NOVUS WWW.NOVUSAUTOMATION.COM	**MICROPROCESSOR BASED TEMPERATURE CONTROLLER** **N 4 8 0 D - V3.2x A** OPERATING MANUAL

1. SAFETY SUMMARY

The symbols below are used on the equipment and throughout this document to draw the user's attention to important operational and safety information.

CAUTION or WARNING: Read complete instructions prior to installation and operation of the unit.	**CAUTION or WARNING:** Electrical Shock Hazard

All safety related instructions that appear in the manual must be observed to ensure personal safety and to prevent damage to either the instrument or the system. *If the instrument is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.*

2. INSTALLATION

The controller should be installed in a panel cut out as specified in item 2. First remove the mounting clamp and insert the controller into the panel cut out. Place the unit into the panel cut-out and slide the mounting clamps from the rear to a firm grip at the panel.

The internal circuitry can be fully removed from the housing without disconnecting any wiring. Grab firmly the front panel and pull out the circuitry from the housing.

2.1 ELECTRICAL CONNECTIONS

All electrical connections are made to the screw terminals at the rear of the controller. They accept wire sizes from 0.5 to 1.5 mm2 (16 to 22 AWG). The terminals should be tightened to a torque of 0.4 Nm (3.5 lb in).

The installation must include a power isolating switch or circuit breaker that disconnects all current carrying conductors. The device should be mounted close to the controller, within easy reach of the operator and marked as the disconnecting device for the instrument.

Figure 1 shows the electrical terminals of the controller.

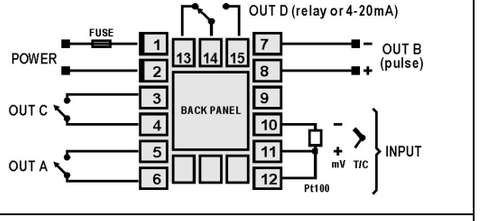


Figure 1 - Back panel terminals

3. SPECIFICATIONS

- Dimensions: 48 x 48 x 110 mm (1/16 DIN). Panel cut-out: 45,5 x 45,5 mm. Weight: 160 g (max);
- Power: 100 to 240 Vac/dc (±10 %), 50/60 Hz or 24 Vdc/ac (±10 %); Max. Consumption: 9 VA;
- Pt100: α= 385. 3-wire connection. Excitation current: 0.170 mA;
- Accuracy: 0.2 % of full scale for Pt100 and 0.25 % of full scale ±1 °C for T/C
- Thermocouple input impedance: 10 MΩ
- A/D converter resolution: 15000 steps
- Sampling rate: 10 measurements per second
- Environmental conditions: 5 to 50 °C; Relative humidity (maximum): 80 % up to 30 ºC. For temperatures above 30 ºC, decrease 3 % per ºC. Installation category II. Pollution degree 2. Altitude < 2000 m.
- Front Panel: Polycarbonate UL94 V-2; Back Panel: ABS + PC UL94 V-0
- EMC: EN 61326-1:1997 and EN 61326-1/A1:1998
- SAFETY: EN61010-1:1993 and EN61010-1/A2:1995

3.1 TEMPERATURE SENSOR INPUT

Thermocouples are connected to terminals 10 and 11 with positive in terminal 11. Pt100 sensors are connected to terminals 10, 11 and 12, as indicated in figure 1. For full compensation of cable resistance only cables with equal wire electrical resistance should be used. Table 1 shows the sensor types accepted and their respective codes.

TIPO	CÓDIGO	FAIXA
J	**0**	-50 to 760 °C (-58 to 1400 °F)
K	**1**	-90 to 1370 °C (-130 to 2498 °F)
S	**2**	0 to 1760 °C (32 to 3200 °F)
Pt100 (Resolution 0,1°C)	**3**	-199.9 to 530.0 °C (-199.9 to 986.0 °F)
Pt100 (Resolution 1°C)	**4**	-200 to 530 °C (-328 to 986 °F)
T	**5**	-100 to 400 °C (-148 to 752 °F)
E	**6**	-30 to 720 °C (-22 to 1328 °F)
N	**7**	-90 to 1300 °C (-130 to 2372 °F)
R	**8**	0 to 1760 °C (32 to 3200 °F)

Table 1 - Sensor types, codes and ranges

3.2 POWER

Mains power is connected to terminals 1 and 2. Check the upper side of the housing for proper power indication.

3.3 CONTROL AND ALARM OUTPUTS

Up to 4 outputs can be configured for control or alarm. The available outputs are identified on the rear panel as OUTA, OUTB, OUTC or OUTD. Electrical characteristics of each output are:

OUTA: SPST Relay, 1,5 A / 250 Vac (3 A / 30 Vdc); Resistive load; 100 k cycles;

OUTB: Voltage Pulse, 5 Vdc / 20 mA;

OUTC: SPST Relay, 1,5 A / 250 Vac (3 A / 30 Vdc); Resistive load; 100 k cycles;

OUTD: SPDT Relay, 3 A / 250 Vac (3 A / 30 Vdc); Resistive load; 6 k cycles;
or 4-20 mA output. With 80 count resolution, precision: 0,25 mA, maximum load: 500 Ohms.

The output function is defined on controller configuration, parameters **IO A**, **IO B**, **IO (** and **IO d**.

Control Output is used to control the process variable using PID algorithm. More than one output can be selected as control output. When OUTD is configured as **Analog Control Output**, all other outputs selected as Control Output will not operate.

Control Outputs are turned off when a sensor error is detected (display "**Erro**").

Alarm Outputs are used to signal abnormal PV values, sensor error or end of program. The alarm function must be selected for each alarm output. (Refer to chapter 9).

4. CONFIGURATION AND OPERATION

Prior to first operation the controller should be fully configured. The user must set basic parameters as temperature type ("**TYPE**"), the desired control set point (" **SP** "), the alarms set points ("**SPA1**" and "**SPA2**"), etc.

4.1 PARAMETERS FLOW CHART

The programming parameters are organized in 4 different sets or levels

Operation level / Alarms and tuning level / Configuration level / Calibration level

At power up the controller displays a prompt at the Operation Level and remains in this level while under normal operation.

The other levels are only accessed when a change of parameters is necessary (except for Set Point change). To reach these other parameters the user must keep the **PROG** Key (P) pressed for about three seconds. After this time the controller will show the first parameter of the next level. By keeping the P key pressed for another 3 seconds the next level will be accessed.

Release the P key when the desired level is reached. Press once the P to go to the next prompt in the same level. When a parameter is shown the display will alternate its name and value. The value can then be changed by pressing the ▼ or ▲ key.

After the last parameter in one level is reached the controller returns to operation level and the display will indicate the measured temperature.

The display will also go back to the measured temperature whenever the display is inactive for 20 seconds or more. When a parameter value is changed via keyboard the controller will only accept the new value after the user presses the P key to go to next prompt or if the keyboard is left inactive for 20 seconds.

4.2 PROGRAM SECURITY

To avoid tampering, parameter "**Prot**" and a hardware jumper can be used to disable access to programming parameters.

With the jumper in the **OFF** position, all program levels are unprotected. The "**Prot**" parameter can only be changed with the jumper in the **OFF** position.

With the jumper in the **ON** position or **removed**, the protection level is defined by the current value of the "**Prot**" parameter:

0 No protection. All parameters can be accessed;
1 No access to the calibration level;
2 No access to calibration and configuration levels;
3 No access to calibration, configuration and tuning and alarms levels;
4 No access to calibration, configuration, tuning and alarms and operation (except SP) levels;
5 Fully blocked.

	
Figure 2 – Protection **Disabled**	Figure 3 – Protection **Enabled**

4.3 OPERATION LEVEL

TEMPERATURE INDICATION END SP	**TEMPERATURE** measured by the sensor. At power up, the upper display shows the process temperature value. It also shows the messages described in chapter 5 of this manual. The lower displays shows the set point value which is the temperature value desired for the process.
rAte	**TEMPERATURE RATE OF RISE**: The user defines the rate of temperature rise from the starting temperature to the value set in " **SP** ". Rate is defined in **°C / minute**.
T Sp	**TIME FOR SOAK**: Time in minutes which the temperature will remain at the selected " **SP** ". Refer to item 4.
Rvn **run**	**RUN**: At this prompt the user sets the control output and alarms to active or to inactive. **0** - inactive outputs; **1** - active outputs;

4.4 TUNING AND ALARMS LEVEL

Atvn	**AUTO-TUNE**: Activates the auto-tuning of PID parameters. **0** - Auto-tune is off; **1** - Auto-tune is on;
Pb **P**roportional **b**and	**PROPORTIONAL BAND**: percentage of maximum input span. When set to zero (**0**), control action is **ON/OFF**.
Ir **i**ntegral **r**ate	**INTEGRAL RATE**: Integral time constant in repetitions per minute (Reset). This constant is not used when controller is set to ON/OFF action (**Pb=0**).
Dt **d**erivative **t**ime	**DERIVATIVE TIME**: Derivative time constant in seconds. This constant is not used when controller is set to ON/OFF action (**Pb=0**).
(t **C**ycle time	**CYCLE TIME**: Pulse Width Modulation (PWM) period in seconds. This term is not used when controller is set to ON/OFF action (**Pb=0**).
KySt **HYSt**eresis	**CONTROL HYSTERESIS**: Is the hysteresis for ON/OFF control (set in temperature units). This parameter is only used when the controller is in ON/OFF mode (**Pb=0**).
A1SP A2SP **SP A**larm	**SETPOINT for Alarm 1/2**: Triping point for alarm 1/2.

4.5 CONFIGURATION LEVEL

Type **t**YPE	**INPUT TYPE**: Selects the input sensor type to be connected to the controller. ***This is the first parameter to be set.*** **0** - Thermocouple type **J**; **5** - Thermocouple type **T**; **1** - Thermocouple type **K**; **6** - Thermocouple type **E**; **2** – Thermocouple type **S**; **7** - Thermocouple type **N**; **3** - **Pt100** with **0,1°** resolution; **8** - Thermocouple type **R;** **4** - **Pt100** with **1°** resolution;
Vnit **unit**	**TEMPERATURE UNIT**: Selects display indication for degrees Celsius or Fahrenheit. **0** - degrees Celsius (**°C**); **1** - degrees Fahrenheit (**°F**);
A(t **AC**tion	**CONTROL ACTION**: **0** - **reverse** action. Generally used for heating. **1** - **direct** action. Generally used for cooling.
Io A **O**ut **A**	**OUTA FUNCTION**: **0** - OUTA is control output. **1** - OUTA is Alarm 1 output. **2** - OUTA is Alarm 2 output.
Io b **O**ut **B**	**OUTB FUNCTION**: **0** - OUTB is control output. **1** - OUTB is Alarm 1 output. **2** - OUTB is Alarm 2 output.
Io (**O**ut **C**	**OUTC FUNCTION**: **0** - OUTC is control output. **1** - OUTC is Alarm 1 output. **2** - OUTC is Alarm 2 output.
Io d **O**ut **D**	**OUTD FUNCTION**: **0** - OUTD is control output. **1** - OUTD is Alarm 1 output. **2** - OUTD is Alarm 2 output. **3** - OUTD is Analog Control Output (4-20mA).
spll **SP L**ow **L**imit	**SET POINT LOW LIMIT:** sets the lower range for SV.
spKl **SP H**igh **L**imit	**SET POINT HIGH LIMIT**: Sets the upper range for SV.
Offs **OFF S**et	**SENSOR OFFSET**: Offset value to be added to the PV to compensate sensor error. Default value: zero.
A1fv A2fv **A**larm **1** **Fu**nction	**FUNCTION OF ALARM 1/2**: Refer to table 2 for function description and respective codes to set at this prompt.
Aiky A2ky **A**larm **HY**steresis	**ALARM 1 AND ALARM 2 HYSTERESIS**: Defines the differential range between the PV value at which the alarm is turned on and the value at which it is turned off.
Prot **Prot**ection	**PROGRAM SECURITY**: Defines the level of parameters protection from tampering. Refer the chapter 4.2.

4.6 CALIBRATION LEVEL

These parameters are used to calibrate the temperature measurement and should only be dealt with by experienced and well equipped personnel.

InI(**I**nput **L**ow **C**alibration	**SENSOR OFFSET CALIBRATION**. Sets the temperature sensor low calibration (offset). The display shows only the corrected temperature and not the offset added. A signal simulator should be used to inject a low value signal to properly adjust the offset.
InK(**I**nput **H**igh **C**alibration	**INPUT HIGH CALIBRATION**. Sets the sensor input circuit gain or high calibration. A signal simulator should be used to inject a high value signal to properly adjust the offset.
(jL **C**old **J**unction **L**ow **C**alibration	**COLD JUNCTION OFFSET CALIBRATION**: Sets the cold junction offset calibration. A good thermometer or a temperature simulator should be used to properly adjust this parameter.
0vl(**ou**tput **L**ow Calibration	***OFFSET*** **CALIBRATION OF ANALOG OUTPUT**: Offset (zero) calibration of the analog control output (4-20 mA).
0vK(**ou**tput **H**igh Calibration	**GAIN CALIBRATION OF ANALOG OUTPUT**: Gain (span) calibration of the analog control output (4-20 mA).

5. RAMP TO SOAK FUNCTION CHARACTERISTICS

This function makes the process temperature rise gradually from the starting point (present PV) to the temperature value set in " **SP** " (Ramp). The user defines the rate of rise in degrees per minute at the "**rAtE**" prompt. When SP is reached the temperature is leveled at this point for 1 to 9999 minutes as programmed at the " **t SP** " prompt. Setting **0** (zero) at " **t SP** " defines an infinite length soak profile.

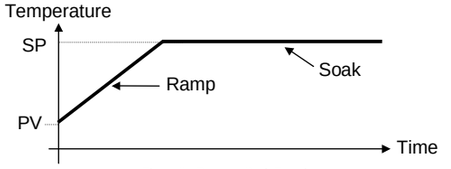


Figure 2 - Ramp to Soak Function

To disable the ramp function Set **0.0** at the "**rAtE**" prompt. To disable the soak function set **1** at the " **t SP** " prompt (thus making a 1 minute soak) and the control output will go off in 1 minute. To restart control set 1 at the " **rvn** " prompt.

After a power failure the controller will resume ramp to soak execution at the equivalent previous ramp point. If the process temperature is the same as the SP (no temperature drop) the controller will repeat the soak segment.

6. PID AUTO TUNE

During auto tune the temperature is controlled in ON/OFF mode at the programmed Set Point (SV). Depending on the process characteristics large oscillations above and below SV may occur and auto tuning may take several minutes to be concluded.

The recommended procedure is as follows:

- Program a new SP close to the desired final temperature other than the present measured temperature.
- Enable the auto tune at the "**Atvn**" prompt by selecting **1**.
- Set **1** at the "**rvn**" prompt. The **TUNE** message will be signaled in the display.

During auto tune large oscillations will be induced around the set point. Make sure the process can accept these oscillations. If auto tuning results are not satisfactory refer to table 3 for manual fine tuning procedure.

PARAMETER	RESPONSE	SOLUTION
Proportional Band	Slow Response	Decrease
	Large Oscillation	Increase
Integral Rate	Slow Response	Increase
	Large Oscillation	Decrease
Derivative Time	Slow Response or Instability	Decrease
	Large Oscillation	Increase

Table 3 - Suggestions for manual tuning of PID parameters

7. ALARM FUNCTIONS

Low and high alarms are used to signal minimum and maximum temperature values as programmed in the "**SPA1**" and "**SPA2**" prompts.

Differential alarms are used to indicate deviations from the desired set point (**SP**) temperature. These deviations are programmed at the "**SPA1**" and "**SPA2**" prompts. Error alarm shows sensor defects or not properly connected. Table 2 shows each alarm function operation with their respective code. Alarm 1 is used as an example.

7.1 ALARM INITIAL BLOCKING

The initial blocking option inhibits the alarm from being recognized if an alarm condition is present when the controller is first energized. The alarm will actuate only after the occurrence of a non alarm condition followed by a new occurrence for the alarm.

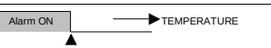
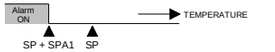
TYPE	CODE	ACTION
LOW	**0**	
HIGH	**1**	
LOW differential	**2**	**SPA1** Negative 
		SPA1 Positive 
HIGH differential	**3**	**SPA1** Negative 
		SPA1 Positive 
differential or deviation	**4**	**SPA1** Negative 
		SPA1 Positive 
Input sensor error or heater break detection	**5**	Alarm is ON whenever: • Temperature is below/above selected range; • Thermocouple or Pt100 is broken; • Pt100 is shorted; badly connected or wire impedance is too high; • The heater resistance is broken
End of Program	**6**	Activated when the programmed soak time is run out. Refer to item 4 of this manual.
Alarm Functions With alarm inhibition at power-up	**7**	Low limit alarm disabled at power-up
	8	High limit alarm disabled at power-up
	9	Differential low limit alarm disabled at power-up
	10	Differential high limit alarm disabled at power-up
	11	Differential alarm disabled at power-up

Table 2 - Alarm functions and their identification codes

8. PROBLEMS WITH THE CONTROLLER

Connection and configuration errors state for most of the problems in using the controller. A final revision of parameters will save time and further losses.

Error messages are displayed to help the user to identify possible problems.

: Process temperature is below the selected sensor range.

: Process temperature is above the selected sensor range

: Controller or sensor error. Example: Broken thermocouple or Pt100, Pt100 badly connected, short-circuited or high cable resistance.

5.1 GETTING THE INSTRUMENT SERIAL NUMBER

Upon power-on, the controller displays its firmware version for 3 seconds. The serial number is accessed when the controller is powered while holding the key ▲ pressed.

9. PRODUCT IDENTIFICATION

The label attached to the controller case identifies the model and the optional present in the product, as described below:

MODEL: **N480D – A – B**, where:

A: Outputs: **RP** (OUT A = Relay, OUT B = Pulse)
RPR (OUT A = Relay, OUT B = Pulse, OUT D = Relay)
RRR (OUT A = Relay, OUT C = Relay, OUT D = Relay);
RAR (OUT A = Relay, OUT C = Relay, OUT D = 4-20 mA)

B. Voltage rating: **blank** (100-240 Vac/dc) or **24V** (24 Vac/dc);

10. TECHNICAL ASSISTANCE

If you encounter a problem with your controller, review the configuration with regard to inputs, outputs, alarms, etc. If the problem persists, contact your supplier or Novus at info@novus.com.br.