

The N321S is a controller intended for solar water heating applications. It controls the water circulation system based on the difference of temperature between the solar collector and the storage tank (or swimming pool).

The instrument contains two NTC-type temperature sensors and a control output for activating the water circulation pump. It provides protections against overheating and freezing to the piping, preventing damages to the system.

## SPECIFICATIONS

### INPUT SENSOR:

- NTC Thermistor, 10 kΩ @ 25 °C; range: -50 a 120 °C (-58 to 248 °F);  
Accuracy: 0.6 °C (1.1 °F);

Sensor interchangeability: 0.75 °C (1.35 °F). This error can be compensated by the **offset** parameter in the controller.

**Note:** Two sensors with 3 m cables (2 x 0.5 mm²) are bundled together with the controller. The sensor cables can be extended up to 200 meters.

**Measurement Resolution:** ..... 0.1° from -19.9 to 119.9° ..... 1 °C elsewhere

**OUTPUT1:** ..... Relay SPDT; 1 HP 250 Vac / 1/3 HP 125 Vac (16 A Resistive)

**POWER SUPPLY:** ..... 100 to 240 Vac/dc ± 10%  
Optional: ..... 12 to 30 Vdc/ac  
Mains Frequency: ..... 50~60 Hz  
Power Consumption: ..... 5 VA

**DIMENSIONS:** Width x Height x Depth: ..... 75 x 33 x 75 mm  
Weight: ..... 100 g  
Panel: ..... 70 x 29 mm

**ENVIRONMENT:** Operating: ..... 0 to 40 °C (32 to 122 °F)  
Storage temperature: ..... -20 a 60 °C (-4 to 140 °F)  
Relative humidity: ..... 20 to 85 % non-condensing

**CASE:** ..... Polycarbonate UL94-2; Protection: Front panel: IP65, Box: IP42  
..... Suitable wiring: Up to 4.0 mm²

**RS-485 digital communication; RTU MODBUS protocol (Optional)**  
Serial interface not isolated from input circuitry.

Serial interface isolated from power supply input, except in 24 V models.

## INSTALLATION

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 that should not be shared with electrical motors, coils, contactors, etc.
- Installing RC filters (47 R and 100 nF, series combination) is strongly recommended at contactor coils or any other inductor.
- Use protection devices like circuit breakers and fuses.

## ELECTRICAL WIRING

Figure 1 below shows the controller connections to sensor, mains and outputs.

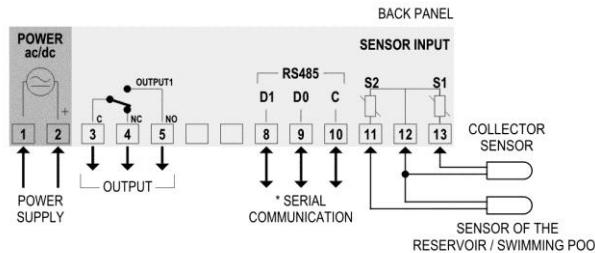


Figure 1 – N321S terminals

\* The serial communication interface is optional.

## OPERATION

The N321S contains several parameters that need to be configured in order to determine system behavior.

These configuration parameters are organized in groups, the so called *parameter levels*.

Level	Function
0	Temperature Measurement
1	Setpoint Adjustment
2	Configuration
3	Calibration

Upon power-up, the N321S display shows for 1 second its firmware version. This information is useful when consulting the factory.

Then, the temperatures of the sensors are displayed, according to the scheme defined in the parameter "ind". This is the parameter level 0 (temperature measurement level).

For accessing the level 1, press the **P** key for 2 seconds until the "D0n" parameter appears. Release the **P** key to remain on this level. Pressing the **P** key successively the other parameters in this level are displayed.

For accessing the level 2, press the **P** key for 4 seconds until the "unt" parameter appears. Release the **P** key to remain on this level. Press **P** again to access the other parameters of this level. After reaching the last parameter, the controller will return to the temperature measurement level.

Use the **▲** and **▼** keys to alter a parameter value. The display alternates the parameters prompts and their respective value.

- Notes:**
- 1 The configuration will be saved by the controller upon advancing to the next parameter in a level.
  - 2 If no keypad activity is detected within 20 seconds, the controller saves the current parameter value and returns to the measurement level.

### Level 1 – Setpoint Adjustment

At this level, the display presents the setpoint parameters. They define the differential temperatures values for the control. Use the **▲** and **▼** keys for setting the suitable values.

<b>D0n</b>	Differential setpoint for activating the pump. When the difference between T1 and T2 is higher than the value configured in <b>d0n</b> the pump will be turned on. Max <b>d0f</b> value: 20 °C.
<b>D0f</b>	Differential setpoint for deactivating the pump. When the difference between T1 and T2 is lower than the value configured in <b>d0f</b> the pump will be turned off. Adjustable between 1 °C and <b>D0n</b> .

### Level 2 – Programming Level

This level contains other configuration parameters that are needed for establishing a proper system performance.

<b>Unit</b>	Temperature Unit – Defines the temperature unit to be displayed. <b>0</b> Temperature in degrees Celsius <b>1</b> Temperature in degrees Fahrenheit
<b>ind</b>	Temperature value exhibited on the display. <b>0</b> Temperature of the collectors (T1) <b>1</b> Temperature of the storage tank (T2) <b>2</b> Temperature difference between the sensors (T1-T2) <b>3</b> Alternates the indication of (T1), (T2) and (T1-T2) at every 3s.
<b>I(e)</b>	Setpoint for low temperature. When the temperature in the solar collector is lower than the value here configured, the pump is turned on, preventing the water from freezing in the pipe system and causing damages to it. Adjustable between <b>spl</b> and <b>spk</b> .
<b>k<sub>t1</sub></b>	Setpoint for high temperature (at collector). When the temperature in the collector is above the value here configured, the pump is turned off, avoiding the overheated water from damaging the pipe system. Adjustable between <b>Spl</b> and <b>SPk</b> .
<b>Kt2</b>	Setpoint for high temperature at S2 (storage tank). When the temperature at the sensor S2 is above the value here configured, the pump is turned off in order to avoid thermal discomfort. This function is useful in swimming pool heating systems which do not use dedicated third sensor. Adjustable between <b>spl</b> and <b>spk</b> .
<b>k<sub>ys</sub></b>	Antifreezing temperature hysteresis of sensor S1 ( <b>i(e)</b> ). In degrees. Adjustable between 0.1 and 50.0 °C
<b>Ky1</b>	Overheating temperature hysteresis of sensor S1 ( <b>k<sub>t1</sub></b> ). In degrees. Adjustable between 0.1 and 50.0 °C

<b>Ky2</b> <i>Hysteresis 2</i>	Overheating temperature hysteresis of sensor S2 ( <b>kt2</b> ). In degrees. Adjustable between 0.1 and 50.0 °C.
<b>dly</b> <i>Delay</i>	Control start delay. After having the controller turned on, the control output will be activated after the time programmed in this parameter has lapsed. Value in seconds, from 0 to 250 seconds.
<b>Of1</b> <i>Offset Sensor 1</i>	Offset correction value for the temperature measured by the sensor 1. This parameter allows for small adjustments in the sensor 1 temperature reading. Measurement differences may happen, for instance, when a temperature sensor is replaced. Adjustable from -10.0 to 10.0 °C.
<b>Of2</b> <i>Offset Sensor 2</i>	Offset correction value for the temperature measured by the sensor 2. This parameter allows small adjustments to the sensor 2 temperature reading. Measurement differences may occur, for instance, when a temperature sensor is replaced. Adjustable from -10.0 to 10.0 °C.
<b>spl</b> <i>SP Low Limit</i>	<b>Lower limit</b> of the setpoint value: defines the <b>minimum</b> value for setpoint adjustment. In degrees. Adjustable between -50 and 120 °C.
<b>spk</b> <i>SP High Limit</i>	<b>Upper limit</b> of the setpoint: defines the <b>maximum</b> value for setpoint adjustment. Must be defined with a value necessarily <b>higher than spl</b> . In degrees. Adjustable between -50 and 120 °C.
<b>Add</b> <i>Address</i>	Modbus Address: used to define a unique network address in instruments that are featured with the optional RS485 Modbus RTU communication. Address range is from 1 to 247.

### Nivel 3 – Calibration level

The N321S inputs are factory calibrated and recalibration should only be done by qualified personnel. If you are not familiar with these procedures do not attempt to calibrate this.

Press the **P** key for 10 seconds to access this level. This level contains also the parameters for configuring the protection.

If you have entered this level accidentally, go through all the parameters without making any changes until the controller returns to the measurement level.

<b>pas</b>	<b>Password</b> - Enter the correct password to unlock write operations in the following parameters.
<b>[I1]</b>	<b>Calibration Low Input 1</b> – Input 1 offset.
<b>[k1]</b>	<b>Calibration High Input 1</b> – Gain adjustment (full scale value).
<b>[I2]</b>	<b>Calibration Low Input 2</b> - Input 2 offset.
<b>[k2]</b>	<b>Calibration High Input 2</b> – Input 2 gain adjustment (full scale value).
<b>FAC</b>	<b>Factory Calibration</b> - Restores factory calibration parameters. Change from 0 to 1 to restore the calibration parameters with factory

	values.
<b>Prt</b>	<b>Protection</b> - Defines the levels of parameters that will be password protected. See "Configuration Protection" for details.
<b>Pa(</b>	<b>Password Change</b> - Allows changing the current password to a new one. Values from 1 to 999 are allowed.
<b>Sn2</b>	<b>Serial number 2</b> - First part of the controller electronic serial number.
<b>sn1</b>	<b>Serial number 1</b> - Second part of the controller electronic serial number.
<b>sn0</b>	<b>Serial number 0</b> - Third part of the controller electronic serial number.

## WORKING WITH THE CONTROLLER

While the solar collector is receiving energy, the temperature in the sensor S1 increases. When T1 – T2 is higher than the value specified in **d0n**, the pump will be turned on, circulating the heated water down and storing it in the tank.

As the pump is operating, the hot water will circulate downwards and the cold water goes upwards. Consequently, the temperature difference between S1 and S2 tends to diminish. When this difference goes under the value configured in **d0f**, the pump will be turned off and the water circulation will stop.

The signaler P1 at the front panel of the controller will light up when the control output is activated.



Figure 2 – Front Panel

Indicator	Function
T1	Sensor 1 temperature
T2	Sensor 2 temperature
T1 T2	S1 – S2 (Differential Temperature)

## CONFIGURATION PROTECTION

A protection system to avoid unwanted changes to the controller parameters is implemented. The level of protection can be selected from partial to full. The following parameters are part of the protection system:

- Pas:** When this parameter is presented, the correct **password** should be entered to allow changes of parameters in the following levels.
- Prt:** Defines the level of parameters that will be password protected:
- 1 - Only **calibration** level is protected (factory configuration);
  - 2 - **Calibration** and **configuration** levels are protected;
  - 3 - All levels are protected – **calibration**, **configuration** and **setpoints**;
- PA(** Parameter for definition of a new password. Since it is located in the calibration level, can only be changed by a user that knows the current password. Valid passwords are in the range 1 to 999.

## CONFIGURATION PROTECTION USAGE

PAS parameter is displayed before entering a protected level. If the correct password is entered, parameters in all following levels can be changed. If wrong or no password is entered, parameters in the following levels will be read only.

### Important notes:

- 1 - After five consecutive attempts to enter a wrong password, new tentative will be blocked for the next 10 minutes. If the current valid password is unknown, the **master password** can be used **only** to define a new password for the controller.
- 2 - The password for a brand new device is 111.

## MASTER PASSWORD

The master password allows user to define a new password for the controller, even if the current password is unknown. The master password is based in the serial number of the controller, and calculated as following:

$$[1] + [ \text{higher digit of SN2} ] + [ \text{higher digit of SN1} ] + [ \text{higher digit of SN0} ]$$

For example the master password for the device with serial number 987123465 is: 1936

As follows: sn2= 987; sn1= 123; sn0= 465 = 1 + 9 + 3 + 6

### How to use the master password:

- 1- Enter the master password value at **PaS** prompt.
- 2- Go to **PA(** parameter and enter the new password, which must not be zero (0).
- 3- Now you can use this new password to access all controller parameters with modify rights.

## ERROR MESSAGES

Sensor measurement errors force the controller outputs to be turned off. The cause for these errors may have origin in a bad connection, sensor defect (cable or element) or system temperature outside the sensor working range. The display signs related to measurement errors are shown below:

T1	• Measured temperature exceeded <b>maximum</b> allowed range for the sensor. Short circuited NTC sensor. <b>IND = 0 or 1</b>
T2	• Measured temperature is below <b>minimum</b> measurement range of the sensor. Broken NTC. <b>IND = 0 or 1</b>
T1 T2	• If the temperature in S1 or S2 exceeds the measurement limit <b>IND = 2</b> , the differential value displayed is <b>0</b> .

## DESIGNATION SYSTEM

N321S	-485	- 24V
A	B	C



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