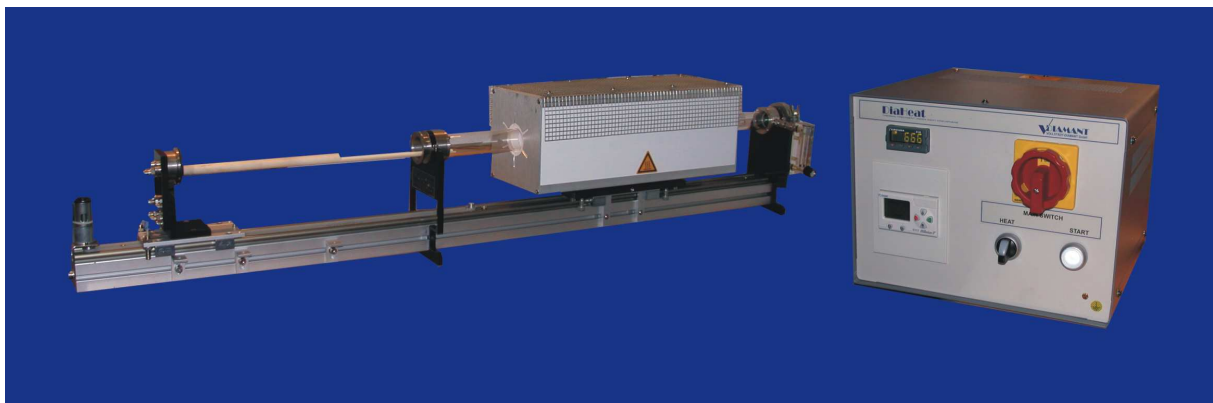


Operating instruction

DiaHeat

**thermal treatment under
inert atmosphere**



The system is designed for the thermal treatment of industrial diamond grit under protective atmosphere up to 1100°C.

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1 General description

For the determination of thermal strength of industrial diamonds or other superabrasives a treatment between 800°C and 1100°C under protective atmosphere is necessary for the subsequent friability testing (TTI) or single crystal strength testing.

DiaHeat is an automatic tube furnace especially designed for this purpose.

The heater block is designed for long life at high temperatures. The heating wire is directly mounted on the inner surface of the heater. This layout provides a high temperature slew rate along with a high working temperature without overheating of the wire.

A flow of protective gas removes the oxygen from inside the furnace and protects the specimen from oxidation.

Two built-in controllers maintain the precise and stable temperature inside the furnace and a precisely timed automatic sample processing.

2 Safety precautions

The furnace should be operated and supervised by trained personnel only.

In any case the user has to keep the area within a distance of 0.5 m around the furnace clear of inflammable goods.

The automatic furnace is a laboratory device and not suitable for manufacturing processes outside a lab.

Public access to the operating furnace must be restricted.

The operator must know:

- The surface of the heater block, the quartz tube, the sample holder and the sample itself might be at high temperature
- In automatic mode the sample holder will move automatically depending on the program step. Keep fingers away from furnace when in automatic mode. Anyway the sample holder cannot apply a harmful force when moving forward and back because of a friction limiter built in.

3 Technical data

Furnace

Geometric dimensions	:	approx. 1370x320x230 mm
Weight	:	approx. 15,5 kg

Heater

Length of the heated zone	:	370 mm
Interior diameter	:	45 ± 1 mm
Weight	:	approx. 7.5 kg
Heating wire	:	CrFeAl
Diameter	:	1mm
Electrical resistance	:	ca. 34,5 Ohm
Heating current	:	max 6.4 A
Heating power	:	max. 1.5kVA
Max. temperature	:	1150°C
Continuous working temperature	:	1100°C
Protection class	:	IP 30
Max. heat-up rate	:	20 K/min.

Quartz tube

length	:	755 mm
inner diameter	:	35 ± 1 mm
outer diameter	:	38 ± 1 mm
glass type	:	C610

Control Unit / Furnace

Geometric dimensions	:	approx. 281x305x220mm (lxwxh)
Weight	:	approx. 3,5 kg
Connection	:	100 V, 50 Hz, 16 A
Protection class	:	IP 41
Temperature controller	:	EUROTHERM Controller 2132
Motion controller	:	Crouzet Millenium 2+
Thermocouple	:	K

Protective gas:

Argon (or Nitrogen)	:	60 litres per hour (1 litre per minute)
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4 Installation

The DiaHeat system consists of the following components:

- Heater block,
- quartz glass tube with holder elements and gas flow control
- sample holder mounted on a belt driven sleigh
- Control unit with controller EURO THERM 2132 E5GN and Millenium 3

The following steps are necessary to make the system ready for operation:

- ✓ Place the furnace at the intended work place. **The area within a distance of at least 0.5 m around the furnace must be clear of inflammable objects. Passers-by should not reach the hot parts of the oven.**
- ✓ Open and remove the clamp which connects the sample holder and quartz tube (Fig. 1).



Fig.1: Remove clamp between sample sleigh and quartz tube

- ✓ Connect the heater block with the control unit with the 4-pole plug at the back of the control unit. (Fig.2), connect the plugs for motor and position switches with the corresponding sockets.
- ✓ Connect the plug of the thermocouple (green compensating cable) with the corresponding socket of the control unit. (Fig.2)
- ✓ Connect the control unit with power supply system 230 V/AC. (Fig.2)

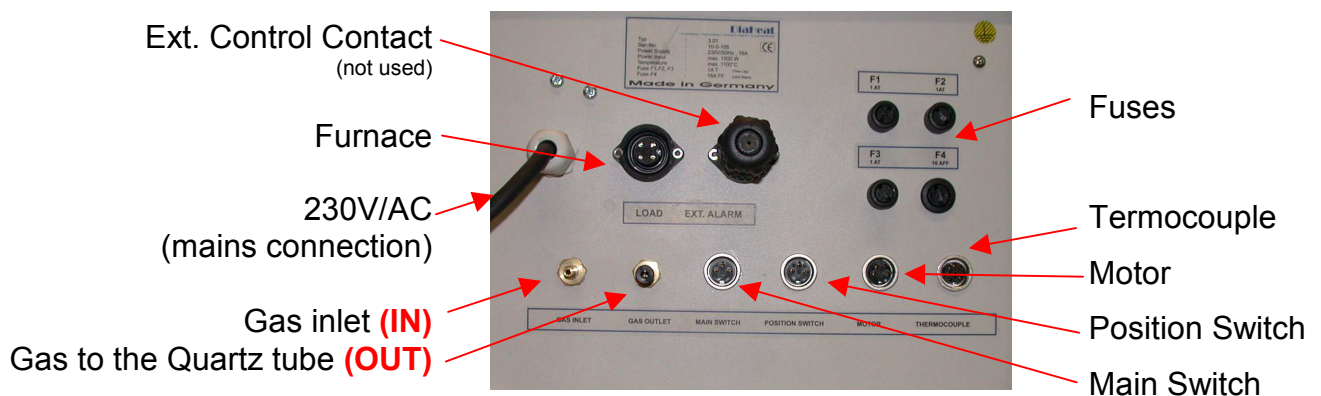


Fig. 2: connections on the control unit

- ✓ Connect the gas inlet (control unit – back side Fig. 2) with your inert gas supply i.e. Argon or Nitrogen
- ✓ Connect the gas outlet at the control unit (back side Fig. 2) with the gas inlet the Quartz tube (Fig. 3).



Fig. 3: Gas inlet Quartz tube



Fig. 4: Gas outlet Quartz tube

5 Operation

After proper installation you can put the furnace into operation. You can operate DiaHeat in **automatic** or in **manual** mode. In **manual** mode the quartz tube is sealable, thus allowing a sample treatment in atmospheres other than inert gas or at reduced flow rates of inert gas. In **automatic** mode the quartz tube remains unsealed, the flow of inert gas provides an oxygen-free atmosphere in both the preheating and heating zone of the furnace.

The layout of the front panel is shown in Fig. 5.

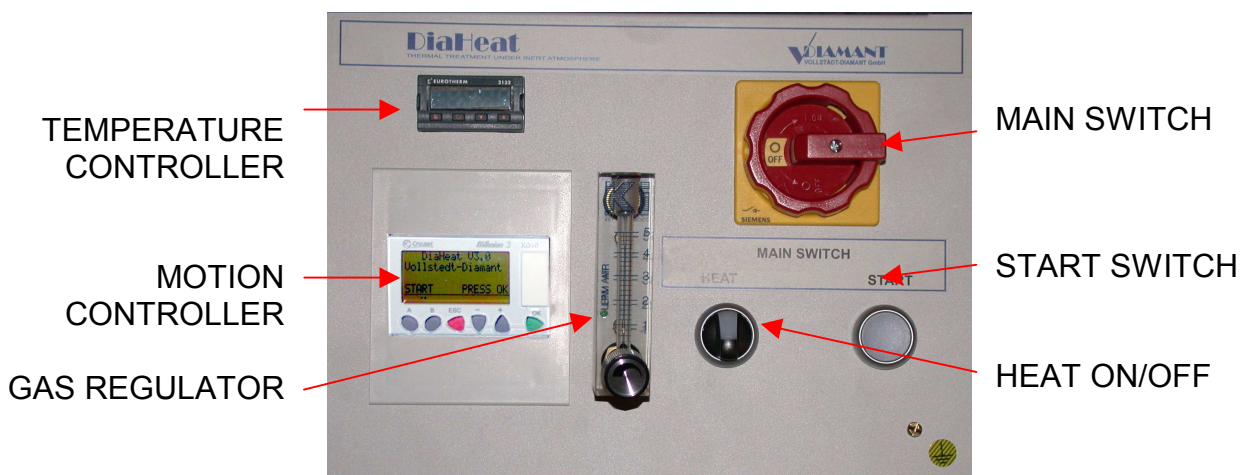


Fig. 5: Control unit

5.1 Operation of the heater block in manual and automatic mode

- Turn on the main switch. Wait a moment until the **self-test sequence** of the temperature controller is finished. The display shows the actual temperature of the furnace.
- Adjust the desired working temperature for your procedure by pressing the UP or DOWN arrows on the temperature controller. Press the arrow button and keep it pressed, the value will increase or decrease on the display. Let go of the button if the desired value has been reached. The display switches back to the actual furnace temperature.
- Switch on the “HEAT” switch and start heating by pushing the “START” button on the panel. The lamp in the HEAT switch indicates the power supply to the heater block. As the temperature comes close to the target temperature the lamp will

start blinking, indicating the reduced power input to the heater. If, by some reason, the allowed maximum temperature of was reached, the alarm circuit will reset the START button and switch off the heater block.

5.2 Operation of the motion controller in manual mode

- Wait until the heater block has reached the desired working temperature.
- Adjust a flow rate of protective gas of 1 litre per minute. This ensures, that the atmosphere starting from the outer edge of the heater block towards the hot zone is free of oxygen.
- Use the MANUAL mode of the motion controller (for operating the motor controller please refer to chapter 6)
- Move the sample holder out of the quartz tube.
- Load a ceramic dish with a diamond sample onto the sample holder (Fig. 6).
- Drive the sample holder into the quartz tube until the desired preheating position is reached. Wait for the specified preheating time.
- Drive the sample holder completely into the quartz tube.
- You can seal the quartz tube now with the clamp. Be sure, that the motion controller remains in manual mode until the sealing clamp is released.

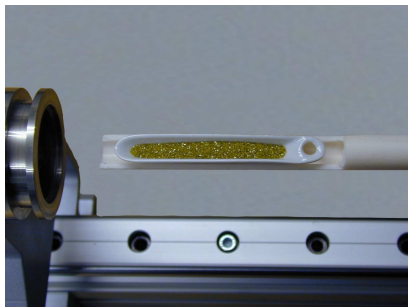


Fig. 6: Ceramic dish with diamond sample in sample holder

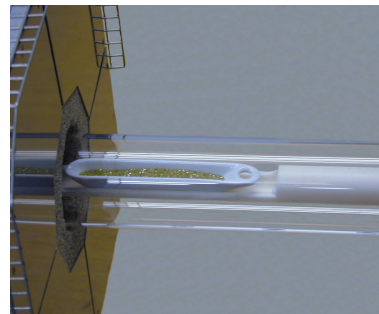


Fig 7: Sample in preheating position

- Move the furnace to the position shown in Fig. 6. The Argon flow can be decreased now to the value of the beginning .
- After the treatment move the sleigh back and cool the sample down for about 10 minutes.
- Take the sample out and let it finally cool to room temperature on a heat resistive support.




















Attention:
***The surface of the heater block, the quartz tube,
the sample holder and the sample itself might be
at high temperature***

5.3 Operation of the motion controller in automatic mode

















- Wait until the heater block has reached the desired working temperature.
- Adjust a flow rate of protective gas of **1 litre per minute**. This ensures, that the atmosphere starting from the outer edge of the heater block towards the hot zone is free of oxygen.
- Use the **AUTO** mode of the motion controller (for operating the motor controller please refer to chapter 6)
- Chose the desired heating time on the motion controller.
- **MOVE HOME** brings the sample holder out of the quartz tube.
- Load a ceramic dish with a diamond sample onto the sample holder.
- **START** initiates the automatic heating procedure: move to the preheating position, 10 minutes preheating, move to the heating position, heating for the programmed time, move to the preheating position, 10 minutes cool down, move out of the hot zone, but stay inside the quartz tube.
- When the display shows “End process” the procedure has been completed and the green Ok button will move the sample out of the furnace.
- The Argon flow can be decreased now.
- Take the sample out and let it finally cool down to room temperature on a heat resistance support.








6 Handling of the motion control unit

6.1 Manual mode

<p>Press  to confirm</p>		<p>Welcome display</p>
<p> Chose manual mode  exit this menu</p>		<p>Mode selection display</p>
<p> Air OFF  Air ON  exit this menu</p>		<p>Manual mode</p>
<p> move into of the tube  move out the tube  exit this menu</p>		
<p> move into the tube</p>		
<p> move out of the tube</p>		
<p> confirm to stop This screen can be accessed by ESC in every processing step, OK will stop any action</p>		<p>After ESC has been pressed</p>

6.2 Automatic mode

<p>Press  to confirm</p>		<p>Welcome display</p>
<p> Chose automatic mode  exit this menu</p>		<p>Mode selection display</p>
<p> increase the heating time  decrease the heating time  confirm the setting</p>		<p>AUTO mode step 1</p>
<p> confirm moving the sample holder into the loading position</p>		<p>AUTO mode step 2</p>
<p>sample holder into the loading position</p>		
<p> confirm starting the complete heating cycle</p>		<p>AUTO mode step 3</p>
<p>Sample moves to preheating position</p>		
<p>Preheating takes 10 mininutes (fixed time, no change possible)</p>		<p>AUTO mode step 4</p>

Sample moves to heating position		
Heating takes place for the selected time		AUTO mode step 5
Sample moves to cooling position		AUTO mode step 6
Sample cools down for 10 minutes (fixed time, no change possible)		
Sample moves to waiting position inside near the end of the tube		AUTO mode step 7
confirm moving the sample holder out of the tube		
<p>Treatment is completed, total operating hours of the furnace are shown on the display  to exit this menu</p>		AUTO mode step 8

7 Technical Safety

The furnace has been manufactured in compliance with the regulations of the valid accident prevention rules and the demands of the legal and industrial safety acts.

Shielding of electromagnetic fields is guaranteed corresponding to the legal regulations.

Attention!

- Never cover up or hang objects over the furnace.
- Never put cold (not preheated) objects directly into the hot zone.
- The manufacturer is not responsible for the results of improper handling.

Remarks:

Alarm temperature is set to 1130°C in the temperature controller! A pending alarm switches off the heating power. Heating power will be enabled again by manually pressing the START button.

The temperature controller is already configured and optimised for the actual heating block. The access to the internal settings of the temperature controller is blocked by passwords. There is no need to access these settings during the normal operation. The passwords will be sent on special request. Vollstaedt-Diamant will be not responsible for any malfunction or damages due to the re-programming or re-configuring of the temperature controller.

8 How to save operating costs

8.1 Saving energy and time

DiaHeat has an energy saving construction, state-of-the-art isolating material along with the new heating coil reduce the energy consumption per sample to a very low value. The high temperature slew rate of up to 20 K / min makes your working schedule more flexible. It takes DiaHeat less than 1 hour to reach 1100°C, so you can turn it on shortly before you want to start the sample treatment.

Fig. 8 shows the typical temperature profile inside the furnace. For some applications it might be possible to load 2 samples onto the sample holder. It's up to you to find out, if the slightly different temperatures at the two sample positions have significant influence on the test result.

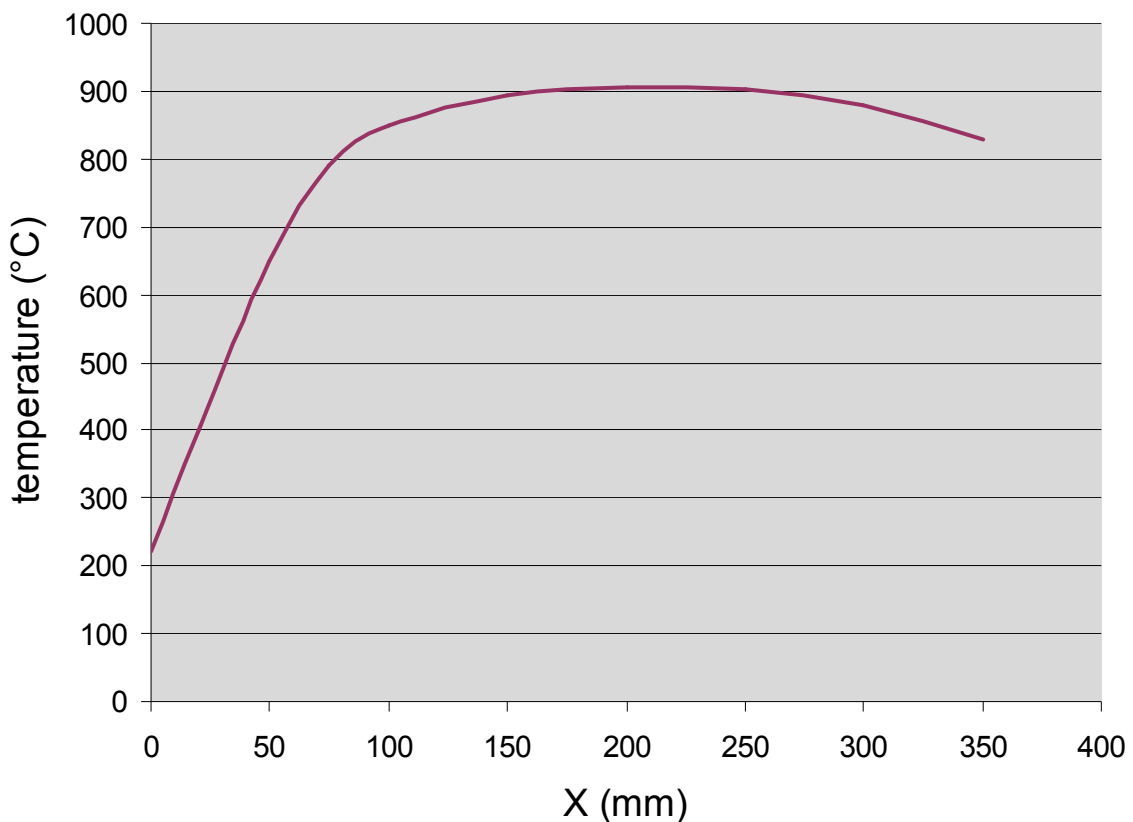


Fig. 8: typical temperature profile inside the furnace

8.2 Saving gas

DiaHeat is intended for the usage with a constant flow of inert gas. The amount and direction of the gas flow (1 litres per hour) keep the ambient air away from the hot zones of the furnace.

The required gas flow can be reduced by 50% to 0,5 litres per minute if a flow barrier as shown in Fig. 9 is mounted onto the sample holder.

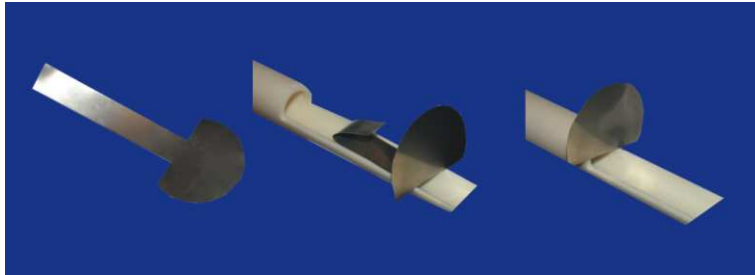


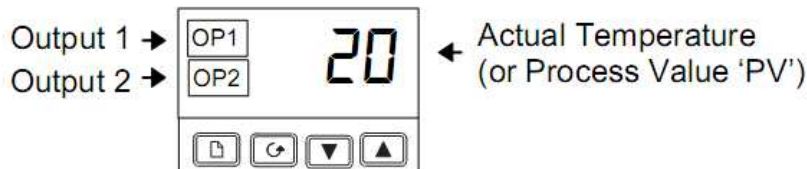
Fig. 9: Flow barrier installation onto the sample holder

ATTENTION: DO NOT USE THE FLOW BARRIER IF THE FURNACE IS OPERATED WITHOUT PROTECTIVE GAS. THE OXYGEN IN THE HOT ZONE WILL DESTROY THE BARRIER FAIRLY SOON.

9 Operating instruction PID Temperature Controller

9.1 Operation

Switch on the controller. Following a 3 second self-test sequence, you will see the display shown below. It is called the HOME display.





OP1 illuminates when the logic output is ON (normally heating).

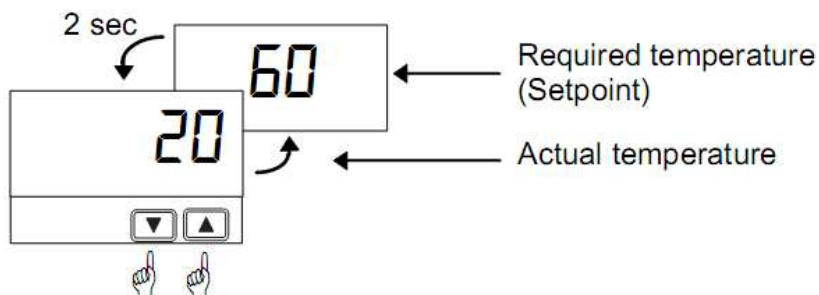
OP2 illuminates when the relay output is ON (normally cooling or alarm).

If **OP1** or **OP2** are configured as alarm outputs (instead of heating and cooling), they will flash when a new 'unacknowledged' alarm occurs and go steady when the alarm is acknowledged but still true.

9.2 To adjust the required temperature

(SETPOINT)



Press and release quickly the  or  button. The setpoint will be displayed for 2 seconds.

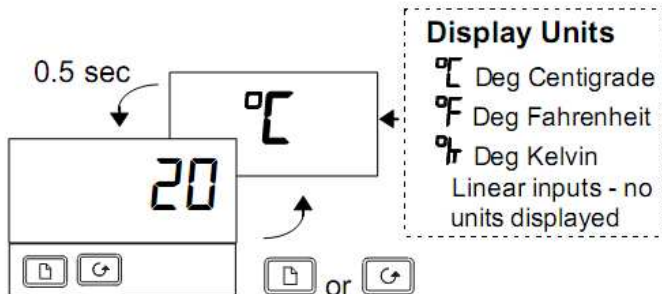




Press and hold  to raise the setpoint

Press and hold  to lower the setpoint

9.3 To view the display units

Press and release quickly the  or  button. The display units will be flashed for 0.5 sec.

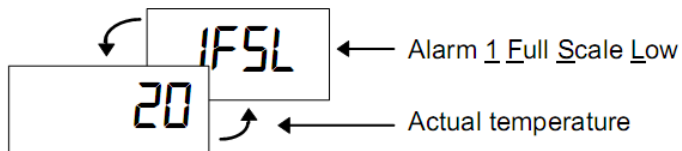


If you get lost, pressing  and  together will always return you to the HOME display.

If, at any time, no key is pressed within 45 seconds, the display will always return to the HOME display.

9.4 Alarm messages

If an alarm occurs a message will be flashed in the display. This alternates with the measured temperature as shown below:



All of the possible messages are shown in this table.

Possible messages	
-FSH	Alarm - Full <u>S</u> cale <u>H</u> igh
-FSL	Alarm - Full <u>S</u> cale <u>L</u> ow
-dEU	Alarm - <u>D</u> eviation
-dHi	Alarm - <u>D</u> eviation <u>H</u> igh
-dLo	Alarm - <u>D</u> eviation <u>L</u> ow
Sbr	<u>S</u> ensor <u>B</u> reak
Lbr	<u>L</u> oop <u>B</u> reak
LdF	<u>L</u> oad <u>F</u> ail
End	<u>E</u> nd of Timing
In place of the dash the alarm number is shown - Alarm 1 or 2 or 3.	

10 Parameter Tables

<u>P</u> _d	<u>PID List</u> (See page 10)	Adjustable Range	Default Setting	Customer setting
<u>P</u> _b	<u>Proportional Band</u>	1 to 999.9 display units	20	
<u>t</u> _i	<u>Integral Time</u>	OFF to 9999 seconds	360	
<u>t</u> _d	<u>Derivative Time</u>	OFF to 9999 seconds	60	
<u>r</u> <u>E</u> <u>S</u>	<u>Manual Reset Value</u> (only present if <u>t</u> _i = OFF)	- 100 to 1000 %	00	
<u>L</u> <u>c</u> <u>b</u>	<u>Low Outback</u>	<u>Auto</u> to 999.9 display units	<u>Auto</u>	
<u>H</u> <u>c</u> <u>b</u>	<u>High Outback</u>	<u>Auto</u> to 999.9 display units	<u>Auto</u>	
<u>r</u> <u>E</u> <u>L</u> <u>E</u>	<u>Relative Cool Gain</u>	0.0 1 to 9.99	1.00	

<u>SP</u>	<u>Setpoint List</u> (See "To Use the Timer" on page 6)	Adjustable Range	Default Setting	Customer setting
<u>SP</u> <u>L</u>	<u>Setpoint Low Limit</u>	- 1999 to 999.9	As per order	
<u>SP</u> <u>H</u>	<u>Setpoint High Limit</u>	- 1999 to 999.9	As per order	
<u>SP</u> <u>r</u> <u>r</u>	<u>Setpoint Rate Limit</u>	OFF to 999.9 display units per minute	OFF	
<u>t</u> <u>m</u> <u>O</u> <u>P</u>	<u>Timer Operating Mode</u>	<u>OPE</u> . 1 to <u>OPE</u> . 5	<u>OPE</u> . 1	
<u>t</u> <u>m</u> <u>r</u>	<u>Time Remaining</u>	0 to 9999 minutes	0	
<u>d</u> <u>w</u> <u>E</u> <u>I</u>	<u>Dwell Time</u>	OFF to 9999 minutes	OFF	
<u>S</u> <u>t</u> <u>A</u> <u>t</u>	<u>Timer Status</u>	OFF or on	OFF	

<u>i</u> <u>P</u>	<u>Input List</u> (See "User Calibration" on page 9)	Adjustable Range	Default Setting	Customer setting
<u>F</u> <u>i</u> <u>L</u> <u>t</u>	<u>Input Filter Time Constant</u>	OFF to 999.9 seconds	1.6	
<u>C</u> <u>J</u> <u>C</u> ^o	<u>Cold Junction Temperature</u> measured at rear terminals		Read only	
<u>m</u> <u>V</u>	<u>Millivolt Input</u> measured at the rear terminals		Read only	
<u>O</u> <u>F</u> <u>S</u>	<u>Process value Offset</u>	- 1999 to 9999 display units	0	
<u>C</u> <u>A</u> <u>L</u> <u>P</u>	<u>Calibration Password</u>	0 to 9999	3	
<u>C</u> <u>A</u> <u>L</u>	<u>User Calibration Enable</u>	<u>FACt</u> Re-instates factory calibration <u>USEr</u> Re-instates user calibration	<u>FACt</u>	
<u>P</u> <u>n</u> <u>t</u> <u>L</u>	<u>Low Calibration Point</u>	- 1999 to 9999 display units	0	
<u>O</u> <u>F</u> <u>S</u> <u>L</u>	<u>Low Point Calibration Offset</u>	- 1999 to 9999 display units	0	
<u>P</u> <u>n</u> <u>t</u> <u>H</u>	<u>High Calibration Point</u>	- 1999 to 9999 display units	100	
<u>O</u> <u>F</u> <u>S</u> <u>H</u>	<u>High Point Calibration Offset</u>	- 1999 to 9999 display units	0	

<u>o</u> <u>P</u>	<u>Output List</u>	Adjustable Range	Default Setting	Customer setting
<u>O</u> <u>P</u> <u>L</u> <u>o</u>	<u>Low Output Power Limit</u>	- 100 to 1000 %	0	
<u>O</u> <u>P</u> <u>H</u>	<u>High Output Power Limit</u>	- 100 to 1000 %	100.0	
<u>C</u> <u>Y</u> <u>C</u> <u>H</u>	<u>Heating Output Cycle Time</u>	0.2 to 999.9 seconds	1.0 Lgc 20 Rly	
<u>C</u> <u>Y</u> <u>C</u> <u>L</u>	<u>Cooling Output Cycle Time</u>	0.2 to 999.9 seconds	5.0 Lgc 20 Rly	
<u>o</u> <u>n</u> <u>t</u> <u>H</u>	<u>Heating Output Minimum On Time</u>	<u>Auto</u> to 999.9 seconds (Auto = 50ms)	<u>Auto</u>	
<u>o</u> <u>n</u> <u>t</u> <u>L</u>	<u>Cooling Output Minimum On Time</u>	<u>Auto</u> to 999.9 seconds (Auto = 50ms)	<u>Auto</u>	

11 Consumables and spare parts

The following parts are available as consumables:

- Thermocouple type S
- Heating block
- Flow barrier
- Ceramic boat

The following parts are available as spare parts:

- Quartz glass tube
- Sample holder (ceramics)
- DC motor with gear
- Belt