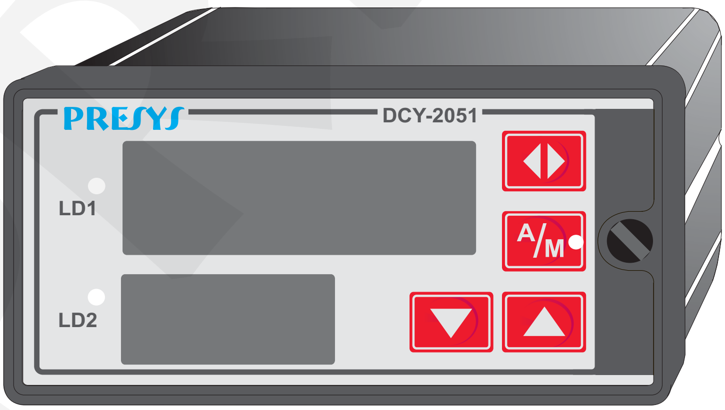
PRESYS | Instruments

# DCY-2050 and DCY-2051 Universal Process Controller


# TECHNICAL MANUAL

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# 1.0 - Introduction

## 1.1 - Description

The PRESYS DCY-2050 and 2051 Controllers are microprocessor-based instruments which control and show any process variable found in industrial plants, such as: temperature, pressure, flow, level etc. The difference between models DCY-2050 and 2051 lies just in the form which process variables are shown. In model DCY-2051 the process variable is shown on a display by four larger size digits. They are provided with two types of non-volatile internal memories (E2PROM and NVRAM) to store configuration and calibration values. Its high accuracy is warranted by auto-calibration techniques based on high thermal stability voltage reference.

They can communicate with computers by optional communication module RS-232 or RS-422/485.

The DCY-2050 and 2051 Controllers have been designed according to modularity and flexibility concepts. Therefore, five plug-in points are provided inside the controllers for the installation of optional modules. By acquiring just these optional modules, the user is capable of transforming a Single-Loop controller, into a Dual-Loop controller, of obtaining a wide variety of control output types, such as: by relay, by open collector voltage, by solid-state relay, voltage (1 - 5V, 0 - 10V), current (4 - 20mA). It can even be provided with three alarm module types, such as: by relay, by open collector voltage and by solid-state relay.

They are provided with several control modes: ON-OFF, PID (with all its combinations), time proportioning, heating-cooling, programmable set-point, cascade and remote set-point input.

The DCY-2050 and 2051 Controllers are provided with auto-tune algorithm to compute the PID parameters for optimizing control capabilities.

They incorporate all standard control characteristics, such as: auto manual bumpless transfer, output saturation, remote set-point and programmable set-point up to ten segments, protection against integral saturation, etc.

They are capable of monitoring two universal standard inputs, accepting a direct thermocouple connection, RTDs, current (mAdc) and voltage (mVdc, Vdc). The thermocouple and RTD inputs are automatically linearized by means of tables stored in the EPROM memory. A 24Vdc voltage source, isolated and with short circuit protection, is provided for transmitter power supply.

The type of input selected by the user is enabled by jumpers and by the software configuration. All configuration data can be protected by a password system, and are stored in the non-volatile memory in the event of a power failure.

They allow a power supply from 90 to 240Vac.

The instruments are housed in an extruded aluminum case which makes them highly immune to electrical noise, electromagnetic interference and resistant to the most severe and rough industrial use conditions.

On the instrument front panels there are two red displays jointly configurable with the decimal point for up to four high visibility digits. The upper display can either show the controlled variable or the mnemonics: SP 1, SP 2, OUT 1, OUT 2 corresponding to the values shown on the lower display. The lower display can show the following values: channel 1 set-point, channel 2 set-point, channel 1 output and channel 2 output. The control outputs 1 and 2 are represented in percentage of full scale output. The function of the UP, DOWN and ENTER keys to change the set-point/output values is described in section 3.1. The A/M key on the controller front panels allows toggling between automatic and manual modes. The green led in the A/M key indicates, when illuminated, the controllers in the manual mode and, when extinguished, the controllers in the automatic mode. In the controllers configuration modes both displays show the mnemonics and the parameter values. The pair of red leds can be used as a visual alarm indication associated to the outputs of alarms 2, 3 and 4, or can indicate that the measured variable and the set-point/output shown on the displays refer to 1 or 2 control loops. We may be provided with up to three alarm outputs. Each of those alarm outputs may be: by relay, by open collector or by triac.

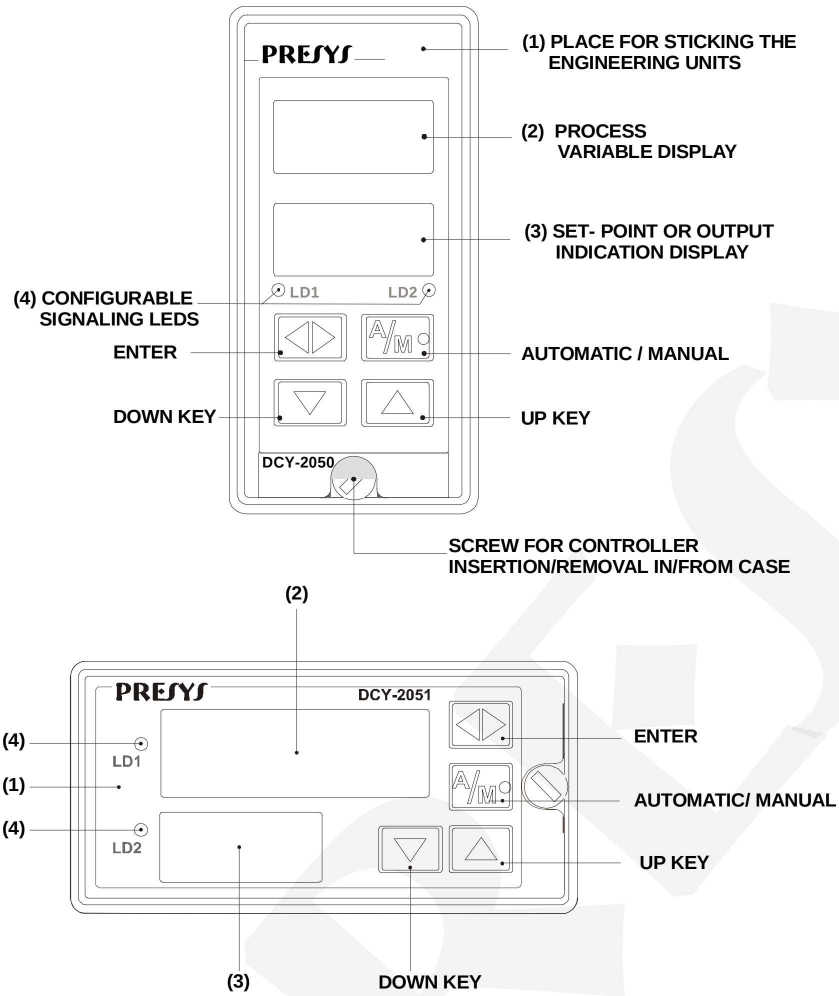



**Fig. 1 - Controllers Front Panel DCY-2050/2051**

## 1.2 - Order Code Number

**Order Code**

DCY - 2050/ 2051 ☐ - ☐ - ☐ - ☐ - ☐ - ☐ - ☐

**Output 1 (For Control only)**

0 - Not used
1 - 4-20 mA
2 - 1-5 Vdc
3 - 0-10 Vdc
4 - SPST Relay
5 - Open collector voltage
6 - Solid-state relay

**Output 2 (Control or alarm)**

Same code as for output 1

**Output 3 (Alarm or control 1 auxiliary " cooling")**

0 - Not used
1 - SPDT Relay
2 - Open collector voltage
3 - Solid-state relay

**Output 4 (Alarm or control 2 auxiliary "cooling")**

Same coding as for output 3

**Power Supply**

1 - 90 to 240 Vac
2 - 24 Vdc

**Communication**

0 - Not used
1 - RS232
2 - RS485
3 - RS422

**Degree of Protection of Enclosure**

0 - General purpose, sheltered place
1 - Front, drip proof
2 - Weather proof

Note - The spans and input types, control algorithms, the indication, the use of relays as alarms and the alarm points are, among others, items which the user may program through the front keys (if desired, specify such information so the whole programming may be previously prepared by Presys).
Note: Any other desired software or hardware characteristics, may be available upon request.

**Code Example:**

1) DCY - 2051 - 1 - 4 - 1 - 1 - 1 - 0 - 0

This code defines a DCY - 2051 Controller with output 1 to 4 at 20mA, output 2 with SPST relay , outputs 3 and 4 with SPDT relay . Power supply in the range of 90 to 240 Vac, does not use communication and is intended for use in a sheltered place. The placing of such optional modules may offer a practical application for channel 1 heating-cooling control (output 1-heating and output 3-cooling) and ON-OFF control for channel 2 (output 2). Output 4 can be a high, low or a deviation alarm output to channel 1 or channel 2.

## 1.3 - Technical Specifications

**Inputs:**

Two thermocouple configurable inputs (J, K, T, E, R, S, under ITS - 90), RTD Pt - 100 under DIN 43760, 4 to 20mA, 0 to 55mVdc, 1 to 5Vdc, 0 to 10Vdc. Input impedance of 250Ω for mA, 10MΩ for 5Vdc and 2MΩ above 5Vdc. Table 1 shows the temperature range limits for thermocouple and RTD and the resolution for the linear input sensors.

| **Input sensor** | **Span** | | | |
|---|---|---|---|---|
| Thermocouple | lower limit °F | higher limit °F | lower limit °C | higher limit °C |
| Type J | -184.0 | 1886.0 | -120.0 | 1030.0 |
| Type K | -346 | 2498 | -210 | 1370 |
| Type T | -418 | 752 | -250 | 400 |
| Type E | -148.0 | 1436.0 | -100.0 | 780.0 |
| Type R | -58 | 3200 | -50 | 1760 |
| Type S | -58 | 3200 | -50 | 1760 |
| RTD Pt-100 2- or 3-wire | -346.0 | 1256.0 | -210.0 | 680.0* |
| Linear | Span | | Resolution | |
| Voltage | 0 to 55mV | | 6µV | |
| | 0 to 5V | | 500µV | |
| | 0 to 10V | | 1mV | |
| Current | 0 to 20mA | | 2µA | |

(*) including wire resistance

Table 1 - Input Sensor Measuring Span

**Control functions:**

* ON-OFF Control.
* PID Control.
* PID Control with AUTO-TUNE.
* Heating-cooling Control.
* Reason Control.
* Cascade Control.
* Remote set-point input
* Programmable set-point

**Control outputs:**

. Analog output 4 to 20mAdc, 1 to 5Vdc, 0 to 10Vdc, use of optional cards with plug-in fitting foreseen for up to two 300 Vac modules galvanically isolated from inputs and power supply. Maximum load of 750Ω.
. SPST relay output with 3A capacity at 220Vac.
. Open collector voltage output (24Vdc, 20mA maximum with isolation).
. Solid-state relay output (2A 250Vac with isolation).

**Alarm outputs:**

. SPST relay output with 3A capacity at 220Vac.
. SPDT output relay with 3A capacity at 220Vac.
. Open collector voltage output (24Vdc, 20mA maximum with isolation).
. Solid-state relay output (2A 250Vac with isolation).

**Serial communication:**

RS-232 or RS-422/485 with isolation at 50Vdc, as an optional module with plug-in fitting independent from outputs.

**Indication:**

Two red display sets with four digits which can be jointly configured with the decimal point.

**Configuration:**

By front panel pushbuttons and internal jumpers.

**Scanning time:**

Standard 130 ms, for input indications within the -999 to 9999 span. Display updating at each 0.5 second.

**Accuracy:**

± 0.1% of full scale for TC, RTD inputs, mA, mV, Vdc.
± 0.5% of full scale for analog control output.

**Linearization:**

± 0.1% for RTD and ± 0.2% for TC.

**Square root extraction:**

± 0.5% of readings, for input above 10% of span. 0 to 5% of programmable Cut-off.

**Cold junction compensation:**

± 2.0°C in the range from 0 to 50°C of ambient temperature.

**2-Wire Transmitter Power Supply:**

24Vdc voltage and 50mA maximum, isolated from outputs, with short-circuit protection.

**Stability at ambient temperature:**

± 0,005% per °C of span referred to an ambient temperature of 25°C.

**Power Supply:**

90 to 240Vac Universal, (10W nominal), 24Vdc. Other values are optional.

**Operating ambient:**

0 to 50°C temperature and 90% maximum relative humidity.

**Dimensions:**

1/8DIN (48 x 96mm) and 162mm depth.
45 x 92mm panel cutout.

**Weight:**

0.5kg nominal.

**Warranty:**

One year.

# 2.0 - Installation

## 2.1 - Mechanical Installation

The DCY - 2050 and 2051 controller front panels are 1/8DIN size (48 x 96mm).

They are attached from the rear by two rails which push the instrument against the panel.

After preparing a 45 x 92mm panel cutout, remove the two rails and slide the instrument from the front until it touches the panel and from the rear engage the rails in the controllers tightening the screws, as illustrated in figure 2.

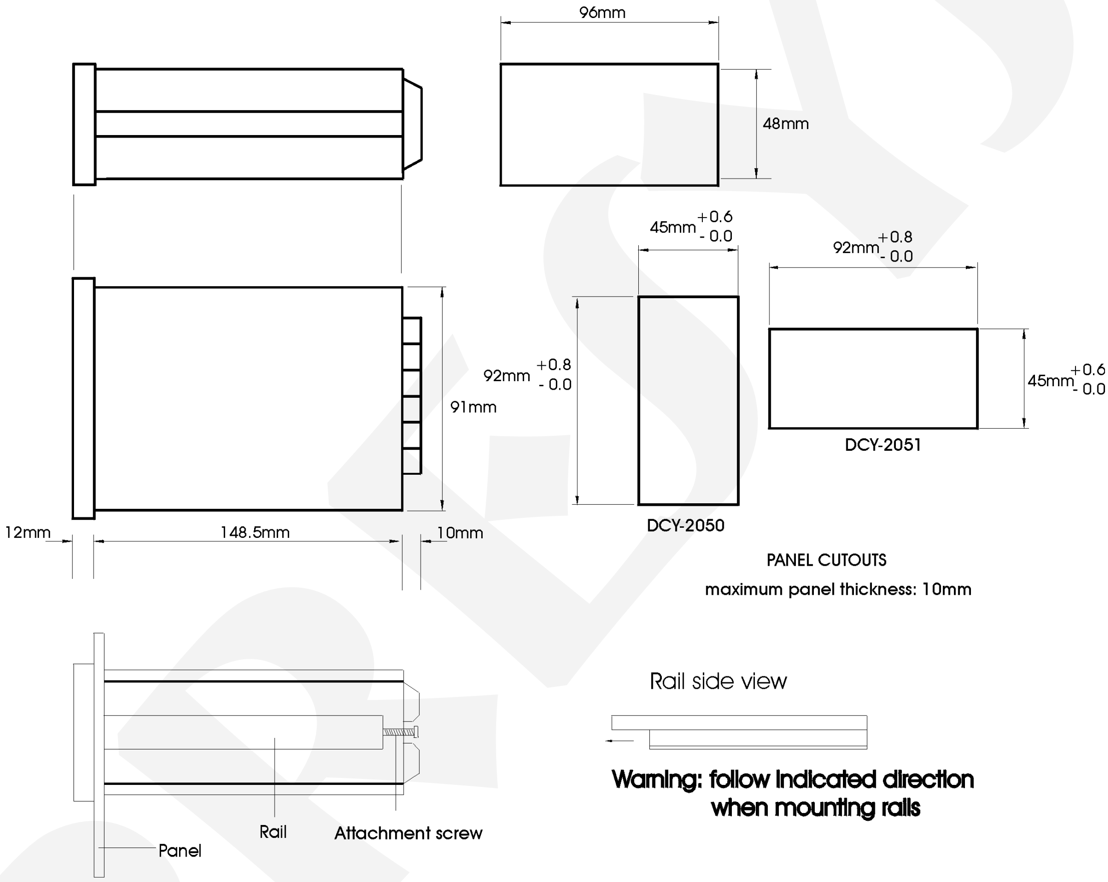



Fig. 2 - Dimensional drawing, panel mounting cutout and side view

## 2.2 - Electrical Installation

The DCY-2050 and 2051 controllers may be powered by any voltage between 90 and 240Vac or Vdc. Note that power is always applied to the internal circuit when the instruments are connected to the AC supply.

Make the connections of the process input and output signals to the instrument with the power off.

Refer to figure 3 on instrument I/O terminal designations for power supply, grounding, communication and process input and output signals.

Signal cables should be kept as far away as possible from the power supply cables..

Since the instrument housing is a metallic case it will be necessary to connect the instrument ground terminal (gnd earth) to the local earth ground; this terminal should never be connected to the neutral loop terminal.

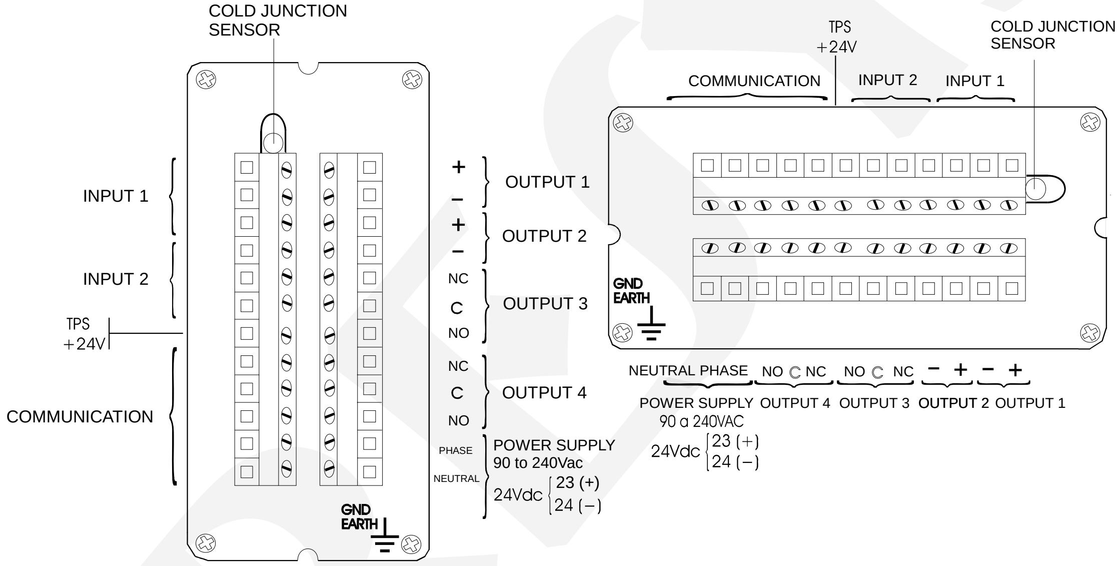



Fig. 3 - DCY-2050 and 2051 Controller Terminals

## 2.3 - Process Input Signal Connections

The DCY-2050 and 2051 controllers in their two standard universal inputs can be connected to thermocouples, 2 or 3-wire RTDs, mA, mV or V. In order to know the input sensor types and spans refer to table 1, section 1.3 on Technical Specifications.

The enabling of a certain type of input sensor is obtained by internal jumpers (refer to section 4.2 on hardware Configuration) and by a proper sensor selection in configuration time (refer to section 3.2 on Configuration). Therefore, the connections explained below shall only become effective if the instrument hardware and software are correctly configured.

The wiring of a type of sensor in input 1, will not restrict the simultaneous use of any other sensor, whether or not of the same type, in input 2.

To prevent noise induction from occurring in the sensor when connecting wire to the I/O terminal use twisted pair cable and run the sensor connection wire through a metallic tube or use a shielded cable. Be sure to connect only one shielded wire end to the negative I/O board terminal, or to the sensor ground, as outlined in the following items.

**WARNING: THE GROUNDING OF THE TWO SHIELDED WIRE ENDS MAY CAUSE DISTURBANCE TO THE CONTROLLERS.**

## 2.3.1 - Thermocouple Connection

Whenever using just one thermocouple, the user should preferably connect it to input 1 of the controllers, in order to obtain a greater accuracy in temperature measurements, since the cold junction sensor is solidly attached to the I/O terminal and closer to input 1.

Apply thermal paste from the thermocouple I/O terminals to the cold junction sensor in order to reduce the cold junction compensation error.

Connect the thermocouple to terminals 2(+) and 3(-) to use input 1 or to terminals 5(+) and 6(-) to use input 2 as shown in figure 4.

Use appropriate compensation cables of the same construction material as the thermocouple to connect the thermocouple to the controller I/O terminals. Check that the correct thermocouple polarity is the same as that of the corresponding terminals.

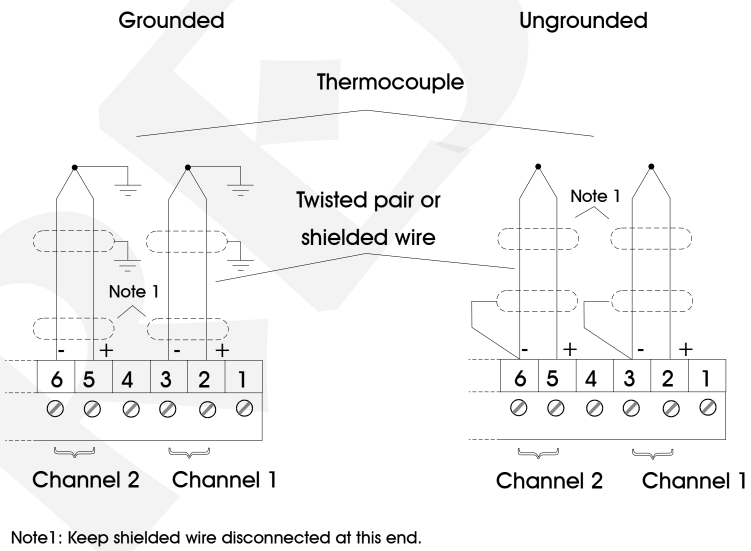



Fig. 4 - Thermocouple Connection

## 2.3.2 - RTD Connection

A RTD accepts a 2-, 3-, or 4-wire connection. All connection types are shown in figure 5.

In the event of a 2-wire RTD, connect the RTD between I/O terminals 1 and 3 to use input 1 or to terminals 4 and 6 to use input 2 as illustrated in figure 5.

For a 3-wire RTD, connect the RTD in the same way as for the previously described 2-wire connection, except that a third wire for RTD compensation should be connected to terminal 2 in the case of input 1 and to terminal 5 in the case of input 2, see figure 5.

A 4-wire RTD should be connected to the controllers in the same manner as for a 3-wire connection, except that the fourth RTD wire is disregarded and left disconnected, see figure 5.

The use of a 3-wire RTD provides a higher accuracy than a 2-wire connection.

The RTD wiring should be of the same material, length and gauge to ensure proper resistance compensation on all terminal connections. The maximum connecting wire resistance is 10Ω per wire. The minimum wire gauge should be 18AWG for distances of up to 50 meters and 16 AWG for distances in excess of 50m.

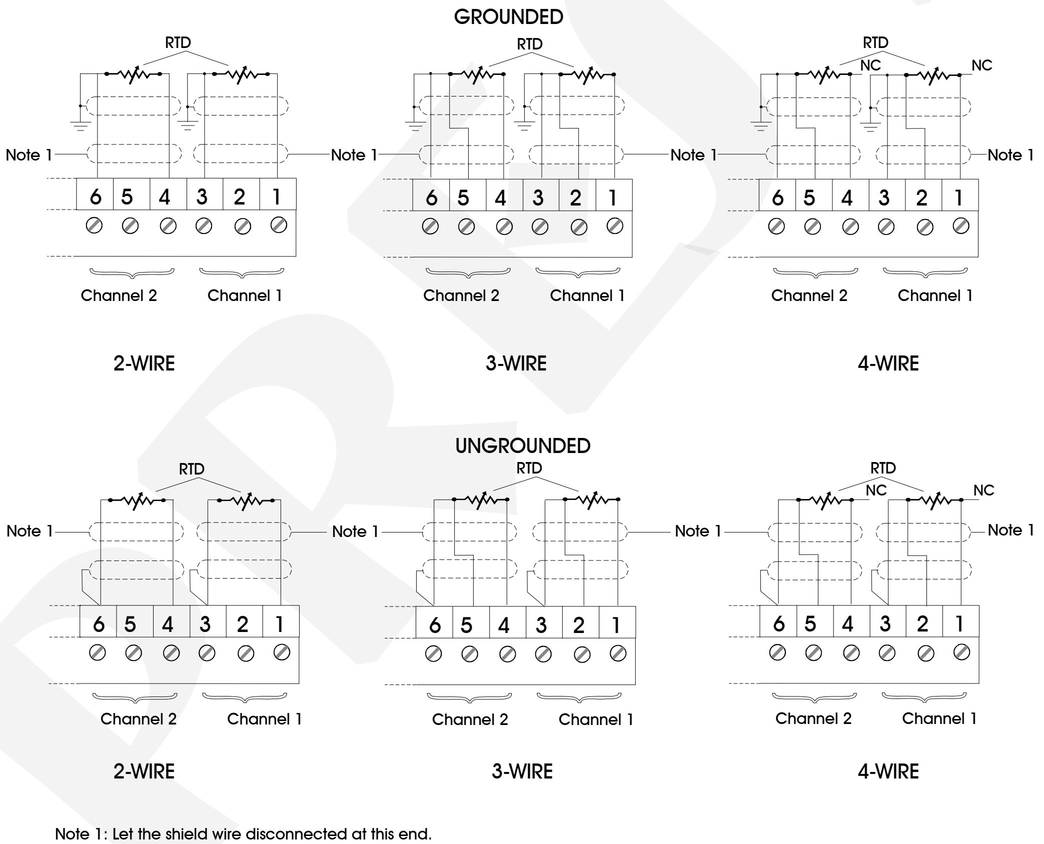



Fig. 5 - RTD Connection

## 2.3.3 - Milliampere Input

A standard 4 to 20mA current source can be applied between terminals 1(+) and 3(-) in the case of input 1, and between terminals 4(+) and 6(-) in the case of input 2; such current can originate from an externally powered Transmitter. In the event that the internal controller 24V voltage source is used to power a 2-wire Transmitter the current is received only on terminal 1(+) in the case of input 1 and received only on terminal 4(+) in the case of input 2. Figure 6 illustrates those two connection possibilities.

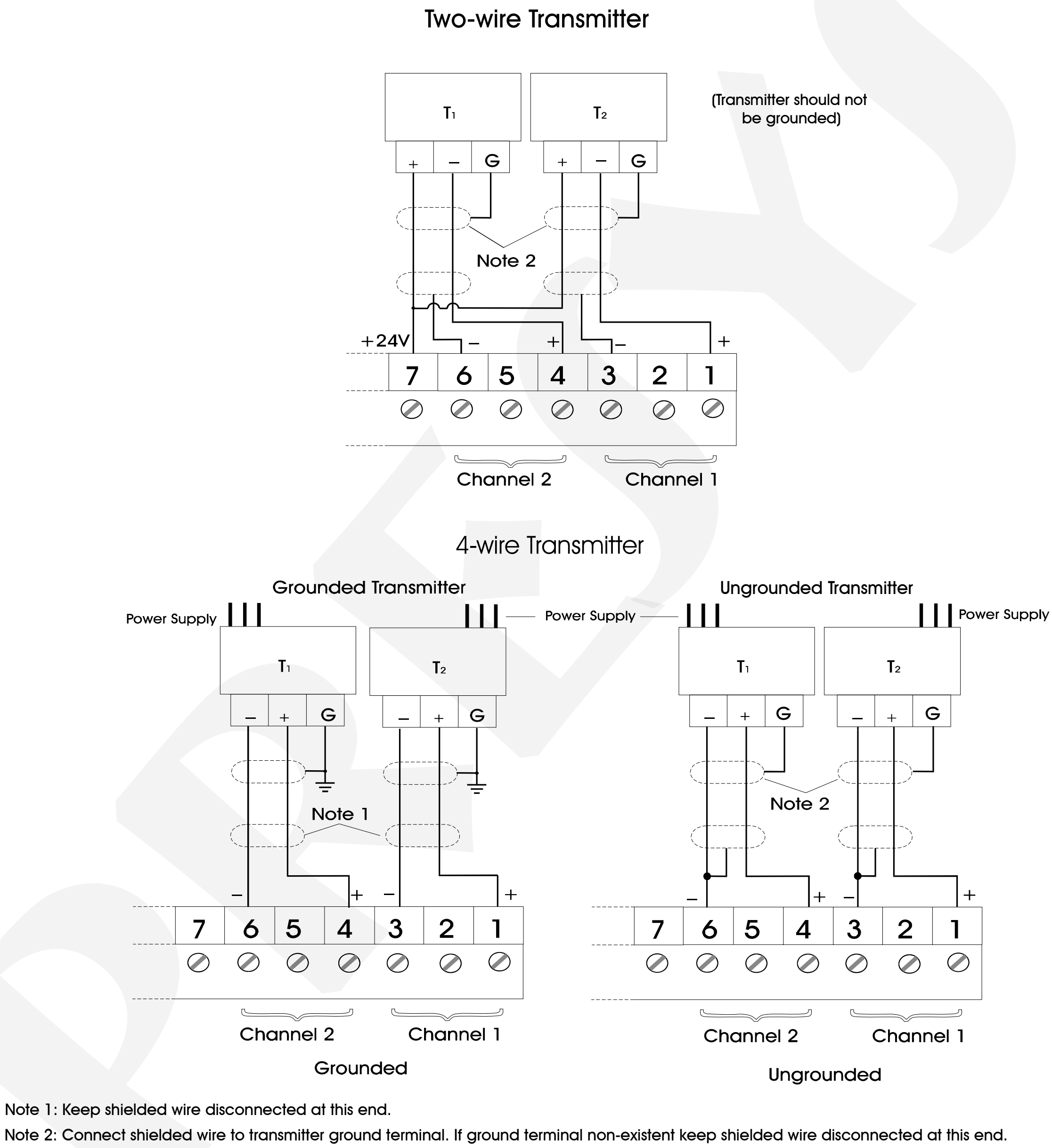
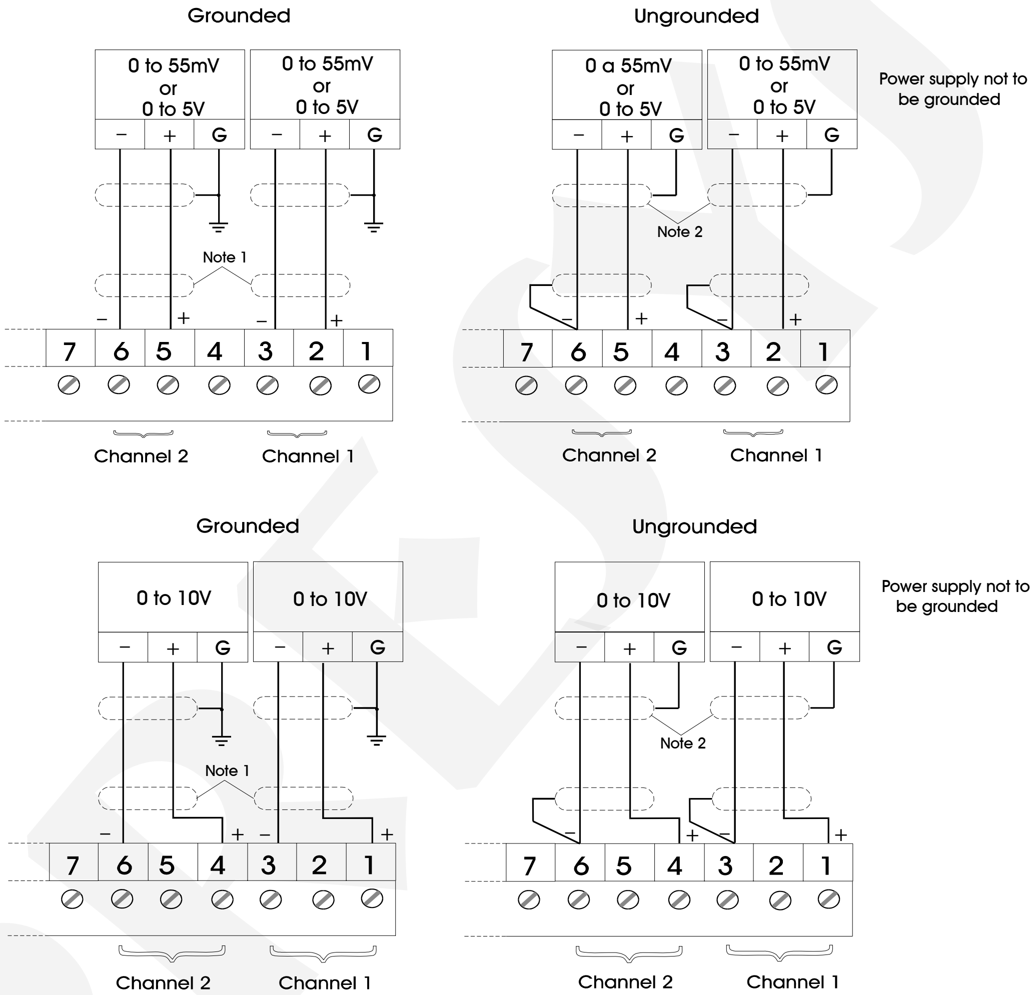



Fig. 6 - Current source Connection

## 2.3.4 - Voltage Source Connection in mV or V

Either a 0 to 55mVdc or a 0 to 5Vdc voltage must be applied between terminals 2(+) and 3(-) in the case of input 1 and between terminals 5(+) and 6(-) in the case of input 2. A 0 to 10Vdc voltage must be applied between terminals 1(+) and 3(-) in the case of input 1 and between terminals 4(+) and 6(-) in the case of input 2. Those connections are illustrated in figure 7.




Note 1: Keep shielded wire disconnected at this end.

Note 2: Connect shielded wire to power supply ground terminal. If ground terminal non-existent keep shielded wire disconnected at this end.

Fig. 7 - Voltage Source Connection

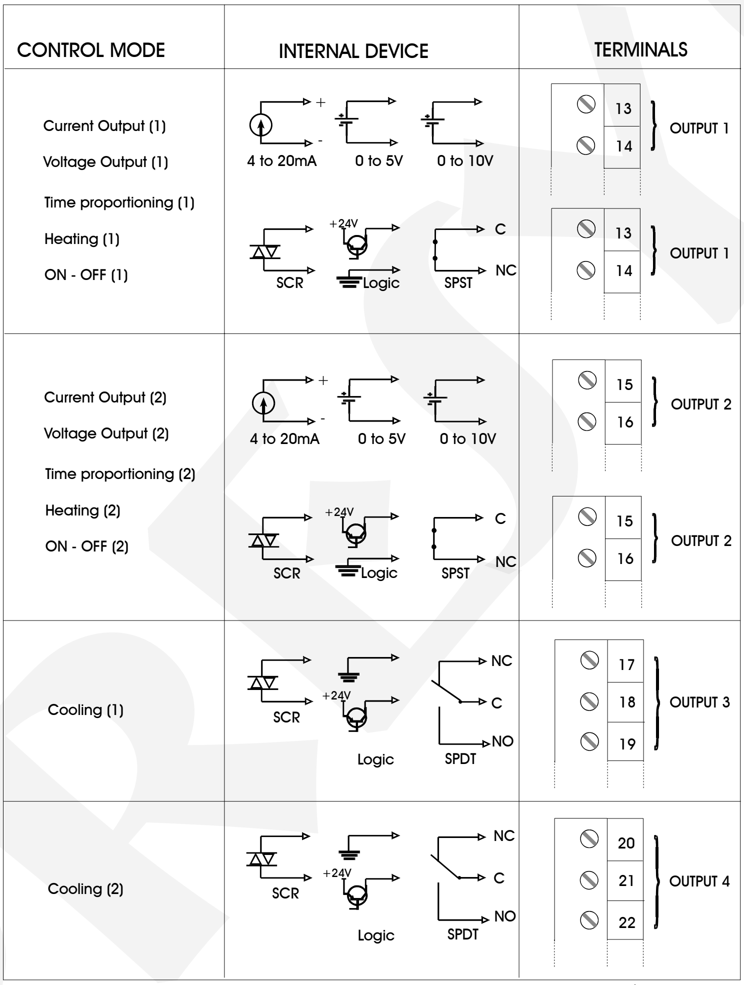
## 2.4 - Control and Alarm Output Signal Connection

In their most complete versions the controllers can be provided with up to four output signals: output 1, output 2, output 3 and output 4. Output 1 can only be used as a control output. Outputs 2, 3 and 4 can be used as control or alarm outputs, depending on controllers software configuration established by the user. A maximum of three alarm outputs can be provided.

In the case of outputs 1 and 2 we can have six types of different outputs between the current I/O terminals: current (4 to 20mA), voltage (0 to 5Vdc), voltage (0 to 10Vdc), SPST relay, open collector voltage and solid state relay.

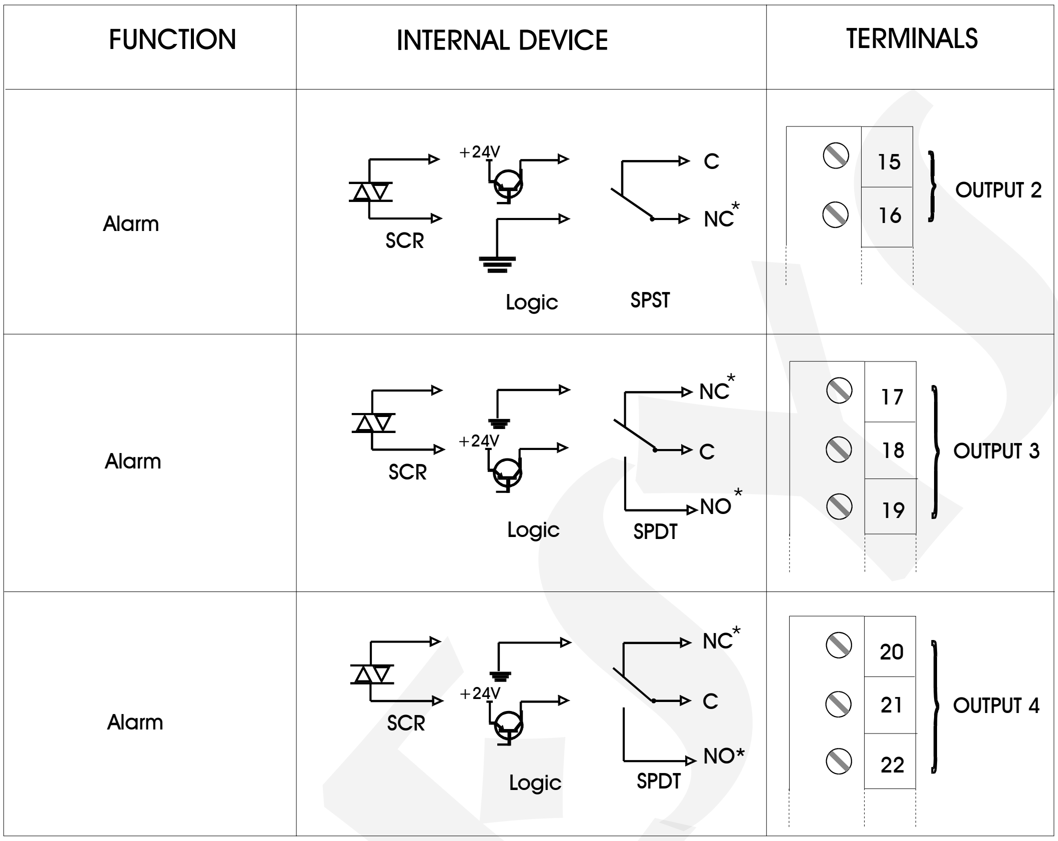
For outputs 3 and 4 there are three types of different outputs: SPDT relay, open collector voltage and solid-state relay. Figure 8 illustrates the control outputs and figure 9 the alarm outputs of the controllers.

Note that the I/O terminals will only show output signals if the corresponding optional module is installed and the output is correctly configured. Refer to sections 3.2 on Configuration and 4.3 on Adding optional modules for more details on installation and configuration of optional modules.




(1) Designates first control loop
(2) Designates second control loop

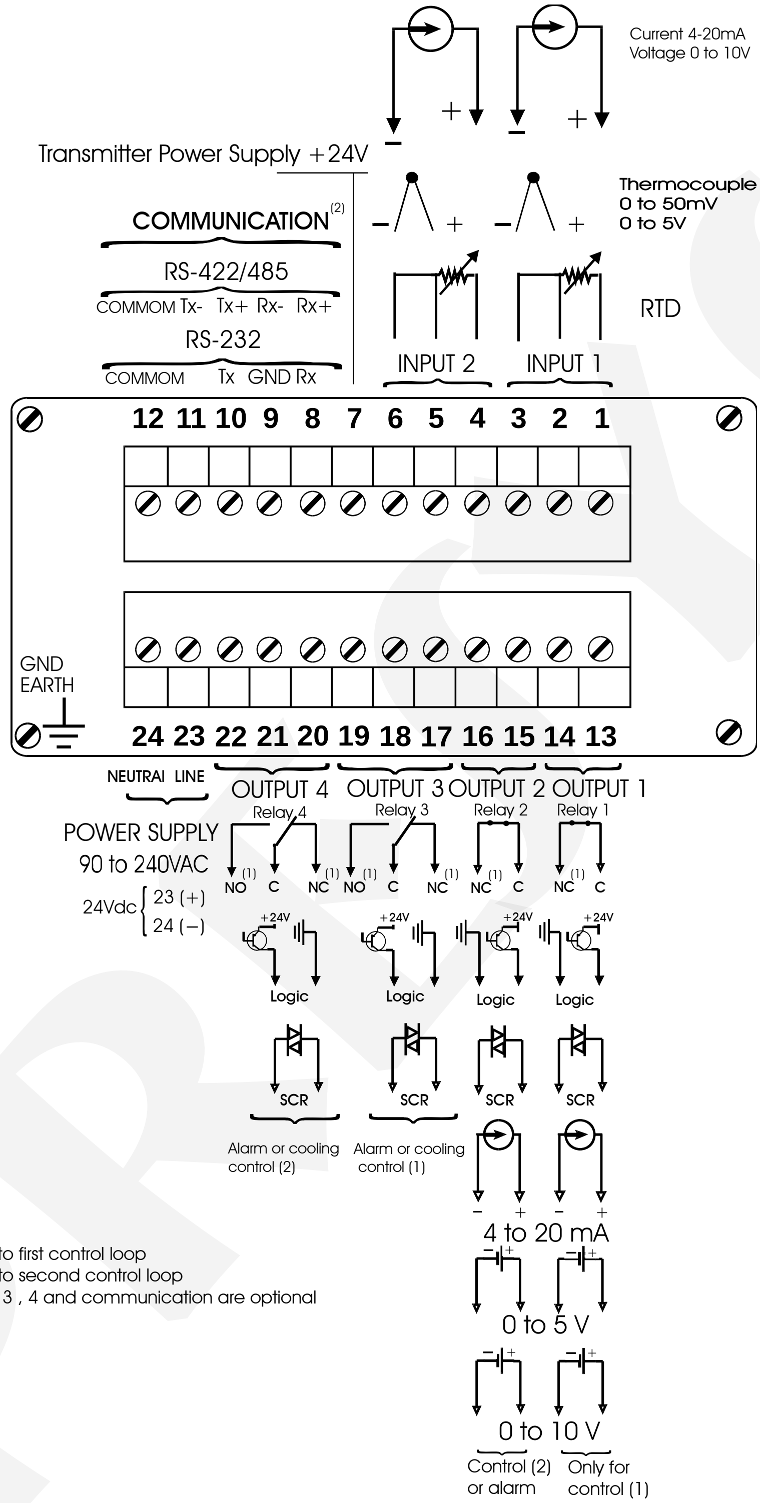
Fig. 8 - Control Output Connections




(*) Relay contacts assume that SAFE condition (see section 3.2 on Configuration) was selected for relays and that the controllers are powered and in no-alarm condition. With no power Supply or in alarm condition with SAFE option selected, contact state is changed.

Fig 9 - Alarm Output Connections

## 2.5 - Connection Diagram




Notes:
- (1) Referring to first control loop
- (2) Referring to second control loop
- Outputs 1, 2, 3 , 4 and communication are optional

## 2.6 - Communication

The DCY-2050 / 2051 controllers can communicate with computers by RS-232 or RS-422/485 since optional module is installed and the communication parameters are configured.

## 2.7 - Engineering Units

A label containing a selection of Engineering Units is supplied with each controller. Select the one corresponding to the variable shown on the display and stick it to the front panel of the controllers.

# 3.0 - Operation

## 3.1 - Normal operation

The DCY-2050 and 2051 controllers are provided with two operational modes: normal mode and configuration mode.

In normal operation mode we can further have the automatic operation mode and the manual operation mode.

In the automatic operation mode (closed loop system) the controllers receive the input signals, compare them with the set-points and automatically generate through control algorithms the output signals which adjust the input signals to the set-points.

In the manual operation mode (open loop system) the user himself establishes the values in output percentage to control the measured variables.

The selection between the automatic and manual modes is made through the automatic/manual (A/M) key on the controllers front panel. When in the manual mode the green LED indicating the manual state is illuminated.

The controllers normal mode, in which they operate most of the time, will be named zero level. In this level the upper display can show: denomination of set-point 1 (SP 1), denomination of output 1 (OUT1), denomination of set-point 2 (SP 2), denomination of output 2 (OUT2), value of input 1 (IN 1) and value of input 2 (IN 2). The lower display can show: the value of set-point 1 (V_SP 1), the value of output 1 (V_OUT 1), the value of set-point 2 (V_SP2) and the value of output 2 (V_OUT 2). Whenever the controllers are connected, they start a display indication of the last selection shown, before being disconnected. In order to switch to other options, the UP, DOWN and ENTER keys should be used, as illustrated in figure 10.

Figure 10, below, illustrates all those display possibilities at the operation level.

## Operation Level

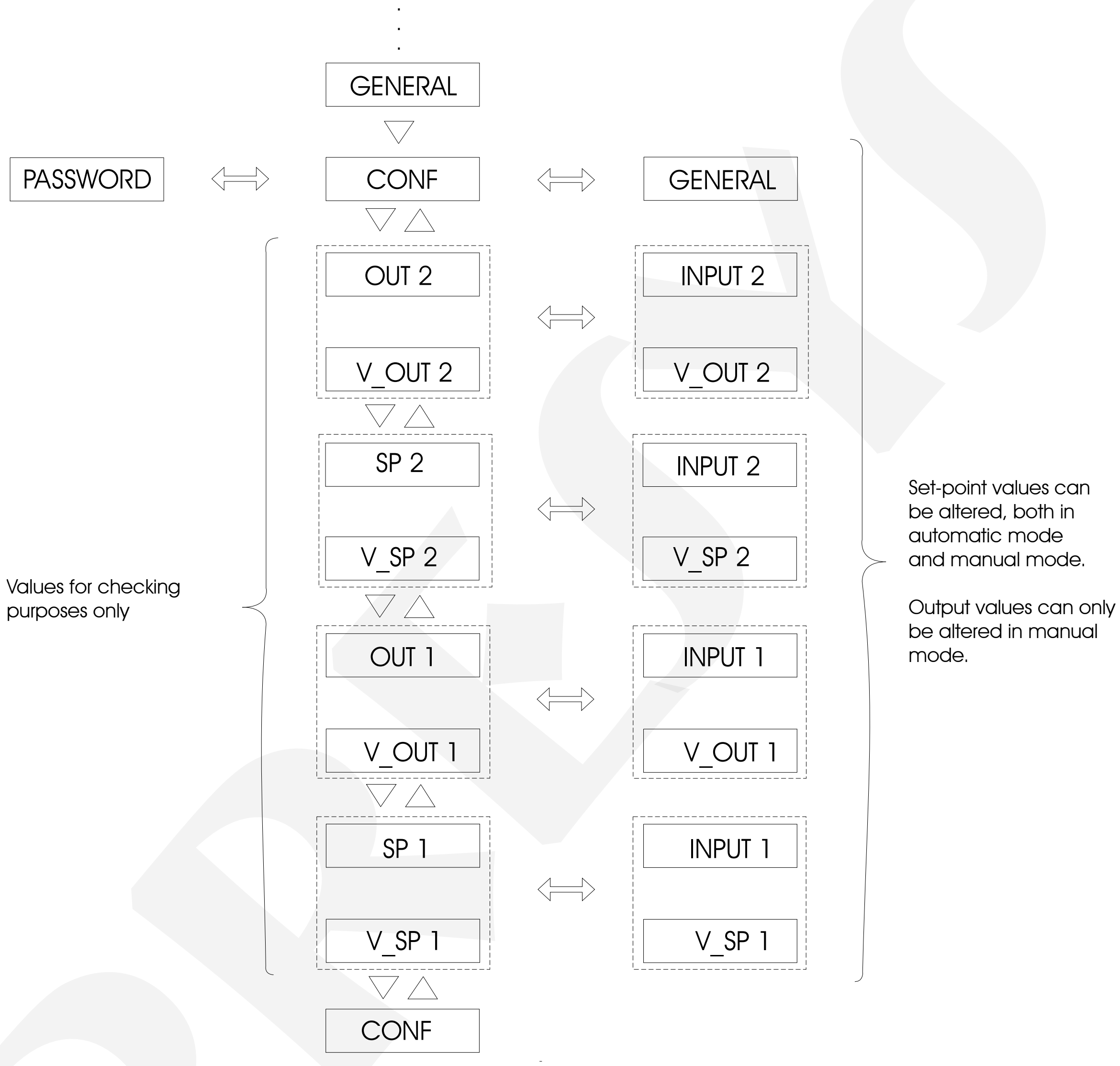



Fig. 10 - Options for Operation Level

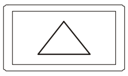
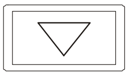
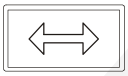
The display shows 4 types of configuration for each channel. The configuration screens on the previous figure are identified by the numbers 1, 2, 3 and 4 for channel 1.

Upon shifting to manual mode (green LED illuminated) the configuration screen shifts to type 3. This allows the output to be immediately modified by the UP and DOWN keys.

On the other hand, by switching to automatic mode (green LED extinguished) the configuration screen switches to type 4. In this case, the set-point can be immediately altered by the UP and DOWN keys.

The same procedure as described for channel 1, will be valid for channel 2.

At the operation level, the keys on the instrument front panels have the following functions:

| | | | |
|---|---|---|---|
| A/M | Key |  | Switches from automatic mode to manual mode and vice-versa. |
| UP | Key |  | Scrolls the display options in ascending order. |
| DOWN | Key |  | Scrolls the display options in descending order. |
| ENTER | Key |  | Replaces the upper display between the denomination (Set-Point or output) and the measured variable of the same channel 1 or 2, as illustrated in fig. 10. |

In order to have access to the configuration levels described in the following sections, one should attain the CONF option.

## 3.2 - Configuration

The DCY 2050 and 2051 controllers can be configured with a password system to prevent unauthorized people from altering critical process parameters.

Therefore, whenever the key ENTER is pressed, with the mnemonic CONF (Configuration) showing on the upper display and depending on configuration, one of the following cases may occur:

i) Enter directly into level 1 (GENERAL) of configuration mode, indicating that the instrument was not configured with the password system.

ii) The display shows the password warning, indicating that the instrument is provided with a password system which can be either by key or by value, as illustrated on figure 11.

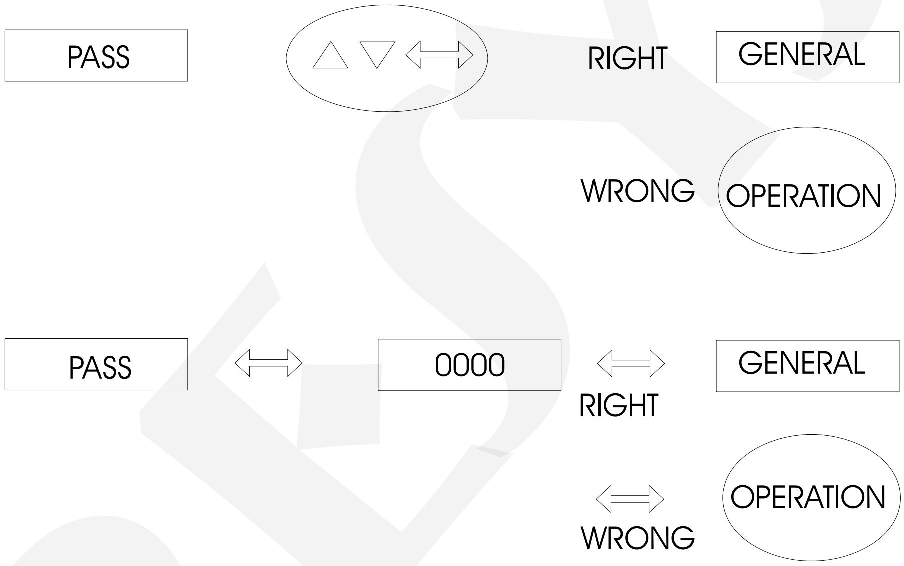



Fig. 11 - Password system by key and by value

In the case of password by key, the user should press the UP, DOWN and ENTER keys in sequence to enter in the configuration levels.

In the case of password by value the user should press the ENTER key a second time to obtain the display of number 0000 with the last digit flashing on the right. The flashing digit indicates the position where the digit of a 4-digit number will be entered by the user. In order to move to the other digits to the left of the number one should press the ENTER key. After entering all digits, press once more the ENTER key to switch to level 1 in case the password is correct; otherwise, the system reverts to normal operation (see figure 11).

The user may even select both password systems, by key and by value. In this case, if upon receiving a request for a password the user enters a wrong key sequence he will be immediately reverted to password by value.

The password may be a number selected by the user (customized), or the numbers 2050 for the case of controller 2050 and 2051 for the case of controller 2051. Note that in the case of password by value the numbers 2050 and 2051 are always enabled, serving as a help to the user in case he may not remember his password. In order to enter a password number or any other parameter value use the front keys on the controllers which have the following functions:

| | | |
|---|---|---|
| UP | Key | Increases the digit |
| DOWN | Key | Decreases the digit |
| ENTER | Key | Moves to digit on the left |

All configuration parameters and the control parameter computing values are stored in the non-volatile memories (E2PROM and NVRAM) and determine the instrument normal operation. Through configuration parameters the user may adapt the instrument according to his requirements. Normally the DCY-2050 and 2051 controllers are factory configured and the user is not expected to enter the configuration mode. However, nothing prevents the user from reconfiguring the instrument in case a new application so requires. This is made possible in view of the great variety of control modes and the universal characteristics of the two inputs in the 2050 and 2051 controllers.

The configuration parameters are distributed over nine increasing hierarchical levels as shown in figure 12.

In order to go through those levels and to have access to their corresponding parameters use the instrument front keys which have the following functions:

| | | |
|---|---|---|
| ENTER | Key | Switches into each level |
| UP | Key | Switches to a higher level |
| DOWN | Key | Switches to a lower level |

Note: in the following diagrams, the controller displays are represented by rectangles in response to the selection ENTER, UP and DOWN keys

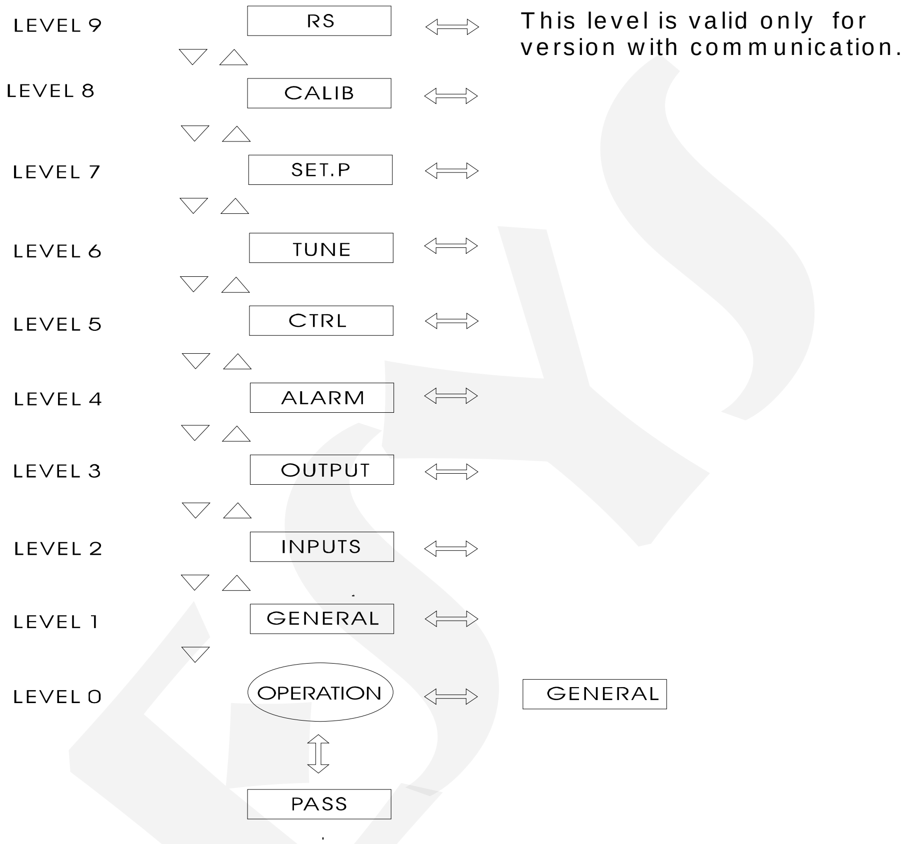



Fig. 12 - Diagram of parameter levels

The hierarchical levels are shown below. A step by step explanation is given for the options in each level, with all the corresponding parameters.

Within each level, the instrument front panel keys have the following functions:

| | | |
|---|---|---|
| UP | Key | Scrolls the options in ascending order |
| DOWN | Key | Scrolls the options in descending order |
| ENTER | Key | Confirms or advances the options within the level whenever the display will not show ESC. When ESC is shown on the display go back one or more positions |

### 3.2.1 - Level 1 - General

In level 1 we have the options: TAG, SOFT, PASS, INDIC, SP.Li, PO.BR, ST.CO, LED1 and LED2 (see figure 13).

TAG - this option enables an alphanumeric identification for the instrument. The procedure to enter a tag or any other parameter is the same as for the previously described password, (see the functions of ENTER, UP and DOWN keys under password by value):

SOFT - shows the number of the software version.

PASS - an option used for entering a password system giving access to the configuration mode. The password system may be entered by key, by value (a number selected by the user or the numbers 2050 or 2051) or both. As previously explained, the sequence for entering a password by key is to press the UP, DOWN and ENTER keys, in that order.

INDIC - Within the option for the indication of controlled variable values (upper display) and the set-point/output (lower display), there is the possibility of having a display of the values associated with the control loop 1 (C - 1) and the control loop 2 (C-2) either on the user initiative, by pressing the UP, DOWN and ENTER keys, or leaving to the instrument itself to alternate between the corresponding values of each loop. In the first instance, NO should be selected for option TWO, and in the second instance, YES (automatic scanning mode) is selected for option TWO, together with the display time, in seconds, assigned to each loop.

SP.Li - this is the option which limits the user selected set-point between the minimum set-point value (SP1L, SP2L) and the maximum set-point value (SP1H, SP2H). Those four parameters are user configurable.

PO.BR - expressed as a percentage of the output value, it determines the output level in the event of temperature sensors (thermocouple and RTD) and linear sensors (55mV, 5V) being damaged. Refer also to option B.OUT, at the input configuration levels. In the case of linear sensors, the occurrence of a signal lower than (the display indicates UNDER) or in excess of (the display indicates OVER) about 10% of the input span forces the output to switch to the manual mode in a PO.BR configured level.

ST.CO - this option allows the selection of the mode in which the controllers should reset after a power failure. If the mnemonic LAST is selected for option ST.CO, the controller will reset to the same configuration it was operating prior to the power failure (manual or automatic). Whenever the MANL option is selected for the ST.CO option, the controller will always reset to the manual mode after a power failure, with the output level being determined by the MANL parameter. The MANL parameter is user adjustable.

LED1 - it allows the association of LED1 in the controller front panel to the control loop 1 (C - 1), the control loop 2 (C - 2), the alarm relay 2 (rl. 2), the alarm relay 3 (rl. 3) or the alarm relay 4 (N.4).

LED2 - it allows the association of LED2 in the controller front panel to the control loop 1 (C - 1), the control loop 2 (C - 2), the alarm relay 2 (rl. 2), the alarm relay 3 (rl. 3) or the alarm relay 4 (rl.4).

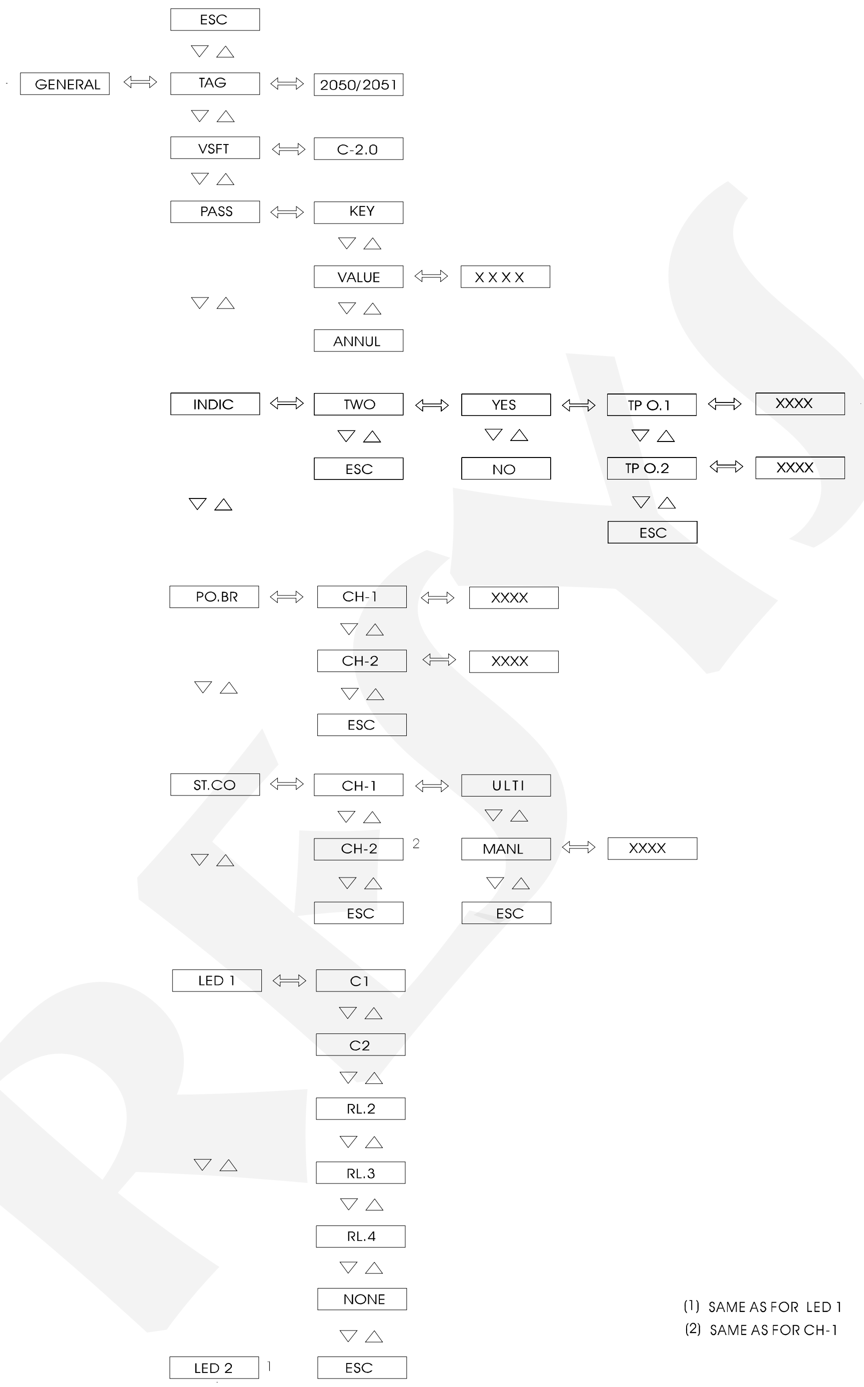



Fig. 13 - GENERAL Level Options

The adjustable parameter span shown on figure 13 is given below.

| Mnemonic | Parameter | Adjustable Span | Factory Value | Unit |
|---|---|---|---|---|
| TAG | instrument identification | ------------- | 2050<br>2051 | ------------- |
| SOFT | software version | ------------- | C - 2.00 | ------------- |
| VALUE | user password | -999 to 9999 | 0 | ------------- |
| TIME1 | channel 1 display time | 1 to 9999 | 5 | seconds |
| TIME2 | channel 2 display time | 1 to 9999 | 1 | seconds |
| SP1L<br>SP2L | set-point lower limit | -999 to 9999 | 0 | EU |
| SP1H<br>SP2H | set-point upper limit | -999 to 9999 | 9999 | EU |
| PO.BR | output power | -100 to 100 | 0 | % |
| MANL | start-up output | -100 to 100 | 0 | % |

## 3.2.2 - Level 2 - Inputs

The level of inputs allows whether or not to enable (by way of the option CANCEL) the sensor type for input 1 and input 2. For sensor types we have the linear option (0 to 5V, 0 to 55mV and 0 to 20mA) and temperature (option TEMP), as illustrated in figure 14.

Input from 4 to 20mA belongs to option 20mA
Input from 1 to 5Vdc belongs to option 5Vdc

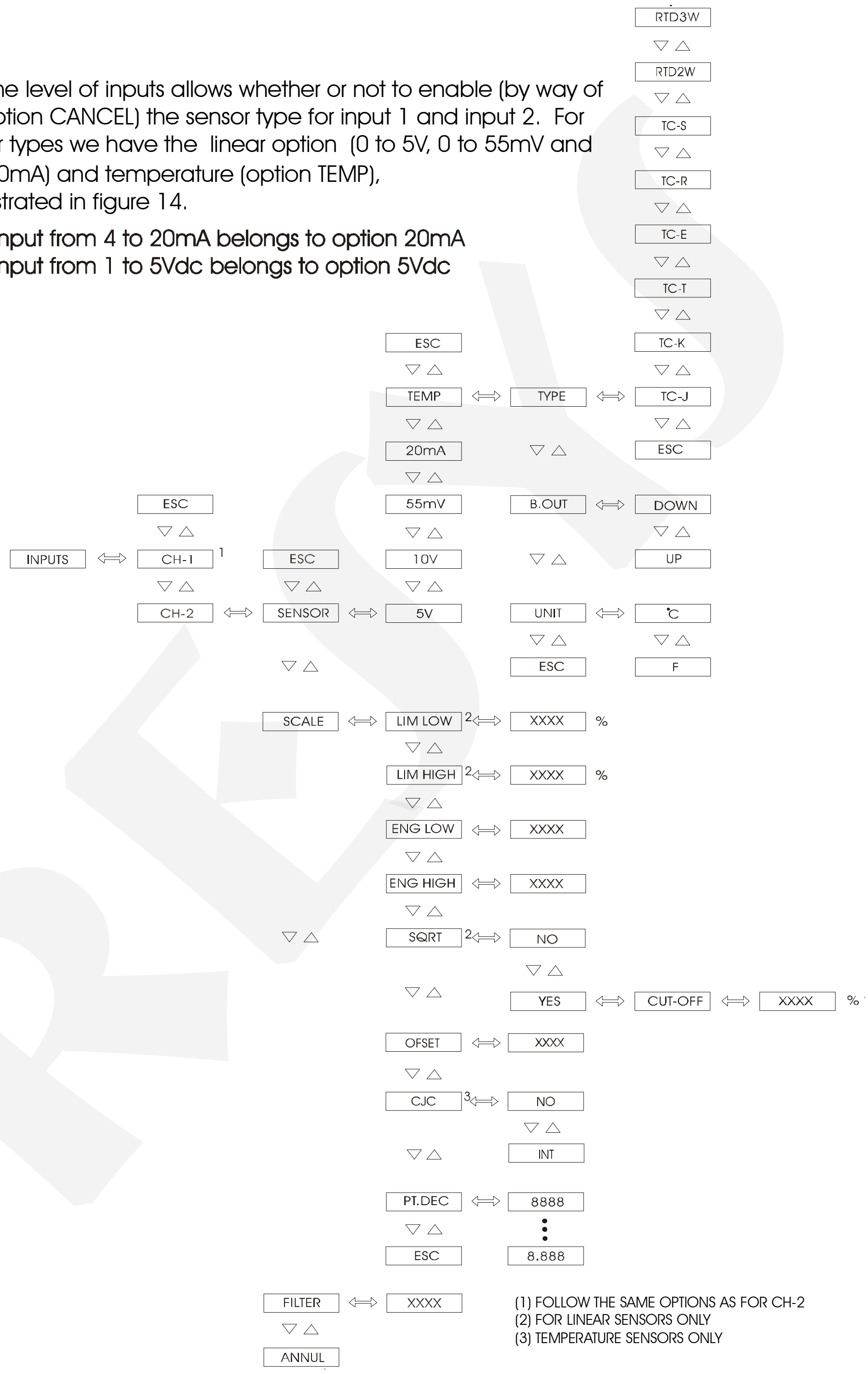



Fig. 14 - INPUT Level Options

The adjustable parameter span shown on figure 14 is given below.

| Mnemonic | Parameter | Adjustable | Factory Value | Units |
|---|---|---|---|---|
| LIM LOW | input signal associated to Eng Low | 0.0 to 100.0 | 0.0 | % |
| LIM HIGH | input signal associated to Eng High | 0.0 to 100.0 | 100.0 | % |
| ENG LOW | display indication associated to Lim Low | -999 to 9999 | 0.0 | EU* |
| ENG HIGH | display indication associated to Lim High | -999 to 9999 | 100.0 | EU |
| CUT-OFF | minimum square root value | 0 to 5 | 0 | % |
| OFF SET | constant added to display indication | -999 to 9999 | 0 | EU |
| FILTER | time constant of first order digital filter | 0.0 to 25.0 | 0.0 | seconds |

(*) EU - Engineering Units

Whenever a linear sensor is selected, the scale should be configured (SCALE option); for that purpose, two points P1(Lim Low, Eng Low) and P2 (Lim High, Eng High) should be defined, as illustrated on figure 15. Lim Low represents the value of the electrical signal, in %, associated to the display indication - Eng Low - , and Lim High corresponds to the value of the electrical signal, in %, associated to the display indication - Eng High.

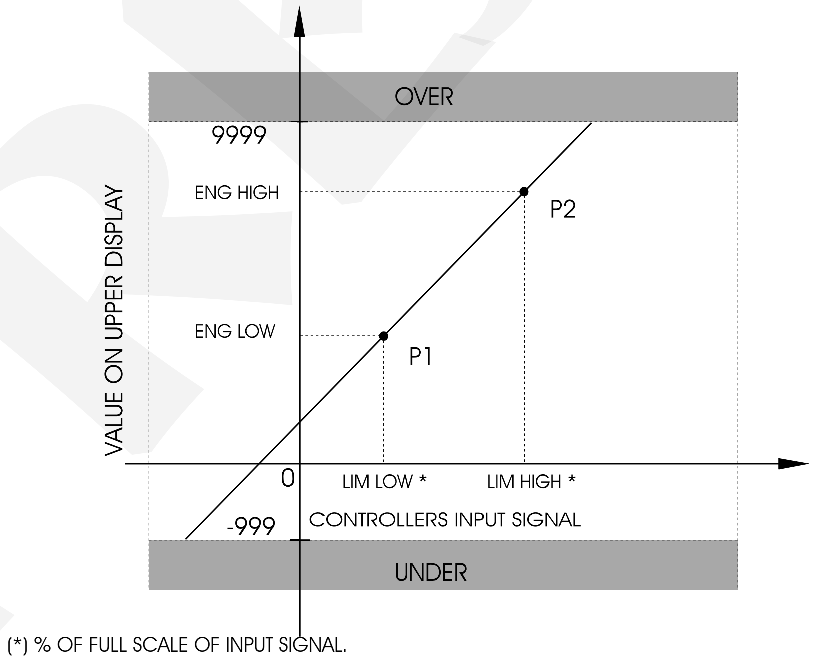



Fig. 15 - Linear Input Configuration

SQRT - shows the square root of the controller input signal on the upper display. The Cut-Off parameter, expressed as a % of the input signal, forces the lower value inputs (Lim Low + Cut Off) to behave as Lim Low. See illustration on figure 16.

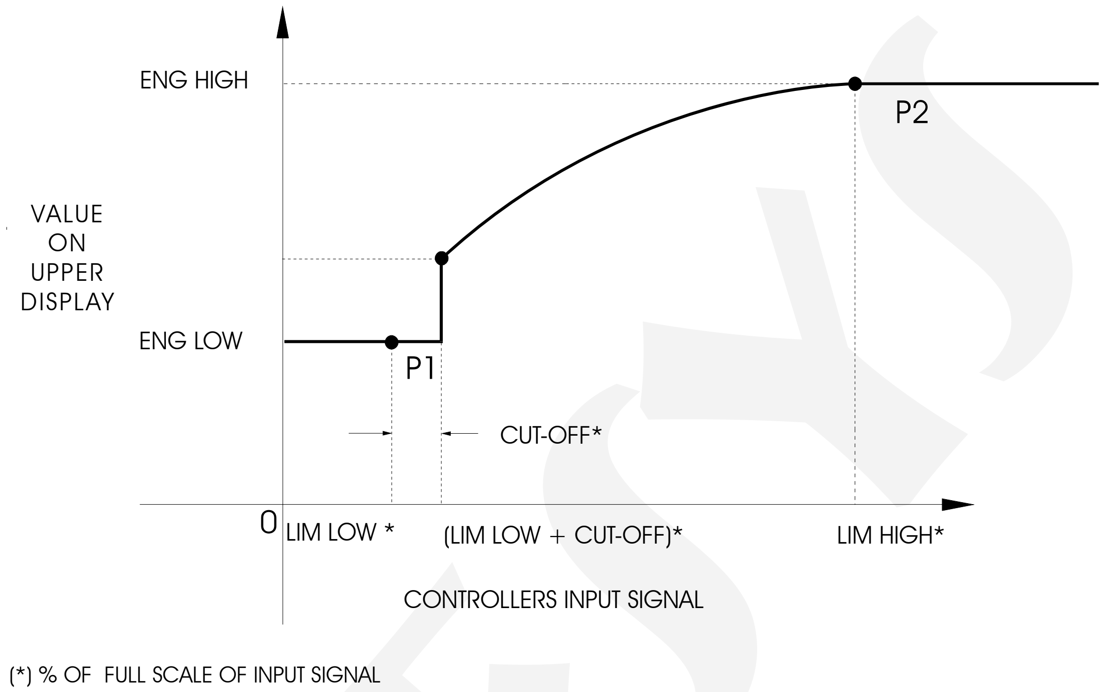



Fig. 16 - Square root of input signal

DEC PT. - sets the decimal point to exhibit the engineering units on the upper display. Up to three decimal digits may be set for linear processes whereas temperature sensors may have one or no decimal digit.

OFST (as shown on the upper display) - it allows the user to enter a fixed off-set value, in engineering units, in addition to the value shown on the upper display. This is a useful option whenever we have more than one instrument controlling the same process variable and showing slightly different readings. The OFST parameter may be used to equalize instrument measurements.

CJC - an option to select whether or not to have a cold junction compensation for thermocouple measurements. In case a cold junction compensation is desired, the internal compensation (INT) should be selected, otherwise, NO should be selected. Usually, INT is selected.

The types of input sensors are described on table - 1 of section 1.3 on Technical Specifications.

FILTER - this parameter provides the time constant for a first order digital filter associated with the selected input. Whenever no filtering of the controlled signal is desired, zero should be assigned to this parameter.

B. OUT - in the event of temperature sensor failure (thermocouple or RTD) or an open connection wire, the display indicates burn-out for the corresponding channel. In such cases, the UP option within this parameter enables the high alarms and the DOWN option disables the low alarms. In the event of a burn-out with the controllers in the automatic mode, they are automatically switched to the manual mode. In this case, the output switches to the parameter defined value - PO.BR (output power level, in case of sensor failure). In the event of a burn-out with the controllers in the manual mode, they remain in the manual mode and the output should be adjusted by the operator and not by the PO.BR parameter. When the controllers leave the burn-out, they go back to the mode in which they were operating prior to occurring the burn-out.

UNITS - selects °C or °F for temperature indication.

### 3.2.3 - Level 3 - Outputs

Level 3 allows the control output types to be configured in accordance with the option module internally installed in the controllers (see figure 17). Six types of outputs are available for control outputs 1 and 2: current (4 to 20mA), voltage (1 to 5V), voltage (0 to 10V), SPST relay, open collector voltage and solid-state relay. In the case of control outputs 3 and 4 the types of output available are: SPDT relay, open collector voltage and solid-state relay.

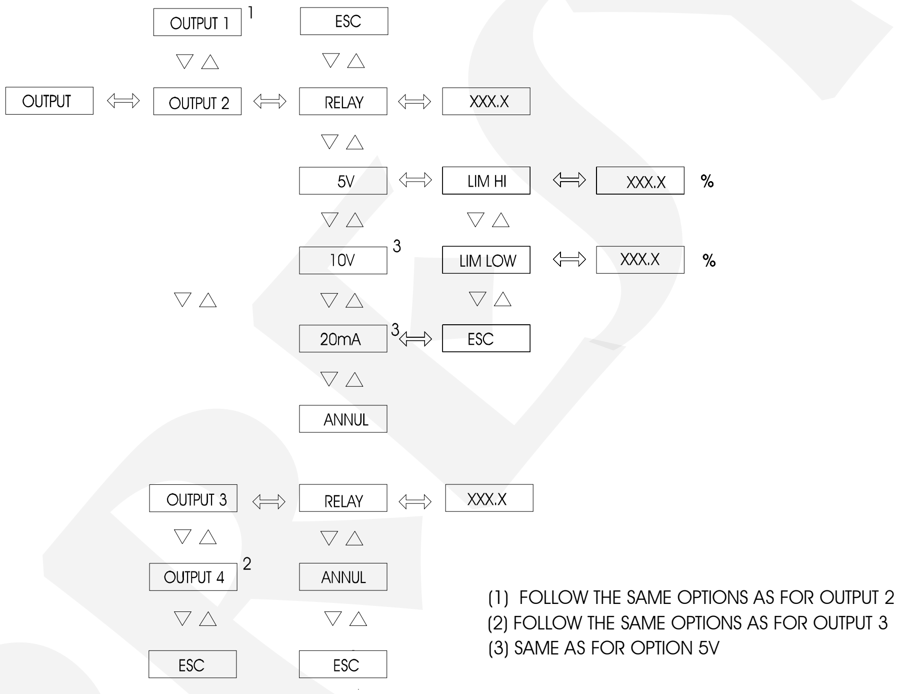



Fig. 17 - OUTPUT Level Options

The adjustable parameter span shown on figure 17 is given below.

| Mnemonic | Parameter | Adjustable Span | Factory Value | Units |
|---|---|---|---|---|
| LIM LOW | percentage of output full scale (20 mA, 5V or 10V) defining the lowest output signal. The output saturates in this value. | 0.0 to 100.0 | 0.0 | % |
| LIM HIGH | percentage of output full scale (20 mA, 5V or 10V) defining the highest output signal. The output saturates in this value. | 0.0 to 105.0% | 100.0 | % |
| RELAY | time associated to relay cycle (PWM period). This represents the heating time for those relays associated to outputs 1 and 2 and the cooling time for relays 3 and 4. | 1.0 to 120.0 | 10.0 | s |

**The control output will only be enabled after a type of output is selected with values being assigned to the related parameters.**

Whenever configured for current and voltage, the control outputs 1 and 2 should have their limits specified by the Lim Low and Lim High parameters. Note that Lim Low and Lim High are expressed as a percentage of output full scale and that the output signal saturates at those points. For example, in order to have an output under a current of 4 to 20mA, we should assign 20.0% for Lim Low and 100.0% for Lim High.

Whenever configured for relay, the control outputs 1, 2, 3 and 4 should have a specified cycle period.

## 3.2.4 - Level 4 - Alarms

In level 4 the outputs 2, 3 and 4 may be configured as alarm outputs; in this case, they are hence called relay 2, relay 3 and relay 4, respectively (see figure 19). A maximum of three alarm relays may be available through the acquisition of the corresponding option modules. The possible types of output for relay 2 are: SPST relay, open collector voltage or solid-state relay. In the case of relays 3 and 4 the available types of output are: SPDT relay, open collector voltage or solid-state relay.

Each relay may be associated to the set-point (SP) and the hysteresis (HYST) of only one type of alarm. There are six possible types of alarm: low for channel 1 (CH1L), high for channel 1 (CH1H), deviation for channel 1 (CH1D), low for channel 2 (CH2L), high for channel 2 (CH2H) and deviation for channel 2 (CH2D).In the case of the deviation alarm, (SP) denotes the span above and below the local set-point determining the lower and higher points where the deviation alarms occur. The alarm relays are only enabled after the user has selected the set-point values and pressed the ENTER key.

DELAY - it causes the alarm operation of each relay to be delayed by a user defined period of time (DELAY). Figure 18 below, illustrates the delay for a high alarm.

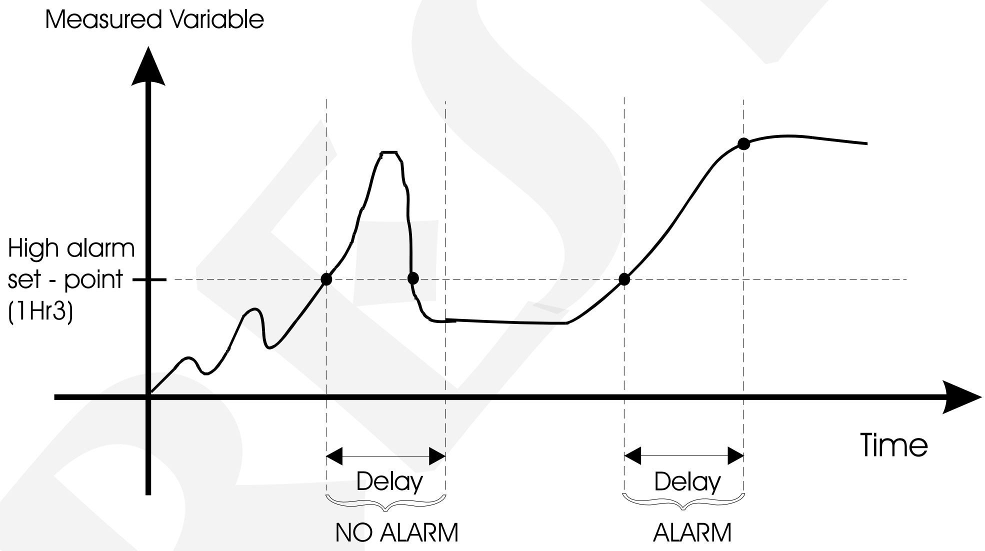



Fig.18 - Relay with delay

SAFE - provides relay safety. Relay safety condition means that relay coils are energized when the instrument is powered and are de-energized under an alarm condition or in the event of a power failure.

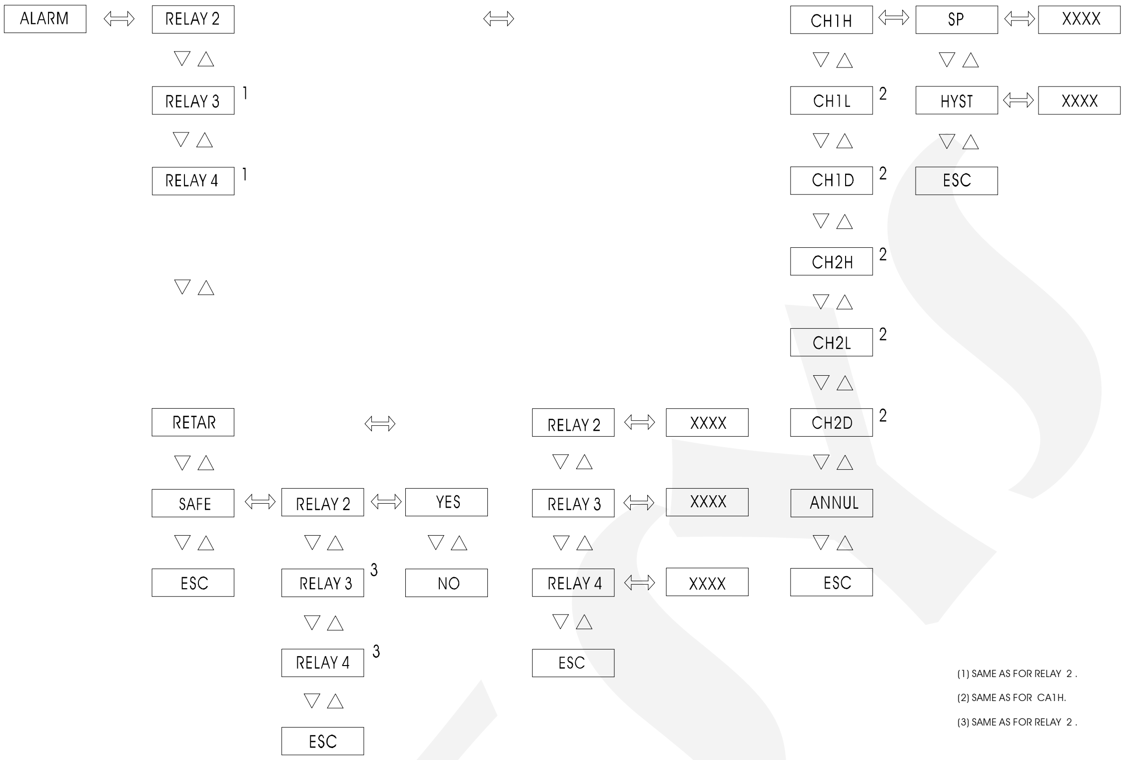



Fig. 19 - ALARM level options

The adjustable parameter span shown on figure 19 is given below.

| Mnemonic | Parameter | Adjustable Span | Factory Value | Units |
|---|---|---|---|---|
| SP | low or high alarm set-point | -999 to 9999 | 75.0 | EU |
| HYST | alarm hysteresis | 0 to 250 | 10 | EU |
| DELAY | delay for relay activation | 0.0 to 999.9 | 0.0 | seconds |
| SP | deviation alarm set-point | 1 to 9999 | 75.0 | EU |

### 3.2.5 - Level 5 - Control

The DCY-2050 and 2051 controllers can control up to two control loops. It is on Configuration level 5 that the desired control mode is selected for the control loops 1 and 2 (see figure 20).

The control capabilities of the DCY-2050 and 2051 controllers include:

* PID Control with voltage or current output.

* PID Control with relay output (time proportioning).

* Dual heating-cooling output control.

* ON / OFF control.

These control modes are independently available, both for the control loop 1 (control block 1) and the control loop 2 (control block 2). They can further be configured for:

* Reason Control.

* Cascade Control.

* Remote Set-Point Input Control.

* Programmable Set-Point Control.

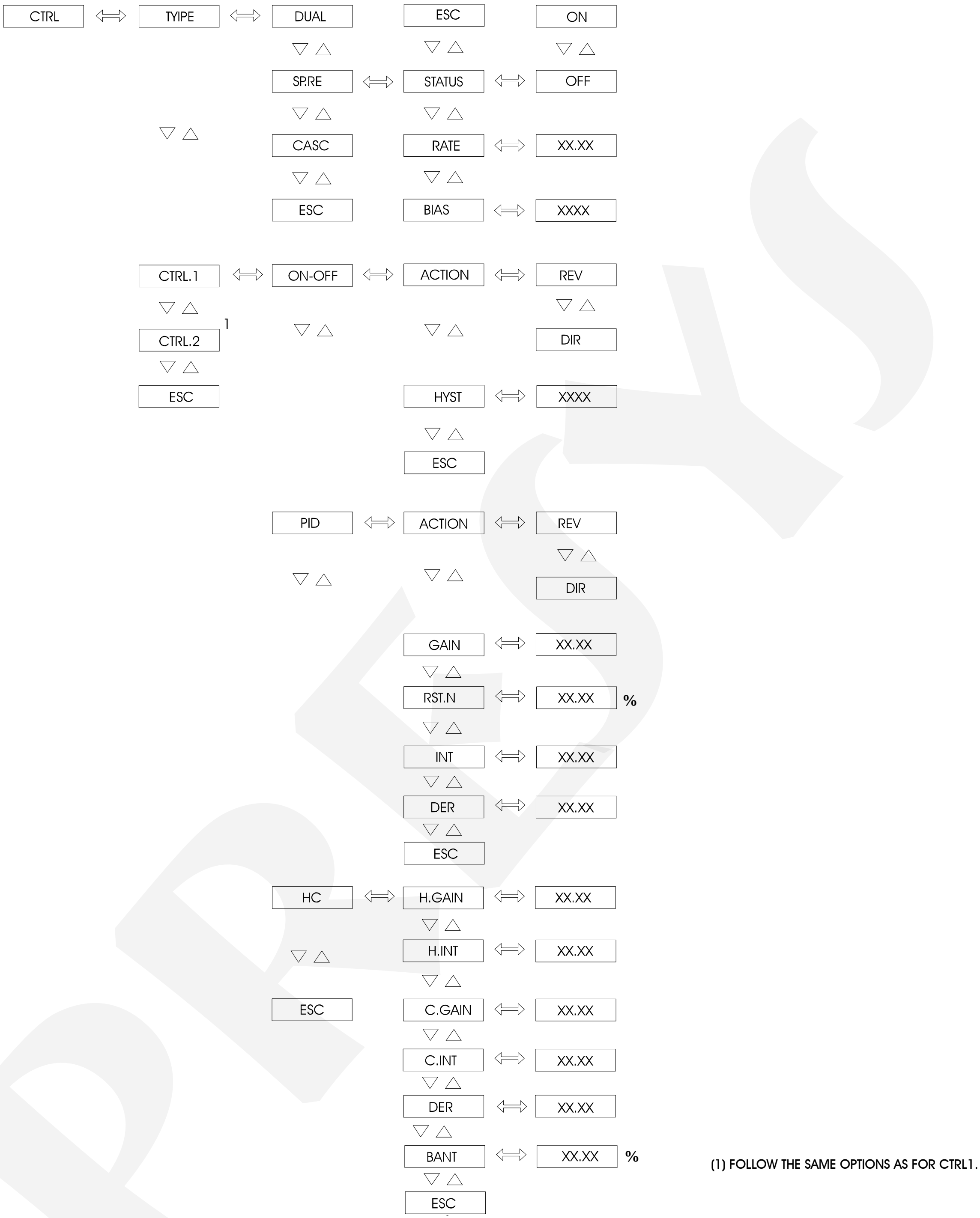



Fig. 20 - CONTROL Level Options

Note that to have a single-loop controller changed into a dual-loop controller it is only necessary to add the option output cards, since both use the same software.

The control modes selected in this level should be compatible with the output types installed in the instruments (see section on Connection of control output signals)

In the DCY-2050 and 2051 controllers the upper and lower displays always show the controlled variable and the set-point/output, respectively, for the control loop 1 or 2. The values shown on the upper and lower displays will always correspond to the same control block 1 or 2.

TYPE - this is the option causing the two control blocks 1 and 2 to actuate either independently or associated. The TYPE selections are:

DUAL - this is the option causing the two control blocks to actuate independently. This option is used both for single-loop and dual-loop control. Figure 21 below, illustrates the functioning of control blocks for such situation.

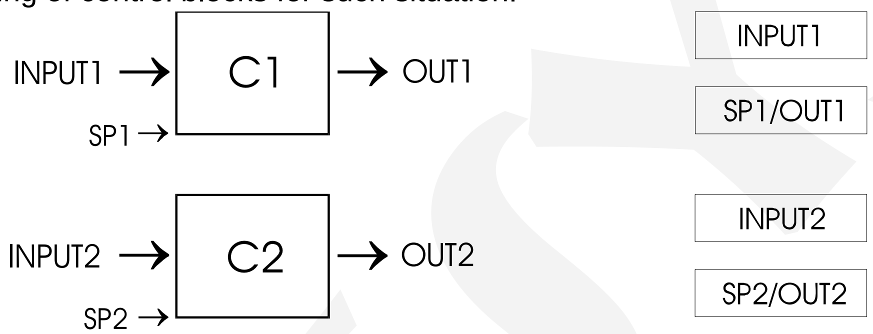



Fig.21 - Conceptual block diagram of control blocks and displays for the dual option

SP.RE - this is the option for a remote set-point input. Local set-point is the name given to the value of the set-point selected by the user and manually introduced by the UP and DOWN keys in the lower display of the controllers and remote set-point is the set-point introduced via the input 2 of the controllers. In this case, only the control block 1 is present, as illustrated on figure 22 below.


Fig.22 - Conceptual block diagram of control block and display for a remote set-point

When the remote set-point is enabled, the lower and upper displays will only indicate the values associated to the control loop 1 and the UP and DOWN keys will not actuate on the set-point value shown on the lower display, since it is being externally controlled.

STATUS - this is the option which actually enables (ON) or disables (OFF) the remote set-point. This is an option which allows a quick changeover between a local and a remote set-point.

Input 2 on the controllers, receiving the remote set-point signal, is adjusted to the span of input 1 in terms of engineering units by means of the RATE and BIAS parameters, according with the equation shown below:

SP.RE = RATE * (Input 2) + BIAS

RATE , BIAS - gain and offset adjusting the span of input 2, in engineering units, to the span, in engineering units of input 1.

CASCADE - this type of control is used for a process in which the controlled variable is affected by several other rapidly varying external variables, but whose effects would be shown with great delay in the controlled variable. This type of control uses two controllers. In the case of the DCY-2050 and 2051 controllers the control block 1 will act as the master controller and its output will provide the slave controller with the set-point which will be the control block 2, as illustrated on figure 23, below.

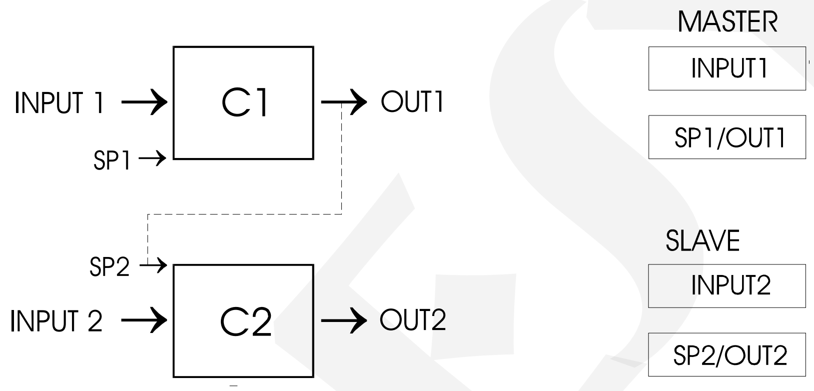



Fig. 23 - Conceptual block diagram of the control blocks and display for the cascade control

In the case of the cascade control indicating the values of the controlled variable (upper display) and the set-point/output (lower display) for control block 2 (slave controller) the UP and DOWN keys will not actuate on the set-point value shown on the lower display, since it is controlled by the output of control block 1 (master controller).

CTRL1, CTRL2 - represent the control blocks 1 and 2; they may associate with the various control modes described below.

ON/OFF Control

ON/OFF - associates the ON/OFF control mode with the related control block, 1 or 2 (or both).

ACTION - this option determines the direction of the control action (direct or reverse).

HYST (hysteresis) - this is the span above and below the set-point value which determines the lower and upper switching limits for the relay contacts (by relay we mean the relay itself, the solid-state relay and the open collector voltage.

REV (reverse) - whenever REV is selected for control action (ACTION), the output signal is switched to OFF when the controlled variable exceeds the set-point value plus the hysteresis (upper limit) and switched to ON when the variable falls below the set-point minus the hysteresis (lower limit).

DIR (direct) - whenever DIR is selected for a control action (ACTION), the output signal is switched to ON when the controlled variable exceeds the set-point value plus the hysteresis (upper limit) and switched to OFF when the variable falls below the set-point minus the hysteresis (lower limit). The ON/OFF control mode with reverse action is illustrated on figure 24 below.

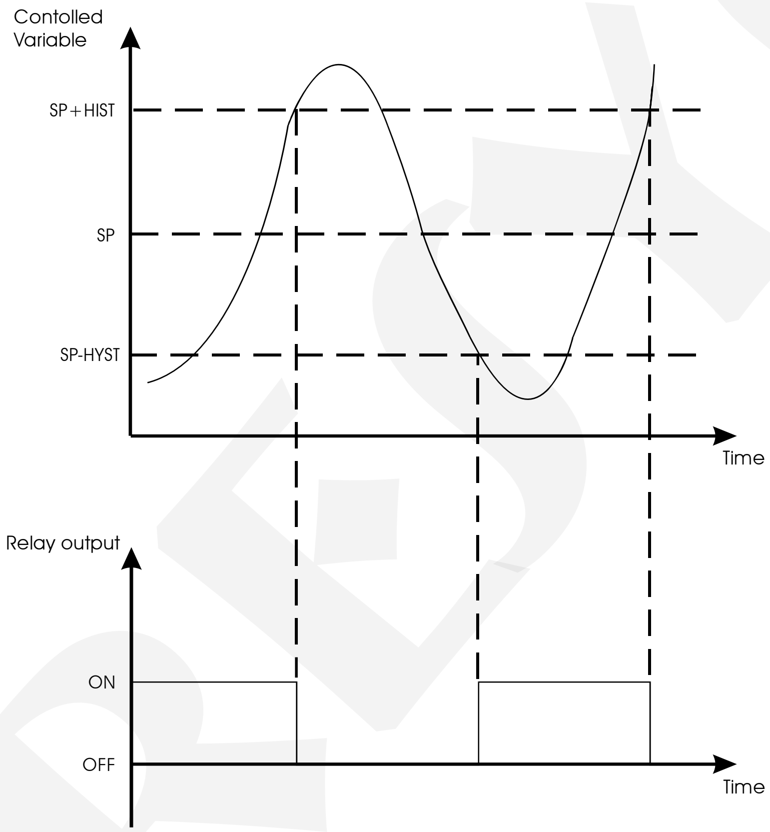



Fig. 24 - ON-OFF control with reverse action

PID control

PID - it associates the PID control mode with the related control block, 1 or 2 (or both).

ACTION - this option determines the direction of the control action (direct or reverse).

REV (reverse) - whenever REV is selected for control action (ACTION), an increase in the input signal will decrease the output signal. The error (E) between the set-point (SP) and the controlled variable (Y) is defined in the reverse action as: E = SP - Y.

DIR (direct) - whenever DIR is selected for a control action (ACTION), an increase in the input signal will decrease the output signal. The error (E) between the set-point (SP) and the controlled variable (Y) is defined in the reverse action as: E = Y - SP.

The choice between direct and reverse action will depend on the system to be controlled.

In the PID control mode the controller output (U) relates to the set-point (SP) and to the controlled variable (Y) through the following equation described in continuous time:

$$U(t) = \frac{GANH \ . \ 100.0}{ENGHIGH - ENGLOW} \cdot \left[ E(t) + INT \int E(t)dt \pm DER \cdot \frac{d}{dt} Y(t) \right] + RSTN$$

In direct action, the positive sign before the derivative is valid and the error (E(t)) is taken as the input (Y(t)) minus the set-point (SP).

In reverse action, the negative sign is valid before the derivative and the error (E(t)) is taken as set-point (SP) minus the input (Y(t)).

The coefficients appearing in the above equation are selected within the PID option and have the following meaning:

GAIN - it amplifies the error signal between the set-point and the controlled variable to establish the output signal.

RSTN - this is the controller's manual reset stated as an offset aggregated to the controller's output signal. It will always be required when proportional control mode (P) or proportional plus derivative control mode (P+D) are used, so as to eliminate the offset between the set-point and the controlled variable.

INT - this is the integral ratio expressed in terms of repeats per minute. It is defined as the number of times the integral action will repeat the proportional action resulting from the occurrence of a step in the controlled variable in 1 minute. The integral action or automatic reset is the most important part governing the set-point control. While an error persists between the set-point and the controlled variable the integral action will actuate on the output signal until the error is brought to zero.

DER - this is the derivative time given in minutes. It is defined as the time advance which the derivative action causes on the output signal in relation to the proportional action whenever a ramp occurs in the controlled variable. The derivative action provides a quick response at the control output resulting from any rapid variation in the controlled variable. It is used to eliminate oscillations. Note that on the DCY-2050 and 2051 controllers the deviate is applied to the controlled variable; this inhibits the derivative action whenever the set-point only is altered.

Proportional control only (P)

The proportional control only, usually results in a response with high overshoot and presenting a regime error (offset) related to the set-point value.

Proportional plus integrative control (P + I)

The PI control eliminates offsets, but causes a response with very high overshoot and a very high stabilization time for the oscillations to cease and the system to reach a stationary regime.

Proportional plus derivative control (P + D)

The PD control, usually, leads the system to the stationary regime with less oscillations; however, the offset may still remain.

Proportional plus derivative plus integrative control (P + I + D)

The PID control is a solution incorporating the advantages of the PI control and the PD control. Therefore, the offset is eliminated by the integrative action . The derivative action eliminates the overshoot and reduces the oscillations caused by the PI control.

PID control with current or voltage output

To obtain this form of control one just has to select the PID control mode within the Control level 5 for the desired control block 1 or 2 and to have voltage or current output modules as built-in output devices (output 1 for control block 1 and output 2 for the control block 2).

Time proportioning control

This PID control mode is provided with an ON/OFF output device: SPST relay, solid-state relay and open collector voltage. Therefore, the difference between this one and the previous form of control is the presence of output devices. Any one of those devices may be plugged-in as output 1 for control block 1 and the same applies to control block 2 which may be equipped with any of those devices to serve as output 2. Note that in this form of control, it is the ON time of the output device that varies according to PID output computation. The device ON/OFF period being constant and defined by the user at level 3 of the Output Configuration (RELAY), it is the duty cycle that actually varies.

Dual output control (heating-cooling)

HC - associates the heating-cooling control mode to the corresponding control block, 1 or 2 (or both).

The heating-cooling control mode is obtained by dividing the scaled output from -100.0% to 100.0% into two portions: the cooling band (-100.0% to 0.0%) and the heating band (0.0% to 100.0%). The transition point between the two bands is 0.0%. Enabling of the heating or cooling output is dependent on the PID output computation relative to the transition point 0.0%. Whenever the computed output is above the transition point the heating output is enabled and when the computed output is below the transition point the cooling output is enabled. At each very moment there is only one enabled output (see figure 25).

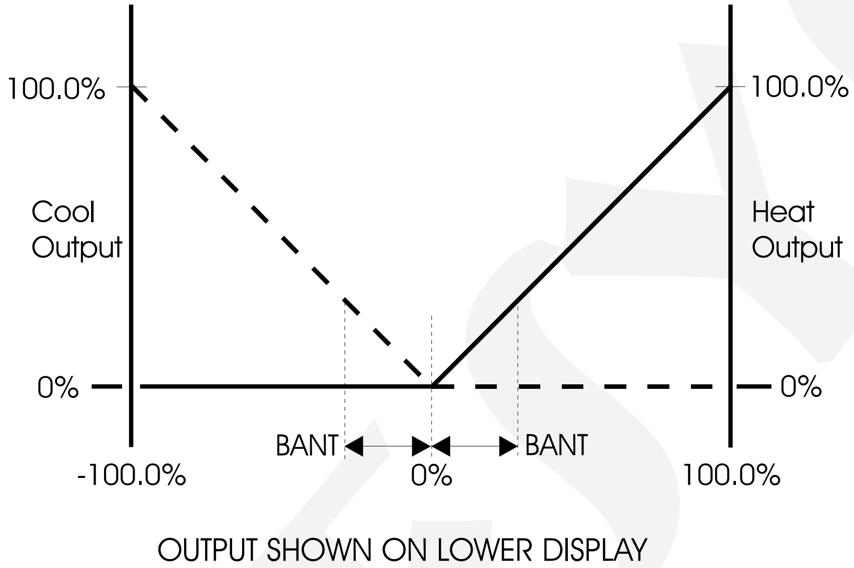



Fig. 25 - Heating-Cooling Output Transition

In the heating-cooling control some alteration may occur in the gain, integrative ratio and derivative time values when crossing from the cooling band to the heating band. Such alteration should not happen in a rough way, as it would correspond to a violent change in control output. In order to prevent such effect from happening a transition band is defined (BANT) below and above the transition point where the PID parameters vary in the form illustrated in figure 26.

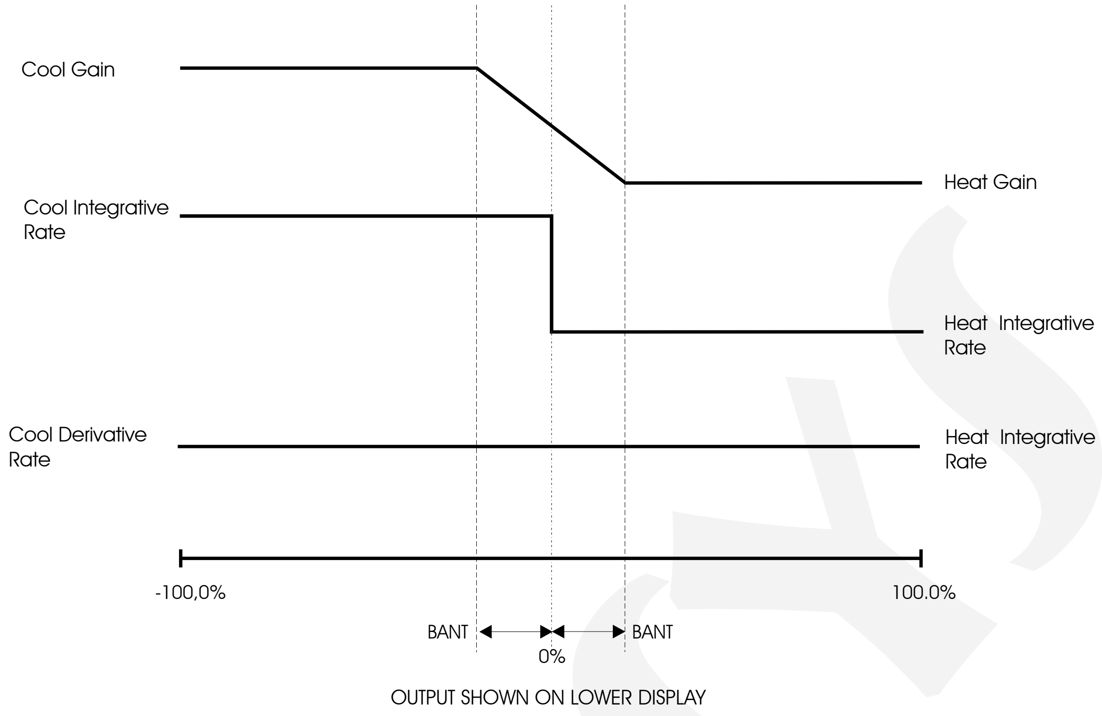



Fig. 26 - PID parameter variation in the heating-cooling transition

As it can be seen on the above figure, the gain in the transition zone shows a linear variation, the integrative ratio shows a step in its variation at that point and the derivative time remains the same. Those parameters correspond to the following mnemonics:

BANT - transition band defined above and below the transition point
H.GAIN - PID gain for the heating output
H.INT - PID integrative ratio for the heating output
C.GAIN - PID gain for the cooling output
C.INT - PID integrative ratio for the cooling output
DER - PID derivative time common to heating and cooling outputs

Whenever the heating-cooling is selected for control block 1, output 1 will be the heating and output 3 will be the cooling output. In case the heating-cooling control is selected for control block 2, output 2 will be the heating and output 4 the cooling output. For outputs 1 and 2 we have the following internally plugged-in module types: voltage output, current output, SPST relay, solid-state relay and open collector voltage. Outputs 3 and 4 we have the following internally plugged-in module types: SPDT relay, solid-state relay and open collector voltage.

The adjustable parameter span shown on figure 20 is given below.

| Mnemonic | Parameter | Adjustable span | Factory Value | Units |
|---|---|---|---|---|
| RATE | Rate | 0.01 to 99.99 | 1 | ------------ |
| BIAS | Offset | -999 to 9999 | 0 | EU |
| HYST | Hysteresis | -999 to 9999 | 0 | EU |
| GAIN | Gain | 0.01 to 99.99 | 1 | ------------- |
| RSTN | Manual reset | 0 to 99.99 | 50.0 | % |
| INT | Integrative rate. | 0 to 99.99 | 0 | rep/min |
| DER | Derivative time | 0 to 99.99 | 0 | min |
| H.GAIN | Heating gain | 0.01 to 99.99 | 1 | ------------- |
| H.INT | Heating integrative rate | 0 to 99.99 | 0 | rep/min |
| C.GAIN | Cooling gain | 0.01 to 99.99 | 1 | -------------- |
| C.INT | cooling integrative rate | 0 to 99.99 | 0 | rep/min |
| DER | Derivative time | 0 to 99.99 | 0 | min |
| BANT | Transition band | 0 to 50 | 0 | % |

### 3.2.6 - Level 6 - Tune

The DCY-2050 and 2051 controllers can apply PID control algorithms both for control loop 1 and for control loop 2. The PID parameters: Gain (GAIN), Integrative Rate (INT) and Derivative Time (DER) are adjustable over a wide span of values in order to accommodate several processes with varying characteristics. In the event of a specific control application, these parameters should be adjusted in order to achieve the best system performance.

For this purpose, the DCY-2050 and 2051 controllers are provided with auto-tune algorithms which, whenever activated by the user, will automatically compute, both on start-up (the controlled variable is far from the set-point, as is usually the case when the instrument is switched on) and on demand (the controlled variable is close t the set-point, as is usually the case when the system already under operational regime), the optimum PID values based on process reaction curve during the auto-tune cycle. After carrying out PID computation via the auto-tune algorithm the controllers start controlling the process in the automatic mode under those new values.

The auto-tune algorithm is only carried out provided:
i) the control is of the DUAL type.
ii) the control algorithm for loop 1 or loop 2 is selected for PID.
iii) the programmable set-point is not enabled; STATE should be switched off.

Warning:

Whenever the derivative time (DER) is configured as zero, the auto-tune algorithm will compute the parameters only for a PI control.

Before carrying out the auto-tune, the user should select the proper control action (reverse or direct) to meet the requirements of this process.

The auto-tune algorithm is not carried out in the ON/OFF control and in the heating-cooling control. For PID adjustment in the heating-cooling control the user should carry out the PID manual adjustment sequence described at the end of this section.

The auto-tune algorithm is carried out regardless of whether the controllers are in the automatic or manual mode.

Types of auto-tune

Auto-tune on start-up

The auto-tune procedure on start-up is carried out whenever the controlled variable is far from its setpoint value, as is usually the case on start-up.

For the user to activate the auto-tune on start-up, he should carry out the following steps:

i) start by entering the Configuration level 6.

ii) to select the control network where the auto-tune will be carried out (CH-1) or (CH-2).

iii) to select the ON option for the St.Up parameter (auto-tune on start-up) and press ENTER.

iv) Note that the controller's upper display show a flashing TUNE message, indicating that the auto-tune algorithm is under development. Upon completion of the auto tune algorithm, the TUNE message disappears from the upper display.

Auto-tune on demand

The on demand auto-tune procedure is carried out whenever the controlled variable is close to its setpoint value and the system has already achieved its steady condition. Therefore, before activating the auto-tune on demand make sure both the controlled variable and the control output are stable.

Whenever the auto-tune on demand is activated, the controllers start generating a square wave in their control outputs with an amplitude selected by the user (D.Out), centered on the output value, in order to cause oscillations on the controlled process, as illustrated on figure 28. Based on such oscillations, on the controlled process, as illustrated on figure 27. Based on such oscillation the auto-tune algorithm computes the PID parameters and from that moment on the plant is controlled by those new parameter values.

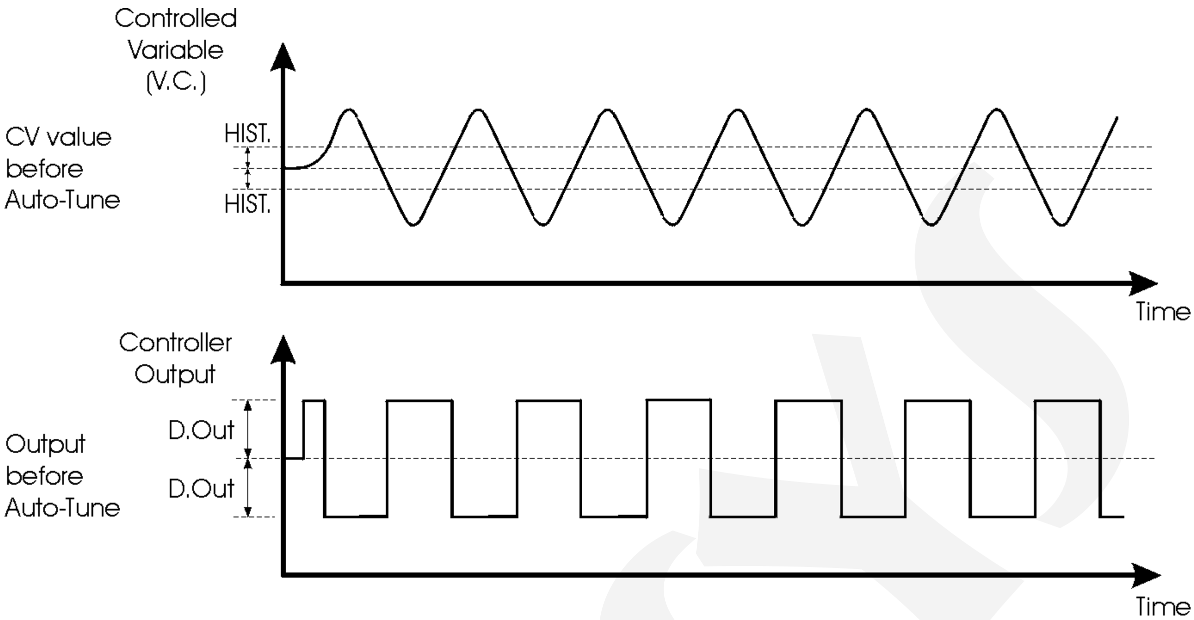



Fig. 27 - Process variable and control output for on demand auto-tune

D.Out - This is the parameter determining the amplitude of the square wave generated in the control output for auto-tune computation. The control output will cause this value to vary for the more and for less from its present output.

Hyst - This is the parameter determining when the output should be changed. Whenever the control variable crosses the upper and lower hysteresis limits, the controller output should cause the D.Out value to vary for the more or for less from its original value.

LIM.S, LIM.I - They correspond to the upper and lower safety limits (trip point), which determine a span within which the control variable can vary due to the auto-tune process. In case the control variable exceeds this span the auto-tune process is aborted.

The on demand auto-tune activation involves the followign steps:

i) start by entering the Configuration level 6.
ii) to select the channel in which the auto-tune will be carried out (CH-1) or (CH-2).
iii) to select the amplitude of the square wave (D.OUT) and of the hysteresis (Hist), see figure 27.
iv) to select the ON option for the AUTO parameter (auto-tune on demand) and press ENTER.

Note that as soon as the third step is completed the controllers will go to normal operation mode with the TUNE message and the controlled variable alternating on the upper display. Upon completion of the auto-tune cycle the instrument no longer displays the TUNE message (see figure 28).

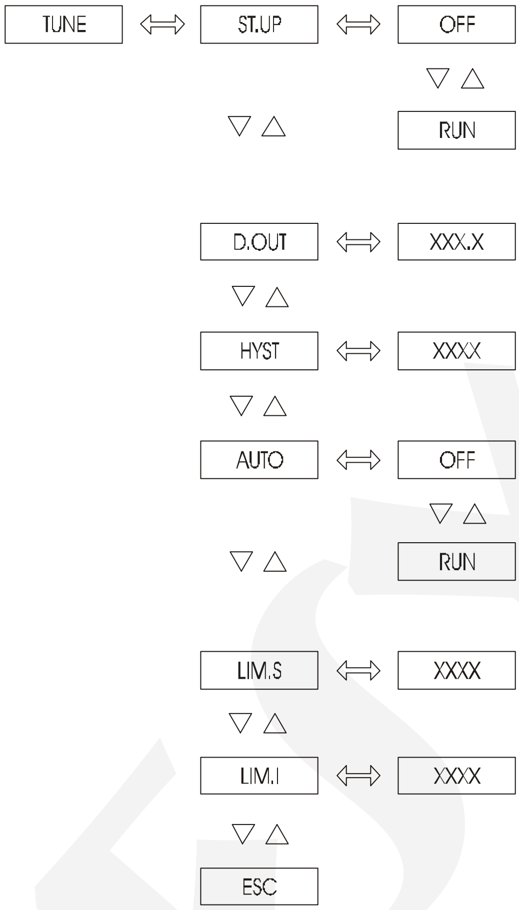



Fig. 28 - TUNE Level Options

The adjustable parameter ranges shown on figure 29 are given below.

| Mnemonic | Parameter | Adjustable Range | Factory Value | Units |
|---|---|---|---|---|
| D.Out | square wave amplitude | 0 to 100.0 | 10.0 | % |
| Hyst | hysteresis above and below the process variable | -999 to 9999 | 10 | EU |
| LIM.S | Upper Limit | -999 to 9999 | 9999 | EU |
| LIM.I | Lower Limit | -999 to 9999 | -999 | EU |

Manual PID adjustment

The manual adjustment of the PID parameters will be based on the Method of ultimate sensitivity developed by Ziegler and Nichols. By this method, the optimum PID adjustment will be that in which the process reaction curve shows consecutive oscillations peaks with amplitudes at the rate of 1/4.

In order to apply this method, the following described steps should be carried out:

i) Set the integrative rate (INT) and the derivative time (DER) to zero, i.e., leave the controllers under proportional action only.
ii) Set an arbitrary gain value (PROP) and record the controlled variable.
iii) Adjust the gain value (PROP), also called sensitivity, until reaching a limit value in which the controlled variable will show a uniform oscillation, i.e., with constant amplitudes (see figure 30). Values above that limit produce amplifying oscillations, whereas gain values below that limit will dampen those oscillations. By ultimate sensitivity (Ku) it is meant that limit gain and by ultimate period (Pu) it is meant the period of constant oscillation caused by this sensitivity.

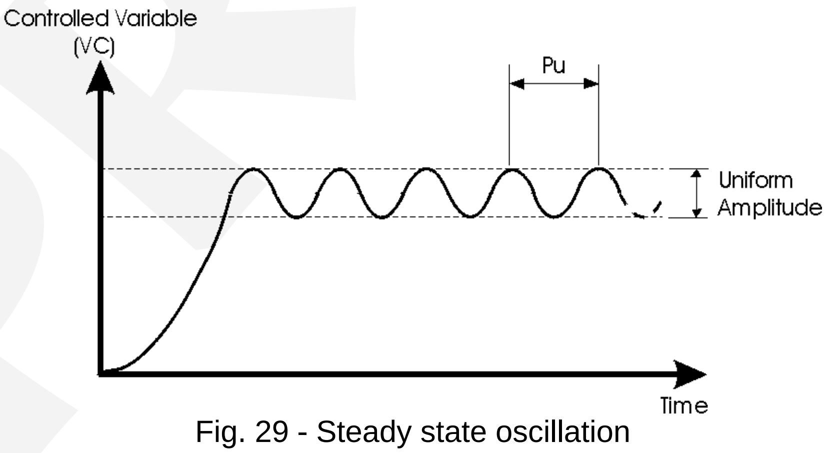



Fig. 29 - Steady state oscillation

Compute the optimum PID parameter adjustment according to the table below:

| Control action | Gain | Integrative Rate (INT) | Derivative time (DER) |
|---|---|---|---|
| P | 0.5 Ku | - | - |
| P + I | 0.45 Ku | 1/(0.83 Pu*) | - |
| P + D | 0.6 Ku | - | 0.125 Pu |
| P + I + D | 0.6 Ku | 1/(0.5 Pu) | 0.125 Pu |

* Pu - given in minutes

PID Adjustment under the heating-cooling mode

Select the heating-cooling control mode (HC) in level 5. Assign the derivative time (DER) with the value obtained from the table. Set the heating integrative rate value (H.Int) to the same value of the cooling integrative rate (C.Int), and both equal to the value obtained from the above table. Note that the equality between derivative time and the integrative rate for the heating and cooling action are justified by the fact that both actuate on the same process and are both related to the process oscillation period. The same does not apply to gain. Therefore, the heating gain may be obtained from the above table, but the cooling gain should be manually adjusted until the best system performance is achieved.

## 3.2.7 - Level 7 - SetP (Programmable Setpoint)

The DCY-2050 / 2051controllers can run a program which generates, repeatedly, up to ten setpoint values.

The setpoint values, the time taken to reach these values and the number of times this setpoint sequence should be repeated are parameters selected by the user within Configuration level 7.

Figure 30 shows an illustration of a wave form obtained from the setpoints programmed by the user. Note that the first setpoint (SP-1) is reached from the local setpoint and that after running the programmable setpoint the value to be used for the local setpoint will be the last value obtained by the programmable set-point.

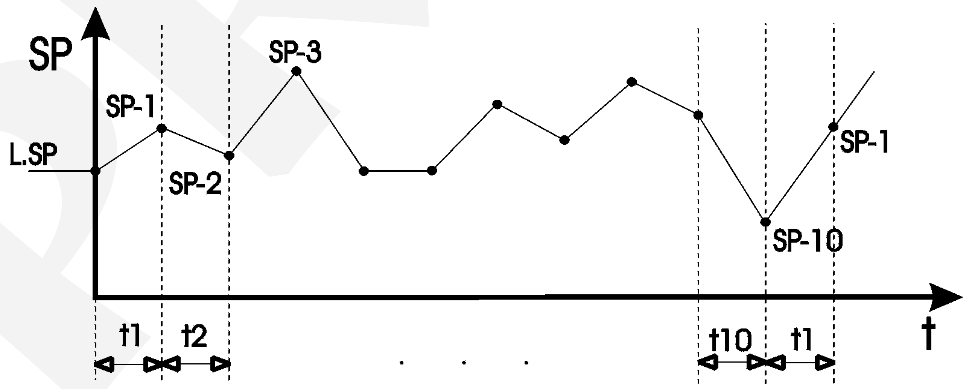



Fig. 30 - Evolution of the programmable setpoint

The options of level 7 are shown on figure 31, below.

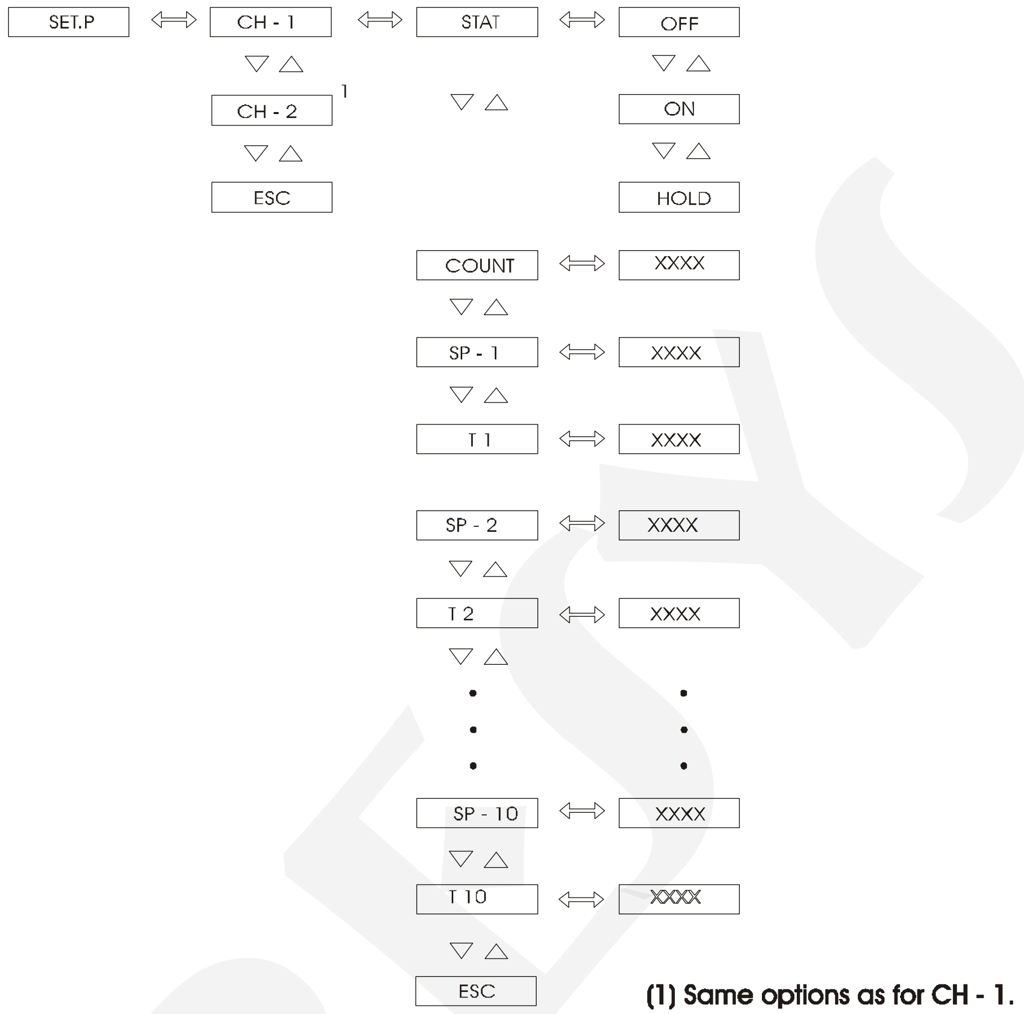



Fig. 31 - Programmable Setpoint Level Options

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STAT (State) - it allows the user to activate the programmable setpoint (ON), disable the programmable set-point (OFF) or to indefinitely suspend (SUSPENDED) set-point execution; in that case, the set-point value remains stationary at the set-point value which was under development when the selection SUSPENDED was assigned to parameter STAT. To reverte, enable the option (ON).

Before enabling the programmable setpoint one should program the setpoint values (SP-1, SP-2,... SP-10), the elapsed times to reach those values (t1, t2,...t10) and the number of times (L.C.) this setpoint sequence should be repeated. Note that t1 is the time interval for the setpoint to develop from the local setpoint to the first programmable setpoint SP-1; t2 is the time interval it takes to reach SP-2 starting from SP-1 etc.

COUNT - this is the parameter programmed by the user which determines the number of times the set-point sequence should be repeated. If COUNT is programmble at 250 the programmable set-point is continuously executed. While the programmable set-point is being executed such parameter may no longer be altered and serves the purpose of showing the user how many cycles are still remaining before ending.

The adjustable parameter ranges are shown below.

| Mnemonic | Parameter | Adjustable Range | Factory Value | Units |
|---|---|---|---|---|
| COUNT | counter determining how many set-point cycles will be executed or how many cycles are left before the end of the programmable set-point execution. | 1 to 250 | 1 | repeats |
| SP-1, SP-2, ... SP-10 | set-point value | -999 to 9999 | 5000 | EU |
| t1, t2, ... t10 | time to reach the set-point | 0 to 9999 | 0 | minutes |

Whenver less than ten set-points are required, just set the time it would take to reach the next set-point value at zero. Exemplifyng, should we require two programmable set-point values SP-1 and SP-2, t3 should be set to zero.

Itis not uncommon that one might require a sequence of set-point ramps alternating with dwell segments. The dwell segment is easily obtained by assigning the same value to two adjacent set-points. Therefore, if we wish the set-point to remain at a specified value for a specified time interval, we just have to assign such value to SP-1 and to SP-2.The duration f such dwell segment is determined by the time t2.

Set-point evolution will be shown on the lower display when the user reverts to operation level. Should he wish to check how many cycles still remaining before ending the program, the user should return to programmable set-point level 7 and note the value of parameter COUNT.

## 3.2.8 - Level 8 Calibration

Level 8 is described in section 4.4 on Calibration.

## 3.2.9 - Level 9 - RS

Refer to the communication manual.

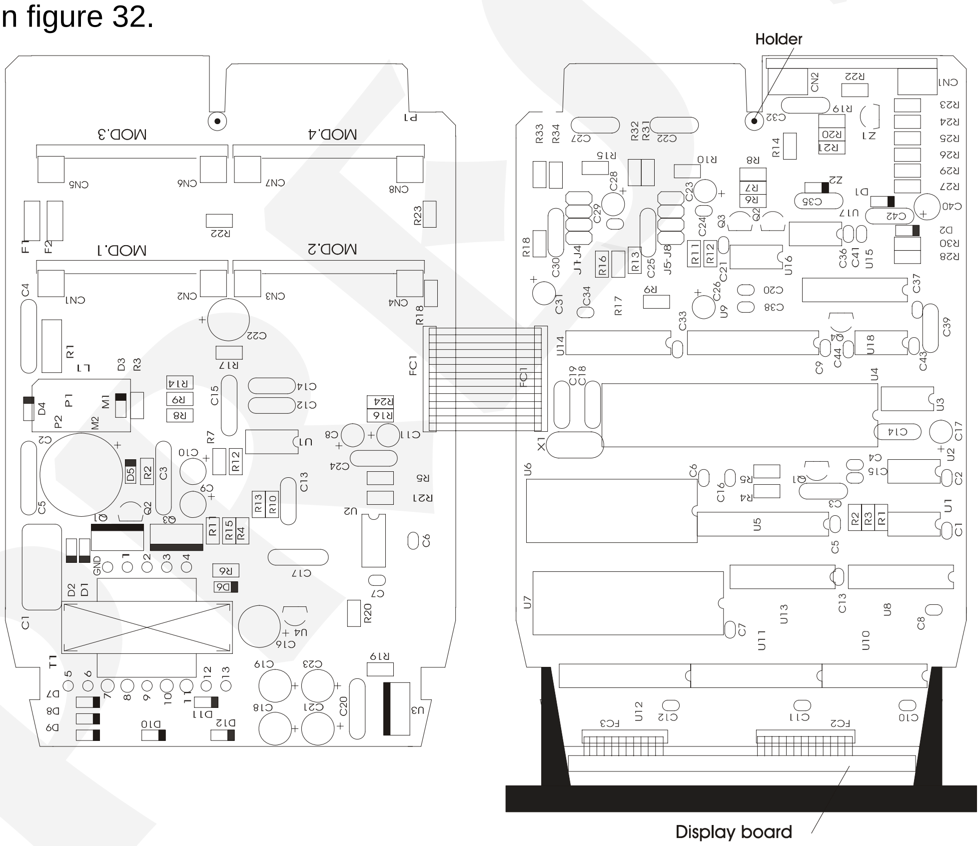
# 4.0 - Maintenance

## 4.1 - Controllers Hardware

Controllers maintenance requires the user to have access to the instrument hardware. The controller hardware is divided into three main circuit boards: the Display Circuit Board, the CPU Circuit Board and the Power Source Circuit Board. The three circuit boards are attached to the aluminum case by only one screw located at the front panel. Loosen this screw and pull the controller front panel to remove the instrument from its case.

The Display Circuit Board is located on the controller's front panel. The front panel is provided with four internal retaining brackets located on the four corners which keep the CPU Circuit Board and the Power Source Circuit Board attached together. A spacer is screwed between the CPU Circuit Board and the Power Source Circuit Board to confer the set a greater rigidity. To open the set follow the instructions below:

i) Remove the screw attaching the spacer located on the rear part of the circuit boards.
ii) Turn the controllers so that its display will be positioned opposite to reading direction.
iii) Just loosen the retaining bracket located on the RH upper corner of the front panel.
iv) Disengage the upper circuit board toward the right and open the circuit boards as shown on figure 32.




Power Supply Board CPU Board

Fig. 32 - Controllers Hardware

## 4.2 - Hardware Configuration

The input level configuration by software (level 2 - Inputs) should be implemented by a process input configuration by hardware, by way of internal jumpers.

There are four places for the installation of jumpers for channel 1: J5, J6, J7 and J8; and also four places for the installation of jumpers for channel 2: J1, J2, J3 and J4. They are located on the CPU Circuit Board as illustrated on figure 33.

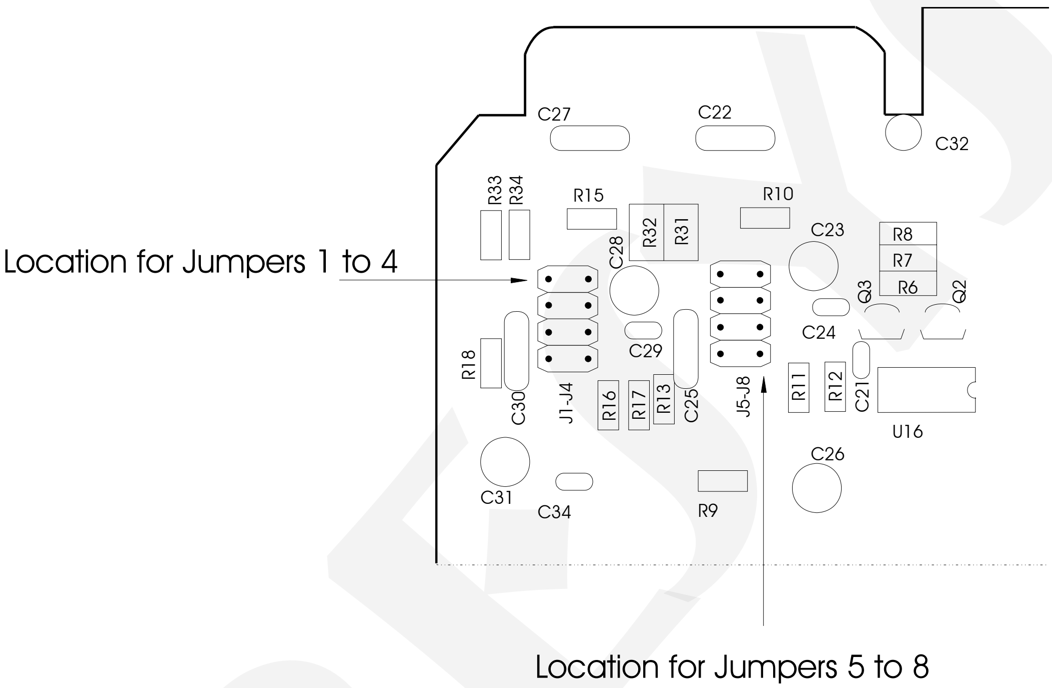



Fig. 33 - Location of Jumpers on the CPU Circuit Board

Table 2 indicates the jumpers to be installed for the various types of inputs. Check the required type of input and locate the jumpers as specified. Make sure only those jumpers corresponding to the required input are installed.

| Input Type | Jumpers | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Channel 2 | | | | Channel 1 | | | |
| Thermocouple | J1 | | | J4 | J5 | | J7 | |
| Voltage (0 to 55mV) | J1 | | | J4 | J5 | | J7 | |
| Voltage (0 to 5V) | J1 | | | J4 | J5 | | J7 | |
| Voltage (0 to 10V)* | | | J3 | | | J6 | | |
| 2-wire or 3-wire RTD | J1 | J2 | | | J5 | | | J8 |
| Current (0 to 20mA) | | | J3 | J4 | | J6 | J7 | |

Table 2 - Configuration jumpers per type of input

(*) In the case of input under a voltage from 0 to 10V the second factory supplied jumper should be stored by the user away from the instrument or simply engaged to one of the connector pins, in a dummy position as illustrated on figure 34.

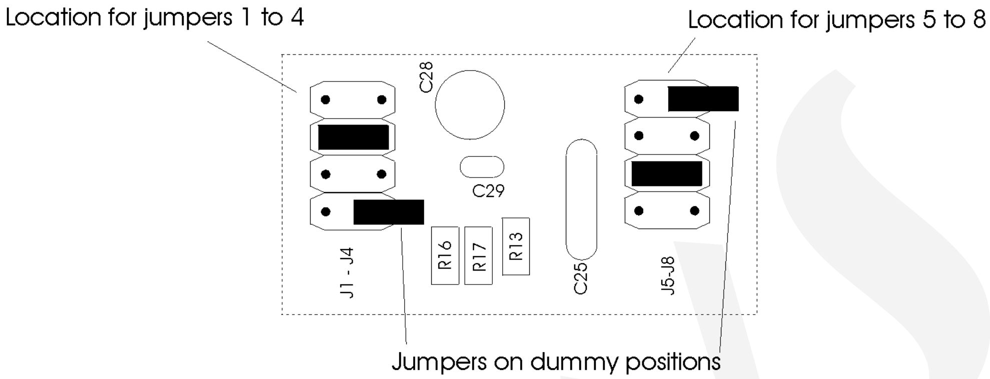



Fig. 34 - Jumpers on dummy positions for a 0 to 10V input

## 4.3 - Snubber use for relay

Relay modules are provided with circuits for eliminating electrical arch (RC snubber). The snubbers are put in parallel with the relay contacts, by placing the jumpers J1 and J2. When the jumpers are not placed, the relay contacts are kept without snubbers. The relay module is sent from factory with the jumpers placed.

Note the position of the jumpers in the following figure. The jumpers may be localized on the front or the back side of the board, depending on its version.

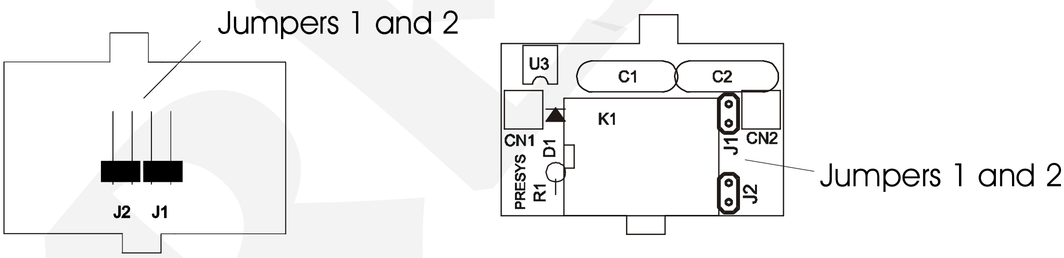



Fig. 35 - Jumpers for selection of snubbers on the relay board

Alarm and control relays are extremely critical in control and safety of industrial processes. In order to ensure the expected relay behavior, consider the following two loading conditions.

- High currents circulating through the relay contacts (from 20mA to 3A). When the relay switches high currents there is the occurrence of electrical arch which damage quickly the relay contacts. Besides, electrical noise is generated. In these conditions, it is recommended to use the RC snubbers which come with the relay module (placed jumpers).

- Low currents circulating through the relay contacts (less than 20mA). The relays could not function properly when the jumpers are placed. In this case, the snubbers maintain a 4.5mAac/9.0mAac current when connected to a 120VAC/220VAC circuit. This current is enough, in certain cases, to power a horn or alarm lamps, preventing their deactivation. In this situation, there is no need to use the snubbers and the jumpers must be removed.

## 4.4 - Optional Module Connections

The DCY-2050 and 2051 controllers may be provided with up to four output signals plus communication. For that purpose, the corresponding optional modules should be installed inside the instrument. By opening the controllers as explained in section 4.1, access is gained to 4 plug-in connections on the Power Source Board, plus one plug-in connection on the CPU Board (see figure 35).

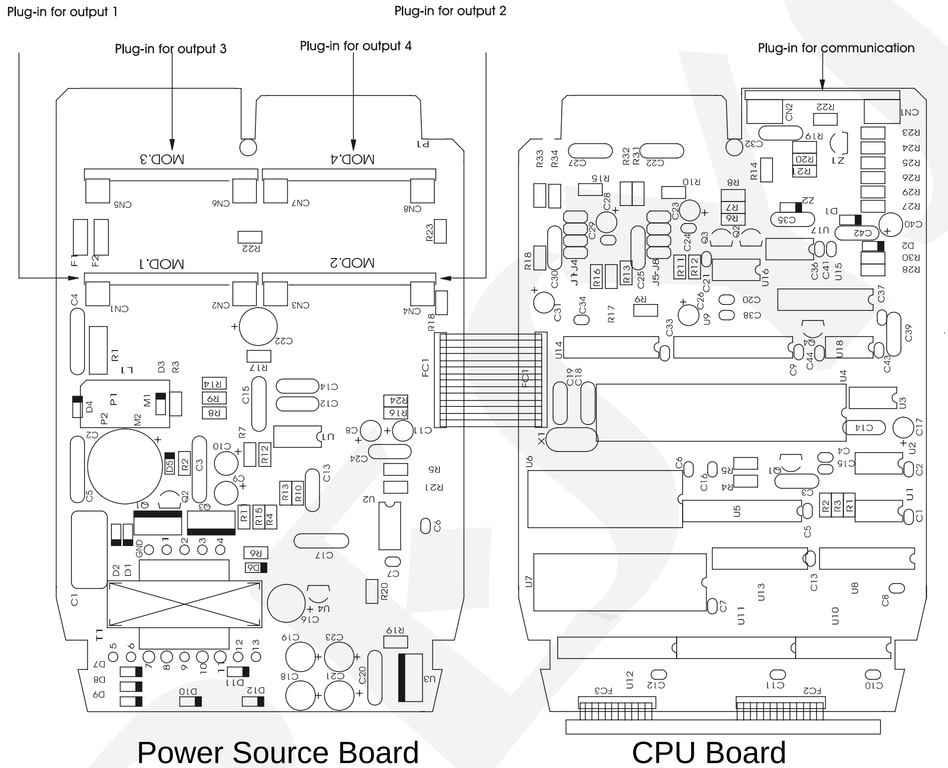



Fig. 36 - Optional Module Connections

The plug-in connections on the Power Source Board are called MOD 1, MOD 2, MOD 3 and MOD 4, and are, respectively, the signal counterparts for output 1, output 2, output 3 and output 4, on the controllers I/O terminals shown on figure 3. The plug-in connection for the communication module is located on the CPU Circuit Board and have no denomination. Any optional module should always be installed with the component side facing the instrument display, as illustrated on figure 36.

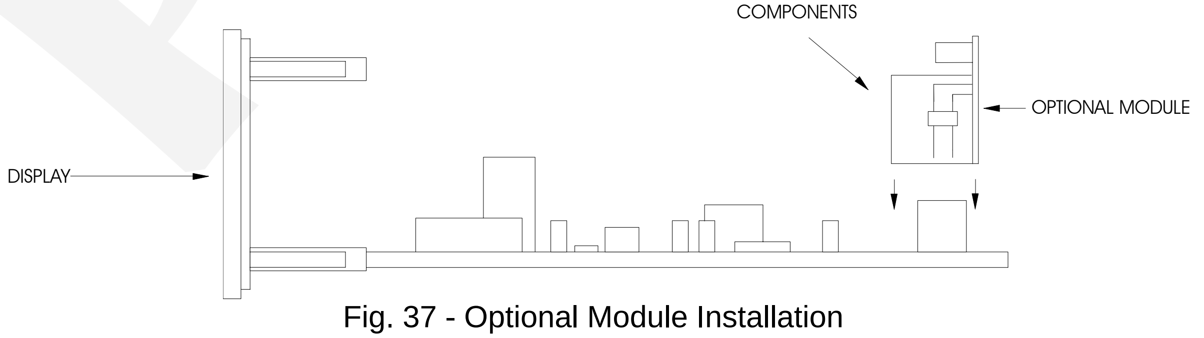



Fig. 37 - Optional Module Installation

Outputs 1 and 2 as analog outputs (optional module code: MSAN-20)

Whenever output 1 is required to be the analog output (4 to 20mA, 1 to 5V or 0 to 10V) the optional module is plugged in the connection called MOD 1. In case an additional analog output is required, a second module is plugged in the connection called MOD 2.

The analog output optional module is provided with two locations for the installation of jumpers: J1 and J2, as illustrated on figure 37.

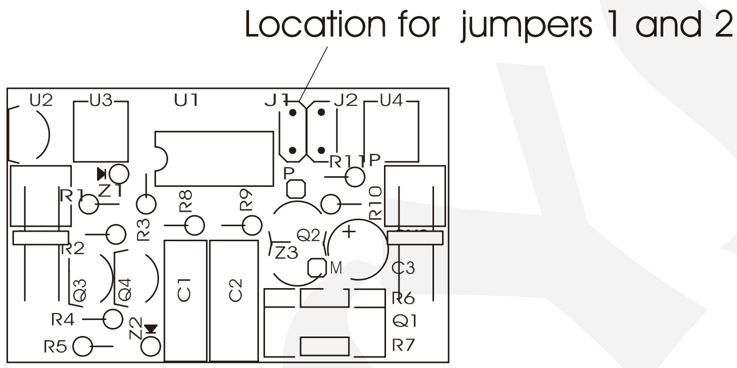



Fig. 38 - Jumper locations on the analog output board

To configure the analog output optional module for control outputs 4 to 20mA, 1 to 5V or 0 to 10V just install the jumper as specified on table 3.

| Analog type output | Jumpers | |
|---|---|---|
| 4 to 20mA* | | |
| 1 to 5V | J1 | |
| 0 to 10V | | J2 |

Table 3 - Analog Type Output Jumper Configuration

(*) In the case of an analog output for 4 to 20mA current, the supplied jumper should be stored away from the instrument or engaged to just one of the connector pins, in a dummy position, similar to that illustrated on figure 34.

Outputs 1 and 2 as Logic Outputs

Whenever output 1 or output 2 are required to function on two states only, the corresponding optional module is plugged-in to the connections called MOD 1 and MOD 2, respectively. Depending on the optional module installed in MOD 1 and MOD 2 we could have three types of possible logic outputs: the SPST relay, the solid-state relay and the open collector voltage. The relationship between the type of logic output and the corresponding optional module is established on table 4.

| Analog output type | Optional module code |
|---|---|
| SPST relay | MALRE - 20 |
| Solid-state relay | MALRS - 20 |
| Open collector voltage | MSD - 20 |

Table 4 - Logic output type for outputs 1 and 2

Outputs 3 and 4 as Logic outputs

Outputs 3 and 4 function with only two states when the corresponding optional module is plugged to connections MOD 3 and MOD 4, respectively. There are three possible types of analog outputs: the SPDT relay, the solid-state relay and the open collector voltage. The relationship between the type of logic output and the corresponding optional module is established on table 5.

| Analog output type | Optional module code |
|---|---|
| SPDT relay | MALRE - 20 |
| Solid-state relay | MALRS - 20 |
| Open collector voltage | MSD - 20 |

Table 5 - Logic output type for outputs 3 and 4

## 4.4 - Calibration

The DCY-2050 and 2051 controllers are accurately calibrated at factory and will not require periodic recalibration under normal conditions. If, for any reason, a recalibration is required, follow the procedure described below.

Disconnect the process signals from the controller I/O terminals.

Prior to carrying out the calibration allow the instrument to warm up for at least 30 minutes to ensure that it reaches stable operating conditions.

This section contains basically two parts: input calibration and output calibration.

Input calibration

The input calibration describes the procedure to be followed when calibrating input 1 and input 2.

The accuracy and precision of the reference generating calibration equipment should be, at least twice as good as the controllers specifications.

References on the following tables relate to the input type to be calibrated. The column on the right on these tables shows the mnemonics displayed in the calibration process.

Always check that the internal jumper configuration correctly matches the input type to be calibrated.

Prior to carrying out the calibration procedure, access Calibration level 5. The calibration level is provided with a password system which prevents the inadvertent access to this level and the likelihood of damaging the controllers calibration parameters. The access password to this calibration level is number 5.

Once the calibration password is acknowledged, select the input type to be calibrated within the option ENTR. Select the channel to be calibrated by pressing ENTER. The display will show the mnemonics corresponding to the references required by the calibration process. Those references should be entered prior to the display of the corresponding mnemonic and the calibration procedure is started by pressing ENTER. At this time the Indicator starts the calibration procedure and the display will flash the mnemonic CAL.

While the display is flashing, the reference should remain connected to the input channel to be calibrated.

When the display stops flashing and the corresponding mnemonic is back on screen, the calibration process for the first point will have ended.

Change to the next reference and press the DOWN key to select the next point. Allow at least 1 minute between any two calibration points. After this time is elapsed, press ENTER to start calibration of the second point.

After running through the two references on the table relative to the input type to be calibrated the calibration process will have been completed.

In the event that the calibration of any particular point has not been properly carried out, there is always the possibility of having that particular point recalibrated without damaging the calibration of any other already calibrated points.

To resume normal operations revert in the hierarchical levels to level zero.

Figure 39 shows the input and output calibration options for calibration level 8.

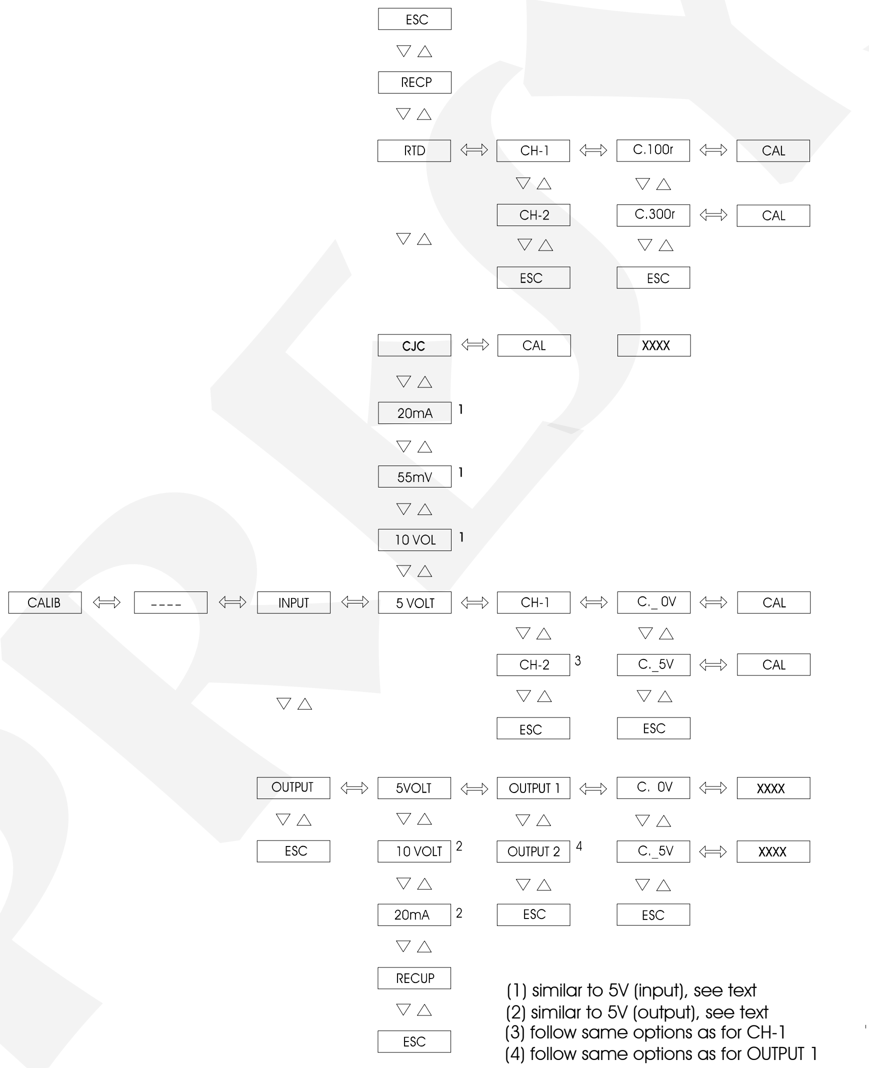



Fig. 39 - Calibration Level Options

Voltage Input Calibration (0 to 55mV)

In order to calibrate the voltage input at 0 to 55mV connect an accurate DC power source to the channel to be calibrated (terminals 2(+) and 3(-) for channel 1 or 5(+) and 6(-) for channel 2). The 2 voltage references listed on table 6 will be required.

| Reference | Mnemonic |
|---|---|
| 0.000 mV | C. 0nV |
| 50.000 mV | C.50nV |

Table 6 - Required voltages for the calibration of voltage inputs from 0 to 55mV

Calibration of voltage input (0 to 5V)

In order to calibrate the voltage input at 0 to 5V connect an accurate DC power source to the channel to be calibrated (terminals 2(+) and 3(-) for channel 1 or 5(+) and 6(-) for channel 2). The 2 voltage references listed on table 7 will be required.

| Reference | Mnemonic |
|---|---|
| 0.0000V | C. 0V |
| 5.000V | C. 5V |

Table 7 - Required voltages for the calibration of voltage inputs from 0 to 5V

Calibration of voltage input (0 to 10V)

In order to calibrate the voltage input at 0 to 10V connect an accurate DC power source to the channel to be calibrated (terminals 1(+) and 3(-) for channel 1 or 4(+) and 6(-) for channel 2). The 2 voltage references listed on table 8 will be required.

| Reference | Mnemonic |
|---|---|
| 0.0000V | C. 0V |
| 10.0000V | C.10V |

Table 8 - Required voltages for the calibration of voltage inputs from 0 to 10V

Calibration of current input (0 to 20mA)

In order to calibrate the current input at 0 to 20mA connect an accurate DC power source to the channel to be calibrated (terminals 1(+) and 3(-) for channel 1 or 4(+) and 6(-) for channel 2). The 2 voltage references listed on table 9 will be required.

| Reference | Mnemonic |
|---|---|
| 0.000 mA | C. 0nA |
| 20.000 mA | C.20nA |

Table 9 - Required current for the calibration of current inputs from 0 to 20mA

Calibration of thermocouple input

The calibration of a thermocouple input is carried out in two steps. Firstly, calibrate the input from 0 to 55mV of the channel to be calibrated and of the input from 0 to 5V of channel 1 (terminals 2(+) and 3(-)) as detailed in tables 6 and 7. Upon calibration completion in mV and V , access the mnemonic CJC within the option ENTR in calibration level 8 (see figure 39).

CJC - is the mnemonic relative to the temperature of the controllers cold junction.

By pressing ENTER after the mnemonic CJC the program automatically starts computing the cold junction temperature. During this period the display flashes the mnemonic CAL.

After approximately 16 seconds the program completes the computation of the cold junction temperature and shows the result on the display, in °C.

This value is a first approximation for the cold junction temperature. The user should then accurately measure the I/O terminal temperature and correct the value submitted by the program in the usual way of introducing parameter values as explained in section 3.2 on Configuration.

Upon completing those two steps the input calibration for any type of thermocouple is concluded.

It will then be possible to resume normal operating conditions by reverting to level zero.

Calibration of 2- or 3-wire RTD input

In order to calibrate the 3-wire RTD input, connect precision resistors of values listed in table 10 to the channel to be calibrated (between terminals 1 and 2 with terminals 2 and 3 short-circuited to channel 1 or between terminals 4 and 5 with terminals 5 and 6 short-circuited to channel 2).

In case a precision decade resistance is available, make sure the three connection wires have exactly the same length, gauge and material.

No calibration procedure is available for a 2-wire RTD input. This is automatically carried out when the 3-wire RTD input is calibrated.

| Reference | Mnemonic |
|---|---|
| 100.000 Ω | C.100r |
| 300.000 Ω | C.300r |

Table 10 - Required resistances for the calibration of a 3-wire RTD input

Output calibration

For output calibration follow the procedure described to calibrate the analog outputs 1 and 2.

The analog outputs will be calibrated by the controllers themselves.

Output 1 will be calibrated by input 1 and output 2 will be calibrated by input 2.

The configuration of input hardware should be the same as for the output (0 to 5V, 0 to 10V or 0 to 20mA) since the controllers themselves will be measuring the output signal. Therefore, check that the configuration of the internal jumpers in the Option Outlet Board and the CPU Board match the corresponding input and output types.

Make sure the input type to be used for the output calibration has already been properly calibrated.

Make the connections listed in table 11 according to which output and output type should be calibrated.

| Output type | Output 1 with Input 1 | Output 2 with Input 2 |
|---|---|---|
| current (0 to 20mA)<br>voltage (0 to 10V) | terminal 13 (+) with 1 (+)<br>terminal 14 (-) with 3 (-) | terminal 15 (+) with 4 (+)<br>terminal 16 (-) with 6 (-) |
| voltage(0 to 5V) | terminal 13 (+) with 2 (+)<br>terminal 14 (-) with 3 (-) | terminal 15 (+) with 5 (+)<br>terminal 16 (-) with 6 (-) |

Table 11 - I/O terminal connections for output calibration

Now enter Calibration level 8 and select which of the two outputs will be calibrated. Select the output type (0 to 20mA, 0 to 5V or 0 to 10V) and press ENTER.

The display will show the mnemonic corresponding to the first calibration point. There are two output calibration points.

In the case of current output the mnemonics correspond to electrical signals from 0 to 20mA. In the case of voltage the mnemonics correspond to signals from 0 to 5V or from 0 to 10V.

By pressing ENTER when the mnemonic corresponding to the first or second calibration point is displayed, the display will show the output value. It will then be possible to have the output value adjusted to the electrical level indicated by the mnemonics with the help of the UP and DOWN keys. Press ENTER after adjusting. When calibrating the first point (0mA, 0V) care should be taken to avoid output signal saturation.

Return to normal operating level by reverting to level zero.

Reverting to factory calibration

The controllers store the factory calibration parameters in the non-volatile memory and these can be retrieved at any time.

Should there be any suspicion that some instrument malfunction might be due to an improper recalibration procedure use the RECUP option (see figure 38).

RECUP - this is the option allowing the retrieval of factory calibration values. This option is valid for both the inputs and outputs.

Enter calibration level 8 and select whether to retrieve input or output values. Select the option RECUP and press ENTER to reload factory values.

## 4.5 - Hardware maintenance guidelines

Prior to returning the instrument to factory check the following possible causes of instrument malfunction.

Instrument showing display errors

After turning on the equipment start the test routine to check the RAM and E2PROM integrity.

Should any of these components have problems the display will show the following error codes:

Err. 1 - RAM error
Err. 2 - E2PROM error

In the event of a RAM error, turn the equipment off and then on again to check whether the error message persists. If affirmative, return the instrument to factory.

In the event of an E2PROM error, press ENTER and reconfigure the equipment. Turn the equipment off and then on again to check whether the error message persists. If affirmative, return the instrument to factory.

During configuration the display may show the following error messages:

The message Err.3 will occur whenever an attempt is made to configure as alarm relay (relay 2, relay 3 or relay 4) any of the outputs 2, 3 or 4 which may have been configured as control output or vice-versa. To prevent this from happening, make sure to disable the related control outputs 2, 3 or 4 prior to enabling any of the alarm relays 2, 3 or 4.

If, during the auto-tune procedure the operator changes the type of control (by changing from dual to SP.re or Casc) or modifies the control algorithm (from PID to ON/OFF or HC) the display will show the following error message: Err.4.

Instrument with no display

Check that the power supply arrives at the power terminals 23 and 24 in the controllers I/O terminals.

Check the integrity of the 1.0 A fuse F1 on the Power Supply Board as shown on figure 32. Due to its ceramic shielding a continuity measurement will be required to detect a possible blown fuse.

Instrument malfunction

Check that the controllers are correctly configured both in terms of software and hardware (internal jumpers).

Check that the option modules are fully engaged in their correct locations.

Measure the voltage at flat-cable 1 as shown on figure 39 to see if they are close to the voltages in table 12 and arriving at the CPU end.

| Points of Flat-cable 1 | Voltages |
|---|---|
| Between point 13(-) and point 1(+) | 5V |
| Between point 13(-) and point 7(+) | 8V |
| Between point 13(-) and point 8(+) | 0V |
| Between point 13(-) and point 9(+) | - 8V |
| Between point 13(-) and point 12(+) | 24V |
| Between point 11(-) and point 10(+) | 5V |

Table 12 - Voltage test points on flat-cable 1

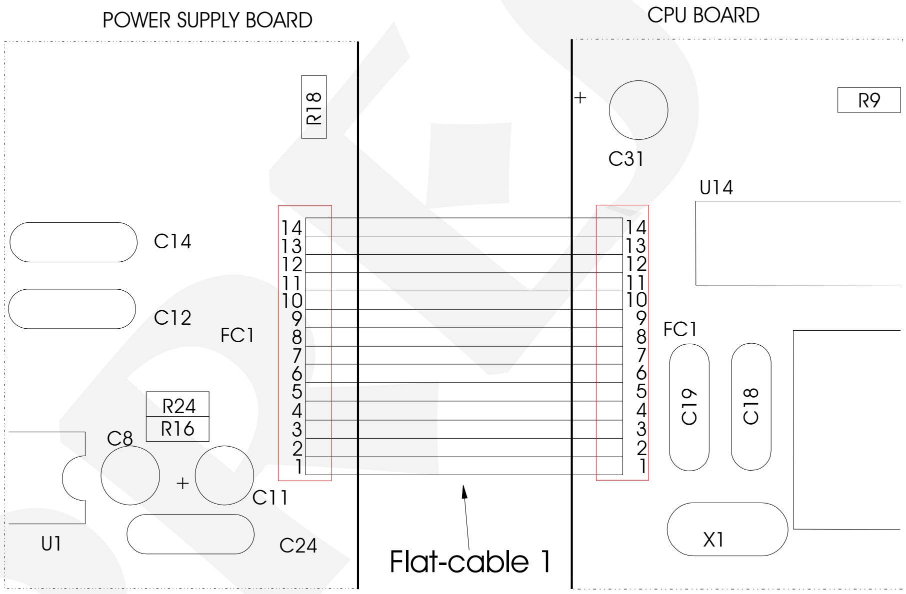



Fig. 40 - Controllers Voltage Test Points

In case the problem is not isolated the instrument should be returned to factory for repairs.

# 4.7 - Parts Listing

## Display Circuit Board

| Code | Components | Reference |
|---|---|---|
| 01.05.0051-20 | Display circuit board - DCY 2050 | --------------------- |
| 01.05.0054-20 | Display circuit board - DCY 2051 | |
| 01.07.0003-21 | Display 14mm | DP1,2,3,4,5,6,7,8 (2050)<br>DP5,6,7,8 (2051) |
| 01.07.0002-21 | Display 17mm | DP1,2,3,4 (2051) |
| 01.04.0001-21 | Diode 4002 | D1,2 |
| 01.07.0005-21 | Led 3mm (Red) | D4,5 |
| 01.07.0004-21 | Led 3mm (Green) | D3 |
| 01.09.0013-21 | Transistor BC 327-25 | Q1,2,3,4,5,6,7,8 |
| 01.02.0038-21 | Resistor 10K | R1,2,3,4 |
| 01.02.0074-21 | Resistor 470 R | R5 |
| 01.15.0003-21 | Key | CH1,2,3,4 |

## Power Supply Board

| Code | Components | Reference |
|---|---|---|
| 01.05.0046-20 | Power I/O circuit board - DCY2050/2051 | --------------------- |
| 01.01.0029-21 | LM 2904CT - 5.0 V | U3 |
| 01.01.0003-21 | LM 1458N | U2 |
| 01.01.0030-21 | UC 3842 | U1 |
| 01.09.0015-21 | Transistor BC 337 | Q2 |
| 01.09.0019-21 | Transistor TIP 50 | Q1 |
| 01.02.0099-21 | Fuse 1 A | F1 |

| | | |
|---|---|---|
| 01.09.0020-21 | IRF 822 | Q3 |
| 01.01.0028-21 | 78L24 | U4 |
| 01.04.0007-21 | Diode 1N4007 | D1,2,3,4,5,6 |
| 01.04.0008-21 | Diode 1N4936 | D7,8,9,10,11,12 |
| 01.03.0009-21 | Ceramic disk capacitor 100 pF X 100V | C12,13,14 |
| 01.03.0035-21 | Multilayer ceramic capacitor 0.1uF X 63 V | C6,7 |
| 01.03.0036-21 | Multilayer ceramic capacitor 0.01uF X63V | C24 |
| 01.03.0039-21 | Polyester capacitor 0.1uF X 250 V | C1,3 |
| 01.03.0040-21 | Polyester capacitor 0.01 uF X 100 V | C15,17 |
| 01.03.0041-21 | Polyester capacitor 0.01 uF X 250 V | C4,5 |
| 01.03.0038-21 | Radial electrolytic capacitor 10 uF X 16 V | C8,11 |
| 01.03.0042-21 | Radial electrolytic capacitor 22 uF X 25 V | C9,C10 |
| 01.03.0027-21 | Radial electrolytic capacitor 100 uF X 25 V | C18,21 |
| 01.03.0043-21 | Radial electrolytic capacitor 100 uF X 35 V | C16,22 |
| 01.03.0044-21 | Radial electrolytic capacitor 220 uF X 10 V | C19,20,23 |
| 01.03.0045-21 | Radial electrolytic capacitor 22 uF X 350 V | C2 |
| 01.02.0107-21 | Resistor 18R X 2W | R1 |
| 01.02.0103-21 | Resistor 68R1 | R10 |
| 01.02.0043-21 | Resistor 20K | R11 |
| 01.02.0080-21 | Resistor 4K7 | R8,12 |
| 01.02.0109-21 | Resistor 3K | R13 |
| 01.02.0110-21 | Resistor 27K | R14 |
| 01.02.0111-21 | Resistor 1R | R15 |
| 01.02.0019-21 | Resistor 1K | R16,24 |
| 01.02.0074-21 | Resistor 470R | R17,18,22,23 |
| 01.02.0108-21 | Resistor 15K4 | R19 |
| 01.02.0112-21 | Resistor 470K | R2 |

| | | |
|---|---|---|
| 01.02.0038-21 | Resistor 10K | R5,20,21 |

| | | |
|---|---|---|
| 01.02.0113-21 | Resistor 47K | R3 |
| 01.02.0114-21 | Resistor 270R | R4 |
| 01.02.0115-21 | Resistor 4R7 | R6 |
| 01.02.0116-21 | Resistor 18K | R7 |
| 01.02.0054-21 | Resistor 150K | R9 |
| 01.06.0003-21 | Transformer | T1 |
| 01.06.0004-21 | Coil | L1 |
| 01.13.0004-21 | Connector | CN1,2,3,4,5,6,7,8 |

## CPU Circuit Board

| Code | Components | Reference |
|---|---|---|
| 01.05.0048-20 | CPU Circuit Board - DMY2030 | ----------------------- |
| 01.01.0007-21 | LM 311 | U18 |
| 01.01.0009-21 | LM 555 | U3 |
| 01.01.0016-21 | EPROM 27C512 | U7 |
| 01.01.0017-21 | RAM 6516 | U6 |
| 01.01.0018-21 | E2PROM X24C04P | U1 |
| 01010034-21 | NVRAM X24C45P | U2 |
| 01.01.0019-21 | 4051 | U14 |
| 01.01.0022-21 | 74HC138 | U8 |
| 01.01.0023-21 | 74HC365 | U10 |
| 01.01.0022-21 | 74HC138 | U8 |
| 01.01.0023-21 | 74HC365 | U10 |
| 01.01.0024-21 | 74HC373 | U5,9,11,12 |
| 01.01.0025-21 | Presys SY-01 | U4 |
| 01.01.0026-21 | AD706 | U16 |
| 01.01.0027-21 | Presys SY-03 | U17 |

| | | |
|---|---|---|
| 01.16.0001-11 | Crystal 11.0592 MHz | X1 |
| 01.09.0015-21 | Transistor BC 337-25 | Q1 |
| 01.09.0013-21 | Transistor BC 327-25 | Q2,3,4 |
| 01.04.0003-21 | Diode 1N4148 | D1,2 |
| 01.04.0005-21 | Reference Diode LM336/5V | Z1 |
| 01.04.0006-21 | Zener BZX 79/C6V2 | Z2 |
| 01.03.0034.-21 | Ceramic disk capacitor 30 pF X 60 V | C18, C19 |
| 01.03.0035-21 | Multilayer ceramic capacitor 0.1 uF X 63 V | C1,4,5,6,7,8,9,10,11,12,13, 15,16,20,21,22,24,25,27,29, 30,32,33,34,35,36,37,38,41, 42,43,44 |
| 01.03.0036-21 | Multilayer ceramic capacitor 0.01uF X 63V | C14 |
| 01.03.0037-21 | Polyester capacitor 0.1 uF X 100 V | C3, C39 |
| 01.03.0038-21 | Radial electrolytic capacitor 10 uF X 16 V | C17,28,23,26,31 |
| 01.03.0027-21 | Radial electrolytic capacitor 100uF X 25 V | C40 |
| 01.02.0101-21 | Resistor 22K | R1 |
| 01.02.0038-21 | Resistor 10K | R2,3,10,13,14,15,18,20 |
| 01.02.0069-21 | Resistor 1M | R11,12,16,17 |
| 01.02.0019-21 | Resistor 1K | R6,19,22,30 |
| 01.02.0010-21 | Resistor 100R | R21,29 |
| 01.02.0102-21 | Resistor 442R | R23 |
| 01.02.0103-21 | Resistor 68R1 | R24 |
| 01.02.0104-21 | Resistor 3K32 | R25 |
| 01.02.0046-21 | Resistor 40K2 | R26 |
| 01.02.0036-21 | Resistor 8K66 | R28 |
| 01.02.0098-21 | Resistor 10M | R31,33 |
| 01.02.0013-21 | Resistor 249R | R32,34 |

| | | |
|---|---|---|
| 01.02.0052-21 | Resistor 100K | R4 |
| 01.02.0092-21 | Resistor 2M2 | R5 |

| | | |
|---|---|---|
| 01.02.0024-21 | Resistor 2K | R27 |

| | | |
|---|---|---|
| 01.02.0031-21 | Resistor 4K99 | R7,8,9 |
| 01.17.0002-21 | Jumper | Selected |
| 01.17.0003-21 | Pin bar | J1-J4 J5-J8 |
| 01.18.0001-21 | Receptacle | U7 |
| 01.13.0005-21 | Connector | CN1,CN2 |
| 01.14.0006-21 | Flat-Cable 12 ways | FC3 |
| 01.14.0007-21 | Flat Cable 14 ways | FC2 |
| 01.14.0008-21 | Flat Cable 15 ways | FC1 |

## I/O Terminal Board

| Code | Components | Reference |
|---|---|---|
| 01.05.0049-20 | I/O terminal board | --------------------- |
| 01.01.0032-21 | AD 592 | U1 |
| 01.13.0002-21 | Terminal | --------------------- |
| 01.13.0003-21 | Connector | P1,2 |

## Analog Output Board

| Code | Components | Reference |
|---|---|---|
| 01.05.0055-20 | Analog output board | --------------------- |
| 01.01.0026-21 | AD 706 | U2 |
| 01.01.0031-21 | Optical coupler 2501 | U1, 3 |
| 01.09.0006-21 | TIP 117 | Q1 |
| 01.09.0015-21 | Transistor BC 337 - 25 Phillips | Q2 |
| 01.09.0021-21 | Transistor B.F. 245A | Q3 |
| 01.04.0009-21 | Zener BZX 79/C2V4 | Z1 |
| 01.04.0011-21 | Zener BZX79/C3V9 | Z3 |

| | | |
|---|---|---|
| 01.04.0005-21 | Reference diode LM 336 / 5.0 V | Z2 |
| 01.03.0042-21 | Radial electrolytic capacitor<br>22 uF X 25 V (85049) | C1 |
| 01.03.0046-21 | Tantalum capacitor 1µFX35V | C 2, 3 |
| 01.02.0080-21 | Resistor 4K7 5% | R1 |
| 01.02.0024-21 | Resistor 2K 1% | R 2, 9 |
| 01.02.0038-21 | Resistor 10K 1% | R3 |
| 01.02.0013-21 | Resistor 249R 1% | R10,11 |
| 01.02.0008-21 | Resistor 49R9 1% | R4 |
| 01.02.0010-21 | Resistor 100R 1% | R5 |
| 01.02.0069-21 | Resistor 1M 1% | R6 |
| 01.02.0047-21 | Resistor 49K9 1% | R7, 8 |
| 01.02.0059-21 | Resistor 301K 1% | R12 |
| 01.02.0115-21 | Resistor 402R 1% | R13 |
| 01.17.0001-21 | Bus MS0.DUP.CR.BAN.J.04 | J1 and J2 |
| 01.17.0004-21 | Bus.msp.dup.cr.ban.j.0 | CN1-CN2 |
| 01.17.0002-21 | Jumper mkb w/o ban. stem. | Selected |
| 01.06.0004-21 | Coil | |
| 4901.05.0054-20 | Analog output board | --------------------- |
| 01.01.0002-11 | OP 07 | U1 |
| 01.01.0028-21 | 78L24 | U2 |
| 01.01.0031-21 | Optical coupler 2501 | U3,4 |
| 01.09.0015-21 | BC 337 | Q2 |
| 01.09.0006-21 | TIP 117 | Q1 |
| 01.09.0021-21 | BF 245 | Q3,4 |
| 01.04.0009-21 | Zener BZX 79/C2V4 | Z1 |

| | | |
|---|---|---|
| 01.04.0010-21 | Zener BZX 79/C5V6 | Z2 |
| 01.04.0005-21 | Reference diode LM 336 / 5.0 V | Z3 |
| 01.03.0037-21 | Polyester capacitor 0.1 uF X 100 V | C1 |
| 01.03.0046-21 | Polyester capacitor 0.22 uF X 100 V | C2 |
| 01.03.0042-21 | Radial electrolytic capacitor 22 uF X 25 V | C3 |
| 01.02.0038-21 | Resistor 10K | R1,7 |
| 01.02.0013-21 | Resistor 249R | R10,11 |
| 01.02.0048-21 | Resistor 61K9 | R2 |
| 01.02.0063-21 | Resistor 499K | R3 |
| 01.02.0056-21 | Resistor 200K | R4 |
| 01.02.0117-21 | Resistor 44R2 | R5 |
| 01.02.0019-21 | Resistor 1K | R6 |
| 01.02.0101-21 | Resistor 22K1 | R8,9 |
| 01.17.0002-21 | Jumper | Selected |
| 01.17.0001-21 | Pin bus | J1 and J2 |
| 01.06.0004-21 | Coil | |
| 01.17.0004-21 | Pin bus | CN1-CN2 |

## Alarm Board

| Code | Components | Reference |
|---|---|---|
| 01.05.0052-20 | Alarm board DMY 2030 | --------------------- |
| 01.01.0033-21 | Optical coupler 2502 | U3 |
| 01.04.0002-21 | Diode 4002 | D1 |
| 01.03.0039-21 | Polyester capacitor 0.1 uF X 250 V | C1,2 |
| 01.02.0114-21 | Resistor 270R | R1 |
| 01.02.0010-21 | Resistor 100R | R2 |
| 01.12.0001-21 | Relay 24 V | K1 |
| 01.17.0004-21 | Pin bus | CN3,4 |

## 4.7 - Recommended Spare Parts Listing

Display Board
Display DP1, 2, 3, 4, 5, 6, 7, 8

I/O Power Board

| | |
|---|---|
| IRF 822 | Q3 |
| UC 3842 | U1 |
| Fuse 1A | F1 |
| LM 1458N | U2 |

I/O Terminal Board

| | |
|---|---|
| AD 592 | U1 |

CPU Board

| | |
|---|---|
| 4051 | U14 |
| Presys SY-02 | U15 |
| Reference diode LM-336/ 5V | Z1 |

Technical Manual
Code 02.10.0008-21

Engineering Units Card
Code 02.10.0003.21

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