N2000S

UNIVERSAL PROCESS CONTROLLER FOR SERVO POSITIONING

OPERATING MANUAL

1. MAIN FEATURES

- Universal multi-sensor input without hardware change.
- Control outputs: 2x 3A/250Vac relays, linear 4-20mA
- 2 alarms: 1 relay and 1 logic (20mA current signal).
- Process Variable or Setpoint 4-20mA analog retransmission.
- Auto/Manual “bumpless” transfer.
- Digital inputs with 3 programmable functions.
- Sensor break protection in any condition.
- Input for feedback potentiometer.
- Ramp and Soak: Four 5-segment profiles, up to 20 segments.
- RS-485 digital Communication. RTU MODBUS protocol.
- Auto tuning PID.
- Unique electronic 8-digit serial number can be viewed at the display.
- Polycarbonate membrane with tactile feedback keyboard.
- Keyboard password protection.
- Circuitry can be removed from the front panel.
- Impact resistant ABS housing.

2. INTRODUCING N2000S

The N2000S front panel is shown in figure 1, following an explanation of its main parts.

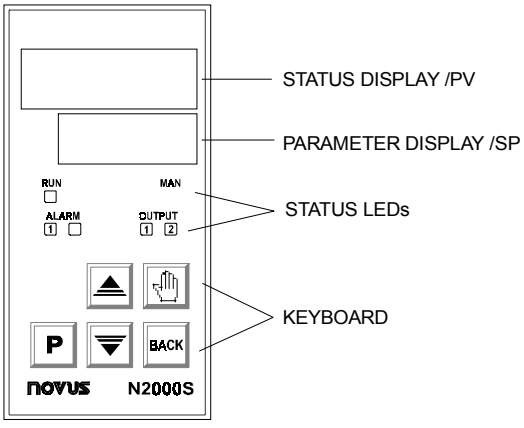


Figure 1 — SX-UNI face plate

Status Display/PV: shows the present value of the process variable (PV). When accessing the programmable parameters it indicates the code that identifies each parameter.

Parameters Display/SV: shows the Set Variable (Set point) and other programmable parameters of the controller.

Alarms 1 and 2 LED's: indicate an alarm when switched on.

OUTPUT LED: indicates that the controller is enabled.

MANUAL LED: indicates that the controller is in manual mode. Flashes during the auto tune cycle.

PARAMETER key “P” : used to show the sequence of parameters.

BACK key: used to move back in the sequence of parameters.

Incremental and Decremental Keys ⇧ and ⇩: these keys are used to change the value of a programmable parameter.
When the controller is energized the status display will show the present value of the PV and the parameter display will show the SV. The parameters at the operating cycle are of free access through the “**P**” key.

(**Manual Key**): toggles the AUTO/MANUAL mode.

The parameters programming is divided in 7 cycles (refer to Parameters Flowchart, figure 11)

Cycle	Access
1- Operation	Free access parameters *
2- Tuning	Reserved access parameters **
3- Program	
4- Alarms	
5- Configuration	
6- I/Os	
7- Calibration	

*These parameters can be viewed but not changed if the cycle is protected.
**Means that a password is required to view or change these parameters.

Press “**P**” to advance and “**BACK**” to go back in the menu cycle.
Keep pressing the “**P**” or “**BACK**” key to move fast forward or backward.
Press “**BACK**” and “**P**” simultaneously to move from one cycle to the next one.
At the end of each cycle the controller returns to the operation cycle.

3. PROGRAM SECURITY

Each menu cycle can be locked (protected) by pressing “**BACK**” and ⇧ simultaneously for 3 seconds. Press “**BACK**” and ⇩ for 3 seconds to unlock.
A short blink of the display confirms the lock/unlock change. This will alternately lock or unlock the⇧ and ⇩keys to avoid tampering.

4. CONFIGURATION AND WIRING

The controller requires some minimal initial parameter settings in order to operate properly. The Parameters Flowchart in figure 11 shows all the parameters in the N2000S.

- Define input and output types to be used in the system;
- Set the desired input type in the “**in.tY**” prompt, according to table 1 (refer to Parameter Flowchart and to chapter 7.5 Configuration Cycle);
- Program the alarm functions “**AlF1**” and “**AlF2**”
- Set the parameters “**SEr.t**”, “**SEr.r**” and “**SEr.F**” (see tuning cycle)

Table 1 - Input Types

TYPE	CODE	CHARACTERISTICS
J	0	range: -50 to 760 °C (-58 to 1400ºF)
K	1	range: -90 to 1370 °C (-130 to 2498ºF)
T	2	range: -100 to 400 °C (-148 to 752ºF)
RESERVED	3	
RESERVED	4	
S	5	range: 0 to 1760 °C (32 to 3200ºF)
Pt100	6	range: -199.9 to 530.0 °C (-328.0 to 986.0ºF)
Pt100	7	range: -200 to 530 °C (-328 to 986ºF)
4-20 mA	8	J linearization. Programmable range: -110 to 760°C
4-20 mA	9	K linearization. Programmable range: -150 to 1370°C
4-20 mA	10	T linearization. Programmable range: -160 to 400°C
RESERVED	11	
RESERVED	12	
4-20 mA	13	S linearization. Programmable Range: 0 to 1760°C
4-20 mA	14	Pt100 linearization. Prog. Range:-200.0 to 530.0°C
4-20 mA	15	Pt100 linearization Prog. Range:-200 to 530°C
0 a 50mV	16	Linear. Programmable indication -1999 to 9999
4-20 mA	17	Linear. Programmable indication -1999 to 9999
0 a 10V	18	Linear. Programmable indication -1999 to 9999

Table 2 - I/O functions for I/O5, to be programmed in "**io.Fu**"

CODE	I/O Type	I/O Function
0	Digital Output	Digital Output to be set by the serial comm.
1	RESERVED	
2	Digital Output	
3	RESERVED	
4	RESERVED	
5	RESERVED	
6	RESERVED	
7	Digital Input	Run/Stop mode change
8	RESERVED	
9	Digital Input	Executes/Holds selected ramp and soak profile
10	Digital Input	Enable/Disable R&S profile 1 selection
11	Analog Output	0 a 20mA Analog control output
12	Analog Output	4 a 20mA Analog control output
13	Analog Output	0 a 20mA PV retransmission
14	Analog Output	4 a 20mA PV retransmission
15	Analog Output	0 a 20mA SP retransmission
16	Analog Output	4 a 20mA SP retransmission

5. INSTALLATION

The controller was designed for panel assembly as shown in Figure 2.

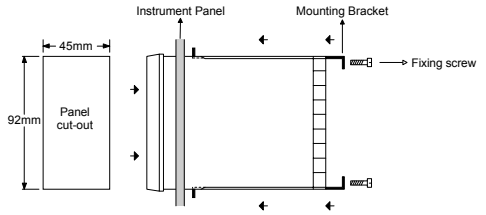


Figure 2 — Assembling the controller at the instrumentation panel

6. ELECTRICAL WIRING

The internal circuitry can be removed through the front panel without disconnecting the electrical wiring at the back panel. Figure 3 shows the back panel connections.

It is important to follow the recommendations below:

- Signal wires should be installed in grounded conduits and away from power or contactor wires.
- The instrument should have its own power supply wires which should not be shared with electrical motors, coils, contactors, etc.
- Installing RC filters is strongly recommended at contactor coils or any other inductors.
- System failure should always be taken into account when designing a control panel to avoid irreversible damage to equipment or people.

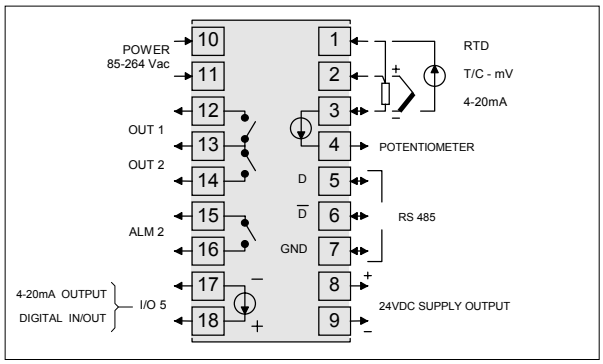


Figure 3 — Back panel terminals

6.1 THERMOCOUPLE OR VOLTAGE INPUT

Thermocouples, 0-50mVdc and 0-10V linear voltage inputs should be connected in accordance to figure 4 and 5.

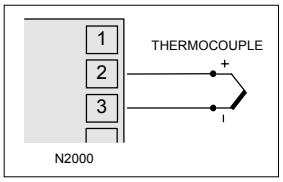


Figure 4 – Thermocouple input

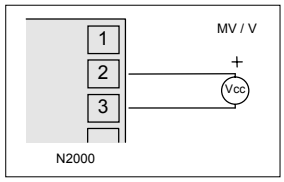


Figure 5 — Voltage input

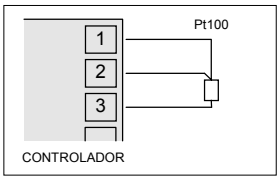


Figura 6 – Pt100 wiring

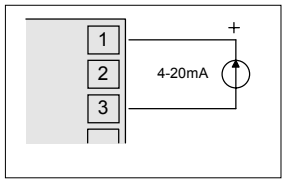


Figura 7 – Current input

6.2 PT100 WIRING

Pt100 should be connected according to figure 6. For proper cable error compensation the wires connected to terminals 1 and 3 should have the same resistance.

6.3 CURRENTE INPUT

Current signals should be connected according to figure 7.
When using the 24Vdc output power supply (terminals 8 and 9), the 4-20mA transmitters should be connected as in figure 8.

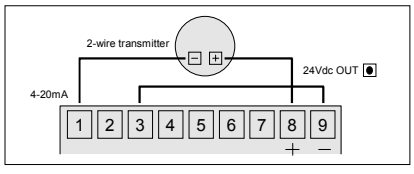


Figure 8 —2 wire transmitter using the 24Vdc output power supply

6.4 POTENTIOMETER INPUT

A 10kΩ feedback potentiometer for visualizing the valve/damper position can be connected to terminals 3 and 4 as shown in Figure 9. The potentiometer reading has no influence on the control positioning, it is provided only for operator's orientation. It is not necessary for the control.
To enable the potentiometer position to be shown on the display, set the "**Pot**" parameter to ***YES***. It's value will be shown instead the MV (manipulated variable).

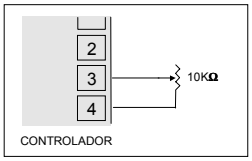


Figure 9 – Potentiometer connection

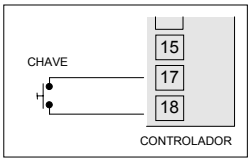


Figure 10 – Digital input connection

6.5 DIGITAL INPUT

Figure 10 shows how to wire the signal to the digital input terminals.

PARAMETERS FLOWCHART

Operation Cycle	Tuning Cycle	Ramp & Soak Cycle	Alarm Cycle	Configuration Cycle	Calibration Cycle
PV e SP	AtUn	Pr n	FuA1	tYPE	InLC
PV e MV	Pb	PtoL	FuA2	dPPo	InHC
Pr n	HYSt	PSP0 - PSP5	bLA1	un It	ouLC
run	Ir	Pt1 - Pt5	bLA2	IoFu	ouHC
	dt	PE1 - PE5	HYA1	oFFS	CJ L
	SErt	LP	HYA2	SPLL	HtYP
	SErr			SPHL	PotL
	SErF			Pot	PotH
	ACt			bAud	
	SPA1			Addr	
	SPA2				

Figure 11 — Parameters Flowchart

7. PARAMETER DEFINITIONS

7.1 OPERATION CYCLE

PV Indication (Red)
SV Indication (Green)

PV AND SV INDICATION: The status display shows the present value of PV (Process Variable). The parameter display shows SV (Set Variable).

The status display shows **- - - -** whenever PV exceeds the maximum range or there is no signal at the input. In case of hardware error the status display will show **Er n**, where n is the error code.

PV Indication (Red)
MV Indication (Green)

MANIPULATED VARIABLE VALUE (MV): The upper display shows PV value and the lower display shows the percentage of MV applied to the control output.

When in manual control the MV value can be manually changed. When in auto mode the MV value can only be viewed.

To distinguish the MV display from the SV display, the MV is shown flashing intermittently.

Pr n RAMP AND SOAK PROGRAM SELECTION: Selects the ramp and soak program to be executed (4 programs possible). Refer to chapter 7 for R&S description.

run CONTROL ENABLE: **YES** means that the control output and alarms are enabled and **NO** means they are disabled.

7.2 TUNING CYCLE

AtUn AUTO-TUNE: **YES** enables the auto tuning of the PID parameters and **NO** disables it.

Pb PROPORTIONAL BAND: Percentage of maximum input span. Select zero for ON/OFF control.

HYSt CONTROL HYSTERESIS (in eng. units): This parameter is only shown for ON/OFF control (Pb=0).

Ir INTEGRAL RATE: Integral time constant in repetitions per minute (Reset).

dt DERIVATIVE TIME: Derivative time constant, in seconds.

SErt SERVO TIME: time for valve to fully open from fully closed.

SErr SERVO RESOLUTION: Minimum output resolution. Determines a dead band in witch the servo does not move.

SErF SERVO FILTER: time for the PID average. The control output is averaged for the time specified before it is enabled to actuate the relays. Recommended value: > 2s.

ACt CONTROL ACTION: For Auto Mode only.
- Reverse Action **rE** usually used for heating.
- Direct Action **dir** usually used for cooling.

SPA1 ALARM 1 PRESET: Tripping point for alarm 1.

SPA2 ALARM 2 PRESET: Tripping point for alarm 2.

7.3 RAMP AND SOAK PROFILE PROGRAMMING CYCLE

Pr n PROGRAM TO BE VIEWED: Selects the ramp and soak profile program to be edited/viewed in the following cycle prompts (4 programs available).

PtoL RAMP AND SOAK TOLERANCE: maximum deviation between PV and SV. Whenever this deviation is exceeded the time counter is halted until deviation lowers to within the tolerance. Set zero to disable this function.

PSP0 RAMP AND SOAK SET POINTS (0 to 5): Set of 6 SV values which define the ramp and soak profile segments. This prompt **PSP0** to **5** is alternated accordingly with **PT1** to **5** and **PE1** to **5** below.
PSP5

Pt1 RAMP AND SOAK SEGMENTS TIME (1 to 5): Set of 5 time intervals in minutes (9999 max.) for the 5 segments of the ramp and soak program.
Pt5

PE1 RAMP AND SOAK EVENT (1 to 5): Set of 5 values that define which alarms must be activated during a ramp and soak program segment (only program 1 has this feature).
PE5

Alarm function depends on **rS** setting (table 3).

LP LINK TO PROGRAM: Number of the next profile program to be linked and follow the current profile. Profiles can be linked to make larger programs of up to 20 segments.

7.4 ALARM CYCLE

FuA1 ALARM 1 FUNCTION: Select options from table 3.

FuA2 ALARM 2 FUNCTION: Select options from table 3.

bLA1 ALARM 1 BLOCK: This function blocks the alarm 1 at power-up when the units is first energized.

YES enables and **NO** inhibits this blocking function.

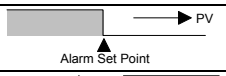
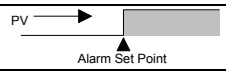
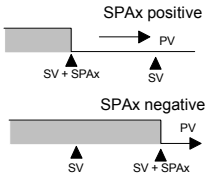
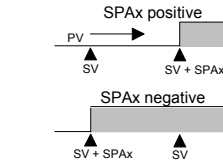
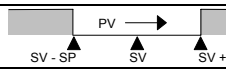
bLA2 ALARM 2 BLOCK: This function blocks the alarm 2 at power-up when the units is first energized.

YES enables and **NO** inhibits this blocking function. When enabled the alarm will not be active at power-up, waiting for the alarm condition to go off before enabling it to become active in the next occurrence of the alarm.

HYA1 ALARM 1 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 (in engineering units).

HYA2 ALARM 2 HYSTERESIS: Same as above.

Table 3 - Alarm functions

TYPE	PROMPT	ACTION
Manual	MAn	Active when the controller is in MANUAL mode..
Sensor Break	tErr	Alarm will be ON if PV sensor breaks, input signal is out of range or Pt100 is shorted.
Event Alarm	rS	Can be activated at a specific segment of ramp and soak program.
Heater Break	rFAIL	Not available in this model
LOW Alarm	Lo	
HIGH Alarm	HI	
LOW Differential	dIFL	
HIGH Differential	dIFH	
Differential	dIF	

7.5 CONFIGURATION CYCLE

tYPE INPUT TYPE: Selects the input signal type to be connected to the process variable input. Refer to table 1.
This is the first parameter to be set.

dPPo DECIMAL POINT POSITION: For input types 16, 17 or 18 only. Selects the decimal point position to be viewed in both PV and SV.

unIt TEMPERATURE INDICATION IN ºC OR ºF: Selects the display indication to be in ºC or ºF. Only available if input type is other than 16, 17 or 18.

Io.Fu (**i/O** 5 **Fu**nction) – Selection of the I/O 5 function, according to table 2.

oFFS (**oFFS**et) - PV OFFSET: Adds an offset value to the Process Variable.

Default value: zero.

SPLL SET POINT LOW LIMIT:

- Linear inputs: Sets the lower range for SV and PV indication.
- T/C and Pt100 inputs: sets the lower range for SV.

SPHL SET POINT HIGH LIMIT:

- Linear inputs: Sets the upper range for SV and PV indication.
- T/C and Pt100 inputs: sets the upper range for SV.

Pot (**Pot**entiometer) – Selects which value will be shown on the MV prompt (second parameter in the main cycle):

"YES" : shows the Potentiometer value

"no" : shows the PID output (MV)

bAud

Addr DIGITAL COMMUNICATON BAUD RATE SELECTION:
0: 1200bps; 1: 2400bps; 2: 4800bps; 3: 9600bps; 4: 19200bps.
SLAVE ADDRESS SELECTION: Identifies a slave in the network. The possible address numbers are from 1 to 247.

7.6 CALIBRATION CYCLE

All input and output types are factory calibrated. This cycle should only be accessed by experienced personnel. If in doubt do not press the ⇧ or ⇩ keys in this cycle.

InLC INPUT LOW CALIBRATION: Sets the Process Variable low calibration (offset). Several keystrokes at ⇧ or ⇩ might be necessary to increment one digit.

InHC INPUT HIGH CALIBRATION: Sets the Process Variable span calibration (gain).

ouLC OUTPUT LOW CALIBRATION: Sets the analog current output low calibration (offset).

ouHC OUTPUT HIGH CALIBRATION: Sets the analog current output span calibration (gain).

CJ L COLD JUNCTION OFFSET CALIBRATION: Sets the cold junction offset calibration.

HtYP HARDWARE TYPE – N2000S hardware configuration. Use always the value of 2.

PotL (**Pot**entiometer **L**ow Calibration) – sets the potentiometer low calibration (offset).

To obtain a change in the reading, it may be necessary several clicks in the ⇧ or ⇩ keys.

PotH (**Pot**entiometer **H**igh Calibration) – sets the potentiometer span calibration (gain).

8. RAMP AND SOAK PROFILE PROGRAM

Four ramp and soak profiles with up to 5 segments each can be programmed. Longer profiles of up to 20 segments can be created by linking 2 or more profiles.

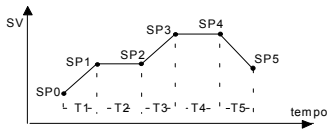


Fig. 1 - Example of a complete ramp and soak profile

To execute a profile with fewer segments just program 0 (zero) for time at the segment that follows the last segment to be executed.

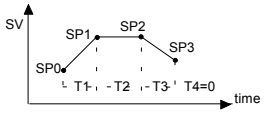


Fig. 2 - Example of a profile with fewer segments. (T4 is set 0)

The program tolerance **Ptol** defines the maximum deviation between PV and SV for the execution of the profile. If this deviation is exceeded, the program will be interrupted until the deviation falls to within the tolerance band.
Programming 0 (zero) at this prompt disables the tolerance and the profile execution will not to be halted even if PV does not follow SV (time priority as opposed to SV priority).

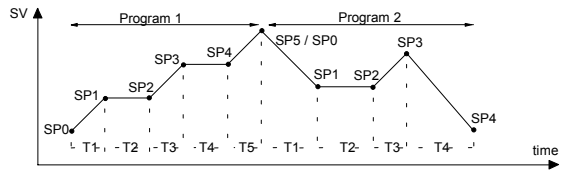


Fig. 3 - Example of two linked programs

The ramp and soak event function is used to activate alarms at any segment of program 1. This applies only to program 1.

To enable this event function the alarms to be activated must be selected for **rS** function and are programmed at the **PE 0** to **PE 5** prompts. The number to be programmed at the prompt defines the alarm to be activated.

Table 5 - Event codes for ramp and soak

Code	Alarm 1	Alarm 2	Alarm 3	Alarm 4
0				
1	X			
2		X		
3	X	X		
4			X	
5	X		X	
6		X	X	
7	X	X	X	
8				X
9	X			X
10		X		X
11	X	X		X
12			X	X
13	X		X	X
14		X	X	X
15	X	X	X	X

To configure and execute a ramp and soak program:

- Program the tolerance value, SV, time and event.
- If any event alarm is required program the ramp and soak event function.
- Set the control mode to automatic.
- Select ramp and soak program to be executed at prompt **Pr n** (0 to 4)
- Start control at the run prompt **run** by selecting **YES**.

Before executing the program the controller waits for PV to reach the first set point **SP0** if **PtoL** is different than zero.
Should any power failure occur the controller resumes at the beginning of the segment it was previously.

9. AUTO TUNE

During auto tune the process 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:

- Disable the control output at the **run** prompt by selecting **NO**.
- Select auto mode operation at the **Auto** prompt by selecting **YES**.
- Disable the ramp and soak function (select **NO**) and program a new SV value other than the present PV (close to the desired set point).
- Enable auto tuning at the **Atun** prompt by selecting **YES.**
- Enable the control output at the **run** prompt by selecting **YES**.

During the auto tune procedure the soft-start function will not operate and large oscillations will be induced around the setpoint. Make sure the process can accept these oscillations and fast control output changes.
If auto tuning results are not satisfactory refer to table 7 for manual fine tuning procedure.

Table 7 - Suggestions for manual tuning of PID parameters

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

10. TECHNICAL CHARACTERISTICS:

- Dimensions: 48x48x106mm (1/16 DIN)
- Panel cut-out: 45x45mm (+0.5 -0.0mm)
- Approximate weight: 150g
- Power: 85 to 264Vac, 50/60Hz. Max. Consumption: 3VA
- Operating environment: 0 to 55°C, humidity: 0 to 95%

INPUT

- Keyboard selection of input type (refer to table 1, page 1)
- Internal resolution: 19500 levels
- Display resolution: 12000 levels (from -1999 to 9999)
- Input sample rate: 4 per second
- Automatic auto zero and auto span
- Accuracy:
  Thermocouples J, K, T and N: 0.25% of full scale ±1°C
  Thermocouples R and S: 0.25% of full scale ±3°C
  Pt100: 0.2% of full scale
  Current or voltage: 0.2% of full scale
- Input impedance: mV, V, Pt100 and t/c: 100MΩ; 4 to 20mA: 10Ω
- Pt100 measurement: 3-wire circuit. Excitation current: 170μA. Calibration complies with DIN43760

This feature requires an external shunt resistor, provided with the instrument, to be connected to terminals. Optionally, a thermocouple signal can be used for heater protection.

CONTROL OUTPUT

Standard Version (up to 3 outputs):

- Three 3A/250Vac Relays (2 for control and 1 for alarm)
- Isolated 0-20mA or 4-20mA control output or PV or SP retransmission, 1500 level resolution, 550Ω max. load (0-10V with external 500Ω resistor).
- 1200 to 19200bps

ALARMS

- 1 relay alarm and 1 logic alarm (20mA current signal). The alarms can be set to 8 different functions. Other alarm features are:
- Independent power-up inhibition.
- Programmable hysteresis.