K31D

ELECTRONIC TEMPERATURE CONTROLLER WITH DIFFERENTIAL CONTROL MODE

OPERATING INSTRUCTIONS

19/04 - Code: ISTR_M_K31D_E_05_--

Ascon Tecnologic S.r.l.
Viale Indipendenza 56, 27029 Vigevano (PV) - ITALY
Tel.: +39 0381 69871 - Fax: +39 0381 698730
Sito: http:\\www.ascontecnologic.com
e-mail: info@ascontecnologic.com

PREFACE

⚠ This manual contains the information necessary for the product to be installed correctly and also instructions for its maintenance and use; we therefore recommend that the most attention is paid to the following instructions and to save it.

Ascon Tecnologic S.r.l. reserves the right to make any formal or functional changes at any moment and without any notice.

Ascon Tecnologic S.r.l. and its legal representatives do not assume any responsibility for any damage to people, things or animals deriving from violation, wrong or improper use or in any case not in compliance with the instrument's features.

⚠ Whenever a failure or a malfunction of the device may cause dangerous situations for persons, thing or animals, please remember that the plant has to be equipped with additional devices which will guarantee safety.

Index

1. INSTRUMENT DESCRIPTION

1.1 General description

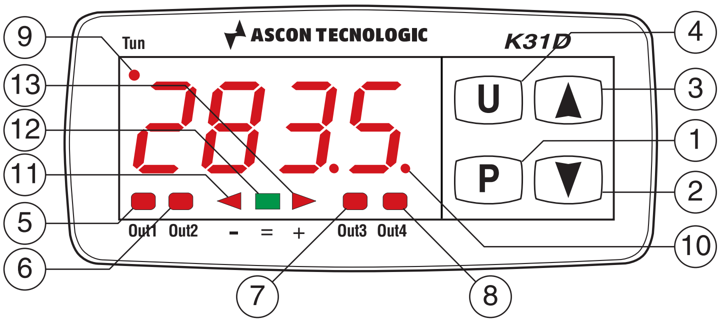
The **K31D** model is a digital temperature controller with a **single loop** microprocessor, with **ON/OFF control**, **Neutral Zone ON/OFF**, **single or double action PID** (direct and inverse) fitted with 2 **PTC**, **NTC** or **Pt1000** temperature input probes by means of which it is possible to obtain **differential temperature control**. It can therefore be used in applications that require a control for the **temperature difference** between 2 **different environments** such as liquid coolers (chillers), natural air-conditioning systems through the air recirculation, heating by solar panels or in many other applications where 2 temperature readings are needed. The controller is also equipped with **Fast** and **Oscillatory Auto-tuning**, **Self-tuning** and **Fuzzy overshoot control** for **adjusting the PID**. The instrument offers the possibility of having **2 programmable digital inputs** and **an RS485 serial communications port** using MODBUS-RTU communications protocol with a **transmission speed** up to **38.4 kbaud**.

The **process value** is displayed on a **4 digit red display**, while the outputs status is shown by **4 LEDs**.

The controller is equipped with a programmable **3 LEDs shift display** (◀ ■ ▶), stores **2 Set Points** and **can have up to 4 outputs** [relay or solid state relays drive type (SSR)]. A model is also available with **Out1 analogue control output** (0/4 ÷ 20 mA or 0/2 ÷ 10 V type).

Other important available functions are: **Loop-Break Alarm** function, **reaching of the Set Point at controlled speed**, **ramp** and **dwell function**, **Soft-Start** function, **protection compressor** function for **neutral zone** control, **parameters protection** on different levels.

1.2 Front Panel Description



1 P: This key is used to access the programming parameters and to confirm selection;

2 ▼: This key is used to decrease the values to be set and to select the parameters. If the key is held down, the user returns to the previous programming level until it exits the programming mode;

3 ▲: This key is used to increase the values to be set and to select the parameters. If the key is held down, the user returns to the previous programming level until it exits the programming mode. Outside the programming mode it permits the visualisation of the output control power;

4 U: This key is used to display the temperatures read by the probes (**Pr1** and **Pr2**) and their difference (**Pr1 - Pr2**). It can also be programmed through the USrb parameter for: Activating Auto-tuning or Self-tuning, setting the instrument to manual regulation, setting the alarm, changing the active Set Point and deactivating the control;

5 LED **OUT1**: Indicates the state of output **Out1**;

6 LED **OUT2**: Indicates the state of output **Out2**;

7 LED **OUT3**: Indicates the state of output **Out3**;

8 LED **OUT4**: Indicates the state of output **Out4**;

9 LED **Tun**: Indicates that the Self-tuning function is activated (light ON) or that Auto-tuning is in progress (flashing);

10 LED **SET**: When flashes, indicates the access to the programming mode;

11 LED ◀ Shift index **-**: Indicates that the process value is **lower than** the one programmed for parameter AdE;

12 LED ■ Shift index **=**: Indicates that the process value is **within the range** [SP + AdE ÷ SP - AdE];

13 LED ▶ Shift index **+**: Indicates that the process value is **higher than** the one set for parameter AdE.

2. PROGRAMMING

2.1 Set Point Fast Programming

This procedure allows you to quickly set the active Set Point and, when required, the alarm thresholds (paragraph 2.3).

Press and release the P key, the display the display will alternate between "SP **n**" and the set value (**n** is the number of the Set Point active at that moment).

To increase/decrease the Set Point value press the ▲/▼ keys. These keys change the value one digit a time but when pressed for more than one second, the value increases or decreases rapidly and, if pressed for more than two seconds, the changing speed increases further to allow the rapid achievement of the desired value.

Once the desired value has been reached, pressing key P it is possible to exit the Set Point fast programming mode or switch to the alarm thresholds display (paragraph 2.3).

To exit the Set Point fast programming mode it is necessary to press the P key after the last Set Point has been displayed, alternatively, operating no keys for about 15 seconds the display will return to normal operation.

2.2 Control Status and Parameter Selection

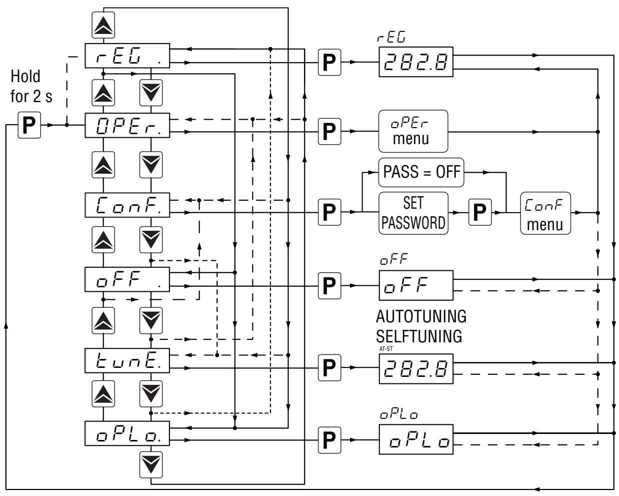
By pushing key P and holding it down for about 2 s it is possible to enter into the main selection menu. Using the ▲/▼ keys, it is then possible to roll over the selections:

oPEr	To enter into the operating parameters menu
ConF	To enter into the configuration parameters menu
oFF	To swap the controller into the OFF state
rEG	To swap the controller into the automatic control state
tunE	To activate the Auto-tuning or Self-tuning function
oPLo	To swap the controller to the manual control state and therefore to program the % control value using the ▲/▼ keys

Once the desired item has been selected, push key P to confirm. Selecting oPEr and ConF gives the possibility of accessing other menus containing additional parameters and more precisely:

oPEr <u>Operating parameters Menu</u>**:** normally contains the Set Point parameters but it can contain all the desired parameters (paragraph 2.3).

ConF <u>Configuration parameters Menu</u>: contains all the operating parameters and the functioning configuration parameters (alarm configuration, control, input, etc.).



To enter the menu oPEr, select the option oPEr and press P.

The display will now show the code identifying the first group of parameters (]SP) and, by pressing the ▲ and ▼ keys, it will be possible to select the group of parameters to be modified.

Once the desired group of parameters has been selected, the code identifying the first parameter of the selected group will be visualised by pushing the P key.

Again using the ▲ and ▼ keys, it is possible to select the desired parameter and, if P is pressed, the display will alternatively show the parameter code and its programming value, which can be modified by using the ▲/▼ keys.

As the desired value has been programmed, press P once again: the new value will be stored and the display will show only the code of the selected parameter.

By using the ▲/▼ keys, it is then possible to select a new parameter (if present) and modify it as described above.

To select another group of parameters, keep the ▲ or ▼ key pressed for about 2 s, afterwards the display shows again the code of the group of parameters.

Release the key and, using the ▲ or ▼ keys, select a new group (if present).

To exit the programming mode, press no keys for about 20 seconds, or keep the ▲ or ▼ pressed until the controller exits the programming mode.

To access the ConF menu, the controller can ask for a personalized Password previously set through the PASS parameter.

If the protection is requested, set the desired password number in the PASS parameter and exit the programming parameters.

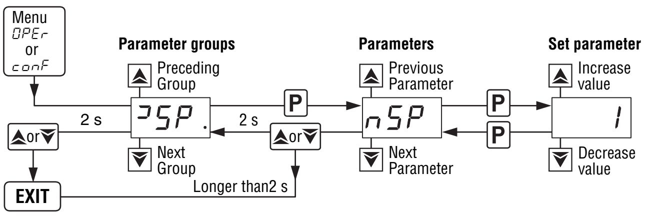
When the protection is active, to access the ConF menu parameters, it is necessary to insert the programmed password number; to do that, use the ▲ and ▼ keys to make the numbers scroll on the display until the previously programmed PASS number is shown on the screen, at this point press the P key.

If a wrong PASS number is entered, the instrument returns to the previous control state.

If the password is correct, the display shows the code of first group of parameters (]SP) and, using the ▲/▼ keys, is possible to select the desired group of parameters.

The modes to program and exit the ConF menu parameters are the same described for those in the oPEr menu.

The protection Password is deactivated by setting: PASS = **OFF**.



Note: If the password is lost, turn OFF the instrument, press P and turn the instrument back ON keeping the key held down for about 5 s. In this way access is made to all parameters of the ConF menu and it will therefore be possible to check and modify the PASS parameter.

2.3 Parameters programming levels

The menu oPEr normally contains the parameters used to program the Set Point; however it is possible to make all desired parameters appear or disappear on this level, by following this procedure:

Enter the menu ConF and select the parameter to be made programmable or not programmable in the menu oPEr.

Once the parameter has been selected, if the LED SET is OFF, this means that the parameter is programmable only in the menu ConF, if instead the SET LED is ON, this means that the parameter is also programmable in the menu oPEr.

To modify the visibility of the parameter, press key U: the LED SET changes its state indicating the parameter accessibility level (**ON** = oPEr + ConF menus; **OFF** = ConF menu only).

The active Set Point and the alarm thresholds will only be visible on the Set Point fast programming level (paragraph 2.1) if the relative parameters are programmed to be visible (i.e. if they are present in the oPEr menu).

The possible changes to these Set Points, with the procedure described in paragraph 2.1, is instead subordinate to what is programmed in parameter Ed it (in the group]PAn).

This parameter can be programmed as:

- SE The active Set Point can be modified while the alarm thresholds cannot be modified;
- AE The active Set Point cannot be modified while the alarm thresholds can be modified;
- SAE Both the active Set Point and the alarm thresholds can be modified;
- SAnE Both the active Set Point and the alarm thresholds cannot be modified.

2.4 Control Satus

The controller can act in 3 different ways:

- rEG Automatic control;
- oFF Control OFF;
- oPLo Manual control.

The instrument is able to pass from one state to the other:

- Through the instrument keyboard to selecting the desired status from the main selection menu;
- By using the key U on the keyboard; suitably programming parameter USrb (USrb = **tunE**; USrb = **oPLo**; USrb = **OFF**) it is possible to pass from rEG state to the state programmed for the parameter and vice versa;
- By using the digital input 1 suitably programming parameter d iF (d iF = **OFF**) it is possible to pass from rEG state to the state **OFF** and vice versa.
- Automatically (the instrument swaps into rEG state at the end of the auto-tuning execution).

When switched ON, the instrument automatically resumes the status it was in when it was switched OFF.

rEG **Automatic control:** Automatic control is the normal functioning status of the controller. During automatic control, pressing key ▲, is possible to show, on the display, the control power. The range of the power value goes from: H 100 (100% of output power for **reverse** heating action); C 100 (100% of output power for **direct** cooling action).

oFF **Control OFF:** The instrument can be swapped into the **OFF** status, i.e. the control and the relative outputs are deactivated. The alarm outputs are instead working normally.

oPLo **Bumpless manual control:** By means of this option it is possible to manually program the power percentage given as output by the controller by deactivating automatic control.

When the instrument is swapped to manual control, the power percentage is the same as the last one supplied and can be modified using the ▲/▼ keys. In the case of **ON/OFF** type setting, **0%** corresponds to the output

OFF, while **any value different from 0** corresponds to an **activated output**.
As in the case of automatic control, the programmable values range from H 100 (**+100%**) to C 100 (**-100%**).
To return to automatic control, select rEG in the selection menu.

2.5 Active Set Point Selection

This instrument allows to program up to 2 different Set Points (SP 1, SP2) and select which must be considered active.

The number of Set Points is determined by the parameter nSP located in the]SP parameters group.

The active Set Point can be selected:

– By parameter SPAt in the group of parameters]SP;
– By key U if parameter USrb = **CHSP**;
– By the digital inputs if parameter diF has been correctly programmed (diF = **CHSP**, diF = **SP1.2**, diF = **HE.Co**);
– Automatically between SP 1 and SP2 if a time dur.t (paragraph 5.9) has been programmed.

Set Points SP 1, SP2 will be visible depending on the maximum number of Set Points selected with parameter nSP and they can be programmed with a value that is between the value programmed in SPLL and the one programmed in SPHL.

Note: In examples that follow the Set Point is indicated as SP, however the instrument will act according to the Set Point selected as active.

3. USAGE WARNING

3.1 Admitted use

The instrument has been projected and manufactured as a measuring and control device to be used according to EN61010-1 for the altitudes operation until 2000 ms.

The use of the instrument for applications not expressly permitted by the above mentioned rule must adopt all the necessary protective measures.

The instrument **MUST NOT** be used in dangerous environments (flammable or explosive) without adequate protection.

The installer must ensure that EMC rules are respected, also after the instrument installation, if necessary using proper filters.

4. INSTALLATION WARNINGS

4.1 Mechanical mounting

The instrument, in case 78 x 35 mm, is designed for flush-in panel mounting. Make a hole 71 x 29 mm and insert the instrument, fixing it with the provided special brackets.

The instrument can be mounted on panels having a maximum thickness of 12 mm.

When the maximum front protection (IP65) is desired, the optional screw type bracket must be used.

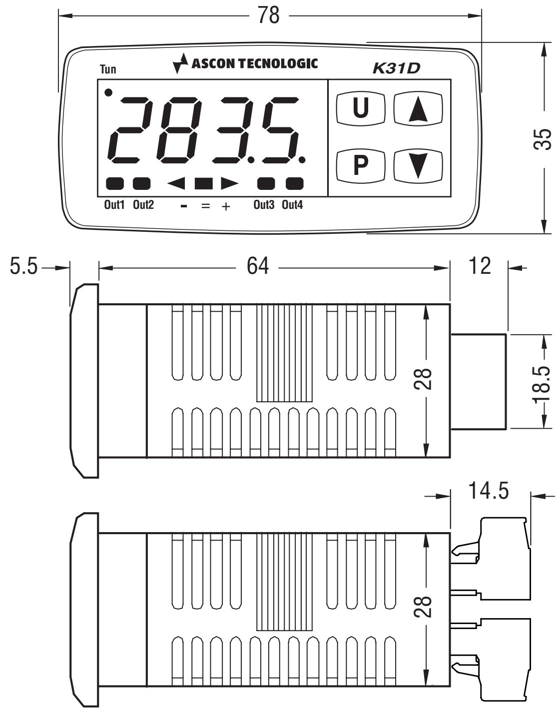
Avoid placing the instrument in environments with very high humidity levels or dirt that may create condensation or cause the introduction of conductive substances into the instrument.

Ensure adequate ventilation to the instrument and avoid installation in containers that house devices which may overheat or which may cause the instrument to function at a temperature higher than the one permitted and declared.

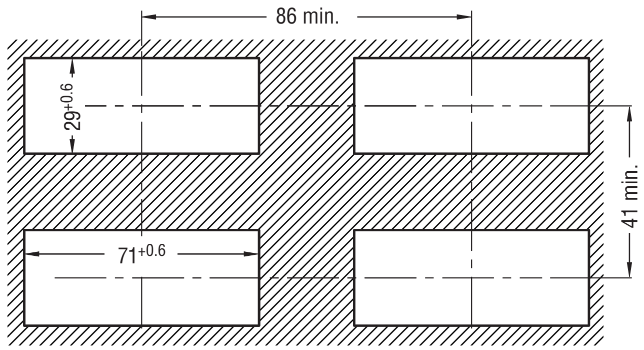
Connect the instrument as far away as possible from sources of electromagnetic disturbances such as motors, power relays, relays, solenoid valves, etc..

4.2 Dimensions (mm)

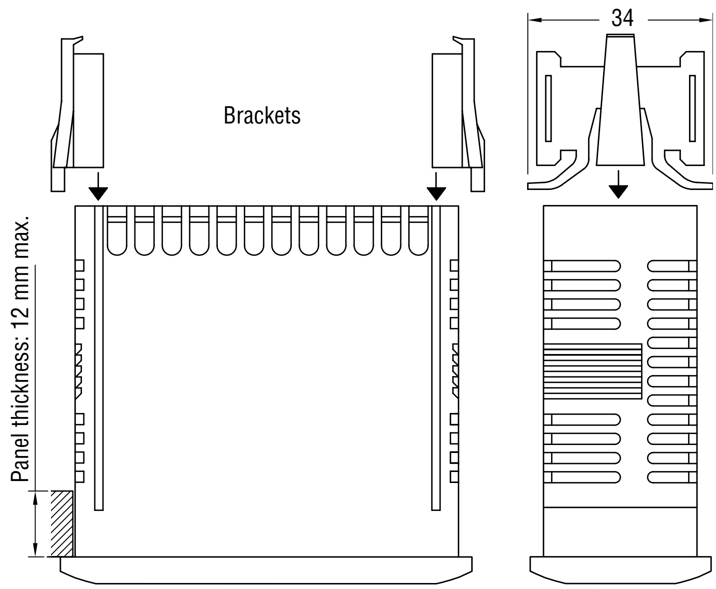
4.2.1 Mechanical dimensions



4.2.2 Panel cut-out



4.2.3 Brackets



4.3 Electrical connections

Carry out the electrical wiring by connecting only one wire to each terminal, according to the following diagram, checking that the power supply is the same as that indicated on the instrument and that the load current absorption is no higher than the maximum electricity current permitted.

As the instrument is a built-in equipment with permanent connection inside housing, it is not equipped with either switches or internal devices to protect against current overloads: the installation must include a two-phase circuit-breaker, placed as near as possible to the instrument, and located in a position that can easily be reached by the user and marked as instrument disconnecting device which interrupts the power supply to the equipment.

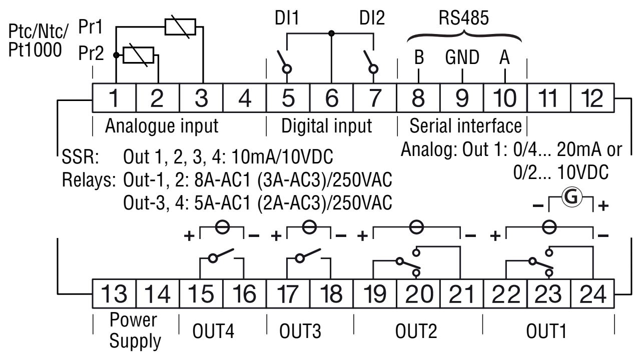
It is also recommended that all the electrical circuits connected to the instrument must be protect properly, using devices (ex. fuses) proportionate to the circulating currents. It is strongly recommended that cables with proper insulation, according to the working voltages and temperatures, be used.

Furthermore, the input cable of the probe must be kept separated from line voltage wiring. If the wiring cables are shielded is recommended to connect the shield to ground at one side only.

For the electrical supply of the instrument it is recommended to use an external transformer TCTR, or with equivalent features, and to use only one transformer for each instrument because there is no insulation between supply and input.

⚠ We recommend that a check should be made that the parameters are those desired and that the application functions correctly **before connecting the outputs to the actuators** so as to avoid malfunctioning that may cause irregularities in the plant that could cause damage to people, things or animals.

4.3.1 Electrical wiring diagram



5. FUNCTIONS

5.1 Measurement and display

All the parameters referring measurements are contained in the group]InP.

Using parameter SEnS, it is possible to select the probe input type, which can be:

– Thermistors PTC KTY81-121 (Ptc) or NTC 103AT-2 (ntc);

– ResistanceThermometer Pt1000 (Pt10).

Notes: 1. We recommend to switch ON and OFF the instrument when these parameters are modified, in order to obtain a correct measuring.

2. When 2 temperature probes are connected to the controller they must be of the same type.

Once the type of probe has been chosen, through the Unit parameter it is possible to choose the temperature measurement unit (°C or °F) and through the dP parameter, the desired temperature resolution (0 = **1**°; 1 = **0.1**°).

If the **Pr2** probe is not used set parameter Pr2 = **NO** to avoid an error being indicated when the probe is not connected.

The instrument allows the measurement calibration, that can be used to recalibrate the instrument according to application needs. This can be done through parameters OFS1, OFS2 and rot.

Setting rot = **1000** and oFS = **1/2** it is possible to set a **positive** or **negative offset** that is simply **added** to the value read by the probe before visualisation, which remains constant for all the measurements.

If instead, it is desired that the **offset** set should **not be constant** for **all measurements**, it is possible to execute a two points calibration.

In this case, in order to decide the values to program on OFSt and rot, the following formulas must be applied:

rot = (D2 - D1)/(M2 - M1) oFS = D2 - (rot x M2)

where:

M1 Measured value 1;

D1 Value to be displayed when the instrument measures M1;

M2 Measured value 2;

D2 Value to be displayed when the instrument measures M2;

Follows that the instrument will visualise:

DV = MV x rot + oFS

Where: **DV** = Displayed value **MV**= Measured value.

<u>*E.g.*</u>: It is desired that the instrument displays the value effectively measured at 20° but that, at 100°, it displays 90° (10° lower than the measured value).

Therefore: M1 = 20; D1 = 20; M2 = 100; D2 = 90

rot = (90 - 20)/(100 - 20) = **0.875**

oFS = 90 - (0.875 x 100) = **2.5**

With parameter FiL it is possible to program time constant of the software filter for the input value measured, in order to reduce noise sensitivity (increasing the reading time).

In case of measurement error, the instrument supplies the power as programmed on parameter OPE. This power is calculated according to cycle time programmed for the PID control, while for the ON/OFF control the cycle time is automatically considered to be 20 s (e.g. In the event of probe error with ON/OFF control and oPE = **50**, the control output will be activated for 10 s, then deactivated for 10 s and so on until the measurement error remains.).

With InE parameter it is possible to decide the input error conditions that force the instrument in supplying the output power programmed with oPE parameter.

The possible values for InE parameter are:

or The condition occurs in case of overrange or probe break.

Ur The condition occurs in case of underrange or probe break.

Our The condition occurs in case of overrange, underrange or probe break.

Through the diSP parameter of the]PAn group it is possible to decide which value the display must normally show; this could be the **Pr1** probe reading (Pr 1), the **Pr2** probe reading (Pr 2), the temperatures **Pr1 - Pr2** difference (P1-2), the power control (Pou), the **active Set Point** (SP.F), the **operative Set Point when there are ramps activated** (SP.o) or the alarm limit **AL 1**, **AL 2**, **AL 3** (AL1, AL2, AL3).

Regardless of diSP parameter setting is possible to show the variables **Pr1**, **Pr2** and **Pr1 - Pr2** in sequentially, pressing and releasing the U key, the display alternately shows the code that identifies the variable (Pr 1, Pr 2, P1-2), then and its value.

After 15 seconds following the last time the U key is pressed, this type of display ends automatically.

Again in the]PAn group is present the parameter AdE that defines the 3 LEDs shift index (◀ ■ ▶) functioning.

The lighting up of the green LED ■ (=) indicates that the process value is within the range [SP + AdE ÷ SP - AdE], the lighting up of the LED ◀ (-) indicates that the process value is lower than [SP - AdE] and the lighting up of the LED ▶ (+) indicates that the process value is higher than [SP + AdE].

5.2 Output Configuration

The instrument outputs can be programmed by entering the group of parameters]Out, where the relative parameters o1F, o2F, o3F and o4F (depending on the number of outputs available on the instrument) are located.

The outputs can be set for the following functions:

- 1.rEG Main control output;
- 2.rEG Secondary control output;
- ALno Alarm output normally open (NO);
- ALnc Alarm output normally closed (NC);
- ALni Alarm output NC with LED reverse indication;
- oFF Output deactivated.

The coupling between output-number – alarm-number can be made in each alarm group referred to each alarm (]AL1,]AL2 or]AL3).

If the instrument has an analogue control output, the type of output can be selected using the Aot parameter in the group] InP with the following possibilities:

- 0-20 0 ÷ 20 mA;
- 4-20 4 ÷ 20 mA;
- 0-10 0 ÷ 10 V;
- 2-10 2 ÷ 10 V.

5.3 Absolute or Differential Temperature Controller

Through the PrrG parameter it is possible to set the process variable used by the controller to operate.

In fact the controller can operate considering the process variable as the value measured at **Input 1** (Pr1), the value measured at **Input 2** (Pr2), the difference between the two inputs **Pr1-Pr2** (P1-2) or can consider the difference between the two inputs **Pr1-Pr2** but with a maximum limit and a minimum limit for the Pr2 measurement (P1-L).

The choices PrrG = **P1-2** or = **P1-L** make the controller operate as a differential controller.

In these cases the controller acts on the control outputs so it keeps the difference **Pr1-Pr2** equal to the Set Point value.

The difference between the two modes lies in the fact that the **P1-L** mode activates a limit in the controller in terms of the calculation of the temperature difference according to the P2HL and P2LL parameters (both in the]SP group) so that:

If **Pr2** ≥ **P2HL** the process value considered by the controller is [**Pr1-P2HL**]

If **Pr2** ≤ **P2HL** the process value considered by the controller is [**Pr1-P2LL**]

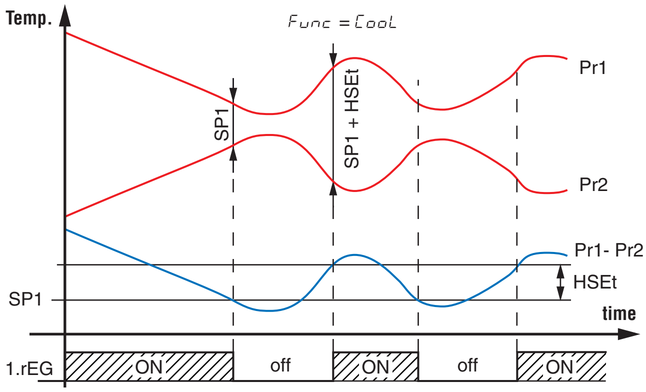
When P2HL and P2LL thresholds are exceeded by **Pr2** temperature, a control takes place as if the **Pr2** temperature is the value of the limit regardless of the value actually read.

The aim of this function is to limit the differential regulation to within a maximum range of the **Pr2** measurement.

With the differential control the working mode Func = **CooL** is used for applications with which the action of the actuator reduces the **Pr1-Pr2** difference (thus countering the **Pr1-Pr2** difference that naturally tends to increase).

Viceversa the Func = **HEAt** mode is used for applications with which the action of the actuator increases the **Pr1-Pr2** difference thus countering the **Pr1-Pr2** difference that naturally tends to decrease).

Obviously the **Neutral Zone** mode or the **Double action** mode will set **OFF** both actions.



Example of differential **ON/OFF** control (On.FA) with Func = **CooL**.

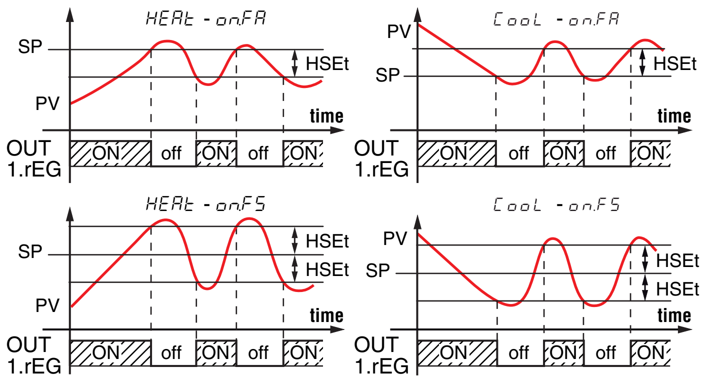
⚠ The controller is already programmed in production to carry out differential regulation and display the temperature difference Pr1 - Pr2.

5.4 ON/OFF Control (1.rEG)

All the parameters referring to the **ON/OFF** control are contained in the group]rEG.

This type of control can be obtained by programming parameter Cont = **On.FS** or = **On.FA** and works on the output programmed as 1.rEG, depending on the process value set with PrrG, on the active Set Point SP, on the functioning mode Func and on the hysteresis HSEt.

The instrument carries out an **ON/OFF** control with symmetric hysteresis if Cont = **On.FS** or with asymmetrical hysteresis if Cont = **On.Fa**.



The control works in the following way: in the case of reverse action, or heating (FunC = **HEAt**), it deactivates the output, when the process value reaches [SP + HSEt] in case of symmetrical hysteresis, or [SP] in case of asymmetrical hysteresis and is then activated again when the process value goes below value [SP - HSEt].

Viceversa, in case of direct action, or cooling (Func = **CooL**), it deactivates the output, when the process value reaches [SP - HSEt] in case of symmetrical hysteresis, or [SP] in case of asymmetrical hysteresis and is activated again when the process value goes above value [SP + HSEt].

5.5 Neutral Zone ON/OFF Control (1.rEG - 2.rEG)

All the parameters referring to **Neutral Zone ON/OFF** control are contained in the group]rEG.

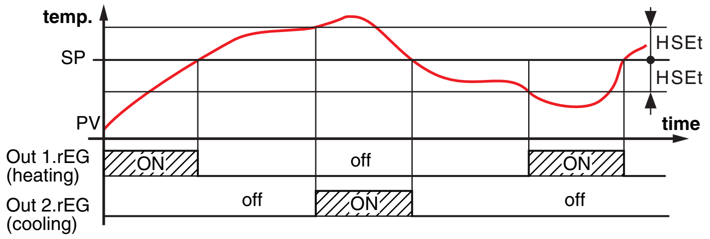
This type of control can be obtained when **2 outputs** are programmed respectively as 1.rEG and 2.rEG and the parameter Cont = **nr**.

The **Neutral Zone control** is used to control plants in which there is **an element** which **causes a positive increase** (e.g. Heater, humidifier, etc.) and **an element** which **causes a negative increase** (e.g. Cooler, de-humidifier, etc.).

The control functions work on the programmed outputs depending on the Process Value (PV), the active Set Point SP and the HSEt hysteresis.

The control works in the following way: **deactivates the outputs** when the **PV reaches** the **Set Point** and it **activates** the **output** 1.rEG when the **PV** goes **below** the [SP - HSEt] value, or **activates** the **output** 2.rEG when the **PV** goes above the [SP + HSEt] value.

Consequently, the element causing a **positive increase** must be **connected to the output programmed as** 1.rEG while the element causing a **negative increase** must be **connected to the output programmed as** 2.rEG.



If 2.rEG output is used to **control a compressor**, it is possible to use the "*Compressor Protection*" function that is used to avoid compressor "*short cycles*". This function **allows a time control** on 2.rEG **output activation**, regardless of the temperature control requests. The protection is a "*delayed after deactivation*" type.

This protection **avoids the output activation** for a **time programmable** at parameter CPdt (in seconds); the output activation occurs only after the CPdt time has elapsed.

The CPdt protection time count starts from the last 2.rEG output deactivation.

Obviously, whether during the time delay caused by the compressor protection function, the control request should stop, the output activation foreseen after time CPdt would be erased.

The function is deactivated by programming CPdt = **OFF**.

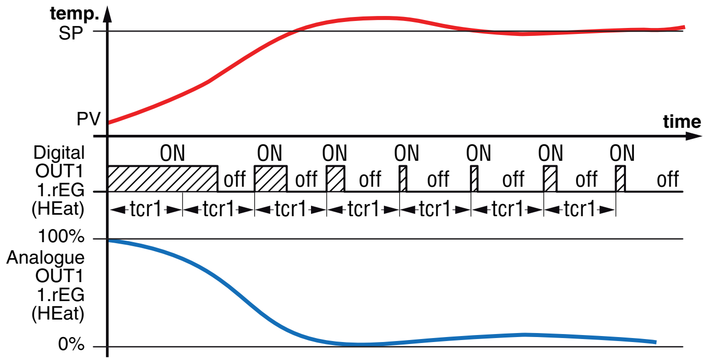
The LED relative to 2.rEG output 2 blinks during the output activation delay, caused by the "*Compressor Protection*" function.

5.6 Single Action PID Control (1.rEG)

All the parameters referring to **PID control** are in]rEG group.

The **Single Action PID** control can be obtained by programming parameter Cont = **Pid** and works on 1.rEG output depending on: the active Set Point SP, the functioning mode Func and on the instrument **PID algorithm** with **2 freedom degrees**.

If the Out1 analogue output is present (0/4 ÷ 20 mA; 0/2 ÷ 10 V) the output will operate as a regulation output providing a value proportional to the regulation power calculated by the instrument.



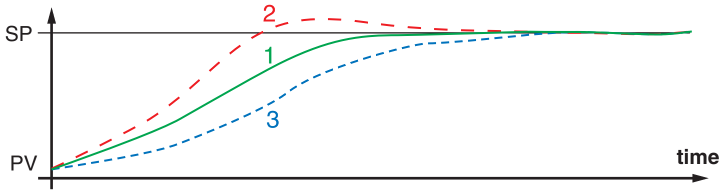
In presence of fast processes, in order to obtain a good **PV** stability, the tcr1 cycle time must have a low value with a very frequent intervention of the control output. In this case we recommend to use a Solid State Relay (SSR) for driving the actuator.

The Single Action PID control algorithm foresees the setting of the following parameters:

Pb Proportional Band;
tcr1 Cycle time of **1.rEG** output;
Int Integral Time;
rS Manual Reset (only if Int = **0**);
dEr Derivative Time;
FuoC Fuzzy Overshoot Control.

This last parameter allows the variable overshoots at the start up of the process or at the changing of the Set Point to be avoided.

Please remember that a low value on this parameter reduces the overshoot while a high value increase it.



1 FuoC Value OK;
2 FuoC Value too high;
3 FuoC Value too low.

5.7 Double Action PID Control (1.rEG - 2.rEG)

All the parameters referring to **PID control** are in]rEG group.

Double Action PID control is used to control plants where there is an element which causes a positive temperature increases (ex. Heating) and an element which causes a negative temperature increases (ex. Cooling) and can be obtained when **2 outputs** are programmed respectively as 1.rEG and 2.rEG and setting Cont = **Pid**.

The element causing the **positive increase** must be connected to the output programmed as 1.rEG while the element causing the **negative increase** must be connected to the output programmed as 2.rEG.

The **Double Action PID control** works on the outputs 1.rEG and 2.rEG depending on the active Set Point SP and on the instrument's **PID algorithm** with **2 freedom degrees**.

In presence of fast processes, in order to obtain a good Process Variable stability, cycle times tcr1 and tcr2 must have a low value with a very frequent intervention of the control outputs.

In this case we recommend to use Solid State Relays (SSR) for driving the actuators.

The **Double Action PID** control algorithm needs the programming of the following parameters:

Pb Proportional Band;
tcr1 Cycle time of the output 1.rEG;
tcr2 Cycle time of the output 2.rEG;
Int Integral Time;
rS Manual Reset (only if Int = **0**);
dEr Derivative Time;
FuoC Fuzzy Overshoot Control.
PrAt Power Ratio or relation between power of the element controlled by output 2.rEG and power of the element controlled by output 1.rEG.
When PrAt = **0** the output 2.rEG is disabled and the control behaves exactly as a **single action PID controller**, through output 1.rEG.

5.8 Auto-tuning and Self-tuning Functions

All the parameters referring to the **Auto-tuning** and **Self-tuning** functions are contained in the group]rEG.

The Auto-tuning and Self-tuning functions allow the **automatic tuning** of the **PID variables**.

Auto-tuning function provides the **calculation** of the **PID parameters** through a **Fast** or **Oscillatory** type tuning cycle, and, at the end of this operation, the parameters **are stored** in the instrument memory and **remain constant during control**.

Self-tuning function (rule based "**TUNE-IN**") instead executes a **control monitoring** and the **continuous calculation of the parameters** during control.

Both functions automatically calculate the following parameters:

Pb Proportional Band;
tcr1 Cycle time of the output 1.rEG;
Int Integral Time;
dEr Derivative Time;
FuoC Fuzzy Overshoot Control;

and, for the **Double Action PID control**, also:

tcr2 Cycle time of the output 2.rEG;
PrAt Ratio between P 2.rEG/P 1.rEG.

5.8.1 How to activate Auto-tuning function

1 Program and activate the desired Set Point;
2 Set parameter Cont = **Pid**;
3 If Single Action control, set parameter Func according to the process to be controlled through output 1.rEG;
4 Program an output as 2.rEG if the instrument controls the plant with double action;
5 Program parameter Auto as:

1 If **FAST** Auto-tuning is desired to **start automatically** all times the **instrument is switched ON**, on the condition that the process value is lower than [SP - |SP/2|] (when Func = **HEAt**) or higher than [SP + |SP/2|] (when Func =**CooL**);

2 If **FAST** Auto-tuning is desired to **start automatically** the **next time** the instrument is switched ON, on the condition that the process value is lower than [SP - |SP/2|] (with Func = **HEAt**) or higher than [SP + |SP/2|] (with Func =**CooL**) and once the tuning is finished, the parameter Auto is automatically switched to the OFF state;

3 If **FAST** Auto-tuning is to be **manually started** selecting the parameter tunE in the main menu or by correctly programming the U key as uSrb = **tune**.
The Auto-tuning starts at the condition that the **PV** is lower than [SP - |SP/5|] (with Func = **HEAt**) or higher than [SP + |SP/5|] (with Func =**CooL**);

4 If **FAST** Auto-tuning is desired to **start automatically** all times the **Set Point is changed** or at the **end** of the programmed **Softstart cycle**.
The Auto-tuning starts anyway if **PV** is lower than [SP - |SP/5|] (with Func = **HEAt**) or higher than [SP + |SP/5|] (with Func =**CooL**);

-1 If **OSCILLATORY** Auto-tuning is desired to **start automatically** all times the **instrument is switched ON**;

-2 If **OSCILLATORY** Auto-tuning is desired to **start automatically** the **next time** the instrument is switched ON and once the tuning is finished, the parameter Auto is automatically switched to the **OFF** state;

-3 If **OSCILLATORY** Auto-tuning is to be **manually started** using the U key;

-4 If **OSCILLATORY** Auto-tuning is desired to **start automatically** all times the **Set Point is changed** or at the **end** of the programmed **Softstart cycle**.

Note: The **Fast**-type Auto-tuning is particularly quick and shows **no signs of having any effect** on the control as it calculates the parameters **while reaching the Set Point**. For the correct execution of the Fast-type Auto-tuning it is however necessary that at start-up there is a **certain difference** between **Process Variable** and **Set Point**. For this reason the instrument only activates the Fast Auto-tuning when:

– For Auto = **1**/**2**: the Process Value is lower than [SP - |SP/2|] (with Func = **HEAt**) or higher than [SP + |SP/2|] (with Func = **CooL**);
– For Auto = **3**/**4**: the Process Value is lower than [SP - |SP/5|] (with Func = **HEAt**) or higher than [SP + |SP/5|] (with Func = **CooL**).
FAST Auto-tuning is not indicated when the **Set Point** is **close** to the **initial reading** or **when** the **variable** measured **varies in an irregular way** during the tuning cycle (for reasons due to the process, the variable rises or decreases).
In these cases it is advisable to use the **Oscillatory** type Auto-tuning which **implements** some **ON/OFF regulation cycles** that make the **process value oscillate** around the Set Point values that once finished pass to the PID type control with the parameters calculated by the Auto-tuning;

6 Exit from the parameter programming;
7 Connect the instrument to the controlled plant;
8 Activate the Autotune process by powering OFF and ON the instrument if Auto = **1**/**2**, or selecting the entry tunE in the main menu (or using the U key, when correctly programmed) if Auto = **3**, or changing the Set Point value if Auto = **4**.

At this point the Auto-tuning function is activated and is indicated by the flashing LED **Tun**.

The controller carries out several operations on the connected plant in order to calculate the most suitable PID parameters. If, at Auto-tuning start, the condition for the lower or higher process value is not found the display will show ErAt and the instrument will be swapped to normal control conditions according to the previously programmed parameters. To make the error ErAt disappear, press key P.

The Auto-tuning cycle duration has been limited to 12 hours maximum. If Auto-tuning is not completed within 12 hours, the instrument shows noAt on the display.

In case of probe error, the instrument automatically stops the cycle in progress.

The values calculated by Auto-tuning are automatically stored in the instrument memory at the end of the correct PID parameters tuning.

5.8.2 How to activate Self-tuning function

1 Program and activate the desired Set Point;
2 Set parameter Cont = **Pid**;
3 If Single Action control, set parameter Func according to the process to be controlled through output 1.rEG;
4 Program an output as 2.rEG if the instrument controls the plant with **double action** or a **time positioning servodrive**;
5 Set parameter SELF = **yES**;
6 Exit from the parameter programming;
7 Connect the instrument to the controlled plant;
8 Activate Self-tuning selecting the entry tunE in the main menu (or using the U key, when correctly programmed) .

When the Self-tuning function is active, the LED tun is permanently lit up and all the PID parameters (Pb, Int, dEr, etc.) **are no longer displayed**.

To stop the Auto-tuning cycle or deactivate the Self-tuning function select a different control type: rEG, oPLo or oFF from the menu SEL. If the instrument is switched OFF during Auto-tuning or with the Self-tuning function activated, these functions will remain activated the next time it is switched ON.

5.9 Dynamic Set Point change and automatic switching between two Set Points (ramps an dwell time)

All parameters referring to the ramps functioning are contained in the group]rEG.

It is possible to reach the Set Point in a predetermined time (in any case longer than the time the plant would naturally need). This could be useful in those processes (heating or chemical treatments, etc.) where the Set Point must be reached gradually or in a predetermined time.

Once the instrument has **reached** the **first Set Point** (SP1) it is possible to **switch** automatically to the **second Set Point** (SP2) **after a set time**, thus obtaining a simple automatic process cycle. These functions are available for all the programmable controls (PID single and double action, ON/OFF and Neutral Zone ON/OFF).

The function is determined by the following parameters:

SLor Gradient of first ramp expressed in unit/minute;
SLoF Gradient of second ramp expressed in unit/minute;
dur.t Dwell time of SP1 Set Point before automatic switching to SP2 Set Point (expressed in hours and minutes).

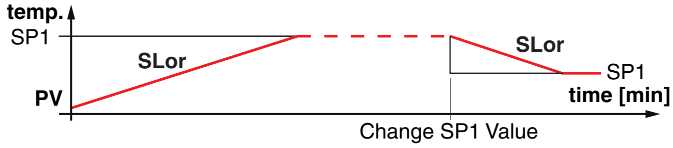
The functions are deactivated when the relative parameters are set to **InF**.

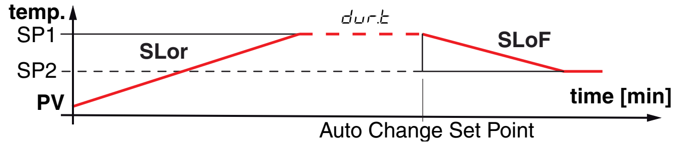
If is desired only one ramp (e.g. to reach SP1) it is enough to program the parameter SLor with the desired value.

The ramp SLor will always be **active** at **Power ON** and when the **Active Set Point value is changed**.

On the contrary, if an **automatic cycle** is to be executed at **Power ON**, program nSP = **2**, then the two Set Point values SP1 and SP2 and naturally parameters SLor, dur.t and SLoF with the desired values.

In this case at the end of the cycle all the ramps would not be more active.





Examples with starts from values lower than SP1 and with decreasing of the Set Point.

Note: In case of PID control, if Auto-tuning is desired whilst the ramp function is active, the ramp will not be carried out until the tuning cycle has been completed. It is therefore recommended that Auto-tuning be started avoiding activating the ramp function and, once the tuning is finished, deactivate Auto-tuning (Auto = **oFF**), program the desired ramp and, if it automatic tuning is desired, enable the Self-tuning function.

5.10 Soft-start function

All parameters referring to the Soft -Start functioning are contained in the group]rEG.

The **Soft-Start function** only works through **PID control** and allows the **limitation of control power** when the instrument is **switched ON**, for a programmable **period of time**.

This is useful when the actuator, driven by the instrument, may be damaged by the excess of power supplied when the application is not yet in the normal rating (e.g. for certain heating elements).

The function depends on the following parameters:

St.P Soft-Start power;
SSt Soft-Start time (expressed in hh.mm);
HSEt End Soft Start cycle threshold.

If both parameters are programmed with values other than **OFF**, when Powered ON the instrument gives the output power set at parameter St.P for the time set at SSt or when is reached the absolute value set at HSEt.

Practically, the instrument works in manual condition and switches to automatic control at the elapsing of time SSt or when is reached the absolute value programmed at parameter HSEt.

To disable the Soft-Start function simply program: SSt = **oFF**.

Whenever a measurement error occurs during the Soft-Start execution, the function is interrupted and the instrument gives the output power programmed at parameter oPE. If the measurement is restored, the Soft-Start remains deactivated.

To activate the Auto-tuning together with Soft-Start set: Auto = **4/-4**.

Auto-tuning starts automatically at the end of the programmed Soft-Start cycle.

5.11 Alarms Output Functions (AL1, AL2, AL3)

For the alarms operation settings, the operation of which is related to the Process Value (**AL1**, **AL2**, **AL3**) it is first of all mandatory to determine to which output the alarm must be addressed.

To obtain this, it is necessary to set, in the parameters group]Out, the parameters related to the output that is to be used by each alarm (O1F, O2F, O3F, O4F):

- AL.no If the alarm output must be **ON** when the **alarm** is **active**, while it is **OFF** when the **alarm** is **not active**;
- AL.nc If the alarm output must be **ON** when the **alarm** is **not active**, while it is **OFF** when the **alarm** is **active** (the LED on the display shows the alarm status);
- AL.ni Same operation as AL.nc, but with a reversed LED indication (LED ON = Alarm OFF).

Note: All the examples that follow are referred to alarm **AL1**. Obviously the functions of the other alarms are similar (change 1 with 2 or 3).

Access at the group]AL1 and program oAL1, to indicate which output the alarm signal must to be sent.

The **AL1** alarm functioning is instead defined by parameters:

- Pr.A1 Which Process Value must be used by AL1;
- AL1t Alarm type;
- Ab1 Alarm configuration;
- AL1 Alarm threshold;
- AL1L Low alarm threshold (for band alarm) or minimum Set Point of **AL1** alarm threshold (for low or high alarm);
- AL1H High alarm threshold (for band alarm) or maximum Set Point of **AL1** alarm threshold (for low or high alarm);
- HAL1 Alarm **AL1** Hysteresis;
- AL1d Alarm activation delay (in seconds);
- AL1i Alarm behaviour in case of measurement error.

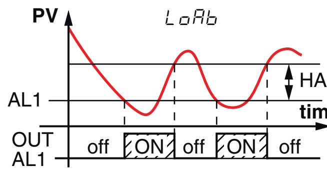
Pr.A1 - *Alarm process measurement*

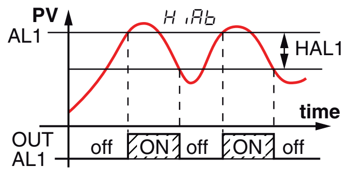
Through this parameter it is possible to set the Process Variable used by the alarm for operating. In fact the alarm can operate considering the process variable as the value measured by Input 1 (**Pr1**), the value measured by Input 2 (**Pr2**), the difference between the two inputs Pr1-Pr2 (**P1-2**) or can consider the difference between the two inputs Pr1-Pr2 but with a maximum limit and a minimum limit for the Pr2 measurement Pr2 (**P1-L**).

AL1t - *Alarm Type*

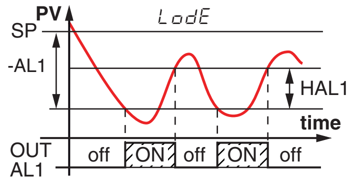
The alarm output can behave in six different ways:

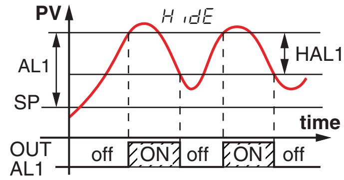
- LoAb **Absolute low alarm**: The alarm is **activated** when the **PV** goes **below** the alarm **threshold** set at parameter AL1 and **deactivated** when the PV goes **above** the value [AL1 + HAL1]. With this mode is possible to program, with AL1L and AL1H parameters, the minimum and the maximum limits of AL1 thresholds.
- HiAb **Absolute high alarm**:
  The **alarm** is **activated** when the PV goes above the alarm threshold set at parameter AL1 and is **deactivated** when thePV goes **below** the value [AL1 - HAL1]. In this way is possible to program, with AL1L and AL1H parameters, the minimum and the maximum limits of AL1 thresholds.



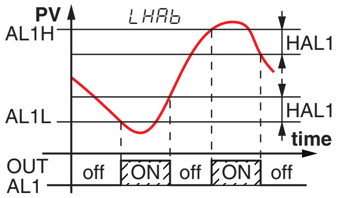


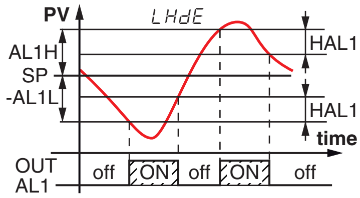
- LodE **Deviation low alarm**: The alarm is **activated** when the process value goes **below the value** [SP + AL1] and is **deactivated** when it goes **above the value** [SP + AL1 + HAL1]. In this way is possible to program, with AL1L and AL1H parameters, the minimum and the maximum limits of AL1 thresholds.
- HidE **Deviation high alarm**: The alarm is **activated** when the process value goes **above the value** [SP + AL1] and is **deactivated** when it goes **below the value** [SP + AL1 + HAL1]. In this way is possible to program, with AL1L and AL1H parameters, the minimum and the maximum limits of AL1 thresholds.





- LHAb **Absolute band alarm**: The alarm is **activated** when the PV goes **under the alarm threshold** set at parameter AL1L or goes **above the alarm threshold** set with parameter AL1H and is **deactivated** when the PV returns **inside the range** [AL1H - HAL1 ÷ AL1L + HAL1].
- LHdE **Deviation band alarm**: The alarm is **activated** when the PV goes **below the value** [SP + AL1L] or **above the value** [SP + AL1H] and is **deactivated** when the PV goes **outside the range** [SP + AL1H - HAL1 ÷ SP + AL1L + HAL1].





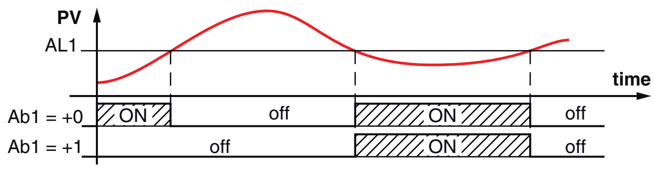
Ab1 - *Alarm configuration*

This parameter can assume a value between **0** and **63**.
The number to be set, which will correspond to the function desired, is obtained by adding the values reported in the following descriptions:

Alarm behaviour at power ON

the alarm output may behave in 2 different ways, depending on the value added to parameter Ab1.

- **+0** Normal behaviour: The alarm is always activated when there are alarm conditions.
- **+1** Alarm not activated at Power ON: If, at power ON, the instrument is in alarm condition, the alarm is not activated. The alarm will be activated only when the Process Palue, after Power ON, has not been brought into the non-alarm conditions and subsequently in the alarm conditions.



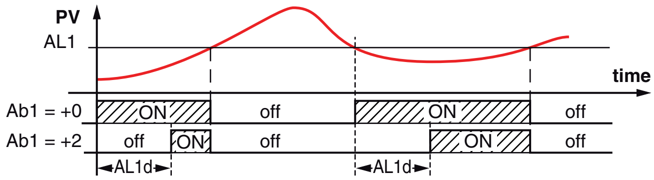
Example with absolute low alarm.

Alarm delay

The alarm output may behave in 2 different ways depending on the value added to parameter Ab1.

+0 Alarm not delayed: The alarm is immediately activated when the alarm condition occurs.

+2 Alarm delayed: When the alarm condition occurs, delay counting begins, as programmed at parameter AL1d (expressed in seconds) and the alarm will be activated only after that time has elapsed.



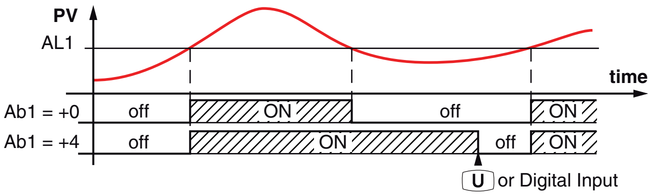
Example with absolute low alarm.

Latched alarm

The alarm output may behave in 2 different ways depending on the value added to parameter Ab1.

+0 Alarm not latched: The alarm remains active **in alarm conditions only**.

+4 Latched alarm: The alarm is active in alarm conditions and **remains active** even when these conditions no longer exist, **until** the correctly **programmed key** [U], (USrb = **Aac**) **is pressed** or is **closed the Digital Input** (diF = **Aac**).



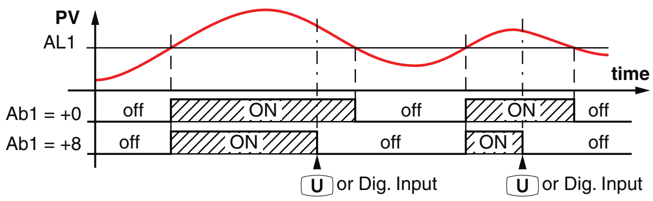
Example with absolute high alarm.

Alarm acknowledgement

The alarm output may behave in 2 different ways depending on the value added to parameter Ab1.

+0 Alarm not acknowledged: The alarm remains active in alarm conditions only.

+8 Alarm acknowledged: The alarm is active in alarm conditions and can be deactivated pressing the [U] key (if properly programmed: USrb = **ASi**) or is closed the Digital Input (diF = **Aac**) also if the alarm conditions are still present.



Example with absolute high alarm.

Alarm behaviour at Set Point change (deviation alarms only)

the alarm output may behave in 2 different ways, depending on the value added to parameter Ab1.

+0 Normal behaviour: The alarm is always activated when there are alarm conditions.

+16 Alarm not activated at Set Point change: In case of a Set Point change, if the instrument is in alarm condition, the alarm is not activated. The alarm will be activated only when the process value, after Set Point change, has not been brought into the non-alarm conditions and subsequently in the alarm conditions.

Control output shutdown with alarm active

There are 2 different alarm output behaviors, depending on the value added to Ab1.

+0 Normal behavior: The alarm does not affect the control output.

+32 Control output shutdown when the alarm is triggered: When the instrument detects the activation of the alarm status, disables the control output. The output is reactivated on the basis of the previously selected alarm options (acknowledgment of alarms, etc.).

AL1i - *Alarm activation in case of measurement error*

This parameter allows to establish how the alarm must behave in the event of a measurement error:

YES Alarm active;

no Alarm deactivated.

5.12 Loop Break Alarm Function

All the parameters referring to the Loop Break alarm function are contained in the group]LbA.

The Loop Break alarm is available on all the instruments, which intervenes when, for any reason (short-circuit of a thermocouple, thermocouple inversion, load interruption), the loop control is interrupted.

First of all, it is necessary to establish to which output the alarm must be addressed.

To do this it is necessary to set, in the group]out, the parameter relative to the output to be used (o1F, o2F, o3F, o4F) programming the parameters as:

ALno If the alarm output must be ON when the alarm is active while it is OFF when the alarm is not active;

ALnc If the alarm output must be OFF when the alarm is active while it is ON when the alarm is not active;

ALni The same behaviour as ALnc but with a reversed LED indication (the LED indicates the output status).

Enter group]LbA and program, with parameter oLbA, to which output the alarm signal must be addressed.

The Loop Break alarm is activated if the output power remains at the 100% for the time programmed at parameter LbAt (expressed in s).

To avoid unwanted alarms, the value of this parameter must be set considering the time the plant takes to reach the Set Point when the measured value is far from it (for example at plant start-up).

When the alarm is triggered, the instrument displays the message LbA and behaves as in the case of a measurement error giving a power output as programmed with parameter OPE (group]InP).

To restore normal functioning after the alarm intervention, select the control mode oFF and then reprogram the automatic control (rEG) after checking the correct functioning of probe and actuator.

In order to exclude the Loop Break alarm, set:

OLbA OFF.

5.13 Functioning of Key [U]

In addition to the normal display function of Pr1, Pr2 and P1-2, the [U] key can be programmed to perform other functions using the USrb parameter contained in the]PAn group.

The parameter USrb can be programmed as:

noF No function;

tunE Pressing the key for at least 1 s, is possible to activate/deactivate Auto-tuning or Self-tuning (if programmed)

oPLo Pressing the key for at least 1 s, it is possible to swap from automatic control (rEG) to manual one (oPLo) and vice-versa;

AAc Pressing the key for at least 1 s, is possible to acknowledge the alarm (paragraph 5.11);

ASi Pressing the key for at least 1 s, is possible to acknowledge an active alarm (paragraph 5.11);

CHSP Pressing the key for at least 1 s, is possible to select, sequentially, one of the 2 pre-programmed Set Points;

oFF Pressing the key for at least 1 s, is possible to swap between automatic control (rEG) to OFF control (oFF) and vice-versa.

5.14 Digital Input

The instrument can be equipped with 2 digital inputs that are managed by 1 parameter .

The function of the digital input can be set through parameter diF contained in the group]InP.

The parameter can diF be programmed as:

noF No function;

AAc Closing the contact connected to digital input 1 is possible to acknowledge the alarm (paragraph 5.11);

ASi Closing the contact connected to digital input 1 is possible to acknowledge an active alarm (paragraph 5.11);

HoLd Closing the contact connected to digital input 1 the istrument holds the measure in that instant (⚠ not the reading on the display, therefore the indication could settle with a delay proportional to the measure filter). With the hold function activated, the instrument operates the control according to the stored measure. Opening the contact, the instrument returns to the normal acquisition of the measure;

oFF When the instrument is in rEG state, closing the contact connected to digital input 1, the instrument is placed in oFF status. Opening the contact, the instrument returns to the rEG automatic control status;

CHSP Closing the contact connected to digital input 1 is possible to select, sequentially, one of the 2 pre-programmed Set Points;

SP1.2 Closing the contact connected to digital input 1 is possible to select as active the **SP2** Set Point. Opening the contact the **SP1** Set Point is selected as active. SP1.2 can be selected only when nSP = **2** and, when active, it disables the selection of the active Set Point through the parameter SPAt and through the [U] key;

HECo Closing the contact connected to digital input 1 is possible to select as active the Set Point SP2 in CooL mode. Opening the contact the **SP1** Set Point is selected as active in HEAt mode. HECo can be selected only when nSP = **2** and, when active, it disables the selection of the active Set Point through the parameter SPAt and through the [U] key.

5.15 RS485 Serial Interface

The instrument can be equipped with a **RS485** serial communications interface, by means of which it is possible to connect the controller to a network to which other instruments (PLC controllers) are connected. All these devices typically depend on a Personal Computer that acts as a plant supervisor. Using a Personal Computer is possible to acquire all the function information and to program all the instrument configuration parameters. The software protocol adopted for **K31D** is a **MODBUS RTU** type, widely used in several PLC and supervision programs available on the market (the manual of the comminications protocol of the **K31D** series is available on request).

The interface circuit allows the connection of up to **32** instruments on the same line.

To maintain the line in rest conditions a 120Ω resistance (**Rt**) must be connected to the end of the line.

The instrument has two terminals called **A** and **B** that must be connected to all network terminals with the same label.

For wiring the line, then a twisted pair of telephone type is sufficient.

However, especially when the network is very long or disturbed, it is advisable to adopt a 3-pole wired and shielded cable connected as shown.

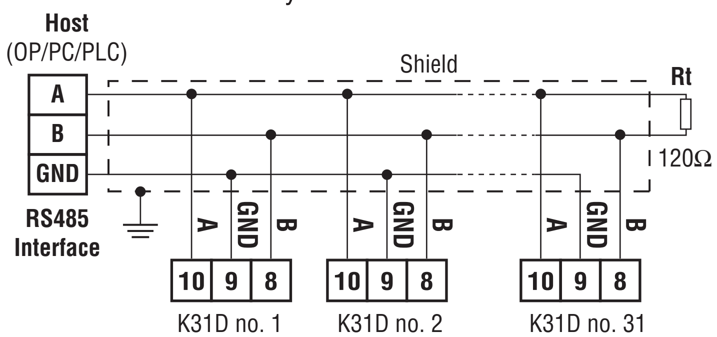
If the instrument is equipped with a serial interface, the parameters to be programmed are the following, all present in the parameters group]SEr:

Add Address of the station. Set a different number for each station. Values: 1 ÷ 255.

bAud Transmission speed (baud-rate). Values:1200 ÷ 38400 baud. All the stations on the line must have the same transmission speed.

PACS Programming access. If programmed as LoCL it means that the instrument is only programmable from the keyboard, if programmed as LorE it is programmable both from the keyboard and serial line.

If an attempt is made to enter the programming from the keyboard whilst a communication through the serial port is in progress the instrument shows the message buSY to indicate the busy state.



6. ACCESSORIES

The instrument has a lateral socket into which a special tool can be inserted.

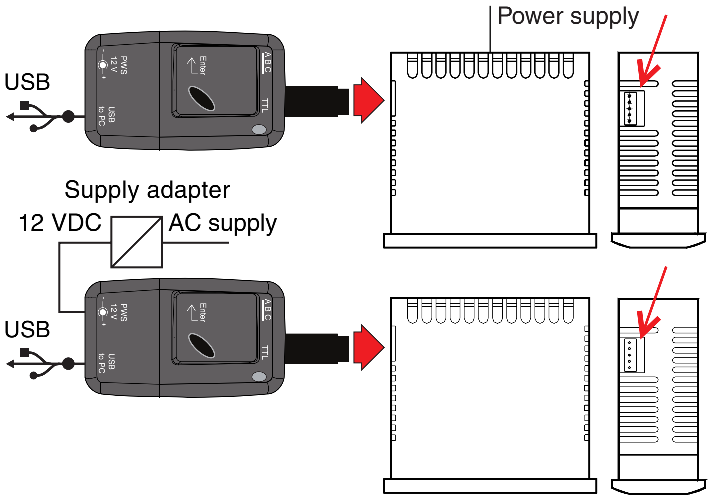
6.1 Parameters configuration by "A01"

The instrument is equipped with a 5 poles connector that allows the transfer from and toward the instrument of the functioning parameters through the device **A01**.

This device it is mainly usable for the serial programming of some instruments which need to have the same parameters configuration or to keep a copy of the parameters setting of an instrument and allow its rapid retransmission.

The same device allows to connect a PC via USB with which, through the appropriate configuration software for "*AT UniversalConf*" tool, the operating parameters can be configured.

To use the **A01** device it is necessary that the device or instrument are being supplied.



Note: For instruments equipped with an RS485 serial communications port, it is essential, also for the A01 key usage, that PAcS = **LorE**.

For additional info, please have a look at the A01 instruction manual.

7. PROGRAMMABLE PARAMETERS

Hereafter is inserted a description of all the parameters available on the instrument. Some of them may not be present, either due to the fact they depend on the type of instrument or because they are automatically disabled as unnecessary.

Group]SP Set Point Parameters

Parameter		Description	Range	Default	Note
1	nSP	Number of the programmable Set Points	1 ÷ 2	1	
2	SPAt	Active Set Point	1 ÷ nSP	1	
3	SP1	Set Point 1	SPLL ÷ SPHL	0	
4	SP2	Set Point 2	SPLL ÷ SPHL	0	
5	P2HL	Upper Pr2 measurement limit for differential control	-1999 ÷ 9999	9999	
6	P2LL	Lower Pr2 measurement limit for differential control	-1999 ÷ 9999	-1999	
7	SPLL	Low Set Point	-1999 ÷ SPHL	-1999	
8	SPHL	High Set Point	SPLL ÷ 9999	9999	

Group] InP Measure Input Parameters

Parameter		Description	Range	Default	Note
9	SEnS	Probes type	Ptc PTC ntc NTC Pt10 Pt1000	ntc	
10	Pr2	Probe Pr2 presence	yES no	yES	
11	dP	Number of decimal figures	0/1	0	
12	Aot	Analogue control Output type	0-20 0 ÷ 20mA 4-20 4 ÷ 20 mA 0-10 0 ÷ 10 V 2-10 0 ÷ 10 V	0-10	
13	Unit	Temperature unit of measurement	°C/°F	°C	
14	FiL	Input digital filter	oFF Not active 0.1 ÷ 20.0 s	1.0	
15	oFS1	Measuring Offset Pr1	-1999 ÷ 9999	0	
16	oFS2	Measuring Offset Pr2	-1999 ÷ 9999	0	
17	rot	Rotation of the measuruing straigìht line	0.000 ÷ 2.000	1.000	
18	InE	oPE functioning in case of measuring error	or Overrange Ur Under range our Overrange and underrange	our	
19	oPE	Output power in case of measuring error	-100 ÷ 100%	0	
20	dIF	Digital inputs function	noF No Function AAc Reset Alarms latch ASi Acknowledged Alarms HoLd Hold Measure oFF Control OFF CHSP Sequential Set Point selection SP12 **SP1** or **SP2** Set Point selection HECo Select HEAt with **SP1** or CooL with **SP2**	noF	

Group]Out Outputs Parameters

Parameter		Description	Range	Default	Note
21	O1F	Output 1 function	1.rEG Control output 1 2.rEG Control output 2 ALno Alarm Output NO ALnc Alarm Output NC ALni Alarm Output NC with reversed LED functioning	1.rEG	
22	O2F	Output 2 function		ALno	
23	O3F	Output 3 function		ALno	
24	O4F	Output 4 function		ALno	

Group]AL1 AL1 Alarm Parameters

Parameter		Description	Range	Default	Note
25	OAL1	Output where alarm AL1 is addressed	oFF Not active Out1/Out2 Out3/Out4	oFF	
26	PrA1	AL1 Alarm PV reference	Pr1/Pr2/P1-2/P1-L	Pr1	
27	AL1t	AL1 Alarm type	LoAb Absolute Low HiAb Absolute High LHAb Absolute Band LodE Deviation Low HidE Deviation High LHdE Deviation Band	LoAb	
28	Ab1	AL1 Alarm functioning	0 ÷ 64 +1 Not active at power ON +2 Delayed alarm +4 Latched alarm +8 Acknowledgeable +16 Not active at Set Point change (relative alarms) +32 Control Output shutdown at alarm intervention	0	
29	AL1	AL1 Alarm threshold	AL1L ÷ AL1H	0	
30	AL1L	Low threshold band alarm AL1 or Minimum set alarm AL1 for high or low alarm	-1999 ÷ AL1H	-1999	
31	AL1H	High threshold band alarm AL1 or Maximum set alarm AL1 for high or low alarm	AL1L ÷ 9999	9999	
32	HAL1	AL1 Alarm hysteresis	oFF Not active 1 ÷ 9999	1	
33	AL1d	AL1 Alarm activation delay	oFF Not active 1 ÷ 9999 s	OFF	
34	AL1i	Alarm AL1 activation in case of probe error	no/yES	no	

Group]AL2 AL2 Alarm Parameters

Parameter		Description	Range	Default	Note
35	OAL2	Output where alarm AL2 is addressed	oFF Not active Out1/Out2 Out3/Out4	oFF	
36	PrA2	AL2 Alarm PV reference	Pr1/Pr2/P1-2/P1-L	Pr1	
37	AL2t	AL2 Alarm type	LoAb Absolute Low HiAb Absolute High LHAb Absolute Band LodE Deviation Low HidE Deviation High LHdE Deviation Band	LoAb	
38	Ab2	AL2 Alarm functioning	0 ÷ 64 +1 Not active at power ON +2 Delayed alarm +4 Latched alarm +8 Acknowledgeable +16 Not active at Set Point change (relative alarms) +32 Control Output shutdown at alarm intervention	0	
39	AL2	AL2 Alarm threshold	AL2L ÷ AL2H	0	
40	AL2L	Low threshold band alarm AL2 or Minimum set alarm AL2 for high or low alarm	-1999 ÷ AL2H	-1999	
41	AL2H	High threshold band alarm AL2 or Maximum set alarm AL2 for high or low alarm	AL2L ÷ 9999	9999	
42	HAL2	AL2 Alarm hysteresis	oFF Not active 1 ÷ 9999	1	
43	AL2d	AL2 Alarm activation delay	oFF Not active 1 ÷ 9999 s	OFF	
44	AL2i	Alarm AL2 activation in case of probe error	no/yES	no	

Group]AL3 AL3 Alarm Parameters

Parameter		Description	Range	Default	Note
45	OAL3	Output where alarm AL3 is addressed	oFF Not active Out1/Out2 Out3/Out4	oFF	
46	PrA3	AL3 Alarm PV reference	Pr1/Pr2/P1-2/P1-L	Pr1	
47	AL3t	AL3 Alarm type	LoAb Absolute Low HiAb Absolute High LHAb Absolute Band LodE Deviation Low HidE Deviation High LHdE Deviation Band	LoAb	
48	Ab3	AL3 Alarm functioning	0 ÷ 64 +1 Not active at power ON +2 Delayed alarm +4 Latched alarm +8 Acknowledgeable +16 Not active at Set Point change (relative alarms) +32 Control Output shutdown at alarm intervention	0	
49	AL3	AL3 Alarm threshold	AL3L ÷ AL3H	0	
50	AL3L	Low threshold band alarm AL3 or Minimum set alarm AL3 for high or low alarm	-1999 ÷ AL3H	-1999	
51	AL3H	High threshold band alarm AL3 or Maximum set alarm AL3 for high or low alarm	AL3L ÷ 9999	9999	
52	HAL3	AL3 Alarm hysteresis	oFF Not active 1 ÷ 9999	1	
53	AL3d	AL3 Alarm activation delay	oFF Not active 1 ÷ 9999 s	OFF	
54	AL3i	Alarm AL3 activation in case of probe error	no/yES	no	

Group]LbA Loop Break Alarm Parameters

Parameter		Description	Range	Default	Note
55	OLbA	Output where LbA alarm is addressed	oFF Not active Out1/Out2 /Out3/Out4	OFF	
56	LbAt	Time necessary to activate alarm LbA	oFF Not active 0 ÷ 9999 s	OFF	

Group]rEG Control Parameters

Parameter		Description	Range	Default	Note
57	Cont	Control type	Pid PID on.FA Asymmetrical ON/OFF on.FS Symmetrical ON/OFF nr Neutral zone ON/OFF	Pid	
58	Func	Functioning mode output 1.rEG	HEAt Heating CooL Cooling	HEAt	
59	PrrG	Control process measurement reference	Pr1/Pr2/P1-2/P1-L	Pr1	
60	HSEt	Hysteresis of ON/OFF control (or end Soft Start cycle threshold)	0 ÷ 9999	1	
61	CPdt	Compressor Protection time for 2.rEG	oFF Not active 0 ÷ 9999 s	0	
62	Auto	Auto-tuning enable: 1, 2, 3, 4 For Fast Auto-tuning -1, -2, -3, -4 For Oscillatory Auto-tuning	oFF Not active 1 Start at each power ON 2 Start at first power ON 3 Start manually 4 Start after a Soft Start or a Set Point change	0	
63	SELF	Self-tuning enable	no/yES	no	
64	Pb	Proportional band	0 ÷ 9999	50	
65	Int	Integral time	oFF Not active 0 ÷ 9999 s	200	
66	dEr	Derivative time	oFF Not active 0 ÷ 9999 s	50	
67	FuOc	Fuzzy overshoot control	0.00 ÷ 2.00	0.5	
68	tcr1	Cycle time of output 1.rEG	0.1 ÷ 130.0 s	20.0/1.0	

Parameter		Description	Range	Default	Note
69	PrAt	Power ratio 2.rEg/1.rEg	0.01 ÷ 99.99	1.00	
70	tcr2	Cycle time of 2.rEg	0.1 ÷ 130.0 s	10.0	
71	rS	Manual reset	-100.0 ÷ 100.0%	0.0	
72	SLor	Gradient of first ramp	inF Ramp not active 0.00 ÷ 99.99 units/min	InF	
73	dur.t	Duration time between 2 ramp	inF Time not active 0.00 ÷ 99.59 h.min	InF	
74	SLoF	Gradient of second ramp	inF Ramp not active 0.00 ÷ 99.99 units/min	InF	
75	St.P	Soft-Start power	-100 ÷ 100%	0	
76	SSt	Soft-Start time	oFF Not active 0.1÷7.59 h.min inF Endless	oFF	

Group]PAn User interface Parameters

Parameter		Description	Range	Default	Note
77	USrb	Funtion recalled by the U key	noF No function tunE Autotune/Selftune start oPLo Manual operation (open loop) AAc Reset Alarm memory ASi Alarms Acknowledge CHSP Active Set Point selection oFF Control in OFF mode	noF	
78	diSP	Displayed Variable	Pr1 Pr1 Value Pr2 Pr2 Value P1-2 Pr1-Pr2 Value Pou Control Power SP.F Active Set Point Value SP.o Operative Set Point value AL1 AL1 threshold AL2 AL2 threshold AL3 AL3 threshold	P1-2	
79	AdE	Shift value for the shift index functioning	0 OFF 1 ÷ 9999	2	
80	Edit	Fast programming Active Set Points and Alarms	SE Set Points changeable, Alarms not changeable AE Alarms changeable, Set Points not changeable SAE Alarms and Set Points changeable SAnE Alarms and Set Points not changeable	SAE	
81	PASS	Password to access ConF menu	oFF Not active 0 ÷ 9999	oFF	

Group]SEr Serial Communications Parameters

Parameter		Description	Range	Default	Note
82	Add	Station address in case of serial communication	0 ÷ 255	1	
83	bAud	Transmissions speed (Baud rate)	1200/2400/9600/19.2/38.4	9600	
84	PACS	Programmability through serial port	LoCL No (programmable only with the keyboard) LorE Yes (programmable with the keyboard and from serial port)	LorE	

8. PROBLEMS, MAINTENANCE AND WARRANTY

8.1 Probe errors

Error	Reason	Action
E1-E1	The probe **Pr1** may be interrupted or in short circuit, or may measure a value outside the allowed range	Check the correct connection of the probe with the instrument and check the probe works correctly
E2-E2	The probe **Pr2** may be interrupted or in short circuit, or may measure a value outside the allowed range	
----	Process measurement not available	

8.2 Other errors

Error	Reason	Action
ErAt	Auto-tuning not possible because the process value is too high or too low	Press the P keyin order to make the error message disappear. Once the error has been found, try to repeat the auto-tuning
noAt	Auto-tuning not finished within 12 hours	Check the the probe and actuator functioning and try to repeat the auto-tuning
LbA	Loop control interrupted (Loop break alarm)	Check the the probe and actuator functioning and swap the instrument to (rEG) control
ErEP	Possible EEPROM memory anomaly	Press the P key

In error conditions, the instrument provides the output power programmed with parameter oPE and activates the desired alarm(s), if the relative parameters ALni have been programmed as **yES**.

8.3 Cleaning

We recommend cleaning of the instrument with a slightly wet cloth using water and not abrasive cleaners or solvents which may damage the instrument.

8.4 Warranty and Repairs

The instrument is under warranty against manufacturing flaws or faulty material, that are found within 18 months from delivery date.

The warranty is limited to repairs or to the replacement of the instrument. The eventual opening of the housing, the violation of the instrument or the improper use and installation of the product will bring about the immediate withdrawal of the warranty effects.

In the event of a faulty instrument, either within the period of warranty, or further to its expiry, please contact our sales department to obtain authorisation for sending the instrument to our company. The faulty product must be shipped to Ascon Tecnologic with a detailed description of the faults found, without any fees or charge for Ascon Tecnologic, except in the event of different agreements.

8.5 Disposal

The appliance (or the product) must be disposed of separately in compliance with the local standards in force on waste disposal.

9. TECHNICAL DATA

9.1 Electrical characteristics

Power supply: 12 VAC/VDC, 24 VAC/VDC, 100 ÷ 240 VAC ± 10%;

Frequency AC: 50/60 Hz;

Power consumption: about 4 VA;

Inputs: 2 inputs for temperature probes:
NTC (103AT-2, 10 kΩ @ 25°C) or
PTC (KTY 81-121, 990Ω @ 25°C) or
Pt1000
+ 2 free voltage digital inputs contacts;

Outputs: Up to 4 relay or Vdc for SSR outputs:

	EN 61810	EN 60730	UL 60730
Out1 - SPDT - 8A - 1/2HP 250 V	8 (3) A	4 (4) A	10 A Res.
Out2 - SPDT - 8A - 1/2HP 250 V	8 (3) A	4 (4) A	10 A Res.
Out3 - SPST-NO - 5A - 1/10HP 125/250 V	5 (1) A	2 (1) A	2 A Gen. Use
Out4 - SPST-NO - 5A - 1/10HP 125/250V	5 (1) A	2 (1) A	2 A Gen.Use

Analogue Control Output: 0/4...20 mA; 0/2...10 V (OUT1 only with type L or H power supply and with no RS485 serial comm.s port);

Relay outputs electrical life as for EN 60730:
Out1, Out2: 100000 operations; Out3, Out4: 100000 operations;

Installation category: II;

Measurement category: I;

Protection class against electric shock:
Class II for Front panel;

Insulation: Reinforced insulation between the low voltage section (relay outputs) and the front panel; Reinforced insulation between the low voltage section (relay outputs) and the extra low voltage section (inputs, SSR outputs); No insulation between power supply, inputs and SSR outputs; 50 V insulation between RS485 and extra low voltage section.

9.2 Mechanical characteristics

Housing: Self-extinguishing plastic, UL 94 V0;

Heat and fire resistance category: D;

Dimensions: 78 x 35 mm, depth 75.5 mm;

Weight: about 150 g;

Mounting: Incorporated flush in panel (panel thickness 12 max. mm) in a 71 x 29 mm hole;

Connections: Fixed or removable screw terminal block for 0.2 ÷ 2.5 mm^2/AWG 24 ÷ 14 cables;

Protection degree: IP65 (NEMA 3S) when mounted with the optional screw type bracket;

Pollution degree: 2;

Operating temperature: 0 ÷ 50°C;

Operating humidity: 30 ÷ 95 RH% with no condensation;

Storage temperature: -10 ÷ +60°C.

9.3 Functional Features

Control: ON/OFF, Neutral zone, single and double action PID;
Measurement range:

Probe type		dP = 0	dP = 1
PTC (KTY81-121)	SEnS = **Ptc**	-55 ÷ +150°C -67 ÷ +302°F	-55.0 ÷ +150.0°C -67.0 ÷ +302.0°F
NTC (103-AT2)	SEnS = **ntc**	-50 ÷ +110°C -58 ÷ +230°F	-50.0 ÷ +110.0°C -58.0 ÷ +230.0°F
Pt1000	SEnS = **Pt10**	-50 ÷ +350°C -58 ÷ +662°F	-50.0 ÷ +350.0°C -58.0 ÷ +662.0°F

Display resolution: According to the probe used 1°/0.1°;
Overall accuracy: ±(0.5% fs + 1 digit);
Sampling rate: 130 ms;
Serial Interface: Isolated RS485;
Communications protocol: MODBUS RTU (JBUS);
Baud rate: Between 1200 ÷ 38400 baud;
Display: 4 Digit Red h 12 mm;
Compliance: ECC directive EMC 2004/108/CE (EN 61326), ECC directive LV 2006/95/CE (EN 61010-1).

10. HOW TO ORDER

Model
K31D = Instrument with mechanical keys

a: Power supply
H = 100... 240 VAC
L = 24 VAC/DC
F = 12 VAC/DC

b: Inputs
2 = For PTC, NTC Thermistors or Pt1000 resistance thermometer

c: Output 1 (Out1)
R = Relay SPDT 8A (resistive load)
O = Vdc for SSR
I = Analogue Output 0/4...20 mA; 0/2...10 V (only with L tye power supply and without RS485)

d: Output 2 (Out2)
R = Relay SPDT 8A (resistive load)
O = Vdc for SSR
- = Not present

e: Output 3 (Out3)
R = Relay SPST-NO 5A (resistive load)
O = Vdc for SSR
- = Not present

f: Output 4 (Out4)
R = Relay SPST-NO 5A (resistive load)
O = Vdc for SSR
- = Not present

g: Communications Interface
S = RS 485 Serial interface
- = Not present

h: Connector Terminals
- = Screw terminals (standard)
E = Removable socket with screw terminals

K31D | **a** | **b** | **c** | **-** | **e** | **-** | **-** | **h** | **i** | **j** | **k** | **ll** | **mm**

Note: To order the screw type bracket necessary to obtain the IP65 protection degree, contact our sales offices.