69 11 01 9C 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: GADR, write process data (SPz)

i) 4.21. KONF Command

Syntax RS232/USB:
- **Read:** **LKONF**
- Response: **AKONF abcd efgh**
- **Write:** **SKONF abcd efgh**
- Response: OK or error acknowledgement; Response time max. 6 ms,
- Release: not in power-on or calibration state

Syntax: RS485:

Read: **Control set, BI = 06h**

Response: **Long set with DB0 and DB1**

DB1								DB0							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
-	-	-	-	-	-	h1	h0	g	f	e1	e0	d	c	b	a

Write: Long set with DB0 and DB1, BI = 06h

DB1								DB0							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
-	-	-	-	-	-	h1	h0	g	f	e1	e0	d	c	b	a

Response: Short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Description: Setting and query of the configuration of the PIREG-C2. The configuration determines whether the temperature setpoint of the PIREG-C2 is controlled via the setpoint input or via the serial interfaces, which setting elements are used, how the alarm and OK output are set, whether the pulse control is used for the calibration start input and whether the actual value output outputs the actual temperature value or operates as a reference voltage source with 10V.

Assignment

a **Temperature Setpoint Control:**
0= Manual control via the Setpoint-Input (0…10 V)
1= Interface control via RS232, RS485 or USB interface

b **Setting control:**
0= Manual setting via DIP switch (not with PIREG-C2 with bus system)
1= Interface control with the EINS command

c **Alarm output control**
0= Alarm output is only set in case of fault after the first heating
1= Alarm output is set immediately in case of fault

d **Alarm output switch type:**
0 = Relay contact closed when alarm
1 = Relay contact open when alarm

e **OK output control:**
0= Calibration-OK message
1= Temperature- OK message
2= Combination of calibration and temperature- OK message. After a Reset or a calibration process the calibration OK message is displayed, with the first “Start” signal the temperature- OK message is displayed.
3= Temperature reached message.

f **OK output switching type:**
0= Relay contact closed when OK
1 = Relay contact open when OK

g **Calibration start input pulse control**
0= No pulse control
1= with pulse control for single-point Tc correction

h **Actual value output function**
0= Actual value output (0…10V)
1= 10V reference voltage source
2= Hold mode, actual value output (0…10V)
3= Hold mode 2s on, actual value output (0…10V)

Example RS232/USB:
Read: LKONF
Response: AKONF 0000 0000
Write: SKONF 1100 0000
Response: QOK00

Example RS485:
Read: 68 03 03 68 21 89 06 B0 16 (GA=21h)
Response: 68 05 05 68 21 00 06 00 00 27 16
Write: 68 05 05 68 21 69 06 03 00 93 16 (GA=21h)
Response: 10 21 00 21 16

Reference: EINS, TOKG

i) 4.22. KOUE Command

Syntax RS232/USB:	**Read:**	**LKOUE n**
	Response:	**AKOUE n a zzz**
	Write:	**SKOUE n a zzz**
	Response:	OK or error acknowledgement; response time max. 6 ms
	Enable:	not in power-on or calibration state

Syntax: RS485:

Read: **Long set with DB0, BI = 0Dh**

DB0
n

Response: **Long set with DB0…DB3**

DB3	DB2	DB1	DB0
H-byte	L-byte		
zzz		a	n

Write: **Long set with DB0…DB3, BI = 0Dh**

DB3	DB2	DB1	DB0
H-byte	L-byte		
zzz		a	n

Response: Short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Description: Setting and query of the state of the activation “a” (0=Off, 1=On) and the set heating time “zzz” (0…99.9s) in 0.1s of the communication monitoring of the interface with the number “n” (1=RS232, 2=RS485 and 3=USB).
If the communication monitoring is active and for a time period, which is longer than the set heating time, there is no communication via the interface, the PIREG-C2 controller switches to Fault (Error 9).

Example RS232/USB:	**Read:**	LKOUE 1	(RS232 interface)
	Response:	AKOUE 1 1 010	
	Write:	SKOUE 1 1 010	(RS232 interface)
	Response:	QOK00	

Example RS485:	**Read:**	68 04 04 68 21 89 0D 01 B8 16	(GA=21h)
	Response:	68 07 07 68 21 00 0D 01 01 0A 00 3A 16	
	Write:	68 07 07 68 21 69 0D 01 01 A0 00 A3 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: FEZU

i) 4.23. KPFK Command

Syntax RS232/USB:	**Read:**	**LKPFK**
	Response:	**AKPFK ppp**
	Write:	**SKPFK ppp**
	Response:	OK or error acknowledgement; response time max. 6 ms
	Enable:	not in power-on or calibration state

Syntax: RS485:

Read: **Control set, BI = 0Fh**

Response: **Long set with DB0**

DB0
ppp

Write: **Long set with DB0, BI = 0Fh**

DB0
ppp

Response: Short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Description: Setting and query of the P-factor- correction value “ppp” in % (0, 30…250 % (from V1.01/1.09/1.07)) for the currently active calibration (1…8). With the P-factor correction value the calibrated P-factor of the controller is adjusted in percentages: If the P-factor correction value is zero, the controller operates with the calibrated P-factor.

Example RS232/USB:	**Read:**	LKPFK
	Response:	AKPFK 080
	Write:	SKPFK 080
	Response:	QOK00

Example RS485:	**Read:**	68 03 03 68 21 89 0F B9 16	(GA=21h)
	Response:	68 04 04 68 21 00 0F 50 80 16	
	Write:	68 04 04 68 21 69 0F 50 E9 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: factory settings:

i) 4.24. KTKZ Command

Syntax RS232/USB:	**Read:**	**LKTKZ**
	Response:	**AKTKZ ttt**
	Write:	**SKTKZ ttt**
	Response:	OK or error acknowledgement; response time max. 6 ms
	Enable:	not in power-on or calibration state

Syntax: RS485:

Read: **Control set, BI = 0Eh**

Response: **Long set with DB0 and DB1**

DB1	DB0
H-byte	L-byte
ttt	

Write: **Long set with DB0 and DB1, BI = 0Eh**

DB1	DB0
H-byte	L-byte
ttt	

Response: Short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Description: Setting and query of the heating time “ttt” in 1s (0…999s) for the automatic execution of the 8-Point Tc Correction during the calibration and the single-point Tc correction, with the external thermometer. After the expiry of the heating time the PIREG- C2 switches to the next temperature step with 8-Point Tc Correction or ends the single-point Tc correction. If the heating time is zero, the temperature coefficient correction is controlled via the Start-Input.

Example RS232/USB:	**Read:**	LKTKZ
	Response:	AKTKZ 120
	Write:	SKTKZ 120
	Response:	QOK00

Exampl e RS485:	**Read:**	68 03 03 68 21 89 0E B8 16	(GA=21h)
	Response:	68 05 05 68 21 00 0E 78 00 A7 16	
	Write:	68 05 05 68 21 69 0E 78 00 10 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: factory settings:

i) 4.25. MEPA Command

Syntax RS232/USB:	**Read:**	**LMEPA**
	Response:	**AMEPA z**
	Write:	**SMEPA z**
	Response:	OK or error acknowledgement; response time max. 1 ms
	Enable:	Only in OFF state

Syntax: RS485:

Read: **Control set, BI = 3Dh**

Response: **Long set with DB0**

DB0
z

Write: **Long set with DB0, BI = 3Dh**

DB0
z

Response: Short set, OK or error acknowledgement; response time max. 1 ms
Enable: Only in OFF state

Description: Setting and query of the “z” (0 or 1) state of the measurement pulse-pause. With the state z=1, the measurement pulse-pause is switched on. If the measurement pulse-pause is switched on, the controller no longer sends any measurement pulse o the sealing transformer. With the start of a sealing process, a calibration or a Reset, the measurement pulse-pause is terminated automatically.
For device type x02, the measurement pulse-pause is also terminated automatically in case of change in calibration.

Example RS232/USB:	**Read:**	LMEPA	
	Response:	AMEPA 1	
	Write:	SMEPA 1	
	Response:	QOK00	

Exampl e RS485:	**Read:**	68 03 03 68 21 89 3D E7 16	(GA=21h)
	Response:	68 04 04 68 21 00 3D 01 5F 16	
	Write:	68 04 04 68 21 69 3D 01 C8 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: --

i) 4.26. PFUE Command

Syntax RS232/USB:	**Read:**	**LPFUE**
	Response:	**APFUE a uuu ooo ppp**
	write:	**SPFUE a uuu ooo**
	Response:	OK or error acknowledgement; response time max. 6 ms
	Enable:	not in power-on or calibration state

Syntax: RS485:

Read: **Control set, BI = 12h**

Response: **Long set with DB0…DB3**

DB3	DB2	DB1	DB0
ppp	ooo	uuu	a

Write: **Long set with DB0…DB2, BI = 12h**

DB2	DB1	DB0
ooo	uuu	a

Response: Short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Description: Setting and reading the parameters of the P-factor monitoring. The P-factor monitoring is a monitoring function which can be switched On (a=1) and Off (a=0) with “a”. With the lower limit “uuu” (1…100) and the upper limit “ooo” (1…100) an OK range is set for controller P-factor determined during the calibration. If the P-factor of the controller is outside the OK range, the PIREG-C2 controller switches to Fault (Error 10).
In addition, the calibrated P-factor “ppp” of the currently active calibration (1…8) of the controller is returned during reading.

Example RS232/USB:	**Read:**	LPFUE	
	Response:	APFUE 1 020 030 024	
	Write:	SPFUE 1 020 030	
	Response:	QOK00	

Example RS485:	**Read:**	68 03 03 68 21 89 12 BC 16	(GA=21h)
	Response:	68 07 07 68 21 00 12 01 14 1E 18 7E 16	
	Write:	68 06 06 68 21 69 12 01 14 1E CF 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: KPFK

i) 4.27. RHZL Command

Syntax RS232/USB:	**Read:**	**LRHZL n z**
	Response:	**ARHZL n z rrrrr**
	Write:	**SRHZL n z**
	Response:	OK or error acknowledgement; response time max. 6 ms
	Enable:	not in power-on or calibration state

Syntax: RS485:

Read: **Long set with DB0 and DB1, BI = 80h**

DB1	DB0
z	n

Response: **Long set with DB0…DB3**

DB3	DB2	DB1	DB0
H-byte	L-byte		
rrrrr		z	n

Write: **Long set with DB0 and DB1, BI = 80h**

DB1	DB0
z	n

Response: Short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Description: Setting and query of the reference resistance R20 of the heating conductor as resistance value R20 value, in Ohm. The standardised reference resistance R20, in the actual resistance value, R20 value, is converted into Ohm via the calibrated voltage (Vu) and current amplification (Vi) of the PIREG-C2. The R20 value includes the tolerances of the amplifiers. (from V1.01/1.09/1.06)

In addition to the R20 value of the last performed calibration process, a reference value of R20 value, e.g. a new heating conductor after the heating conductor replacement, can be saved and read for each calibration (1…8).

The following parameters are used for the command:

- Calibration number "n": 0: Current calibration
  1…8: Calibration number
- Read/write access "z": 0: Read current R20 value
  1: Save or read reference R20 value
  2: Delete reference R20 value
- R20 value "rrrrr" in 0.01 Ω (0.01…655.33 Ω, 0: deleted, 65534: overflow).

Example RS232/USB:	**Read:**	LRHZL 1 0	
	Response:	ARHZL 1 0 00021	
	Write:	SRHZL 1 1	
	Response:	QOK00	
Example RS485:	**Read:**	68 05 05 68 21 89 80 01 00 2B 16	(GA=21h)
	Response:	68 07 07 68 21 00 80 01 00 15 00 B7 16	
	Write:	68 05 05 68 21 69 80 01 01 0C 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: RRUE, KANR

i) 4.28. RRUE Command

Syntax RS232/USB:	**Read:**	**LPRUE**
	Response:	**APRUE a uuu ooo**
	Write:	**SPRUE a uuu ooo**
	Response:	OK or error acknowledgement; response time max. 6 ms
	Enable:	not in power-on or calibration state
Syntax: RS485:	**Read:**	**Control set, BI = 15h**
	Response:	**Long set with DB0…DB2**
	Write:	**Long set with DB0…DB2, BI = 15h**
	Response:	Short set, OK or error acknowledgement; response time max. 6 ms
	Enable:	not in power-on or calibration state

Response:

DB2	DB1	DB0
ooo	uuu	a

Write:

DB2	DB1	DB0
ooo	uuu	a

Description: Setting and reading the reference R20 value monitoring parameters. The reference R20 value monitoring is a monitoring function which can be switched On (a=1) and Off (a=0) with “a”. With the downwards deviation “uuu” in % (5…100) and upwards deviation “ooo” in % (5…100) an OK range is defined around the reference R20 value for the R20 value (in 0.01 Ω) of the controller currently determined during calibration. If the current R20 value of the controller is outside the OK range, the PIREG-C2- Controller switches to Fault (Error 10). (from V1.01/1.09/1.06)

The reference R20 value monitoring is performed only if the reference R20 value is defined with command (RHZL) for the respective calibration.

Example RS232/USB:	**Read:**	LPRUE	
	Response:	ARRUE 1 010 010	
	Write:	SRRUE 1 005 005	
	Response:	QOK00	
Exampl e RS485:	**Read:**	68 03 03 68 21 89 15 BF 16	(GA=21h)
	Response:	68 06 06 68 21 00 15 01 0A 0A 4B 16	
	Write:	68 06 06 68 21 69 15 01 05 05 AA 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: RHZL

i) 4.29. SOLW Command

Syntax RS232/USB:	**Read:**	**LSOLW**
	Response:	**ASOLW sss**
	Write:	**SSOLW sss**
	Response:	OK or error acknowledgement; response time max. 1 ms
	Enable:	in all states

Syntax: RS485:

Read: **Control set, BI = 35h**

Response: **Long set with DB0 and DB1**

DB1	DB0
H-byte	L-byte
sss	

Write: **Long set with DB0 and DB1, BI = 35h**

DB1	DB0
H-byte	L-byte
sss	

Response: Short set, OK or error acknowledgement; response time max. 1 ms

Enable: in all states

Description: Setting and query of the temperature setpoint used “sss” in °C of the PIREG-C2. Depending on the selected configuration of the PIREG-C2, either the voltage at the Setpoint Input is used as setpoint or the setpoint specified with this command. This command is effective only if the control of the setpoint is enabled via the interfaces with the SKONF command. The temperature setpoint “sss” is monitored for the level of the temperature range.

Example RS232/USB:	**Read:**	LSOLW
	Response:	ASOLW 185
	Write:	SSOLW 185
	Response:	QOK00

Example RS485:	**Read:**	68 03 03 68 21 89 35 DF 16	(GA=21h)
	Response:	68 05 05 68 21 00 35 B9 00 0F 16	
	Write:	68 05 05 68 21 69 35 B9 00 78 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: KONF

i) 4.30. STEU Command

Syntax RS232/USB:	**Read:**	**LSTEU**
	Response:	**ASTEU abc def**

Syntax: RS485:

Read: **Control set, BI = 36h**

Response: **Long set with DB0**

DB0							
7	6	5	4	3	2	1	0
f	e1	e0	d	-	c	b	a

Description: Query of the states of the manual control inputs “abc” and the control state via the interfaces “def” of the PIREG-C2.

Assignment			
a	**Manual start input:**	0= not activated	1= activated
b	**Manual calibration input**:	0= not activated	1= activated
c	**Manual Reset input:**	0= not activated	1= activated
d	**Control state start:**	0= not set	1= set
e	**Control state calibration:**	0= not set 1= calibration set 2= single-point Tc correction	
f	**Control state reset:**	0= not set	1= set

Example RS232/USB:	**Read:**	LSTEU
	Response:	ASTEU 100 000

Example RS485:	**Read:**	68 03 03 68 21 89 36 E0 16	(GA=21h)
	Response:	68 04 04 68 21 00 36 01 58 16	

Reference: STST, STRS, STKA

i) 4.31. STKA Command

Syntax RS232/USB:	**Write:**	**SSTKA z**
	Response:	OK or error acknowledgement; response time max. 1 ms
	Enable:	in all states (effective only in the OFF state)

Syntax: RS485:	**Write:**	**Long set with DB0, BI = 38h**	DB0 z
	Response:	Short set, OK or error acknowledgement; response time max. 1 ms	
	Enable:	in all states (effective only in the OFF state)	

Description: Setting the following control states for calibration:

Assignment	
0	**Home position:** The calibration and single-point Tc correction start from the Home Position.
1	**Control state calibration:** The calibration of the controller starts with setting the State z=1 if it is in OFF or Fault state. The state must be reset before the calibration can be restarted. Functionally, the control state calibration is connected parallel to the calibration input.
2	**Single-point Tc correction:** Single-point Tc correction is set with the z=2 state. The state remains until it is reset. The single-point Tc correction can be set only if the 8-Point Tc Correction is not active.
3	**Tc correction saving:** With the state z=3 the current 8-Point or single-point Tc correction is saved, so that it is retained after calibration. Once the action is performed it returns the previous state.
4	**Cancel Tc correction saving**: The saving of the temperature coefficient correction is cancelled again with the z=4 state. Once the action is performed it returns the previous state.

Example RS232/USB:	**Write:**	SSTKA 1	
	Response:	QOK00	
Example RS485:	**Write:**	68 04 04 68 21 69 38 01 C3 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: STEU, KAPA

i) 4.32. STRS Command

Syntax RS232/USB:	**Write: SSTRS z**	
	Response:	OK or error acknowledgement; response time max. 1 ms
	Enable:	in all states

Syntax: RS485:	**Write:**	**Long set with DB0, BI = 39h**	DB0 z
	Response:	Short set, OK or error acknowledgement; response time max. 1 ms	
	Enable:	in all states	

Description: Setting the following control states for the Reset

Assignment	
1	A reset of the controller and the bus system is triggered by setting the z=1 state. Functionally, the control state Reset z=1 is connected parallel to the Reset input. Once the reset is performed the control state is Reset.
2	Only a reset of the controller is triggered by setting the z=2 state. PIREG-C2 bus system does not perform any reset. This ensures that communication via the bus system during a Reset is retained. Once the reset is performed the control state is Reset. (from V1.01/1.20/1.14)

Example RS232/USB:	**Write:**	SSTRS 1	
	Response:	QOK00	(GA=21h)
Example RS485:	**Write:**	68 04 04 68 21 69 39 01 C4 16	
	Response:	10 21 00 21 16	

Reference: STEU

i) 4.33. STST Command

Syntax RS232/USB:	**Write:**	**SSTST z**
	Response:	OK or error acknowledgement; response time max. 1 ms
	Enable:	In all states (effectiveness depends on state)
Syntax: RS485:	**Write:**	**Long set with DB0, BI = 3Ah**
	Response:	Short set, OK or error acknowledgement; response time max. 1 ms
	Enable:	In all states (effectiveness depends on state)

DB0
z

Description: Setting the control state Start "z" (1= set). A sealing process is started with this state. The sealing process is terminated by resetting the control state. Functionally, the control state Start is connected parallel to the Start input.

Example RS232/USB:	**Write:**	SSTST 1
	Response:	QOK00
Example RS485:	**Write:**	68 04 04 68 21 69 3A 01 C5 16 (GA=21h)
	Response:	10 21 00 21 16

Reference: STEU

i) 4.34. TKEI Command

Syntax RS232/USB:	**Read:**	**LTKEI**
	Response:	**n;rrrr:bbbb (9 times)**
Syntax: RS485:	**Read:**	**Control set, BI = 72h**
	Response:	**Long set with DB0…DB4 (9 times)**

DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte	
bbbb		rrrr		n

Description: Reading of the determined temperatures for the controller "rrrr" and for the heating tape "bbbb", in 0.1° C, for the point "n" (0…8) during the 8-Point Tc Correction of the current calibration. When the temperatures are not defined the value is output as zero. For the RS232 and USB interface the output is done in CSV format.
During the RS485 communication the nine longitudinal sets of the response are sent consecutively with a pause of 3ms.

Example RS232/USB:	**Read:**	LTKEI
	Response:	0;0251;0273 1;0500;0569 … 8;2400;2761
Example RS485:	**Read:**	68 03 03 68 21 89 72 1C 16 (GA=21h)
	Response:	68 08 08 68 21 00 72 01 FB 00 11 01 A1 16 68 08 08 68 21 00 72 02 F4 01 39 02 C5 16 … 68 08 08 68 21 00 72 08 60 09 C9 0A D7 16

Reference: TKEK

i) 4.35. TKEK Command

Syntax RS232/USB:	**Read:**	**LTKEK k**
	Response:	**k;n;rrrr:bbbb (9-times)**
Syntax: RS485:	Read:	**Long set with DB0, BI = 73h**

DB0
k

Response: **Long set with DB0…DB5 (9 times)**

DB5	DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte		
bbbb		rrrr		n	k

Description: Reading of the determined temperatures for the controller "rrrr" and for the heating tape "bbbb", in 0.1° C, for the point "n" (0…8) during the 8-Point Tc Correction "k" calibration. When the temperatures are not defined the value is output as zero. For the RS232 and USB interface the output is done in CSV format.
During the RS485 communication the nine longitudinal sets of the response are sent consecutively with a pause of 3ms.

Example RS232/USB:	**Read:**	LTKEI
	Response:	1;0;0251;0273 1;1;0500;0569 … 1;8;2400;2761

Example RS485:	**Read:**	68 04 04 68 21 89 73 01 1E 16	(GA=21h)
	Response:	68 09 09 68 21 00 73 01 00 FB 00 11 01 A2 16 68 09 09 68 21 00 73 01 01 F4 01 39 02 C6 16 … 68 09 09 68 21 00 73 01 08 60 09 C9 0A D9 16	

Reference: TKEI

i) 4.36. TOKG Command

Syntax RS232/USB:	**Read:**	**LTOKG**
	Response:	**APFUE uuu ooo sss**
	writing:	**STOKG uuu ooo sss**
	Response:	OK or error acknowledgement; response time max. 6 ms
	Enable:	not in power-on or calibration state

Syntax: RS485:

Read: **Control set, BI = 08h**

Response: **Long set with DB0…DB3**

DB3	DB2	DB1	DB0
H-byte	L-byte		
sss		ooo	uuu

Write: **Long set with DB0…DB3, BI = 08h**

DB3	DB2	DB1	DB0
H-byte	L-byte		
sss		ooo	uuu

Response: Short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Description: Setting and query of the lower limit “uuu” and the upper limit “ooo” in K (5…99 K) of the temperature OK range and the stabilisation time “sss” in 0.1 s (0…99.9 s) of the temperature OK message. The temperature limits are the maximum permissible deviation of the actual value from setpoint. If the actual value is in the temperature OK range the temperature- OK message is set.
The stabilisation time starts as soon as the temperature actual value has reached the temperature OK range. If the actual value leaves the temperature OK range during the stabilisation time, the temperature- OK message is reset.
The temperature- OK message is output with the OK-output and is effective only if the temperature- OK message has been selected with the SKONF command.

Example RS232/USB:	**Read:**	LTOKG
	Response:	ATOKG 010 010 010
	Write:	STOKG 010 010 010
	Response:	QOK00

Exampl e RS485:	**Read:**	68 03 03 68 21 89 08 B2 16	(GA=21h)
	Response:	68 07 07 68 21 00 08 0A 0A 0A 00 47 16	
	Write:	68 07 07 68 21 69 08 0A 0A 0A 00 B0 16	(GA=21h)
	Response:	10 21 00 21 16	

Reference: KONF

i) 4.37. TUEE Command

Syntax RS232/USB:
- **Read:** **LTUEE**
- Response: **APFUE a uuu ooo sss**
- **writing:** **STUEE a uuu ooo sss**
- Response: OK or error acknowledgement; response time max. 6 ms
- Enable: not in power-on or calibration state

Syntax: RS485:
- **Read:** **Control set, BI = 09h**
- Response: **Long set with DB0…DB4**

DB4	DB3	DB2	DB1	DB0
H-byte	L-byte			
sss		ooo	uuu	a

Write: Long set with DB0…DB4, BI = 09

DB4	DB3	DB2	DB1	DB0
H-byte	L-byte			
sss		ooo	uuu	a

- Response: Short set, OK or error acknowledgement; response time max. 6 ms
- Enable: not in power-on or calibration state

Description: Setting and reading the parameters of the Temperature monitoring. The temperature monitoring is a monitoring function which can be switched On (a=1) and Off (a=0) with “a”. A temperature OK range is set around the setpoint with the lower limit “uuu” (5…99K) and upper limit “ooo” (5…99 K) in K. If the actual value leaves this range during the sealing once it has reached it, the PIREG-C2 switches to Fault (Error 8).
The stabilisation time “sss” in 0.1s (0…99.9 s) starts as soon as the actual value has reached the temperature OK range. If the actual value leaves the temperature OK range during the stabilisation time, the PIREG-C2 does not switch to Fault. The stabilisation starts again in case of a change in the setpoint value of more than 2° C.

Example RS232/USB:
- **Read:** LTUEE
- Response: ATUEE 1 010 010 010
- **Write:** STUEE 1 010 010 010
- Response: QOK00

Example RS485:
- **Read:** 68 03 03 68 21 89 09 B3 16 (GA=21h)
- Response: 68 08 08 68 21 00 09 01 0A 0A 0A 00 49 16
- **Write:** 68 08 08 68 21 69 09 01 0A 0A 0A 00 49 16 (GA=21h)
- Response: 10 21 00 21 16

Reference: FEZU

i) 4.38. UIMW Command

Syntax RS232/USB:
- **Read:** **LUIMW**
- Response: **AUIMW uuuuu vvvvv iiiii ccccc**
- Release: only in OFF and ON state

Syntax: RS485:
- **Read:** **Control set, BI = 71h**
- Response: **Long set with DB0…DB7**

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte	H-byte	L-byte	H-byte	L-byte
ccccc		iiiii		vvvvv		uuuuu	

Description: On the one hand, the command queries the sample values of Ur “uuuuu”, in 0.01V, and Uir “iiiii”, in 0.001V, at the sampling time 0.045T before the zero crossing. On the other hand, the recalculated effective values of Ur “vvvvv”, in 0.01V, and Ir “ccccc”, in 0.1A, are queried. For the calculation of the effective values the values of the A/D converters are offset against the set amplifications. For the calculation of Ir a transmission ratio of 1000:1 is assumed for the current converter.

Example RS232/USB:
- **Read:** LUIMW
- Response: AUIMW 00093 00235 00028 00145

Example RS485:
- **Read:** 68 03 03 68 21 89 71 1B 16 (GA=21h)
- Response: 68 0B 0B 68 21 00 71 50 02 DC 05 05 01 2C 05 FC 16

Reference: --

i) 4.39. VERS Command

Syntax RS232/USB:	**Read:**	**LVERS**
	Response:	**AVERS vvv ggg mmm**
Syntax: RS485:	**Read:**	**Control set, BI = 69h**
	Response:	**Long set with DB0…DB5**

DB5	DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte	H-byte	L-byte
mmm		ggg		vvv	

Description: The PIREG-C2 is equipped with two controls each with a separate program, there are also two program versions. One controller is located on the galvanically isolated side with the version "ggg" and the other controller is located on the measurement device side with the version "mmm", each in 0.01 values. The device version "vvv" in 0.01 values is valid for the controller as a whole.

Example RS232/USB:	**Read:**	LVERS	
	Response:	AVERS 100 101 101	
Example RS485:	**Read:**	68 03 03 68 21 89 69 13 16	(GA=21h)
	Response:	68 09 09 68 21 00 69 64 00 66 00 65 00 B9 16	

Reference: --

i) 4.40. WESE Command

Syntax RS232/USB:	**Write:**	**SWESE z**
	Response:	OK or error acknowledgement; response time max. 600 ms
	Enable:	not in power-on or calibration state
Syntax: RS485:	**Write:**	**Long set with DB0, BI = 0Ch**
	Response:	Short set, OK or error acknowledgement; response time max. 600 ms
	Enable:	not in power-on or calibration state

DB0
z

Description: Setting the following factory settings when the parameter is z=1. After the command the PIREG-C2 controller performs a Reset.

Factory Settings:

Setting Switch (SEINS):

Heating ramp:	Off
Temperature Coefficient:	Tk1 = 7.46x10-4 1/K, Tk2 = 0, Tk3 = 0 (Alloy L)
Calibration Comparison Time:	15s
Temperature range:	0…300°C
Calibration Type:	Save calibration
Transformer type:	Sealing transformer with EI or UI core
Reference temperature:	20 °C for Calibration
Tc Correction:	without temperature coefficient correction (delete saved Tc corrections)

Configuration (SKONF):

Setpoint Control:	with interface control
Setting Control:	with interface control
Alarm Output Control:	Alarm output is set in case of fault after the first heating
Alarm output switch type:	Relay contact closed with alarm
OK output control:	Standard: Calibration-OK message for device type x02: Calibration No. message
OK output Switching type:	Relay contact closed when OK
Cal. input pulse control:	No pulse control
Actual value output function:	Actual value output (0…10)

Setting parameters (SEIPA):

Reference temperature:	20°C
Temperature range:	200°C
Temperature coefficients:	Tk1= +3.00 x10-4 1/K, Tk2= -0.01 x10-9 1/K Tk3= -0.01 x10-9 1/K

Modulation reserve (SKASR):

Modulation reserve:	20%

P-factor correction value (SKPFK):

P-factor correction value:	0 (no P-factor correction)

Heating time of the automatic Tc correction (SKTKZ):
Heating time: 0 s (no automatic Tc correction)
Calibration setting 1…8 (LKAPK n):
All parameters: 0 (Delete the Tc correction memory)
Temperature OK message (STOKG):
Temperature lower limit: 5 K Stabilisation time: 0
Temperature upper limit: 5 K
Temperature monitoring (STUEE):
Activation: Off Temperature lower limit: 5 K
stabilisation time: 0 Temperature upper limit: 5 K
Heating monitoring (SAHUE):
Activation: Off Temperature lower limit: 5 K
heating time: 0 Temperature upper limit: 5 K
Variant: 1 (Heating time lower limit 1023)
P-factor monitoring (SPFUE):
Activation: Off Lower limit: 1
Upper limit: 100
Heating time limit (SHZBG):
Maximum heating time: 0 (Off)
Reference R20 value monitoring (SRRUE): (from V1.01/1.09/1.06)
Activation: Off Lower deviation: 5 %
Upper deviation: 5 %
Communication monitoring (SKOUE):
For all interfaces: Activation: Off Downtime: 0
Communication configuration (SKOKO):
Addressed RS232 communication: Off
External thermometer communication: DTM3000
(from V1.01/1.16/1.10)
Bus system reset execution: Reset of the PIREG-C2 only
(from V1.01/1.20/1.14)
Interfaces:
Baud rate for all interfaces (SBRAT): 9600 Baud
device address for RS485 communication (SGADR): 0
Controller calibration setting 1…8 (LTKEK n):
All parameters: 0
Counter (SZYKL):
Calibration cycle counter 1…8: 0
Error configuration (SFEKO): (from V1.01/1.06/1.06)
all error messages: activated
Error memory:
Contents: deleted

Example RS232/USB: **Write:** SWESE 1
Response: QOK00

Example RS485: **Write:** 68 04 04 68 21 69 0C 01 97 16 (GA=21h)
Response: 10 21 00 21 16

Reference: --

i) 4.41. ZPFA Command

Syntax RS232/USB: **Read:** **LZPFA**
Response: **AZPFA iii aaaaa**

Syntax: RS485: **Read:** **Control set, BI = 78h**
Response: **Long set with DB0…DB3**

DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte
aaaaa		iii	

Description: Reading the values of the time log function OFF state. The PIREG-C2 records the following values after an ON state in the subsequent OFF Sate, in order to monitor the cooling phase of the sealing system for long-term changes:

- Temperature actual value “iii” in °C of the PIREG-C2 at the start of the OFF state. The actual value “iii” is limited to maximum 999 and negative actual values are set as zero.
- Cooling time “aaaaa” in 0.01 s (max. 655.53s). The cooling time ends when the actual value falls below 50° C.
The values are reset at the start of the OFF state and then reset again and remain until a new OFF Sate starts.

Example RS232/USB:	**Read:** Response:	LZPFA AZPFA 150 00379

Example RS485:	**Read:** Response:	68 03 03 68 21 89 78 22 16 68 07 07 68 21 00 78 96 00 7B 01 AB 16	(GA=21h)

Reference: ZPFE

i) 4.42. ZPFE Command

Syntax RS232/USB:	**Read:** Response:	**LZPFE** **AZPFE iii sss aaaaa hhhhh mmm ggggg**
Syntax: RS485:	**Read:** Response:	**Control set, BI = 79h** **Long set with DB0…DB11**

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
H-byte	L-byte	H-byte	L-byte	H-byte	L-byte	H-byte	L-byte
hhhhh		aaaaa		sss		iii	

DB11	DB10	DB9	DB8
H-byte	L-byte	H-byte	L-byte
ggggg		mmm	

Description: Reading the values of the time log function ON state. The PIREG-C2 records the following values during the ON state in order to monitor the heating phase of the sealing system for long-term changes:

- Temperature actual value “iii” in °C of the PIREG-C2 before the heating. The actual value “iii” is limited to maximum 999 and negative actual values are set as zero.
- Temperature setpoint “sss” in °C of the PIREG-C2 before the heating.
- Heating time “aaaaa” in 0.01 s (max. 655.53s). Heating time ends if the actual value exceeds the 95% of the setpoint.
- Sealing time “hhhhh” in 0.01 s (max. 655.53s). Sealing time starts if the actual value exceeds 95% of the setpoint.
- Mean value of the temperature actual value “mmm” in °C during the sealing time. The mean value is limited to maximum 999 and negative actual values are set as zero.
- Heating time “ggggg” in 0.01 s (max. 655.53s). The heating time starts with the Start-Signal is applied and ends with the removal of the Start-Signal.

The values are reset at the start of the ON state and then reset again and remain until a new On-Sate starts.

Example RS232/USB:	**Read:** Response:	LZPFE AZPFE 022 150 00052 00166 148 00218

Example RS485:	**Read:** Response:	68 03 03 68 21 89 79 23 16 68 0F 0F 68 21 00 79 16 00 96 00 34 00 A6 00 94 00 DA 00 8E 16	(GA=21h)

Reference: ZPFA

i) 4.43. ZUST Command

Syntax RS232/USB:	**Read:** Response:	**LZUST** **AZUST bb kk**
Syntax: RS485:	**Read:** Response:	**Control set, BI = 37h** **Long set with DB0**

DB0							
7	6	5	4	3	2	1	0
k3	k2	k1	k0	b3	b3	b1	b0

Description: Query of the state of the PIREG-C2 with the following assignments:

Assignment			
bb	**Operating state:**	0= Initialisation 1= OFF state 2= ON state 3= Calibration state	4= FAULT state 5= Adjustment state 6= Reset state
kk	**Calibration state:**	0= OK 1= Initialise calibration 2= Calibrate input amplifier 3= Determine phase shift 4= Determine reference resistance (R20) 5= Calibration comparison time 6= Check reference resistance (R20) 7= Determine P-factor 8= Initialising remanence setting	

9= 8-Point Tc Correction
10= Save controller settings
11= Initialise single-point Tc correction
12= Disable single-point Tc correction
13= Heat single-point Tc correction
14= Set and save single-point Tc correction
20= Calibration switching

Example RS232/USB:	**Read:**	LZUST	
	Response:	AZUST 01 00	
Example RS485:	**Read:**	68 03 03 68 21 89 37 E1 16	(GA=21h)
	Response:	68 04 04 68 21 00 37 01 59 16	
Reference:	FEZU		

i) 4.44. ZYKL Command

Syntax RS232/USB:
- **Read:** **LZYKL n**
- Response: - Total cycle counter: **AZYKL 0 ggggggggg**
  - Cal. cycle counter 1…8: **AZYKL n zzzzzzz**
- **Write:** - Cal. cycle counter 1…8: **SZYKL n**
- Response: OK or error acknowledgement; response time max. 6 ms
- Enable: not in power-on or calibration state

Syntax: RS485:

Read: **Long set with DB0, BI = 6Eh**

DB0
n

Response: - Total cycle counter: **Long set with DB0…DB4**

DB4	DB3	DB2	DB1	DB0
Byte 3	Byte 2	Byte 1	Byte 0	
ggggggggg				n

- Calibration cycle counter: **Long set with DB0…DB3**

DB3	DB2	DB1	DB0
Byte 2	Byte 1	Byte 0	
zzzzzzz			n

Write: - Calibration cycle counter: **Long set with DB0, BI = 6Eh**

DB0
0

Response: Short set, OK or error acknowledgement; response time max. 6 ms
Enable: not in power-on or calibration state

Description: Query of the sealing cycles “zzzzzzz” (0…9999999) performed by the PIREG-C2 for the saved calibrations (parameter “n”=1…8) and the total sealing cycles “ggggggggg” (0…999999999) performed by the PIREG-C2 with the value zero for the parameter “n”. The calibration cycle counters (1…8) are set to zero in which the parameter “z” is transferred with the respective number (1…8) of the calibration cycle counter.

Example RS232/USB:	**Read:**	LZYKL 0	
	Response:	AZYKL 0 000018553 (Total cycle counters)	
	Write:	- Calibration cycle counter: SZYKL 1	
	Response:	QOK00	
Example RS485:	**Read:**	68 04 04 68 21 89 6E 00 18 16	(GA=21h)
	Response:	68 07 07 68 21 00 6E 79 48 00 00 50 16	
	Write:	- Calibration cycle counter: 68 04 04 68 21 69 6E 01 F9 16	(GA=21h)
	Response:	10 21 00 21 16	
Reference:	BSTZ		

TOSS

VERPACKUNGSSYSTEME

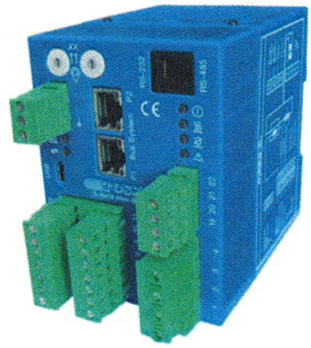
Original Konformitätserklärung

EU-Konformitätserklärung
EU Declaration of Conformity

Firma | Company

TOSS GmbH & Co. KG
-Verpackungssysteme-
Danziger Str. 15
DE-35418 Alten-Buseck

Hiermit erklären wir in alleiniger Verantwortung, dass das folgende
| Hereby we declare under our sole responsibility, that the following



Produkt |Product: **Temperaturregler** | Temperature controller

Typ |Type:
PIREG-C2-200, Nr.|no. 11407043
PIREG-C2-220, Nr.|no. 11407047
PIREG-C2-400, Nr.|no. 11407049
PIREG-C2-420, Nr.|no. 11407053

folgenden einschlägigen Bestimmungen/Richtlinien entspricht
| complies with the requirements of the following regulations and directives:

- **2014/35/EU Niederspannungs-Richtlinie** | low voltage directive
- **2014/30/EU EMV-Richtlinie** | electromagnetic compatibility directive
- **2011/65/EU RoHS 2 Richtlinie** | RoHS directive

Es wurden folgende harmonisierte Normen angewendet (Auszug)
| In particular, the following harmonised standards have been applied (excerpt)

DIN EN 61010-1:2020-03, DIN EN IEC 61000-6-2:2019-11, DIN EN IEC 61000-6-3:2022-06

Hinweise | Notes
Bei einer nicht mit uns abgestimmten Änderung der oben bezeichneten Produkte verliert diese Erklärung ihre Gültigkeit |This declaration loses its validity in the event of a change to the above-mentioned products that has not been agreed with us.

Diese Erklärung bestätigt, dass der Temperaturregler die o. g. Richtlinien und die CE-Konformität erfüllt. Nachdem der Regler in ein Gesamtsystem integriert wurde, obliegt es dem Anwender/Inverkehrbringer dessen Konformität zu prüfen und zu bescheinigen. | This declaration confirms that the temperature controller fulfils the above-mentioned directives and CE conformity. Once the controller has been integrated into a complete system, it is the responsibility of the user/distributor to check and certify its conformity.

Alten-Buseck, 11.08.2025

TOSS
GmbH & Co. KG
VERPACKUNGSSYSTEME
D-35418 ALTEN-BUSECK

Nico Cappeller
Geschäftsführung | Management