N2000S CONTROLLER

USER GUIDE V3.0x C

We Measure, We Control, We Record

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 Read the manual fully before installing and operating the device.	**CAUTION OR HAZARD** Risk of electric shock.	**ATTENTION** Material sensitive to static charge. Check precautions before handling.

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. INTRODUCTION

N2000S is a controller for servo positioners with two control relays: one to open and other to close the valve (or damper). Moreover, it has an analog output that can be programmed to control or retransmit input or setpoint signals. Its universal input accepts most industry manufactured sensors and signals.

Configuration can be entirely achieved through the keyboard. No circuit changes are required. Selection of input and output type, alarms configuration, and other especial functions are accessed and programmed through the frontal panel.

It is important that you read the manual thoroughly before using the controller. Be sure the manual corresponds to your instrument (the number of the software version can be seen when the controller is turned on).

- Sensors break protection in any condition.
- Universal input for multiple sensors without changing hardware.
- Potentiometer input for current position reading.
- Auto-tuning of PID parameters.
- Relay control outputs.
- Automatic/Manual "bumpless" transfer.
- 2 alarm outputs with the following functions: minimum, maximum, differential (deviation), open sensor and event.
- 2 alarm timers.
- 4-20 mA or 0-20 mA analog output for Process Variable (PV) or Setpoint (SP) retransmission.
- 4 function digital input.
- Ramp and soak with 7 concatenable 7-segment programs.
- RS485 serial communication; RTU MODBUS protocol.
- Configuration protection.
- Dual voltage.

3. OPERATION

The controller frontal panel is shown in the figure below:

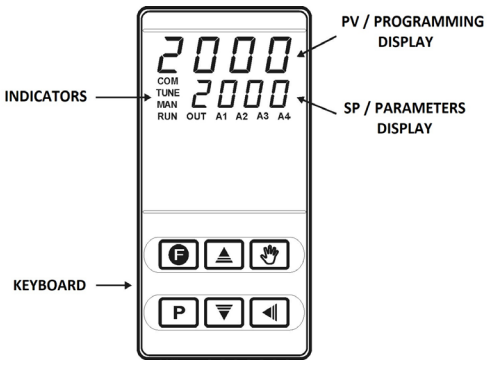


Figure 1

PV / Programming Display: Shows the PV (Process Variable) value. When in operating or programming mode, shows the parameter mnemonic.

SP / Parameters Display: Shows the SP (Setpoint) and other programmable parameter values of the controller.

COM Indicator: Flashes when data is exchanged with the external environment.

TUNE Indicator: Lights when the controller runs the automatic tuning operation.

MAN Indicator: Indicates that the controller is in the manual control mode.

RUN Indicator: Indicates that the controller is active and with control and alarm outputs enabled.

OUT Indicator: When the analog output (0-20 mA or 4-20 mA) is configured for control mode, it remains constantly on.

A1, A2 Indicators: Indicates the respective alarm status.

A3 Indicators: Indicates the valve (I/O3) opening output status.

A4 Indicators: Indicates the valve/dumper (I/O4) closing output status.

P **PROG key:** Key used to show the controller programmable parameters.

BACK Key: Keu used to return to the previous parameter shown in the parameter display.

Increase and **Decrease keys:** Key used to change the parameter values.

Auto/Man key: Special function key used to switch the control mode between Automatic and Manual.

Programmable Function Key: Key used to perform the special functions described in the KEY FUNCTIONS.

When the controller is turned on, its firmware version is displayed for 3 seconds. After that, the controller starts operating normally. The PV and SV values are displayed in the upper and lower displays, respectively. Outputs are enabled at this moment as well.

The relay associated to the valve closing is activated during the time required for the complete valve to close (see parameter **SErt**) so that the controller starts operating with a known reference.

To run smoothly, the controller requires some basic configuration:

- Input type (Thermocouples, Pt100, 4-20 mA, etc.).
- Control setpoint value (SP).
- Control output type (relays, 0-20 mA, pulse).
- PID parameters (or hysteretic for ON / OFF control).

Other special functions, including ramp and soak, alarm timer, digital input, etc., can be used to achieve better performance.

The setup parameters are grouped in cycles, in which each message is a parameter to be defined. The 7 parameter cycles are:

CYCLE	ACCESS
1 − Operation	Free
2 − Tuning	Reserved access
3 − Programs	
4 − Alarms	
5 − Input configuration	
6 − I/O	
7 − Calibration	

Table 1

The operation cycle (1st cycle) is freely accessed. The other cycles require a keystroke combination to enable access, as shown below:

Press (BACK) and P (PROG) simultaneously

When the required cycle is found, all the parameters within this cycle can be accessed by pressing the P key (or pressing the key to go backwards). To return to the operation cycle, press P many times up to all parameters of the current cycle have been shown.

All parameters set up are stored in a protected memory. Changed values are automatically saved when the user goes to the next parameter. The SP value is saved when parameters are changed or at every 25 seconds.

3.1 CONFIGURATION PROTECTION

It is possible to prevent undue changes, so that the parameter values cannot be changed after the final configuration. The parameters are still displayed but can no longer be changed. The protection happens with the combination of a key sequence and an internal key.

The sequence of keys to protect is ▲ and ◄|, pressed simultaneously for 3 seconds in the parameter cycle to protect. To unprotect a cycle, just press ▼ and ◄| simultaneously for 3 seconds.

Displays will flash briefly to confirm locking or unlocking operation.

Within the controller, the **PROT** key completes the locking function. When PROT is **OFF**, the user can lock and unlock the cycles. When PROT is **ON**, changes are not allowed. If there are protections for the cycles, they cannot be removed; if they do not exist, they cannot be promoted.

3.2 CONTROL OPERATION

The controller is based on the **SErt** parameter (Servo excursion time). This is the time the serve requires to open completely when it is in the closed position. The output percentage calculated by the PID (0 to 100 %) is transformed into the serve activation time to reach a relative position.

A new output value of the PID is calculated at every 250 ms. The **SErF** parameter defines the time in seconds for the calculation and activation of a new output value. This parameter works as a filter. It makes the output slower and increases the time intervals.

The minimum resolution for a new position change is given by the parameter **SErr**. If the difference between the current output value and the new value calculated by the PID is lower than the programmed percentage of this parameter, no activation is performed.

If the calculated output is between 0 % or 100 % and it is maintained for some time, the opening relay (when in 0 %) or the closing relay (when in 100 %) will be periodically activated for a time fraction to assure that the real position is close to the estimated position, for mechanical problems or non-linearity of the process.

4. CONFIGURATION / RESOURCES

4.1 INPUT TYPE SELECTION

The input type must be selected by the user in the **tYPE** parameter and using the keyboard.

TYPE	CODE	FEATURES
J	0	Range: -50 to 760 °C (-58 to 1400 °F)
K	1	Range: -90 to 1370 °C (-130 to 2498 °F)
T	2	Range: -100 to 400 °C (-148 to 752 °F)
N	3	Range: -90 to 1300 °C (-130 to 2372 °F)
R	4	Range: 0 to 1760 °C (32 to 3200 °F)
S	5	Range: 0 to 1760 °C (32 to 3200 °F)
Pt100	6	Range: -199.9 to 530.0 °C (-199.9 to 986.0 °F)
Pt100	7	Range: -200 to 530 °C (-328 to 986 °F)
4-20 mA	8	J Linearization. Programmable range: -110 to 760 °C (-166 to 1400 °F)
4-20 mA	9	K Linearization. Programmable range: -150 to 1370 °C (-238 to 2498 °F)
4-20 mA	10	T Linearization. Programmable range: -160 to 400 °C (-256 to 752 °F)
4-20 mA	11	N Linearization. Programmable range: -90 to 1370 °C (-130 to 2498 °F)
4-20 mA	12	R Linearization. Programmable range: 0 to 1760 °C (32 to 3200 °F)
4-20 mA	13	S Linearization. Programmable range: 0 to 1760 °C (32 to 3200 °F)
4-20 mA	14	Pt100 Linearization. Programmable range: -200 to 530 °C (-328 to 986°F)
4-20 mA	15	Pt100 Linearization. Programmable range: -200 to 530 °C (-328 to 986°F)
0-50 mV	16	Linear. Programmable indication from -1999 to 9999
4-20 mA	17	Linear. Programmable indication from -1999 to 9999
0-5 Vdc	18	Linear. Programmable indication from -1999 to 9999
4-20 mA	19	Input square root extraction.

Table 2

Note: All available input types are factory calibrated.

4.2 I/O CHANNELS CONFIGURATION

The controller input/output channels can undertake multiple functions: Control output, digital input, digital output, alarm output, PV, and SP retransmission. These channels are identified as **I/O 1**, **I/O2**, **I/O 3**, **I/O 4**, **I/O 5**, and **I/O 6**.

The function code of each I/O can be selected among the following options. Only valid function codes are displayed for each I/O.

4.2.1 I/O 1 AND I/O2 – USED AS ALARM OUTPUTS

2 SPDT relays are available in terminals 7 to 12. They can be assigned codes **0, 1** or **2**. Where:

0	Disables the alarm.
1	Defines channel as alarm **1**.
2	Defines channel as alarm **2**.

4.2.2 I/O 3 AND I/O4 – USED AS CONTROL OUTPUTS

2 SPST relays, available in terminals 3 to 6. They are assigned code **5**. Where:

5	Defines channel as control output.

4.2.3 I/O 5 – ANALOG OUTPUT

0-20 mA or 4-20 mA analog channel output used to retransmit PV and SP values or perform functions of digital input and output. They can be assigned codes **0** to **16**. Where:

0	No function (disabled).
1	Defines the channel as alarm **1**.
2	Defines the channel as alarm **2**.
3	Invalid selection.
4	Invalid selection.
5	Invalid selection.
6	Defines the channel to behave as Digital Input and switch between Automatic and Manual control mode: Closed = Manual control. Open = Automatic control.
7	Defines the channel to act as Digital Input that turns the control on and off (run = YES / no). Closed = Outputs enabled. Open = Outputs disabled.
8	Invalid selection.
9	Defines the channel to control the programs operation. Closed = Enables the program execution. Open = Interrupts the program. **Note:** When the program is interrupted, the execution is suspended at the point where it is (the control is still active). The program resumes normal execution when the signal applied to the digital input allows (contact closed).
10	Defines the channel to select the program 1 execution. This option is useful when you want to switch between the main Setpoint and a second Setpoint defined in the program of ramps and soaks. Closed = Selects program 1. Open = Assumes the main Setpoint.
11	Configures the analog output to operate as an analog 0-20 mA control output.
12	Configures the analog output to operate as an analog 4-20 mA control output.
13	Analog 0-20 mA retransmission of PV.
14	Analog 4-20 mA retransmission of PV.
15	Analog 0-20 mA retransmission of SP.
16	Analog 4-20 mA retransmission of SP.

4.2.4 I/O 6 – DIGITAL INPUT

0	Disables the alarm.
6	Defines the channel to behave as Digital Input and switch between Automatic and Manual control mode: Closed = Manual control. Open = Automatic control.
7	Defines the channel to act as Digital Input that turns the control on and off (run = YES / no). Closed = Outputs enabled. Open = Control outputs and alarms disabled.
8	Invalid selection.
9	Defines the channel to control the programs operation. Closed = Enables the program execution. Open = Interrupts the program. **Note:** When the program is interrupted, the execution is suspended at the point where it is (the control is still active). The program resumes normal execution when the signal applied to the digital input allows (contact closed).
10	Defines the channel to select the program 1 execution. This option is useful when you want to switch between the main Setpoint and a second Setpoint defined in the program of ramps and soaks. Closed = Selects program 1. Open = Assumes the main Setpoint. **Note: When a function is selected to operate through digital input, the controller does not respond to the equivalent function command given in the frontal keypad**.

4.3 POTENTIOMETER INPUT

The potentiometer of valve position can be seen in the controller. It must be 10 kΩ and connections must be as **Figure 7** shows. The potentiometer reading does not power the valve position for control effects, it only informs the operator the valve current position. The control action happens regardless of the potentiometer.

To visualize the potentiometer reading, the **Pot** parameter must be enabled. When enabled (**YES**), the potentiometer position is displayed on the prompt screen that shows the Manipulated Variable (MV). When the potentiometer visualization is selected, the MV is not shown anymore, and the percentage value of valve opening is shown instead. The MV screen is the second prompt of the main cycle.

4.4 ALARM CONFIGURATION

The controller has 2 independent alarms. They can be programmed to operate with nine different functions, represented in the table below.

4.4.1 OPEN SENSOR

It is activated whenever the input sensor is broken or disconnected.

4.4.2 EVENT ALARM

It activates alarms in specific segments of the program (see ALARM CYCLE).

4.4.3 RESISTANCE FAIL

It detects a heater broken condition by monitoring the load current when the control output is activated. This alarm function requires an optional device (option 3).

4.4.4 MINIMUM VALUE

It triggers when the measured value is **below** the value set by the alarm Setpoint.

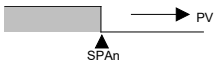
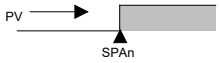
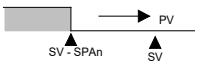
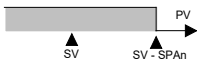
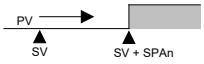
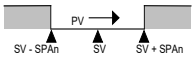
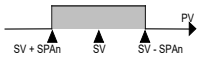
TYPE	SCREEN	ACTION	
Disabled	oFF	No active alarm. This output can be used as a digital output to be set by the serial communication.	
Sensor Break (input Error)	IErr	Alarm will be ON if PV sensor breaks, input signal is out of range or Pt100 is shorted.	
Event Alarm (ramp and Soak)	rS	Can be activated at a specific segment of ramp and soak program.	
Detection resistance failure	rFAIL	Detects a heater broken condition.	
Low Alarm	Lo		
High Alarm	HI		
Differential Low	dIFL	 positive SPAn	 negative SPAn
Differential High	dIFH	 positive SPAn	 negative SPAn
Differential	dIF	 positive SPAn	 negative SPAn

Table 3

SPAn refers to **SPA** and **SPA2** alarm Setpoints.

4.4.5 MAXIMUM VALUE

It triggers when the measured value is **above** the value set by the alarm Setpoint.

4.4.6 DIFFERENTIAL (OR BAND)

In this function, the parameters **SPA1** and **SPA2** represent the PV deviation as compared to the main SP.

In a positive deviation, the differential alarm will be triggered when the measured value is **out** of the range defined in:

(SP – Deviation) and (SP + Deviation)

In a negative deviation, the differential alarm will be triggered when the measured value is **within** the range defined above.

4.4.7 MINIMUM DIFFERENTIAL

It is activated when the measured value is below the value defined in.

(SP – Deviation)

4.4.8 MAXIMUM DIFFERENTIAL

It is activated when the measured value is above the value defined in:

(SP + Deviation)

4.5 ALARM TIMER

Alarms can be programmed to have timer functions. The user can delay alarm activation, set one pulse per activation, or make the alarm signals operate in sequential pulses. Alarm timer is available only for alarms 1 and 2 when **A1t1**, **A1t2**, **A2t1** and **A2t2** parameters are programmed.

Figures shown in **Table 4** represent these functions, t 1 and t 2 may vary from 0 to 6500 seconds and their combinations define the timer mode. For normal operation, with no alarm timer activation, t 1 and t 2 must be assigned 0 (zero).

The LEDs associated to the alarms will flash whenever an alarm condition is acknowledged, regardless the actual state of the output relay, which may be temporarily off because of temporization.

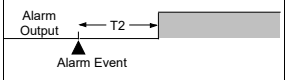
ALARM FUNCTION	t1	t2	ACTION
Normal	0	0	
Delayed	0	1 to 6500 s	
Pulse	1 to 6500 s	0	
Oscillator	1 to 6500 s	1 to 6500 s	

Table 4

4.6 ALARM INITIAL BLOCKING

The **Initial Blocking** option prevents the alarm from being recognized if an alarm condition is present when the controller is turned on for the first time. The alarm could be activated only after the occurrence of a non-alarm condition followed by a new occurrence of an alarm condition.

The initial blocking is useful, for example, when one of the alarms is programmed as minimum value alarm, which can trigger the alarm at the system startup. This is not always required.

The initial blocking is disabled for the Open Sensor function.

4.7 PV AND SP ANALOG RETRANSMISSION

The controller has an analog output (I/O 5) that can make a 0-20 mA or 4-20 mA retransmission proportional to the PV or SP values assigned. The analog retransmission is scalable, this means it has maximum and minimum limits that define the output range, which can be defined in parameters **SPLL** and **SPHL**.

To obtain voltage retransmission the user must install a shunt resistor (550 Ω max.) in the analog output terminal. The resistor value depends on the voltage range required.

4.8 KEY FUNCTIONS

key (special function key) in the frontal panel of the controller can perform the same function as the Digital Input I/O 6 (except function **6**). The key function is defined by the user in the **FFun** parameter:

0	Disables the alarm.
1	Defines the channel to act as Digital Input that turns the control on and off (**run** = ***YES*** / ***no***). Closed = Outputs enabled. Open = Control output and alarms disabled.
8	Invalid selection.
9	Defines the channel to control the programs operation. Closed = Enables the program execution. Open = Interrupts the program. **Note:** When the program is interrupted, the execution is suspended at the point where it is (the control is still active). The program resumes normal execution when the signal applied to the digital input allows (contact closed).
10	Defines the channel to select the program 1 execution. This option is useful when you want to switch between the main Setpoint and a second Setpoint defined in the program of ramps and soaks. Closed = Selects program 1. Open = Assumes the main Setpoint. **Note: When a function is selected to operate through digital input, the controller does not respond to the equivalent function command given in the frontal keypad**.

4.9 KEY

No function.

5. INSTALLATION / CONNECTIONS

The controller must be panel-mounted following the steps presented below:

- Make the panel slot.
- Remove fixing brackets.
- Insert the controller into the panel slot.
- Replace the clamps in the controller pressing it to reach a firm grip at the panel.

It is not necessary to disconnect the rear panel terminals to remove the internal circuit. The figure below shows how signals are distributed in the controller rear panel:

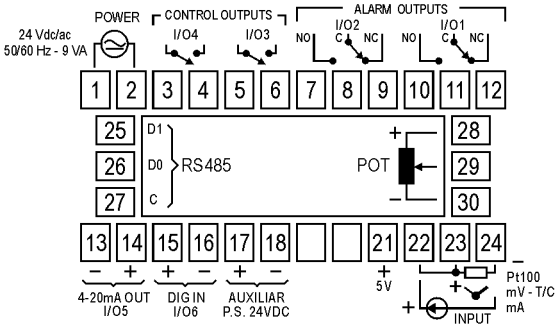
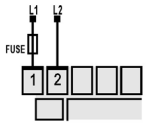


Figure 2

5.1 INSTALLATION RECOMMENDATIONS

- Conductors of input signals must be distant from activation or high-tension/current conductors, preferably passing through grounded conduits.
- A specific electrical power supply network should be provided for instruments use only.
- In controlling and monitoring applications, possible consequences of any system failure must be considered in advance. The internal relay alarm does not provide total protection.
- RC filters (for noise reduction) in inductor charges (contactors, solenoids, etc.) are recommended.

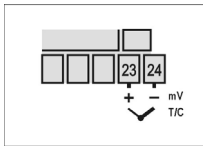
5.2 POWER SUPPLY CONNECTIONS

Observe the requested supply voltage	 **Figure 3**

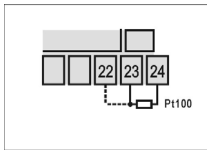
5.3 INPUT CONNECTIONS

It is important that they are very well connected; the sensor wires must be well fixed in the terminals of the rear panel.

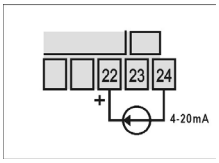
THERMOCOUPLE (T/C) AND 50 mV

	 **Figure 4**	The figures below show how connections are made. If extension of the thermocouple is required, proper compensation cables should be provided.

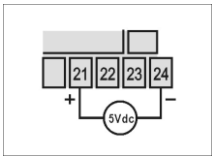
RTD (Pt100)

	 **Figure 5**	The figure shows the Pt100 wiring for 3 conductors. Terminals 22, 23, and 24 must have the same wire resistance for proper cable length compensation (use conductors with the same gauge and length). In case the sensor has 4 wires, one should be left loose near the controller. For 2-wire Pt100, short circuit terminals 22 and 23

4-20 mA

	 **Figure 6**	The figure shows the 4-20 mA current signals wiring.

0-5 Vcc

	 **Figure 7**	The figure shows the 0-5 Vdc voltage signals wiring.

5.3.1 ALARM AND OUTPUT CONNECTION

When I/O channels are set up as output channels, they must have their capacity respected, according do specifications.

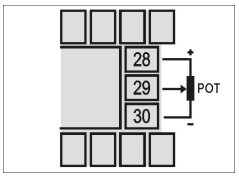


Figure 8

Note: It is recommended to disable/suspend the control (**run** = **no**) whenever it is necessary to change the device settings.

6. CONFIGURATION PARAMETERS

6.1 OPERATION CYCLE

PV Indication (Red) SV Indication (Green)	PV and SP indication. The upper status display shows the current value of PV. The lower parameter display shows SP value of automatic control mode. The upper display shows **- - - -** whenever PV exceeds the maximum range or there is no signal at the input.
PV Indication (Red) MV Indication (Green)	Manipulated variable value (MV) (control output). 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 changed. When in auto mode, the MV value is only for visualization. To distinguish the MV display from the SP display, the MV flashes intermittently.
Pr n *Program number*	Program execution. Selects the ramp and soak program to be executed. **0** Does not run any program. **1, 2, 3, 4, 5, 6** Respective program. When the control is enabled, the program selected runs immediately. In the program cycle of ramp and soak there is a parameter with the same name. In that context, the parameter is associated with the number of the program that will run.
run	Enables control and alarms output. **YES** Control and alarm enabled. **NO** Control and alarms disabled.

6.2 TUNING CYCLE

AtUn *Auto-tune*	Auto-tune of PID parameters. See PID PARAMETERS AUTO-TUNING. **YES** Run auto-tune. **NO** Does not run auto-tune.
Pb *Proportional band*	Proportional band. **P** term value of the PID control, percentage of maximum input type span. Adjustable between 0 and 500 %. **If adjusted to zero, control is ON/OFF.**
HySt *Hysteresis*	Control hysteresis. Hysteresis value for ON/OFF control. This parameter is shown only for ON/OFF control (Pb=0).
Ir *integral rate*	Integral rate. Value of **I** term of PID control in repetitions per minute (Reset). Adjustable between 0 and 24.00. Presented if proportional band ≠ 0.
dt *derivative time*	Derivative time. Value of **D** term of the PID control in seconds. Adjustable between 0 and 250 s. Presented if proportional band ≠ 0.
SErt *Servo time*	Time of servo excursion, from totally open to totally closed. Programmable from 15 to 600 s.
SErr *Servo resolution*	Control resolution. Determines the dead band of servo activation. Very low values (<1 %) make the servo "nervous"
SErF *Servo filter*	PID output filter, before use by the servo control. It is the time the PID mean is made, in seconds. The output is only activated after this time. Recommended value: > 2 s.
Act *Action*	Control action. Only in the automatic control mode. rE **Reverse** action. Usually used for heating. dIr **Direct** action. Usually used for cooling.
SPA1 SPA2 *Alarm Setpoint*	Alarm SP. Value that defines the trigger point of alarms programmed with the Lo or HI functions. In alarms programmed with the function **Differential** this parameter defines the deviation. It is not used in other alarm functions.

6.3 PROGRAM CYCLE

tbAS *Time base*	Time base. Selects the time base for the ramp and soak. Valid for all profile programs. **0** Time base in seconds. **1** Time base in minutes.
Pr n *Program number*	Program editing. Selects the ramp and soak program to be edited in the next screens of this cycle.
PtoL *Program tolerance*	Program tolerance. Maximum deviation between PV and SP. Whenever this deviation is exceeded the time counter is halted until deviation lowers to acceptable values. Set zero to disable this function.
PSP0 PSP7 *Program SetPoint*	Program SPs. From 0 to 7. Set of 8 SP values that define the ramp and soak program profile.
Pt 1 Pt7 *Program time*	Program segments time. From 1 to 7. It defines the duration time (in seconds or minutes) of each segment of the program.
PE 1 PE7 *Program event*	Event alarms. From 1 to 7. Parameters that define which alarms must be triggered while a program segment is running, according to codes from 0 to 3 presented in **Table 6**. Alarm function depends on **rS** setting.
LP *Link to Program*	Link to program. Number of the next program to be connected. Programs can be linked to generate profiles of up to 49 segments. **0** Do not connect to any other program. **1** Connect to program 1. **2** Connect to program 2. **3** Connect to program 3. **4** Connect to program 4. **5** Connect to program 5. **6** Connect to program 6. **7** Connect to program 7.

6.4 ALARM CYCLE

FuA 1 FuA2 *Alarm function*	Alarm function. Defines the alarm functions according to options shown in **Table 3**.
bLA 1 bLA2 *Alarm blocking*	Alarm initial blocking. Alarm initial blocking function for alarms 1 to 4 **YES** Enables initial blocking. **NO** Disables initial blocking.
HyA 1 HyA2 *Alarm hysteresis*	Alarms 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. One hysteresis value is set for each alarm.
A 1t 1 ***A**larm **1** **t**ime **1***	Alarm 1 time 1. Defines the period, in seconds, in which the alarm output will be on when alarm 1 is activated. Set zero to disable this function.
A 1t2 ***A**larm **1** **t**ime **2***	Alarm 1 time 2. Defines the period in which alarm 1 will be off after being activated. Set zero to disable this function.
A2t 1 ***A**larm **2** **t**ime **1***	Alarm 2 time 1. Defines the period, in seconds, in which the alarm output will be on when alarm 2 is activated. Set zero to disable this function.
A2t2 ***A**larm **2** **t**ime **2***	Alarm 2 time 2. Defines the period in which alarm 2 will be off after being activated. Set zero to disable this function. **Table 4** shows the advanced functions one can obtain with timer.

6.5 INPUT CONFIGURATION CYCLE

tYPE *Type*	Input type. Selection of the type of signal connected to the PV input. See **Table 1**. ***This must be the first parameter to be set up.***
dPPo *Decimal Point Position*	Decimal point position. When configuring the input (**tYPE**) with temperature sensors (J, K, Pt100, etc), in addition to the integer part of the measurement, the **dPPo** parameter will only display decimal values (XXX.X). When configuring the input (**tYPE**) with linear signals (mA, mV, V), the **dPPo** parameter determines the position of the decimal point of the measured value (XXXX, XXX.X, XX.XX, X.XXX)
unit *Unit*	Temperature. Selects the temperature unit: Celsius (**°C**) or Fahrenheit (**°F**). Invalid for inputs 16, 17, 18 and 19.
oFFS *Offset*	Offset for PV. Offset value to be added to the PV to compensate sensor error. Default value: zero. Adjustable between -400 and 400.
SPLL *Setpoint Low Limit*	Setpoint low limit. For linear inputs, selects the minimum value of indication and adjustment for parameters related to PV and SP. For thermocouples and Pt100, selects the minimum value for SP adjustment. Also defines the lower limit value for retransmission of PV and SP.
SPHL *Setpoint High Limit*	Setpoint higher limit. For linear inputs, selects the maximum value of indication and adjustment for parameters related to PV and SP. For thermocouples and Pt100, selects the maximum value for SP adjustment. Also defines the higher limit value for retransmission of PV and SP.
Pot *Potentiometer*	Selects value that will be displayed in the MV screen (the second screen of the main cycle). **YES** Shows the potentiometer value. **NO** Shows the PID output.
bAud	Communication Baud Rate. Available with RS485. **0** 1200 bps **1** 2400 bps **2** 4800 bps **3** 9600 bps **4** 19200 bps
Addr *Address*	Communication address. With RS485, number that identifies the controller in the communication between 1 and 247.

6.6 I/O CYCLE (INPUTS AND OUTPUTS)

Io1 **Io2**	(**i**nput/**o**utput **1 / 2**) – Alarm outputs 1 and 2.
Io3 **Io4**	(**i**nput/**o**utput **3 / 4**) – Control outputs.
Io5	(**i**nput/**o**utput **5**) I/O 5 function. Selects the I/O function to be used at I/O 5. Options 0 to 16 are available. Usually employed in analog control or retransmission.
Io6	(**i**nput/**o**utput **6**) I/O 6 function. Selects the I/O function to be used at I/O 6. Options 0, 7, 8, 9 and 10 are possible for this input.
FFunc	**Key function**: Allows definition of the key function. Available functions: **0** Key not used. **7** Controls output and alarm outputs (RUN function). **8** Invalid selection. **9** Hold program execution. **10** Selects program 1. These functions are described in KEY FUNCTIONS.

6.7 CALIBRATION CYCLE

All input and output types are factory calibrated. Recalibration is not recommended. If necessary, recalibration must be performed by specialized personnel.

If this cycle is accessed by mistake, do not press ▲ or ▼ keys, go all through the prompts up to the operation cycle is reached again.

InLC *Input Low Calibration*	Input offset calibration. Makes possible to calibrate the PV offset. To change one digit, press ▲ or ▼ as many times as necessary.
InHC *Input High Calibration*	Input span calibration (gain). Makes possible to calibrate the PV offset.
ouLL *Output Low Calibration*	Output Offset calibration. Value to calibrate the offset of the current control output.
ouHC *Output High Calibration*	Output high calibration. Value for current output high calibration.
CJ L	Cold joint Offset calibration. Parameter to adjust the cold joint temperature offset.
PotL	Potentiometer low calibration. To change one digit, press ▲ and ▼ as many times as necessary.
PotH	Calibration of the potentiometer's full scale.

7. RAMP AND SOAK PROGRAM

Feature that allows to elaborate a behavior profile for the process. Each program is composed of a set of up to **7 segments**, named RAMP AND SOAK PROGRAM, defined by SP values and time intervals.

When the program is defined and runs, the controller starts to automatically generate the SP according to the program.

At the end of the program execution, the controller turns the control output off (**run** = **no**).

Up to **7 different programs** of ramp and soak can be created. The figure below shows an example of the program:

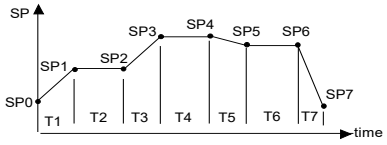


Figure 9

To execute a profile with fewer segments, set 0 (zero) for the time intervals that follow the last segment to be executed.

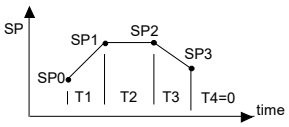


Figure 10

The **PtoL** Tolerance Function defines the maximum deviation between PV and SP during the program execution. If this deviation is exceeded, the program will be interrupted until the deviation falls within the tolerance range (regardless of time). Programming 0 (zero) at this prompt disables the tolerance; the profile execution will not be halted even if PV does not follow SP (only considers time).

7.1 LINK OF PROGRAMS

It is possible to create a more complex program, with up to 49 segments, joining the 7 programs. This way, at the end of a program execution the controller immediately starts to run another one.

When a program is created, it must be defined in the **LP** screen whether there will be or not another program.

To make the controller run a given program or many programs continuously, it is only necessary to link a program to itself or the last program to the first.

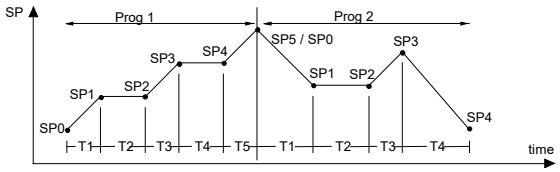


Figure 11

7.2 EVENT ALARM

This function makes possible to program the activation of alarms in specific segments of a program.

For such, alarms must have their function set as **rS** and be programmed in **PE 1** to **PE7** according to the table below. The number programmed in the event prompt defines the alarms to be activated.

CODE	ALARM 1	ALARM 2
0		
1	×	
2		×
3	×	×

Table 5

To configure a ramp and soak program:

- Tolerance values, SPs, time, and event should be programmed.
- If an alarm will be used with the event function, set up its function to Event Alarm.
- Set control mode to automatic.
- Enable program execution at the **rS** screen.
- Start the control at the **run** screen.

Before executing the program, the controller waits for PV to reach the initial Setpoint (**SP0**). Should any power failure occur, the controller resumes at the beginning of the segment it was running.

8. PID PARAMETERS AUTO-TUNING

During auto tune the process is controlled in ON / OFF mode at the programmed SP. Depending on the process features, large oscillations above and below SP may occur. Auto-tuning may take several minutes to be concluded in some processes.

The recommended procedure is as it follows:

- Disable the control output at the **run** screen.
- Select automatic mode operation at the **Auto** screen.
- Select a value different form zero for the proportional band.
- Disable the Soft Start function.
- Disable the ramp and soak function and program SP to a value different from the current PV value and close to the value at which the process will operate after tuning.
- Enable auto-tuning at the **Atun** screen.
- Enable the control at the **run** screen.

The **TUNE** flag will remain on during the auto-tuning process.

For the control output with relays or current pulse, automatic tune calculates the highest possible value for the PWM period. This value can be reduced in cases of low instability. For a relay of solid state, reduction to 1 second is recommended.

If the automatic tune does not result a satisfactory control, the table below guides how to correct the process behavior:

PARAMETER	PROBLEM	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 6

9. CALIBRATION

9.1 INPUT CALIBRATION

All input and output types are factory calibrated. Recalibration is not recommended for operators with no experience. In case recalibration of any scale is necessary, proceed as it follows:

1. Set up the input type to be calibrated.
2. Set the lower and upper limits of extreme values for the input type.
3. Apply a signal to the input that corresponds to a known value and a little bit over the lower limit of the indication.
4. Access the **InLc** parameter. By using the ▲ and ▼ keys, select the expected value that will appear in the parameters display.
5. Apply a signal to the input that corresponds to a known value and a little bit under the lower limit of the indication.
6. Access the **InLc** parameter. By using the ▲ and ▼ keys, select the expected value that will appear in the parameters display.
7. Repeat **3** to **6** up to no new adjustment is necessary.

Note: When the controller is calibrated, check if the required excitation current of Pt100 is compliant to the Pt100 excitation current used in this instrument: 0.17 mA.

9.2 ANALOG OUTPUT CALIBRATION

1. Configure I/O 5 for 11 (0-20 mA) or 12 (4-20 mA) values.
2. Connect a mA meter in the analog control output.
3. Disable Auto-Tune and Soft Start functions.
4. Program the lower limit of MV in the **ouLL** screen with 0.0 % and the upper limit of MV in the **ouHL** screen with 100.0%.
5. Set **no** for the manual mode **Auto** screen.
6. Enable the control (**YES**) at the **run** screen.
7. Program MV in 0.0 % in the operation cycle.
8. Select the **ouLc** screen. Use the ▲ and ▼ keys to obtain the 0 mA (or 4 mA for type 12) reading in the mA meter.
9. Program MV in 100.0 % in the operation cycle.
10. Select the **ouHc** screen. Use the ▲ and ▼ keys to obtain the 20 mA.
11. Repeat **7** to **10** up to no new adjustment is necessary.

9.3 POTENTIOMETER CALIBRATION

1. Set up the input type to be calibrated.
2. Set the lower and upper limits of indication for the extremes of the input type.
3. Adjust the potentiometer with the minimum value.
4. Access the **PotL** parameter. By using the ▲ and ▼ keys, select 0.0 in the parameters display.
5. Adjust the potentiometer with the maximum value.
6. Access the **PotH** parameter. By using the ▲ and ▼ keys, select 100.0 in the parameters display.
7. Repeat **c** to **f** up to no new adjustment is necessary.

10. SERIAL COMMUNICATION

An optional master-slave RS485 serial communication interface is available. It is used for communication with a supervisor machine (master). The controller is always the slave.

Communication starts only with the master, which sends a command to the slave address with which it wants to communicate. The slave takes the command and sends the correspondent response to the master.

The controller accepts also broadcast commands.

10.1 FEATURES

Signals compliant to the RS485 standard. Two-wire connection between the master and up to 31 instruments in bus topology (it may address up to 247 instruments). Maximum cable length: 1,000 meters. Time to disconnect from the controller. Maximum 2 ms after the last byte.

Communication signals are electrically isolated from the rest of the device, speed options are 1200, 2400, 4800, 9600 or 19200 bps.

Number of data bits: 8, without parity.

Number of stop bits: 1.

Time of response transmission start: Maximum 100 ms after receiving the command.

Protocol used: MODBUS (RTU), available in most market-available supervisory software.

RS485 signals are:

D1	D	D+	B	Bidirectional data line.	Terminal 25
D0	$\overline{D}$	D-	A	Inverted bidirectional data line.	Terminal 26
C				Optional connection that improves communication performance.	Terminal 27
GND					

Table 7

10.2 SERIAL COMMUNICATION CONFIGURATION

You must configure 2 parameters to use the serial:

bRud: Communication speed. All equipment's with the same speed.

Addr: Controller communication address. Each controller must have an exclusive address.

11. PROBLEMS WITH THE CONTROLLER

Connection errors and inadequate programming are the most common errors found during the controller operation. A final review may avoid loss of time and damages.

The controller displays some messages to help the user identify problems.

MESSAGE	PROBLEM
----	Open input. Without sensor or signal.
Err 1	Connection problems in the Pt100 cable.

Table 8

Other error messages displayed by the controller can account for errors in the input connections or type of selected input non-compliant with the sensor or signal applied to the input. If errors persist even after a review, contact the manufacturer. Also inform the device serial number. To find out the serial number, press ◄ for more than 3 seconds.

The controller also has a visual alarm (the display flashes) when the PV value is out of the range set by SPHL and SPLL.

12. SPECIFICATIONS

DIMENSIONS: ..... 48 x 96 x 92 mm (1/16 DIN)

Approximate weight: ..... 250 g

PANEL CUT-OUT: ..... 45 x 93 mm (+0.5 -0.0 mm)

POWER: ..... 100 to 240 Vac / dc (±10 %), 50/60 Hz.

Optional 24 V: ..... 12 to 24 Vdc / 24 Vac (-10 % / +20 %)

Max. Consumption: ..... 3 VA

ENVIRONMENTAL CONDITIONS: ..... 5 to 50 °C

Relative humidity (maximum): ..... 80 % up to 30 °C

..... For temperatures above 30 °C, decrease 3 % per °C

..... Internal use, Installation category II. Pollution degree 2.

..... Altitude < 2000 m

INPUT: T/C, Pt100, voltage and current, configurable according to **Table 1**.

Internal resolution: ..... 19500 levels

Display resolution: ..... 12000 levels (from -1999 to 9999)

Input sample rate: ..... 5 per second

Accuracy: ..... Thermocouples J, K and T: 0.25 % of span ±1 °C

..... Thermocouple N, R, S: 0.25 % of span ±3 °C

..... Pt100: 0.2 % of span

..... 4-20 mA, 0-50 mV, 0-5 Vdc: 0.2 % of span

Input impedance: ..... 0-50 mV, Pt100 and thermocouples: >10 MΩ

..... 0-5 V: >1 MΩ

..... 4-20 mA: 15 Ω (+2 Vdc @ 20 mA)

Pt100 measurement: 3-wire circuit, cable resistance compensation (α=0.00385), Excitation current: 0.170 mA

All input types are factory calibrated. Thermocouples according to NBR 12771/99, RTD's NBR 13773/97.

DIGITAL INPUT (I/O6): ..... Dry contact or NPN open collector

ANALOG OUTPUT (I/O5): ..... 0-20 mA or 4-20 mA, 550 Ω max.

1500 levels, isolated, control output or PV or SP retransmission.

CONTROL OUTPUT:

..... 2 Relays SPDT (I/O1 and I/O2): 3 A / 240 Vac

..... 2 Relays SPST-NO (I/O3 and I/O4): 1.5 A / 250 Vac

..... Voltage pulse for SSR (I/O 5): 10 V max. / 20 mA

AUXILIARY VOLTAGE SUPPLY: ..... 24 Vdc, ±10 %; 25 mA

EMC: ..... EN 61326-1:1997 and EN 61326-1/A1:1998

SAFETY: ..... EN61010-1:1993 and EN61010-1/A2:1995

PROPER CONNECTIONS FOR 6.3 MM PIN TYPE THERMINALS.

FRONT PANEL: ..... IP65, polycarbonate UL94 V-2

HOUSING: ..... IP20, ABS+PC UL94 V-0

CERTIFICATIONS: CE, UL and UKCA

PROGRAMMABLE PWM CYCLE FROM 0.5 TO 100 SECONDS.

AFTER POWER UP, IT STARTS OPERATION AFTER 3 SECONDS.

13. WARRANTY

Warranty conditions are available on our website www.novusautomation.com/warranty.

14. ATTACHMENT 1 – COMMUNICATION PROTOCOL

14.1 COMMUNICATION INTERFACE

The optional RS485 serial interface allows you to address up to 247 networked controllers, communicating remotely with a computer or master controller.

14.2 RS485 INTERFACE

- Compatible line signals with RS485 standard.
- 2-wire connection between master and up to 31 slaves controllers in a bus topology. With converters with multiples outputs, it is possible to address up to 247 nodes.
- Maximum communication distance: 1000 meters.
- The RS485 signals are:

D1	**D**	**D+**	**B**	Bidirectional data line.	Terminal 25
D0	**$\overline{D}$**	**D-**	**A**	Inverted bidirectional data line.	Terminal 26
C				Optional connection that improves communication performance.	Terminal 27
GND					

Table 9

14.3 GENERAL FEATURES

- Serial interface optical isolation.
- Programmable Baud Rate: 1200, 2400, 4800, 9600 or 19200 bps.
- Data Bits: 8.
- Parity: None.
- Stop Bits: 1.

14.4 COMMUNICATION PROTOCOL

The device supports slave Modbus RTU protocol, available in most supervisory software found in the market.

Using the Register Tables, you can access (read and/or write) the controller configurable parameters. By using address **0**, it is possible to write to the registers in Broadcast mode.

The available Modbus commands are the following:

03	*Read Holding Register*
05	*Force Single Coil*
06	*Preset Single Register*

The registers are presented in a table, so that it is possible to read several registers with one request.

14.4.1 SETTING THE COMMUNICATION PARAMETERS

To use the serial, you must set 2 parameters:

bRud: Communication baud rate. All devices have the same baud rate.

Addr: Controller communication address. Each controller must have a unique address.

14.4.2 REGISTER TABLE

Same as the Holding Registers (reference 4X). The registers are the internal parameters of the controller. Most of the registers up to address 12 are read-only. Check each case.

Each parameter in the table is a 16-bit word with sign represented as a 2 complement.

HOLDING REGISTERS	PARAMETER	REGISTER DESCRIPTION
0000	Active SP	Reading: Active control Setpoint (main screen, Ramps and Soaks, or remote Setpoint). Writing: Control Setpoint on the main screen. Maximum range: From **SPLL** to the value set in **SPHL**.
0001	PV	Reading: Process variable. Writing: Not allowed. Maximum range: The minimum value is the value set in **SPLL** and the maximum value is the value set in **SPHL**. The decimal point depends on the **dPPo** screen.
0002	MV	Reading: Active output power (manual or automatic). Writing: Not allowed. See address 28. Range: 0 to 1000 (0.0 to 100.0 %).
0003	-	Reserved.
0004	Screen Value	Reading: Value on the current screen. Write: Value on the current screen. Maximum range: -1999 to 9999. The range depends on the screen shown.
0005	Screen Number	Reading: Current screen number. Writing: Not allowed. Range: 0000 h to 060 Ch. Formation of the screen number: XXYYh, where: XX → Number of the screen cycle. YY → Number of the screen.
0006	Status Word 1	Reading: Status bits of the controller. Writing: Not allowed. Read value: See STATUS WORDS section.
0007	Software Version	Reading: Software version of the controller. Writing: Not allowed. Values read: If the device version is V1.00, for example, 100 will be read.
0008	ID	Reading: Device identification number: 68. Writing: Not allowed. Read values: 1 → **N1100**. 2 → **N2000**. 3 → **N1500**. Other values: Especial devices.
0009	Status Word 2	Reading: Status bits of the controller. Writing: Not allowed. Read value: See STATUS WORDS section.
0010	Status Word 3	Reading: Status bits of the controller. Writing: Not allowed. Read value: See STATUS WORDS section.
0011	**Ir**	Integral Rate (in repetitions / min). Range: 0 to 3000 (0.0 to 30.00).
0012	**dt**	Derivative Time (in seconds). Range: 0 to 250.
0013	**Pb**	Proportional Band (in percentage). Range: 0 to 5000 (0.0 to 500.00).
0014	-	Reserved.
0015	**ct**	PWM Cycle time (in seconds). Range: 5 to 1000 (0.5 to 100.0).
0016	**SErF**	PID output filter.
0017	**HYSt**	ON/OFF control hysteresis (in the unit of the selected type). Range: 0 to **SPHL** - **SPLL**.

HOLDING REGISTERS	PARAMETER	REGISTER DESCRIPTION
0018	SErt	Servo excursion time. Range: 15 to 600 s.
0019	-	Reserved.
0020	-	Reserved.
0021	-	Reserved.
0022	-	Reserved.
0023	Serial number High	Displays the first 4 digits of the serial number. Range: 0 to 9999. Read-only.
0024	Serial number Low	Displays the last 4 digits of the serial number. Range: 0 to 9999. Read-only.
0025	SV	Control Setpoint (screen Setpoint). Range: From SPLL to SPHL.
0026	SPLL	Setpoint lower limit. Range: The minimum value depends on the input type selected in type. The maximum value is set in SPHL.
0027	SPHL	Setpoint upper limit. Range: From SPLL to the maximum allowed for the input selected in type.
0028	Manual MV	Output power in manual (in percent). Range: 0 to 1000 (0.0 to 100.0 %).
0029	oFFS	PV Offset value (Process Variable). Range: From SPLL to SPHL.
0030	dPPo	Position of the PV decimal point. Range: 0 to 3. 0 → X.XXX. 1 → XX.XX. 2 → XXX.X. 3 → XXXX.
0031	SPA 1	Alarm 1 preset. Range: Between SPLL and SPHL for non-differential alarm and SPHL - SPLL for differential alarm.
0032	SPA2	Alarm 2 preset. Range: Same as the spa1 screen.
0033	-	Reserved.
0034	-	Reserved.
0035	FuA 1	Alarm 1 function. Range: 0 to 8. 0 → oFF. 1→ lErr. 2 → rS. 3 → rFA 1. 4 → Lo. 5 → H 1. 6 → d 1FL. 7 → d 1FH. 8 → d 1F.
0036	FuA2	Alarm 2 function. Range: Same as the fua1 screen.
0037	-	Reserved.
0038	-	Reserved.
0039	HyA 1	Alarm 1 hysteresis. Range: 0 to 9999 (0.00 to 99.99 %).
0040	HyA2	Alarm 2 hysteresis. Range: 0 to 9999 (0.00 to 99.99 %).

HOLDING REGISTERS	PARAMETER	REGISTER DESCRIPTION
0041	-	Reserved.
0042	-	Reserved.
0043	tYPE	Type of PV input sensor. Range: 0 to 18.
0044	Addr	Slave address. Range: 1 to 247.
0045	bAud	Communication Baud Rate. Range: 0 to 4. 0 → 1200. 1 → 2400. 2 → 4800. 3 → 9600. 4 → 19200.
0046	Auto	Control mode. Range: 0 → Manual. 1 → Automatic.
0047	run	Enable control. Range: 0 → No. 1 → Yes.
0048	Act	Control action. Range: 0 → Direct. 1 → Reverse.
0049	Atun	Enable Auto-tuning. Range: 0 → No. 1 → Yes.
0050	bLA1	Alarm 1 - Initial Block. Range: 0 → No. 1 → Yes.
0051	bLA2	Alarm 2 - Initial Block. Range: Same as the bla1 screen.
0052	-	Reserved.
0053	-	Reserved.
0054	Key	Remote action of the pressed key. Range: 0 to 9. 1→ ⬭. 2→ ⏶. 4 → ⏷. 8 → BACK. 9 → BACK and ⬭.
0055	SErr	Set the servo drive deadband.
0056	Pot	Select whether the MV value shown on the display is the internally estimated value or the measured potentiometer position. Range: 0 → Internal MV. 1 → Potentiometer.
0057	Io1	Reserved.
0058	Io2	Reserved.
0059	-	Reserved.
0060	-	Reserved.

HOLDING REGISTERS	PARAMETER	REGISTER DESCRIPTION
0061	**io5**	IO function. Range: 0 to 16.
0062	-	Reserved.
0063	-	Reserved.
0064	-	Reserved.
0065	-	Reserved.
0066	-	Reserved.
0067	**un it**	Temperature unit. Range: 0 → °C. 1 → °F.
0068	-	Reserved.
0069	**io6**	IO function.
0070	-	Reserved.
0071	R&S Segment	Number of the Ramps and Soaks segment running (read-only). Range: 0 to 4.
0072	**Pr n**	Ramps and Soaks program to be viewed (edited). Range: 1 to 4.
0073	**PE 1**	Event from segment 1 of program 1 (R&S). Range: 0 to 15.
0074	**PE2**	Event from segment 2 of program 1 (R&S). Range: Same as the **PE 1** screen.
0075	**PE3**	Event from segment 3 of program 1 (R&S). Range: Same as the **PE 1** screen.
0076	**PE4**	Event from segment 4 of program 1 (R&S). Range: Same as the **PE 1** screen.
0077	**PE5**	Event from segment 5 of program 1 (R&S). Range: Same as the **PE 1** screen.
0078	**PE6**	Event from segment 6 of program 1 (R&S). Range: Same as the **PE 1** screen.
0079	**PE7**	Event from segment 7 of program 1 (R&S). Range: Same as the **PE 1** screen.
0080	**PE 1**	Event from segment 1 of program 2 (R&S). Range: Same as the **PE 1** screen.
0081	**PE2**	Event from segment 2 of program 2 (R&S). Range: Same as the **PE 1** screen.
0082	**PE3**	Event from segment 3 of program 2 (R&S). Range: Same as the **PE 1** screen.
0083	**PE4**	Event from segment 4 of program 2 (R&S). Range: Same as the **PE 1** screen.
0084	**PE5**	Event from segment 5 of program 2 (R&S). Range: Same as the **PE 1** screen.
0085	**PE6**	Event from segment 6 of program 2 (R&S). Range: Same as the **PE 1** screen.
0086	**PE7**	Event from segment 7 of program 2 (R&S). Range: Same as the **PE 1** screen.
0087	**PE 1**	Event from segment 1 of program 3 (R&S). Range: 0 to 15.
0088	**PE2**	Event from segment 2 of program 3 (R&S). Range: Same as the **PE 1** screen.
0089	**PE3**	Event from segment 3 of program 3 (R&S). Range: Same as the **PE 1** screen.
0090	**PE4**	Event from segment 4 of program 3 (R&S). Range: Same as the **PE 1** screen.

HOLDING REGISTERS	PARAMETER	REGISTER DESCRIPTION
0091	PE5	Event from segment 5 of program 3 (R&S). Range: Same as the PE 1 screen.
0092	PE6	Event from segment 6 of program 3 (R&S). Range: Same as the PE 1 screen.
0093	PE7	Event from segment 7 of program 3 (R&S). Range: Same as the PE 1 screen.
0094	PE 1	Event from segment 1 of program 4 (R&S). Range: 0 to 15.
0095	PE2	Event from segment 2 of program 4 (R&S). Range: Same as the PE 1 screen.
0096	PE3	Event from segment 3 of program 4 (R&S). Range: Same as the PE 1 screen.
0097	PE4	Event from segment 4 of program 4 (R&S). Range: Same as the PE 1 screen.
0098	PE5	Event from segment 5 of program 4 (R&S). Range: Same as the PE 1 screen.
0099	PE6	Event from segment 6 of program 4 (R&S). Range: Same as the PE 1 screen.
0100	PE7	Event from segment 7 of program 4 (R&S). Range: Same as the PE 1 screen.
0101	PE 1	Event from segment 1 of program 5 (R&S). Range: 0 to 15.
0102	PE2	Event from segment 2 of program 5 (R&S). Range: Same as the PE 1 screen.
0103	PE3	Event from segment 3 of program 5 (R&S). Range: Same as the PE 1 screen.
0104	PE4	Event from segment 4 of program 5 (R&S). Range: Same as the PE 1 screen.
0105	PE5	Event from segment 5 of program 5 (R&S). Range: Same as the PE 1 screen.
0106	PE6	Event from segment 6 of program 5 (R&S). Range: Same as the PE 1 screen.
0107	PE7	Event from segment 7 of program 5 (R&S). Range: Same as the PE 1 screen.
0108	PE 1	Event from segment 1 of program 6 (R&S). Range: 0 to 15.
0109	PE2	Event from segment 2 of program 6 (R&S). Range: Same as the PE 1 screen.
0110	PE3	Event from segment 3 of program 6 (R&S). Range: Same as the PE 1 screen.
0111	PE4	Event from segment 4 of program 6 (R&S). Range: Same as the PE 1 screen.
0112	PE5	Event from segment 5 of program 6 (R&S). Range: Same as the PE 1 screen.
0113	PE6	Event from segment 6 of program 6 (R&S). Range: Same as the PE 1 screen.
0114	PE7	Event from segment 7 of program 6 (R&S). Range: Same as the PE 1 screen.
0115	PE 1	Event from segment 1 of program 7 (R&S). Range: 0 to 15.
0116	PE2	Event from segment 2 of program 7 (R&S). Range: Same as the PE 1 screen.
0117	PE3	Event from segment 3 of program 7 (R&S). Range: Same as the PE 1 screen.
0118	PE4	Event from segment 4 of program 7 (R&S).

HOLDING REGISTERS	PARAMETER	REGISTER DESCRIPTION
		Range: Same as the **PE 1** screen.
0119	**PE5**	Event from segment 5 of program 7 (R&S). Range: Same as the **PE 1** screen.
0120	**PE6**	Event from segment 6 of program 7 (R&S). Range: Same as the **PE 1** screen.
0121	**PE7**	Event from segment 7 of program 7 (R&S). Range: Same as the **PE 1** screen.
0122	**PtoL**	Tolerance of program 1 (Ramps and Soaks). Range: 0 to (**SPHL** - **SPLL**) value.
0123	**LP**	Program 1 Link (Ramps and Soaks). Range: 0 to 7.
0124	**Pt 1**	Program 1 - Time 1. Range: 0 to 9999 minutes.
0125	**Pt2**	Program 1 - Time 2. Range: 0 to 9999 minutes.
0126	**Pt3**	Program 1 - Time 3. Range: 0 to 9999 minutes.
0127	**Pt4**	Program 1 - Time 4. Range: 0 to 9999 minutes.
0128	**Pt5**	Program 1 - Time 5. Range: 0 to 9999 minutes.
0129	**Pt6**	Program 1 - Time 6. Range: 0 to 9999 minutes.
0130	**Pt7**	Program 1 - Time 7. Range: 0 to 9999 minutes.
0131	**PSP0**	Program 1 - Setpoint 0. Range: The minimum value is the value set in **SPLL** and the maximum value is the value set in **SPHL**.
0132	**PSP 1**	Program 1 - Setpoint 1 (Ramps and Soaks). Range: Same as the **PSP0** screen.
0133	**PSP2**	Program 1 - Setpoint 2 (Ramps and Soaks). Range: Same as the **PSP0** screen.
0134	**PSP3**	Program 1 - Setpoint 3 (Ramps and Soaks). Range: Same as the **PSP0** screen.
0135	**PSP4**	Program 1 - Setpoint 4 (Ramps and Soaks). Range: Same as the **PSP0** screen.
0136	**PSP5**	Program 1 - Setpoint 5 (Ramps and Soaks). Range: Same as the **PSP0** screen.
0137	**PSP6**	Program 1 - Setpoint 6 (Ramps and Soaks). Range: Same as the **PSP0** screen.
0138	**PSP7**	Program 1 - Setpoint 7 (Ramps and Soaks). Range: Same as the **PSP0** screen.
0139	**PtoL**	Tolerance of program 2 (Ramps and Soaks). Range: 0 to (**SPHL** - **SPLL**) value.
0140	**LP**	Program 2 Link (Ramps and Soaks). Range: 0 to 7.
0141	**Pt 1**	Program 2 - Time 1. Range: 0 to 9999 minutes.
0142	**Pt2**	Program 2 - Time 2. Range: 0 to 9999 minutes.
0143	**Pt3**	Program 2 - Time 3. Range: 0 to 9999 minutes.
0144	**Pt4**	Program 2 - Time 4. Range: 0 to 9999 minutes.
0145	**Pt5**	Program 2 - Time 5.

HOLDING REGISTERS	PARAMETER	REGISTER DESCRIPTION
		Range: 0 to 9999 minutes.
0146	Pt6	Program 2 - Time 6. Range: 0 to 9999 minutes.
0147	Pt7	Program 2 - Time 7. Range: 0 to 9999 minutes.
0148	PSP0	Program 2 - Setpoint 0. Range: The minimum value is the value set in SPLL and the maximum value is the value set in SPHL.
0149	PSP1	Program 2 - Setpoint 1 (Ramps and Soaks). Range: Same as the PSP0 screen.
0150	PSP2	Program 2 - Setpoint 2 (Ramps and Soaks). Range: Same as the PSP0 screen.
0151	PSP3	Program 2 - Setpoint 3 (Ramps and Soaks). Range: Same as the PSP0 screen.
0152	PSP4	Program 2 - Setpoint 4 (Ramps and Soaks). Range: Same as the PSP0 screen.
0153	PSP5	Program 2 - Setpoint 5 (Ramps and Soaks). Range: Same as the PSP0 screen.
0154	PSP6	Program 2 - Setpoint 6 (Ramps and Soaks). Range: Same as the PSP0 screen.
0155	PSP7	Program 2 - Setpoint 7 (Ramps and Soaks). Range: Same as the PSP0 screen.
0156	PtoL	Tolerance of program 3 (Ramps and Soaks). Range: 0 to (SPHL - SPLL) value.
0157	LP	Program 3 Link (Ramps and Soaks). Range: 0 to 7.
0158	Pt1	Program 3 - Time 1. Range: 0 to 9999 minutes.
0159	Pt2	Program 3 - Time 2. Range: 0 to 9999 minutes.
0160	Pt3	Program 3 - Time 3. Range: 0 to 9999 minutes.
0161	Pt4	Program 3 - Time 4. Range: 0 to 9999 minutes.
0162	Pt5	Program 3 - Time 5. Range: 0 to 9999 minutes.
0163	Pt6	Program 3 - Time 6. Range: 0 to 9999 minutes.
0164	Pt7	Program 3 - Time 7. Range: 0 to 9999 minutes.
0165	PSP0	Program 3 - Setpoint 0. Range: The minimum value is the value set in SPLL and the maximum value is the value set in SPHL.
0166	PSP1	Program 3 - Setpoint 1 (Ramps and Soaks). Range: Same as the PSP0 screen.
0167	PSP2	Program 3 - Setpoint 2 (Ramps and Soaks). Range: Same as the PSP0 screen.
0168	PSP3	Program 3 - Setpoint 3 (Ramps and Soaks). Range: Same as the PSP0 screen.
0169	PSP4	Program 3 - Setpoint 4 (Ramps and Soaks). Range: Same as the PSP0 screen.
0170	PSP5	Program 3 - Setpoint 5 (Ramps and Soaks). Range: Same as the PSP0 screen.
0171	PSP6	Program 3 - Setpoint 6 (Ramps and Soaks). Range: Same as the PSP0 screen.

HOLDING REGISTERS	PARAMETER	REGISTER DESCRIPTION
0172	PSP7	Program 3 - Setpoint 7 (Ramps and Soaks). Range: Same as the PSP0 screen.
0173	PtoL	Tolerance of program 4 (Ramps and Soaks). Range: 0 to (SPHL - SPLL) value.
0174	LP	Program 4 Link (Ramps and Soaks). Range: 0 to 7.
0175	Pt 1	Program 4 - Time 1. Range: 0 to 9999 minutes.
0176	Pt2	Program 4 - Time 2. Range: 0 to 9999 minutes.
0177	Pt3	Program 4 - Time 3. Range: 0 to 9999 minutes.
0178	Pt4	Program 4 - Time 4. Range: 0 to 9999 minutes.
0179	Pt5	Program 4 - Time 5. Range: 0 to 9999 minutes.
0180	Pt6	Program 4 - Time 6. Range: 0 to 9999 minutes.
0181	Pt7	Program 4 - Time 7. Range: 0 to 9999 minutes.
0182	PSP0	Program 4 - Setpoint 0. Range: The minimum value is the value set in SPLL and the maximum value is the value set in SPHL.
0183	PSP 1	Program 4 - Setpoint 1 (Ramps and Soaks). Range: Same as the PSP0 screen.
0184	PSP2	Program 4 - Setpoint 2 (Ramps and Soaks). Range: Same as the PSP0 screen.
0185	PSP3	Program 4 - Setpoint 3 (Ramps and Soaks). Range: Same as the PSP0 screen.
0186	PSP4	Program 4 - Setpoint 4 (Ramps and Soaks). Range: Same as the PSP0 screen.
0187	PSP5	Program 4 - Setpoint 5 (Ramps and Soaks). Range: Same as the PSP0 screen.
0188	PSP6	Program 4 - Setpoint 6 (Ramps and Soaks). Range: Same as the PSP0 screen.
0189	PSP7	Program 4 - Setpoint 7 (Ramps and Soaks). Range: Same as the PSP0 screen.
0190	PtoL	Tolerance of program 5 (Ramps and Soaks). Range: 0 to (SPHL - SPLL) value.
0191	LP	Program 5 Link (Ramps and Soaks). Range: 0 to 7.
0192	Pt 1	Program 5 - Time 1. Range: 0 to 9999 minutes.
0193	Pt2	Program 5 - Time 2. Range: 0 to 9999 minutes.
0194	Pt3	Program 5 - Time 3. Range: 0 to 9999 minutes.
0195	Pt4	Program 5 - Time 4. Range: 0 to 9999 minutes.
0196	Pt5	Program 5 - Time 5. Range: 0 to 9999 minutes.
0197	Pt6	Program 5 - Time 6. Range: 0 to 9999 minutes.
0198	Pt7	Program 5 - Time 7. Range: 0 to 9999 minutes.

HOLDING REGISTERS	PARAMETER	REGISTER DESCRIPTION
0199	PSP0	Program 5 - Setpoint 0. Range: The minimum value is the value set in SPLL and the maximum value is the value set in SPHL.
0200	PSP1	Program 5 - Setpoint 1 (Ramps and Soaks). Range: Same as the PSP0 screen.
0201	PSP2	Program 5 - Setpoint 2 (Ramps and Soaks). Range: Same as the PSP0 screen.
0202	PSP3	Program 5 - Setpoint 3 (Ramps and Soaks). Range: Same as the PSP0 screen.
0203	PSP4	Program 5 - Setpoint 4 (Ramps and Soaks). Range: Same as the PSP0 screen.
0204	PSP5	Program 5 - Setpoint 5 (Ramps and Soaks). Range: Same as the PSP0 screen.
0205	PSP6	Program 5 - Setpoint 6 (Ramps and Soaks). Range: Same as the PSP0 screen.
0206	PSP7	Program 5 - Setpoint 7 (Ramps and Soaks). Range: Same as the PSP0 screen.
0207	PtoL	Tolerance of program 6 (Ramps and Soaks). Range: 0 to (SPHL - SPLL) value.
0208	LP	Program 6 Link (Ramps and Soaks). Range: 0 to 7.
0209	Pt1	Program 6 - Time 1. Range: 0 to 9999 minutes.
0210	Pt2	Program 6 - Time 2. Range: 0 to 9999 minutes.
0211	Pt3	Program 6 - Time 3. Range: 0 to 9999 minutes.
0212	Pt4	Program 5 - Time 4. Range: 0 to 9999 minutes.
0213	Pt5	Program 6 - Time 5. Range: 0 to 9999 minutes.
0214	Pt6	Program 6 - Time 6. Range: 0 to 9999 minutes.
0215	Pt7	Program 6 - Time 7. Range: 0 to 9999 minutes.
0216	PSP0	Program 6 - Setpoint 0. Range: The minimum value is the value set in SPLL and the maximum value is the value set in SPHL.
0217	PSP1	Program 6 - Setpoint 1 (Ramps and Soaks). Range: Same as the PSP0 screen.
0218	PSP2	Program 6 - Setpoint 2 (Ramps and Soaks). Range: Same as the PSP0 screen.
0219	PSP3	Program 6 - Setpoint 3 (Ramps and Soaks). Range: Same as the PSP0 screen.
0220	PSP4	Program 6 - Setpoint 4 (Ramps and Soaks). Range: Same as the PSP0 screen.
0221	PSP5	Program 6 - Setpoint 5 (Ramps and Soaks). Range: Same as the PSP0 screen.
0222	PSP6	Program 6 - Setpoint 6 (Ramps and Soaks). Range: Same as the PSP0 screen.
0223	PSP7	Program 6 - Setpoint 7 (Ramps and Soaks). Range: Same as the PSP0 screen.
0224	PtoL	Tolerance of program 7 (Ramps and Soaks). Range: 0 to (SPHL - SPLL) value.
0225	LP	Program 7 Link (Ramps and Soaks).

HOLDING REGISTERS	PARAMETER	REGISTER DESCRIPTION
		Range: 0 to 7.
0226	Pt 1	Program 7 - Time 1. Range: 0 to 9999 minutes.
0227	Pt2	Program 7 - Time 2. Range: 0 to 9999 minutes.
0228	Pt3	Program 7 - Time 3. Range: 0 to 9999 minutes.
0229	Pt4	Program 7 - Time 4. Range: 0 to 9999 minutes.
0230	Pt5	Program 7 - Time 5. Range: 0 to 9999 minutes.
0231	Pt6	Program 7 - Time 6. Range: 0 to 9999 minutes.
0232	Pt7	Program 7 - Time 7. Range: 0 to 9999 minutes.
0233	PSP0	Program 7 - Setpoint 0. Range: The minimum value is the value set in SPLL and the maximum value is the value set in SPHL.
0234	PSP 1	Program 7 - Setpoint 1 (Ramps and Soaks). Range: Same as the PSP0 screen.
0235	PSP2	Program 7 - Setpoint 2 (Ramps and Soaks). Range: Same as the PSP0 screen.
0236	PSP3	Program 7 - Setpoint 3 (Ramps and Soaks). Range: Same as the PSP0 screen.
0237	PSP4	Program 7 - Setpoint 4 (Ramps and Soaks). Range: Same as the PSP0 screen.
0238	PSP5	Program 7 - Setpoint 5 (Ramps and Soaks). Range: Same as the PSP0 screen.
0239	PSP6	Program 7 - Setpoint 6 (Ramps and Soaks). Range: Same as the PSP0 screen.
0240	PSP7	Program 7 - Setpoint 7 (Ramps and Soaks). Range: Same as the PSP0 screen.

Table 10

14.4.3 STATUS WORDS

REGISTER	VALUE FORMAT
Status Word 1	bit 0 – Alarm 1 (0 → Disabled / 1 → Enabled) bit 1 – Alarm 2 (0 → Disabled / 1 → Enabled) bit 2 – Alarm 3 (0 → Disabled / 1 → Enabled) bit 3 – Alarm 4 (0 → Disabled / 1 → Enabled) bit 4 – Input 0 - I/O 5 (0 → Disabled / 1 → Enabled) bit 5 – Input 1 - I/O 3 (0 → Disabled / 1 → Enabled) bit 6 – Input 2 - I/O 4 (0 → Disabled / 1 → Enabled) bit 7 – Reserved bit 8 – Value to detect hardware bit 9 – Value to detect hardware bit 10 – Reserved bit 11 – Reserved bit 12 − Reserved bit 13 − Reserved bit 14 − Reserved

REGISTER	VALUE FORMAT
	bit 15 – Reserved
Status Word 2	bit 0 − Automatic (0 → Manual / 1 → Automatic) bit 1 − Run (0 → Stop / 1 → Run) bit 2 – Control action 1 (0 → Direct / 1 → Reverse) bit 3 – Reserved bit 4 – Auto-tune (0 → No / 1 → Yes) bit 5 – Alarm initial blocking 1 (0 → No / 1 → Yes) bit 6 – Alarm initial blocking 2 (0 → No / 1 → Yes) bit 7 – Alarm initial blocking 3 (0 → No / 1 → Yes) bit 8 – Alarm initial blocking 4 (0 → No / 1 → Yes) bit 9 − Unit (0 → °C / 1 → °F) bit 10 − Reserved bit 11 – Output 1 status bit 12 – Output 2 status bit 13 – Output 3 status bit 14 – Output 4 status bit 15 – Output 5 status
Status Word 3	bit 0 – Very low PV conversion (0 → No / 1 → Yes) bit 1 – Negative conversion after calibration (0 → No / 1 → Yes) bit 2 – Very high PV conversion (0 → No / 1 → Yes) bit 3 – Exceeded linearization limit (0 → No / 1 → Yes) bit 4 – The Pt100 cable resistance is too high (0 → No / 1 → Yes) bit 5 – Auto-Zero conversion out-of-range (0 → No / 1 → Yes) bit 6 – Auto-Span conversion out-of-range (0 → No / 1 → Yes) bit 7 − Cold Junction conversion out-of-range (0 → No / 1 → Yes) bit 8 − Reserved bit 9 − Reserved bit 10 − Reserved bit 11 − Reserved bit 12 − Reserved bit 13 − Reserved bit 14 − Reserved bit 15 − Reserved

Table 11

You can only write to the digital output bits when the outputs are set to OFF in the controller I/O configuration.

COIL STATUS	OUTPUT DESCRIPTION
0	Output 1 status (I/O1)
1	Output 2 status (I/O2)
2	Output 3 status (I/O3)
3	Output 4 status (I/O4)
4	Output 5 status (I/O5)

Table 12

14.5 EXCEPTION RESPONSES – ERROR CONDITIONS

When receiving a command, the Modbus protocol checks the CRC of the received data block. If there is a CRC error during reception, the master will receive no response.

After receiving an error-free packet, the controller processes the packet and verifies whether the request is valid or not. If invalid, an exception response, containing the corresponding error code, will be sent. In exception responses, the field corresponding to the Modbus command in the response will be added to 80 H.

If a command writing a value to a parameter has a value outside the allowed range, the maximum allowed value for this parameter will be forced, which will return this as the response.

The controller ignores the read commands in Broadcast. That is, there will be no response. You can only write in Broadcast mode.

ERROR CODES	ERROR DESCRIPTION
01	Invalid or non-existent command.
02	Register number invalid or out of range.
03	Number of registers invalid or out of range.

Table 13