XMT-7100

Operating Manual

Intelligent Temperature Controller
P/N: IL 20210
Version: 1.2. (English) - ©2018

1
Overview

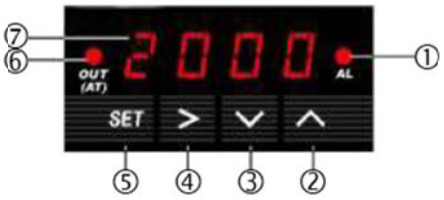
The XMT-7100 is a miniature temperature controller in panel format (48x24 mm) with selectable PID and hysteresis control strategy for heating or cooling applications. The device has one relay and one solid-state-relay (SSR) output, where either of them could be configured for PID loop controlled output. Control can be optimized with a single shot autotune either on initial warm-up or at setpoint. A wide range of sensors like thermocouples (TC) and resistance thermometer (RTD) are supported for the input signal. The temperature measurement unit can be set to display degrees of Fahrenheit (F°) or Celsius (C°). All functions are front selectable by using the keypad.

FEATURES:

- Selectable sensor type
- Relay or SSR output
- Alarm output
- Configurable heat/cool control
- Four different control modes
- Autotune optimized control loop
- Input offset calibration
- Parameter access protection

XMT-7100 Intelligent Temperature Controller

PANEL DESCRIPTION:



① Alarm relay LED indicator (AL)
② Next parameter / value increment
③ Previous parameter / value decrement
④ Select digit / start autotune
⑤ Set parameter / confirm parameter
⑥ Output active / Autotune (AT) LED indicator
⑦ Temperature reading / settings display

NOTE

During the autotune process the AT indicator LED ⑥ is constantly blinking with a frequency of around one Hertz. Under default operation the OUT indicator LED signalize an active controlled output.

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Safety Information

The XMT-7100 is designed for use under the safety requirements of EN61010-1 (2001) within installation Categories II and III environment and pollution degree level 2. To avoid possible hazards accessible conductive parts of final installation should be protectively earthed in accordance with EN61010 for Class 1 equipment. Output wiring should be within a grounded housing. Sensor sheaths should be bonded to ground or not be accessible. Live parts should not be accessible without use of a tool. It is the responsibility of the installation engineer to ensure that this equipment's compliance to EN61010 is not impaired when fitted to the final installation and to use this equipment as specified in this manual. Failure to do so may impair the protection provided. Always insure that the installation is in compliance with appropriate wiring regulations.

The XMT-7100 controller is designed to be mounted in a 1/32 DIN panel cutout. Its front bezel assembly rated NEMA4/IP60 protection is provided, if the panel is smooth and the panel cutout is accurate. The controller should be isolated before removing or refitting it in the panel, and electrostatic precautions should be observed when handling the device outside the housing.

Read this document carefully before using this device. The installation process requires expert knowledge by a qualified installer. It is the responsibility of the installing engineer to ensure that the configuration is safe.

CAUTION

Do not use the AL output port as the sole safety alarm where personal injury or damage may be caused by equipment failure.

CAUTION

Do not use the device in locations subject to corrosive and flammable gases.

CAUTION

The device must be protected against inadmissible humidity, vibrations and severe soiling. Further make sure, that the operational temperature is not exceeded (see Chapter 3 Specifications).

3
Specifications

ENVIRONMENTAL CONDITIONS	
Operating/Storage Temperature	0 … +50°C (32 … 130°F) / -25 … +70°C (-13 … +158°F)
Relative Humidity	max 80% up to 31°C, decreasing linearly 50% at 40°C
Rated Pollution Degree	according to EN60529 Front Panel: IP60 / NEMA 4X Rear Panel: IP20
Safety Requirements	EN61010-1 (2001)
EMC Emission	EN61326-1 (1997), A1 (1998), A2 (2001)
Altitude	up to 2000 m
Mouldings	flame retardant polycarbonate
Weight	110 g (3.9 oz.)
Outline Dimensions	48×24×75 mm
Panel Cutout Dimensions	45×22 mm

ELECTRICAL CHARACTERISTICS	
Supply Voltage	85 – 260V AC/DC (50Hz/60Hz)
Power Consumption	< 2 Watt
Wiring Connections	2.5 mm^2 screw-terminals
Relay Contact Output	250V AC, 3A (for resistive loads), normally open (NO)
Relay Lifetime Expectancy	> 1×10^5 operations
Solid State Relay (SSR) Driver	8 – 10V DC, 30mA non-insolated
Sampling Time	4Hz / 250ms
Temperature Precision	0.2% of full scale ±1 digit
Sensor Line Resistance	max 100Ω for TC, 0.2mA constant current for RTD
Display	4 digits seven segment red LED, 7 mm (0.28”) height 2 red LEDs for OUT/Autotune and ALARM outputs

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Electrical Installation

The controller is designed for operation under a supply voltage of 85-260VAC / 50-60Hz. A polarity is not required between LINE and NEUTRAL terminal ports ① and ②. To protect the equipment the LINE input should be fitted with a 250mA/F-type fuse. The EARTH port ③ should always be connected to a common AC ground level. Either output device RELAY J1 or SSR may be chosen to control the setpoint (SP). Choose the most suitable output device arrangement for the application and wire accordingly.

NOTE

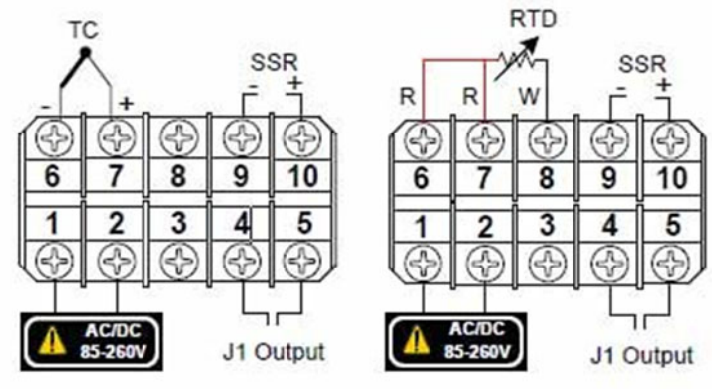
To gain maximal flexibility of the configuration the SSR output ports ⑨ and ⑩ should be mostly selected to switch the load using an external solid state relay, why the RELAY J1 outputs ④ and ⑤ are used as an alarm contact.

NOTE

For two wire RTDs (PT-100), the input terminals ⑥ and ⑦ must be bridged (short circuited) with a jumper, why the sensor itself is connected to the terminal ⑦ and ⑧ as shown in the right figure below. For thermocouples sensors pay attention to the polarity of the sensor cable as shown in the left figure. If EEEE is shown on the display, it indicates a wrong connected or faulty sensor.

CAUTION

Prepare all cables carefully, remove a maximum of 7 mm (0.275 in) insulation and ideally tin to avoid bridging. Prevent excessive cable strain.



5
Configuration

After power-up the controller requires programming with the following information. Please check the default settings below if any modifications are necessary. The first three settings are located in the code protected level 3 "*Initialization Parameters*", why the SV setpoint is located in level 1 "*Temperature & Alarm Parameters*". Please refer to the following pages for a detailed description of all three available levels and on how to access them.

- Type of Input Sensor `IntY` (def. P10.0 ≡ PT-100 high resolution)
- Control Output Type `outY` (def. 2 ≡ PID control loop for SSR)
- Temperature Unit `CorF` (def. Celsius °C)
- Setpoint (SV) `Su` (def. 80°C)

NOTE

In normal operation mode (display not flashing) the setpoint value SV can be changed directly without entering level 1. Pressing the up ⮝ ② or down ⮟ ③ key the flashing display will show the actual setpoint value SV. Press the ➢ ④ key to select a digit and use the up ⮝ ② and down ⮟ ③ key again to increase or decrease the setpoint by one digit. Press **SET** ⑤ to confirm the entry and switch back to normal operation mode.

Each level is protected by a specific access code to prevent unintentional modifications. To gain level access press **SET** ⑤ followed by the appropriate code. Use the ➢ ④ key to select a digit and the up ⮝ ② and down ⮟ ③ key to toggle the code value. Press **SET** ⑤ again to confirm the code and to enter the level (see example key instructions below). In setup mode the display is always flashing to differentiate it from normal the operation mode. After ~10 seconds of no user interaction, the device switches back to normal operation automatically. In this case all parameter changes, which are not confirmed by the **SET** ⑤ key, are lost.

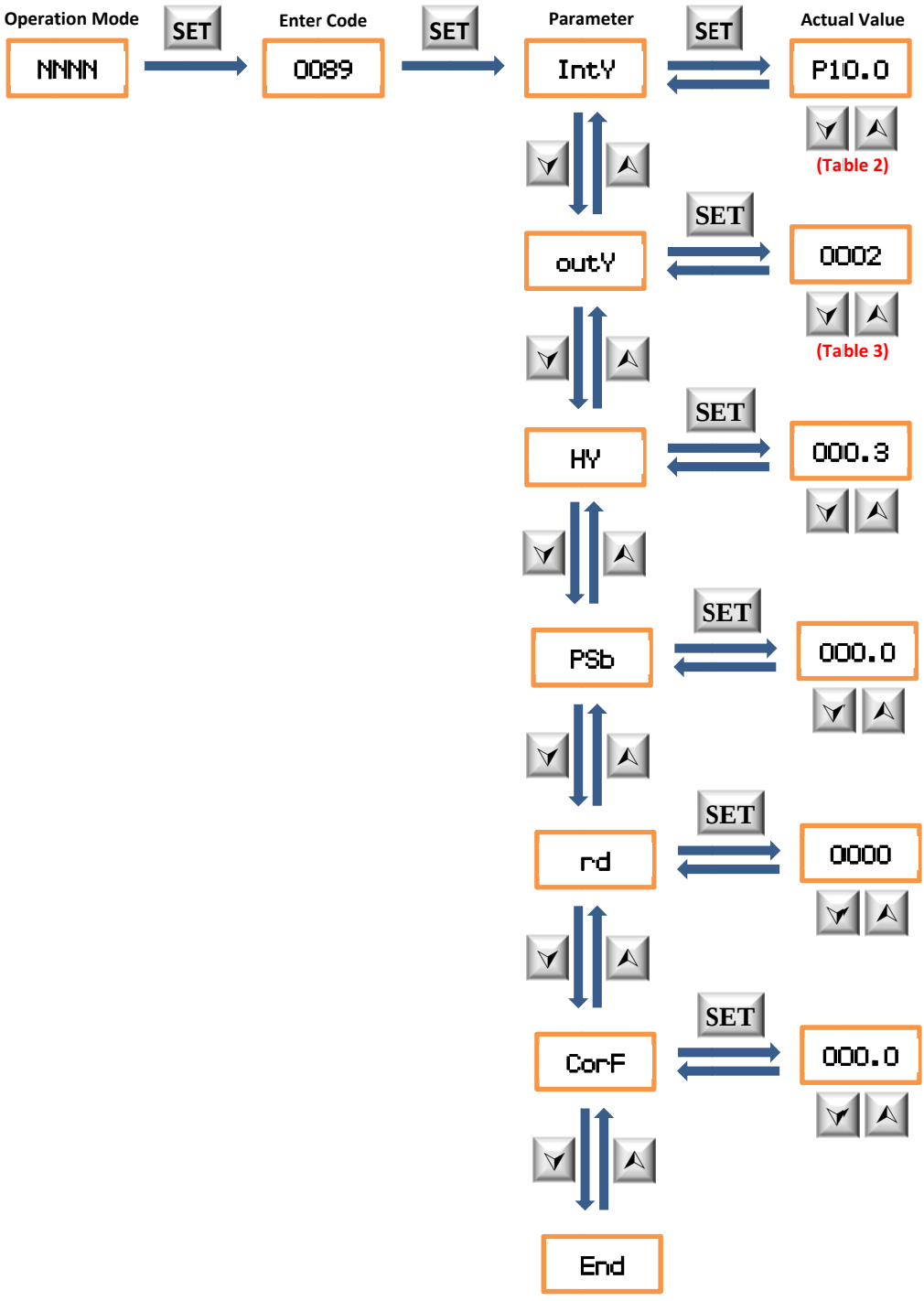
1) Press **SET** ⑤ key => `0000` display flashing
2) Press ➢ ④ ➢ ④ ⮟ ③ ⮟ ③ => `0080` first digit of code
3) Press ➢ ④ ⮟ ③ => `0089` code *0089* complete for level 3
4) Press **SET** ⑤ key => `IntY` first parameter of level 3 shown

Configuration

Inside a level use the up ② or down ③ key to switch between different parameters. Use the **SET** ⑤ key to select a parameter, followed by an up ② or down ③ key to change its value. Press **SET** ⑤ again to confirm the change. To leave a level, scroll to and select the End parameter, press the **SET** ⑤ key to switch back to normal operation mode.

Initialization Parameters (Level 3)

Access code: 0089



Configuration

Table 1: Initialization Parameters

Symbol	Description	Range	Default	mySetting
IntY	Input Sensor Type	see table 2	P100	
outY	Control Output Type	see table 3	2	
HY	Hysteresis value for outputs (only valid for parameter outY=3 or 4)	0 – 999 [°C/°F]	0.3	
PSb	Temperature Sensor Correction	-100 – 100 [°C/°F]	0.0	
rd	Control Action Type	Heating = 0 Cooling = 1	0	
CorF	Temperature Unit Selection (degree of Celsius or Fahrenheit)	[°C] = 0 [°F] = 1	0	
End	Exit from Level 3			

Table 2: Temperature Sensor Types for IntY Parameter

Display	Symbol	Description	Temperature Range	Wire Colour
t	**T**	T Thermocouple Cu-CuNi	-270 – 400 [°C]	+ brown – white
r	**R**	R Thermocouple $PtRh^{13}$-Pt	-50 – 1600 [°C]	+ orange – white
J	**J**	J Thermocouple Fe-CuNi	-200 – 1200 [°C]	+ black – white
WrE	**WRe**	Thermocouple WRe^{3}-WRe^{25}	0 – 2300 [°C]	no standard specification
b	**B**	B Thermocouple $PtRh^{30}$-Pt	350 – 1800 [°C]	+ grey – white
S	**S**	S Thermocouple $PtRh^{10}$-Pt	-50 – 1600 [°C]	+ orange – white
u	**K**	K Thermocouple Ni-CrNi	-200 – 1300 [°C]	+ green – white
E	**E**	E Thermocouple NiCr-CuNi	-200 – 900 [°C]	+ violet – white
P10.0	**P10.0**	PT-100 RTD, decimal point	-199.9 – 600.0 [°C]	no standard specification
P100	**P100**	PT-100 RTD	-200 – 600 [°C]	no standard specification
Cu50	**Cu50**	Cu50 RTD, decimal point	-50.0 – 150 [°C]	no standard specification

**for thermocouple sensors the input circuit has an internal resistance of 100 KΩ*
***for resistance temperature detectors (RTD's) a constant output current of 0.2 mA is used*

Configuration

Table 3: Control Output Type for outY Parameter

Setting	Description	Function
0	Only alarm output on Relay J1 active, SSR disabled, setpoint value SV invalid, AH1 and Al1 value used	Alarm Trigger Control (figure 1)
1	PID controlled output on Relay J1, SSR disabled, setpoint SV is target value	Constant Temperature Control (figure 2)
2	PID controlled 10 V/DC pulse output on SSR, Relay J1 as alarm output, setpoint SV is target value	Constant Temperature Control with fast response time (figure 2)
3	Hysteresis (ON/OFF) mode controlled output on SSR, Relay J1 as alarm output, setpoint SV is target value	Temperature Control around setpoint (figure 3)
4	Hysteresis (ON/OFF) controlled output on Relay J1, SSR disabled, setpoint SV is target value	Temperature Control around setpoint (figure 3)

If the relay J1 is configured as an alarm output (outY = 0, 2 or 3), the AH1 value defines the alarm switching ON temperature, why the AL1 value defines the switching OFF point. For an upper limit alarm, AH1 must be greater than AL1 (AH1 > AL1) and for a lower limit alarm AH1 must be less than AL1 (AH1 < AL1) like shown in figure 1 below.

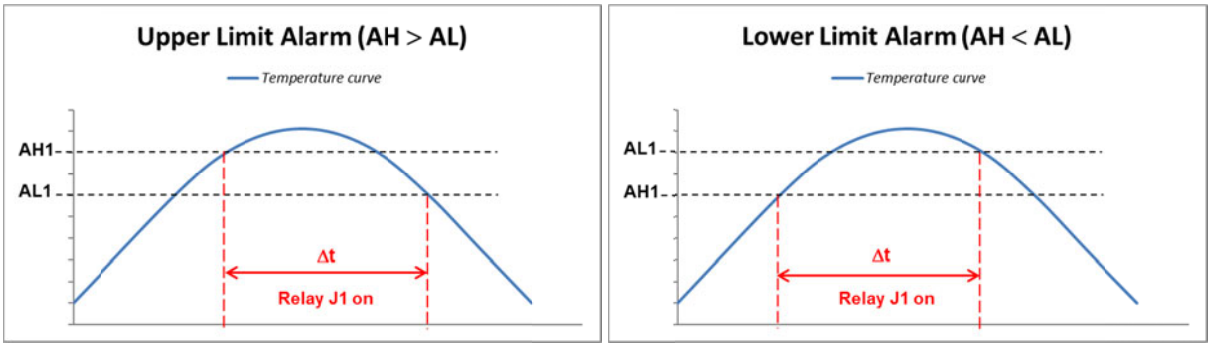


Figure 1: Alarm configuration for upper and lower limits

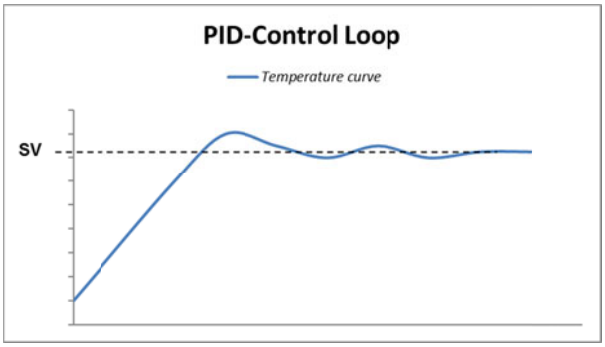


Figure 2: PID controlled output

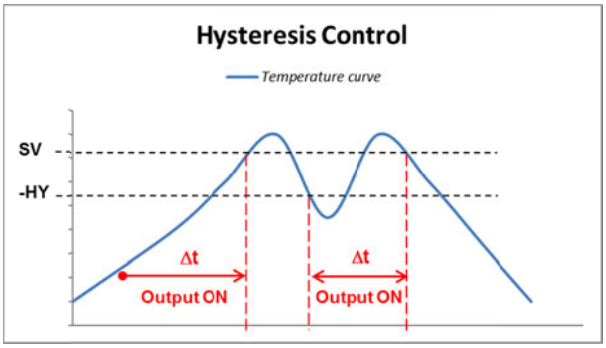


Figure 3: Hysteresis mode for heating (rd = 0)

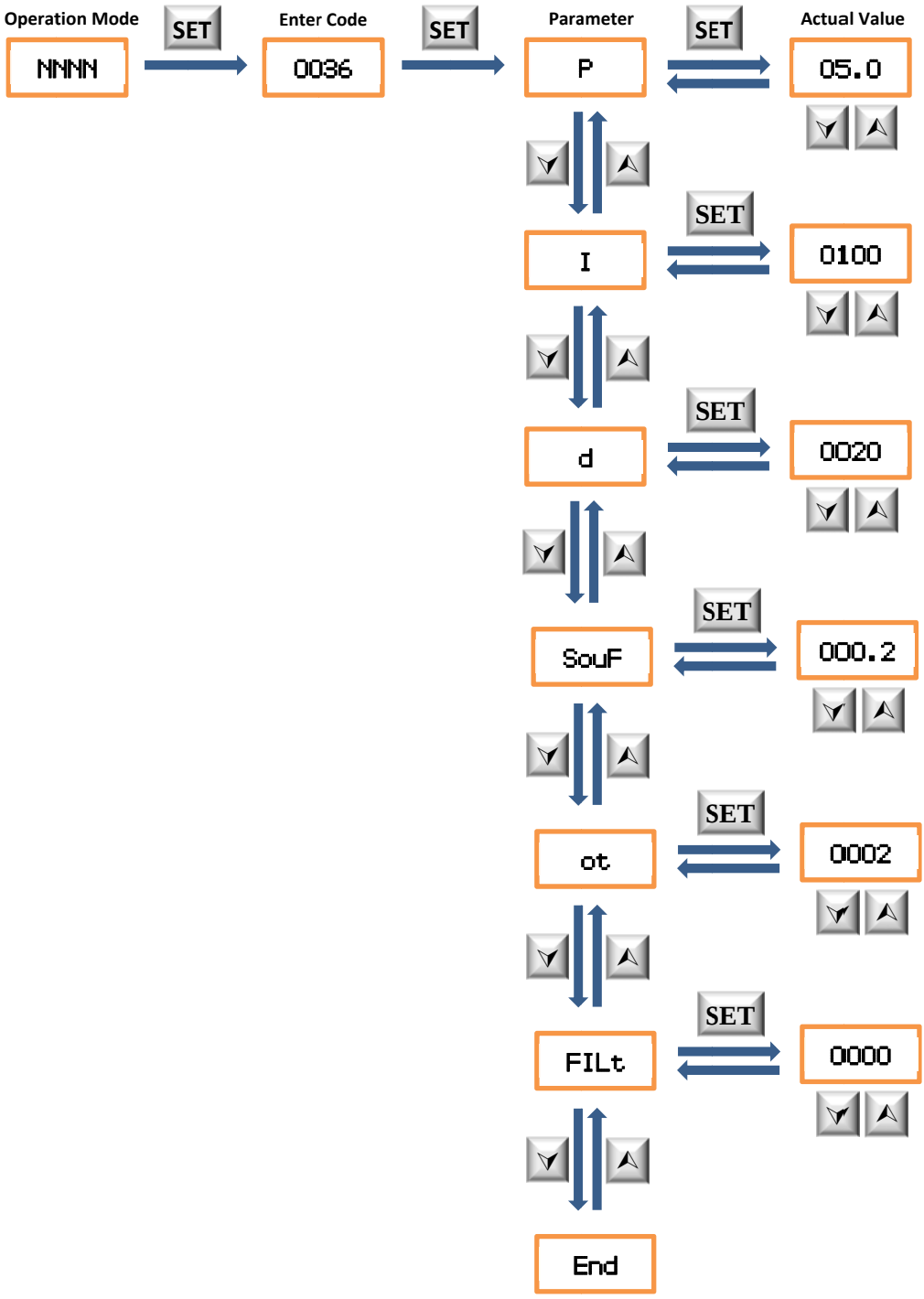
NOTE

For a PID control scheme (outY = 1 or 2) the control period ot parameter should be adapted to the selected output type (SSR or Relay) and the inertial mass of the system. See Level 2 parameter on the following page for a detailed description.

PID Parameters (Level 2)

Access code: 0036

P, I, d parameters are controlling the accuracy and response time of the temperature controller. **AUTO-tuning** (Chapter 6) is always recommended for users, who are not familiar with the PID control theory. P, I, d values should only be adjusted by professionals.



Configuration

Table 4: PID Parameters

Symbol	Description	Range	Default	mySetup
P	Proportional Band[1)]	0.1 – 99.9 [%]	5.0	
I	Integration Time[2)]	2 – 1999 [sec]	100	
d	Derivative Time[3)]	0 – 399 [sec]	20	
SouF	Overshoot Suppression Factor[4)]	0.0 – 1.0	0.2	
ot	Control Period[5)]	2 – 199 [sec]	2	
FILt	Digital Filter Factor	0 – 3 [sec]	0	
End	Exit from Level 2			

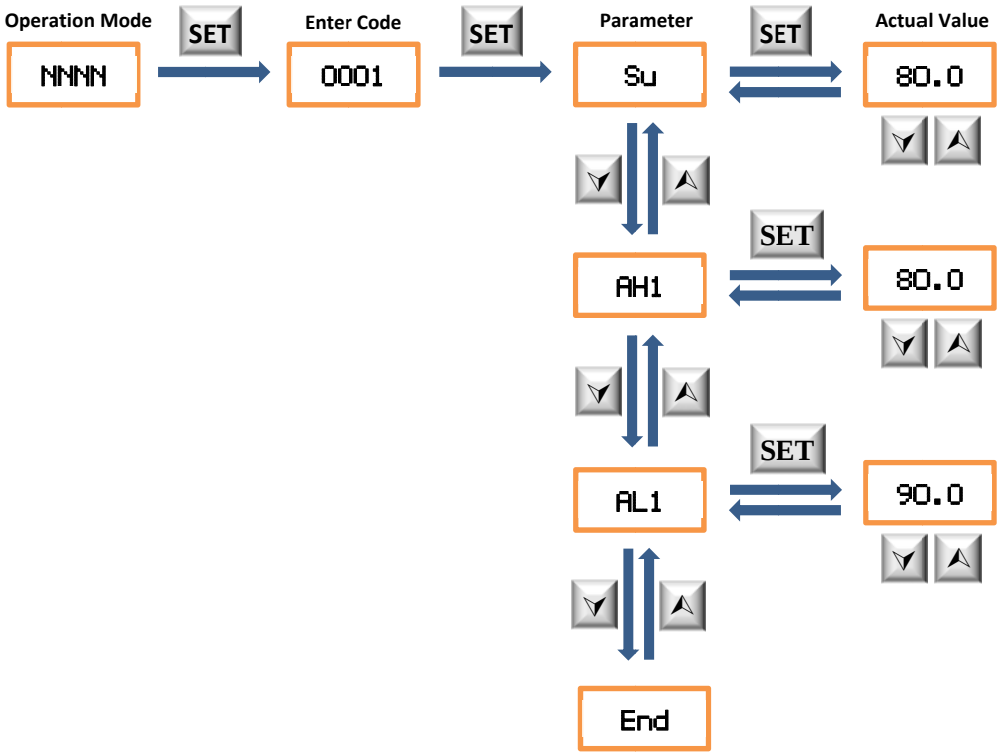
NOTE

1) The temperature oscillation around the setpoint SV is inverse proportional to the P value and proportional to the response speed of the control loop. When P increases, temperature oscillation is decreasing; when P decreases, temperature fluctuation is increasing. If the P value is too small, the temperature setpoint would not be reached and control loop becomes unstable.
2) The integration time I is designed to reduce or eliminate the static offset error, which will occur under proportional control mode only. When I decreases the responds speed will be faster, but the control loop becomes less stable. If I increases the responds speed will be slower, but the system is more stable.
3) The derivative time d prevents ripples in the control loop by predicting output changes and compensates delays. It therefore improves overall system stability. Setting the d value too small or too large will produce control loop oscillations or even non-coverage of the setpoint.
4) The overshooting suppression factor Souf restricts the temperature overpassing above the setpoint. Slightly increase the parameter to supress an overshooting temperature.
5) The control period ot defines the respond (cycle) time of the complete control loop. With smaller values, the loop reacts faster and the setpoint temperature is more stable. In case of contact control (relay output) the relay lifetime decreases significantly (values < 5) due to contact wear out. For contact control (Relay Switching) a value from 8~30 seconds, depending from the heated mass, is suggested. When non-contact control (SSR output) is used, a lower value of ot=2 is normal.

Temperature & Alarm Parameters (Level 1)

Access code: 0001

Use this level to set the target temperature Su value, together with the alarm high AH1 and low temperature AL1 parameter, if the alarm relay output (J1) is configured for your setup. Details of the available Control Output Types are described on Table 3.



NOTE

In normal operation mode (display not flashing) the setpoint Su value can be changed directly without entering level 1. Pressing the up ② or down ③ key the flashing display will show the actual setpoint value for SV. Press the ④ key to select a digit and use the up ② and down ③ key again to increase or decrease the setpoint by one digit. Press **SET** ⑤ to confirm the entry and switch back to normal operation mode.

Configuration

Table 5: Temperature and Alarm Parameters

Symbol	Description	Range	Default	mySetup
Su	Target Temperature (set value)	Sensor depending see table 2	80.0	
AH1	Alarm High value (Relay J1 closed, Alarm LED AL ① on)	Sensor depending see table 2	80.0	
AL1	Alarm Low value (Relay J1 open, Alarm LED AL ① off)	Sensor depending see table 2	90.0	
End	Exit from Level 1			

NOTE

1) In case the alarm values for AH1 = AL1 the relay output J1 is disabled.
2) For an upper limit alarm (see figure 1), AH1 must be greater than AL1 (AH1 > AL1). The AH1 value should also be greater than the setpoint SV (AH1 > Su) to establish an overheat protection. For good starting point values and an example of an overheat protection setup, please follow on with the next chapter “Quick Setup”.
3) For a lower limit alarm AH1 must be less than AL1 (AH1 < AL1) like shown in figure 1 on the right.

6
Quick Setup

The first time the controller is powered-up, it uses factory default settings. Please check the default settings below if any modifications are necessary. The first three settings are located in the code protected level 3 "*Initialization Parameters*", why the others are located in level 1 "*Temperature & Alarm Parameters*". Please refer to Chapter 5 for a detailed description of all three available levels and on how to access them.

- Type of Input Sensor  (def. P10.0 ≡ PT-100 high resolution)
- Control Output Type  (def. 2 ≡ PID control loop for SSR)
- Temperature Unit  (def. Celsius °C)
- Setpoint Value (SV)  (def. 250°C)
- Alarm High (AH1)  (def. 270°C)
- Alarm Low (AL1)  (def. 255°C)

AUTOTUNE

After first time installation and/or new configuration, always initiate an Autotune process to optimize the PID control loop for the connected heater. It should be activated during normal heating operation, but before the Setpoint Su is reached! To start the Autotune, long press (~3 seconds) the ➢ ④ key up to the Autotune LED indicator (AT) ⑥ is flashing (1 Hz). During Autotune a slightly overshooting temperature is normal. The self-tuning function is finished, when the Autotune LED (AT) is no longer continuously flashing. The PID-parameter are automatically updated and stored in the non-volatile memory. To abort an accidently initiated Autotune process, long press again the ➢ ④ key, up to the Autotune LED (AT) is off. In this case no parameters will change.

NOTE

The relay output J1 is used for an overheating shutdown security function in our *Heater Control Modules* (HCM). It can be configured with the alarm AH1 and AL1 settings. Reaching the high temperature alarm level of AH1, the heating power is switched off completely, indicated by the Alarm relay LED (AL) ① on the front panel. Therefore this value should be around 20°C higher then the Setpoint Su value, to allow some small overshooting during the Autotune process. After reaching the low temperature alarm level of AL1, the heating power is switched back to normal operation mode. This value must be lower than the high temperature alarm setting. Otherwise the system will stay off up to a manual triggered power cycle.