ThermoEst

N120 Controller

INSTRUCTIONS MANUAL – V2.0x G

INTRODUCTION

Extremely versatile process controller. In a single model, it accepts most of the sensors and signals used in the industry and offers the main output types required for several processes.

Configuration can be performed on the controller or through the USB interface once the **QuickTune** software has been installed on the computer to be used. Once the device is connected to the USB interface, it will be recognized as a serial communication (COM) port operating with Modbus RTU protocol.

Through the USB interface, even if disconnected from the power supply, the configuration performed can be saved on file and repeated on other devices that require the same configuration.

Besides being a controller, the **N120** is an electronic data logger. The electronic data logger operates independently of the controller. The configuration of the data logger parameters is performed by the **LogChart-II** software.

Before using the controller, it is important to read this manual and check if the version of this manual coincides with the version of the device. The software version number is shown when the controller is energized.

MAIN FEATURES

- Storage capacity: 32700 logs (data logger);
- Universal multi-sensor input without hardware change;
- Protection for open sensor in any condition;
- Relay and pulse type control outputs (all available);
- Automatic tuning of PID parameters;
- Automatic/Manual modes with bumpless transfer;
- 04 independent alarms with functions of minimum, maximum, differential (deviation), open sensor and event;
- Timer function for all alarms;
- Digital input with 04 functions;
- Soft Start programmable;
- Ramp and Soak feature with 20 programs of 9 segments, concatenable in a total of 180 segments;
- Password to protect the keyboard;
- LBD (loop break detector) function;
- Dual voltage.

OPERATION

The controller front panel is shown in **Fig. 1**:

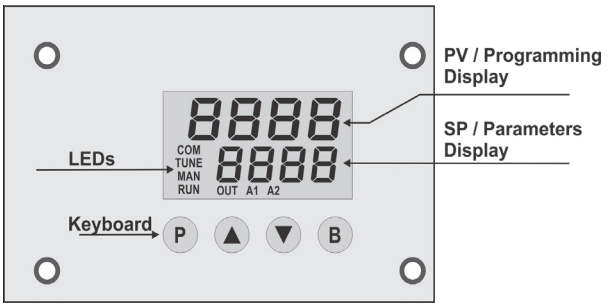


Fig. 1 – Front panel elements

- **PV / Programming Display:** Displays the current value of PV (Process Variable). During configuration, it shows the mnemonics of the parameters that must be set.
- **SP / Parameters Display:** Displays the value of SP (Setpoint). During configuration, it shows the values defined for the parameters.
- **COM LED:** Blinks every time the controller exchanges data via RS485 interface.
- **TUNE LED:** Remains on while the controller is in tuning process.
- **MAN LED:** Indicates that the controller is in manual control mode.
- **RUN LED:** Indicates that the controller is active, with the control output and alarms enabled.
- **OUT LED:** For relay or pulse control output. Indicates the current state of this output.
- **A1, A2, A3 and A4 LEDs:** Indicate the occurrence of an alarm situation.
- **P (Prog) Key:** Key used to advance the parameters.
- **B (Back) Key:** Key used to move the parameters back.
- **▲ Increment key and ▼ Decrement key**: Keys used to change parameter values.

When it is turned on, the controller displays the software version number for 3 seconds. Then it starts normal operation, showing the process variable (PV) in the upper display and the Setpoint control value in the parameter / SP display.

To operate properly, all the controller parameters must be configured. The user must understand and determine a valid condition or a valid value for each parameter.

Important:
The input type is the first parameter to be configured.

The configuration parameters are gathered in groups, called parameter levels. The 7 parameter levels are:

LEVEL	ACCESS
1 – Operation	Free access
2 – Tuning	Reserved access
3 – Programs	
4 – Alarms	

5 – Scale	
6 – I/O	
7 – Calibration	

Table 1 – Parameters cycles

The operating level (1st level) can be accessed through the **P** key. The other level can be accessed through a key combination:

B key + P key pressed simultaneously

In the desired level, it is possible to move through the parameters by pressing the **P** key (or pressing the **B** key to go back in the level). To return to the operation level, press **P** until all the parameters of the level are gone through or press **B** for 3 seconds.

All the configured parameters are stored in protected memory. The changed values are saved when the user moves to the next parameter. The SP value is also saved when changing from one parameter to the other or every 25 seconds.

CONFIGURATION / FEATURES

INPUT TYPE SELECTION

The type of input to be used by the controller is defined during the device configuration. **Table 2** shows all the available options:

TYPE	CODE	MEASUREMENT RANGE
J	tc J	Range: -110 to 950 °C (-166 to 1742 °F)
K	tc K	Range: -150 to 1370 °C (-238 to 2498 °F)
T	tc t	Range: -160 to 400 °C (-256 to 752 °F)
N	tc n	Range: -270 to 1300 °C (-454 to 2372 °F)
R	tc r	Range: -50 to 1760 °C (-58 to 3200 °F)
S	tc S	Range: -50 to 1760 °C (-58 to 3200 °F)
B	tc b	Range: 400 to 1800 °C (752 to 3272 °F)
E	tc E	Range:-90 to 730 °C (-130 to 1346 °F)
Pt100	Pt	Range: -200 to 850 °C (-328 to 1562 °F)
0-20 mA	L0.20	Linear Signals Programmable indication from -1999 to 9999.
4-20 mA	L4.20	
0–50 mV	L0.50	
0-5 Vdc	L0.5	
0-10 Vdc	L0.10	

Table 2 - Input types

Notes: All available input types are already factory calibrated.

OUTPUT CHANNELS

The controller has 03 output channels (**out1**, **out2** and **out3**), which can operate as control output or alarm output.

OUT1 Voltage Pulse, 5 Vdc / 25 mA;

OUT2 Output to Relay SPST-NA;

OUT3 Output to Relay SPST-NA.

The function to be used in each channel is defined by the user according to the options shown in **Table 3** and **Table 4**.

OUTPUTS FUNCTIONS	CODE
Inoperative	oFF
Alarm 1 output	A1
Alarm 2 output	A2
Alarm 3 output	A3
Alarm 4 output	A4
Loop Break Detection output	Lbd
Control 1 output (Relay or digital pulse)	Ctr1
Control 2 output (Relay or digital pulse)	Ctr2

Table 3 – Outputs functions types

When configuring channels, only the options valid for each channel are shown on the display. These functions are described below:

- **oFF** – No function

The I/O channel programmed with code **oFF** will not be used by the controller.

Note: Although without function, this channel can be activated by commands via serial communication (MODBUS command 5).

- **A1**, **A2**, **A3**, **A4** – Alarm output

Defines that the programmed I/O channel operates as an alarm output.

- **Lbd** – Loop Break Detector function

Defines the I/O channel as the output of the Loop Break Detector function.

- **Ctr1** – Control output 1
- **Ctr2** – Control output 2

DIGITAL INPUT

Defines the operation function adopted by the digital input available at terminals 7 and 8 of the controller. In parameter **di.in1**, the user selects the desired function. There are 5 possible options:

DIGITAL INPUT FUNCTIONS	CODE
No function	oFF
Switch between Automatic/Manual modes	MAn
Switch between Run/Stop modes	run
Stop the program	HPrG
Select program 1	Pr 1

Table 4 – Functions for the digital input channels

These functions are described below:

- **MAn** - Digital input with Automatic/Manual function:
  Closed = Manual control;
  Open = Automatic control.
- **run** - Digital input with RUN function:
  Closed = The outputs are enabled;
  Open = The control output and alarms are off.
- **HPrG** - Digital input with *Hold Program* function:
  Closed = Enables the program execution;
  Open = Stop (freezes) the program execution.
  Note: Even when the program is interrupted, the control output remains active and controlling the process at the interruption point (Setpoint). The program will resume its normal execution starting from this same point when the digital input is closed.
- **Pr 1** - Digital Input with Run Program 1 function:
  Useful function when it is necessary to switch between the main Setpoint and a second Setpoint defined by **program 1.**
  Closed = Selects program 1;
  Open = Selects the main Setpoint.

Even when ED is set to OFF, **LogChart II** can start logging.

ALARMS FUNCTIONS

The controller has 04 independent alarms. These alarms can be configured to operate with 08 different functions, presented in **Table 5**.

- **oFF** – The alarms are turned off.
- **tErr** – Sensor break alarm.

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

- **rS** – Ramp & soak program event alarm

Configures the alarm to act on specific segments of the ramp and soak programs to be created by the user.

- **Lo** – Absolute Minimum Value Alarm

It is activated when the measured value is **below** the value defined in the alarm Setpoint.

- **HI** – Absolute Maximum Value Alarm

It is activated when the measured value is **above** the value defined in the alarm Setpoint.

- **dIF** – Differential Value Alarm

In this function, the "**SPA1**", "**SPA2**","**SPA3**" and "**SPA4**" parameters represent the PV deviation as compared to the main SP.

Using Alarm 1 as an example: For positive SPA1 values, the Differential alarm will be triggered when the PV value is **out** of the range defined by:

(SP – SPA1) to (SP + SPA1)

For a negative SPA1 value, the differential alarm will be triggered when the PV value is **within** the range defined above.

- **dIFL** – Minimum Differential Value Alarm

It is activated when the PV value is below the value defined in:

(SP – SPA1)

Using Alarm 1 as an example.

- **dIFH** – Maximum Differential Value Alarm

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

(SP + SPA1)

Using Alarm 1 as an example.

The alarm functions are described in **Table 5**:

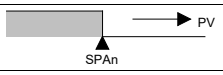
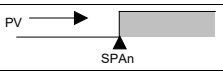
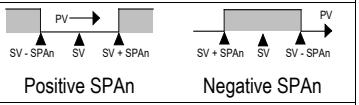
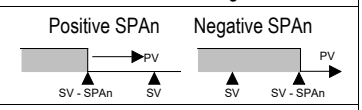
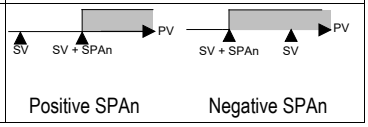
SCREEN	TYPE	ACTUATION
oFF	Inoperative	The output is not used as an alarm.
IErr	Open sensor (input **Err**or)	Activated when the input signal of PV is interrupted, it is out of range or when the Pt100 in short-circuit.
rS	Event (**r**amp and **S**oak)	Activated in a specific program segment.
Lo	Minimum value (**Lo**w)	
HI	Maximum value (**Hi**gh)	
dIF	Differential (**diFf**erential)	
dIFL	Minimum Differential (**diFf**erential **L**ow)	
dIFH	Maximum differential (**diFf**erential **H**igh)	

Table 5 – Alarm Functions

SPAn refers to "**SPA1**", "**SPA2**", "**SPA3**" and "**SPA4**" alarm setpoints.

ALARM TIMER MODES

The controller alarms can be configured to perform 03 timer modes:

- Activation for a defined time;
- Activation with delay;
- Intermittent activation.

The figures in **Table 6** show the behavior of the alarm outputs with various combinations for **t1** and **t2** times available in **A1t1**, **A1t2**, **A2t1**, **A2t2**, **A3t1**, **A3t2**, **A4t1** and **A4t2** parameters.

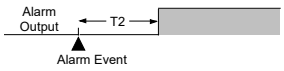
OPERATION	T 1	T 2	ACTION
Normal operation	0	0	
Activation for a defined time	1 to 6500 s	0	
Activation with delay	0	1 to 6500 s	
Intermittent activation	1 to 6500 s	1 to 6500 s	

Table 6 – Alarm temporization functions

The LEDs related to the alarms will light up whenever the alarm condition occurs, regardless of the state of the alarm output

ALARM INITIAL BLOCKING

The Initial Blocking option inhibits the alarm activation if there is an alarm condition at the moment the controller is turned on. The alarm will only be enabled after the process goes through a non-alarm condition.

The initial blocking is useful, for example, when one of the alarms is configured as a minimum value alarm, causing the activation of the alarm soon upon the process start-up, an occurrence that may be undesirable.

The initial blocking is disabled for the Open Sensor function.

SOFT START

This feature prevents abrupt variations in the power delivered to the load by the controller's control output.

A time interval defines the maximum rate of increase of the power delivered to the load, where 100 % of the power will only be reached at the end of this interval.

The value of power delivered to the load is still determined by the controller. The Soft Start function limits the rate of increase of this power value over the time interval defined by the user.

Normally, the Soft Start function is used in processes that require a slow start where the instantaneous application of 100 % of the available power on the load may damage parts of the process.

In order to disable this function, the Soft Start parameter must be configured with 0 (zero).

CONTROL MODE

The controller can act in 02 modes: Automatic mode or Manual mode. In automatic mode, the controller sets the MV value to be applied to the process based on the parameters set (SP, PID, etc.). In manual mode, the user sets this value. Parameter "**CtrL**" defines the control mode to be adopted for both Control 1 and Control 2.

PID AUTOMATIC MODE

In Automatic mode, there are 02 control strategies: PID control and ON/OFF control.

The PID control is based on a control algorithm that works as a function of the PV deviation from the SP and based on the established **Pb**, **ir** and **dt** parameters.

The ON/OFF control (obtained when Pb=0) operates with 0 % or 100 % of power when the PV deviates from the SP.

The determination of **Pb**, **ir** and **dt** parameters is described in the PID PARAMETERS DEFINITION chapter of this manual.

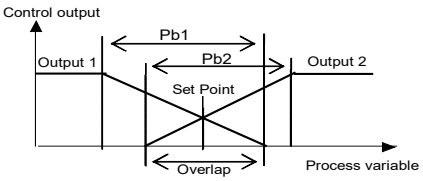
CONTROL 2

A second independent control output (Control Output 2) can be used. This output, with only proportional action, is typically used for cooling a process whose heating is controlled by control output 1.

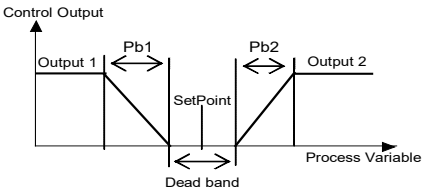
When the application requires simultaneous heating and cooling, the user must set the parameter **Act=rE** and adjust the overlap (**oLAP**) to determine the type of operation.

There are 03 types of situations:

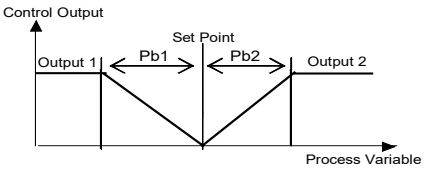
oLAP > 0; when there are overlapping between heating and cooling actions.



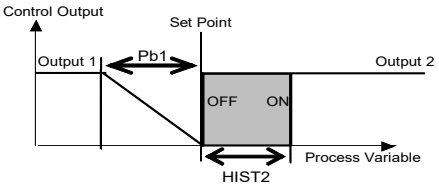
oLAP < 0; when there is a dead zone of power action between heating and cooling.



oLAP = 0; when there is no overlap or dead zone. There is no output action at the point where the PV reaches the SP.



The proportional band 2 (Pb2) and the cycle time of PWM 2 (Ct2) are independent. There is the minimum and maximum power setting for control 2.



LBD - LOOP BREAK DETECTION FUNCTION

The parameter **Lbd.t** defines a maximum time interval, in minutes, for the PV to react to a control output command. If the PV does not react properly throughout this interval, the controller signals the occurrence of the LBD event, which indicates control loop problems.

The LBD event can also be directed to one of the output channels. The user must configure the desired output channel with the **Ldb** function that, in the occurrence of this event, has the respective output activated.

If configured with 0 (zero), this function is disabled.

This function may be used to detect installation problems such as defective actuator, load power supply failure, etc.

SAFE OUTPUT VALUE WITH SENSOR FAILURE

Function that puts control output 1 in a safe condition for the process when a sensor input error is identified.

With an error identified in the sensor (input), the controller switches to manual control mode and MV assumes the percentage value defined in parameter **IE.ou**. The controller will remain in this new condition even if the sensor error disappears.

To enable this function, an alarm must be configured with the **IErr** function and the **IE.ou** parameter must be different from zero.

With **IE.ou** at 0 (zero), this function will be disabled, and the control output will be turned off when a sensor failure occurs.

This function may be used to detect installation problems such as defective actuator, load power supply failure, etc.

USB INTERFACE

The USB interface is used to CONFIGURE, MONITOR or UPDATE the controller FIRMWARE. The user should use **QuickTune** software, which offers features to create, view, save and open settings from the device or files on the computer. The tool for saving and opening configurations in files allows the user to transfer settings between devices and perform backup copies.

For specific models, **QuickTune** allows to update the firmware (internal software) of the controller via the USB interface.

For MONITORING purposes, the user can use any supervisory software (SCADA) or laboratory software that supports the MODBUS RTU communication over a serial communication port. When connected to a computer's USB, the controller is recognized as a conventional serial port (COM x).

The user must use **QuickTune** software or consult the DEVICE MANAGER on the Windows Control Panel to identify the COM port assigned to the controller.

The user should consult the mapping of the MODBUS memory in the controller's communication manual and the documentation of the supervision software to start the MONITORING process.

Follow the procedure below to use the USB communication of the device:

1. Download **QuickTune** software from our website and install it on the computer. The USB drivers necessary for operating the communication will be installed with the software.
2. Connect the USB cable between the device and the computer. The controller does not have to be connected to a power supply. The USB will provide enough power to operate the communication (other device functions may not operate).
3. Run the **QuickTune** software, configure the communication and start the device recognition.

	The USB interface is NOT ISOLATED from the signal input (PV) and the digital inputs and outputs of the controller. Its purpose is the temporary use during CONFIGURATION and MONITORING periods. For the safety of people and device, it should only be used with the device disconnected from the input/output signals. Using the USB in any other type of connection is possible, but requires a careful analysis by the person responsible for installing it. For long term MONITORING and with the inputs and outputs connected, it is recommended to use the RS485 interface, available or optional in most of our products.

INSTALATION

The controller was designed to be fixed by screws to metallic panels of equipment or machines. Display and keyboard must fit into the appropriate cutouts of these panels.

The following figures shows the dimensions and distances required for fixing:

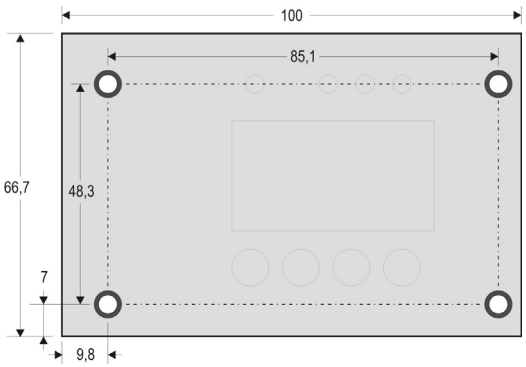


Fig. 2a – Screws mounting holes (Frontal view)

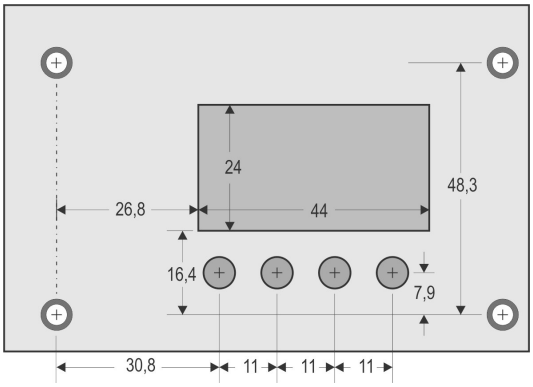


Fig. 2b – Keypad, display and LED distances (Frontal view)

RECOMMENDATIONS FOR THE INSTALLATION

- The input signals conductors shall be positioned throughout the factory separate from the output and the power supply conductors. If possible, in grounded conduits.
- The power supply of the electronic instruments should come from a network suitable for the instrumentation.
- It is strongly recommended to apply RC FILTERS (noise suppressor) in contactor coils, solenoids, etc.
- In control applications, it is essential to consider what can happen when any part of the system fails. The controller features by themselves cannot assure total protection.

ELECTRICAL WIRING

Fig. 3a and **Fig. 3b** shows the electrical connections:

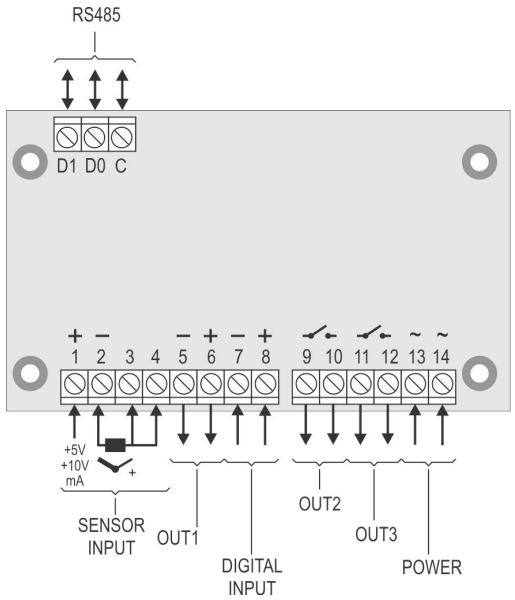


Fig. 3a – Input, outputs, power supply and RS485 interface

The connections of several input types are shown in the figures below. The type of input to be connected must be according to the selection made in **tYPE** parameter.

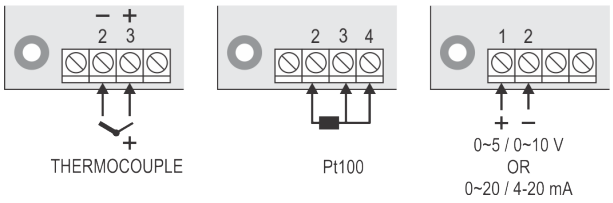


Fig. 3b – Input, outputs, power supply and RS485 interface

The input types 0~20 and 4~20 mA are not available in the controller's standard model, although shown as an option at the **tYPE** parameter. These inputs are only available in some custom models.

In special models where 0~20 mA and 4~20 mA input types are accepted, 0~5 V and 0~10 V types are no longer available.

PARAMETERS DESCRIPTION

OPERATION LEVEL

PV Indication (Red screen) SP Indication (Green screen)	**PV and SP indication**. The upper display shows the PV current value. The lower display shows the control SP value.
CtrL	**Control Mode:** **Auto** - Means automatic control mode; **iMAn** - Means manual control mode. Bumpless transfer between automatic and manual control modes.
PV Indication (Red Screen) MV Indication (Green Screen)	**Manipulated Variable 1 Value (MV).** The upper display shows the PV value and the lower display shows the percentage of MV1 applied to the control output. When in manual control, the MV1 value can be changed. When in auto mode, the MV1 value can only be viewed. To distinguish the MV1 display from the SP display, the MV1 is shown flashing intermittently.
PV Indication (Red Screen) MV Indication (Green Screen)	**Manipulated Variable 2 Value (MV).** The upper display shows the PV value and the lower display shows the percentage of MV2 applied to the control output. When in manual control, the MV2 value can be changed. When in auto mode, the MV2 value can only be viewed. The MV2 value also remains flashing. To distinguish the MV2 display from the MV1 display, the MV2 value is shown with a negative sign.
E Pr	Enable Program. Selects the ramp and soak program to be performed. **0** - Does not execute any program; **1 to 20** - Number of the program to be executed. With enabled outputs (**run** = **YES**), the selected program starts running immediately.
P.SEG	Screen for indication only. When a ramp and soak program is in progress, this parameter shows the number of the segment under execution. From 1 to 9.
t.SEG	Screen for indication only. When a ramp and soak program is in progress, this parameter shows the remaining time to the end of the current segment in units of time configured in the **Pr.tb** parameter.
run	Enables control outputs and alarms. **YES** - Outputs enabled; **no** - Outputs not enabled.

TUNING LEVEL

AtUn	Automatic tuning. Defines the control strategy to be used: oFF – Off; FASt – Fast automatic tuning; FULL – More precise automatic tuning; SELF – Precise + auto-adaptative tuning; rSLF – Forces a new precise automatic tuning + auto-adaptative tuning; tGHt – Forces a new precise automatic tuning + auto-adaptative tuning when run = YES or the controller is turned on.
Pb 1	Proportional Band. Proportional range for control output 1: Value of the PID control term in percent of the maximum range of the input type. If set to 0 (zero), the control is ON/OFF.
Ir	Integral Rate. Derivative time for the control output 1: Value of the term **I** of the PID control, in repetitions per minute (Reset). Displayed only if proportional band ≠ 0.
dt	Derivative Time. Derivative time for the control output 1: Value of the term **D** of the PID control, in seconds. Displayed only if proportional band ≠ 0.
Ct 1	Cycle Time. Pulse Width Modulation (PWM) cycle time: Value in seconds for the PWM output period. Displayed only if proportional band ≠ 0.
HYt 1	Hysteresis. Control 1 Hysteresis: Hysteresis value for control 1 in ON/OFF (Pb 1=0).
Act	Control Action. For automatic mode only. rE Reverse action. Appropriate for **heating**; d Ir Direct Action. Appropriate for **cooling**. For the control output 2, the control action is always opposite to the one defined for control output 1.
b IAS	Function Bias**.** Allows the user to change the percentage value of the control output (MV), adding a value between -100 % and +100 %. The value 0 (zero) disables the function. Displayed only if proportional band ≠ 0.
o 1LL	Output Low Limit. Lower limit for the control 1 output. Minimum percentage value assumed by the control output when in automatic mode and in PID. Normally equal to 0.0.
o 1HL	Output High Limit. Upper limit for the control 1 output. Maximum percentage for the control output when in automatic mode and in PID. Normally equal to 100.0.
Pb2	Proportional Band 2. Value of the **P** term for control output 2 in percentage of the maximum span of the input type. **If set to 0 (zero), control 2 is ON/OFF and the control hysteresis is configured on the oLAP screen**.
HYt2	Control 2 Hysteresis. This parameter is only shown for ON/OFF control (Pb2=0).
oLAP	Overlap. Defines the overlap between the heat and cool outputs. When the overlap value is negative, it represents the value of the dead-band instead. Displayed only if proportional band 2 ≠ 0
Ct2	Cycle Time. PWM cycle time for control output 2: Value in seconds of PWM output period. Displayed only if proportional band ≠ 0.
o2LL	Output Low Limit: minimum. Lower limit of control output 2: Minimum percentage value assumed by control output 2 when in automatic mode. Normally equal to 0.0.
o2HL	Output High Limit: Upper limit of control output 2: Maximum percentage value assumed by the manipulated variable (MV) when in automatic mode. Normally equal to 100.0.
SFSt	Soft Start function. Time interval, in seconds, during which the controller limits the rate of increase of the control output (MV). The value zero (0) disables Soft Start function.
Lbdt	Loop Break Detection time. Time interval for the LBD function. Defines the maximum interval of time for the PV to react to a control command. In minutes.
SPA 1 SPA2 SPA3 SPA4	Alarm Setpoint. Value that defines the point of activation for the programmed alarms with the "Lo" or "H I" functions. For the alarms configured with **Differential** type functions, this parameter defines deviation. Not used for the other alarm functions.

PROGRAMS LEVEL

PrtB	Program time base. Defines the time base adopted by the programs being edited and those already created. SEC - Time base in seconds; Min - Time base in minutes;
Pr n	Program number. Selects the program of ramps and soaks to be defined on the following screens of this level. There are 20 possible programs.
PtoL	Program tolerance. Maximum deviation allowed between PV and SP. If exceeded, the program is suspended (stops counting time) until the deviation is within this tolerance. The value 0 (zero) disables the function.
PSP0 PSP9	Program SP's, 0 to 9: Starting SP of the ramps and soaks program.
Pt 1 Pt9	Segments durations, 1 to 9: Defines the time of duration, in second or minutes, of the segments of the program being edited.
PE 1 PE9	Program event. Event alarms, 1 to 9: Parameters that define which alarms are to be activated during the execution of a certain program segment. The alarms chosen must have its function configured as "rS."
PSP 1 PSP9	Program SP's, 0 to 9: Set of 10 SP values which define the ramp and soak profile segments.
LP	Link Programs. Number of the next profile program to be linked following the current program. Profiles can be linked together to produce larger programs of up to 180 segments. **0** – Do not link to any other program.

ALARMS LEVEL

FuA 1 FuA2 FuA3 FuA4	Alarm functions. Defines the alarm functions among the options of **Table 5**. oFF, tErr, rS, Lo, H I, d IFL, d IFH, d IF
bLA 1 bLA2 bLA3 bLA4	Initial alarm blocking. Initial blocking function for alarms 1 to 4. YES - Enables initial blocking; no - Inhibits the blocking function.
HYA 1 HYA2 HYA3 HYA4	Alarm Hysteresis. Defines the difference between the PV value at which the alarm is turned on and the value at which it is turned off. A hysteresis value for each alarm.
A 1t 1 A2t 1 A3t 1	Alarm Time **t1.** Defines the temporization time **t1**, in seconds, for the alarms. Defines the temporization time **t1**, in seconds, for the alarms time functions.

A4t 1	The value zero (0) disables the function.
A 1t2 A2t2 A3t2 A4t2	Alarm Time **t2.** Defines the temporization time **t2,** in seconds, for the alarms. Defines the temporization time **t2**, in seconds, for the alarms time functions. The value 0 (zero) disables the function.
FLSh	Flash. Signals the occurrence of alarm conditions by flashing the PV indication on the indication screen. The user selects the numbers of the alarms that he wishes to display this feature.

SCALE LEVEL

tYPE	Input Type. Selects the input signal type to be connected to the process variable input. See **Table 2**. **Necessarily, the first parameter to be configured.**
FLtr	Digital Input Filter. Used to improve the stability of the measured signal (PV). Adjustable between 0 and 20. In 0 (zero) means filter turned off and in 20 means maximum filter. The higher the filter value, the slower is the response of the measured value.
dP.Po	Decimal Point. Defines the decimal point position.
un It	Unit. Temperature indication in °C or °F. Not shown for linear inputs. Parameter presented when used temperature sensors.
OFFS	Sensor Offset. Parameter to allow corrections in the indicated PV value.
SPLL	Setpoint Low Limit. Defines the lower limit for SP adjustment. For the linear analog input types available (0-20 mA, 4-20 mA, 0-50 mV and 0-5 V), defines the minimum PV indication range, besides limiting the SP adjustment. Defines lower limit for PV and SP range retransmission.
SPHL	Setpoint High Limit. Defines the upper limit for SP adjustment. For the linear analog input types available (0-20 mA, 4-20 mA, 0-50 mV and 0-5 V), defines the maximum PV indication range, besides limiting the SP adjustment. Defines upper limit for PV and SP range retransmission.
IEou	Percentage output value that will be transfer to MV when the Safe Output function is enabled. If IEou = 0, the Safe Output function is disabled, and the outputs are turned off in the occurrence of a sensor fail.
bAud	Serial communication baud rate. In kbps. 1.2, 2.4, 4.8, 9.6, 19.2, 38.4, 57.6 and 115.2.
PrtY	Serial communication parity. nonE - Without parity; EUEn - Even parity; Odd - Odd parity.
Addr	Communication address. Number that identifies the controller in the serial communication network, between 1 and 247.

I/O LEVEL (INPUTS AND OUTPUTS)

out1	I/O 1 Function: Selects the I/O function to be used at I/O 1 (relay 1), as shown in **Table 3**.
out2	I/O 2 Function: Selects the I/O function to be used at I/O 2 (relay 2), as shown in **Table 3**.
out3	I/O 3 Function: Selects the I/O function to be used at I/O 3 (relay 3), as shown in **Table 3**.
d.in1	Digital Input function, as shown in **Table 4**.

CALIBRATION LEVEL

All input and output types are factory calibrated. If a recalibration is necessary, it must be performed by a specialized professional. If this level is accessed by accident, it is necessary to go through all the parameters without changing their values.

PASS	Access password input. This parameter is presented before the protected levels. See **Configuration Protection** chapter.
CAL Ib	Allows the user to calibrate the controller. YES - Perform a calibration; no - Do not perform any calibration.
inLC	Input Low Calibration. See MAINTENANCE / Input Calibration chapter. Enter the value corresponding to the low scale signal applied to the analog input.
inHC	Input High Calibration. See MAINTENANCE / Input Calibration chapter. Enter the value corresponding to the full scale signal applied to the analog input.
rStr	Restores the factory input and output analog calibrations, eliminating all changes made by the user.
CJ	Adjusts the of cold junction temperature value.
PASC	Allows the user to define a new access password, always different from zero.
Prot	Sets up the Protection Level. See **Table 6.**
FrEQ	Frequency. Frequency of the local electrical network.

CONFIGURATION PROTECTION

The controller allows the user to protect the configuration created, preventing improper changes. The **Protection** (Prot) parameter of the **Calibration** level determines the protection level to be adopted, limiting access to the levels, as shown in the table below:

PROTECTION LEVEL	PROTECTED LEVELS
1	Only the Calibration level is protected.
2	I/O and Calibration levels are protected.
3	Scale, I/O and Calibration levels are protected.
4	Alarm, Scale, I/O and Calibration levels are protected.
5	Programs, Alarm, Scale, I/O and Calibration levels are protected.
6	Tuning, Programs, Alarm, Scale, I/O and Calibration levels are protected.
7	Operation (except SP), Tuning, Programs, Alarm, Scale, I/O and Calibration levels are protected.
8	Operation (including SP), Tuning, Program, Alarm, Scale, I/O and Calibration levels are protected.

Table 7 – Configuration protection levels

ACCESS PASSWORD

When accessed, the protected levels request the **Access Password** which, if entered correctly, allows the user to change the parameters configuration of these levels.

The access password is entered in the PASS parameter, shown in the first of the protected levels.

Without the password, the parameters of the protected levels can only be displayed.

The access password is set in the **Password Change** (PASC) parameter, present in the **Calibration** level.

The new controllers leave the factory with the access password set to 1111.

ACCESS CODE PROTECTION

The controller provides a security system that helps to prevent the entry of numerous passwords in an attempt to set the correct

password. Once 05 invalid passwords are identified in a row, the controller stops accepting passwords for 10 minutes.

MASTER PASSWORD

If the user forgets the password, it is possible to use the **Master Password** feature. This password allows to modify the **Password Change** (**PASC**) parameter and define a new access password for the controller.

The Master Password is composed by the last three digits of the controller's serial number **added** to the number 9000.

As an example, the master password is 9 3 2 1 for a device with serial number 07154321.

RAMP AND SOAK PROGRAMS

This feature allows the user to create a profile for the process. Each program is composed by a set of up to **9 segments**, named RAMP AND SOAK PROGRAM, defined by SP values and time intervals.

It is possible to create up to **20 different** ramp and soak programs.

The figure below displays a program model:

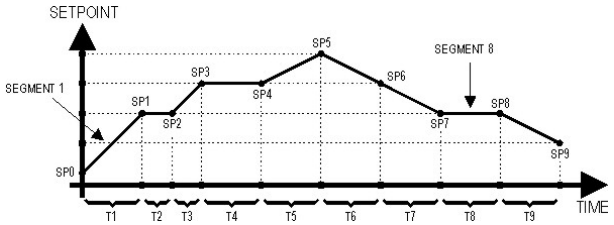


Fig. 4 - Example of a Ramp and Soak program

Once the program is defined and put into operation, the controller generate the SP according to the created program.

To perform a program with fewer segments, just program 0 (zero) for the time values of the segments following the last segment to be executed.

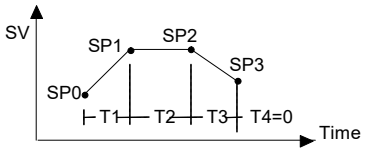


Fig. 5 - Program example with few segments

The program tolerance function **PtoL** defines the maximum deviation between PV and SP during program execution. If this deviation is exceeded, the time count is interrupted until the deviation is within the programmed tolerance (gives priority to SP).

If programed with zero tolerance, the controller performs the defined program without considering eventual deviations between PV and SP (gives priority to the time).

PROGRAMS LINK

It is possible to create a more complex program, with up to 180 segments, linking 20 programs. This way, at the end of a program execution, the controller immediately starts to run the next one.

When editing/creating a program, the user must define on the **LP** screen whether or not there will be a connection to another program.

To force the controller to 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.

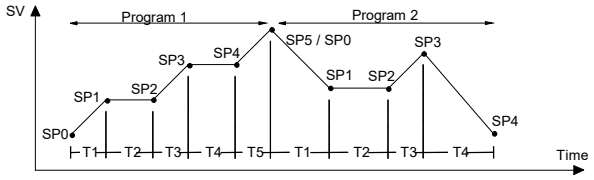


Fig. 6 - Example of interlinked programs

EVENT ALARM

The Event Alarm function associates the alarms to a program specific segment. The information of which alarms are to be triggered are defined in **rS** parameter and are configured in **PE1** to **PE9** parameters.

Notes:

1. Before starting the program, the controller waits for the PV to reach the initial setpoint (**SP0**).
2. When returning from a power outage, the controller resumes the program execution from the beginning of the segment in which it was interrupted.

PID PARAMETERS DEFINITION

The determination (or tuning) of the PID control parameters in the controller can be carried out in an automatic mode and auto-adaptative mode. The **automatic tuning** is always initiated under request of the operator. The **auto-adaptive tuning** is initiated by the controller itself whenever the control performance becomes poor.

AUTOMATIC TUNING

In the beginning of the **automatic tuning**, the controller has the same behavior of an ON/OFF controller, applying minimum and maximum performance to the process. Along the tuning process, the controller's performance is refined until its conclusion, already under optimized PID control. It begins immediately after the selection of the options FAST, FULL, RSLF or TGHT, defined by the operator in the ATUN parameter.

AUTO-ADAPTIVE TUNING

Is initiated by the controller whenever the control performance is worse than the one found after the previous tuning. In order to activate the performance supervision and **auto-adaptative tuning**, the ATUN parameter must be adjusted for SELF, RSLF or TGHT.

The controller's behavior during the **auto-adaptative tuning** will depend on the worsening of the present performance. If the maladjustment is small, the tuning is practically imperceptible for the user. If the maladjustment is big, the **auto-adaptive tuning** is similar to the method of **automatic tuning**, applying minimum and maximum performance to the process in ON/OFF control.

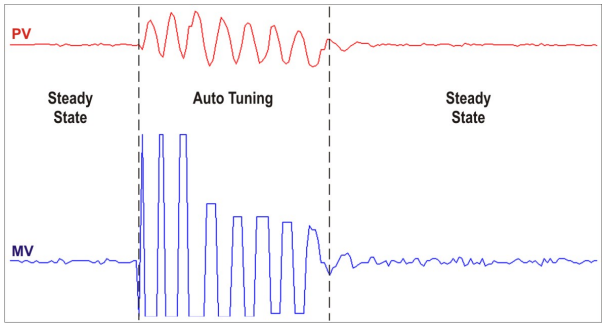


Fig. 7 – Automatic tuning example

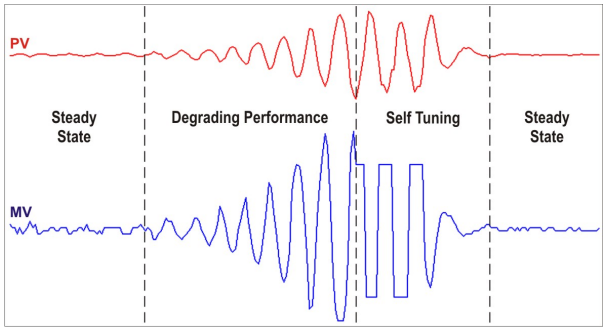


Fig. 8 - Auto-adaptative tuning example

Through the ATUN parameter, the user may select the desired tuning type among the following options:

- **OFF:** The controller does not carry through **automatic tuning** or **auto-adaptative tuning**. The PID parameters will **not** be automatically determined **nor** optimized by the controller.
- **FAST:** The controller will accomplish the process of **automatic tuning** one single time, returning to the OFF mode after finishing. In this mode, the tuning is completed in less time, but not as precise as in the FULL mode.
- **FULL:** The same as the FAST mode, but the tuning is more precise and slower, resulting in better performance of the PID control.
- **SELF:** The performance of the process is monitored and the **auto-adaptative tuning** is automatically initiated by the controller whenever the performance becomes poorer.

  After the tuning process, the controller enters a learning phase when it collects data relative to the process performance. This phase, which is dependent of the response time of the process, is indicated by a flashing TUNE indicator. Once this learning is completed, the controller is able to decide whether or not a new tuning is required to improve system response.

  It is recommended not to turn the controller off neither change the SP value during this phase.
- **rSLF:** Accomplishes the **automatic tuning** and returns into the SELF mode. Typically used to force an immediate **automatic tuning** of a controller that was operating in the SELF mode, returning to this mode at the end.
- **TGHT:** Similar to the SELF mode, but, in addition to the **auto-adaptative tuning**, it also executes the **automatic tuning** whenever the controller is set in run = YES or when the controller is turned on.

Whenever the ATUN parameter is modified by the user to a value different from OFF, an automatic tuning is immediately initiated by the controller (if the controller is not in run = YES, the tuning will be initiated when moving to this condition). Performing the automatic tuning is essential for the proper operation of the auto-adaptative tuning.

The **automatic tuning** and **auto-adaptative tuning** modes are suitable for most of the industrial processes. However, there may be processes or even specific situations where the methods are not capable to determine the controller's parameters in a satisfactory way, resulting in undesired oscillations or even leading the process to extreme conditions. The oscillations themselves imposed by the tuning methods may be intolerable for certain processes. These possible undesirable effects should be considered before using the controller. Preventive measures must be taken to ensure the process and users integrity.

The "**TUNE**" LED will stay on during the tuning process.

In case of PWM or pulse output, the quality of the tuning will also depend on the cycle time previously adjusted by the user.

If the tuning does not result in a satisfactory control, **Table 8** shows how to correct the process behavior:

PARAMETER	VERIFIED PROBLEM	SOLUTION
Proportional Band	Slow answer	Decrease
	Great oscillation	Increase
Rate of Integration	Slow answer	Increase
	Great oscillation	Decrease
Derivative Time	Slow answer or instability	Decrease
	Great oscillation	Increase

Table 08 - Guidance for manual adjustment of the PID parameters

SPECIFICATIONS

DIMENSION: ..... 100 x 67 mm
..... Approximate Weight: 80 g

POWER SUPPLY: ..... 100 to 240 Vac/dc (±10 %), 50/60 Hz,
Maximum consumption: ..... 5 VA

ENVIRONMENTAL CONDITIONS:
Operating Temperature: ..... 5 to 60 °C
Relative Humidity: ..... 80 % max.

INPUT ..... T/C, Pt100, voltage and current (according to **Table 2**)
Internal Resolution: ..... 32767 levels (15 bits)
Display Resolution: ..... 12000 levels (from - 1999 up to 9999)
Input reading rate: ..... Up to 55 per second
Accuracy: Thermocouples **J**, **K**, **T**, **E:** 0.25% of the span ± 1 °C
..... Thermocouples **N**, **R**, **S**, **B**: 0.25% of the span ± 3 °C
..... Pt100: 0.2% of the span
..... 0-50 mV, 0-5 Vdc: 0.2% of the span
Input Impedance: ..... 0-50 mV, Pt100, T/C: > 10 MΩ
..... 0-5 V: > 1 MΩ
..... 4-20 mA: 15 Ω (+2 Vcc @ 20 mA)
Pt100 Measurement: ..... Three wire type, (α=0.00385)
with compensation for cable length, excitation current of 0.170 mA.
All input and output types are factory-calibrated. Thermocouples according to standard NBR 12771 / 99, RTD's NBR 13773 / 97.
Heating Time: ..... 15 minutes

INPUT DIGITAL (DIG INP): ..... Contact Dry or NPN open collector

OUT1: ..... Voltage pulse, 5 V / 20 mA

OUT2 (*): ..... Relay SPST, 3 A / 250 Vac

OUT3: ..... Relay SPST, 3 A / 250 Vac

(*) In models with adjustable outputs – **PR,** one relay SPDT-NO 10 A / 250 VAC is available at OUT2. In these models, OUT3 is not available.

USB Interface: 2.0, CDC class (virtual communications port), Modbus RTU protocol.

PROPER CONNECTIONS FOR TERMINAL PIN-TYPE.

PROGRAMMABLE PWM CYCLE FROM 0.5 TO 100 SECONDS.

START-UP OPERATION: After 3 seconds connected to the power supply.

IDENTIFICATION

N120	- A	- B

Where:

A: Output configuration
PR: OUT1: Pulse / OUT2: Relay SPDT
PRR: OUT1: Pulse / OUT2: Relay SPST / OUT3: Relay SPST (*)

B: Additional Features
485: Device with RS485 serial communication
DL: With a built-in Data logger

(*) Basic model configuration.

MAINTENANCE

PROBLEMS WITH THE CONTROLLER

Connection errors and improper configuration 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 to identify problems:

MESSAGE	PROBLEM DESCRIPTION
----	Open input. No sensor or signal.
Err 1 Err6	Connection and/or configuration errors. Check the wiring and the configuration.

Other error messages may indicate hardware problems requiring maintenance service. When contacting the manufacturer, the user must inform the device serial number, obtained by pressing the **B** key for more than 3 seconds.

INPUT CALIBRATION

All types of controller inputs are already factory-calibrated. Recalibration is an inadvisable procedure for inexperienced operators. In case it is necessary to recalibrate some scale, proceed as follows:

a) Configure the input type to be calibrated.

b) Configure the lower and upper indication limits for the extremes of the input type.

c) At the input, apply a signal that corresponds to a known indication value a little above the lower display limit.

d) Access InLc parameter. With the ▲ and ▼ keys, adjust the display reading such as to match the applied signal. Then, press the **P** key.

e) At the input, apply a signal that corresponds to a value a little lower than the upper display limit.

f) Access InLc parameter. With the ▲ and ▼ keys, adjust the display reading such as to match the applied signal. Then, press the **P** key.

Note: When performing calibrations on the controller, observe if the Pt100 excitation current required by the calibrator used is compatible with the Pt100 excitation current used in this instrument: 0.170 mA.

Warranty conditions are available on our web site www.thermoest.com

APPENDIX 1 – SOFTWARE LOGCHART-II

INSTALLING LOGCHART-II

The **LogChart-II** configurator software, which can be downloaded for free from the Downloads sections of the **NOVUS** website, allows configuring the parameters associated with the controller operation as a data logger and downloading the acquired data.

Important: The date in the Windows must be configured as a bar. For example: dd/mm/yyyy or dd/mm/yyyyy.

RUNNING LOGCHART-II

When opening the **LogChart-II**, the main window will be displayed:

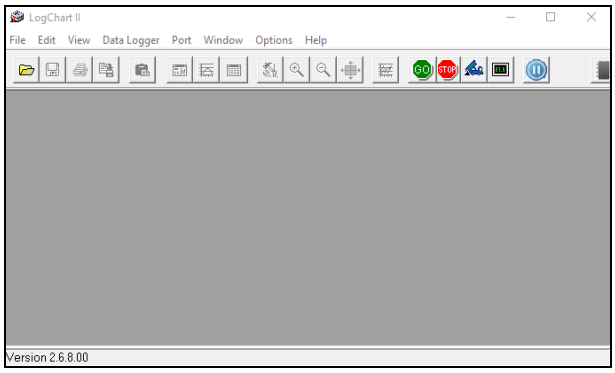


Fig. 1 – **LogChart-II** main window

Next, the user must indicate the serial port to be used by the communication interface through the "Port" menu. This menu presents all the serial ports available on the computer.

After that, it is necessary to choose a port that presents the **N120** device in its description:

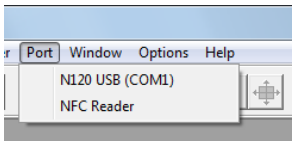


Fig. 2 – Selecting the USB serial port where the **N120** controller is connected

Once a valid serial port is selected, the icons for communication with the controller will be activated:

Fig. 3 – Icons enabled when the communication port selected is a valid port

CONFIGURING THE CONTROLLER

To configure the controller, press the button: 

The **Configuration Settings** window is displayed. The **LogChart-II** window allows the user to set the controller operating mode and also provide general information about the device **(Fig. 4).**

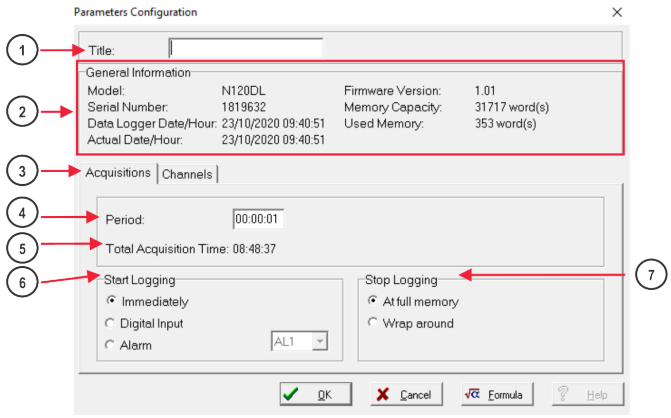


Fig. 4 – Controller configuration (Logging)

The configuration fields are:

1 **Title**: In this field, the user identifies the download, giving it a name (up to 16 characters).

2 **General Information**: Information field. There are presented information regarding the controller: Model (**N120**), serial number, date/time of the controller, current date/time of the PC, firmware version (model controller), memory capacity and number of acquisitions in memory.

In this field, the time is constantly updated while the communication between controller and computer is established.

Note: The clock of the controller may be with a little difference compared to the current time of the computer. When the controller is configured, their clock is updated.

3 **Acquisitions:** Presents a series of parameters that define how measurements will take place.

4 **Period**: Defines the interval between readings. Minimum interval is 1 (one) second.

5 **Total Acquisition Time**: In this parameter, the controller informs how long it will take to fully occupy the memory in the conditions defined in the elaborate configuration.

6 **Start Logging**: Readings can be started in one of 03 different modes:

- **Immediately**: The logging begin immediately, as soon as the programming is finished and sent (OK) to the controller.
- **Digital Input**: The logging are started whenever the digital input of the **N120** is activated. Otherwise, the acquisitions are interrupted.
- **Alarm**: The logging are initiated whenever the condition associated with alarm 1 (AL1) of the controller is met. Otherwise, the acquisition is interrupted.

7 **Stop Logging:** The options for the end of the acquisitions are:

- **At Memory Full:** The logging happens until the available memory capacity is reached.
- **Wrap Aroung:** The logging happens continuously, overwriting older logs as the number of logs exceeds the memory capacity.

8 **Channels**: Shows the parameters relative to device channel 1 (Temperature). None of these parameters can be changed via **LogChart-II**. To do this, the **N120** interface must be used directly.

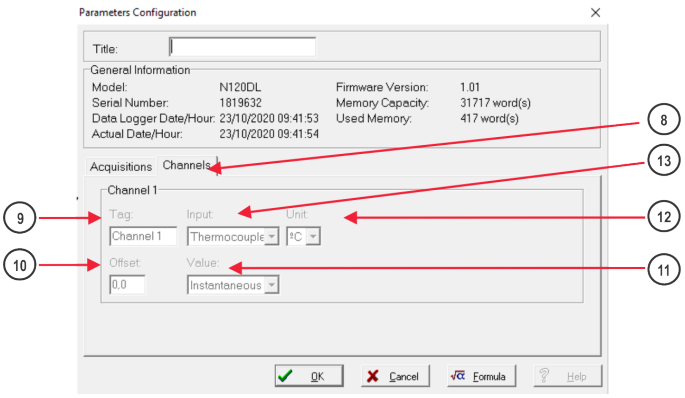


Fig. 5 – Controller Configuration (Channels)

9 **Tag**: Defines a name for the temperature logs.

10 **Offset**: Indicates the correction of the registered value.

11 **Value**: Indicates how the measured value will be logged.

(12) **Unit**: Indicates the measurement unit of the monitored magnitude in channel 1 (temperature): °C or °F.

(13) **Input**: Indicates the type of sensor selected for channel 1 (temperature).

After filling the fields and selecting "OK", the configuration will be sent to the data logger.

Important: Setting the **N120** will erase all the logs present in its data memory.

DOWNLOADING AND VIEWING DATA

The data acquired by the controller can be transferred to a PC using the **LogChart-II** software, which presents it in graphic and table form. The data can be saved in files for future analysis and comparisons.

DOWNLOADING THE DATA 

The download of the acquired data is done by clicking on the **Download Acquisitions** icon. During the data transfer process, a progress bar is shown, indicating how much has already been transferred. The data transfer time is proportional to the number of acquisitions made.

VIEWING THE DATA DOWNLOADED

After the transfer of the acquisitions, the data are displayed in graphical form.

CHART WINDOW 

The user can select a region of the graph to be viewed in detail (zoom). The zoom commands can be accessed through the **View** menu or through the zoom icons on the toolbar.

The user can also select the area of the graphic to zoom by clicking and dragging the mouse, creating a zoom region from the top left corner of the desired graphic area.

The graphic window shows the minimum and maximum values of channel 1. It also shows a horizontal line dotted with the configured alarm value.

When selecting a curve point with a double click, the value corresponding to the point on the curve of the collection graph and the acquisition table is shown.

By selecting a curve point with a double click with the Shift key pressed, it is possible to associate a text to the curve point.

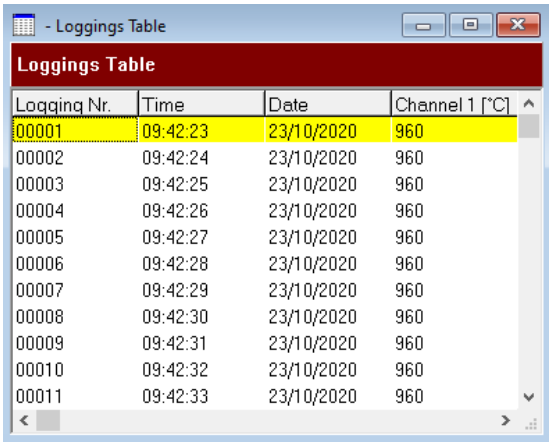
Fig. 6 - Graphical display of the downloaded data

The download of acquisitions **does not** interrupt the process of measuring and downloading data.

LOGGINGS TABLE WINDOWS 

It is possible to view the presentation in table form by pressing the **View Loggings Table** icon. This mode shows the values acquired in table format, listing the time of the measurement, the date and its value (**Fig. 7**).

When selecting a table line with a double click, this line is marked (in yellow) and, at the corresponding point on the download graph curve, the value.



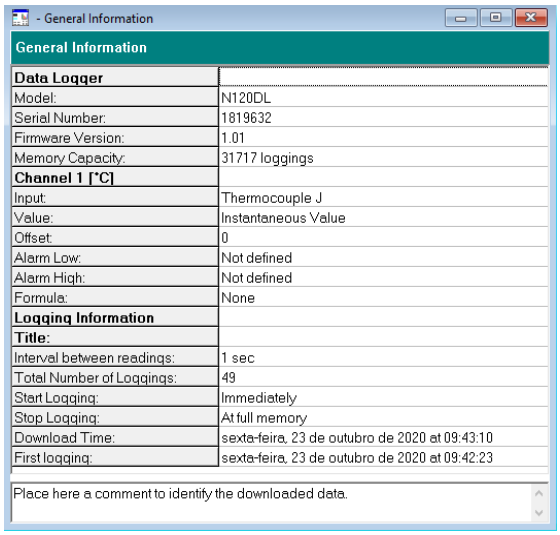
Logging Nr.	Time	Date	Channel 1 [°C]
00001	09:42:23	23/10/2020	960
00002	09:42:24	23/10/2020	960
00003	09:42:25	23/10/2020	960
00004	09:42:26	23/10/2020	960
00005	09:42:27	23/10/2020	960
00006	09:42:28	23/10/2020	960
00007	09:42:29	23/10/2020	960
00008	09:42:30	23/10/2020	960
00009	09:42:31	23/10/2020	960
00010	09:42:32	23/10/2020	960
00011	09:42:33	23/10/2020	960

Fig. 7 – Loggings Table

GENERAL INFORMATION WINDOW 

This window shows some information about the controller and its configuration. This screen can be displayed through the **View General Information** icon.

At the end of the **General Information** window (**Fig. 8**), the user can add a text with remarks about the downloaded data.



Data Logger	
Model:	N120DL
Serial Number:	1819632
Firmware Version:	1.01
Memory Capacity:	31717 loggings
Channel 1 [°C]	
Input:	Thermocouple J
Value:	Instantaneous Value
Offset:	0
Alarm Low:	Not defined
Alarm High:	Not defined
Formula:	None
Logging Information	
Title:	
Interval between readings:	1 sec
Total Number of Loggings:	49
Start Logging:	Immediately
Stop Logging:	At full memory
Download Time:	sexta-feira, 23 de outubro de 2020 at 09:43:10
First logging:	sexta-feira, 23 de outubro de 2020 at 09:42:23

Place here a comment to identify the downloaded data.

Fig. 8 – General Information

SELECTING A SELECTION OF SERIAL (COM) - WINDOWS DETERMINATION

The serial port related to the **N120** is automatically determined by the operating system a few moments after connecting the **N120**. The user can easily identify or change the COM port associated to the **N120** by accessing the Windows Device Manager:

Control Panel / System / Hardware / Device Manager / COM & LPT Ports

It is also possible to open the Device Manager by executing the following command: "devmgmt.msc".

After opening the Device Manager, it is possible to check the Serial Port (COM) related to the **N120**. As can be seen in **Fig. 9a** and **Fig.9b**, the **N120** is associated with COM7.

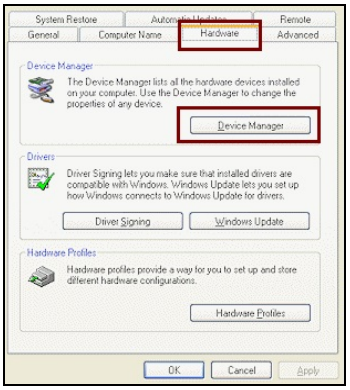


Fig. 9a – Determining the COM port

Fig. 9b - Determining the COM port

SELECTION

If it is necessary to modify the Serial Port (COM) related to the **N120**, select the "USB Serial Port (COM X)" where the **N120** is connected.

Access "Action/Properties" and, on the "Port Settings" tab, click on "Advanced...", as shown in **Fig. 10a** and **Fig. 10b**. If this tab does not appear, it means that the driver was not installed correctly. It is necessary to reinstall the **DigiConfig** software.

In the "Advanced settings for COMX" window, change the parameter "COM port number:" to the desired COM, as shown in **Fig. 11**. Some serial ports may be marked in use. It is necessary to select one of these ports if the user are sure it is not being used by another device on the computer.

In some situations, serial ports may be marked as in use even when the associated device is no longer installed on the computer. In this case, it is safe to associate this port with the **N120**.

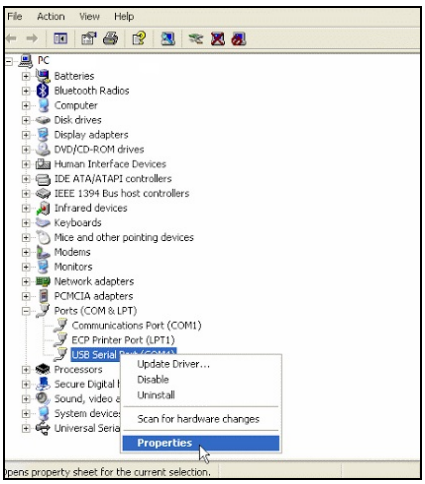


Fig. 10a - Accessing Advanced COM port setting

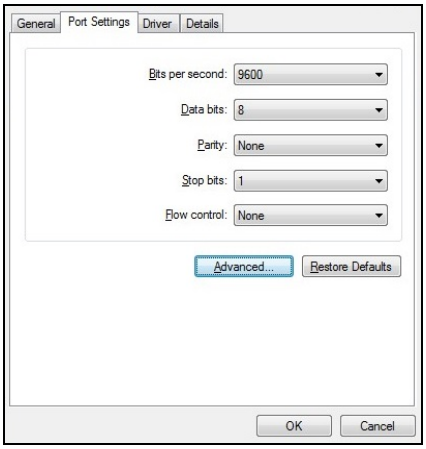


Fig. 10b - Accessing Advanced COM port setting

IMPORTANT RECOMMENDATION

To improve the communication of the USB interface, it is recommended to set the Latency Timer. This parameter can be modified by accessing the "Advanced settings for COMX" window, as shown in **Fig. 10a** and **Fig. 10b**.

Later, it is possible to check, according to **Fig. 11**, the field "Latency Timer (ms)", which should be changed to **4**.

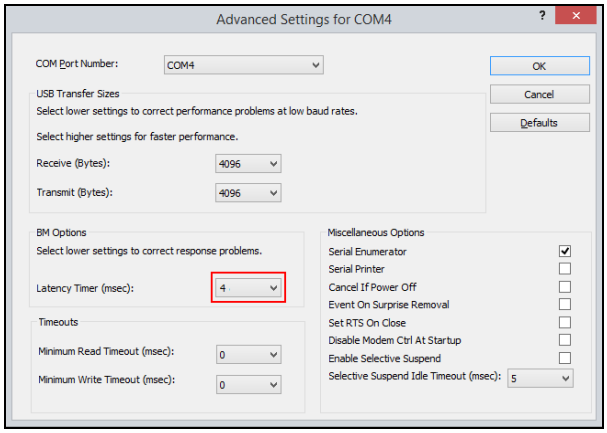


Fig. 11 – Advanced Settings for COM

APPENDIX 2 – SERIAL COMMUNICATION

The controller can be supplied with an asynchronous RS-485 serial communication interface for communication with a host computer (master). The controller always acts as a slave.

The communication is always initiated by the master, who transmits a command to the address of the slave with whom he wishes to communicate. The addressed slave assumes the command and sends the response to the master. The controller also accepts broadcast-type commands.

FEATURES

- Signals compatible with RS-485 standard. MODBUS (RTU) Protocol. 2-wire connection between 1 master and up to 31 (addressing up to 247 possible) instruments in bus topology. The communication signals are electrically insulated from the rest of the device.
- Maximum connection distance: 1000 meters.
- Disconnection time for the controller: Maximum 2 ms after last byte.
- Selectable speed; 8 data bits; 1 stop bit; selectable parity (no parity, pair or odd);
- Time at the beginning of response transmission: Maximum 100 ms after receiving the command.

The RS-485 signals are:

D1	**D**	**D +**	**B**	Bi-directional data line.	Terminal 16
D0	$\overline{D}$:	**D -**	**A**	Bi-directional inverted data line.	Terminal 17
C				Optional connection that improves the performance of the communication.	Terminal 18
GND					

PARAMETERS CONFIGURATION FOR SERIAL COMMUNICATION

Two parameters must be configured for using the serial type:

bAud: Communication speed;

PrtY: Communication parity;

Addr: Communication address for the controller.

COMMUNICATION PROTOCOL

The MOSBUS RTU slave is implemented. All configurable parameters can be accessed for reading or writing through the communication port. Broadcast commands are supported as well (address 0).

The available Modbus commands are:

03 - *Read Holding Register*	06 - *Preset Single Register*
05 - *Force Single Coil*	16 - *Preset Multiple Register*

HOLDING REGISTERS TABLE

Follows a description of the usual communication registers. For full documentation download the Registers Table for Serial Communication in the **N120** section of our web site.

ADDRESS	PARAMETER	REGISTER DESCRIPTION
0000	Active SP	Read: Active control SP (main SP, from ramp and soak or from remote SP). Write: To main SP. Range: From **SPLL** to **SPHL**.
0001	PV	Read: Process Variable. Write: Not allowed. Range: Minimum value is the one configured in **SPLL** and the maximum value is the one configured in **SPHL**. Decimal point position depends on **dPPo** value. In case of temperature reading, the value read is always multiplied by 10, independently of **dPPo** value.
0002	MV	Read: Output power in automatic or manual mode. Write: Not allowed. See address 28. Range: 0 to 1000 (0.0 to 100.0 %).