PIREG-C2 Device Description: Resistance temperature controller

TOSS®

Applications:
Packaging machines for sealing plastic foils

PIREG-C2 controller

PIREG-CT-50 current transformer

EMV-Filter

Contents:

1. General, safety and warning instructions

1.1. Note on the device description

The purpose of this device description is to ensure optimum installation, commissioning, operation and maintenance of the PIREG-C2 and must be read prior to carrying out any of the actions described. Keep the device description handy and accessible to all users for possible referencing. Pass this manual on to future users of the PIREG-C2.
All necessary settings are described in this device description. Should difficulties nevertheless arise during commissioning or operation, please do not carry out any unauthorised manipulations. You could put yourself and others at risk as well as jeopardize your warranty claim. In such cases, please contact us immediately:

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1.2. Icons and symbols

Danger (EN)**:** Indicates a hazard that could result in personal injury. Whenever this symbol is used, the device description must be consulted and the accompanying instructions must be observed and followed in order to avoid hazards.
Danger (FR)**:** Indique un danger pouvant entrainer des atteintes à la santé des personnes. Lorsque ce symbole est utilisé, la description de l'appareil doit être consultée et les indications doivent être observées et respectées afin d'éviter toute mise en danger.

Danger (EN)**:** Indicates a hazard due to electrical current. Failure to observe the safety instructions may result in serious or fatal injuries.
Danger (FR)**:** Indique un danger d'électrocution. Un non-respect de ces indications de sécurité entraine un danger de blessures graves, voire mortelles.

Danger (EN)**:** Indicates a hazard due to hot surfaces or burn up that could result in personal injury.
Danger (FR)**:** Indique un danger dû aux surfaces brûlantes, voire rougeoyantes pouvant entrainer des atteintes à la santé des personnes.

Note (EN)**:** Indicates particularly important information which, if ignored, can lead to material damage, for example.
Indications (FR)**:** Indique une information particulièrement importante pouvant entrainer des dégâts matériels en cas de non-respect.

1.3. General safety instructions

EN: The safety instructions and warnings given in this description must be followed to guarantee safe operation of the equipment. The equipment can be operated without impairing the operational reliability if the conditions stated in the technical specifications are observed.
The equipment may only be installed and started-up by suitably trained personnel.
Maintenance and repair of the equipment may only be carried out by trained personnel, who are familiar with the dangers and guarantee conditions.
FR: Les indications et mises en garde contenues dans cette description doivent être respectées afin de garantir un fonctionnement sûr. Si les consignes de sécurité de fonctionnement sont respectées, l'appareil peut être exploité aux conditions mentionnées dans les données techniques.
Cet appareil ne peut être installé et mis en service que par un personnel qualifié en technique électronique !
Les travaux d'entretien et de réparation ne peuvent être effectués que par des personnes formées et spécialistes familiarisées avec les dangers liés à l'appareil et les conditions de garantie.

1.4. Application

EN: The PIREG-C2 resistance temperature controller may only be used for the heating and temperature control of heating conductors as specified via isolating transformers in accordance with the regulations, notes and warnings contained in this description.
Non-observance of the instructions or incorrect use of the equipment can result in impairment of the safety or overheating of the heating conductor, the electrical wiring or the transformer.
FR: Le régulateur de température à résistance PIREG-C2 ne doit être utilisé que pour le chauffage et la régulation de température de conducteurs de chaleur expressément conçus à cet effet par l'intermédiaire de transformateurs de séparation conformément aux prescriptions, indications et mises en garde mentionnés dans cette description.
Le non-respect ou l'utilisation non conforme peut compromettre la sécurité ou entrainer le surchauffe des conducteurs de chaleur, des câbles électriques, du transformateur, etc.

1.5. Note on the heating conductor

A basic precondition for the function and safe operation of the complete heating system is the application of suitable heating conductors.

The positive temperature coefficient of the heating conductor used must be equal or greater than the positive temperature coefficient set at the PIREG-C2. The appropriate temperature coefficient of the heating conductor must be set at the PIREG-C2 by means of the DIP switches or via the interfaces. The temperature coefficient of the heating conductor must be positive over the entire temperature range. The following temperature coefficients can be set using the DIP switches:

Alloy L:	Tc1= $7{,}46 \times 10^{-4}$ 1/K	Tc2= 0	Tc3= 0
Alloy M:	Tc1= $8{,}62 \times 10^{-4}$ 1/K	Tc2= 0	Tc3= 0
Alloy A20:	Tc1= $10{,}8 \times 10^{-4}$ 1/K	Tc2= 0	Tc3= 0
Norex:	Tc1= $48{,}3 \times 10^{-4}$ 1/K	Tc2= $-6{,}12 \times 10^{-6}$ 1/K²	Tc3= $2{,}80 \times 10^{-9}$ 1/K³

In addition to those already mentioned above, the following temperature coefficients can also be set via the interfaces (RS232, RS485 or USB):

Alloy A20C:	Tc1= $12{,}65 \times 10^{-4}$ 1/K	Tc2= 0	Tc3= $-0{,}70 \times 10^{-9}$ 1/K³
Alloy A20D:	Tc1= $12{,}55 \times 10^{-4}$ 1/K	Tc2= 0	Tc3= 0
Variable:	Tc1= $+3{,}00 \ldots +99{,}99 \times 10^{-4}$ 1/K	Tc2= $-99{,}99 \ldots +99{,}99 \times 10^{-6}$ 1/K²	Tc3= $-99{,}99 \ldots +99{,}99 \times 10^{-9}$ 1/K³

Caution (EN)**:** Using heating conductors with too low a temperature coefficient, or adjusting the controller to a temperature coefficient that is too high, can result in uncontrolled overheating or **melting** of the heating conductor.
Attention (FR)**:** Si un conducteur de chaleur est utilisé avec un petit coefficient de température ou qu'un coefficient de température trop grand est réglé sur le régulateur, les conducteurs de chaleur vont chauffer de manière incontrôlée et peuvent aller jusqu'à **fondre**.

Heating conductors with a lower temperature coefficient can also be used when correcting the setpoint voltage (→ 4.1.3.).

Temperature regulation of heating conductors connected in parallel must be more precise than of heating conductors connected in series. However, the wiring must be strictly symmetrical and performed in such a way that no overcurrent arises when two heating conductors on opposite sides contact each other.

If series-connected heating conductors have to be used, the effect on the overcurrent reaction should be taken into consideration if two opposite sealing bands touch each other.

1.6. Note on the sealing transformer

The sealing transformer must be configured according to EN 61558 (VDE 0570) resp. UL 5085 (isolating transformer with reinforced isolation) and in a single-chamber design. All types and designs that comply with the standards can be used as sealing transformers. The induction in the transformer's iron core must not be reduced as is normally the case with primary side thyristor operation. A transformer with low losses are disrupted less on the secondary side than with transformers that have low energizing currents. Thus in applications with short heating and sealing times, stiff and generally larger transformers should be used. Where a great deal of sealing is to be performed, a transformer with a primary voltage of 400 V is advantageous, because this way, the switching capacity of the PIREG-C2's internal actuator is more likely to be sufficient and an external actuator with solid-state relay will not have to be used.

Caution (EN)**:** There must be sufficient protection against accidental contact if the transformer is installed in a machine frame. Furthermore, ensure that water, cleaning liquids or conducting liquids do not come into contact with the transformer. The conductor wiring cross sections should be designed to match the actual currents. Non-observance of these notes may result in impairment of the electrical safety.
Attention (FR)**:** Si le transformateur est placé dans le corps de la machine, une protection suffisante contre les contacts accidentels doit être prévue. De plus, il convient d'empêcher l'eau, les solutions de nettoyage ou les liquides conducteurs d'entrer en contact avec le transformateur. Les sections des câbles doivent être conçues en fonction des courants réels. Le non-respect de ces instructions compromet la sécurité électrique.

For best results, the transformer's performance and the secondary voltage must be suited to the heating conductor. A short heat-up period is reached with of a high transformer output voltage. However, the voltage selected should not be too large so that not less than 12 controller measurements are needed for a target temperature increase of 300°C when heating up (heat-up period ≥ 240 ms). For smaller heat-up curves, correspondingly fewer measurements are necessary. (The PIREG-C2 takes a measurement every 20 ms while heating).

The larger the transformer's secondary voltage for a given heating conductor, the more energy is fed into the heating conductor, even in the OFF state. This is done by means of temperature measuring impulses, which the controller regularly sends to the heating conductor. Therefore, the higher the secondary voltage of the transformer the greater is the difference between the resting temperature and the ambient temperature in the OFF state.

1.7. Note on the current transformer

EN: The current transformer is an essential part of the control system. Only Toss current transformers may be used. The current transformer may only be operated with ballast resistance. The ballast resistance is integrated into the PIREG-C2. The current transformer must be mounted in such a way that magnetic leakage fields from the sealing transformer or other leakage fields do not affect the measurement.

FR: Le transformateur de courant fait partie du système de régulation. Seuls les transformateurs de courant Toss peuvent être utilisés. Le transformateur de courant ne doit être utilisé qu'avec une résistance ohmique apparente. La résistance ohmique apparente est intégrée dans le PIREG-C2. Le transformateur de courant doit être monté de telle sorte que les champs magnétiques de dispersion du transformateur de soudage ou d'autres champs de dispersion n'influencent pas la mesure.

Caution (EN)**:** The used cable to the heating conductor can heat up the current transformer.
Attention (FR)**:** Le conduit utilisé allant vers le conducteur de chaleur peut chauffer le transformateur de courant.

1.8. General assembly instructions

The PIREG-C2 resistance temperature controller is only suited for use in a switch cabinet. Open operation is not permitted.
The controller as well as the current transformer are mounted on 35mm mounting rails as per EN 60715 (EN 50022). When assembling the controller on the mounting rail, there must be a distance of at least 20 mm to the next device.
Heat dissipation from neighbouring devices must be taken into account (note the ambient temperature specifications).

1.9. Maintenance

The PIREG-C2 resistance temperature controller does not require any special maintenance. However, an occasional check or tightening of the connection terminals is recommended. Dust deposits on the controller can be removed with dry compressed air once the power has been switched off.

1.10. Validity

The first device type (vw) delivered was the series 1.00 with the program version 1.01 for the electrically separate side (ggg) and 1.01 for the instrumentation side (mmm). Supplements in this description which are only valid from a later version and include the version, the notation Vvvv/ggg/mmm, e.g. V1.00/1.01/1.01 from which they are valid. The device and program versions are read by command (VERS) via the interfaces.

2. Short description

The PIREG-C2 resistance temperature controller is used to control the temperature of heating conductors for the heat-impulse sealing of foils. The sealing transformer is used by the PIREG-C2 on the primary side. The internal actuator or an external solid-state relay which is controlled by the PIREG-C2 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 are made available to the controller.

The temperature coefficient Tc of the heating conductor must be positive. This increases the resistance of the heating conductor when heated. This effect is used for temperature control. The temperature controller measures and regulates the resistance of the heating conductor. The temperature coefficient Tc is a material constant that depends on the alloy used for the heating conductor. The actual temperature is determined by measuring the voltage and current.

The PIREG-C2 operates as a proportional control unit that independently determines the P-factor (the control amplification) for the controlled system of a process during calibration itself. The controlled system consists of a sealing transformer and a heating conductor. The P-factor determined during calibration can afterwards still be corrected by command or via the target value input (→ 5.4. and 4.5.2.). An additional compensation function allows to minimise the permanent control deviation typical of a proportional controller.

The PIREG-C2 is operated either conventionally with a setpoint potentiometer or setpoint voltage, or using actual value instruments, LEDs, switches or digital signals and DIP switches (→ 4.1. - 4.4.), or via the RS232, RS485 or USB interface (→ 5.) with which the PIREG-C2 is equipped. Combinations of both types of operation are possible. During operation via an RS232, RS485 or USB interface, there extended adjustments are possible, for instance freely selectable temperature coefficients and temperature ranges.

The PIREG-C2 is set to the temperature coefficients (→ 4.1.3.. and 5.4.). If the temperature coefficient values differ, the setpoint voltage must be corrected. The PIREG-C2 can also determine the actual temperature coefficient of a heating conductor itself by means of a temperature coefficient correction (Tc correction) (→ 4.1.9., 4.1.10. and 5.4.). Connect the PIREG-C2 via the RS232 interface to an external thermometer, DTM3000 (from V1.01/1.16/1.10) or previous TM6, which measures the actual temperature of the heating conductor to simplify the Tc correction. Depending on the setting, the PIREG-C2 can operate up to a temperature range of 500 °C.

During calibration, the controller sets itself to the secondary voltage of the transformer and the current through the heating conductor. The secondary voltage of the transformer may be within a range of 1...120 V. The current measured with a current transformer can range from 20 to 500 A. The calibration values can be stored in the controller, so that there is no need for renewed calibration and start-up time after switching on the power when conditions have not changed.
The PIREG-C2 can conduct the calibration at room temperature (always taken to be 20°C) as well as at any other ambient temperature between 0 - 50 °C. The controlled is informed of the actual reference temperature from outside. This is advantageous in the case of constant sealing temperatures with different environmental conditions (→ 4.1.8 and 5.4.).

High quality sealing transformers, such as toroidal core transformers, are switched by the PIREG-C2 on the primary side. A smooth switching procedure is employed that compensates for the remanence of the sealing transformer. An initialising remanence setting is made automatically after switching on the power and following calibration. Only a short remanence setting lasting 40 ms for EI core transformers and 80 ms for toroidal core transformers is needed before each sealing process. If, with toroidal core transformers, the pause between two sealing processes is longer than 10 minutes, the remanence setting takes 160 ms. The remanence is the residual magnetization in the transformer's iron core. During the initial remanence setting procedure, the heating conductor has to be heated for a short time to approx. 40 to 70 °C. The PIREG-C2 itself uses a phase angle controller to regulate the temperature.

3. Operating states

3.1. Calibration

During calibration, the PIREG-C2 automatically adapts to the sealing transformer/heating conductor combination. At the same time, the voltage "Ur" at the heating conductor and the current "Ir" through the heating conductor are measured every second. In this condition, the blue "calibration" LED is lit up and the calibration OK signal is reset. The calibration OK signal is sent by the OK output if the appropriate function has been set by command (KONF). The OK output is factory set to the Calibration-OK message feature. The actual value output is used to display the individual steps. The actual value output is updated every second.
The controlling PLC can track the calibration process by observing the actual value output at terminal 17 and can recognise the end of the calibration from the calibration OK signal. The sealing controls are then released. During calibration steps 1 to 7, no "Start" signal may be given as otherwise the PIREG-C2 will interrupt the calibration with error 2.

The calibration process will undergo the following steps:

3.1.1. Initialisation: During initialisation, the PIREG-C2 determines the data necessary for calibration. In addition, it checks the selected temperature coefficient for dynamics and continuity in the selected temperature range. Should the dynamics and continuity exceed the permitted limits, the PIREG-C2 will stop the calibration procedure with Error 13 (parameter error). The reference temperature still set is checked in the permitted range of 0…50 °C. If the reference temperature is outside this range, the PIREG-C2 will also stop the calibration procedure with Error 13 (reference temperature selected too large).

3.1.2. Calibrating the input amplifier: The input amplifiers for Ur and Ir are adjusted in steps to the voltage and current at the heating conductor. In the first step, the required modulation reserve for the sealing transformer/heating conductor combination is determined automatically if not set manually by command (KASR).
During this step, different voltage values are applied to the actual value output every second. The measured current or voltage value is connected alternately. The measured value of the current is displayed in the 0 - 5 V range, the voltage in the 5 - 10 V range. The zero point of the measured values is 5 V. At the beginning of the calibration, the amplifiers (for Ur and Ir) are initialised with minimum amplification. At the end of the calibration procedure, if the adjustment has been made successfully, the range for the displayed current value is from 1.66 - 3.33 V and the range for the displayed voltage value is from 6.66 - 8.33 V.

3.1.3. Determining the phase shift: During this step, the transformer-dependent phase shift between Ur and Ir is measured and corrected. The controller automatically sets the optimum scan times for Ur and Ir. The actual value output displays the phase shift. A signal of approx. 5 V corresponds to the ideal value.

3.1.4. Determining the reference resistance: (→ 4.1.8. and 5.4.) The reference resistance of the heating conductor (Rref) is determined in this step. The controller assumes a constant reference temperature of 20 °C for calibration. Alternatively, a variable reference temperature of 0...50 °C can be entered as nominal value (50 °C = 1.66 V at 300 °C and 1.00 V at 500 °C). While the calibration is being initialised, the PIREG-C2 reads the variable reference temperature, depending on the settings. During calibration, the heating conductor must be at the reference temperature to ensure that regulation is exact. By standardizing the voltage signal (Ur) and the current signal (Ir), the reference resistance for the different temperature coefficients is always within the same resistance range. If 20 °C has been selected as the reference temperature, then heating conductor's R20 is directly determined as the reference resistance. If a heating conductor temperature other than 20 °C has been selected for calibration, then the determined reference resistance corresponds to the temperature coefficient above or below the value for the R20. The reference resistance is displayed for one second at calibration stage 4 at the actual value output. At a reference temperature of 20 °C, the voltage at the actual value output is 7…8 V. At a variable reference temperature the voltage will be between 6 and 10V.

3.1.5. Temperature comparison time: (→ 4.1.4. and 5.4.) The aim of the temperature comparison time is to ensure that the comparator resistance can only be determined when the heating conductor has completely cooled down. During this comparison time, the signal at the actual value output declines from 10 V to 0 V. Times of 15 or 30 s can be chosen for the temperature comparison time.

3.1.6. Checking the reference resistance: The comparator resistance is checked after the temperature reference time is finished. If calibration takes place on a heating conductor that has cooled down still further during the temperature comparison time, the entire calibration will be discarded and the procedure automatically restarted. Once the reference resistance has been successfully checked, the PIREG-C2 calculates the R20 (resistance at 20 °C) of the heating conductor from the type of reference temperature set, the temperature coefficients selected and the reference resistance (Rref) determined.
The comparator resistance measured is displayed for one second at the actual value output. The same voltage must be set at the actual value output as when the reference resistance was determined (→ 3.1.4).

3.1.7. Determining the P-factor: The P-factor of the sealing transformer/heating conductor combination is determined by heating with a constant correction variable. The heating conductor is either warmed by a maximum of approx. 60 K or charged for a maximum of 120 network periods with a defined control value. The total amplification of the control system is calculated from the measurement of the power fed into the heating conductor and the measurement of the temperature increase of the heating conductor. The P-factor for the PIREG-C2 is calculated from this.
In the case of adverse conditions of the sealing transformer/heating conductor combinations or the public supply the P-factor of the PIREG-C2 can be corrected manually within a range of 30…110 % (→ 5.4. and 4.5.2.).
The P-factor monitoring which is set by command (PFUE) is used to monitor the P-factor determined by PIREG-C2 on a valid range (→ 3.4.4. and 5.4.).

3.1.8. 8-point Tc correction: The 8-point temperature coefficient correction function can be used to correct tolerances of the temperature coefficients. These result from the dispersion of the metallurgical composition of the heating conductors.
In calibration stage 8, the PIREG-C2 gradually heats up the heating conductor in eight temperature increments or stages. The PIREG-C2 compares its actual value temperature with the actual temperature of the heating conductor, which it receives as a target value or directly as a measured temperature value.
The size of each increment is a result of the selected temperature range. The first temperature increment is always 50 °C. The temperature of the eighth temperature increment falls 20% below the final value of the temperature range. The six other temperature increments are equidistant between these points.

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

The actual temperature of the heating conductor must be sent back externally to the PIREG-C2 as a target value or directly as a measured value of the external thermometer. Deviations of up to ±20 % between the calculated actual value temperature and the actual temperature of the heating conductor can be corrected (→ 4.1.9. and 5.4.). The correction process is controlled with the “Start” signal or by command (STST).
The 8-point Tc correction can be saved by command (STKA) so that it doesn't need to be repeated after a new calibration but only when the heating conductor is replaced.

Performing the 8-point Tc correction:

- manual operation: The actual temperature of the heating conductor is reported back to the PIREG-C2 via the set value input. The next temperature step is switched to with the rising edge of the “Start” signal. After the heating conductor has reached a uniform temperature the temperature set as the target value is taken over as the actual temperature of the heating conductor with the falling edge of the “Start” signal. After heating to the next temperature stage, only accept the temperature once the heating conductor itself has reached the specified temperature. The actual value output indicates the corresponding, not yet corrected actual value temperature of the PIREG-C2.
At the beginning of the 8-point Tc correction, the "Calibration" LED flashes while the communication setup time at a cycle rate of 1 Hz, while the PIREG-C2 tries to establish the connection to the external thermometer.

- manual operation with the external thermometer: The 8-point Tc correction is 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-C2. The PIREG-C2 automatically tries to establish a connection with the external thermometer in the communication setup time at the beginning of the 8-point Tc correction. The "Calibration" LED flashes at a cycle rate of 1 Hz during connection establishment and when the connection to the external thermometer has been established.

- automatic 8-point Tc correction: The PIREG-C2 must be connected to the external thermometer and the set value for the heating time must be greater than zero for the automatic 8-point Tc correction. The heating time is the period until the heating conductor has reached a uniform temperature at a temperature stage. The heating time is set either in the Reset state or by command (KTKZ) (→ 5.4. and 4.5.3.). The PIREG-C2 undergoes the automatic 8-point Tc correction independently and remains at each temperature stage for the preset heating time.

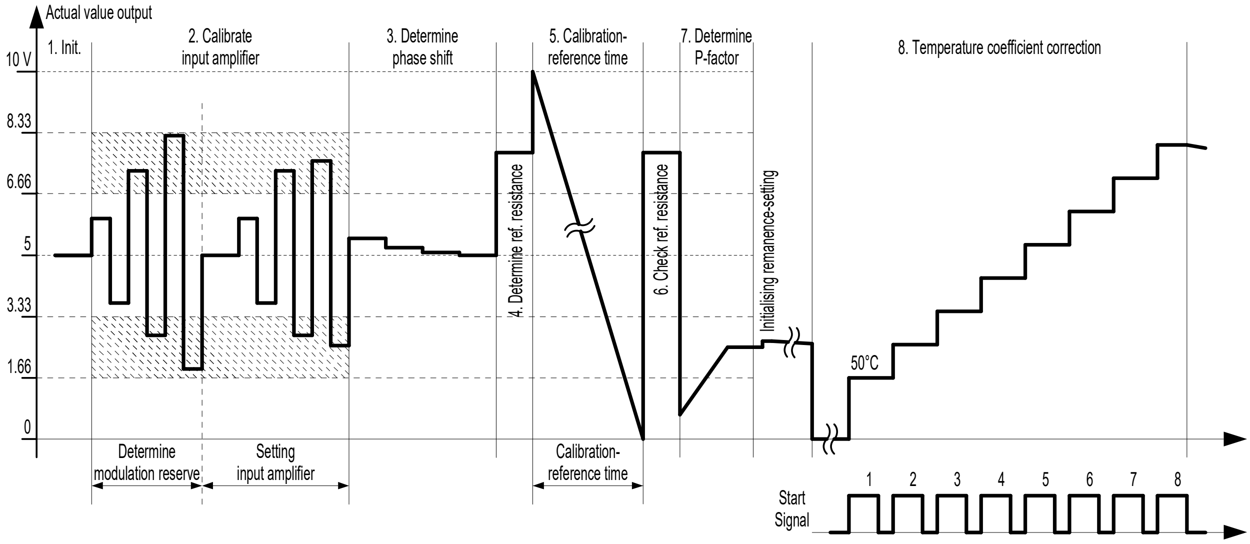


Figure 1: Calibration process

The controller must undergo calibration steps one to seven for each calibration. Step eight is a selectable calibration function (→ 3.1.8.). If an error occurs during the individual calibration steps, the PIREG-C2 stops the calibration process and then restarts the calibration. Calibration is stopped with an error message after attempt five was not successful (→ 3.4.).

Calibration must be carried out when the heating conductor has reached a temperature of approx. 20 C or the externally determined calibration temperature to ensure that the R20 reference resistance of the heating conductor is calculated correctly. The time required for a calibration process depends on various factors. The calibration duration is determined by the voltage at the heating conductor, the current flowing through the conductor, the phase shift from Ur and Ir and the P-factor of the sealing transformer/heating conductor combination. The controller needs maximum 48 or 63 seconds for one calibration process.
If the calibration process is not successful, e.g. because the P-factor has been determined incorrectly, the controller makes another four attempts before reporting an error. In this case, the maximum calibration time can amount to 240 or 315 s, depending on the temperature comparison time.

If the calibration mode **"New calibration"** is chosen, the controller always switches to calibration immediately after a power-on or after a reset and carries out a new calibration. Calibration can also be started in the OFF or error state with the signal "Calibration Start".

If the calibration mode **"Save"** is chosen, the controller switches to calibration when in an OFF or error state or before power-on only when the "Calibration Start" signal is applied. In this type of calibration, the calibration values are saved in a non-volatile memory and are loaded immediately after a power-on or the "Reset" signal.

The operator or the controlling PLC can recognize the end of a successful calibration process as follows:

- without 8-point Tc correction: By observing the actual value on the characteristic voltage curves (→ Figure 1, steps 5, 6 and 7 with subsequent remanence and subsequent cooling of the heating conductor from approx. 50 °C to approx. ambient temperature).

- with 8-point Tc correction: As before, but with subsequent 8-point Tc correction (→ step 8). After the last correction step, the controller is ready for operation. The PLC must then wait until the temperature of the heating conductor has cooled down.

- with calibration OK message: The calibration OK message is reset when calibration is started and reset at the end of successful calibration. The calibration OK message is the factory setting of the OK output, which can be changed by command (KONF).

3.1.9. Single-point Tc correction: With the single-point temperature coefficient correction the tolerances of the temperature coefficient of the heating conductor can be corrected for just one operating point. For this operating point the actual temperature of the heating conductor is reported back to the PIREG-C2 as actual value or directly as measured value of the external thermometer from outside. The single-point Tc correction is carried out outside the standard calibration and is started from the OFF state. Single-point Tc correction has an OFF and an ON state. After the single-point Tc correction was started, the PIREG-C2 is in the OFF state. When the PIREG-D is in the ON state, the heating conductor is heated to the temperature which was set as target value in the OFF state. After heating, only accept the temperature once the heating conductor itself has reached the specified temperature. The actual value output indicates the not yet corrected actual value temperature of the PIREG-C2. The single-point Tc correction finishes upon exiting the ON state. The correction process is controlled with the "Start" signal or by command (STST). Deviations of up to ±20 % between the calculated actual value temperature and the actual temperature of

the heating conductor can be corrected. The single-point Tc correction can only be performed if an 8-point Tc correction was not carried out during calibration. The single-point Tc correction is reset at each calibration.
The single-point Tc correction can be saved by command (STKA) so that it doesn't need to be repeated after a new calibration but only when the heating conductor is replaced (→ 5.4.).

Performing the single-point Tc correction:

- manual operation: The single-point Tc correction is started by switching the DIP switch 10 for less than one second in the ON position or by command (STKA). If the pulse-control was configured by command (KONF) for the calibration start input (5), the single-point Tc correction can also be started by applying a high signal for less than one second (→ 5.4.). The PIREG-C2 retains the temperature set as set value as the temperature of the operating point as long as a low-signal is applied as “Start” signal. When a high signal is applied as “Start” signal the PIREG-C2 heats the heating conductor to the temperature of the operating point. Now the actual temperature of the heating conductor is set as target value. When a low-signal is applied again as "Start” signal, the PIREG-C2 calculates the correction factors for the single-point Tc correction and saves these values, if "Save" was selected as the calibration type.

- manual operation with the external thermometer: The single-point Tc correction is started and controlled 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 automatically tries to establish a connection with the external thermometer at the beginning of the single-point Tc correction The Calibration LED flashes at a cycle rate of 1 Hz when connection to the external thermometer has been established.

- automatic single-point Tc correction: The PIREG-C2 must be connected to the external thermometer and the set value for the heating time must be greater than zero for the automatic single-point Tc correction. The heating time is the period until the heating conductor has reached a uniform temperature in the ON state of the single-point Tc correction. The heating time is set either in the Reset state or by command (KTKZ) (→ 5.4. and 4.5.3.). Automatic single-point Tc correction is started as described above for manual operation. The PIREG-C2 undergoes the automatic single-point Tc correction independently and remains in the ON state for the preset heating time.

3.1.10. P-factor correction: The P-factor correction is used for subsequent manual correction of the calibrated P-factor (→ 3.1.7.) in the case of very unfavourable conditions of the sealing transformer/heating conductor combinations or the public supply. The correction range is 30…250 % (from V1.01/1.09/1.07).
When the DIP switch 2 is switched in the ON position in the Reset state (→ 4.5.) the PIREG-C2 will adopt the temperature set as the target value (1 °C corresponds to 1%) as the correction factor and terminate the Reset state. As only the values zero, no P-factor correction and 30…250 % (from V1.01/1.09/1.07) are permitted as correction value of the P-factor correction, the setting will only be accepted and the reset state terminated if the set value is within the permissible range. In the Reset state the currently set correction value of the P-factor correction is indicated at the actual value output (1 °C corresponds to 1%). The P-factor correction can be set by command (KPFK). The P-factor correction value will not be reset during a calibration as it is system dependent (→ 5.4.).

3.2. OFF state

In the OFF state, the PIREG-C2 regularly measures the resistance of the heating conductor and from this value determines the temperature and forwards this to the actual value output.
For each resistance measurement a positive and negative power line half-wave of the same fixed angle of current flow (1.8 ms at 50 Hz mains frequency) is applied to the transformer. The time intervals of the measurements depend on the temperature of the heating conductor. When the heating conductor has reached a temperature of 20 °C, the measuring interval is 1.5 s. At a temperature of 300 °C, the measuring interval is only 100 ms.
The heating conductor is heated in the OFF state and dependent on the voltage by the energy introduced when measuring the resistance.
The controller switches from the OFF state to the ON state as soon as the “Start” signal is applied. When the "Calibration Start" signal is applied the PIREG-C2 returns to calibration and to the OFF state after the end of a successful calibration. The PIREG-C2 then stays in the OFF state even when the "Calibration Start" signal is still applied (evaluation of the rising edge).
If the DIP switch 10 is switched in the ON position for less than one second, the PIREG-C2 is set to the single-point Tc correction. If the pulse control was configured by command (KONF) for the calibration start input (5), the PIREG-C2 switches in the single-point Tc correction when a high-signal is applied for less than one second (→ 5.4.).

3.2.1. Measurement pulse-pause: In the off state, the measurement pulse-pause can be switched on and off per command (MEPA, → 5.4.). When measurement pulse-pause is activated, the PIREG-C2 stops sending measurement pulses to the sealing transformer in order to determine the temperature of the heating conductor.

The actual value output indicates the value determined last. Only the monitoring of the mains voltage and the device function is still active. All other monitoring functions that relate to the measurement pulses are disabled.
The measurement pulse-pause is for applications in which the primary or secondary circuit of the sealing transformer has to be interrupted during operation without the PIREG-C2 switching to the error state.
With the start of a sealing process, a calibration or a reset, the measurement pulse-pause is automatically terminated.

3.2.2. Calibration switching: The PIREG-C2 offers the possibility to save eight calibrations and to switch between them by command (KANR). In the off state, a changeover between the eight calibrations is made by command (KANR). Calibration 1 is always active after power on or reset.
The heating conductors of the eight calibrations must be the equal for the temperature coefficient, temperature range and the other calibration settings. A possible temperature coefficient correction is performed separately for each calibration. The PIREG-C2 performs its own calibration for each heat conductor, which is also stored separately.

3.2.3. Time log functions: The PIREG-C2 offers the possibility to record the time behaviour of a sealing process, e.g. to detect long-term changes (from V1.01/1.09/1.06). The time log functions are used to record the time behaviour of the sealing system, which essentially consists of the sealing transformer and heating conductor, during a sealing process. The recording is carried out separately for the heating phase in the on-state and the subsequent cooling phase in the off-state.

- Heating phase: The recorded values for the previous heating phase are read out by command (ZPFE) in the off-state for the previous on-state. The following values are recorded for the heating phase:

- Actual temperature value before heating.
- Target temperature value before heating.
- Heating-up time; the heating-up time ends when the actual value exceeds 95% of the target value.
- Sealing time; the sealing time starts when the actual value exceeds 95% of the target value.
- Average of the actual temperature value during the sealing time.
- Heating time; the heating time starts and ends when the start signal is applied and removed.

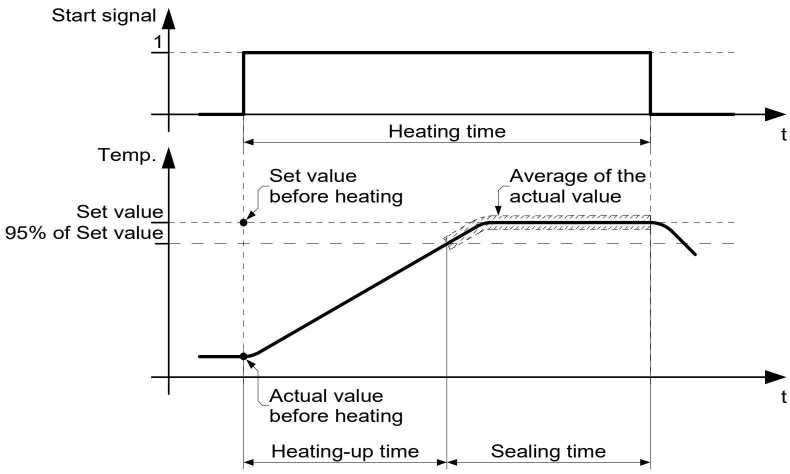


Figure 2: Time log function – Heating phase

- Cooling phase: The recorded values for the cooling phase should be read out by command (ZPFA) in the off-state as soon as the actual temperature value has fallen below 50°C or directly 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 value falls below 50°C.

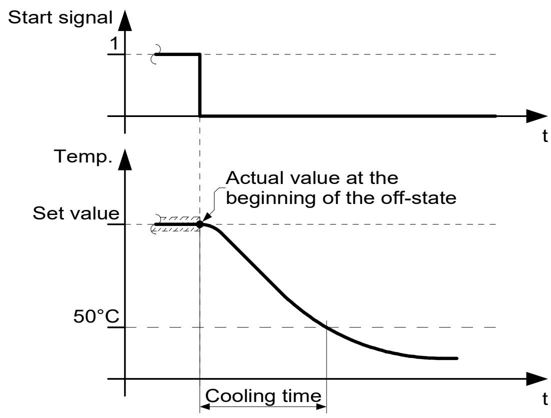


Figure 3: Time log function – Cooling phase

3.3. ON state

In the ON state, the PIREG-C2 controls the temperature of the heating conductor in accordance with the target value. A phase angle controller is used. The controller returns to the OFF state when the “Start” signal is removed.

3.4. Error state

The error state is indicated on the PIREG-C2 only when an error occurs. The controller monitors the line voltage, the temperature of the heating conductor, the values of the voltage and current measurements at the heating conductor and the calibration parameters. The Table 2 lists remedies and error areas for the individual errors (→ Table 2).
The alarm output is set in the error state. In the event of a power line error (error 3), actuation takes place with a delay of 2 seconds. In the error state, the alarm and calibration LED’s are triggered with different cycle rates of 1 or 4 Hz depending on the error that has occurred (→ Table 1). The actual value output is also cycled in some error cases. The voltage at the actual value output then changes every second between the voltages applicable to the different errors (→ Table 1). The error state can only be cancelled by switching off the power supply, the „Reset“ signal and „Calibration Start“. With errors 1 and 3 the error state cannot be cancelled with the "Calibration Start" signal.
In the OFF state, after switching on the power or following a reset, errors 4 - 13 are only reported by the LEDs and actual value output; however, the alarm output is not set in the factory default. This way, a calibration error does not lead to a machine malfunction when switching on. The factory setting can be changed with a command (KONF).

3.4.1. Temperature monitoring: The monitoring of the temperature is an additional monitoring function which is activated and adjusted with a command (TUEE). The actual temperature value is monitored during the sealing process in the ON state to ensure that it is within a temperature OK range. If the actual value leaves the temperature OK range during the sealing process after the stabilisation time has ended the PIREG-C2 will go to error state with error 8. The stabilisation time begins as soon as the actual value has reached the temperature OK range. In the event of a change of the target value by more than 2 °C, the stabilisation period is restarted.

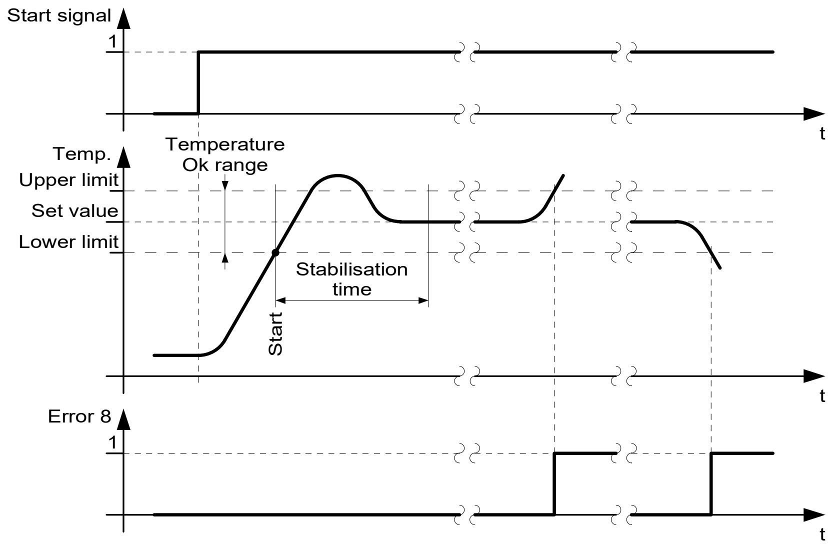


Figure 4: Temperature monitoring

3.4.2. Heating monitoring: The monitoring of the heating is an additional monitoring function which is activated and adjusted with the command (AHUE). With this function the temperature rise is monitored after the “Start" signal was applied.

- Variant 1: Under variant 1, the PIREG-C2 monitors the heating time to a maximum value. If the actual value of the temperature does not reach the temperature OK range within the set heating time, the PIREG-C2 switches to the error state with error 8.

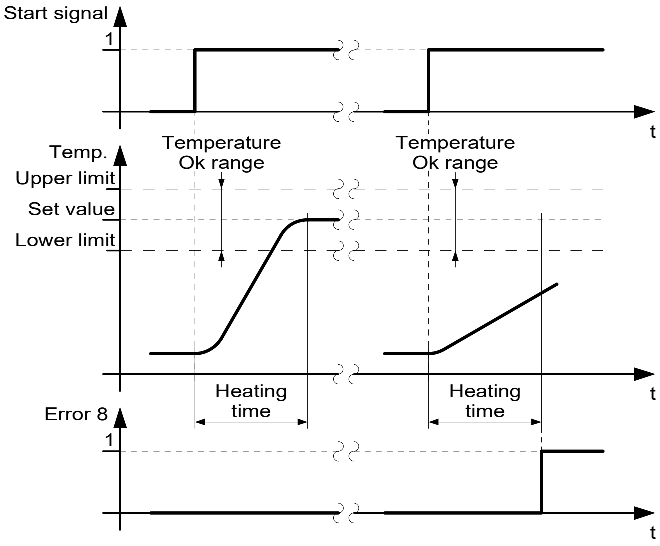


Figure 5: Heating monitoring - Variant 1

- Variant 2: Under variant 2, the PIREG-C2 monitors the heating time to a minimum and maximum value. If the actual value of the temperature does not reach the temperature OK range within the set time window, the PIREG-C2 switches to the error state with error 8.

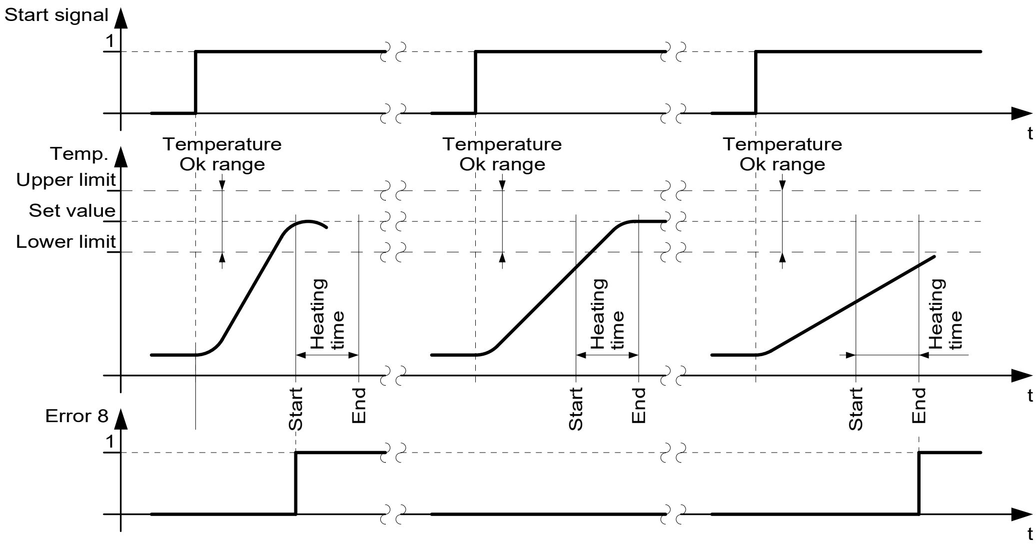


Figure 6: Heating monitoring - Variant 2

3.4.3. Communication monitoring: The monitoring of the communication is an additional monitoring function for the three interfaces of the PIREG-C2 and is activated and set with a command (KOUE) for each interface individually. This function monitors communication via the interfaces for interruptions. If the communication via the interface is interrupted for a longer time than the set downtime, then the PIREG-C2 switches to the error state with error 9.

3.4.4. P-factor monitoring: The P-factor monitoring is an additional monitoring function for the calibrated P-factor (→ 3.1.7.), which is set with a command (PFUE). This function is used to monitor 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 will go to the error state with error 10.
A calibration with the intended sealing transformer/heating conductor combination should first be carried out to determine the OK range of the P-factor monitoring. The calibrated P-factor of PIREG-C2 can be read back by command (PFUE). The upper and lower limits should be set according to this value. In addition to the sealing transformer/heating conductor combination, the level of the mains voltage during calibration has an impact on the calibrated P-factor of PIREG-C2.

3.4.5. Heating time limit: The heating time limit is a monitoring function to prevent unintentional continuous heating of the PIREG-C2 due to an operating error. A command (HZBG) activates the monitoring function and sets the maximum heating time. If the set maximum heating time is exceeded in the ON state, the PIREG-C2 goes to error state with error 2 and stops heating.

3.4.6. Reference R20 value monitoring: The reference R20 value monitoring is a monitoring function for the R20 value determined during calibration of the PIREG-C2 (from V1.01/1.09/1.06). The reference R20 value monitoring function can be used to detect and monitor changes in the R20 value, e.g. due to ageing or wear of the heating conductor band during calibration. In addition, the reference R20 value monitoring can be used to prevent disturbances caused by interruptions in parallel-connected heating conductor bands from being "calibrated away". The reference R20 value monitoring only works during calibration.
A command (RHZL) first stores the reference resistance R20 of the heating sealing band as the reference R20 value, e.g. after calibrating a new heating conductor band. A further command (RRUE) activates the reference R20 value monitoring and sets the OK range around the stored reference R20 value. If the currently calibrated R20 value of the controller is outside the OK range, the PIREG-C2 will go to the error state with error 10.

3.4.7. Error causes - Display: **Table 1**

No.	**Error** Symbols: ○ : off / not set ◐ : flashing 1Hz ● : on / set ◕ : flashing 4Hz	**Actual value output** [V]	**Alarm-LED** (red)	**Calibr.-LED** (blue)	**Alarm-Output** **after Reset**	**Alarm-Output** **after "Start" signal**
1	Device error	4.66 / 0	●	○	●	
2	- Internal error, - Read-write error in the non-volatile memory, - "Start" signal during calibration or - Heating time limit	4.00	●	○	●	
3	Power line error (under-/overvoltage or line frequency error)	3.33	●	◕	●	
4	Current signal Ir and voltage signal Ur too low	2.00	●	◐	○	●
5	Voltage signal Ur too low	1.33	●	◐	○	●
6	Current signal Ir too low	0.66	●	◐	○	●
7	Current and/or voltage signal too high	5.33<>10	◕	◐	○	●
8	- Temperature too low or too high (heating conductor error), - Temperature monitoring, - Heating monitoring or - Temperature jump downwards or upwards	2.66	●	●	○	●
9	- Data error, stored calibration values do not match setting or - Communication monitoring	6.00<>10	◕	◕	○	●
	Calibration not possible because					
10	- Current signal Ir and voltage signal Ur are too low or too high, - R20 cannot be determined, - Reference R20 value monitoring, - Phase shift cannot be determined, - P-factor cannot be determined or - P-factor monitoring has triggered	8.00<>10	◐	◕	○	●
11	- Voltage signal Ur too low, too high or unstable	7.33<>10	◐	◐	○	●
12	- Current signal Ir too low, too high or unstable	6.66<>10	◐	◐	○	●
13	- Selected reference temperature is too high, - Temperature coefficient correction range exceeded or - Parameter error: continuity and dynamics of the selected temperature coefficients in relation to the temperature range.	8.66<>10	◐	◕	○	●

3.4.8. Error causes - Remedy: Table 2

No.	Error	Remedy and error areas [n]	
		At the installation	During operation
1	Device error	perform reset check controller [1]	
2	- Internal error, - Read-write error in the non-volatile memory,	perform reset check controller [1]	
	- “Start” signal during calibration or	→ 4.3.1.	
	- Heating time limit	→ 3.4.5.	
3	Power line error (under-/overvoltage or line frequency error)	check 120/240V mains voltage changeover (→ 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 [3]
5	Voltage signal Ur too low	check connection to voltage measurement Ur [4] perform calibration	check connection to voltage measurement Ur [4]
6	Current signal Ir too low	check connection to current measurement Ir [5] perform calibration	check connection to current measurement Ir [5]
7	Current and/or voltage signal too high	check heating conductor [6] perform calibration	check heating conductor [6]
8	- Temperature too low or too high (heating conductor error),	check heating conductor [6] perform calibration	check heating conductor [6]
	- Temperature monitoring,	→ 3.4.1.	
	- Heating monitoring or	→ 3.4.2.	
	- Temperature jump downwards or upwards	check heating conductor connection [7]	
9	- Data error, stored calibration values do not match setting or	perform calibration	
	- Communication monitoring	→ 5.4. (KOUE)	
	Calibration not possible because		
10	- Current signal Ir and voltage signal Ur are too low or too high,	check heating conductor connection [7] check dimensioning [8]	
	- R20 cannot be determined,	check dimensioning [8]	
	- Reference R20 value monitoring,	→ 3.4.6.	
	- Phase shift cannot be determined, - P-factor cannot be determined or	check dimensioning [8]	
	- P-factor monitoring has triggered	→ 3.4.4.	
11	- Voltage signal Ur too low, too high or unstable	check connection to voltage measurement Ur [4] check heating conductor [6] check dimensioning [8]	
12	- Current signal Ir too low, too high or unstable	check connection to current measurement Ir [5] check heating conductor [6] check dimensioning [8]	
13	- Selected reference temperature is too high,	→ 3.1.1.	
	- Temperature coefficient correction range exceeded or	→ 3.1.8 and 3.1.9.	
	- Parameter error: continuity and dynamics of the selected temperature coefficients in relation to the temperature range.	→ 3.1.1.	

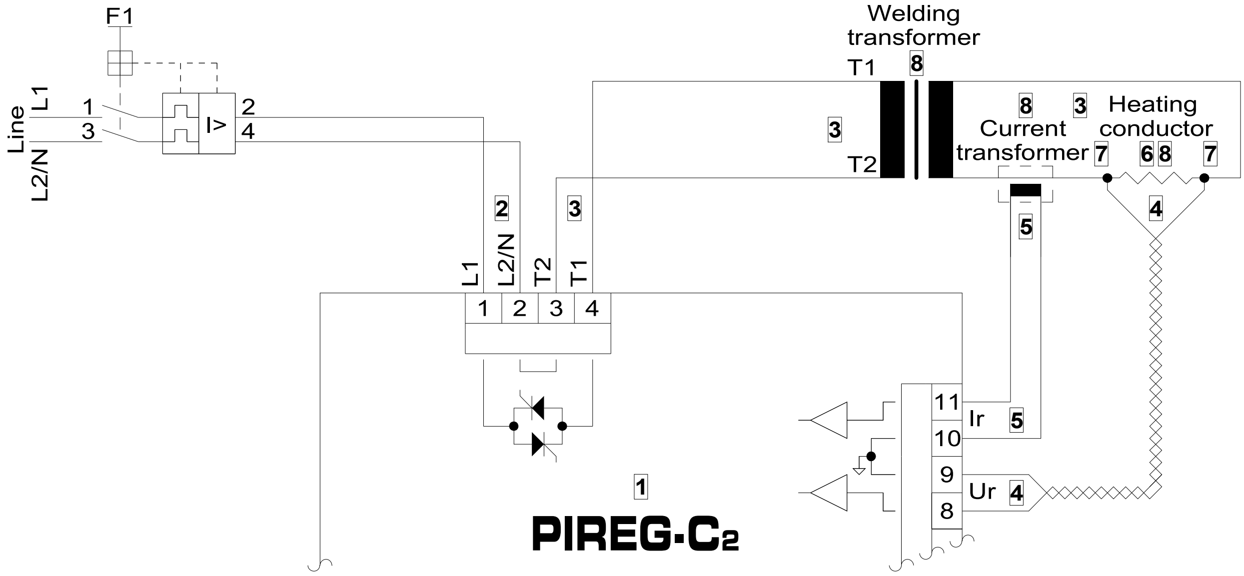


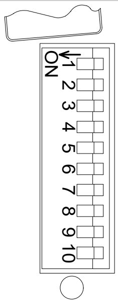
Figure 7: Error areas

3.4.9. Error memory: The PIREG-C2 has an error memory in which the last 100 error events are stored. The error memory can be read out by command (FESP) and cleared by command (FESL). The respective error event is stored together with the value of the operating hours counter at the time of the error, so it can be linked to a time.

4. Operation

The PIREG-C2 offers two means of operation. One is conventional operation with setpoint potentiometer or setpoint voltage, actual value instrument or actual voltage value, switches or digital signals, LEDs and DIP switches (factory setting). The other is extended operation via the RS232 (1), RS485 (2) and USB interfaces (3), with which the PIREG-C2 is equipped. Combinations of both types of operation are possible. When operating via an RS232, RS485 or USB interface, extended adjustments are possible, for instance freely selectable temperature coefficients and temperature ranges.

4.1. DIP switches



1: Ramp 1
2: Ramp 2
3: Tk 1
4: Tk 2
5: Verify Time
6: Temp.-Select
7: Calbr.-Select
8: Transformer-Select
9: Ref.-Temp.
10: Temp.-Correction

The controller settings are carried out on 10 DIP switches (→ Table 3). The PIREG-C2 automatically adapts to the Ur voltage and the Ir current of the heating conductor and to the P-factor (control amplification). DIP switches 3…10 must be set before starting the calibration. DIP switches 1 and 2 are read in when the PIREG-C2 is in the OFF state.
In the Reset state (→ 4.5.) further manual settings on the PIREG-C2 are possible using the DIP switches which are otherwise only possible by communication via the interfaces.

4.1.1. DIP switch settings: **Table 3**

Sw.	Function	Position		Assignment
1/2	Heating ramp	**2**	**1**	heating ramp of the heating conductor
		Off	Off	without heating ramp
		Off	On	2 s heating ramp
		On	Off	3 s heating ramp
		On	On	5 s heating ramp
3/4	Temperature coefficient	**4**	**3**	temperature coefficient of the heating conductor
		Off	Off	Tc1= 7.46×10^{-4} 1/K, Tc2= 0, Tc3=0 (Alloy L)
		Off	On	Tc1= 10.8×10^{-4} 1/K, Tc2= 0, Tc3=0 (Alloy A20)
		On	Off	Tc1= 48.3×10^{-4} 1/K, Tc2= -6.12×10^{-6} 1/K², Tc3= 2.80×10^{-9} 1/K³ (NOREX)
		On	On	Tc1= 8.62×10^{-4} 1/K, Tc2= 0, Tc3=0 (Alloy M)
5	Calibration comparison time	Off		15 s
		On		30 s
6	Temperature range	Off		0 - 300 °C, over-temperature 360 °C, under-temperature -10 °C
		On		0 - 500 °C, over-temperature 600 °C, under-temperature -10 °C
7	Calibration mode	Off		new calibration after reset or after switching on the power
		On		store calibration at the end of calibration
8	Transformer type	Off		welding transformer with EI or UI-iron core
		On		welding transformer with toroidal iron core
9	Reference temperature	Off		reference temperature 20 °C
		On		variable reference temperature 0 - 50 °C
10	8-point Tc correction	Off		without 8-point Tc correction
		On		with 8-point Tc correction
		On < 1 s		start single-point Tc correction

4.1.2. Switches 1/2, heating ramp: The time value during which the controller adjusts the actual temperature to the target temperature in a linear ramp is set at DIP switches 1 and 2. This allows the heating conductor to be heated gradually.

4.1.3. Switches 3/4, temperature coefficient setting: The temperature coefficient of the heating conductor used is set at DIP switches 3 and 4.

Caution (EN)**:** Using heating conductors with too low a temperature coefficient, or adjusting the controller to a temperature coefficient that is too high, can result in uncontrolled overheating or **melting** of the heating conductor.
Attention (FR)**:** Si un conducteur de chaleur est utilisé avec un petit coefficient de température ou qu'un coefficient de température trop grand est réglé sur le régulateur, les conducteurs de chaleur vont chauffer de manière incontrôlée et peuvent aller jusqu'à **fondre**.

The actual value can then not reach the target value and the controller continues to heat continuously. The setpoint voltage must be corrected for heating conductors with a different temperature coefficient or the single-point (→ 3.1.9.) or 8-point Tc correction (→ 3.1.8.) must be carried out.

Example: The temperature coefficient of the heating conductor is 4.3 x10^{-4} 1/K and it cannot be set directly with the DIP switches. The smallest Tc that can be set with DIP switches 3 and 4 is 7.46 x10^{-4} 1/K. Calculation: 7.46 / 4.3 = 100 % / X. This gives: nominal value X = 57%. The nominal value is not 10 V but rather only = 5.7 V for 300 °C with the 7.46 x10^{-4} 1/K setting. When the nominal value = 10 V, the controller would try to regulate the temperature at 526 °C instead of at 300 °C.
Using the interfaces, it is possible to set the temperature coefficient of the heating conductor exactly at the PIREG-C2 by commands (EIPA and KONF).

4.1.4. Switch 5, calibration comparison time: The temperature comparison time is set at DIP switch 5. During calibration, the resistance of the heating conductor is determined from the reference temperature after the input amplifier has been calibrated. To ensure that the reference resistance value determined is correct, the resistance of the heating conductor is measured again after the calibration comparison time has expired, and compared with the determined reference resistance measured previously. If the difference between both measurements is greater than 1.2% a new calibration process is started. This ensures that calibration of the PIREG-D does not take place during cooling of the heating conductor. By extending the calibration comparison time, changes in the resistance of the heating conductor during cooling can be detected more quickly.

4.1.5. Switch 6, temperature range: The working temperature range of the controller is set between 300 and 500 °C with DIP switch 6. The limits for the over- and under-temperatures apply, as defined by the DIP switch settings shown in table 3.

4.1.6. Switch 7, calibration type:
New calibration: If the calibration mode “new-calibration“ is chosen, the PIREG-D performs a calibration after every power-on or the signal “Reset”. The calibration values are not saved. Calibration can also be started in the OFF or error state with the signal “Calibration Start”.
Calibration storage: Calibration is only started with the signal “Calibration Start”. The signal “Calibration Start” can be applied in the OFF or error state or before power-on. The calibration values are stored in a non-volatile memory and cannot be deleted by a power on or the "Reset" signal. This means that a new calibration must be performed after the heating conductor configuration was changed or modifications were carried out on the transformer. The saved values are then overwritten with the newly determined values.

4.1.7. Switch 8, transformer type: The PIREG-C2 is adjusted to the transformer type with DIP switch 8. After power-on or "Reset" signal several unipolar phase controls are applied to the transformer so that the remanence in the iron core of the transformer is brought into a defined position. The angle of current flow of the phase angle control for remanence setting must be matched to the transformer type. The quick switch-on procedure is used for every sealing during which only a few remanence-pulses are applied to the transformer before it is switched on. If the pause between two sealing processes is longer than 10 minutes for toroidal core transformers the number of the remanence pulses of the quick switch-on procedure is doubled. The soft switch-on procedure is used for switching on high-quality transformers without power surges.

4.1.8. Switch 9, reference temperature: DIP switch 9 is used to determine whether calibration is performed with a fixed reference temperature of 20 °C or a variable reference temperature between 0 and 50 °C. The variable reference temperature can also be used to calibrate the heating conductor exactly when the temperature of the heating conductor differs greatly from 20 °C. If the temperature of the heating conductor is measured with a temperature sensor before the start of calibration, the influence of the ambient temperature during calibration can be completely excluded. The variable reference temperature must be preset in the PIREG-C2 as a nominal value prior to the start of calibration.
This can be done with a potentiometer, by the PLC or by an external temperature sensor at the target value input or via the interfaces by command (EIPA and KONF). If the reference temperature of +50 °C is exceeded, then an error message is displayed (error 13). The PIREG-C2 reads the variable reference temperature during the calibration initialisation (→ Figure 1). A nominal value of 50 °C corresponds to 1.66 V in the 300 °C range and 1.0 V in the 500 °C range.

4.1.9. Switch 10, 8-point Tc correction: DIP switch 10 can be used to activate the 8-point Tc correction. With this function, scattering of the heating conductor materials due to the alloys used can be corrected. For the correction process the heating conductor of the PIREG-C2 is automatically heated in eight temperature increments during calibration. The first temperature increment is always 50 °C. The temperature of the eighth temperature increment falls 20 % below the final value of the temperature range. The six other temperature increments are equidistant between these points.

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

At each step the actual temperature of the heating conductor is reported back to the PIREG-C2 as a target value or directly as a measured value of the external thermometer from outside. Each individual setting point is checked immediately when a maximum deviation of ±20 % is recorded (error 13). From these measurement points, the PIREG-C2 calculates seven regression lines in order to correct its actual value in relation to the actual temperature of the heating conductor.

Acknowledgement with voltage: for 300 °C with 10 V.
Acknowledgement with potentiometer: for 300 °C, set the potentiometer at 300 °C.

The correction procedure is controlled by the “Start” signal. The next temperature step is switched to with the rising edge of the signal (heat up) and the externally measured nominal temperature of the heating conductor is adopted by the controller with the falling edge. So that the heating conductor can adopt the temperature exactly after a jump in the nominal value, a dwell time of at least 30 s (system dependent) is needed following a heating phase.
If the external thermometer is used for temperature measurement of the heating conductor and the heating time of the temperature stages is preset, the PIREG-C2 can carry out the 8-point Tc correction automatically (→ 3.1.8.).
The temperature values determined by the PIREG-C2 during 8-point Tc correction can be read out by command (TKEI).

4.1.10. Switch 10, Single-point Tc correction: If in the OFF state the DIP switch 10 is switched in the ON position for less than one second, the PIREG-C2 will start the single-point Tc correction. The tolerances of the temperature coefficient of the heating conductor can thus be corrected for just one operating point. For this operating point the actual temperature of the heating conductor is reported back to the PIREG-C2 as actual value or directly as measured value of the external thermometer from outside. The single-point Tc correction is carried out outside the standard calibration and is started from the OFF state.
Single-point Tc correction has an OFF and an ON state. After start-up the PIREG-C2 is in the OFF state. When the PIREG-D is in the ON state, the heating conductor is heated to the temperature which was set as target value in the OFF state. A dwell time of at least 30 seconds (depending on the system) is required for the heating conductor to reach the temperature after the heating phase. The single-point Tc correction finishes upon exiting the ON state. The correction procedure is controlled by the “Start” signal. Deviations of up to ±20 % between the calculated actual value temperature and the actual temperature of the heating conductor can be corrected. The single-point Tc correction can only be performed if an 8-point Tc correction was not carried out during calibration. The single-point Tc correction is reset at each calibration.
The single-point Tc correction can be saved by command (STKA) so that it doesn't need to be repeated after a new calibration but only when the heating conductor is replaced.

4.2. LEDs

4.2.1. Power: The green Power LED indicates that the PIREG-C2 is connected to the line voltage.
After switching on or resetting, the mains LED flashes at 1Hz for 5s if interface control is selected for the temperature setpoint or setting control, see command KONF.

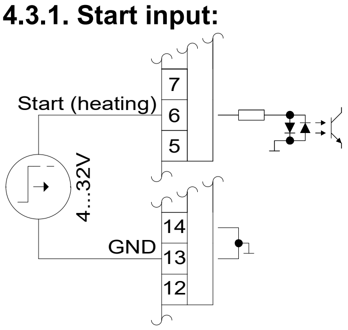
4.2.2. Heat: The yellow Heat LED is directly connected in parallel to the controller's actuator. The brightness of this LED is directly proportional to the energy in the heating conductor.

4.2.3. Calibration: The blue calibration LED lights continuously during calibration and is used for indicating errors. If there is a connection to the external thermometer during calibration or the single-point Tc correction, the LED will flash with 1 Hz.

4.2.4. Alarm: The red Alarm LED, together with the yellow calibration LED, indicates resistance temperature controller errors.

4.3. Inputs

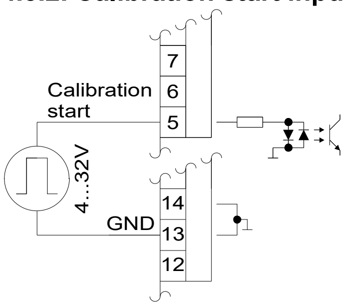
4.3.1. Start input:



The sealing process is initiated by applying a high signal to the start input (6). The controller begins to set the temperature of the heating conductor to the set value temperature and maintains this temperature constantly as long as a high signal is applied to the start input.
If 8-point Tc correction is selected with DIP switch 10 for calibration, the correction process is also controlled by the start input for manual operation. The single-point Tc correction is also controlled by the start input.

During calibration steps 1 to 7, the "Start" signal must not be given, because the PIREG-C2 will then abort the calibration with error 2.

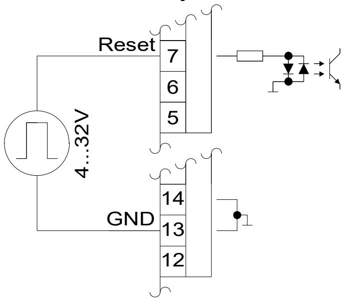
4.3.2. Calibration start input:



When a high signal is applied to the calibration start input (5) in the OFF or error state of the controller, it switches to the calibration state. Normally the controller is adapted to the sealing transformer/heating conductor combination. During calibration of the controller the signal can be switched back to Low.

The calibration start input can also be configured for pulse control by command (KONF). The single-point Tc correction can be started in this way in the OFF state when a high signal is applied to the calibration start input for less than one second. If the high signal is applied for more than one second, the PIREG-C2 switches in the calibration state.

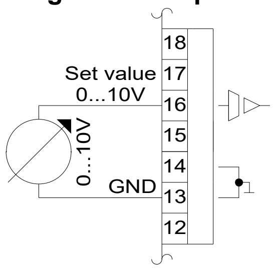
4.3.3. Reset input:



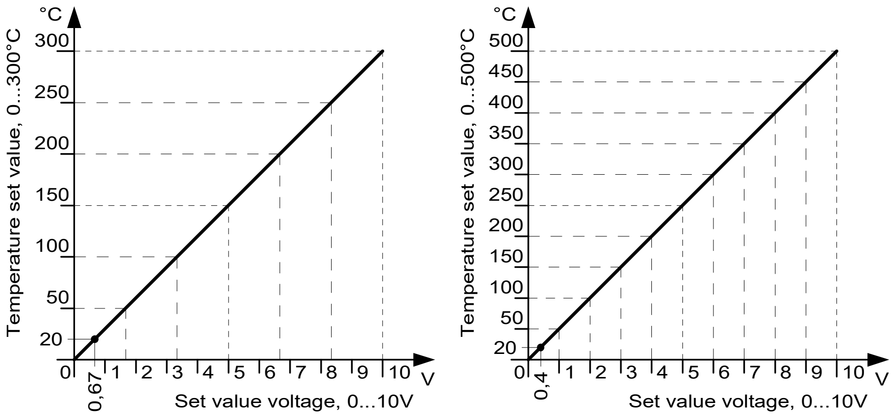
When a high signal is applied to the reset input (7), the PIREG-C2 is reset to the state after power-on. This allows you to leave the error state without switching off the mains voltage. It can also be used to cancel a calibration in progress.

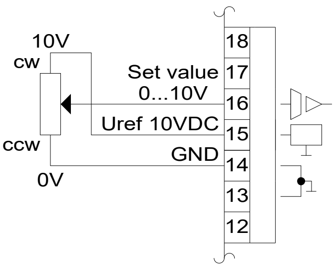
If the high signal is applied for more than 3 sec. to the Reset input, the PIREG-C2 is switched in the Reset state (→ 4.5.).

4.3.4. Target value input:



The temperature set value of the controller is applied to the target value input (16) with an analogue voltage. For a calibration with variable reference temperature, the reference temperature is applied to the target value input and for the 8-point and single-point Tc correction, the actual temperature of the heating conductor is applied. The voltage range of the target value input is 0 - 10 V. The selected temperature range applies to the maximum target voltage i.e. 10 V at the target value input correspond to 300 °C or 500 °C in the temperature range 300 °C or 500 °C.





A potentiometer can also be used for the setpoint, whose sliding contact is connected to the target value input, the CW connection to the Uref output (15) and the CCW connection to the corresponding GND connection (13 or 14). When connecting the setpoint potentiometer, pay attention to the direction of rotation of the potentiometer. The voltage at the target value input should increase when turning the setpoint potentiometer clockwise (CW).

4.4. Outputs

4.4.1. Uref output: The Uref output (15) provides a reference voltage of +10 V needed to obtain the set value using a potentiometer. Should the PIREG-C2 be operated without an additional power supply, the switches for the control inputs can also be connected to the Uref output. The Uref output can supply a maximum current of 20 mA.

4.4.2. Actual value output: The actual value output (17) supplies a voltage in the range 0 - 10 V, proportional to the temperature of the heating conductor. The voltage range relates to the selected temperature range. In other words, 10 V at the target value input corresponds to 300 °C or 500 °C. The actual value output can supply a current of max. 5 mA.

- Hold mode: When the Hold mode is activated by command (KONF), the temperature measured at the end of the sealing process is also displayed at the actual value output in the OFF state. You can select whether the measured temperature is only displayed for 2 seconds or until the following sealing process is started.

4.4.3. Alarm output: The alarm output (12/18) is a relay switching contact. A command (KONF) can be used to set whether the alarm output is opened or closed in the case of a fault. The factory setting of the relay contact is “closed” when a fault occurs. In the event of a power line error (error 3), it is set with a delay of 2 s, for all other errors immediately.
In addition, the SKONF command can be used to specify whether the alarm output should be set immediately in the event of an error or only after the sealing process has been performed. This way, a calibration error does not lead to a machine malfunction when switching on.

4.4.4. OK output: The OK output (21/22) is a relay switching contact. A command (KONF) can be used to set whether the OK output is opened or closed if the situation is OK. When supplied from the factory, the relay contact is closed in the OK case. The OK output has the following actuation functions, which can be specified by command (KONF):

- Calibration OK message: This is the factory setting. The OK output is reset during calibration. It is set again after a successful calibration. End of calibration is indicated with the calibration OK message. If the stored calibration values do not match the setting, the OK output is also reset.

- Temperature OK message: The OK output is activated if the actual value is within the temperature OK range. The temperature OK range and corresponding stabilising time are set by a specific command (TOKG).

- Combination of calibration and temperature OK message: This is the combination of the two functions above. This means that the calibration OK message is sent following a reset or a calibration process, and the temperature OK message is sent after the first "Start" signal.

- Temperature reached message: If the actual value reaches 95% of the setpoint temperature in the ON state, the OK output is activated. When leaving the ON state, the OK output is reset.

4.4.5. ELR output: The ELR output (19/20) controls an external solid-state relay which is used as actuator instead of the internal actuator of the controller. Combinations of heating conductor and sealing transformer which have a greater capacity than the maximum permissible capacity of the internal actuator can be switched with the external solid-state relay.

4.5. Reset state

In the Reset state manual settings at the PIREG-C2 are possible using the DIP switches which are otherwise only possible by communication via the interfaces.
Switch the DIP switches 1 to 3 in the OFF position and apply a high signal to the Reset input (7) for more than 3 seconds to set the PIREG-C2 in the Reset state. The PIREG-C2 indicates the Reset state by the mains LED (gn) which is off and the Calibration (bl) and Alarm LEDs (rd) which are on. When the signal is no longer applied to the Reset input without actuating one of the DIP switches 1 to 3, the PIREG-C2 exits the Reset state without any settings. If a DIP switch is switched in the ON position, the PIREG-C2 will perform the corresponding adjustment with subsequent reset. Then the mains LED lights again and the Calibration and Alarm LEDs are off

The following settings are possible in the Reset state:

4.5.1. Switch 1 Factory settings: When the DIP switch 1 is switched in the ON position in the Reset state, the PIREG-C2 will reset the factory settings (→ 5.4.40.).

4.5.2. Switch 2 P-factor correction: The P-factor correction is used for subsequent manual correction of the calibrated P-factor (→ 3.1.7.) in the case of very unfavourable conditions of the sealing transformer/heating conductor combinations or the public supply. The correction range is 30…250 % (from V1.01/1.09/1.07).
When the DIP switch 2 is switched in the ON position in the Reset state the PIREG-C2 will adopt the temperature set as the set value (1 °C corresponds to 1%) as the correction factor. As only the values zero, no P-factor correction and 30…250 % (from V1.01/1.09/1.07) are permitted as correction value of the P-factor correction, the setting will only be accepted and the reset state terminated if the set value is within the permissible range. In the Reset state the currently set correction value of the P-factor correction is indicated at the actual value output (1 °C corresponds to 1%). The P-factor correction can also be set by command (KPFK). The P-factor correction value will not be reset during a calibration as it is system dependent.

4.5.3. Switch 3 Heating time of the automatic temperature coefficient correction: When the DIP switch 3 is switched in the ON position in the Reset state the PIREG-C2 will adopt the value set at the DIP switches 6 to 10 (0…310 s in 10 second steps) as the heating time for the automatic temperature coefficient correction. The setting with the DIP switches 6 to 10 is binary coded, i.e. the DIP switches 6 to 10 have the following priority:

Switch 6 = 1	Switch 7 = 2	Switch 8 = 4	Switch 9 = 8	Switch 10 = 16

The heating time is calculated as follows: Priority of the DIP switches 6 to 10 x 10 s

5. Interface

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

5.1. Communication

5.1.1. RS232 and USB communication: The RS232 and the USB interfaces use the same command set, which consists of alphanumeric characters. This makes it easily understandable by the user. Every interface has a 64-byte data memory. The Baud rate can be set separately for each interface by command (BRAT). As a factory default setting, both interfaces have the following data format:

9600 Baud	1 start bit	8 data bits	1 stop bit	no parity

Protocol: ASCII characters are used for the communication telegrams. Both large and small letters may be used. The PIREG-C2 does not initiate any communication by itself to its communication partner, it behaves passively. The PIREG-C2 acknowledges every communication from its partner either with the response required or with the OK acknowledgement. There is an error acknowledgement in the event of defective communication. For its acknowledgements and responses, the PIREG-C2 only uses large letters.
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 blank space. The data to be transferred are transmitted with a constant width and, if necessary, with leading zeros. If several data are transmitted, they are separated by blank spaces.

5.1.2. Addressed RS232 communication: 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. In this way, a communication partner can communicate with up to three PIREG-C2 via an RS232 interface. The addressing of the RS232 communication is switched on and off by command (KOKO). The address of the RS232 communication is set by command (GADR) and is also used for RS485 communication. The space for addresses covers the 0 - 250 range. The factory setting is 0.

Protocol: The form described above is used for the telegrams of addressed RS232 communication. The address is placed before the command, the acknowledgement and the response and separated by a blank space. Three digits are always used for the address.

5.1.3. RS485 communication: The RS485 interface uses a binary command set to increase the rate of communication. The interface has a 64-byte data memory. The PIREG-C2 has an address for RS485 communication that can be set by a command (GADR). This address is also used for addressed RS232 communication. This addressing means that up to 31 PIREG-C2 can be operated on the same RS485 bus. The space for addresses covers the 0 - 250 range. The Baud rate can be set by command (BRAT). The address 0 is the factory setting and the interface has the following data format:

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

Protocol: The protocol used is based on DIN 19244. The PIREG-C2 does not initiate any communication by itself to the master in the bus system, it behaves passively. The PIREG-C2 responds with a minimum delay of 3 ms for a secure change of direction of the RS485 communication. The following telegram formats are used:

Short set: Short sets are sent from the master (on the calling side) to the PIREG-C2:
→ to transmit short commands to the PIREG-C2 (e.g. reset).
→ to quickly call up important data from the PIREG-C2.
Short sets are used (on the response side) by the PIREG-C2:
→ to acknowledge call ups that do not require any response data.

SZ	GA	FF	PS	EZ

Control set: Control sets are only used by the master on the call-up side. They are used to call up all the commands that cannot be called up by means of short sets because a more detailed specification is required for them. The control set has a fixed length (LG) of three.

SZ	LG	LG	SZ	GA	FF	BI	PS	EZ

Long set: Long sets are used:
→ to transfer commands with parameters to the PIREG-C2
→ to permit the master to take over data from the PIREG-C2.
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 character indicates the telegram (1 byte,)
→ Start character for short set: 10h
→ Start character for control set and long set: 68h

Device address GA: → 0- 250 range for the individual device addresses of the PIREG-C2. The address 0 is the factory setting.
→ 255, at this address, all the PIREG-C2s connected to a bus can be addressed at the same time. The data and commands transferred by this address are taken over by all the devices. There is no acknowledgement to the master, however.
The device address GA 255 is also acknowledged for the short set with the function field AAh in the call-up direction.

Function field FF: The function field includes
→ with short sets, the actual information, predefined bit by bit and differing in the call up or response direction.
→ with control and long sets, the directional and control information for the data block being transferred.

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

Call-up control:	Code:	Type of set:	Remark:
Reset device	09h	Short set	Only the codes specified are evaluated by the PIREG-C2, invalid codes are answered by an error acknowledgement.
Recognise device. The PIREG-C2 transmits an acknowledgement also in the case of the device address 255.	AAh		
Transmit data to PIREG-C2.	69h	Control and long set	
Querying data from PIREG-C2.	89h		

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

Bit no.	Function:	Value:	Assignment:
0…2	Reserved	000	Fixed assignment
3	Command lock	0	Command carried out, PIREG-C2 ready
		1	PIREG-C2 is not ready for this command
4	Command error	0	Command carried out
		1	The function key FF or the command index BI is unknown.
5	Transfer error	0	Call-up telegram is correct
		1	A parity defect has occurred or the checksum PS is defective.
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 carried out is specified by the command index. The PIREG-C2 acknowledges as errors all those command indices that are not assigned to a command.

Length LG: The length of the data block DB is variable and depends on the command index BI and the function field FF. The control set has a fixed length of three. With the long set, the length LG consists of the length of the data block plus three.

Data block DB: Data block DB may contain parameters and data from and to the PIREG-C2. Negative numbers are displayed as two's complements.

Checksum PS: With a short set, the checksum is the sum of the device address GA and function field FF without any overrun summation. With a control set, the checksum is the sum of the device address GA, function field FF and command index BI without any overrun summation. With a long set, the checksum is the sum of all the characters of the device address GA until the last character of the data block DB without any overrun summation.

Terminator EZ: The terminator is 16h, for all types of set.

5.1.4. RS232 communication with the external thermometer: The external thermometer, DTM3000 (from V1.01/1.16/1.10) or previous TM6, can be connected to the RS232 interface of the PIREG-C2 with a special connection cable. The thermometer TM6 is no longer available. The configuration is setting per command (KOKO). The communication is factory set to thermometer DTM3000. The PIREG-C2 tries to establish a connection with the external thermometer when the 8-point Tc correction is started during

calibration and when the single-point Tc correction is started. While the communication is being triggered, the PIREG-C2 sends the request telegram up to four times to the thermometer if it doesn't receive a valid reply before. The maximum communication setup time results from the transmission interval time. If communication cannot be established, the PIREG-C2 will reset the previous interface configuration.
The data format for the communication to the external thermometer is as follows:

	Request telegram	Transmission interval time	Maximum Communi-cation 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	

After the communication was established the PIREG-C2 continues to send the request telegram to the thermometer with the transmitting interval time. The communication to the thermometer is monitored. If three successive request telegrams are not answered or three successive answers are faulty, the PIREG-C2 switches in the error state with error 9.
The PIREG-C2 will terminate the communication with the thermometer and reset the previous interface configuration after the 8-point and the single point Tc correction correction are ended.

5.2. RS232 and USB interface acknowledgements

5.2.1. OK acknowledgement

Syntax: **Acknowledgement: QOK00**

Description: With this acknowledgement, PIREG-C2 acknowledges error-free communication during which no response is transmitted.

Example **Message:** QOK00

Reference: Error acknowledgements

5.2.2. Error 1 acknowledgement

Syntax: **Acknowledgement: QFE01**

Description: The PIREG-C2 sends this acknowledgement if the received command name is unknown to the controller.

Example **Message:** QFE01

Reference: OK acknowledgement

5.2.3. Error 2 acknowledgement

Syntax: **Acknowledgement: QFE02**

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

Example **Message:** QFE02

Reference: OK acknowledgement

5.2.4. Error 3 acknowledgement

Syntax: **Acknowledgement: QFE03**

Description: The PIREG-C2 transmits this acknowledgement if the telegram's activities have not yet been approved or if the code number entered is incorrect.

Example **Message:** QFE03

Reference: OK acknowledgement

5.2.5. Error 4 acknowledgement

Syntax: **Acknowledgement: QFE04**

Description: The PIREG-C2 transmits this acknowledgement if an error occurs when saving data to the EEPROM memory.

Example **Message:** QFE04

Reference: OK acknowledgement

5.3. RS485 interface acknowledgements

During communication via the RS485 interface, acknowledgement is identified through the function field FF in the response telegram.

5.3.1. OK acknowledgement

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

Description: The OK acknowledgement is given by setting the function field FF to 00h. This is done directly in the response telegram, either as a long or short set.

Example **Message:** 10 21 00 21 16 (short set, GA = 21h)

Reference: Error acknowledgements

5.3.2. Command lock

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

Description: The PIREG-C2 transmits this acknowledgement if the telegram's activities have not yet been approved or if the code number entered is incorrect.
In addition, the PIREG-C2 transmits this acknowledgement if an error occurs when saving data to the EEPROM memory.

Example **Message:** 10 21 08 29 16 (short set, GA = 21h)

Reference: OK acknowledgements

5.3.3. Command error

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

Description: The PIREG-C2 transmits this acknowledgement if the code of the function field FF or the command index BI is unknown to the controller.

Example **Message:** 10 21 10 31 16 (short set, GA = 21h)

Reference: OK acknowledgements

5.3.4. Transfer error

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

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

Example **Message:** 10 21 20 41 16 (short set, GA = 21h)

Reference: OK acknowledgements

5.3.5. Syntax or parameter error

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

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

Example **Message:** 10 21 80 A1 16 (short set, GA = 21h)

Reference: OK acknowledgements

5.4. Interface commands

Reading (S...) and writing (L...) commands are available for setting the parameters and for operating and controlling the PIREG-C2. The controller parameters can be set and sealing processes controlled with these commands. The factory settings can be reset with a command (WESE) or manually (→ 4.5.).
At the RS232 and USB interfaces, each telegram of a command begins with the character "S" or "L", depending on the type of command. The response telegrams to read commands begin with the character "A", followed by the name of the command. The response times for read commands are between typically 0.5 ms and a maximum of 1 ms, if nothing else is indicated. The data in the response telegrams are separated by blank spaces.
In addressed RS232 communication, each telegram starts with the address, which consists of three digits, and is separated by a space from the telegram structure of a command, an acknowledgement or an answer described above.
For the RS485 interface, the command for writing is identified with 69h and for reading with 89h in the functional field FF. In the following examples, 21h is used for the controller's device address (GA). The terminator of each telegram at the RS485 interface is 16h.
The limits of the input values are monitored.

Command overview

L	S	Com.	Description	BI	Item
X	X	**AHUE**	Setting and querying the settings of the heating monitoring	0Bh	**5.4.1.**
X	X	**BRAT**	Setting and querying the baud rate of the interface	0Ah	**5.4.2.**
X		**BSTZ**	Querying the status of the operating hours counter	6Fh	**5.4.3.**
X		**DIPS**	Querying the settings of the DIP switches	01h	**5.4.4.**
X	X	**EINS**	Setting and querying the setting switches of the PIREG-C2	02h	**5.4.5.**
X	X	**EIPA**	Setting and querying the setting parameters reference temperature, temperature range and temperature coefficients	03h	**5.4.6.**
X	X	**FEKO**	Setting and querying of the settings of the error configuration of the controller	14h	**5.4.7.**
	X	**FESL**	Clear the contents of the error memory	6Ch	**5.4.8.**
X		**FESP**	Read out the contents of the error memory	76h	**5.4.9.**
X		**FEZU**	Querying the error state	33h	**5.4.10.**
X	X	**GADR**	Setting and querying the device address GA of the addressed RS232 and RS485 communication	07h	**5.4.11.**
X		**GTYP**	Querying the device type of the PIREG-C2 controller	6Bh	**5.4.12.**
X		**GWPA**	Querying the selected parameters to be used for the next calibration	04h	**5.4.13.**
X	X	**HZBG**	Setting and querying the set maximum heating time	70h	**5.4.14.**
X		**ISTW**	Querying the current actual temperature value	34h	**5.4.15.**
X	X	**KANR**	Setting and querying the calibration number (1…8) of the active calibration.	3Ch	**5.4.16.**
X		**KAPA**	Querying the parameters of the current active calibration	05h	**5.4.17.**
X		**KAPK**	Querying the parameters of the calibrated calibration (1...8)	13h	**5.4.18.**
X	X	**KASR**	Setting and querying the calibration parameter modulation reserve	10h	**5.4.19.**
X	X	**KOKO**	Setting and querying the communication configuration of the controller	11h	**5.4.20.**
X	X	**KONF**	Setting and querying the configuration of the PIREG-C2	06h	**5.4.21.**
X	X	**KOUE**	Setting and querying the settings of the communication monitoring	0Dh	**5.4.22.**
X	X	**KPFK**	Setting and querying the P-factor correction value	0Fh	**5.4.23.**
X	X	**KTKZ**	Setting and querying the heating time for the automatic execution of the Tc correction	0Eh	**5.4.24.**
X	X	**MEPA**	Setting and querying the state of the measurement pulse-pause	3Dh	**5.4.25.**
X	X	**PFUE**	Setting and querying the parameter of the P-factor monitoring	12h	**5.4.26.**
X	X	**RHZL**	Setting and querying the reference resistance R20 of the heating conductor	80h	**5.4.27.**
X	X	**RRUE**	Setting and querying the parameters of the reference R20 value monitoring	15h	**5.4.28.**
X	X	**SOLW**	Setting and querying the temperature setpoint	35h	**5.4.29.**
X		**STEU**	Querying the states of the manual and interface control inputs	36h	**5.4.30.**
	X	**STKA**	Setting the control states for calibration	38h	**5.4.31.**
	X	**STRS**	Setting of the reset	39h	**5.4.32.**
	X	**STST**	Setting of the signal start	3Ah	**5.4.33.**
X		**TKEI**	Read out the settings of the 8-point Tc correction of the current calibration	72h	**5.4.34.**
X		**TKEK**	Read out the settings of the 8-point Tc correction of the of the calibrated calibration (1...8)	73h	**5.4.35.**
X	X	**TOKG**	Setting and querying the temperature limits and the stabilisation time of the temperature OK message	08h	**5.4.36.**
X	X	**TUEE**	Setting and reading the parameter of the temperature monitoring	09h	**5.4.37.**
X		**UIMW**	Querying the samples of Ur and Uir and calculated of the effective values of Ur and Uir	71h	**5.4.38.**
X		**VERS**	Querying the device and both program version of the PIREG-C2 controller	69h	**5.4.39.**
	X	**WESE**	Setting the factory settings	0Ch	**5.4.40.**
X		**ZPFA**	Reading the values of the time log function OFF state	78h	**5.4.41.**
X		**ZPFE**	Reading the values of the time log function ON state	79h	**5.4.42.**
X		**ZUST**	Querying the state of the PIREG-C2	37h	**5.4.43.**
X	X	**ZYKL**	Reset and querying the sealing cycles counter	6Eh	**5.4.44.**

Shortcuts: L: Read command; BI: Command index to RS485 interface; S: Write command

5.4.1. 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 max. 6 ms	
	Release:	not in the 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
Release: not in the On or calibration state

Description: Setting and querying the settings of the heating monitoring. The heating monitoring is a monitoring function with two variants. In variant 1, a maximum time is monitored in which the heating must be carried out. In variant 2, a time range is monitored within which the heating must take place.
With “a” the monitoring function is activated (a=1) and deactivated (a=0). A temperature OK range around the nominal value is set with lower limit "uuu" (5…99K) and upper limit "ooo" (5…99 K) 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 expired in 0.1 s (0 ... 99.9s). In variant 2, the actual value must have reached the temperature OK range within the time window "sss" in 0.1 s (0...99.8s) until "eee" in 0.1 s (0.1...99.9s). Otherwise the PIREG-C2 switches to the error state (error 8).
Monitoring of the heating time is restarted if the set value increases by more than 5°C.

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

5.4.2. 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
Release: not in the 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
Release: not in the On or calibration state

Description: Setting and querying the baud rate "bbbb", in 0.1 kBaud, and the interface with number "n" (1=RS232, 2=RS485 and 3=USB). The following baud rate values are valid: 9.6 kBaud, 19.2 kBaud, 38.4 kBaud, 57.6 kBaud and 115.2 kBaud.
The acknowledgement is already transmitted 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: --

5.4.3. 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: Querying the status of the operating hours counter in hours "hhhhhhhh" (0...999999), minutes "mm" (0...59) and seconds "ss" (0...59). The time units are separated by 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

5.4.4. DIPS command

Syntax RS232/USB:	**Read:**	**LDIPS**
	Response:	**ADIPS abcd efgh**
Syntax: RS485:	**Read:**	**Control set, BI = 01h**
	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	g	f	e	d	c	b1	b0	a1	a0

Description: Querying the setting of the DIP switches of the PIREG-C2. The DIP switches have the same function as the setting switches. The KONF command is used to select whether the DIP switches or the setting switches are to be used.

Assignment

a Heating ramp of the heating conductor:
0 (S2=Off/S1=On) = without 1 (S2=Off/S1=On) = 2 s
2 (S2=On/S1=Off) = 3 s 3 (S2=On/S1=On) = 5 s

b Temperature coefficient of the heating conductor:
0 (S4=Off/S3=Off) = Tk1= 7.46x10^{-4} 1/K, Tk2= 0, Tk3=0 (Alloy L)
1 (S4=Off/S3=On) = Tk1= 10.8x10^{-4} 1/K, Tk2= 0, Tk3=0 (Alloy A20)
2 (S4=On/S3=Off) = Tk1= 48.3x10^{-4} 1/K, Tk2= -6.12x10^{-6} 1/K²,
Tk3= 2.80x10^{-9} 1/K³ (NOREX)
3 (S4=On/S3=On) = Tk1= 8.62x10^{-4} 1/K, Tk2= 0, Tk3=0 (Alloy M)

c Calibration comparison time:
0 (S5=Off) = 15 s 1 (S5=On) = 30 s

d Temperature range:
0 (S6=Off) = 0...300 °C 1 (S6=On) = 0...500 °C

e Calibration type:
0 (S7=Off) = new calibration with power on or reset
1 (S7=On) = store calibration

f Transformer type:
0 (S8=Off) = sealing transformer with EI or UI-iron core
1 (S8=On) = sealing transformer with toroidal iron core

g Reference temperature:
0 (S9=Off) = reference temperature 20 °C for calibration
1 (S9=On) = variable reference temperature 0 - 50 °C for calibration

h 8-point Tc correction:
0 (S10=Off) = without 8-point Tc correction
1 (S10=Off) = with 8-point Tc correction

Example RS232/USB:	**Read:**	LDIPS	
	Response:	ADIPS 0010 1000	
Example RS485:	**Read:**	68 03 03 68 21 89 01 AB 16	(GA=21h)
	Response:	68 05 05 68 21 00 01 50 00 72 16	

Reference: EINS, KONF, EIPA

5.4.5. 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 the 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
Release: not in the On or calibration state

Description:	Setting and querying the setting switches of the PIREG-C2. The setting switches have the same function as the ten DIP switches on the PIREG-C2 without bus system. The KONF command is used to select whether the DIP switches or the setting switches are to be 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= Tc1= $7.46x10^{-4}$ 1/K, Tc2= 0, Tc3=0 (Alloy L)
1= Tc1= $10.8x10^{-4}$ 1/K, Tc2= 0, Tc3=0 (Alloy A20)
2= Tc1= $48.3x10^{-4}$ 1/K, Tc2= $-6.12x10^{-6}$ 1/K², Tc3=$2.80x10^{-9}$ 1/K³ (NOREX)
3= Tc1= $8.62x10^{-4}$ 1/K, Tc2= 0, Tc3=0 (Alloy M)
4= Setting with SEIPA TK command
5= Tc1= $12.65x10^{-4}$ 1/K, Tc2= 0, Tc3= $-0.70 x10^{-9}$ 1/K³ (Alloy A20C)
6= Tc1= $12.55x10^{-4}$ 1/K, Tc2= 0, Tc3= 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= Setting with SEIPA TB command
e	**Calibration type:**	0= new calibration after a power on or reset 1= calibration storage
f	**Transformer type:**	0= sealing transformer with EI or UI-iron core 1= sealing transformer with toroidal iron core
g	**Reference temperature:**	0= reference temp. 20 °C for calibration 1 = variable reference temperature 0 - 50 °C for calibration 2= setting with SEIPA BT command
h	**8-point Tc correction:**	0= without 8-point Tc correction 1= with 8-point Tc 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		

5.4.6. 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 the 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	
	Release:	not in the 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 coefficients
	Response:	**AEIPA TK sss ddd**	; response time max. 26 ms
	Release:	not in the 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 coefficients

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 coefficients, 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

Release: not in the On or calibration state

Write: Set temperature coefficients, 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**

Response time max. 26 ms

DB4	DB3	DB2	DB1	DB0
H byte	L byte	H byte	L byte	index
ddd		sss		xx

Release: not in the On or calibration state

Description: The command has the function of setting and querying the following setting parameters, which are stored and released by the EINS command:

Reference temperature BT:

Setting and querying the reference temperature "ttt" (0...50) in 1 °C for performing the calibration.

Temperature range TB:

Setting and querying the parameter only 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 over-temperature limit is always 20 % higher than the upper limit of the temperature range. The value for the under-temperature limit is set at -10 °C.

Temperature coefficient TK:

Setting and querying the three coefficients of the heating conductor:

- Tc1= „±aaaa" in $0.01x10^{-4}$ 1/K (+300…+9999)
- Tc2= „±bbbb" in $0.01x10^{-6}$ $1/K^2$ (-9999…+9999)
- Tc3= „±cccc" in $0.01x10^{-9}$ $1/K^3$ (-9999…+9999)

At the same time, the PIREG-C2 also checks the progress of the resistance, given by the stored temperature coefficients, for continuity and dynamics in the -20 …+600 °C temperature range. As a response, the PIREG-C2 provides the temperature range "sss" for continuity and "ddd" for dynamics in °C. The temperature range of the PIREG-C2 must be smaller or, at most, only be equal to the limit temperatures for continuity 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

5.4.7. 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
	Release:	not in the On or calibration state

Syntax: **Read RS485:** **Control set, BI = 14h**

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: OK or error acknowledgement; response time max. 6 ms
Release: not in the On or calibration state

Description: Setting and querying of the settings of the error configuration of the PIREG-C2 controller. With the error configuration the following error messages can be activated and deactivated at the PIREG-C2. (from V1.01/1.06/1.06)

Assignment

a	**Temperature jump:**	0= active	1= deactivated
b	not assigned		
c	not assigned		
d	not assigned		
e	not assigned		
f	not assigned		
g	not assigned		
h	not assigned		

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

5.4.8. FESL command

Syntax RS232/USB: **Write: SFESL z**
Response: OK or error acknowledgement; response time max. 225 ms
Release: not in the 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
Release: not in the On or calibration state

Description: Clear the contents of the error memory with the status z=1. The PIREG-C2 stores the last 100 error events. After deletion, all values of 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

5.4.9. 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 downward compatibility, bit "c2" of parameter "C" is in data byte DB8 as bit 4 and bits "d2" and "d3" of parameter "D" are in data byte DB8 as bits 5 and 6. (see FEZU command)

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: Read 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. All values are zero for unoccupied memory locations. The output is in 100 lines. The error with the number 1 is the newest error event. The error with the number 100 is the oldest error event.
In RS485 communication, the hundred long sets of the response are sent one after the other with a pause of 3ms each.

Assignment

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

a **Hardware error:** 0= Ok 1= error
b **Power line error:** 0= Ok 1= undervoltage
2= overvoltage 3= line frequency error
c **Data error:** 0= Ok
1= Calibration values do not suit the setting
2= Read/write error in 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 temp.:** 0= Ok 1= too small 2= too large
with temperature monitoring: 3= too small 4= too large
with heating monitoring: 5= heating time exceeded
6= heating time fallen below
Temperature jump: 7= downwards 8= upwards

h	**Calibration error:**	0= Ok 1= Parameter error 2= Voltage or current signal defective (see above) 3= Error in determining the phase shift 4= R20 can not be determined or Reference R20 value monitoring (from V1.01/1.09/1.06) 5= Error in determining the P-factor or P-factor monitoring 6= The selected reference temperature is too high 7= Range of temperature coefficient correction exceeded 8= Start signal during calibration 9= Data error on 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

5.4.10. FEZU command

Syntax RS232/USB:
Read: **LFEZU**
Response: **AFEZU abcd efgh**

Syntax: RS485:
Read: **Control set, BI = 33h**
Response: **Long set with DB0…DB2**
Note: For reasons of downward compatibility, bit "c2" of parameter "C" is in data byte DB2 as bit 4 and bits "d2" and "d3" of parameter "D" are 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: Querying the error state of the PIREG-C2.

Assignment

a	**Hardware error:**	0= Ok 1= error 2= undervoltage bus system supply 3= overvoltage bus system supply
b	**Power line error:**	0= Ok 1= undervoltage 2= overvoltage 3= line frequency error
c	**Data error:**	0= Ok 1= Calibration values do not suit the setting 2= Read/write error in 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 temp.:**	0= Ok 1= too small 2= too large
	with temperature monitoring:	3= too small 4= too large
	with heating monitoring:	5= heating time exceeded 6= heating time fallen below
	Temperature jump:	7= downwards 8= upwards

h	**Calibration error:** 0= Ok 1= Parameter error 2= Voltage or current signal defective (see above) 3= Error in determining the phase shift 4= R20 can not be determined or Reference R20 value monitoring (from V1.01/1.09/1.06) 5= Error in determining the P-factor or P-factor monitoring 6= The selected reference temperature is too high 7= Range of temperature coefficient correction exceeded 8= Start signal during calibration 9= Data error on access	

Example RS232/USB:
Read: LFEZU
Response: 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

5.4.11. GADR command

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

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

DB0
Addr.
aaa

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

DB0
Addr.
aaa

Response: short set, OK or error acknowledgement; response time max. 6 ms
Release: not in the On or calibration state

Description: Setting and querying the device address GA "aaa" (0...250) of the addressed RS232 and RS485 communication. The factory setting is "000". If the device address is changed, the acknowledgement is still made 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

5.4.12. 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: Querying the device type "ttt" (line voltage,...) 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

5.4.13. 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: Querying the following parameters to be used for the next calibration of the PIREG-C2:
- Settings "defg" (see below)
- Reference temperature "bbb" (0...50) in 1 °C
- Temperature range "ttt" (100...500) in 1 °C
- Temp. coeffic. of the heating conductor Tc1 "±aaaa" (+300…+9999) in $0.01x10^{-4}$ 1/K
- Temp. coeffic. of the heating conductor Tc2 "±bbbb" (-9999…+9999) in $0.01x10^{-6}$ $1/K^2$
- Temp. coeffic. of the heating conductor Tc3 "±cccc" (-9999…+9999) in $0.01x10^{-9}$ $1/K^3$

If the variable reference temperature is selected for calibration, the actual target value is output for the reference temperature "bbb". If the target value is greater than 50°C, the value "999" is output.

Assignment Settings:

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

e **Calibration type:** 0= new calibration after a power on or reset
1= calibration storage

f **Transformer type:** 0= sealing transformer with EI or UI-iron core
1= sealing transformer with toroidal iron 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

5.4.14. HZBG command

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

Description: Setting and querying the 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 ON state, the PIREG-C2 goes to error state with error 2 and stops 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

5.4.15. 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: Querying the current actual temperature value "iii" in °C of the PIREG-C2. The actual value "iii" is limited to a maximum of 999 and negative actual values are set to 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: --

5.4.16. KANR command

Syntax RS232/USB:	**Read:**	**LKANR**
	Response:	**AKANR n**
	Write:	**SKANR n**
	Response:	OK or error acknowledgement; response time max. 1 ms
	Release:	not in the On or calibration state

Syntax: RS485:	**Read:**	**Control set, BI = 3Ch**
	Response:	**Long set with DB0**

DB0
n

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

DB0
n

	Response:	short set, OK or error acknowledgement; response time max. 1 ms
	Release:	not in the On or calibration state

Description: Setting and querying the calibration number "n" (1...8) of the active calibration. With the calibration number, the associated calibration is activated for use and any running measurement pulse-pause is terminated.
If the calibration mode "New calibration after a power on or reset" is selected, the PIREG-C2 always performs a calibration after the calibration switchover.
Calibration 1 is always active after power on or reset.

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: --

5.4.17. 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: Querying the following parameters of the current active calibration (1...8) of the PIREG-C2:
- Settings "defg" (see below)
- Reference temperature "bbb" (0...50, 255 with variable reference temperature) in 1 °C
- Temperature range "ttt" (100...500) in 1 °C
- Temp. coeffic. of the heating conductor Tc1 "±aaaa" (+300…+9999) in $0.01x10^{-4}$ 1/K
- Temp. coeffic. of the heating conductor Tc2 "±bbbb" (-9999…+9999) in $0.01x10^{-6}$ $1/K^2$
- Temp. coeffic. of the heating conductor Tc3 "±cccc" (-9999…+9999) in $0.01x10^{-9}$ $1/K^3$

Assignment Settings:

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

e **Calibration type:** 0= new calibration after a power on or reset
1= calibration storage

f **Transformer type:** 0= sealing transformer with EI or UI-iron core
1= sealing transformer with toroidal iron 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

5.4.18. 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:	Querying the following parameters of the calibrated calibration (1...8) of the PIREG-C2 controller: **-** Settings "defg" (see below) - Reference temperature "bbb" (0...50, 255 with variable reference temperature) in 1 °C - Temperature range "ttt" (100...500) in 1 °C - Temp. coeffic. of the heating conductor Tc1 "±aaaa" (+300…+9999) in $0.01x10^{-4}$ 1/K - Temp. coeffic. of the heating conductor Tc2 "±bbbb" (-9999…+9999) in $0.01x10^{-6}$ $1/K^2$ - Temp. coeffic. of the heating conductor Tc3 "±cccc" (-9999…+9999) in $0.01x10^{-9}$ $1/K^3$ - Modulation reserve "rrr" (000= auto modulation reserve, 20...100 %) in 1 % - Heating time for automatic Tc correction "zzz" (0...999 s) in 1 s - P-factor correction value "ppp" in % (0, 30…250 % (from V1.01/1.09/1.07)) If the heating time "zzz" is equal to zero, the Tc correction is controlled via the start input. If the P-factor correction value "ppp" is equal to zero, the controller operates with the calibrated P-factor.		

Assignment Settings:

d	**Calibration comparison time:**	0= 15 s	1= 30 s
e	**Calibration type:**	0= new calibration after a power on or reset 1= calibration storage	
f	**Transformer type:**	0= sealing transformer with EI or UI-iron core 1= sealing transformer with toroidal iron 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

5.4.19. KASR command

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

Description: Setting and querying the calibration parameter 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" leads to error 9 and a new calibration must be carried out. When reading, the calibrated modulation reserve "kkk" in % (20...100%) of the current active calibration is also output.
When determining the automatic modulation reserve (rrr=000), the controller independently determines the necessary modulation reserve during calibration.

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

5.4.20. 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
	Release:	not in the On or calibration state

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

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 = 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

Release: not in the On or calibration state

Description: Setting and querying the communication configuration of the PIREG-C2 controller. The communication configuration is used to make the following additional settings for the RS232, RS485 and USB interfaces and the respective communication:

Assignment			
a	**Addressed RS232 communication:**	0= Off	1= On
b	**Communication external thermometer:** (from V1.01/1.16/1.10)	0= Off	1= On
c	**Communication external thermometer type:** (from V1.01/1.16/1.10)	0= DTM3000	1= TM6
d	not assigned		
e	not assigned		
f	not assigned		
g	not assigned		
h	not assigned		

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

5.4.21. 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 the On or calibration state

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

RS485: 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

Release: not in the On or calibration state

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

Assignment

a **Temperature nominal value control:**
0= Manual control via nominal value input (0…10 V)
1= interface control via RS232, RS485 or USB interface

b **Setting control:**
0= Manual setting via DIP switches
1= Interface control with EINS command

c **Activation of the alarm output**
0= Alarm output is only set in the event of a malfunction following initial heating
1= Alarm output is immediately set in event of a malfunction

d **Alarm output switching type:**
0= relay point closed during alarm
1= relay point open during alarm

e **OK output activation:**
0= Calibration OK message
1= Temperature OK message
2= Combination of calibration and temperature OK message. The calibration OK message is sent following a reset or a calibration process, and the temperature OK message is sent after the first "Start" signal.
3= Temperature reached message.

f **OK output switching type:**
0= relay point closed during OK
1= relay point open during OK

g **Pulse control of the calibration start input**
0= no pulse control
1= with pulse control for single-point Tc correction

h **Actual value output feature**
0= Actual value output (0…10V)
1= 10V reference voltage source
0= Hold mode, actual value output (0…10V)
0= 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

5.4.22. 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
	Release:	not in the 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
Release: not in the On or calibration state

Description: Setting and querying the state of the activation “a” (0=off, 1=on) and the set downtime “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)
The PIREG-C2 controller switches to an error state (error 9) if the communication monitoring is activated and there is no communication via the interface for a time longer than the set downtime.

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

5.4.23. KPFK command

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

Description: Setting and querying the P-factor correction value "ppp" in % (0, 30... 250 % (from V1.01/1.09/1.07)) for the current active calibration (1...8). The calibrated P-factor of the controller is adjusted in percent using the P-factor correction value: If the P-factor correction value is equal to zero, the controller will be running 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

5.4.24. KTKZ command

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

Description: Setting and querying the heating time "ttt" in 1s (0...999s) for the automatic execution of the 8-point Tc correction during calibration and the single-point Tc correction using the external thermometer. After the heating time has elapsed, the PIREG-C2 moves to the next temperature step in the 8-point Tc correction or ends the single-point Tc correction. If the heating time is equal to zero, the temperature coefficient corrections are controlled via the start input.

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

5.4.25. MEPA command

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

Description: Setting and querying the state of "z" (0 or 1) of the measurement pulse-pause. With state z=1, the measurement pulse-pause is activated. If the measurement pulse-pause is activated, the controller stops sending measurement pulses to the sealing transformer.
With the start of a sealing process, a calibration or a reset, the measurement pulse-pause is automatically terminated.
With device type x02, the measurement pulse-pause is also automatically terminated when the calibration is changed.

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

5.4.26. 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
- Release: not in the 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
- Release: not in the On or calibration state

Description: Setting and reading the parameter of the P-factor monitoring. The P-factor monitoring is a monitoring function that can be switched on with "a" (a=1) and switched off (a=0). The lower limit "uuu" (1…100) and the upper limit "ooo" (1…100) are used to define an OK range for the P-factor of the controller determined during the calibration. If the P-factor of the controller is outside the OK range, the PIREG-C2 controller switches to the error state (error 10).
During reading, the calibrated P-factor "ppp" of the current active calibration (1...8) of the controller is additionally returned.

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

5.4.27. 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
- Release: not in the 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
- Release: not in the On or calibration state

Description:	Setting and querying the reference resistance R20 of the heating conductor as a resistance value, R20 value, in ohms. Via the calibrated voltage (Vu) and current (Vi) amplification of the PIREG-C2, the standardised reference resistance R20 is converted into the real resistance value, R20 value, in ohms. The tolerances of the amplifiers are included in the R20 value. (from V1.01/1.09/1.06) In addition to the R20 value of the last executed calibration process, a reference value of the R20 value, e.g. of a new heating conductor after the heating conductor has been changed, can also be stored and read for each calibration (1...8). The following parameters are used for the command: - Number of the calibration "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 0.01Ω (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		

5.4.28. RRUE Befehl

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
	Release:	not in the On or calibration state
Syntax: RS485:	**Read:**	**Control set, BI = 15h**
	Response:	**Long set with DB0…DB2**

DB2	DB1	DB0
ooo	uuu	a

	Write:	**Long set with DB0…DB2, BI = 15h**

DB2	DB1	DB0
ooo	uuu	a

	Response:	Short set, OK or error acknowledgement; response time max. 6 ms
	Release:	not in the On or calibration state
Description:	Setting and reading the parameters of the reference R20 value monitoring. The reference R20 value monitoring is a monitoring function that can be switched on with "a" (a=1) and off (a=0). With the downward deviation "uuu" in % (5...100) and the upward 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 the error state (error 10). (from V1.01/1.09/1.06) The reference R20 value monitoring is only carried out if the reference R20 value is defined by command (RHZL) for the respective calibration.	

Example RS232/USB:	**Read:**	LPRUE	
	Response:	ARRUE 1 010 010	
	Write:	SRRUE 1 005 005	
	Response:	QOK00	
Example 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		

5.4.29. SOLW command

Syntax RS232/USB:	**Read:**	**LSOLW**
	Response:	**ASOLW sss**
	Write:	**SSOLW sss**
	Response:	OK or error acknowledgement; response time max. 1 ms
	Release:	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 = 02h**

DB1	DB0
H byte	L byte
sss	

Response: short set, OK or error acknowledgement; response time max. 1 ms
Release: in all states

Description: Setting and querying the temperature setpoint "sss" in °C of the PIREG-C2. Depending on the selected configuration of the PIREG-C2, either the voltage at the setpoint input or the setpoint specified with this command is used as setpoint. This command is only effective if the setpoint is controlled via the interfaces with the SKONF command. The nominal temperature "sss" is monitored at the height 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

5.4.30. 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: Querying the states of the manual control inputs "abc" and the control states via the PIREG-C2's "def" interface.

Assignment

a	**Manual start input:**	0= not actuated	1= actuated
b	**Manual calibration input:**	0= not actuated	1= actuated
c	**Manual reset input:**	0= not actuated	1= actuated
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

5.4.31. STKA command

Syntax RS232/USB:	**Write:**	**SSTKA z**
	Response:	OK or error acknowledgement; response time max. 1 ms
	Release:	in all states (effective only in the OFF state)
Syntax: RS485:	**Write:**	**Long set with DB0, BI = 38h**
	Response:	short set, OK or error acknowledgement; response time max. 1 ms
	Release:	in all states (effective only in the OFF state)

DB0
z

Description: Setting the following control states for calibration:

Assignment	
0	**Home position:** Calibration and single-point Tc correction are started from the home position.
1	**Calibration control state:** Calibration of the controller (provided it is switched off or in an error state) is started when z= 1 is set. Before calibration can be restarted the state must be reset. The calibration control state is functionally connected in parallel to the calibration input.
2	**Single-point Tc correction:** Single-point Tc correction is set with z= 2. The state is retained until it is reset. The single-point Tc correction can only be set when the 8-point Tc correction is not activated.
3	**Saving Tc correction:** The current 8-point or single-point Tc correction is saved with z= 3 so that it is retained after a calibration. After this action was carried out the device returns to the previous state.
4	**Cancelling saving the Tc correction:** Saving the Tc corrections is cancelled with z= 4. After this action was carried out the device returns to 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		

5.4.32. STRS command

Syntax RS232/USB:	**Write:**	**SSTRS z**
	Response:	OK or error acknowledgement; response time max. 1 ms
	Release:	in all states
Syntax: RS485:	**Write:**	**Long set with DB0, BI = 39h**
	Response:	short set, OK or error acknowledgement; response time max. 1 ms
	Release:	in all states

DB0
z

Description: Setting of the reset "z" control state (1= set). A reset of the controller is triggered in this state. The reset control state is functionally connected in parallel to the reset input. Once the reset has been performed, the control state is reset.

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

5.4.33. STST command

Syntax RS232/USB:	**Write:**	**SSTST z**
	Response:	OK or error acknowledgement; response time max. 1 ms
	Release:	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
	Release:	in all states (effectiveness depends on state)

DB0
z

Description: Setting of the start "z" control state (1= set). A sealing process is started in this state. The sealing process is ended by resetting the control state. The start control state is functionally connected in 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

5.4.34. 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: Read out the determined temperatures for the controller "rrrr" and for the heating tape "bbbb", in 0.1°C, for the points "n" (0...8) during the 8-point Tc correction of the current calibration. At undefined temperatures, the value zero is output. For the RS232 and USB interfaces, the output is in CSV format.
In RS485 communication, the nine long sets of the response are sent one after the other with a pause of 3ms each.

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

5.4.35. 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: Read out the determined temperatures for the controller "rrrr" and for the heating tape "bbbb", in 0.1°C, for the points "n" (0...8) during the 8-point Tc correction of the calibration "k" (1…8).. At undefined temperatures, the value zero is output. For the RS232 and USB interfaces, the output is in CSV format.
In RS485 communication, the nine long sets of the response are sent one after the other with a pause of 3ms each.

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

5.4.36. TOKG command

Syntax RS232/USB:
- **Read:** **LTOKG**
- Response: **ATOKG uuu ooo sss**
- **Write:** **STOKG uuu ooo sss**
- Response: OK or error acknowledgement; response time max. 6 ms
- Release: not in the 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
- Release: not in the On or calibration state

Description: Setting and querying the lower limit "uuu" and of the upper limit "ooo" in K (5…99 K) of the temperature OK range and of the stabilisation time "sss" in 0.1 s (0…99.9 s) of the temperature OK message. The temperature limits are the maximum allowed deviations of the actual value from the target value. If the actual value is within the temperature OK range, the temperature OK message is set.
The stabilisation time begins 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 temperature OK message is not reset.
The temperature OK message is output with the OK output and is only effective if the temperature OK message was selected with the SKONF command.

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

5.4.37. TUEE command

Syntax RS232/USB:
- **Read:** **LTUEE**
- Response: **ATUEE a uuu ooo sss**
- **Write:** **STUEE a uuu ooo sss**
- Response: OK or error acknowledgement; response time max. 6 ms
- Release: not in the 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
- Release: not in the On or calibration state

Description: Setting and reading the parameter of the temperature monitoring. The temperature monitoring is a monitoring function, that can be switched on with "a" (a=1) and switched off (a=0). A temperature OK range around the nominal value is set with lower limit "uuu" and upper limit "ooo" in K (5…99 K). If the actual value leaves this range during sealing, once the range has already been reached the PIREG-C2 controller goes into error (error 8).

The stabilisation time "sss" in 0.1s (0…99.9 s) begins 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 controller does not go into error. In the event of a change of the target value by more than 2 °C, the stabilisation period is restarted.

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

5.4.38. 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: Firstly, the command queries the samples of Ur "uuuuuu", in 0.01V, and Uir "iiiiii", in 0.001V, at the sampling time 0.045T before the zero crossing. Secondly, the recalculated effective values of Ur "vvvvvv", 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 transformer.

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: --

5.4.39. 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: As PIREG-C2 is equipped with two controllers, which each have their own program, there are also two program versions. One controller is positioned on the electrically separate side (version "ggg") and the other controller is on the side with the instrumentation (version "mmm"), each in 0.01 increments. The "vvv" device version (0.01 increments) is intended for the entire controller.

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: --

5.4.40. WESE command

Syntax RS232/USB: **Write: SWESE z**

Response: OK or error acknowledgement; response time max. 600 ms
Release: not in the On or calibration state

Syntax: RS485: **Write:** **Long set with DB0, BI = 0Ch**

DB0
z

Response: short set, OK or error acknowledgement; response time max. 600 ms
Release: not in the On or calibration state

Description: Setting the following factory settings if the parameter z=1. After the command, the PIREG-C2 controller carries out a reset.

Factory settings:

Setting switch (SEINS):

Heat-up ramp:	Off
Temperature coefficient:	Tc1= 7.46x10-4 1/K, Tc2= 0, Tc3=0 (Alloy L)
Calibration comp. time:	15s
Temperature range:	0…300°C
Calibration type:	calibration storage
Transformer type:	sealing transformer with EI or UI-iron core
Reference temperature:	20 °C for calibration
Tc correction:	without temperature coefficient correction (Clear storage of Tc corrections)

Configuration (SKONF):

Nominal value control:	Man. control via nominal value input (0…10V)
Setting control:	Manual setting via DIP switch
Alarm output activation:	Alarm output is set in the event of a malfunction following initial heating
Alarm output switching type:	Relay point closed during alarm
OK output activation:	Standard: Calibration OK message For device type x02: Calibration no. message:
OK output switching type:	Relay point closed during OK
Cal. Input pulse contr.:	no pulse control
Actual value output feature:	Actual value output (0…10V)

Setting parameters (SEIPA):

Reference temperature:	20°C
Temperature range:	200°C
Temperature coefficients:	Tc1= +3.00 x10-4 1/K, Tc2= -0.01 x10-9 1/K Tc3= -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 value)

Heating time of auto Tc correction (SKTKZ):

Heating time: 0 s (no auto Tc correction)

Setting of calibration 1…8 (LKAPK n):

all parameters: 0 (clear storage of Tc correction)

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
Stabilization 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 (SHBZG):

maximum heating time: 0 (Off)

Reference R20 value monitoring (SRRUE): (from V1.01/1.09/1.06)

Activation:	Off	Downward deviation:	5 %
		Upward deviation:	5 %

Communication monitoring (SKOUE):
For all interfaces: Activation: Off Downtime: 0

Communication configuration (SKOKO):
Addressed RS232 communication: Off
Communication external thermometer: DTM3000 (from V1.01/1.16/1.10)

Interfaces:
Baud rate for all interfaces (SBRAT): 9600 Baud
Device address for RS485 communication (SGADR): 0

Setting of controller calibration 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: active

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: --

5.4.41. 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-state in order to monitor the cooling phase of the sealing system for long-term changes:
- Actual temperature value “iii” in °C of the PIREG-C2 at the beginning of the off-state. The actual value “iii” is limited to a maximum of 999 and negative actual values are set to zero.
- Cooling time “aaaaa” in 0.01s (max. 655.53s). The cooling time ends when the actual value falls below 50°C.

The values are reset at the beginning of the off-state, then set again and are retained until a new off-state begins.

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

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

Reference: ZPFE

5.4.42. ZPFE command

Syntax RS232/USB: **Read:** **LZPFE**
Response: **AZPFE iii sss aaaaa hhhhh mmm ggggg**

Syntax: RS485: **Read:** **Control set, BI = 79h**
Response: **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:
- Actual temperature value “iii” in °C of the PIREG-C2 before heating. The actual value "iii" is limited to a maximum of 999 and negative actual values are set to zero.
- Temperature setpoint value “sss” in °C of the PIREG-C2 before heating.

- Heating-up time “aaaaa” in 0.01s (max. 655.53s). The heating-up time ends when the actual value exceeds 95% of the target value.
- Sealing time “hhhhh” in 0.01s (max. 655.53s). The sealing time starts when the actual value exceeds 95% of the target value.
- Average of the actual temperature value “mmm” in °C during the sealing time. The average value “iii” is limited to a maximum of 999 and negative actual values are set to zero.
- Heating time “ggggg” in 0.01s (max. 655.53s). The heating time begins when the start signal is applied and ends when the start signal is removed.
The values are reset at the beginning of the on-state, then set again and are retained until a new on-state begins.

Example RS232/USB:	**Read:**	LZPFE	
	Response:	AZPFE 022 150 00052 00166 148 00218	
Example RS485:	**Read:**	68 03 03 68 21 89 79 23 16	(GA=21h)
	Response:	68 0F 0F 68 21 00 79 16 00 96 00 34 00 A6 00 94 00 DA 00 8E 16	
Reference:	ZPFA		

5.4.43. ZUST command

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

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

Description: Querying 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= Error state 5= Calibration state 6= Reset state
kk	**Calibration state:**	0= Ok 1= initialise calibration 2= calibrate input amplifier 3= determine the phase shift 4= determine the reference resistance (R20) 5= calibration comparison time 6= check reference resistance (R20) 7= determine the P-factor 8= set initialising remanence 9= 8-point Tc correction 10= save controller settings 11= initialise single-point Tc correction 12= single-point Tc correction Off 13= single-point Tc correction heating 14= set and save single-point Tc correction 20= calibration switchover	

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		

5.4.44. 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

Release: not in the 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

Release: not in the On or calibration state

Description: Querying the "zzzzzzz" (0...9999999) sealing cycles performed by the PIREG-C2 for the stored calibrations (parameters "n"=1...8) and the total number of "ggggggggg" (0…999999999) sealing cycles performed by PIREG-C2 with the value zero for the parameter "n".
The calibration cycle counters (1...8) are set to zero by transferring the parameter "z" with the respective number (1...8) of the calibration cycle counter.

Example RS232/USB:

Read: LZYKL 0

Response: AZYKL 0 000018553 (total cycle counter)

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

6. Installation and commissioning

Firstly, check that the stated voltage of the PIREG-C2 power line matches the power line voltage being used, and that the transformer primary current matches the controller's load current capability.

EN: For safe operation, the PIREG-C2 resistance temperature controller may only operate in symmetrical TN and TT networks.
FR: Pour un fonctionnement sûr, le régulateur de température à résistance PiREG-C2 ne peut être exploité que sur des réseaux symétriques TN et TT.

EN: During installation, an overcurrent protection device must be provided in front of the mains input of the PIREG-C2.
The PIREG-C2 must be connected to the mains voltage via an easily accessible and marked isolating device (e.g. switch or circuit breaker).
FR: Pour l'installation, un disjoncteur à maximum doit être prévu devant l'entrée du réseau du PIREG-C2.
Le PIREG-C2 doit être raccordé à la tension du réseau via un disjoncteur marqué et facilement accessible (par exemple un interrupteur ou un sectionneur de puissance).

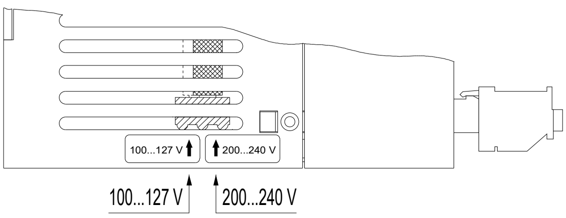
6.1. Installation

The PIREG-C2 resistance temperature controller is only suited for use in a switch cabinet. Open operation is not permitted.
The PIREG-C2 is intended to be used in a safety enclosure which should confirm with requirements for protection against the spread of fire, against electrical shock, against mechanical hazards and should have adequate rigidity according to UL 61010-1.
The controller as well as the current transformer are mounted on 35mm mounting rails as per EN 60715 (EN 50022). When mounting the controller, observe a minimum distance of at least 20 mm to adjacent devices and cabling on all sides.
Heat dissipation from neighbouring devices must be taken into account (note the ambient temperature specifications).

6.2. 120/240V mains voltage changeover

The PIREG-C2-2xx resistance temperature controller has a manual 120/240V mains voltage changeover. The mains voltage is switched by means of a slide switch which is operated from the outside with a screwdriver. The slide switch can be accessed from the underside of the PIREG-C2 between the ventilation slots.
Depending on the setting, the resistance temperature controller type PIREG-C2-2xx can be operated at both a mains voltage of 100...127 V and a mains voltage of 200...240 V using the mains voltage changeover. The resistance temperature controller type PIREG-C2-4xx has no mains voltage changeover.
The resistance temperature controller type PIREG-C2-2xx is factory-set for a mains voltage of 200...240 V.

EN: The manual 120/240V mains voltage changeover may only be operated with a suitable screwdriver when the PIREG-C2 is de-energised.
The 120/240V mains voltage changeover must be set according to the mains voltage used. Non-observance will cause the PIREG-C2 to malfunction or damage the PIREG-C2 if the mains voltage is too high.
FR: Le changement de tension de secteur 120/240V ne peut être effectué que lorsque le PIREG-C2 est hors tension et à l'aide d'un tournevis adapté.
Le changement de tension de secteur 120/240V doit être réglé conformément à la tension réseau utilisée. En cas de non-respect, le PIREG-C2 ne fonctionne pas ou il peut être endommagé par une tension de secteur trop élevée.



Setting of 120/240V mains voltage changeover:

Mains voltage 100…127 V:
Switch in "left" position
Mains voltage 200…240 V:
Switch in "right" position

View: Bottom side of the PIREG-C2

6.3. Configuring the settings

The following settings can be made at the ten DIP-switches or via the interfaces:

Heating ramp
Temperature coefficient
Temperature comparison time
Temperature range
Calibration type
Transformer type
Reference temperature
8-point Tc correction.

Prior to initial operation, the correct temperature coefficient must be set for the heating conductor being used. Setting too high a temperature coefficient may lead to overheating or melting of the heating conductor.

In addition, the temperature comparison time, the temperature range, the calibration type and the transformer type must be set. If necessary, the variable reference temperature and the 8-point Tc correction must also be activated. A signal must therefore be applied to the set point input. The setting for the heating ramp can be made before or after calibration.

6.4. Connecting the PIREG-C2

The resistance temperature controller must be connected according to the connection diagram, depending on the type of actuator used. It is not necessary to pay attention to the polarity of the current Ir and voltage Ur measurement cables to the heating conductor, nor to how the sealing transformer is connected on the primary or secondary side.

The measurement cable of the Voltage measuring input Ur (8/9) and of the Current measuring input Ir (10/11) may not be interchanged, because an interchange can cause a damage of the Current measuring input Ir.
It is recommended to check the connection of the Voltage measuring input Ur (8/9) and of the Current measuring input Ir (10/11) again before commissioning.

When connecting a target value potentiometer, it is vital to pay attention to the correct phase sequence. In the 0 °C setting, the resistance between terminals 13 and 16 must be 0 Ω.
The measurement cables for voltage measurement Ur must be connected directly to the heating conductor and have to be twisted. (≥50 turns/m). The cables from the sealing transformer should be connected to the heating conductor with cable lugs and not with plug-type connections. Ensure that the conductors are of adequate cross-section. No additional components, such as fuses, switches or resistance-loaded ammeters should be integrated in the secondary circuit of the sealing transformer.

6.5. Control inputs

Ensure that there are no high signals applied to the reset and start control inputs before the controller is started up for the first time. (If the calibration to an altered heating band is not appropriate, it may overheat).

6.6. Connecting to the mains voltage

The green Power LED will light following connection to the mains.
If “new calibration” is chosen as calibration mode, the PIREG-C2 will start the calibration procedure immediately after the power has been switched on and it will adjust the controller to the combination of sealing transformer and heating conductor. The blue Calibration LED will light up and the yellow Heat LED will flash. After successful calibration, the PIREG-C2 will return to the OFF state and be on standby (→ Figure 1).
If "Store calibration" is chosen as calibration mode, the PIREG-C2 will return to the off or error state after the power is switched on and will wait for the "Calibration start" signal. The alarm and calibration LEDs may be off, on or flashing. If there are no errors from 1 to 3 (→ Table 1), then the calibration can be activated.

6.7. Burning in the heating conductor

With the sealing tool held open, the heating conductor should best be "burned in" in such a way that the "Start" signal is given and the nominal temperature is slowly increased from zero to the burn-in temperature. The final burn-in temperature should be at least 50°C above the maximum sealing temperature on the heating conductor. The heating conductor should be monitored (initial colours, hot spots). Calibration should be carried out again following burn-in.
The initial slow increase of the target temperature is also recommended if a thermally pretreated heating conductor is used which does not need to be burnt in. In this way the correct temperature conductance of the heating conductor can be monitored. Errors arising during calibration and the selection of the temperature coefficient can be checked without the heating conductor can get overheated or burn up (→ 7.).

6.8. When the controller does not work correctly

See point 3.4., point 4.1., point 6.4., point 1.3., point 1.4., point 6.3., point 6.4., point 6.7. and point 7..

6.9. Current Transformer

Caution (EN)**:** To reduce the risk of electric shock, always open or disconnect circuit from power distribution system (or service) or building before installing or servicing current transformers.

Attention (FR)**:** Pour réduire le risque de choc électrique, il faut toujours ouUrir ou déconnecter le circuit du système de distribution électrique (ou du service) du bâtiment avant d'installer ou d'entretenir des transformateurs de courant.

EN: The following must be observed when installing the current transformer:

- The current transformers may not be installed in equipment where they exceed 75 percent of the wiring space of any cross-sectional area within the equipment.
- Restrict installation of current transformer in an area where it would block ventilation openings.
- Restrict installation of current transformer in an area of breaker arc venting.
- Not suitable for Class 2 wiring methods and Not intended for connection to Class 2 equipment.
- Secure current transformer and route conductors so that the conductors do not directly contact live terminals or bus.

FR: Les points suivants doivent être respectés lors de l'installation du transformateur de courant:

- Le transformateur de courant ne doit pas être installé dans des équipements dans lesquels ils dépassent 75 % de l'espace de câblage de toute section transversale de l'équipement.
- Ne doit pas être installé dans une zone dans laquelle ils bloquent les orifices de ventilation.
- Ne doit pas être installé dans une zone d'évacuation d'arc du disjoncteur.
- Ne convient pas aux méthodes de câblage de la classe 2 et n'est pas destiné à être connecté à des équipements de la classe 2.
- Protéger le transformateur de courant et acheminer les conducteurs de manière à ce qu'ils ne soient pas en contact direct avec des bornes sous tension ou avec le bus.

7. The heating conductor

The heating conductor is an important component of the control circuit because it functions both as a temperature sensor and heating element at the same time. Due to the complexity and variety involved, the influence of heating conductor geometry is not discussed here. However, some issues concerning physical and electrical properties will be addressed.

The measurement principle of the resistance temperature controller requires that the heating conductor has a positive temperature coefficient, which is set at the PIREG-C2. The use of a heating conductor with a smaller temperature coefficient than that set on the controller can result in the heating conductor getting overheated or burning up (→ 4.1.3. and 5.4.). Despite full heating capacity, the actual value cannot reach the target value.

During initial heating of the heating conductor to between 250 and 300 °C, the cold resistance of the heating conductor varies by 2 - 3 % (burn-in effect). This resistance variation results in a zero-point error of 20 - 30 °C. After a few heating cycles, this zero-point error needs to be corrected by a new calibration.

Overheated or burnt-out heating conductors should not be used because of irreversible changes in the temperature coefficients.

A constructional measure to improve the exact temperature control and to increase the lifetime of the heating conductor and the Teflon (PTFE) coating is to copper-plate or silver-plate the heating conductor contacts. This measure ensures that the heating conductor contacts remain cold and allows the controller to measure only where sealing is taking place. The temperature of the heating conductor can only be determined by the PIREG-C2 as the mean of all parts of the heating conductor. If any individual parts of the heating conductor are exposed or otherwise not in contact with any heat dissipating areas, they will heat up faster than those sections of the heating conductor that are able to dissipate their heat. In this case, the temperature reached at these sections will be lower than the temperature displayed by the controller and the sealing performance will be worse.

Calibration of the PIREG-C2 is recommended every time a heating conductor is replaced, in order to correct any tolerances of the heating conductor arising during manufacture. When new heating conductors are used, burn-in will again be necessary.

8. Technical data

8.1. Controller

Mains voltages: Terminal L1 (1), L2/N (2), T2 (3) and T1 (4)

Standard: 100 (-15 %) … 127 V (+10 %) / 200 (-15 %) … 240 V (+10 %)
(Voltage fluctuation: 85 … 140 VAC / 170 … 264 VAC)
with 120/240V mains voltage changeover (→ 6.2.)

Allowable mains supply systems and mains voltage:
- Three-phase four-wire system with earthed neutral (symmetrical TN and TT networks)
  - 66/115 V
  - 120/208 V   127/220 V
  - 220/380 V   230/400 V   240/415 V
- Single-phase (split-phase) three-wire systems
  - 100/200 V   110/220 V   115/230 V   120/240 V
  - 220/440 V   240/480 V

Remarks to voltage value above:
- „Outer conductor–neutral conductor"/„Outer conductor–outer conductor"

Option: 380 (-15%) … 415 V (+10%) (Voltage fluctuation: 320 … 457 VAC)

Allowable mains supply systems and mains voltage:
- Three-phase four-wire system with earthed neutral (symmetrical TN and TT networks)
  - 220/380 V   230/400 V   240/415 V

Remarks to voltage value above:
- „Outer conductor–neutral conductor"/„Outer conductor–outer conductor"

Mains connection: Connection between outer and neutral conductor or between two outer conductors, whereby the nominal voltage between outer conductor and earth must not exceed 300 V.

Overvoltage category: III

Mains frequency: 50 - 60 Hz (Frequency fluctuation: 45 … 65 Hz)

Current consumption: Terminal L1 (1), L2/N (2), T2 (3) and T1 (4)
Nominal current: I_{max}= 5 A (Actuator Internal thyristors)

Actuators:

Internal thyristors: Actuator with antiparallel thyristors on an internal heat sink in the PIREG-C2

Continuous heating, maximum load current:	I_{max}= 5 A	- 100 % operation factor
Impulse heating, maximum load current:	I_{max}= 25 A	- max. 20 % operation factor, resp. - max. 6 s on-time
Max. peak current (t_{peak} = 10ms):	I_{TSM}= 500 A	
Leakage current in closed state:	at 240 V:	I_D= 11 mA
	at 415 V:	I_D= 13 mA
Power limit load, integral (t=10ms)	I^2t= 1250 A²s	

Fusing: The fuse must suffice for the electrical current limits defined above.

External solid-state relay: Solid-state relay, instantaneous switching

Galvanic separation: The galvanic separation between the control (Terminal 19 and 20) and the load circuit (Mains) must be configured as double or reinforced isolation, according to EN 61010 resp. UL 61010.

Characteristic values for the solid-state relay:

DC no-load voltage load of the PIREG-C2:	U_{HiLo}= 5 V
DC internal resistance of the PIREG-C2:	R_{vh}= 18 Ω
Maximum supply output current:	I_{HiLo}= 30 mA
Maximum allowable switch-on delay:	t_{ein}= 0.2 ms
Maximum allowable switch-off delay:	t_{out}= 0.25 ms
Connection of control circuit at PIREG-C2:	Terminal 19 (+) / Terminal 20 (-)
Circuit:	SELV or PELV circuit

Power consumption: 3 W

Overcurrent protection device

Max. nominal current: I_{nommax}= 10 A

Fuse types: For a UL-compliant installation, UL 248 or UL 489 overcurrent protection devices should be used.
- Miniature circuit breakers acc. to EN 60898 (characteristics B, C, D, K or Z)
- Miniature circuit breakers acc. to UL489 (characteristics B, C, D, K or Z)
- Fuse gG according to IEC 60269
- Fuse Class CC or Class J according to UL 248 (characteristics Fast-Acting or Time-Delay)

Temperature coefficients:

		Tc1	Tc2	Tc3	
DIP switch 3 and 4:	Temp. coefficient 1:	Tc1= 7.46x10^{-4} 1/K	Tc2= 0	Tc3= 0	(Alloy L)
	Temp. coefficient 2:	Tc1= 10.8x10^{-4} 1/K	Tc2= 0	Tc3= 0	(Alloy A20)
	Temp. coefficient 3:	Tc1= 48.3x10^{-4} 1/K	Tc2= -6.12x10^{-6} 1/K²	Tc3= 2.80x10^{-9} 1/K³	(NOREX)
	Temp. coefficient 4:	Tc1= 8.62x10^{-4} 1/K	Tc2= 0	Tc3= 0	(Alloy M)
Interfaces:	Temp. coefficient 1:	Tc1= 7.46x10^{-4} 1/K	Tc2= 0	Tc3= 0	(Alloy L)
	Temp. coefficient 2:	Tc1= 10.8x10^{-4} 1/K	Tc2= 0	Tc3= 0	(Alloy A20)
	Temp. coefficient 3:	Tc1= 48.3x10^{-4} 1/K	Tc2= -6.12x10^{-6} 1/K²	Tc3= 2.80x10^{-9} 1/K³	(NOREX)
	Temp. coefficient 4:	Tc1= 8, 62x10^{-4} 1/K	Tc2= 0	Tc3= 0	(Alloy M)
	Temp. coefficient 5:	Tc1= 12.65x10^{-4} 1/K	Tc2= 0	Tc3= -0,70 x10^{-9} 1/K³	(Alloy A20C)
	Temp. coefficient 6:	Tc1= 12.55x10^{-4} 1/K	Tc2= 0	Tc3= 0	(Alloy A20D)
	Temperature coefficient with EIPA TK command	Tc1= +3.00… +99.99x10^{-4} 1/K	Tc2= -99.99… +99.99x10^{-6} 1/K²	Tc3= -99.99 +99.99x10^{-9} 1/K³	

Temperature range:

DIP switch 6	Temp. range 1:	0…300 °C	Undertemperature –10 °C	Overtemperature 360 °C
	Temp. range 2:	0...500 °C	Undertemperature –10 °C	Overtemperature 600 °C
Interfaces:	Temp. range 1:	0...300 °C	Undertemperature –10 °C	Overtemperature 360 °C
	Temp. range 2:	0...500 °C	Undertemperature –10 °C	Overtemperature 600 °C
	Temp. range with EIPA TB command	0…υ_{nom} υ_{nom}= 100…500 °C	Undertemperature –10 °C	Overtemperature υ_{nom} +20 %

Time values (50Hz):	Initialisation:	After power on or reset signal:	500 ms
	Power interruption:	During an interruption to the line voltage, the PIREG-C2 switches to the error state or starts with a reset once the line voltage has been re-established.	≥80 ms
	Reset	Stop heating	5...25 ms
	Start (heating):	Switch on delay:	7...27 ms
		Switch off delay:	17...44 ms
	Remanence setting:	After power on, reset and calibration of EI core transformer:	80 ms
		After power on, reset and calibration of toroidal core transformer:	300 ms
		During sealing process with EI core transformers	40 ms
		During sealing process with toroidal core transformers	80 ms
		During sealing process with toroidal core transformers with sealing pauses of longer than 10 minutes	160 ms
		Current conduction angle of EI core transformer:	3.1 ms
		Current conduction angle of toroidal core 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 (DIP switch 5 =Off, or interfaces):	15 s
		Temperature comparison time 2 (DIP switch 5 =Off, or interfaces):	30 s
	Heat-up ramp:	The heating ramp is selected by DIP switches 1 and 2 or interfaces:	without /2 /3 /5 s
Control inputs:	Start (6), calibr. start (5) and reset input (7) are floating		
	control voltage:	U_{contr}= 4…32 VDC (polarity independent)	
	Max. control voltage:	$U_{contr.max}$= ±40 V	
	Control current:	$I_{contr.}$= 0.5…4.5 mA	
	Supply:	SELV or PELV circuit	
Target value input:	The input (16) is electrically isolated from the measurement side		
	Target value voltage:	$U_{set\ value}$= 0...10 VDC, depending on the set temp. range, corresponds to: 0...300 °C / 0...500 °C / 0…υ_{nom}	
	Max. control voltage:	$U_{set\ value\ max}$= 11 V	
	Max. input current:	I_{inmax}= 11 µA	
	Input resistance:	R_{in}= 1 MΩ	
	Supply:	SELV or PELV circuit	
Voltage measuring input:	Signal voltage (8/9):	U_r= 0.4...120 V	
	Max. signal voltage:	U_{rmax}= 160 V	
	Max. input current:	I_{inmax}= 1,5 mA	
	Input resistance:	Range 1: R_{in}= 105 kΩ	at U_r= 11...120 V*
		Range 2: R_{in}= 13.1 kΩ	at U_r= 1.4...11 V*
		Range 3: R_{in}= 1.67 kΩ	at U_r= 0.4...1.4 V*
			*: e.g. for Alloy A20, temp. range 300°C
	Measurement Category:	CAT II	
	Supply:	Secondary circuit provides by the mains voltage (see above, Overvoltage category III). The sealing transformer must be configured according to EN 61558 (VDE 0570) resp. UL 5085 (isolating transformer with reinforced isolation) and UL 61010.	
Current measuring input:	Signal current (10/11):	I_r= 20...500 mA U_{ir}= 0.1...2.5 V	
	Max. signal current:	I_{rmax}= 1500 mA U_{irmax}= 5 V	
	Input resistance:	R_{in}= 5 Ω (load resistance)	
	Measurement Category:	CAT II	
	Circuit:	SELV or PELV circuit	
Uref output:	The reference output (15) is electrically isolated from the measurement side and overload-protected.		
	Reference voltage:	U_{ref}= 9.9…10.1 VDC	
	Max. output current:	I_{refmax}= 20 mA	
	Internal resistance:	R_i= 51.1 Ω	
	Circuit:	SELV or PELV circuit	
Actual value output:	The actual value output (17) is electr. isolated from the measurement side and overload protected.		
	Actual value voltage:	$U_{actual\ value}$= 0...10 VDC, depending on the set temp. range, corresponds to: 0...300 °C / 0...500 °C / 0…υ_{nenn}	
	Max. output voltage:	$U_{actual\ .value\ max}$= 10.1 VDC	
	Max. output current:	$I_{actual\ value}$= 5 mA	
	Internal resistance:	R_i= 100 Ω	
	Circuit:	SELV or PELV circuit	
Alarm output:	Reed relay normally open contact (12/18), floating		
	Max. switching capacity (ohmic load):	10 W	
	Max. switching voltage:	60 VDC/ 30 VAC	
	Max. switching current:	0,5 ADC/ 0,35 AAC	
	Nominal load (ohmic load):	50 V / 100 mA	
	Lifetime: electrical	$1x10^7$ at nominal load	$1x10^9$ bei 5V mit 100mA
	Supply:	SELV or PELV circuit	
Ok output:	Reed relay normally open contact (22/22), floating		
	Max. switching capacity (ohmic load):	10 W	
	Max. switching voltage:	60 VDC/ 30 VAC	
	Max. switching current:	0,5 ADC/ 0,35 AAC	
	Nominal load (ohmic load):	50 V / 100 mA	
	Lifetime: electrical	$1x10^7$ at nominal load	$1x10^9$ bei 5V mit 100mA
	Supply:	SELV or PELV circuit	

Interfaces:		
RS232 interface:	Format (factory setting):	9600 baud, 1 start bit, 8 data bits, 1 stop bit, no parity
	Baud rates:	9600 bits/s 19200 bits/s 38400 bits/s 57600 bits/s 115200 bits/s
	RxD input voltage:	±25 V RxD input resistance: 3…7 kΩ
	TxD output voltage:	±5 V with 3 kΩ load TxD output resistance: 300 Ω
	Supply:	SELV or PELV circuit
	Connection interface:	RJ-12, 6P6C
RS485 interface:	Format (factory setting):	9600 baud, 1 start bit, 8 data bits, 1 stop bit, even parity
	Baud rates:	9600 bits/s 19200 bits/s 38400 bits/s 57600 bits/s 115200 bits/s
	R input voltage:	±14 V R input resistance: 24 kΩ
	T output voltage:	1.5…3 V at 54 Ω
	Reference resistances:	+R/+T signal (A): 5.6 kΩ to +5 V
		+R/+T signal (B): 5.6 kΩ to GND
		+R/+T signal (A) to -R/-T signal (B): 2.7 kΩ
	Supply:	SELV or PELV circuit
	Connection interface:	RJ-12, 6P6C
USB interface:	Format:	USB 1.1 and 2.0 Converter from USB to RS232 interface
	RS232 format (fact. set.):	9600 baud, 1 start bit, 8 data bits, 1 stop bit, no parity
	RS232 baud rates:	9600 bits/s 19200 bits/s 38400 bits/s 57600 bits/s 115200 bits/s
	USB input voltage:	-0,5…+3,63V
	Supply:	SELV or PELV circuit
	Controller:	FDTI chip FT230XS internet: http://www.ftdichip.com
	Connection interface:	Micro USB 2.0 type B
EMV (CE):	Interfer. immunity:IEC 61000-6-2.	
	Interfer. emission:IEC 61000-6-3	To comply with the limit value for interference emission, the PIREG-C2 must not be operated without additional mains filtering.
Connections:	Plug-in screw terminals Clamping range 0.2...2.5 mm² (AWG 24...12), tightening torque 0.5...0.6 Nm Material: polyamide, not reinforced, flammability class UL94 V0	
Connecting cable:	Rigit or Flexible	Mains cable: cross-section 0,82…2,5 mm² (AWG 18…12) Control cable: cross-section 0,2…2,5 mm² (AWG 24…12)
	Max. current consumption. 5 A:	minimum temperature rating 70 °C
	Max. impulse current 25 A:	minimum temperature rating 105 °C
Type:	Encapsulated in isolating case	
Housing:	Material: polycarbonate fibre-reinforced, PC-F, flammability class UL94 V0 (no fire protection housing)	
Protection class:	Protection class II	
Pollution class:	2	
Protection type:	IP20* (*: not part of the acceptance according to UL 61010)	
Mounting:	fast mounting on 35-mm mounting rails, in accordance with EN 60715 (EN 50022)	
Dimensions (W x H x D):	75 x 102.5 x 105.5 mm	
Installation:	Minimum distance to adjacent devices and cabling on all sides at least 20 mm	
Weight:	520 g	
Shock resistance:	10 g	
Altitude:	max. 2000 m	
Humidity:	Maximum relative humidity 80% at temperatures up to +31°C, decreasing linearly up to 50% relative humidity at +40°C.	
Operating temperature:	Max. current consumption 5 A: 5…50 °C	Max. impulse current 25 A: 5…40 °C
Storage temperature:	-10…70 °C	
UL file:	E509199	

8.2. Current transformer

Type:	PIREG-CT-50	
Max. nom. input current:	500 A	Through hole (Primary circuit)
	Supply:	Secondary circuit provides by the mains voltage (see above, Overvoltage category III). The sealing transformer must be configured according to EN 61558 (VDE 0570) resp. UL 5085 (isolating transformer with reinforced isolation) and UL 61010.
Measurement Category:	CAT II	
Max. operation voltage:	160 V	(Voltage between primary and secondary circuit at non isolated though hole conductor.)
Mains frequency:	50 - 60 Hz	
Max. nom. output voltage:	2,5 V	Terminal 1 and 2 (Secondary circuit)
Max. nom. output current	500 mA	
Maximum load resistor:	5 Ω	
Transformation ratio:	1 : 1000	
Connections:	Plug-in screw terminals Clamping range 0.2...2.5 mm² (AWG 24...12), tightening torque 0.5...0.6 Nm Material: polyamide, not reinforced, flammability class UL94 V0	
Connecting cable:	Rigit or Flexible	cross-section 0,2…2,5 mm² (AWG 24…12)
Type:	Encapsulated in isolating case	
Housing:	Material: polyamide fibre-reinforced, PA-F: sealing compound: polyurethane, flammability class UL94 V0	
Mounting plate:	Material: polyamide, PA, flammability class UL94 V0	
Pollution class:	2	
Protection type:	IP20*	(*: not part of the acceptance according to UL 61010)
Mounting:	fast mounting on 35-mm mounting rails, in accordance with EN 60715 (EN 50022)	
Dimensions (W x H x D):	70 x 42,5 x 103,5 mm	
Weight:	180 g	
Shock resistance:	10 g	

Altitude:	max. 2000 m
Humidity:	Maximum relative humidity 80% at temperatures up to +31°C, decreasing linearly up to 50% relative humidity at +40°C.
Operating temperature:	0…50 °C
Storage temperature:	-10…70 °C
UL file:	E509199

8.3. Potentiometer

Type:	0...300 °C		
Resistance:	5 kΩ ±5 %	Linearity: ±0.25 %	Temperature coefficient: 50 ppm/°C
Total load capacity:	1.0 W		
Turning angle:	1080 °		
Connections:	soldered fitting		
Type:	open		
Housing:	Glass-fibre reinforced plastic		
Mounting hole:	28.45…28.90 mm		
Pollution class:	2		
Protection type:	IP00		
Dimensions (L x D):	57.4 x 32 mm		
Weight:	51 g		
Humidity:	95 %, no condensation		
Altitude:	max. 2000 m		
Operating temperature:	0…50 °C		
Storage temperature:	-10…70 °C		

8.4. Analogue display

Type:	Display 2060 0 - 300 °C		
Scale:	0...300 °C	Accuracy: ±1.5 %	Vertical nominal situation
Input voltage:	0 - 10 VDC		
Input resistance:	10.3 kΩ		
Connections:	soldered fitting		
Type:	open		
Housing:	Glass-fibre reinforced plastic		
Section of front panel:	61.2 x 32.2 mm		
Pollution class:	2		
Protection type:	IP00		
Dimensions (W x H x D):	63 x 50.6 x 51.7 mm		
Weight:	65 g		
Humidity:	95 %, no condensation		
Altitude:	max. 2000 m		
Operating temperature:	0…50 °C		
Storage temperature:	-10…70 °C		

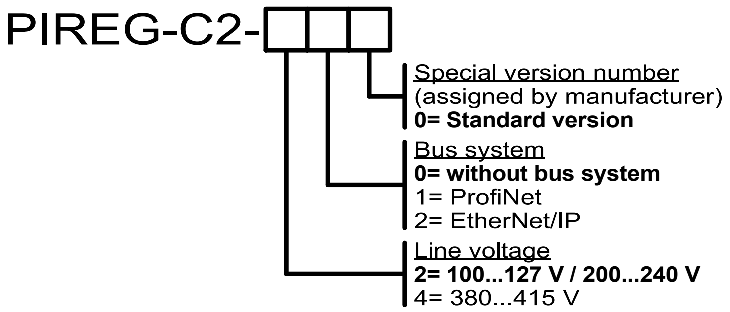
8.5. Sealing transformer

The sealing transformer must be configured according to EN 61558 (VDE 0570) resp. UL 5085 (isolating transformer with reinforced isolation). The sealing transformer must not be applied with reduced induction.

8.6. External thermometer DTM3000

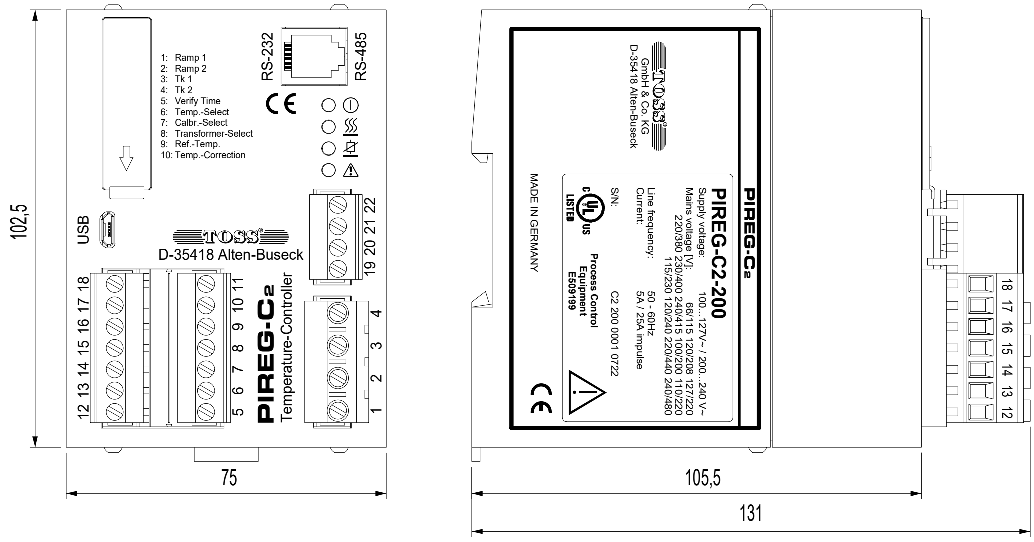
Type:	The DTM300 is a handy thermometer for thermocouple sensors.	
Sensor:	Thermocouple type K (NiCr-Ni)	
Measuring range:	-200 °C...+1370 °C	
Accuracy:	±0.1 % Full-Scale (only instrument)	
Resolution:	0.1 °C	
Display:	1-line LCD	
connection:	Miniature flat plug	
RS232 interface:	Format:	9600 baud, 1 start bit, 8 data bits, 1 stop bit, no parity
	Connection:	Binder series 719, 4 pole
Supply voltage:	Battery:	9V-Block, size 6F22
	Lifetime:	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	
Remark:	The thermometer TM6 is no longer available.	

8.7. Ordering codes

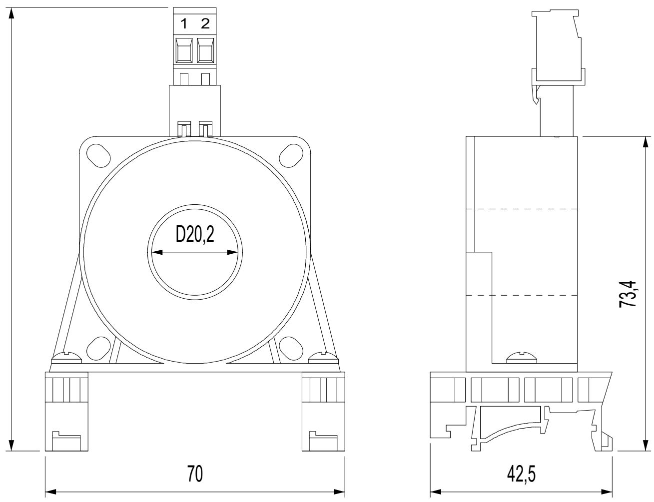


8.8 Housing

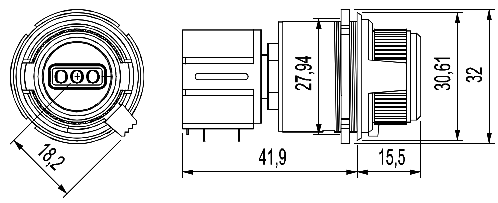
8.8.1. PIREG-C2 housing



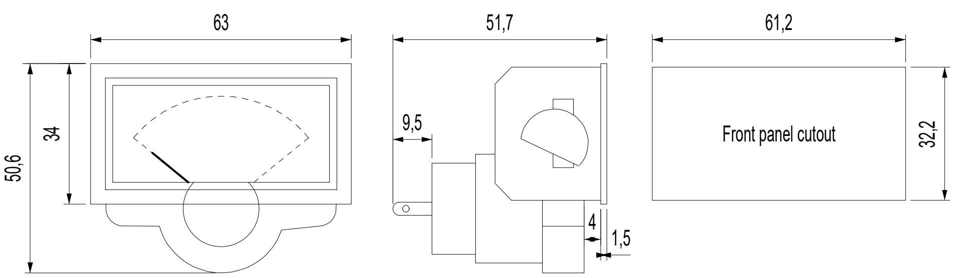
8.8.2. Current transformer housing



8.8.3. Potentiometer housing



8.8.4. Analogue display housing

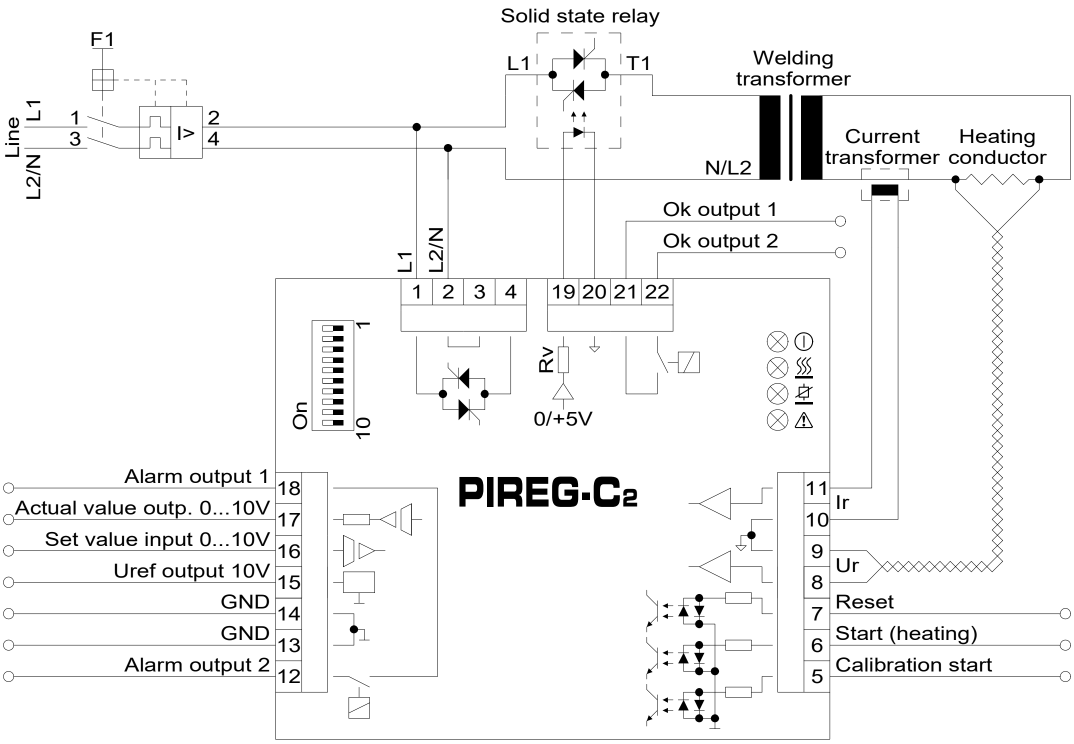


7.9. Spare parts

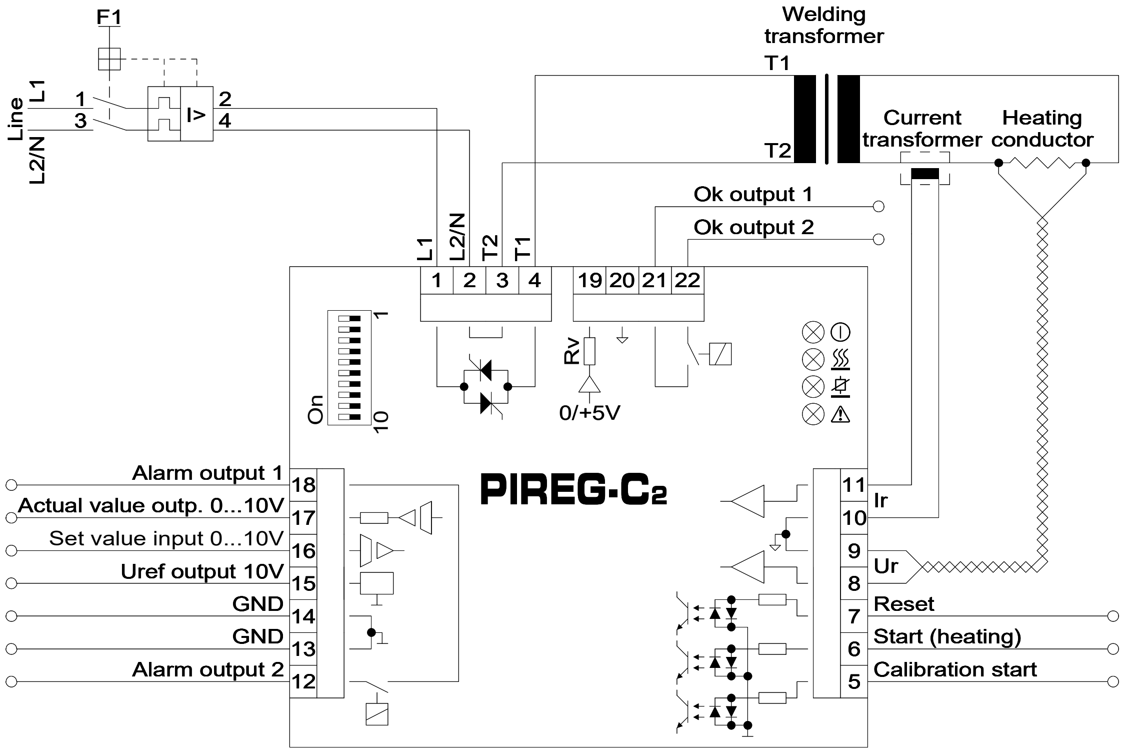
Terminal 1…4:	Phoenix Contact	GMVSTBW 2,5 HV/ 4-ST-7,62BD1-4	1711127
Terminal 5…11:	Phoenix Contact	MVSTBR 2,5/ 7-ST BD:5-11	1881998
Terminal 12…18:	Phoenix Contact	MVSTBW 2,5/ 7-ST BD:18-12	1882036
Terminal 19…22:	Phoenix Contact	MVSTBW 2,5/ 4-ST BD:19-22	1752094
Terminal 1…2:	Phoenix Contact	MVSTBW 2,5/ 2-ST-5,08 BD:1-2	1722325
Anschluss RJ-12, 6P6C	MH Connectors	MHRJ12-6P6CR	6510-0104-04

9. Connection diagrams

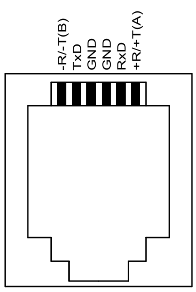
9.1. Connection diagram for PIREG-C2 with external solid-state relay



9.2. Connection diagram for PIREG-C2 with internal thyristors



9.3. RS232 / RS485 connection - interface



Connection interface: RJ-12, 6P6C

TxD: Output at PIREG-C2
RxD: Input at PIREG-C2

10. Application note

10.1. Application instructions

The following application instructions are available for the PIREG-C2 which should simply operation of the PIREG-C2.

8-point Tc correction: Operation of the 8-point Tc correction, which is an additional component of the calibration of the PIREG-C2 to perform a temperature coefficient correction for the heating conductor (→ 3.1.8.).

Single-point Tc correction: Operation of the single-point Tc correction for correcting tolerances of the temperature coefficient of the heating conductor in only one operating point (→ 3.1.9.).

Ur voltage range extension: Dimensioning of the voltage divider to expand the measuring range of the Ur input (8/9) for Ur voltages greater than 120V.

11. Disposal

EN: Do not dispose of the device with household waste! The PIREG-C2 and its components must be disposed of via the local collection points for electronic waste in accordance with the WEEE Directive 2012/19/EU on waste electrical and electronic equipment.
FR: Ne pas jeter l'appareil dans les ordures ménagères ! Le PIREG-C2 et ses composants doivent être éliminés conformément à la directive DEEE 2012/19/UE relative aux déchets d'équipements électriques et électroniques via les points de collecte locaux des déchets d'équipements électroniques.
EN: Incorrect disposal can pose a risk to the environment. The PIREG-C2, its components and packaging materials must be disposed of in accordance with national waste treatment and disposal regulations.
FR: Une élimination incorrecte peut entraîner des risques pour l'environnement. Le PIREG-C2, ses composants et matériaux d'emballage doivent être éliminés conformément aux réglementations nationales en matière de traitement et d'élimination des déchets.

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