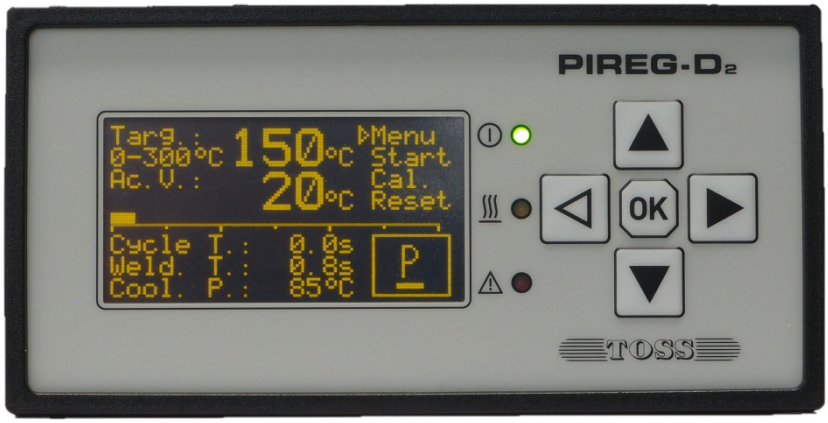
Operating Instructions

Temperature Controller PIREG®-D2



With kind regards

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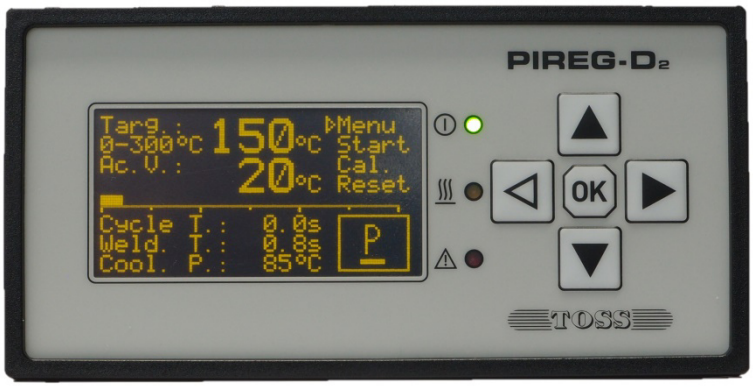
PIREG-D2 Device description: Resistance Temperature Controller

TOSS®

Applications:

Packaging machine for sealing plastic films.



c UL us LISTED

Controller PIREG-D2

c UL us LISTED

Current transformer PIREG-CT-50

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-D2 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-D2.

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-D2 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-D2 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-D2. The appropriate temperature coefficient of the heating conductor must be set on the display unit of the PIREG-D2 or via the interface. The temperature coefficient of the heating conductor must be positive over the entire temperature range.

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**.

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-D2'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-D2 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-D2. 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-D2. 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-D2 resistance temperature controller is only suited for use in a switch cabinet. Open operation is not permitted.
The controller is designed for installation into the switch panel and the current transformer is fitted on a 35 mm mounting rail according to EN 60715 (EN 50022). When installing the controller in the switch panel, there must be a distance of at least 20 mm from the neighbouring device. Heat dissipation from neighbouring devices must be taken into account (note the ambient temperature specifications).

1.9. Maintenance

The PIREG-D2 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 version (v.vv) shipped was the version 1.00 with program versions 1.13 for the display unit (d.dd), 1.16 for the electrically isolated side (g.gg) and 1.10 for the instrumentation side (m.mm).
Supplements in this description which are only valid from a later version include the version, the notation Vv.vv/d.dd/g.gg/m.mm, e.g. V1.00/1.13/1.16/1.10 from which they are valid. The device and program versions are read from the Information menu or by a command (LVERS) via the interface.

2. Short description

The PIREG-D2 resistance temperature-controller is a temperature controller with a built-in sequence control, which is used to control temperatures of heat conductors for heat pulse sealing of films and for controlling film sealing machines.
The sealing transformer is used by the PIREG-D2 on the primary side. The heat conductor is fed from the secondary side of the transformer. The measuring signals are received directly at the heat conductor and are made available to the controller.

The PIREG–D2 temperature controller has four control inputs and three relay outputs to control the film sealing machine. The PIREG-D2 temperature controller can control a film sealing machine independently via the latter and the integrated sequence control. The three relay outputs are divided into one message output and two control outputs with different capacities. In addition, there is an alarm output.

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

The PIREG-D2 operates as a proportional control unit that independently determines the P-factor (the control amplification) for the controlled part of a process during calibration itself. The controlled system consists of a sealing transformer and a heat conductor. The P-factor detected during the calibration process may still be corrected later by the setting in the display unit or by a command (→ 5.2.5.). With an additional control-function the typical offset at proportional controller will be minimized (from V1.00/1.23/1.30/1.25).

The PIREG-D2 is operated either via the built-in display unit (→ 5.) by five buttons (→ 4.1.) or by the RS232 or USB interface which is fitted to the PIREG-D2. Combinations of both types of operation are also possible. An OLED module with eight lines with twenty-one digits each is used as display.

The PIREG-D2 is adjusted to the heat conductor's temperature coefficients (→ 5.7.1.). The PIREG-D2 can also determine a heat conductor's actual temperature coefficient itself by means of a temperature coefficient correction (→ 5.7.4.**)**. Connect the PIREG-D2 via the RS232 interface to an external thermometer exTM, DTM3000 (from V1.00/2.08/1.33/1.26) or previous TM6, which measures the actual temperature of the heating conductor to simplify the temperature coefficient correction. Depending on the setting, the PIREG-D2 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 heat conductor. the secondary voltage of the transformer may be within a range of 1...80 V. The current measured with a current transformer can range from 20 to 400A. The calibration values are stored in the PIREG-D2, so that there is no need for renewed calibration and start-up time after switching on the power, if conditions have not changed.
The PIREG-D2 can store the calibration settings for two heat conductors (from V1.00/1.23/1.30/1.25). At this two calibrations it is necessary to use the same temperature coefficients, the same temperature range, and the same other calibration settings (→ 3.). For each heat conductor a separate temperature coefficient correction will be determined. The activation of the calibration switching and the change between this two calibrations will do by command or by control inputs (→ 5.6.2).
The PIREG-D2 performs the calibration process within a variable room temperature range of 0-50°C. During the process, the actual reference temperature must be set in the controller's display unit (→ 5.7.2.). That is advantageous for constant sealing temperatures with differing environmental conditions.

High quality sealing transformers, such as toroidal core transformers, are connected by the PIREG-D2 on the primary side, without current surges occurring. 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 el core transformers and 80 ms with 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 heat conductor has to be heated for a short time to approx. 40 °C – 70 °C. The PIREG-D2 itself uses a phase angle controller to regulate the temperature.

The PIREG-D2 provides the function measurement pause (from V1.00/1.23/1.30/1.25). At the measurement pause the PIREG-D2 stops the sending of measurement impulse to the sealing transformer. Therefore it is possibly to work at the head conductor circuit without to generate an error. The measurement pause is controlled by control inputs or by command (→ 5.6.2.).

3. Functions

3.1. Control

With the PIREG-D2, there are the following control settings which must be performed before calibration start. The PIREG-D2 peforms the heat conductor's adaptation to the voltage Ur and the current Ir and the P-factor (control amplification) on its own.

3.1.1. Heat-up ramp: A heat-up ramp is used to set the time value in which the controller increases the actual temperature value to the target value with a linear ramp (→ 5.7.3.). This allows the heat conductor to be heated gradually.

3.1.2. Setting temperature coefficients: The heat conductor's temperature coefficient, which must be positive, must be set on the PIREG-D2 (→ 5.7.1.). The temperature coefficient is a material constant that depends on the alloy used for the heat conductor.

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 cannot then reach the target value and the controller continues to heat up. For heat conductors which have a temperature coefficient deviating from the four possible ones, the variable temperature coefficient setting must be used.

3.1.3. Calibration reference time: In the calibration process (→ 3.2.), the heat conductor's resistance is determined at reference temperature. To ensure that the reference resistance value determined is correct, the resistance of the heat conductor is measured again after the calibration reference time has expired, and compared to the determined reference resistance measured previously. If the difference between the two measurements is greater than 1.2%, a new calibration process is started. This prevents calibration from taking place on a heat conductor which is still cooling. The greater the calibration reference time selected, the sooner resistance changes in the heat conductor, caused by cooling during calibration, are detected .

3.1.4. Temperature range: The PIREG-D2 offers a choice between the four fixed temperature ranges of 200, 300, 400 and 500°C and a variable temperature range with an adjustment range of 100°C-500°C. The overtemperature (rated value +20%) and undertemperatures (-10°C) apply accordingly.

3.1.5. Calibration mode:
- New calibration: If the calibration mode "new-calibration" is chosen, the PIREG-D2 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".
- Save calibration: 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 signal "Reset". 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.

3.1.6. Transformer type: The PIREG-D2 must be adapted to the type of sealing transformer, EI or toroidal core. The next time the power is switched on, the transformer is charged with multiple unipolar phase angles and the remanence is taken to a specified position in the transformer's iron core. The phase angle's current conduction angle for setting the remanence is adapted to the type of transformer, during the process. The rapid switch-on process is used for every sealing procedure with the transformer being charged by only a small number of remanence setting pulses before being switched on completely. With toroidal core transformers, if the pause between the two sealing procedures is longer than 10 minutes, the number of rapid switch-on process pulses is doubled. The soft switch-on procedure is used for switching on high-quality transformers without power surges occurring.

3.1.7. Reference temperature: The reference temperature is the environmental temperature at which the heat conductor resistance, called reference resistance (Rref) is determined during the calibration process. With the PIREG-D2, the reference temperature may be set between 0 and 50°C.

3.1.8. Temperature coefficient correction: The PIREG-D2 provides two temperature coefficient corrections, with which scattering of the heat conductor materials, caused by alloys, can be corrected.
- Temperature coefficient correction: In normal temperature coefficient correction, the heat conductor is heated up in eight temperature steps. At each step there is a comparison with the actual heat conductor temperature and an actual value correction depending on the deviation. The normal temperature coefficient correction is part of the calibration process (→ 3.2.) and also occurs as part of it.
- Single-point temperature coefficient correction: In the case of the single-point temperature coefficient correction, correction occurs for one operating point. The single-point temperature coefficient correction is carried out outside of the calibration process and is started from the Off state.

3.2. Calibration

During calibration, the PIREG-D2 independently adapts to the combination of sealing transformer and heat conductor. At the same time, the voltage Ur at the heat conductor and the current Ir through the heat conductor is measured every second. This status is indicated by the corresponding operating status symbols in the symbol field of the Working menu on the display unit (→ 5.3.). If you make suitable adjustments, a Calibration OK message, which is reset during calibration, may be issued by the PIREG-D2's three relay outputs. Additional information on the progress of the individual calibration steps is shown by the actual value display or output. The actual value is updated every second.

The calibration process runs through the following steps:

3.2.1. Initialisation: During the initialisation stage, the PIREG-D2 identifies the data necessary for calibration. In addition, it checks the selected temperature coefficient for dynamics and continuity within the selected temperature range. Should the dynamics and continuity exceed the permitted limits, the PIREG-D2 will stop the calibration procedure with Error 133 (parameter error).

3.2.2. Calibrate 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 (from V1.00/1.23/1.30/1.25).
In this calibration step, the actual value display shows different values every second and the actual value output is charged with different voltages every second. The measured current or voltage value is displayed or issued alternately.
With the actual value being shown on the display, the current value is shown in the controller's 0-50% set temperature range and the voltage value is shown in the 50-100% range. The zero point of the displayed values is set at 50 %. At the beginning of the calibration, the amplifiers (for Ur and Ir) are initiallised 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 16-33% and the range for the measured voltage value is from 66–83%. The current value is displayed accordingly in the 0-5V range at the actual value output and the voltage is displayed in the 5-10 V range. The measurements' zero point is around 5V. The amplifiers (for Ur and Ir) are initialised with minimum amplification at the start of the calibration process. 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.

3.2.3. Determining the phase shift: During this step, the phase shifts between Ur and Ir, caused by the transformer, are measured and corrected. The controller automatically sets the optimum scan times for Ur and Ir. The actual value display and the actual value output show the phase shift. A display of approx. 50% of the controller's set temperature range or a signal of approx. 5V corresponds to the optimal value.

3.2.4. Determine reference resistance: The reference resistance of the heat conductor (Rref) is determined in this step. A reference temperature of 0-50°C must be set in the controller (→ 5.7.2.), for the calibration process. During calibration, the heat 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 heat conductor's R20 is directly determined as the reference resistance. If a heat conductor temperature other than 20 °C has been selected for calibration, then the determined reference resistance corresponds to the temperature coefficients above or below the value for the R20. The reference resistance is displayed for one second at calibration stage 4 as an actual value and at the actual value output. At a reference temperature of 20°C, 70%-80% of the set temperature range is displayed as an actual value or the actual value output voltage amounts to 7-8V. For the entire range of the reference temperature of 0-50°C the actual value display is within a range of 60%-100% and the voltage at the actual value output is within a range of 6-10V.

3.2.5. Temperature comparison time: (→ 5.7.3.) The aim of the temperature reference time is to ensure that the reference resistance can only be detemined when the heat conductor has completely cooled down. During the comparison period, the actual value display goes down to from 100% to 0% of the controller's set temperature range. During this reference 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 reference time.

3.2.6. Check reference resistance: Here the reference resistance is checked after the temperature comparison period has expired. If calibration takes place on a heat conductor that has cooled down still further during the course of the temperature reference time, the entire calibration will be discarded and the procedure automatically restarted. Once the reference resistance has been successfully checked from the set reference temperature, the temperature coefficient selected and the calculated reference resistance, the PIREG-D2 calculates the heat conductor’s R20 (resistance at 20°C).
The reference resistance measured is displayed for one second at the actual value output. The same voltage set at the actual value output as when the reference resistance was determined (→ 3.2.4).

3.2.7. Determine the P-factor: The P-factor of the sealing transformer/heat conductor combination is determined by specific heating at a constant actuating variable. The heat 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 heat conductor and the measurement of the temperature increase of the heat conductor. The P-factor for the PIREG-D2 is calculated from this.
In the case of highly adverse conditions in the sealing transformer and heat conductor combinations or the mains supply, the PIREG-D2’s P-factor can be corrected manually within a range of 30…250 % (→ 5.5.4.).

3.2.8. Set initialising remanence: The soft switch-on process is performed by setting the initialising remanence, in order to connect the sealing transformer after calibration, without current surges. The initialising remanence setting lasts 80 ms with EI transformers and 300 ms with toroidal core transformers (at a mains frequency of 50Hz).

3.2.9. Temperature-coefficient correction: Tolerances in the temperature coefficients can be corrected by this feature. These result from the dispersion of the metallurgical composition of the heat conductors.
In Calibration Step 9, the heat conductor is heated up in eight temperature stages by the PIREG-D2. The PIREG-D2 then compares its actual-value temperature with the heat conductor's actual temperature, which is transmitted to it as a set value or directly as the value of the external thermometer exTM.
The length of the steps is a result of the selected temperature range. The first temperature step is always 50°C. The temperature of the eighth temperature step is 20% below the final value of the selected temperature range. The six other temperature steps are equidistant between these. For the 300 °C temperature range, this gives the temperatures 50, 77, 104, 131, 159, 186, 213 and 240°C. For the 500 °C temperature range, this gives the temperatures 50, 100, 150, 200, 250, 300, 350 and 400°C.
The heat conductor's actual temperature must be set as a set value in the display unit or directly reported back to the PIREG-D2 as a measurement by the external thermometer exTM via the RS232 interface. Deviations of up to ±20 % between the calculated actual value temperature and the actual temperature of the heat conductor can be corrected (→ 5.7.4.). The correction process is controlled by the "Start"/"Heat" selection point on the Working menu, the "Start" sinal or by command. When the TK correction heating period is set accordingly, the correction process can also run automatically.
The three relay outputs of the PIREG-D2 can be programmed to provide a control message to open and close the heat seal jaw bar, while the temperature-coefficient correction is in process. When programmed, the chosen relay is actuated after a delay of 250 ms and when the actual temperature has exceeded 95% of the desired temperature. The chosen relay is released when the heat seal band's actual temperature is reported back to the PIREG-D2. The next heat-up stage is approached using the Tc correction control message with a delay of 250ms to allow the heat seal jaw to open before heating. (from V1.00/1.07/1.29/1.23)
The temperature coefficient correction can be saved, so that it does not have to be performed again in the case of a new calibration process, but only when the heat conductor is changed (→ 5.2.5.).

Performing the temperature coefficient correction:
- manual operation: The heat conductor's actual temperature is reported back to the PIREG-D2 as a set value. There is a switch to the next temperature heating step, with the rising edge of the "Start" signal. After the heat conductor has reached a uniform temperature the temperature set as the set value is taken over as the actual temperature of the heat conductor with the falling edge of the "Start" signal. Operation can also occur with the "Start"/"Heat" selection point in the working menu (→ 5.2.).
After heating up to the next temperature stage, for the temperature to be accepted it is necessary to wait until the heat conductor has actually accepted the new temperature. The actual value display and the actual value output show the PIREG-D2's corresponding actual value temperature, still uncorrected.
- manual operation with the external thermometer exTM: The temperature coefficient correction is also controlled by the "Start" signal resp. the "Start"/"Heat" selection point in the working menu, as described above. The heat conductor's actual temperature is measured with the thermometer exTM which is connected to the PIREG-D2's RS232 interface. The PIREG-D2 automatically tries to establish a connection with the thermometer exTM at the beginning of the temperature coefficient correction. As soon as a connection to the thermometer exTM has been established the measured value is displayed (→ 5.2.).
If the thermometer DTM3000 is using as external thermometer exTM, the PIREG-D2 automatically set temperature unit to the selected temperature unit of the display unit (→ 5.8.). Ensure that the same temperature unit is set on the TM6 thermometer and on the PIREG-D2 display unit (→ 5.8.).
- automatic temperature coefficient correction: The external thermometer exTM must be connected to the PIREG-D2 for the automatic temperature coefficient correction and the set value for the Tc correction heating time must be greater than zero. The heating time is the period until the heat conductor has reached a uniform temperature at a temperature stage. The heating time is set in the display unit or by command (→ 5.7.3.). The PIREG-D2 runs through the automatic temperature coefficient correction on its own and remains at each temperature stage for the preset heating time

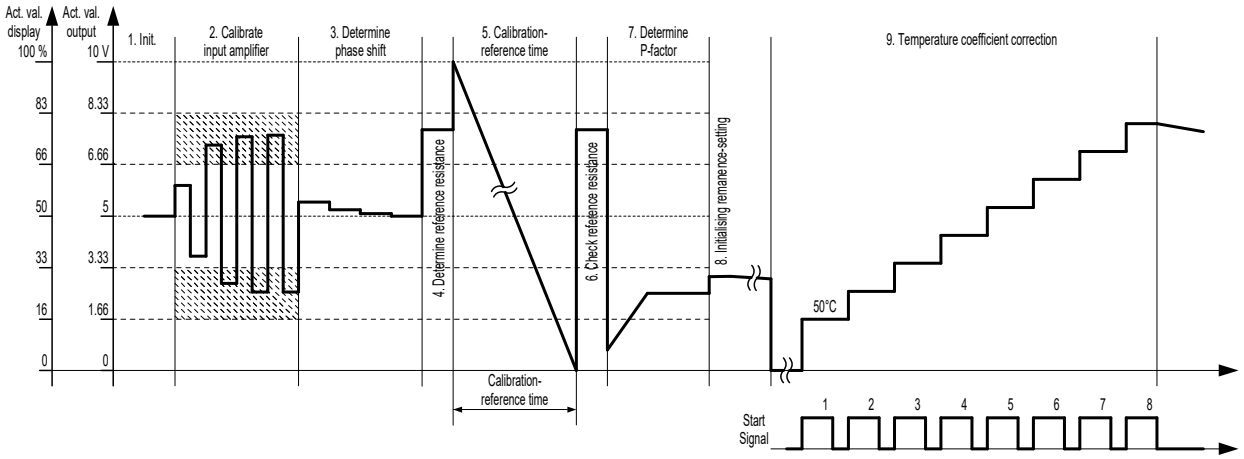


Figure 1: Calibration sequence

For each calibration, Calibration Steps 1 to 8 must be completed by the controller. Step 9 is an optional calibration function (→ 5.7.4.). If an error occurs during the individual calibration steps, the PIREG-D2 stops the calibration procedure and begins a new attempt. After the fifth attempt it aborts the calibration process with an error message (→ 3.7.).
After successful calibration, the PIREG-D2 returns to the Off state.

So that the heat conductor's R20 reference resistance is set correctly, calibration must be performed when the heat conductor is at the reference temperature detected. The time required for a calibration process is influenced by various factors. The voltage level on the heat conductor, the current passing through it, the Ur and Ir phase shift and the P-factor of the sealing transformer-heat conductor combination determine the duration of calibration. The controller requires a maximum of 46 resp. 60 s for one calibration process. (from V1.00/1.23/1.30/1.25)
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 230 resp. 305 s, depending on the temperature reference 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" or from the Calibration selection menu of the display unit.
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. Calibration can also be started in the Off- or error state from the Calibration selection menu on the display unit (→ 5.2.5.). 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.

3.2.10. Single-point temperature coefficient correction: With the single-point temperature coefficient correction, the heat conductor's temperature coefficient tolerances can be corrected for just one operating point. For this operating point the heat conductor's actual temperature is reported back to the PIREG-D2 as a set value or directly as a measurement of the thermometer exTM. The single-point temperature coefficient correction is carried out outside the standard calibration and is started from the Off-state. The single-point temperature coefficient correction has one Off- and one On-state. After the single-point temperature coefficient correction has been started, the PIREG-D2 is in the Off state. When the PIREG-D2 is in the On-state, the heating conductor is heated to the temperature which was set as the set value in the Off-state. After heating the temperature is only accepted when the heating conductor has definitely reached the temperature. The actual value display or the actual value output show the PIREG-D2's actual value temperature, still uncorrected. The single-point temperature coefficient correction is ended upon exiting the On-state. The correction process is controlled by the "Start"/"Heat" selection point in the working menu, the "Start" single or by command. When the TK correction heating period is set accordingly, the one-point temperature coefficient correction process can also run automatically.
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 temperature coefficient correction can only be performed if the normal temperature coefficient correction covering eight points (→ 3.2.9.) has not been carried out during calibration. The single-point temperature coefficient correction is reset at each calibration.
The temperature coefficient correction can be saved, so that it does not have to be performed again in the case of a new calibration process, but only when the heat conductor is changed (→ 5.2.5.)

Performing the single-point temperature coefficient correction:
- manual operation: Single-point temperature coefficient correction is started from the Calibration selection menu on the display unit (→ 5.2.5.) of the PIREG-D2 or by command when the PIREG-D2 is in the Off-state. The PIREG-D2 retains the temperature set as target 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-D2 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-D2 calculates the correction factors for the single-point temperature coefficient correction and saves these values, if "Save" was selected as calibration mode. The single-point temperature coefficient correction using the "Start"/"Heat" option from the Working menu is controlled as described above. The status of the single-point temperature coefficient correction is indicated by the corresponding operating status symbols in the symbol field of the Working menu on the display unit (→ 5.2.).

- manual operation with the external thermometer exTM: The single-point temperature coefficient correction is started and controlled as described above. The actual temperature of the heating conductor is measured with the thermometer exTM which is connected to the RS232 interface of the PIREG-D2. The PIREG-D2 automatically tries to establish a connection with the thermometer exTM at the beginning of the singlepoint temperature coefficient correction. As soon as a connection to the thermometer exTM has been established the measured value is displayed (→ 5.2.).

- automatic single-point temperature coefficient correction: The PIREG-D2 must be connected to the thermometer exTM and the set value for the Tc correction heating time must be greater zero for the automatic single-point temperature coefficient 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 in the display unit or by command (→ 5.7.3.). Automatic single-point temperature coefficient correction is started as described above for manual operation. The PIREG-D2 undergoes the automatic single-point temperature coefficient correction independently and remains in the On state for the preset heating time.

3.2.11. P-factor correction: The P-factor correction is used to later correct the calibrated P-factor manually (→ 3.2.7.), in the case of the sealing transformer-heat conductor combination or the mains connection being in highly adverse conditions. The correction range is 30…250 %.

The P-factor correction is set in the display unit or by command (→ 5.2.5.). The P-factor correction value is not reset during a calibration process, since it is system-dependent.

3.3. Off-state

In the Off state, the PIREG-D2 continually measures the heat conductor's resistance, calculates its temperature from that and shows the latter in the display as an actual value or issues it as an actual value.

For this purpose, a positive and negative power line half-wave always of the same polarity with a fixed current conduction angle (1.8 ms at 50 Hz line frequency) is applied to the transformer, for each measurement. The intervals between the measurements depend on the heat conductor temperature. When the heat conductor has reached a temperature of 20°C, the time between measurements is 1.5 s. At a temperature of 300°C, the time between measurements is only 100 ms.

Since power is introduced to the heat conductor for measuring the resistance, it heats up in the Off state, depending on the heat conductor voltage.

The controller switches from the Off state to the On state as soon as the "Start" signal is applied. If the "Calibration Start" signal is applied, the PIREG-D2 switches to calibration mode and returns to the Off state when calibration has been successful. The PIREG-D2 remains in the Off state, even when the "Calibration Start" signal is still present (for evaluating the rising edge). A corresponding control is also possible with the "Start"/"Heat" selection point in the Working menu (→ 5.2.). Single-point temperature coefficient correction can be started from the Calibration selection menu of the display unit of the PIREG-D2 when in the Off-state (→ 5.2.5.).

3.2.1. Measurement pulse-pause: In the off state, the measurement pulse-pause can be switched on and off per command or, if configured, via the control inputs (→ 5.6.2.). When measurement pulse-pause is activated, the PIREG-D2 stops sending measurement pulses to the sealing transformer in order to determine the temperature of the heating conductor. (from V1.00/1.23/1.30/V1.25)

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-D2 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-D2 offers the possibility to save two calibrations and to switch between them (from V1.00/1.23/1.30/V1.25). The calibration switching is activated by command or by configuring the control inputs (→ 5.6.2.). In the off state, a changeover between the two calibrations is made by command or, if configured accordingly, via the control inputs. For the calibration switchover, a delay time can be set in which the PIREG-D2 executes a correspondingly long measuring pulse-pause during the switchover.

The heating conductors of the two calibrations must be the equal for the temperature coefficient, temperature range and the other calibration settings (→ 3). A possible temperature coefficient correction is performed separately for each calibration. The PIREG-D2 performs its own calibration for each heat conductor, which is also stored separately. The validity of the calibration settings is saved for each calibration. If

the settings change, the validity of both calibrations will be reset and a new calibration will have to be performed for both heating conductors, starting with calibration 1.

3.4. On state

In the On-state, the PIREG-D2 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. A corresponding control is also possible with the “Start”/”Heat” selection point in the Working menu (→ 5.2.).
When sequence control is activated the On state additionally consists of the Start delay and the cooling phase (→ 5.4.).

3.5. Sequence control

The sequence control can be switched on and off (→ 5.4.). If the sequence control is switched off, then a sealing process with the set desired temperature is activated and deactivated after the “Start” signal. If the sequence control is switched on, a sealing cycle with subsequent start delay, sealing time and cooling time will be started automatically after the “Start” signal.

3.5.1. Preheating: Preheating is used to preheat the heating element during a pause in a sealing process or a sealing cycle. Preheating is controlled via the “Preheat” signal. When the “Preheat” signal is applied, the PIREG-D2 adjusts the heat conductor temperature to the preset preheating temperature. The preheating temperature can be set irrespective of the desired temperature. Preheating is also possible when the sequence control is switched off.

3.5.2. Start delay: Start delay is the delay time after the “Start” signal has been applied and until sealing time starts. During the start delay the heat conductor is not heated by the PIREG-D2. If preheating has been switched on, it continues.

3.5.3. Sealing time: During the sealing time the PIREG-D2 adjusts the the heat conductor temperature according to the set target value. Depending on the settings the sealing time starts when this sequence phase is reached or after the actual temperature has exceeded 95% of the desired value.

3.5.4. Cooling phase: The sealing time is followed by the cooling phase. Depending on the setting the heating conductor is to cool down for a set time or to the preset temperature during the cooling phase. The cooling temperature can either be set as an absolute value or as percentage of the desired value.

3.6. Monitoring

3.6.1. Temperature monitor: The temperature monitor is a monitoring feature enabled and set in the display unit (→ 5.5.1) or by command. During the sealing process, the actual temperature value is monitored to ensure that it is within an temperature ok range. If the actual value comes out of the temperature ok range after expiry of the stabilisation time, the PIREG-D2 enters the Fault state, displaying Error 83 or 84. The stabilisation period is restarted, in the case of a change in the set value by over 2°C.

3.6.2. Heating monitor: The heating monitor is a monitoring feature enabled and set in the display unit (→ 5.5.2.) or by command. With this feature, the temperature rise is monitored after the “Start" signal has been applied. If the actual temperature value does not reach the set temperature ok range within the set heating period, the PIREG-D2 enters the Fault state, displaying Error 85. If the set value increases by more than 5°C, the heating monitor is restarted.

3.6.3. Start monitor: A sealing cycle can be aborted by the “Start” monitor. The sealing cycle is interrupted when the “Start” signal is no longer applied during the running sealing cycle. An Emergency Stop function will then be executed. (→ 5.5.)

3.6.4. Communication monitor: The communication monitoring is an additional monitoring function for the two interfaces of the controller PIREG-D2, which only with one command is independently activated and set for each interface. The communication monitor is an additional monitoring feature for the PIREG-D2 controller’s two interfaces, which are automatically enabled and set with one single command. This function monitors the communication via the interfaces. If communication via the interface is interrupted for a longer time than the set downtime, the PIREG-D2 enters Fault state.

3.7. Error state

The error state is indicated on the PIREG-D” 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, the calibration parameters and the monitoring functions.
The Alarm output and the Alarm LED are switched in the error state. 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 10…33 the error state cannot be cancelled with the “Calibration Start” signal.
In the error state the Error menu can be called from the display unit (→ 5.2.4.). Here, the error number, an error description and possible corrective actions are displayed.

3.7.1. Possible errors: Table 1

No.	Error	Actual value output	Corrective action
10	Device error	4.66 / 0 V	perform reset
21	internal error	4.00 V	perform reset
22	read-write error in the non-volat. Memory		
31	mains voltage too low	3.33 V	check mains connection and perform reset
32	mains voltage too high		
33	mains frequency error		
40	current signal Ir and voltage signal Ur too low	2.00 V	perform calibration and check heating circuit
50	voltage signal Ur too low	1.33 V	perform connection to voltage measurement Ur and calibration
60	current signal Ir too low	0.66 V	check connection to current measurement Ir and perform calibration
71	current signal Ir too high	5.33<>10 V	check heat conductor and perform calibration
72	voltage signal Ur too high		check connection to voltage measurement Ur and perform calibration
73	current sig. Ir and voltage sig. Ur too high		perform calibration
81	heat conductor temperature too high	2.66 V	check heat conductor and perform calibration
82	heat conductor temperature too low		
83	temperature monitor (→ 3.6.1.) temperature too high		check setting, check heat conductor and perform calibration
84	temperature monitor (→ 3.6.1.) temperature too low		
85	heating monitor (→ 3.6.2.)		
87	temperature step down (from V1.00/1.07/1.29/1.23)		loose contact, check heating circuit
88	temperature step up (from V1.00/1.07/1.29/1.23)		
90	data error - saved calibration values do not match setting	6.00<>10 V	perform calibration
91	communication monitor RS232 interface (→ 3.6.4)		check RS232 interface connection
92	internal communication monitor 1		perform reset
93	communication monitor USB interface (→ 3.6.4)		check USB interface connection
94	internal communication monitor 2		perform reset
95	communication monitor RS232 interface for exTM thermometer		check RS232 interface connection and exTM thermometer
	Calibration error:		
101	current signal Ir and voltage signal Ur too high	8.00<>10 V	check dimensioning
102	current signal Ir and voltage signal Ur too low		check heat conductor connection and dimensioning
103	current signal Ir too low and voltage signal Ur too high		check dimensioning
104	current signal Ir too high and voltage signal Ur too low		
105	R20 cannot be detected		
106	P-factor unable to be determined		
111	voltage signal Ur too low	7.33<>10 V	check connection to voltage measurement Ur and dimensioning
112	voltage signal Ur too high		check connection to voltage measurement Ur, heat conductor and dimensioning
113	voltage signal Ur unstable (from V1.00/1.01/1.19/1.18)		check connection to voltage measurement Ur

121	current signal Ir too low	6.66<>10 V	check current measurement Ir connection and dimensioning
122	current signal Ir too high		check heat conductor and dimensioning
123	current signal Ir unstable (from V1.00/1.01/1.19/1.18).		check current measurement Ir connection
131	reference temperature selected too high	8.66<>10 V	correct setting
132	range of temperature coefficient correction exceeded		repeat calibration
133	parameter error - constancy and dynamics of the selected temperature coefficients are below the temperature range		change settings

3.8. Relay functions

The following same functions can be set independently for each of the message and the two control relay outputs.

3.8.1. Temperature function: The relay is actuated if the actual temperature is in the “Temperature ok” range. A delay during which the actual temperature has stabilized can be set with the stabilization time. The holding function is an additional function during which the relay remains activated after the welding cycle and until start of the following welding cycle.

3.8.2. Sequence function: This relay function is used to set the conditions when the relay is actuated:
- Active upon “Start” signal: The relay is actuated as soon as the “Start” signal is applied and is released when the cooling time has elapsed.
- Active when temperature is reached: The relay is actuated when the actual temperature has exceeded 95% of the desired value and is released when the cooling time has elapsed.
- Active during heating phase: The relay is actuated while the welding time is running off.
- Active during cooling phase: The relay is actuated during the cooling phase.
- Calibration Ok: The relay is not actuated during calibration. It is actuated again after a successful calibration. End of calibration is indicated with the “Calibration Ok” function.
- Active while Alarm: The Relay is actuated while the error state.
- Active as Temperature-coefficient correction control message: The relay is used as control message to open and close the welding bar while the temperature-coefficient correction (8- point). The relay is actuated after a delay of 250 ms and when the actual temperature has exceeded 95% of the desired value. The relay is released when the heat conductor's actual temperature is reported back to the PIREG-D2. (from V1.00/1.07/1.29/1.23)

3.8.3. Time pulse function: The following switching pulses can be generated with the relays using the “Time pulse” function:
- Heating phase: The relay is actuated for the set pulse time when the sealing time starts, i.e. during heating of the heating conductor.
- Cooling phase: The relay is actuated for the set pulse time at the start of the cooling phase.
- Pulse end: The relay is actuated for 500 ms at the end of the cooling phase.

3.9. Display functions

3.9.1. Languages: The following languages can be set for the PIREG-D2 display unit:

German English French Italian Dutch Russian

3.9.2. Brightness: The brightness of the background lighting is set as a percentage value in a range of 30…100 % in 5%-steps.

3.9.3. Hold mode: If the “Hold” mode is activated the actual temperature value which was measured at the end of the welding process or the welding time will also displayed. You can select whether the measured actual value is only displayed for 2 seconds or until the following welding process or welding cycle is started.

3.9.4. Cycle counter: The PIREG-DIS display unit has a cycle counter (0…9999999) for counting the welding cycles. Der Zyklen-Zähler kann zurückgesetzt werden. Bei einem Überlauf beginnt der Zähler wieder bei Null.
In addition the PIREG-DIS display unit has a total cycle counter (0…999999999) which is used as „service life counter“, but cannot be reset.

3.9.5. Saving: With the display unit settings can be saved and restored. One distinguishes between parameter sets (→ 5.9.1.) and factory settings (→ 5.9.2.). The settings for different applications of the welding machine are saved using the five parameter sets so that the machine can be adjusted quickly when the application was changed. One basic setting of the machine can be saved and restored with the factory settings. In addition the PIREG-DIS display unit can be reset to its factory settings.

3.9.6. Releases: The display unit has three release levels (→ 5.8.4.) with which different user-dependent operating levels can be realized. Each release level has its own release number. All release numbers are

factory-set to “0000”. This means that all release levels are activated after the display unit was switched on and the display unit can be adjusted. The following settings are assigned to the individual release levels.

- Level 0: Control via the inputs and buttons of the display unit (unprotected).

- Level 1:
- Setting of level 0
- Target value
- Welding time and cooling time
- Reference temperature for calibration
- Reading parameter sets 1…5

- Level 2:
- Setting of level 1
- all controller settings
  (settings of the TC temperature, time, calibration and target value)
- Saving parameter sets 1…5

- Level 3:
- Setting of level 2
- all settings of the PIREG-D2

3.9.7. Temperature unit: With the display unit the temperature values can be indicated in [°C] or [°F] (→ 5.8.). The temperature unit is only used for display of the temperature values. The display unit continues to operate internally with the unit [°C] even when [°F] is displayed which results in temperature leaps of 2 °F when the unit [°F] is set as temperature value.
If the thermometer DTM3000 is using as external thermometer exTM, the PIREG-D2 automatically set temperature unit to the selected temperature unit of the display unit. When working with the TM6 thermometer the same temperature unit must be set on the thermometer and on the PIREG-D2 display unit.

4. Operation

4.1. Keys

The following five keys are used for operating the PIREG-D2 display unit:

Up ▲ Down ▼ Right ▶ Left ◁ Accept Ok

4.1.1. Cursor: The cursor ▷ is moved to the possible setting items using the arrow keys in the display. There are numerical values which can be set, options which can be selected and menu items for calling another menu. An empty triangle ▷ is used as symbol for the cursor. The cursor remains on the menu item which was selected last after the menu was changed.

4.1.2. Setting numerical values: Move the cursor ▷ to the numerical value to be set and confirm with the Ok button. As soon as the value is changed using the buttons ▲ and ▼ the value starts flashing at a frequency of 1 Hz indicating that the value was changed. The value is accepted after the Ok button was pressed and stops flashing. Press the ◁ key to cancel the changes and to restore the original value.
If the ▲ and ▼ buttons are pressed for more than 1 second the numerical value starts to run at a rate of change of 10 dig/sec.. If the button is pressed more than 3 seconds the rate of change increases to 100 dig/sec..

4.1.3. Selecting functions: Move the cursor ▷ to the item to be selected. Press the Ok button to select the item. A filled triangle ▶ is used as selection cursor. If the cursor ▷ and the selection cursor ▶ are on the same function, the display changes between the selection cursor and the cursor at a frequency of 1Hz.

4.1.4. Acceptance of the settings: The set numerical values are accepted by pressing the Ok button. If the setting is not accepted within 3 seconds after it was changed with the Ok button, then the setting will be discarded and the old value will be further used.
The numerical values can also be accepted automatically, i.e. the setting will be accepted if it was not changed for more than 3 seconds. The automatic acceptance is activated and deactivated in the “Operating” menu (→ 5.8.3.).

4.1.5. Menu change: Move the cursor ▷ to the menu item if you want to change the menu. If the menu item is also a option, you should use the button ▶ to change the menu. Press the Ok button if it is a mere menu item. Exit the menu with the button ◁.
Switch to the last changed setting in a menu by pressing the ▲ + ▼ simultaneously in the Working menu.

4.1.6. Menu return: If no changes were made, the program will return from all menus to the Working menu after 20 seconds at the latest. Press the key combination ◁ + ▶ to jump to the position in the menu where the program returned to the Working menu. The menu return can be activated and deactivated in the Operating menu (→ 5.8.3.).

4.1.7. Locking: A locking which prevents unintentional changes of the settings is provided which can be activated and deactivated by pressing the key combination ◁ + ▼ + Ok. First, however, the locking must be activated in the Display Settings menu (→ 5.8.).

4.1.8. Execution prevention: If a setting or menu change is not possible, the cursor ▷ changes to a diagonal cross ✕ for one second to indicate this condition.

Note: During calibration and On state, most settings on the PIREG-D2 can not be changed.

4.2. Leuchtdioden

4.2.1. Power: The green LED “Power” indicates that the mains voltage is applied to the PIREG-D2.

4.2.2. Heat: The yellow LED “Heat” indicates that a welding cycle is executed if the sequence control is switched on. If the sequence control is switched off, this LED only signalizes the welding process itself.

4.2.3. Alarm: The red LED “Alarm” indicates that an error is present and that the PIREG-D2 is in the fault condition. The fault itself is shown in plain text in the Error menu (→5.2.4.).

4.3. Inputs

4.3.1. Start inputs: The PIREG-D2 has two Start inputs. On the one hand, there is the Start input (3) in which the control operates with an external voltage. On the other hand, there is the Start-Contact input (7) with control occurring by the input, for example, being connected to AGND (2) by a switch.
By applying the high signal to the Start input (3) or applying the connection of the Start-Contact input (7) to AGND (2), a sealing process or a sealing cycle is started. If the sequence control is switched on and the “Start” monitoring function is deactivated, a sealing cycle will only be started with rising edge.
If the normal temperature coefficient correction is selected during calibration via eight points, the correction process is also controlled by the Start inputs, during manual operation. The single-point temperature coefficient correction is also controlled by the start inputs.

4.3.2. Preheat inputs: The PIREG-D2 has two preheat inputs. On the one hand, there is the Preheat input (22) in which the control operates with an external voltage. On the other hand, there is the Preheat-Contact input (19) with control occurring by the input, for example, being connected to AGND (2) by a switch.
If there is a high signal applied to the Preheat input (22) between two sealing processes or two sealing cycles or the Preheat-Contact input (19) is connected to AGND (2), the PIREG-D2 regulates the heat conductor temperature to the set preheat temperature (→ 5.4.1.).

4.3.3. Calibration Start Input: With a high signal at the Calibration Start input (25) in the Off and Fault states, the PIREG-D2 switches to the calibration state. Here, the controller is adapted to the combination of heat conductor and sealing transformer. During the controller's calibration function, the signal can redescend to low.

4.3.4. Reset Input: With a high signal at the Reset input (26), the PIREG-D2 is reset to the Power On state in the event of a fault even without switching off at the mains.

The following two input functions can be configured independently for each of the four inputs of the PIREG-D2 instead of the above basic function (→ 5.6.2):

4.3.5. Measurement pause: With a high signal at the correspondingly configured input in the Off state the PIREG-D2 stops sending the measurement impulse to the sealing transformer. Therefore it is possibly to work at the head conductor circuit without to generate an error. (from V1.00/1.23/1.30/1.25)

4.3.6. Calibration switching: With a high signal at the correspondingly configured input in the Off state the PIREG-D2 change from calibration 1 to the calibration 2. With a low signal the PIREG-D2 change back to the calibration 1. (from V1.00/1.23/1.30/1.25)

4.3.8. Set value input: At the set value input (23) the temperature set value may also be set, as an alternative to setting the set value in the PIREG-D2's display unit. An analogue voltage is used for the setting at the set value input. The selection regarding which setting possibility should be used for the temperature set value is made in the display unit (→ 5.7.5.) or by command.
- Internal: The set value is set in the PIREG-D2's display unit (→ 5.2.)
- U set value: Set the temperature set value with an analogue voltage. The voltage set value range is 0-10V. The only selected temperature range is linearly imaged to the maximum set-value voltage , i.e. 10V at the set value input corresponds to 300°C, if the selected temperature range is 300°C.
- R set value: The temperature set value is set by a potentiometer. in the case of the potentiometer, the cutter is linked to the set-value input (23), the CW connection to the actual value output (24) and the CCW connection to the GND connection (20). In this setting, the actual value output operates as a reference voltage source with an output voltage of 10V. Pay attention to the direction of rotation when connecting the potentiometer. In the case of clockwise rotation on the potentiometer, the voltage should increase at the set value input. The chosen temperature range is imaged to the set value voltage, as described above.

4.4. Outputs

4.4.1. Actual Value Output: The actual value output (24) supplies a voltage in the range 0-10V, proportional to the heat conductor's temperature. The voltage range relates to the selected temperature range, i.e. 10V at the actual value output corresponds to 300°C, if the selected temperature range is 300°C. The actual value output can supply a maximum current of 5 mA.
While the set value output is being used with a potentiometer ("R set value" setting) the actual value output acts as a constant voltage source with an output voltage of 10V.

4.4.2. Message relay output: Message relay output 1 (21) provides a NO contact, which works against the GND contact (20). It can be set whether the contact is open or closed when the relay is actuated. The switching capacity of the relay contact is only designed for message functions. The relay contact has been factory-set in such a way that the relay contact is closed when the relay is pressed.

4.4.3. Control relay outputs: The control relay outputs 1 (16/17/18) and 2 (27/28/29) each provide a change-over contact. The switching capacity is only designed for control functions.

4.4.4. Alarm output: The alarm output (5/6) is a relay switching contact. It can be set to determine 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.

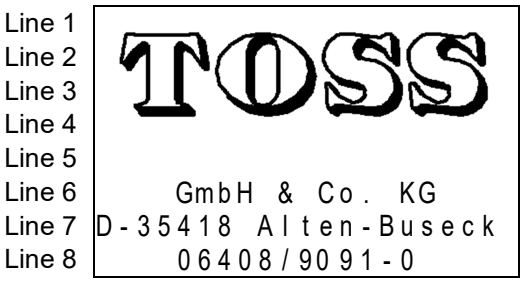
4.4.5. ELR output: The ELR output (1/2) is used to control an external solid-state relay, which is used as an actuator instead of the controller's internal actuator. Using the external solid-state relay, it is possible to connect combinations of the conductor and sealing transformer to loads which are greater than internal actuator's permitted load.

4.5. Interfaces

We will provide you with the detailed interface description of the control system with integrated PIREG-D2 resistance temperature controller for packaging machines if required.

5. Menu structure

5.1. Switching on

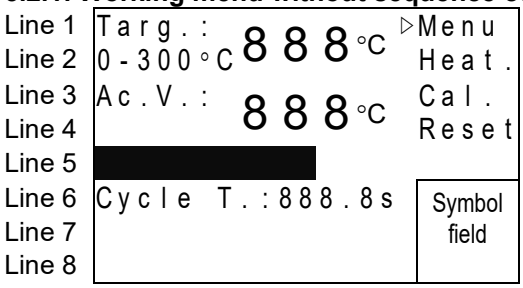


After switching the display unit on, the initial screen will be displayed for 2 seconds before the Working menu is called automatically (→ 5.2.).

Line 1…4: Logo of the Toss company
Line 6: Legal form of the Toss company
Line 7: Seat of the company incl. zip code and town
Line 8: Telephone number of the Toss company

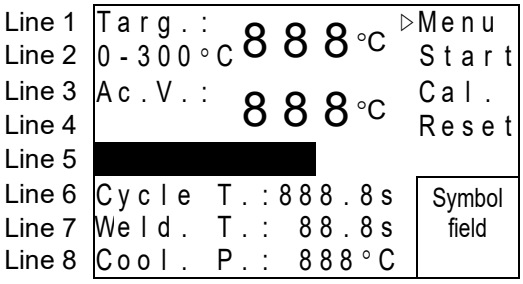
5.2. Working menu

5.2.1. Working menu without sequence control



Line 1…2: Display and adjustment of the desired value as numerical value. The adjustable desired value range is shown in line 2.
Line 3…4: Actual value display; when the Hold mode is activated “Hold” is displayed in line 4 as long as the actual value is maintained.
When the external thermometer exTM is connected the measured value of the thermometer exTM “888.8°C” is displayed in line 4 during standard and single-point temperature coefficient correction.
Line 1…4: Four items for selection are displayed on the right half. Click the “Menu” menu item to call the Selection menu (→ 5.3.). If the locking was activated then the text „####“ will be shown instead of the text “Menu”.
The following option “Heat.” or “Start” is only available if the Start function (→ 5.4.2.) was activated.
- without sequence control: Select the “Heat” option to execute a manual welding process and keep the Ok button pressed.

5.2.2. Working menu with sequence control



- with sequence control: If the Start function “Start welding cycle” is selected for the sequence control, a welding cycle will be started manually with the “Start” selection point. If “Heating only” is selected for the Start function a welding process will be executed manually with the “Weld” option as long as the Ok button is pressed.
The “Cal.” menu item calls up the Calibration selection menu (→ 5.2.5.).
Select “Reset” to reset the display unit and the controller.
Line 5: Bar chart of the actual value.
Line 6: Display of the cycle time, i.e. the duration (0…999.9s) of the last welding process or welding cycle.
During automatic temperature coefficient correction with the thermometer exTM the ending TC correction heating time is displayed instead of the cycle time.
Line 6…8: A symbol field for the operating status is shown on the right half. This symbol field can be selected in the case of an alarm and an Error menu (→ 5.2.4.) with an error description and possible corrective actions will be displayed.
- with sequence control:
Line 7: Welding time of the sequence control; the numerical value can be changed either in the Working menu or in the Welding menu (→ 5.4.4.). The value of the ending welding time which – depending on the setting - is counted up or down can be displayed here during the welding process.
Line 8: Cooling phase of the sequence control; the value can be changed either in the Working menu or in the Cooling Phase menu (→ 5.4.5.).
The value of the ending cooling time which – depending on the setting - is counted up or down during the cooling process is displayed here. This requires that the cooling time was selected for the cooling phase.

5.2.3. Symbols for the operating status

Establishing a connection: The controler establishes a connection via the RS485 interface.

Pause: The control is paused between two welding processes or welding cycles.

Preheating pause: The preheating is switched on during the pause, but is not active.

Measurement pause: The measurement pause is actvated. The controller stops sending the measurement impulse to the heating conductor

Calibration switching: Display the active calibration at active calibration switching in the upper right corner of the symbols of the operatus status.

Preheating active: The preheating is switched on during the pause and is active.

Start delay: The Start delay as part of the sequence control runs down.

Welding: A welding process is carried out when the sequence control is switched off. When the sequence control is switched on, the welding time runs down.

Cooling phase: The Cooling phase as part of the sequence control runs down.

Alarm: An error has occurred. This symbol field can be selected in the case of an alarm and an Error menu with an error description and possible corrective actions will be displayed.

Calibration: The controller executes a calibration. The digit on the right-hand side indicates the calibration step which is currently being carried out (→ 3.2.).

Tc Start correction: Calibration is at the 9th step of the Tc correction and waits for the Start signal in order to start heating.

Tc Heating correction: The Tk correction is executed and the heating element is heated to the corresponding temperature step (1…8), example here: step 3.

Tc Correction acceptance: The Tc correction is executed and the actual temperature measured of the heating element was accepted for the corresponding temperature step, example here step 3.

Single-pt. Tc correction Off: The single-point Tc correction is started. The target value for heating in the On-state is set. Correction is switched on with the “Start” signal.

Single-pt. Tc correction On: The heating element is heated to the temperature set as the target value in the Off state.

5.2.4. Error menu

Line 1	ERROR MENU No.: 40
Line 2	Cur. signal Ir and
Line 3	voltage signal Ur
Line 4	to low
Line 5	Calibrate
Line 6	Check heating circuit
Line 7	
Line 8	

Press the button ◁ to return to the Working menu (→ 5.2.1./5.2.2.).

Line 1: Menu name, the error number is displayed on the right hand side.

Line 2…8: First, there is an error description and then possible corrective measures are displayed.

5.2.5. Kalibrierungs-Auswahlmenü

Line 1	CAL. SELECTION MENU
Line 2	▷Calibration
Line 3	Single-point Off
Line 4	tc correction
Line 5	Tc correction ▶Off
Line 6	storage: On
Line 7	P-factor-correction
Line 8	Value: 888% 30-250%

Press the button ◁ to return to the Working menu (→ 5.2.1./5.2.2.) without starting a calibration.
Line 1: Menu name
Line 2: Select “Calibration” to activate a standard calibration process of the controller. The Calibration Information menu (→ 5.2.5.1.) where the calibration settings are shown is opened before calibration is started.
Line 3…4: Option for starting the single-point temperature coefficient correction; after start of the correction the Working menu (→ 5.2.1./5.2.2.) is recalled automatically. The status of the single-point TC correction is displayed on the right hand side.
Line 5…6: Options “Activating and deactivating saving of the TC correction” for standard and single-point TC correction.
Line 7: Name of the following adjustment possibility.
Line 8: Adjustment of the correction value for the P-factor correction. When the P-factor correction is deactivated, “Off” will be displayed instead of a number value. The adjustable correction range is displayed on the right hand side.

5.2.5.1. Calibration Information menu

Line 1	CAL.-INFO. ▷Start
Line 2	Tc: Alloy A20
Line 3	Temp. range: 300°C
Line 4	Ref. temp.: 20°C
Line 5	Compare time: 15s
Line 6	Typ of Cal.: Save
Line 7	Tc correktion: Off
Line 8	Transform.: EI core

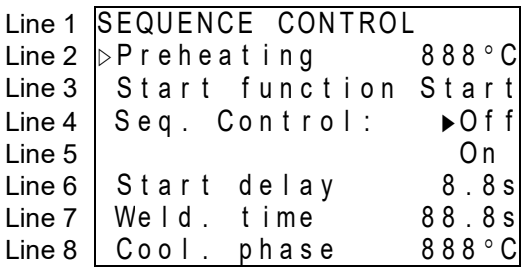
Press the button ◁ to return to the Calibration selection menu (→ 5.2.5.) without starting a calibration.
Line 1: Menu name and “Start” option for starting the calibration. The Working menu (→ 5.2.1./5.2.2.) is recalled automatically when starting a calibration.
From the Calibration Information menu you can directly call up the Settings menus and change the settings before a calibration.
Line 2: Menu item and display of the selected temperature coefficient or material of the heating band (→ 5.7.1.)
Line 3: Menu item and display of the selected temperature range (→ 5.7.2.)
Line 4: Menu item and display of the selected reference temperature for calibration (→ 5.7.2.)
Line 5: Menu item and display of the selected calibration reference time (→ 5.7.3.)
Line 6: Menu item and display of the selected calibration type (→ 5.7.4.)
Line 7: Menu item and display whether the standard Tc correction is used for calibration or not (→ 5.7.4.)
Line 8: Menu item and display of the selected transformer type (→ 5.7.4.)

5.3. Selection menu

Line 1	SELECTION MENU
Line 2	▷Sequence control
Line 3	Control
Line 4	In-/Output
Line 5	Controller setting
Line 6	Display setting
Line 7	Storage
Line 8	Information

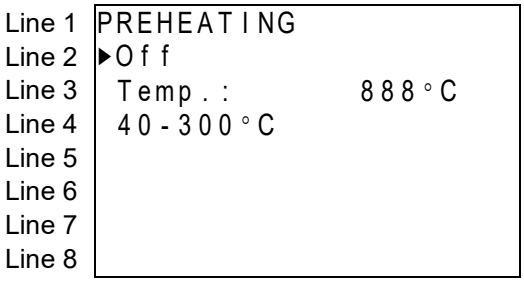
Press the button ◁ to return to the Working menu (→ 5.2.1./5.2.2.).
Line 1: Menu name
Line 2: Menu item “Sequence control” (→ 5.4.)
Line 3: Menu item “Monitoring” (→ 5.5.)
Line 4: Menu item “In-/Output setting” (→ 5.6.)
Line 5: Menu item “Controller setting” (→ 5.7.)
Line 6: Menu item “Display setting” (→ 5.8.)
Line 7: Menu item “Storage” (→ 5.9.)
Line 8: Menu item “Information menu” (→ 5.10.)

5.4. Sequence Control menu



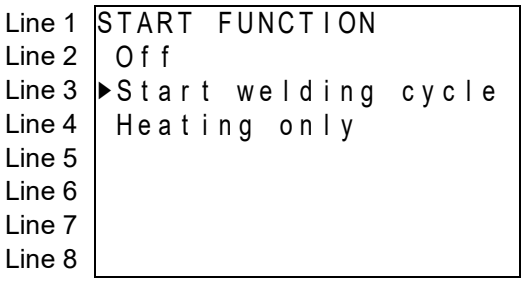
Press the button ◁ to return to the Selection menu (→ 5.3.).
Line 1: Menu name
Line 2: Menu item “Preheating” menu (→ 5.4.1.); the preset preheating temperature or the status “Off” is displayed on the right-hand border.
Line 3: “Start function” menu item (→ 5.4.2.); the preset Start function (“Start”/”Heat.”) is displayed on the right-hand border.
Line 4…5: Options for switching the sequence control on and off
Line 6: Menu item “Start Delay” menu (→ 5.4.3.); the preset start delay time or the status “Off” is displayed on the right-hand border.
Line 7: Menu item “Welding Time” menu (→ 5.4.4.); the preset welding time is displayed on the right-hand border.
Line 8: Menu item “Cooling Phase” menu (→ 5.4.5.): the set parameters (absolute or relative cooling temperature or cooling time) are displayed on the right-hand border.

5.4.1. Preheat menu



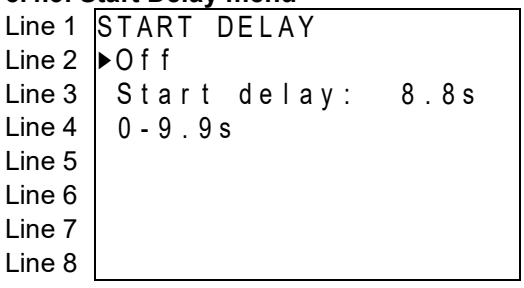
Press the button ◁ to return to the Sequence Control menu (→ 5.4.).
Line 1: Menu name
Line 2: Menu item “Preheat” deactivated
Line 3…4: Option for activating the preheating and setting the preheating temperature. The preheating temperature can also be set when the preheating function is switched off. The adjustable range is shown in line 4. The maximum adjustable preheating temperature is a result of the selected temperature range.

5.4.2. Start Function menu



Press the button ◁ to return to the Sequence control menu (→ 5.4.).
Line 1: Menu name
Line 2: Option for deactivating the Start function. No welding cycle or heating can then be started from the Working menu.
Line 3: “Start welding cycle” option; with this setting a welding cycle which corresponds to the settings in the sequence control is started with “Start” in the Working menu (→5.2.2.).
Line 4: “Only heating” option; with this setting a welding cycle is executed manually with “Heat.” in the Working menu as long as the button Ok is pressed.

5.4.3. Start Delay menu



Press the button ◁ to return to the Sequence Control menu (→ 5.4.).
Line 1: Menu name
Line 2: Option “Start delay” deactivated
Line 3…4: Option for activating the “Start delay” and setting the “Start delay time”. The “Start delay” can also be set when the “Start delay” function is switched off. The adjustable range is shown in line 4.

5.4.4. Welding Time menu

Line 1	WELDING TIME
Line 2	Welding time:▶ 88.8s
Line 3	0-99.9s Extern
Line 4	Start of- ▶with start
Line 5	welding with temp.
Line 6	time: reached
Line 7	Display- ▶Off Up
Line 8	Counting: Down

Press the button ◁ to return to the Sequence Control menu (→ 5.4.).
Line 1: Menu name
Line 2…3: Options of the “Welding time” function. Can be set via the time (line 2) or externally via the “Start” signal. The welding time is as long as the “Start” signal is applied. Setting of the welding time: the adjustable range is shown in line 3.
Line 4…6: Options for the start conditions of the welding time if the welding time is controlled via the time. If the function “when temperature reached” is selected the welding time will start when the temperature of the heater band exceeds 95% of the desired value.
Line 7…8: Options for display counting in the Working menu (→ 5.2.2.) during the welding process.

5.4.5. Cooling Phase menu

Line 1	COOLING PHASE
Line 2	Abs.cool temp.: 888°C
Line 3	Cooling temperature:
Line 4	▶Absolute: 50-300°C
Line 5	Relative: 40-100%
Line 6	C.off time: 0-99.9s
Line 7	Display- ▶Off Up
Line 8	Counting: Down

Press the button ◁ to return to the Sequence Control menu (→ 5.4.).
Line 1: Menu name
Line 2: Setting of the selected cooling phase function: absolute cooling temperature, relative cooling temperature and cooling time. The text on the left hand side and the format of the setting value on the right hand side are adapted to the selection.
Line 4: Option for the Absolute Cooling Temperature function. The adjustable temperature range is displayed on the right hand side.
The maximum adjustable absolute cooling temperature is a result of the selected temperature range.
Line 5: Option for the Relative Cooling Temperature function. The adjustable cooling temperature range is displayed on the right hand side.
Line 6: Option for the Cooling Time function. The adjustable time range is displayed on the right hand side.
Line 7…8: Options for display counting in the Working menu (→ 5.2.2.) during the cooling phase when cooling time was selected.

5.5. Monitoring menu

Line 1	CONTROL
Line 2	▷Temp. contr. Off
Line 3	Preheat. contr. Off
Line 4	Start contr.: ▶Off
Line 5	On
Line 6	
Line 7	
Line 8	

Press the button ◁ to return to the Selection menu (→ 5.3.). Additional error functions for monitoring the welding process are set in the Monitoring menu.
Line 1: Menu name
Line 2: Menu item “Temperature monitoring” (→ 5.5.1.); whether the temperature monitoring is activated or deactivated is displayed on the right-hand border.
Line 3: Menu item “Preheat monitoring” (→ 5.5.2); whether the preheat monitoring is activated or deactivated is displayed on the right-hand border.
Line 4…5: Options for switching the Start monitoring on and off. The Start monitoring can only be activated when the sequence control is switched on. If the “Start monitoring” function is activated the welding cycle will be interrupted as soon as the “Start” signal is no longer applied (Emergency Off). If the “Start monitoring" function is deactivated the welding cycle which was just started will be continued until the "Start" signal is removed.

5.5.1. Temperature monitoring menu

Line 1	TEMP. CONTROL
Line 2	▶Off
Line 3	Off
Line 4	Temp.-Ok: -88K
Line 5	5-99K +88K
Line 6	Delay: 88.8s
Line 7	0-99.9s
Line 8	

Press the button ◁ to return to the Monitoring menu (→ 5.5.).
Line 1: Menu name
Line 2…3: Options for switching the temperature monitoring on and off.
Line 4…5: Setting of the upper and lower limit of the temperature Ok-range around the desired value for the temperature monitoring. The adjustable range is shown in line 5.
Line 6…7: Setting of the delay time for the temperature monitoring. The temperature monitoring will only be activated after this delay time has elapsed. The delay time is started as soon as the actual value is within the temperature Ok-range. The adjustable range is shown in line 7.

5.5.2. Heating monitoring menu

Line 1	PREHEAT. CONTROL
Line 2	▶Off
Line 3	Off
Line 4	Temp.-Ok: -88K
Line 5	5-99K +88K
Line 6	Preh. time: 88.8s
Line 7	0-99.9s
Line 8	

Press the button ◁ to return to the Monitoring menu (→ 5.5.).
Line 1: Menu name
Line 2…3: Options for switching the heating monitoring on and off.
Line 4…5: Setting of the upper and lower limit of the temperature Ok-range around the desired value for the heating monitoring. The adjustable range is shown in line 5.
Line 6…7: Setting of the admissible heating time; the actual value should be within this temperature Ok-range. The adjustable range is shown in line 7.

5.6. In-/Output settings menu

Zeile 1	EIN-/AUSGÄNGE
Zeile 2	▷Relay setting
Zeile 3	Input setting
Zeile 4	
Zeile 5	
Zeile 6	
Zeile 7	
Zeile 8	

Press the button ◁ to return to the Selection menu (→ 5.3.).
Line 1: Menu name
Line 2: Menu item “Relay setting” (→ 5.6.1.)
Line 3: Menu item “Input setting” (→ 5.6.1.)

5.6.1. Relais setting menu

Line 1	RELAY SETTING
Line 2	▷Message relay 1
Line 3	Control relay 1
Line 4	Control relay 2
Line 5	Alarm relay
Line 6	Status relay output
Line 7	
Line 8	

Press the button ◁ to return to the In-/Output settings menu (→ 5.6.).
Line 1: Menu name
Line 2: Menu item “Message relay 1 setting” (→ 5.6.1.1.)
Line 3: Menu item “Control relay 1 setting” (→ 5.6.1.2.)
Line 4: Menu item “Control relay 2 setting” (→ 5.6.1.2.)
Line 5: Menu item “Alarm relay setting” (→ 5.6.1.3.)
Line 6: Menu item “Status displ. relay outputs” (→ 5.6.1.4.)

5.6.1.1. Message Relay 1 settings menu

Line 1	MESSAGE RELAY 1
Line 2	Oontact: ▶NOC
Line 3	NC
Line 4	▶Off
Line 5	Temp. function
Line 6	Sequnce function
Line 7	Time Pulse function
Line 8	

Press the button ◁ to return to the Relay settings menu (→ 5.6.1.).
Line 1: Menu name
Line 2…3: Options for the switching mode of the relay; the relay can be set as NO or NC when the corresponding function is activated.
Line 4: Option of the message relay is deactivated
Line 5: Selection and menu items (→ 5.6.1.1.1.) of the temperature functions for the message relay.
Line 6: Selection and menu items (→ 5.6.1.1.2.) of the sequence functions for the message relay.
Line 7: Selection and menu items (→ 5.6.1.1.3.) of the time pulse function for the message relay.

5.6.1.1.1. Message Relay 1 Temperature function menu

Line 1	TEMPERATURE FUNCTION
Line 2	Temp.-Ok: ▷ -88K
Line 3	5-99K +88K
Line 4	Stab. time: 88.8s
Line 5	0-99.9s
Line 6	Hold: ▶Off
Line 7	On
Line 8	

Press the button ◁ to return to the Message Relay 1 settings menu (→ 5.6.1.1.).
Line 1: Menu name
Line 2…3: Setting of the upper and lower limit of the temperature Ok-range around the desired value. The adjustable range is shown in line 3.
Line 4…5: Setting of the stabilisation time of the temperature Ok message. The adjustable range is shown in line 5.
Line 6…7: Options for switching the holding function of the message relay on and off. The relay remains actuated after a welding cycle up to the start of the following welding cycle.

5.6.1.1.2. Message Relay 1 Sequence function menu

Line 1	SEQUENCE FUNCTION
Line 2	▶Act. with start sig.
Line 3	Act. with temp. rea.
Line 4	Act. dur. heat.phase
Line 5	Act. dur. cool.phase
Line 6	Calibration Ok
Line 7	Alarm
Line 8	Tc corr. sequence

Press the button ◁ to return to the Message Relay 1 settings menu (→ 5.6.1.1.).
Line 1: Menu name
Line 2: Option that the message relay picks up when the “Start” signal is applied and is released when the cooling phase has elapsed.
Line 3: Option that the message relay picks up when the actual value has reached 95% of the desired value and is released when the cooling phase has elapsed.
Line 4: Option that the message relay is actuated during the heating phase.
Line 5: Option that the message relay is actuated during the cooling phase.
Line 6: Option that the message relay is actuated after a successful calibration.
Line 7: Option that the message relay is actuated in the error state (from V1.00/1.19/1.16/1.10).
Line 8: Option that the message relay performs the control message for the temperature coefficient correction (from V1.00/1.23/1.30/1.25)

5.6.1.1.3. Message Relay 1 Time Pulse function menu

Line 1	TIME PULSE FUNCTION
Line 2	▶Preheat. ph.: 88.8s
Line 3	0-99.9s
Line 4	Cool. phase: 88.8s
Line 5	0-99.9s
Line 6	End of pulse
Line 7	
Line 8	

Press the button ◁ to return to the Message Relay 1 settings menu (→ 5.6.1.1.).
Line 1: Menu name
Line 2…3: Option that the message relay is actuated for the preset time when the welding process or the welding time is started. The adjustable range is shown in line 3.
Line 4…5: Option that the message relay is actuated for the preset time when the cooling phase (end of the heating phase) is started. The adjustable range is shown in line 5.
Line 6: Option that the message relay is actuated for 500ms at the end of the cooling phase.

5.6.1.2. Control Relay 1 and 2 settings menu

Line 1	CONTROL RELAY ½
Line 2	▶Off
Line 3	Temp. function
Line 4	Sequnce function
Line 5	Time Pulse function
Line 6	
Line 7	
Line 8	

Press the button ◁ to return to the Relay settings menu (→ 5.6.1.). Here, the control relay 1 and 2 can be set.
Line 1: Menu name
Line 2: Option “Control relay is deactivated”
Line 3: Selection and menu items (→ 5.6.1.2.1.) of the temperature functions for the control relay.
Line 4: Selection and menu items (→ 5.6.1.2.2.) of the sequence functions for the control relay.
Line 5: Selection and menu items (→ 5.6.1.2.3.) of the time pulse function for the control relay.

5.6.1.2.1. Control Relay 1 and 2 Temperature function menu

Line 1	TEMPERATURE FUNCTION
Line 2	Temp.-Ok: ▷ -88K
Line 3	5-99K +88K
Line 4	Stab. time: 88.8s
Line 5	0-99.9s
Line 6	Hold: ▶Off
Line 7	On
Line 8	

Press the button ◁ to return to the Control Relay settings menu (→ 5.6.1.2.). Here, the control relay 1 and 2 with the function “Temperature Ok-message” can be set.
Line 1: Menu name
Line 2…3: Setting of the upper and lower limit of the temperature Ok-range around the desired value. The adjustable range is shown in line 3.
Line 4…5: Setting of the stabilisation time of the temperature Ok message. The adjustable range is shown in line 5.
Line 6…7: Options for switching the holding function of the control relay on and off. The relay remains actuated after a welding cycle up to the start of the following welding cycle.

5.6.1.2.2. Control Relay 1 and 2 Sequence function menu

Line 1	SEQUENCE FUNCTION
Line 2	▶Act. with start sig.
Line 3	Act. with temp. rea.
Line 4	Act. dur. heat.phase
Line 5	Act. dur. cool.phase
Line 6	Calibration Ok
Line 7	Alarm
Line 8	Tc corr. sequence

Press the button ◁ to return to the Control Relay settings menu (→ 5.6.1.2.). Here, the control relay 1 and 2 can be set.
Line 1: Menu name
Line 2: Option that the control relay picks up when the “Start” signal is applied and is released when the cooling phase has elapsed.
Line 3: Option that the control relay picks up when the actual value has reached 95 % of the desired value and is released when the cooling phase has elapsed.
Line 4: Option that the control relay is actuated during the heating phase.
Line 5: Option that the control relay is actuated during the cooling phase.
Line 6: Option that the control relay is actuated after a successful calibration.
Line 7: Option that the control relay is actuated in the error state (from V1.00/1.19/1.16/1.10).
Line 8: Option that the control relay performs the control message for the temperature coefficient correction (from V1.00/1.23/1.30/1.25)

5.6.1.2.3. Control Relay 1 and 2 Time Pulse function menu

Line 1	TIME PULSE FUNCTION
Line 2	▶Preheat. ph.: 88.8s
Line 3	0-99.9s
Line 4	Cool. phase: 88.8s
Line 5	0-99.9s
Line 6	End of pulse
Line 7	
Line 8	

Press the button ◁ to return to the Control Relay settings menu (→ 5.6.1.2.). Here, the control relay 1 and 2 can be set.
Line 1: Menu name
Line 2…3: Option that the control relay is actuated for the preset time when the welding process or the welding time is started. The adjustable range is shown in line 3.
Line 4…5: Option that the control relay is actuated for the preset time when the cooling phase (end of the heating phase) is started. The adjustable range is shown in line 5.
Line 6: Option that the control relay is actuated for 500ms at the end of the cooling phase.

5.6.1.3. Alarm Relay settings menu

Line 1	ALARM RELAY
Line 2	Oontact: ▶NOC
Line 3	NC
Line 4	
Line 5	
Line 6	
Line 7	
Line 8	

Press the button ◁ to return to the Relay settings menu (→ 5.6.1.).
Line 1: Menu name
Line 2…3: Options for the switching mode of the relay, in case of an error either as NO or NC.

5.6.1.4. Relay Outputs status menu

Line 1	RELAY OUTPUT STATUS
Line 2	Message relay 1 o
Line 3	Control relay 1 o
Line 4	Control relay 2 o
Line 5	Alarm relay o
Line 6	
Line 7	
Line 8	

Press the button ◁ to return to the Relay settings menu (→ 5.6.1.). If the relay is not actuated an empty circle (o) is displayed, if the relay is actuated a filled circle (•) is displayed.
Line 1: Menu name
Line 2: Status message relay 1
Line 3: Status control relay 1
Line 4: Status control relay 2
Line 5: Status alarm relay

5.6.2. Input setting menu

Line 1	INPUT SETTING
Line 2	▷Preheating input
Line 3	Start input
Line 4	Cal.-Start input
Line 5	Reset input
Line 6	
Line 7	
Line 8	

Press the button ◁ to return to the In-/Output settings menu (→ 5.6.).
Line 1: Menu name
Line 2: Menu item “Preheating input setting” (→ 5.6.2.1.)
Line 3: Menu item “Start input setting” (→ 5.6.2.2.)
Line 4: Menu item “Cal.-Start input setting” (→ 5.6.2.2.)
Line 5: Menu item “Reset input setting” (→ 5.6.2.3.)

5.6.2.1. Preheating input setting menu

Line 1	PREHEATING INPUT
Line 2	▶Preheating
Line 3	Measurement pause
Line 4	Cal.-changing
Line 5	Delay: 88.8s
Line 6	0-99.9s
Line 7	
Line 8	

Press the button ◁ to return to the Input settings menu (→ 5.6.2.).
Line 1: Menu name
Line 2: Selection item Preheating input
Line 3: Selection item Measurement pause input
Line 4: Selection item Calibration switching input
Line 5…6: Setting of the delay time for the calibration switching. During the delay time the controller prforms a measurement pause. At Line 5 the adjustable range is showed.

5.6.2.2. Start input setting menu

Line 1	START INPUT
Line 2	▶Start
Line 3	Measurement pause
Line 4	Cal.-changing
Line 5	Delay: 88.8s
Line 6	0-99.9s
Line 7	
Line 8	

Press the button ◁ to return to the Input settings menu (→ 5.6.2.).
Line 1: Menu name
Line 2: Selection item Start input
Line 3: Selection item Measurement pause input
Line 4: Selection item Calibration switching input
Line 5…6: Setting of the delay time for the calibration switching. During the delay time the controller prforms a measurement pause. At Line 5 the adjustable range is showed.

5.6.2.3. Calibration-Start input setting menu

Line 1	CAL.-START INPUT
Line 2	▶Cal.-Start
Line 3	Measurement pause
Line 4	Cal.-changing
Line 5	Delay: 88.8s
Line 6	0-99.9s
Line 7	
Line 8	

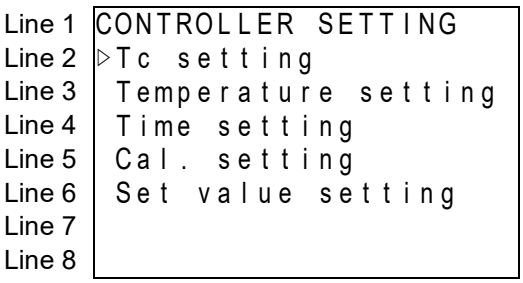
Press the button ◁ to return to the Input settings menu (→ 5.6.2.).
Line 1: Menu name
Line 2: Selection item Calibration-Start input
Line 3: Selection item Measurement pause input
Line 4: Selection item Calibration switching input
Line 5…6: Setting of the delay time for the calibration switching. During the delay time the controller prforms a measurement pause. At Line 5 the adjustable range is showed.

5.6.2.4. Reset input setting menu

Line 1	RESET INPUT
Line 2	▶Reset
Line 3	Measurement pause
Line 4	Cal.-changing
Line 5	Delay: 88.8s
Line 6	0-99.9s
Line 7	
Line 8	

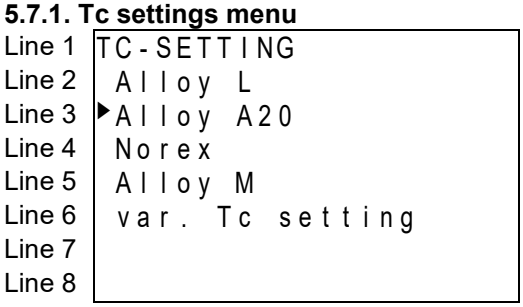
Press the button ◁ to return to the Input settings menu (→ 5.6.2.).
Line 1: Menu name
Line 2: Selection item Reset input
Line 3: Selection item Measurement pause input
Line 4: Selection item Calibration switching input
Line 5…6: Setting of the delay time for the calibration switching. During the delay time the controller prforms a measurement pause. At Line 5 the adjustable range is showed.

5.7. Controller setting menu



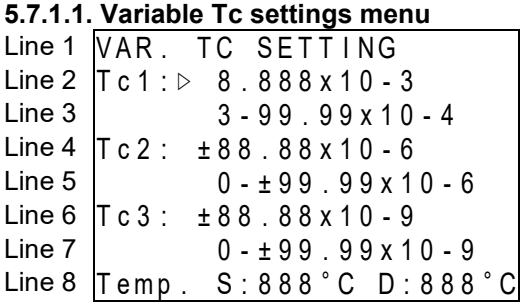
Press the button ◁ to return to the Selection menu (→ 5.3.).
Line 1: Menu name
Line 2: Menu item “Tc setting” menu for the regulator (→ 5.7.1.)
Line 3: Menu item “Temperature setting” menu for the regulator (→ 5.7.2.)
Line 4: Menu item “Time setting” menu for the regulator (→ 5.7.3.)
Line 5: Menu item “Calibration setting” menu for the regulator (→ 5.7.4.)
Line 6: Menu item “Set value setting” menu for the controller (→ 5.7.5.)

5.7.1. Tc settings menu



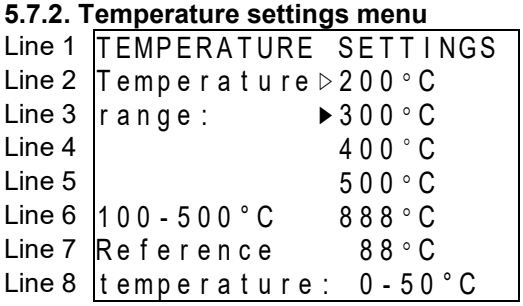
Press the button ◁ to return to the Regulator settings menu (→ 5.7.).
Line 1: Menu name
Line 4…7: Options for the four definite Tc settings of the regulator via the material designation.
Line 8: Selection and menu item (→5.7.1.1.) for the variable Tc-setting. The variable Tc setting is also possible if it is not activated. Press the button ▶ to switch to the menu.

5.7.1.1. Variable Tc settings menu



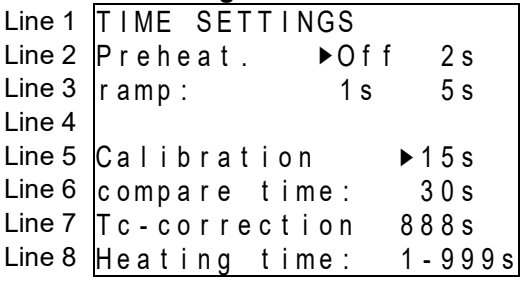
Press the button ◁ to return to the Tc-settings menu (→ 5.7.1.).
Line 1: Menu name
Line 2…3: Setting of the Tc1 value. The adjustable range is shown in line 3.
Line 4…5: Setting of the Tc2 value. The adjustable range is shown in line 5.
Line 6…7: Setting of the Tc3 value. The adjustable range is shown in line 7.
Line 8: The controller PIREG-D2 will calculate automatically the maximum temperature for the continuity (S) and dynamic (D) resistance behavior of the heater band for each variable Tc setting. In any case the set temperature range must be lower than the temperature value for continuity (S) and dynamics (D).

5.7.2. Temperature settings menu



Press the button ◁ to return to the Regulator settings menu (→ 5.7.).
Line 1: Menu name
Line 2…5: Options for preset temperature ranges.
Line 6: Selection and setting item for the variable temperature range. The variable temperature range can also be set if it was not selected. The admissible setting range is shown on the left half.
Line 7…8: Setting of the variable calibration reference temperature. The admissible setting range is shown in line 8 in the right half of the screen.

5.7.3. Time settings menu



Press the button ◁ to return to the Regulator settings menu (→ 5.7.).
Line 1: Menu name
Line 2…3: Options for the heating ramp duration.
Line 5…6: Options for the calibration comparison time.
Line 7…8: Adjustment of the heating time for automatic temperature coefficient correction with the external thermometer exTM. With “Off” the temperature coefficient correction must be controlled manually. The admissible setting range is shown in line 8 on the right hand side of the screen.

5.7.4. Calibration settings menu

Line 1	CALIBRATION SETTINGS
Line 2	Type of New
Line 3	cal.: ▶Save
Line 4	Transfor- ▶El core
Line 5	mer type: Ring core
Line 6	Tc-corr.: ▶Off
Line 7	On
Line 8	

Press the button ◁ to return to the Regulator settings menu (→ 5.7.).
Line 1: Menu name
Line 2…3: Option for the calibration mode.
Line 4…5: Option for the transformer type.
Line 6…7: Options for activating and deactivating the Tc correction during calibration.

5.7.5. Set value settings menu

Line 1	SET VALUE SETTING
Line 2	▶Internal
Line 3	Set value input U
Line 4	Set value input R
Line 5	
Line 6	
Line 7	
Line 8	

Press the ◁ button to return to the Controller settings menu (→ 5.7.).
Line 1: Menu name
Line 2: Selection point for the set value setting via the display unit of the controller.
Line 3: Selection point for the set value setting via the set value input of the controller with an analogue voltage.
Line 4: Selection point for the set value setting via the set value input of the controller with a set value potentiometer. The actual value output has the function of the reference voltage source (10 V).

5.8. Display settings menu

Line 1	DISPLAY SETTING
Line 2	▷Language a. Brightn.
Line 3	Hold mode
Line 4	Control
Line 5	Temp. unit: ▶°C °F
Line 6	Release
Line 7	Cycles 8888888
Line 8	Tot.-Cycl.:888888888

Press the button ◁ to return to the Selection menu (→ 5.3.).
Line 1: Menu name
Line 2: Menu item for setting the language and brightness of the display unit (→ 5.8.1.)
Line 3: Menu item “Hold mode” menu of the display unit (→ 5.8.2.)
Line 4: Menu item “Control” menu of the display unit (→ 5.8.3.)
Line 5: Option for the temperature unit on the display. The temperature unit is only used for display of the temperature values. The display unit continues to operate internally with the unit [°C] even when [°F] is displayed which results in temperature leaps of 2 °F when the unit [°F] is set as temperature value.
If the thermometer DTM3000 is using as external thermometer exTM, the PIREG-D2 automatically set temperature unit to the selected temperature unit of the display unit. When working with the TM6 thermometer the same temperature unit must be set on the thermometer and on the display unit.
Line 6: Menu item “Releases menu” of the display unit (→ 5.8.4.)
Line 7: Display of the welding cycles carried out. Press the button ▶ to reset the counter. Press the Ok button to reset the counter to zero.
Line 8: Display of the total cycle counter of all welding cycles which cannot be reset.

5.8.1. Settings menu for language and brightness

Line 1	LANGUAGE A. BRIGHTN.
Line 2	▶Deutsch
Line 3	english
Line 4	francais
Line 5	italiano
Line 6	Nederlands
Line 7	Русский
Line 8	Brightness: 888%

Press the button ◁ to return to the Display settings menu (→ 5.8.).
Line 1: Menu name
Line 2…7: Options of the display languages of the PIREG-DIS display unit
Line 8: Setting the brightness (30…100%) of the display lighting in 5%-steps (from V1.04/2.00/1.30/1.25).

5.8.2. Hold Mode menu

Line 1	HOLD-MODE
Line 2	▶Off
Line 3	On
Line 4	2s On
Line 5	
Line 6	
Line 7	
Line 8	

Press the button ◁ to return to the Display settings menu (→ 5.8.).
Line 1: Menu name
Line 2: The “Hold mode” option is deactivated
Line 3: The “Hold mode” option is activated, the last actual value during the welding process is displayed until the following welding process or welding cycle is started.
Line 4: The “Hold mode” option is activated, the last actual value during a welding process is displayed for 2 seconds.

5.8.3. Operating menu

Line 1	CONTROL
Line 2	Auto. transfer: ▶Off
Line 3	On
Line 4	Locking: ▶Off
Line 5	On
Line 6	Menu return: Off
Line 7	▶20s
Line 8	

Press the ◁ button to return to the Display settings menu (→ 5.8.).
Line 1: Menu name
Line 2…3: Options for activating and deactivating the automatic acceptance of the set numerical values (→ 4.1.4.).
Line 4…5: Options for activating and deactivating the locking of the display unit against unintentional changes of the settings (→ 4.1.7.). The locking must be deactivated with the key combination ◁ + ▼ + Ok before any settings can be made. The locking is activated again using the same key combination.
Line 6…7: Options for activating and deactivating the automatic menu return after 20 sec. (→ 4.1.6.) if no change was made.

5.8.4. Releases menu

Line 1	RELEASE
Line 2	Status of
Line 3	▷release level 1: 🔓
Line 4	release level 2: 🔒
Line 5	release level 3: 🔒
Line 6	
Line 7	Enter no.: 8888
Line 8	Change no.: 8888

Press the ◁ button to return to the Display settings menu (→ 5.8.).
Line 1: Menu name
Line 3…5: Options for the three release levels. When a lower level is released the levels above are released as well. The icons on the right hand side 🔒 (locked) and 🔓 (released) indicate whether the corresponding level and its settings were released. The cursor jumps automatically in line 7 for entering the release number after an option was selected.
Line 7: Input of the release number to release the selected release level. The release number is set per digit. Use the ◁ and ▶ keys to toggle between the individual digits.
Additional the release level 3 can be activated with the Toss number as emergency access.
An released release level can be disabled again by entering the release number "0000" without having to switch off the controller.
Line 8: You can only go to Line 8 if the corresponding level or a higher one was released.
Input of a new release number for the selected release level. However, the level must have been released before. The release number is set per digit. Use the ◁ and ▶ keys to toggle between the individual digits.

Important:
- After switch off or a reset of the controller PIREG-D2, all relase levels are locked whose release number is not "0000".
- To permanently released a release level, the release number of this release level must be set to "0000".

The following settings are assigned to the individual release levels.

Level 1:
- Target value
- Welding time and cooling time
- Reading parameter sets 1…5
- Reference temperature for calibration

Level 2: - Settings for level 1
- all controller settings
(settings for Tc, temperature, time, calibration and target value)
- Saving parameter sets 1…5

Level 3: - Settings for levels 1 and 2
- all settings of the PIREG-D2

5.9. Save menu

Line 1	STORAGE
Line 2	▷Parameter sets
Line 3	Factory settings
Line 4	
Line 5	
Line 6	
Line 7	
Line 8	

Press the ◁ button to return to the Selection menu (→ 5.3.).
Line 1: Menu name
Line 2: Menu item “Reading and writing parameter sets” (→ 5.9.1.)
Line 3: Menu item “Factory setting” (→ 5.9.2.)

5.9.1. Parameter sets menu

Line 1	PARAMETER SETS
Line 2	▷Read ▷1
Line 3	Parameter set: 2
Line 4	3
Line 5	Save 4
Line 6	Parameter set: 5
Line 7	
Line 8	Execute? Yes!

Press the ◁ button to return to the Save menu (→ 5.9.).
Line 1: Menu name
Line 2…3: Options on the left hand side to read the saved parameter sets 1…5. After selection of this option the cursor jumps automatically to the right hand side to select the number of the parameter set.
Line 5…6: Options on the left hand side to save the current setting as parameter set 1…5 so that it can be restored. After selection of this option the cursor jumps automatically to the right hand side to select the number of the parameter set.
Line 2…7: Options for the parameter set number to be read or saved. When the number was selected the cursor moves automatically in line 8 for a confirmation prompt.
Line 8: Confirmation prompt to prevent unintentional processes. Pressing the ▶ key activates „Yes!“ which must be confirmed with Ok so that the selected process is executed. Pressing the ◁ button cancels the process.

5.9.2. Factory Settings menu

Line 1	FACTORY SETTING
Line 2	▷Restore saved
Line 3	maschine setting
Line 4	Save current
Line 5	maschine setting
Line 6	Restore
Line 7	factory setting
Line 8	Execute? Yes!

Press the button ◁ to return to the Selection menu (→ 5.3.).
Line 1: Menu name
Line 2…3: Option, option for restoring the last Machine setting which was saved. When this option was selected the cursor moves automatically in line 8 for a confirmation prompt.
Line 4…5: Option for saving the current device settings so that it can be restored with the above option. When this item is selected the cursor automatically moves in line 8 for confirmation prompt.
Line 6…7: Option for restoring the factory device settings (→ 4.9.5.). When this item is selected the cursor automatically moves in line 8 for confirmation prompt.
Line 8: Confirmation prompt to prevent unintentional processes. Press the ▶ button to confirm with “Yes!“ and confirm again by pressing the Ok button so that the selected process is executed. Pressing the ◁ button cancels the process.

5.10. Informations-Menü

Line 1	
Line 2	PIREG-D2 200
Line 3	
Line 4	Vers.:
Line 5	1.05 2.08 1.33 1.26
Line 6	
Line 7	
Line 8	www.toss-gmbh.de

Press the button ◁ to return to the Selection menu (→ 5.3.).
Line 2: Device type of the controller PIREG-D2
Line 5: Device and program version of the controller PIREG-D2 (f. l. t. r.: vvv ddd ggg mmm)
Line 8: Internet address of the Toss company

6. Installation and commissioning

First, check that the voltage stated on the PIREG-D2 resistance temperature controller matches the mains voltage, and that the transformer primary current matches the controller's load current capability.

EN: For safe operation, the PIREG-D2 resistance temperature controller may only operate in symmetrical TN and TT networks.
FR: Pour un fonctionnement sûr, le régulateur de température à résistance PiREG-D2 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-D2.
The PIREG-D2 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-D2.
Le PIREG-D2 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-D2 resistance temperature controller is only suited for use in a switch cabinet. Open operation is not permitted.
The PIREG-D2 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 is designed for mounting in a control panel and the current transformer is 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. Configuring the settings

The following settings must be made in the display unit of the PIREG-D2 after switching on but before commissioning.

Heating ramp	**Calibration mode**
Temperature coefficient	**Transformer type**
Temperature reference time	**Reference temperature**
Temperature range	**Temperature coefficient 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 reference time, the temperature range, the calibration type and the transformer type must be set. If necessary, the variable reference temperature must be set and the temperature coefficient correction must be also be activated. The heating ramp can be adjusted before or after calibration.
Then the PIREG-D2 controller can be calibrated. The settings for the sequence control, monitoring, relays etc. can be specified before or after calibration.

6.3. Connection of the PIREG-D2

The resistance temperature controller PIREG-D2 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.
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 20 and 23 must be 0 Ω.
The measurement cables for voltage measurement Vr 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.

6.4. Control inputs

Ensure that there are no high signals applied to the start and preheating 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).

6.5. Connecting to the mains voltage

The green LED "Mains" will light up after the controller were connected to the mains voltage. Then the display unit switches in the fault mode with the error message "Data error, saved calibration values do not match the setting" as settings were not yet made and the factory settings of the display unit and controller are different. The necessary settings via the menus or interfaces and calibration must now be carried out. The symbol "Pause" should be displayed following a successful calibration.

6.6. 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.).

6.7. When the controller does not work correctly

See points 3.7., 3.6., 5.7., 4.8., 1.3., 1.4., 6.1., 6.2. 6.5. and 7..

6.8. 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 ouvrir 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-D2. 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 (→ 5.7.1.). 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-D2 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-D2 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 (15), L2/N (14), T2 (13) and T1 (12)	
Option:	110 (-15%) … 120 V (+10%)	(Voltage fluctuation: 93 … 132 VAC)
	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 - Single-phase (split-phase) three-wire systems 110/220 V 115/230 V 120/240 V Remarks to voltage value above: - „Outer conductor–neutral conductor“/„Outer conductor–outer conductor“
Standard:	220 (-15%) … 240 V (+10%)	(Voltage fluctuation: 187 … 264 VAC)
	Allowable mains supply systems and mains voltage:	- Three-phase four-wire system with earthed neutral (symmetrical TN and TT networks) 127/220V 220/380 V 230/400 V 240/415 V - Single-phase (split-phase) three-wire systems 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: 323 … 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 (15), L2/N (14), T2 (13) and T1 (12)	
	Nominal current:	I_{max}= 5 A (Actuator Internal thyristors)
Actuators:		
Internal thyristors:	Actuator with antiparallel thyristors on an internal heat sink in the PIREG-D2	
	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 120 V: I_D= 12 mA at 240 V: I_D= 11 mA at 415 V: I_D= 13 mA
	Power limit load, integral (t=10ms)	I^2t= 1250 A^2s
	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-D2:	V_{HiLo}= 5 V
	DC internal resistance of the PIREG-D2:	R_{vh}= 94 Ω
	Maximum supply output current:	I_{HiLo}= 10 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-D2:	Terminal 1 (+) / Terminal 2 (-)
	Circuit:	SELV or PELV circuit
Power consumption:	7,8 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:				
	Temperature coeff. 1:	Tk1= 7.46x10^{-4} 1/K	TK2= 0	Tk3= 0 (Alloy L)
	Temperature coeffi. 2:	Tk1= 12.35x10^{-4}	TK2= -50 x10^{-6} 1/K²	Tk3= 12x10^{-9} 1/K³ (Alloy A20C) (from V1.00/1.07/1.30/1.23)
	Temperature coeffi. 3:	Tk1= 48.3x10^{-4} 1/K	TK2= -6.12x10^{-6} 1/K²	Tk3= 2.80x10^{-9} 1/K³ (NOREX)
	Temperature coeffi. 4:	Tk1= 8.62x10^{-4} 1/K	Tk2= 0	Tk3= 0 (Alloy A20K)
	Temperature coefficient variable setting	Tk1= +4.00… +99.99x10^{-4} 1/K	Tk2= -99.99… +99,99x10^{-6} 1/K²	Tk3= -99.99 +99,99x10^{-9} 1/K³

Temperature range:			
Temp. range 2:	0…200 °C	Under-temp. –10 °C	Over-temperature 240 °C
Temp. range 3:	0...300 °C	Under-temp. –10 °C	Over-temperature 360 °C
Temp. range 4:	0...400 °C	Under-temp. –10 °C	Over-temperature 480 °C
Temp. range 5:	0...500 °C	Under-temp. –10 °C	Over-temperature 600 °C

	Temperature range variable setting	$0…\upsilon_{nominal}$ Under-temp. –10 °C Over-temperature $\upsilon_{nominal}$ +20 % $\upsilon_{nominal}$ = 100…500 °C	
Time values (50Hz):	Initialization:	After power on or reset signal:	2 s
	Power interruption:	During an interruption to the line voltage, the PIREG-D2 switches to the error state or starts with a reset once the line voltage has been re-established.	≥80 ms
	Start (heating):	Switch on delay:	35..0.55 ms
		Switch off delay:	25..0.45 ms
	Preheating	Switch on delay:	25…80 ms
		Switch off delay:	25…75 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:	45..0.55 ms
	Calibration:	Max. calibration time temperature reference time= 15 s:	215 s
		Max. calibration time temperature reference time= 30 s:	290 s
		Temp. reference time 1:	15 s
		Temp. reference time 2:	30 s
	Reset:	Trigger delay:	55…65 ms
	Heat-up Ramp:		without /2 /3 /5 s
Control inputs:			
control voltage :	Start (3), calibr. start (25) and reset input (26) are floating		
	control voltage :	V_{contr}= 4…32 VDC (bipolar)	
	Max. control voltage:	$V_{contr.max}$= ±40 V	
	Control current:	$I_{contr.}$= 1…12 mA	
	Supply:	SELV or PELV circuit	
Control contact:	Control contact (7) and preheating contact input (19) on the potential of the measuring side		
	Contact voltage	$U_{Contact}$= 5 V	
	Contact current:	$I_{Contact}$= 4 mA	
	Contact type:	potential-free switching contact	
	Circuit:	SELV or PELV circuit	
Set value input:	The input (23) is floating and protected against polarity mismatch		
	Set value voltage:	V_{set}= 0…10 VDC. Depending on the set temp. range, corresponds to: 0...200 °C 0...300 °C 0...400 °C 0...500 °C 0…$\upsilon_{nominal}$	
	Max. control voltage:	$V_{set\ val.max}$= ±20 V	
	Max. input current:	I_{inmax}= 20 µA	
	Input resistance:	R_{in}= 1 MΩ	
	Supply:	SELV or PELV circuit	
Voltage measuring input:	Signal voltage (10/11):	V_R= 1 - 80 V	
	Max. signal voltage:	V_{Rmax}= 120 V	
	Max. input current:	I_{inmax}= 2 mA	
	Input resistance:	Range 1: R_{in}= 6.4 kΩ at U_R= 1…11.3 V Range 2: R_{in}= 60 kΩ at V_R= 11.3 - 80 V	
	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 (8/9):	I_R= 20...400 mA V_{IR}= 0.1 - 2 V	
	Max. signal current:	I_{IRmax}= 500 mA V_{IRmax}= 2.5 V	
	Input resistance:	R_{in}= 5 Ω (ballast resistance)	
	Measurement Category:	CAT II	
	Circuit:	SELV or PELV circuit	
Actual Value Output:	The output (24) is floating and protected against mismatch of polarity		
	Actual value voltage:	$V_{actual\ value}$= 0...10 VDC, depending on the set temp. range, corresponds to: 0...200 °C 0...300 °C 0...400 °C 0...500 °C 0…$\upsilon_{nominal}$	
	Max. output voltage:	$V_{actual\ .value\ max}$= 10.1 VDC	
	Max. output current:	$I_{actual\ value}$= 5 mA	
	Internal resistance:	R_i= 10 Ω	
	Circuit:	SELV or PELV circuit	
Message relay output:	Reed relay contact NO contact message relay (21/29), 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	$1x10^9$ at 5V with 100mA
	Supply:	SELV or PELV circuit	
Control relay outputs:	Relay change-over contact control relay 1 (16/17/18) and 2 (27/28/29), floating		
	Max. switching capacity (ohmic load):	2000 VA/ 192 W	
	Max. switching voltage:	150 VDC/ 250 VAC	
	Max. switching current:	10 A	
	Nominal load (ohmic load):	8 A/ 250 VAC	8A/ 24 VDC
	Lifetime: electrical:	$100x10^3$ with ohmic load	
	mechanical:	$20x10^6$	
Alarm output:	Reed relay normally open contact (5/6), 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		$1x10^9$ at 5V with 100mA
	Supply:		SELV or PELV circuit		
Interfaces:					
RS232 interface:	Format (factory setting):	9600 bauds, 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:	±30 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			
USB interface:	Format:	USB 1.1 and 2.0	Converter from USB to RS232 interface		
	RS232 format (factory setting):	9600 bauds, 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…+3,8 V			
	Supply:	SELV or PELV circuit			
	Controller:	FDTI Chip FT232RL	website: http://www.ftdichip.com		
	Connection interface:	USB 2.0 Typ B			
EMC (CE):	Interfer. immunity:	IEC 61000-6-2			
	Interfer. emission:	IEC 61000-6-3	The PIREG-D2 complies with the limits of the interference emission only with the addition of a mains filter (compulsory).		
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 0,2…4 mm² (AWG 24…10) Control cable: cross-section 0,2…2,5 mm² (AWG 24…12) minimum temperature rating 70 °C			
Type:	Encapsulated in isolating case				
Housing:	Switchboard housing according to IEC 61554/Din 43700, Material: Noryl fiber reinforced PPE/PS, flammability class UL94 V0 (no fire protection housing)				
Protection class:	Protection class II				
Pollution class:	2	(*: not part of the acceptance according to UL 61010)			
Protection type:	IP20				
Mounting:	Mounted switchboard, cut-out 138 x 68 mm				
Dimensions (W x H x D):	144 x 72 x 169 mm				
Installation:	Minimum distance to adjacent devices and cabling on all sides at least 20 mm				
Weight:	970 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:	5…50 °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		

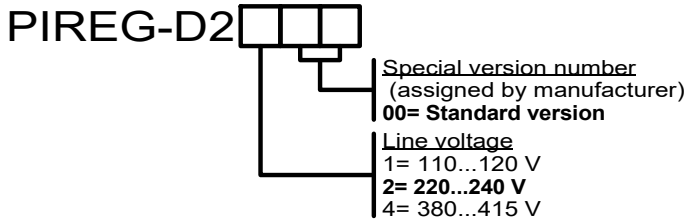
8.3. Sealing transformer

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.

8.4. External thermometer DTM3000

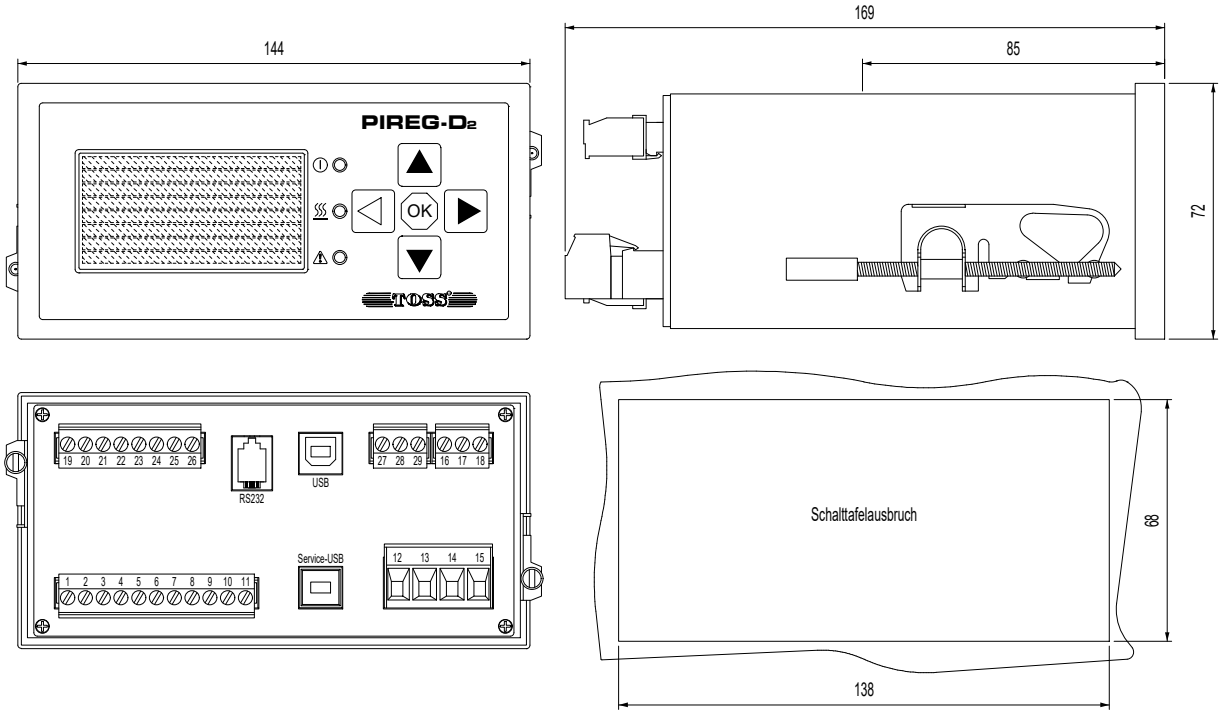
Type:	The DTM300 is a handy thermometer for thermocouple sensors.	
Sensor:	Thermocouple type K (NiCr-Ni)	
Measuring range:	-200 °C...+1370 °C	
Accuracy:	±0.1 % Full-Scale (only instrument)	
Resolution:	0.1 °C	
Display:	1-line LCD	
Connection:	Miniature flat plug	
RS232 interface:	Format:	9600 baud, 1 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.	

8.5. Ordering codes

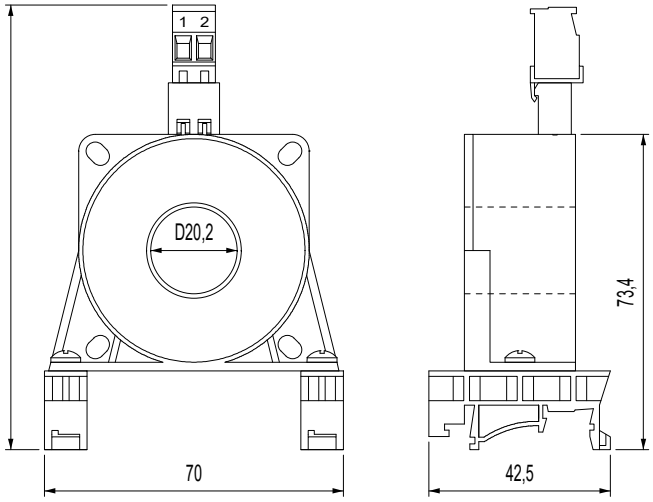


8.6. Housing

8.6.1. PIREG-D2 housing



8.6.2. Current transformer housing

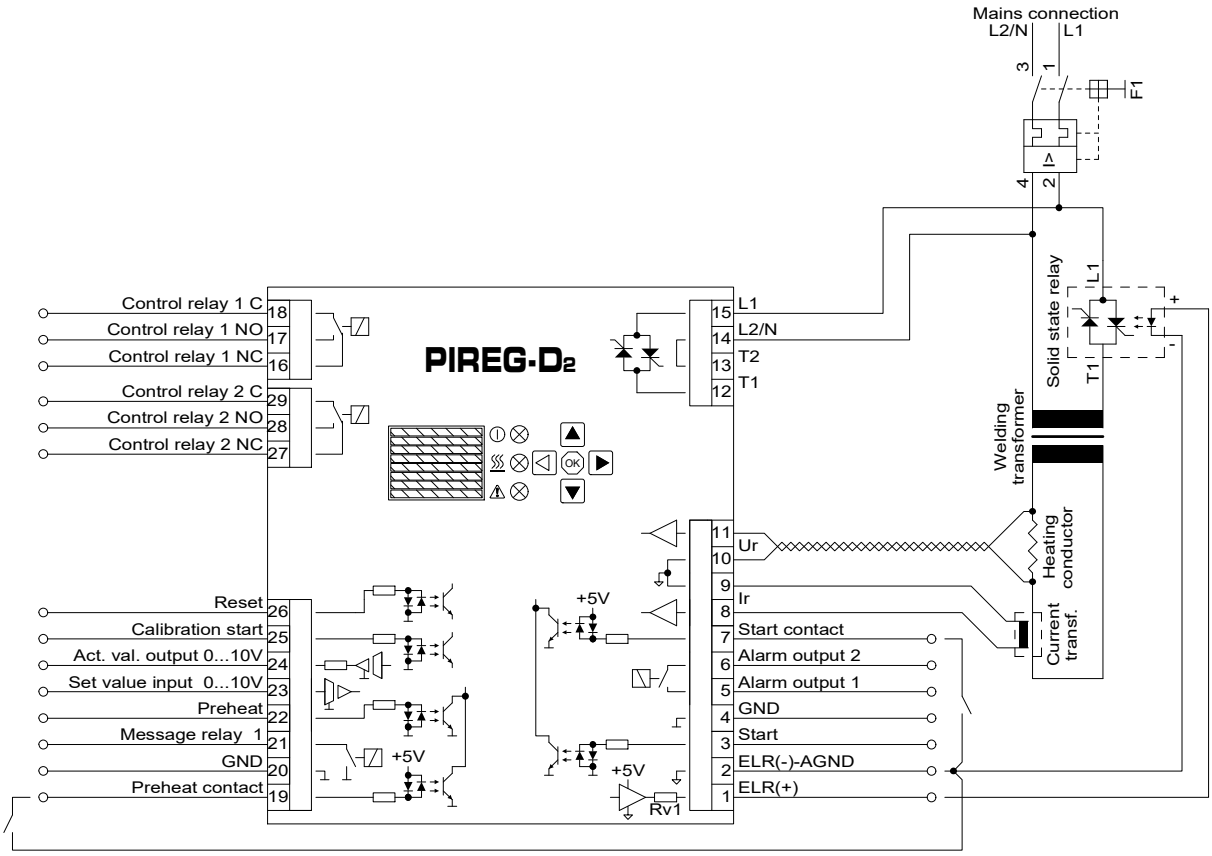


8.7. Spare parts

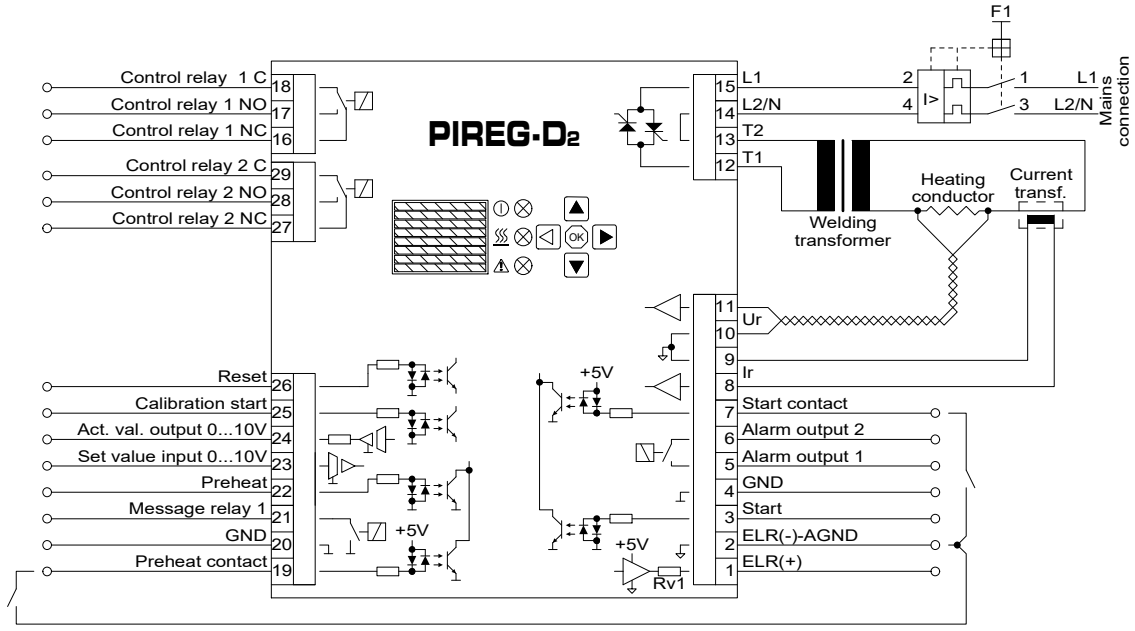
Terminal 1…11:	Phoenix Contact	MVSTBW 2,5/11-ST BDO:1-11	1926633
Terminal 12…15:	Phoenix Contact	PC 4/ 4-ST-7,62	1804920
Terminal 16…18:	Phoenix Contact	MVSTBW 2,5/ 3-ST BD:18-16 SO	1882010
Terminal 19…26:	Phoenix Contact	MVSTBW 2,5/ 8-ST BD2:26-19 SO	1942138
Terminal 27…29:	Phoenix Contact	MVSTBW 2,5/ 3-ST BD2:29-27 SO	1703746
Terminal 1…2:	Phoenix Contact	MVSTBW 2,5/ 2-ST-5,08 BD:1-2	1942138

9. Connection diagrams

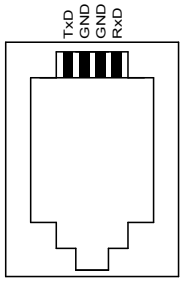
9.1. Connection diagram for PIREG-D2 with external solid-state relay



9.2. Connection diagram for PIREG-D2 with internal thyristors



9.3. RS232 / RS485 connection - interface



TxD: Output at PIREG-D2
RxD: Input at PIREG-D2

10. Application note

10.1. Application instructions

The following application instructions are available for the PIREG-D2 controller which simplify operation of the PIREG-D2:

Temperature coefficient correction: Operation of the temperature coefficient correction which is an additional calibration component of the PIREG-D2 (→ 3.2.9.).

Single-point TC correction: Operation of the single-point temperature coefficient correction for correcting tolerances of the temperature coefficient in only one operating point (→ 3.2.10).

11. Disposal

EN: Do not dispose of the device with household waste! The PIREG-D2 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-D2 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-D2, 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-D2, 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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