DCY-2057 Pressure Controller

TECHNICAL MANUAL

DCY - 2057 Pressure Controller

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1 - Introduction

1.1 - Description

The PRESYS DCY-2057 Controller is a microprocessor-based instrument which control and show any process variable found in industrial plants, such as: pressure, temperature, flow, level etc. It is 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.

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

The DCY-2057 Controller was designed according to modularity and flexibility concepts. Therefore, five plug-in points are provided inside the Controller 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.

It is provided with several control modes: ON-OFF, PID (with all its combinations), time proportioning, programmable setpoint, cascade and remote setpoint input.

The DCY-2057 Controller is provided with auto-tune algorithm to compute the PID parameters for optimizing control capabilities.

It incorporates all standard control characteristics, such as: auto-manual bumpless transfer, output saturation, remote setpoint and programmable setpoint up to ten segments, protection against integral saturation, etc.

It is capable of monitoring two inputs. Input 1 is a pressure input, and input 2 can be configured as another pressure input or as an universal standard analogical input.

Thus, the Controller can accept one or two inputs of gage or absolute pressure or vacuum. There are versions available for use with air and inert gases or sealed for fluids compatible with 316L stainless steel. In the version for single pressure input, the second input accepts the connection of 4-20mA, 1-5VDC, 0-10VDC, thermocouple and RTD.

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.

Except for pressure input, the input type for channel 2 can be selected by the user and enabled by jumpers and 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.

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It accepts 90 to 240VAC or 130 to 340VDC (with any polarity) power supply.
The instrument is housed in an extruded aluminum case which makes it highly immune to electrical noise, electromagnetic interference and resistant to the most severe and rough industrial use conditions.
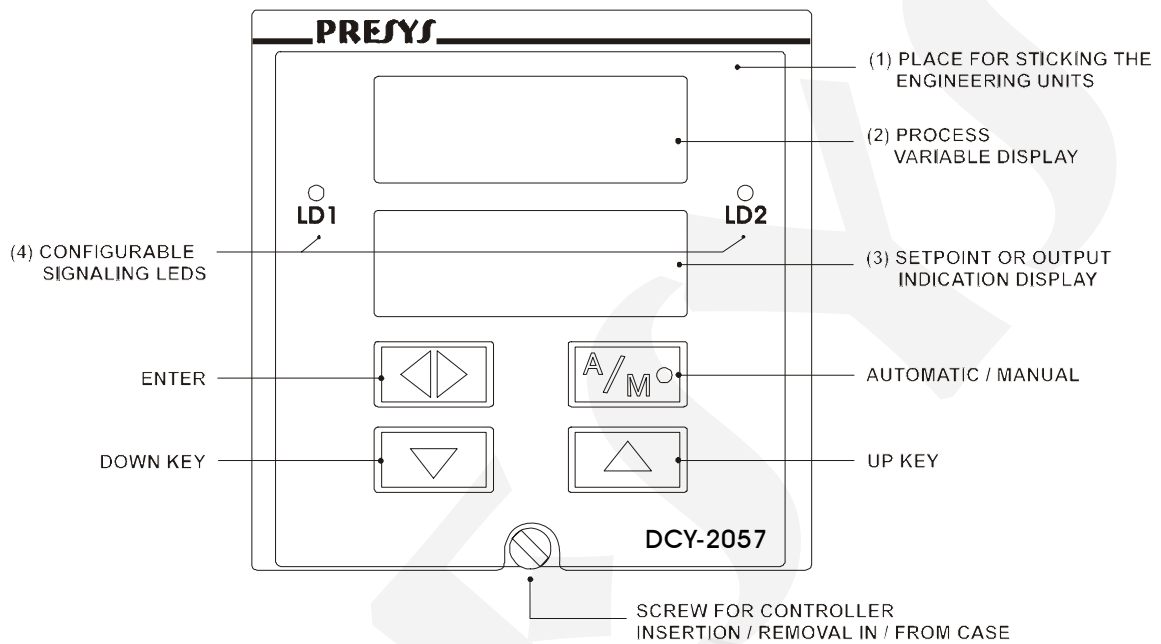
Fig. 1 - DCY - 2057 Controller Front Panel.

On the instrument front panel there are two red displays 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 setpoint, channel 2 setpoint, channel 1 output and channel 2 output. The control outputs 1 and 2 are represented in percentage of full scale output. The functions of the UP, DOWN and ENTER keys to change the setpoint/output values are described in section 3.1. The A/M key on the Controller front panel allows toggling between automatic and manual modes. The green led in the A/M key indicates, when illuminated, the Controller is in the manual mode and, when extinguished, the Controller is in the automatic mode. In the Controller 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 setpoint/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.

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1.2 - Order Code Number

Input 1
Range
1 - 0 - 10"H$_2$O (air and inert gases)
2 - 0 - 1psi (air and inert gases)
3 - 0 - 5psi (air and inert gases)
4 - 0 - 15psi (air and inert gases or sealed)
5 - 0 - 30psi (air and inert gases or sealed)
6 - 0 - 100psi (air and inert gases or sealed)
7 - 0 - 250psi (sealed)
8 - 0 - 500psi (sealed)
9 - 0 - 1000psi (sealed)
Pressure Type
1 - Gage
2 - Absolute
3 - Vacuum (0 to 1atm)
Sensor Type
1 - For air and inert gases
2 - Sealed for fluids compatible with
   316L stainless steel
Input 2
Same code of Input 1. For single pressure version,
put 0 - 0 - 0 for auxiliary universal input for RTD, TC,
4-20mA, 0-55mVdc, 1-5Vdc and 0-10Vdc.
Output 1 (Only for Control)
0 - None
1 - 4 - 20mA
2 - 1 - 5Vdc
3 - 0 - 10Vdc
4 - SPST Relay
5 - Open Collector Voltage
Output 2 (Control or Alarm)
Same code of Output 1
Output 3 (Only for Alarm)
0 - None
1 - SPDT Relay
2 - Open Collector Voltage
Output 4 (Only for Alarm)
Same code of Output 3
Power Supply
1 - 90 to 240Vac or 130 to 340Vdc
2 - 24Vdc
3 - 12Vdc
4 - Others, under consult
Communication
0 - None
1 - RS-232
2 - RS-485
3 - RS-422
Case Protection Grade
0 - General usage, protected place
1 - Front aspersion-proof
2 - Weather-proof

Note 1: 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 this information so that all the configuration can be made by PRESYS).

Note 2: Other hardware and software features can be available under previous consult.

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Code Example:

1) DCY - 2057 - 6 - 1 - 1 - 8 - 1 - 2 - 1 - 4 - 1 - 1 - 1 - 0 - 0

This code defines a DCY - 2057 Controller with two pressure inputs, the first in the 0 to 100 psi range, gage pressure and use with air, the second in the 0 to 500 psi range, gage pressure and use with fluid. It provides output 1 with 4 to 20mA, output 2 with SPST relay, outputs 3 and 4 with SPDT relay. Power supply in the 90 to 240VAC ou 130 to 340VDC range, does not use communication and is intended for use in a sheltered place. The use of such optional modules allows a practical application such as PID control for channel 1 (output 1) and ON-OFF control for channel 2 (output 2). Outputs 3 and 4 can be configured as high, low or deviation alarm outputs for channel 1 or channel 2.

1.3 - Technical Specifications

Inputs:

• One or two pressure inputs for gage, absolute or vacuum pressure. Ranges from 0 to 250 mmH$_2$O (0 to 10"H$_2$O), 0 to 1 psi, 0 to 5 psi, 0 to 15 psi, 0 to 30 psi, 0 to 100 psi, 0 to 250 psi, 0 to 500 psi and 0 to 1000 psi for gage pressure. Same ranges beginning from 15 psi for absolute pressure. VACuum ranges from 0 to 1 atm.

• Ranges up to 15 psi used with air and inert gases. From 15 psi up to 250 psi, sensors are available for air or fluids. Above 250 psi they are sealed for use with fluids compatible with 316L stainless steel. Note: the sersor for fluids also accepts air / gases, but the opposite is not allowed.

• Auxiliar universal input, for the single pressure input version, configurable for thermocouple (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 pressure range limits, thermocouple and RTD temperature range limits and the resolution for the linear input sensors.

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Input sensor	Span			
	Sensor	lower limit psi		higher limit psi
Pressure	250 mmH$_2$O	0		0.355
	1 psi	0		1.000
	5 psi	0		5.000
	15 psi	0		15.00
	30 psi	0		30.00
	100 psi	0		100.0
	250 psi	0		250.0
	500 psi	0		500.0
	1000 psi	0		1000
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.
* Ratio Control.

* Cascade Control.
* Remote setpoint input
* Programmable setpoint

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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.

Engineering Units:
psi, atm, inH_2O, kgf/cm^2, mH_2O, inHg, mmHg, cmHg, bar, mbar, kPa and mmH_2O.

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:
$\pm$ 1 % of full scale for 0 to 250 mmH_2O range.
$\pm$ 0.1% of full scale for other pressure ranges.
$\pm$ 0.1% of full scale for TC, RTD inputs, mA, mV, VDC.
$\pm$ 0.5% of full scale for analog control output.

Linearization:
$\pm$ 0.1% for RTD and $\pm$ 0.2% for TC.

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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:
Universal 90 to 240VAC or 130 to 340VDC (any polarity), 10W nominal; 24VDC, 12VDC and other values are optional.

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

Dimensions:
1/4 DIN (96 X 96mm) and 162mm depth.
92 X 92 mm panel cutout.

Pneumatic / hydraulic connection:
Junction for 1/4" plastic tube for using with air or 1/4" NPTF for using with other fluids.

Weight:
0.5kg nominal.

Warranty:
One year.

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2 - Installation

2.1 - Mechanical Installation

The DCY - 2057 Controller front panel has 1/4 DIN size (96 X 96 mm).
It is fixed by the rails which press it against the back side of the panel.
After preparing a 92 X 92 mm cut in the panel, remove the rails from the Controller and slide its rear through the cut until its front reaches the panel. Place the rails again in the Controller from the back of the panel and tighten the screws as shown in figure 2.
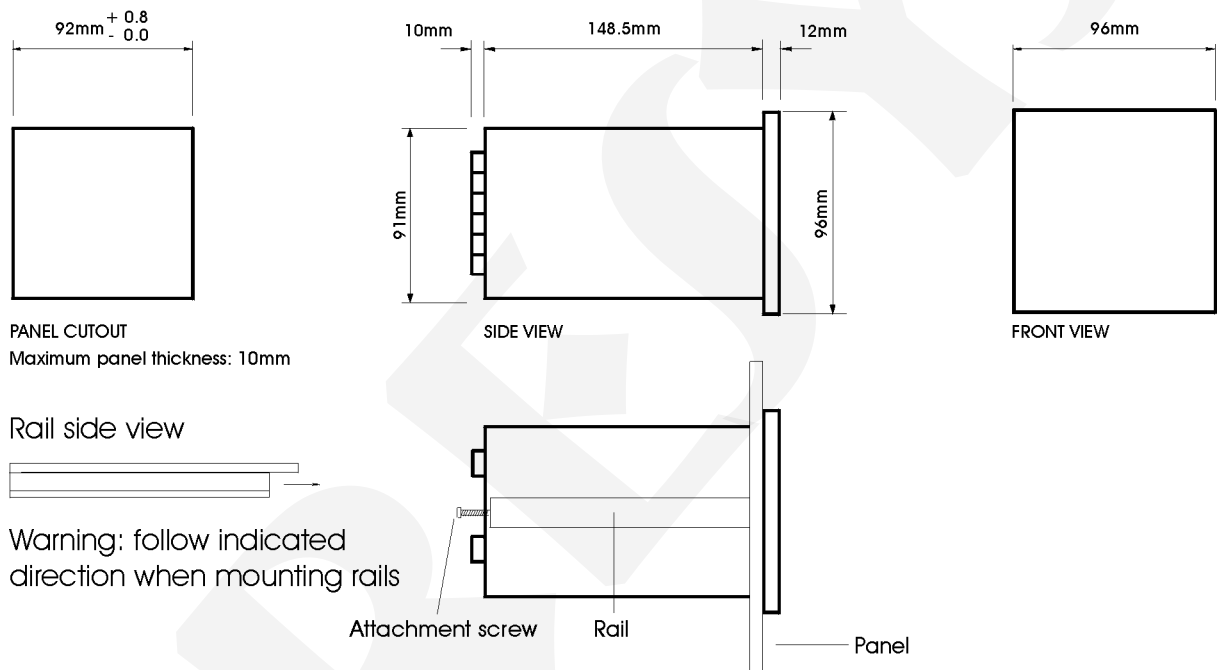

Fig. 2 - Dimensional drawing, panel cutout and side view

2.2 - Electrical Installation

DMY-2017 Controller may be powered by voltage between 90 and 240VAC or 130 to 340VDC, any polarity. Remember that the internal circuit is powered whenever the instrument is connected to the external power supply.
Input and output signals must be connected to the instrument only when it is turned off.
Figure 3 shows the instrument rear terminals for connection of power supply, ground, communication, process input and output signals.
Signal wiring must be kept far away from power wires.
Due to its metal case the instrument ground should be connected to earth ground. Never connect the ground to neutral terminal.
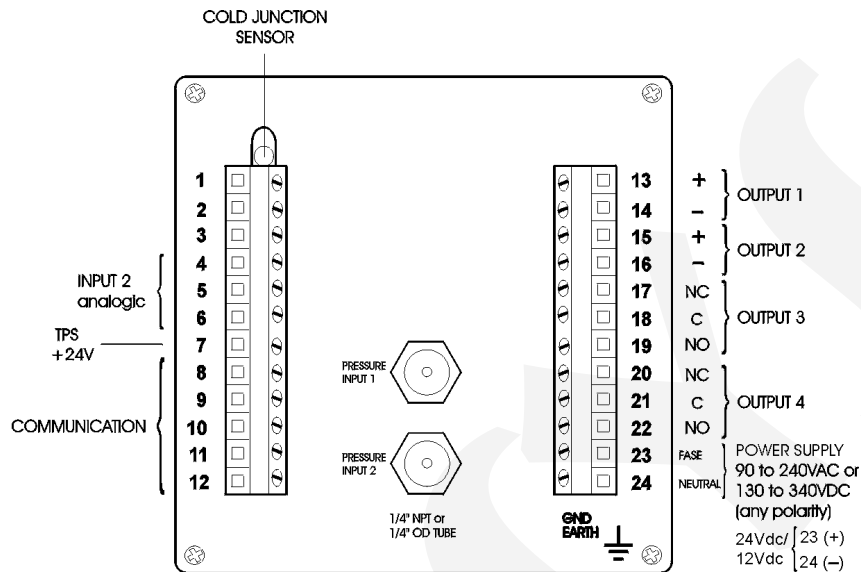

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Fig. 3 - DCY-2057 Controller Terminals

2.3 - Process Input Signal Connections

Pressure inputs 1and 2 (optional), shown in figure 3, require pneumatic / hydraulic connection with junction for 1/4" plastic tube for use with air or 1/4" NPTF for use with other fluids.

The single pressure version of the Controller accepts connection 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.

A certain type of input sensor is enabled by means of internal jumpers (refer to section 4.2 on Hardware Configuration) and by the proper sensor selection in configuration mode (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 connection of a certain type of sensor in input 1 does not restrict the simultaneous use of other sensor, of the same type or different, in input 2.

In order to avoid noise in the wiring, use twisted pair cable and cross sensor connection wire inside a metallic tube or use shielded cable. Make sure to connect only one shield wire end either to board terminal or to sensor ground, as shown in the next items.

WARNING: GROUNDING TWO SHIELD WIRE ENDS MAY CAUSE NOISE IN THE CONTROLLER.

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2.3.1 - Thermocouple Connection

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

Use appropriate compensating cables with the same material of the thermocouple in order to connect it to the instrument. Check if the thermocouple polarity is equal to those of the terminals.
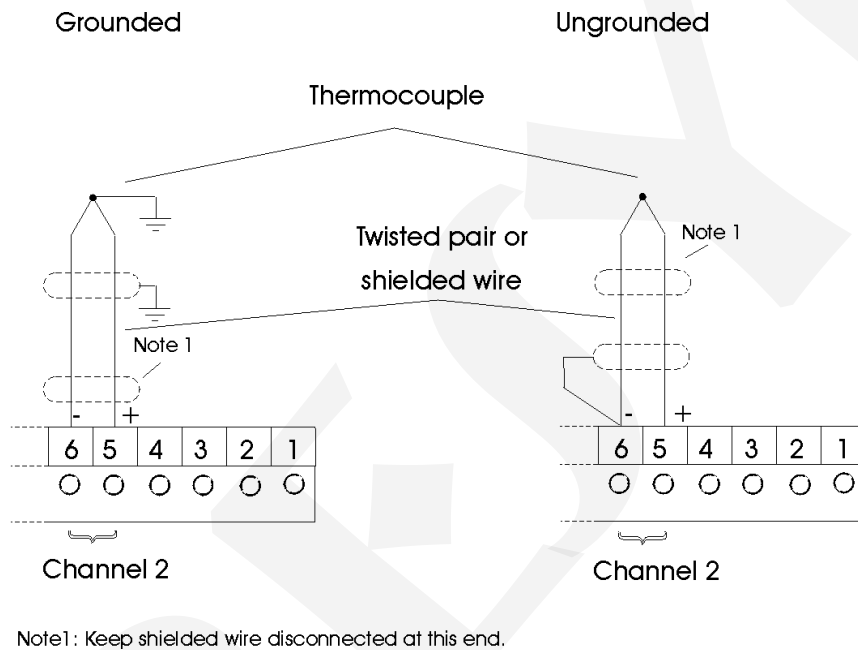

Fig. 4 - Thermocouple Connection

2.3.2 - RTD Connection

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

In case of a 2-wire RTD, connect the RTD between terminals 4 and 6 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 5, see figure 5.

A 4-wire RTD should be connected to the Controller in the same manner as 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 10 Ω per wire. The minimum wire gauge should be 18 AWG for distances of up to 50 meters and 16 AWG for distances above 50 m.

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GROUNDED

2-WIRE   3-WIRE   4-WIRE

UNGROUNDED

2-WIRE   3-WIRE   4-WIRE

Note 1: Keep shielded wire disconnected at this end.

Fig. 5 - RTD Connection

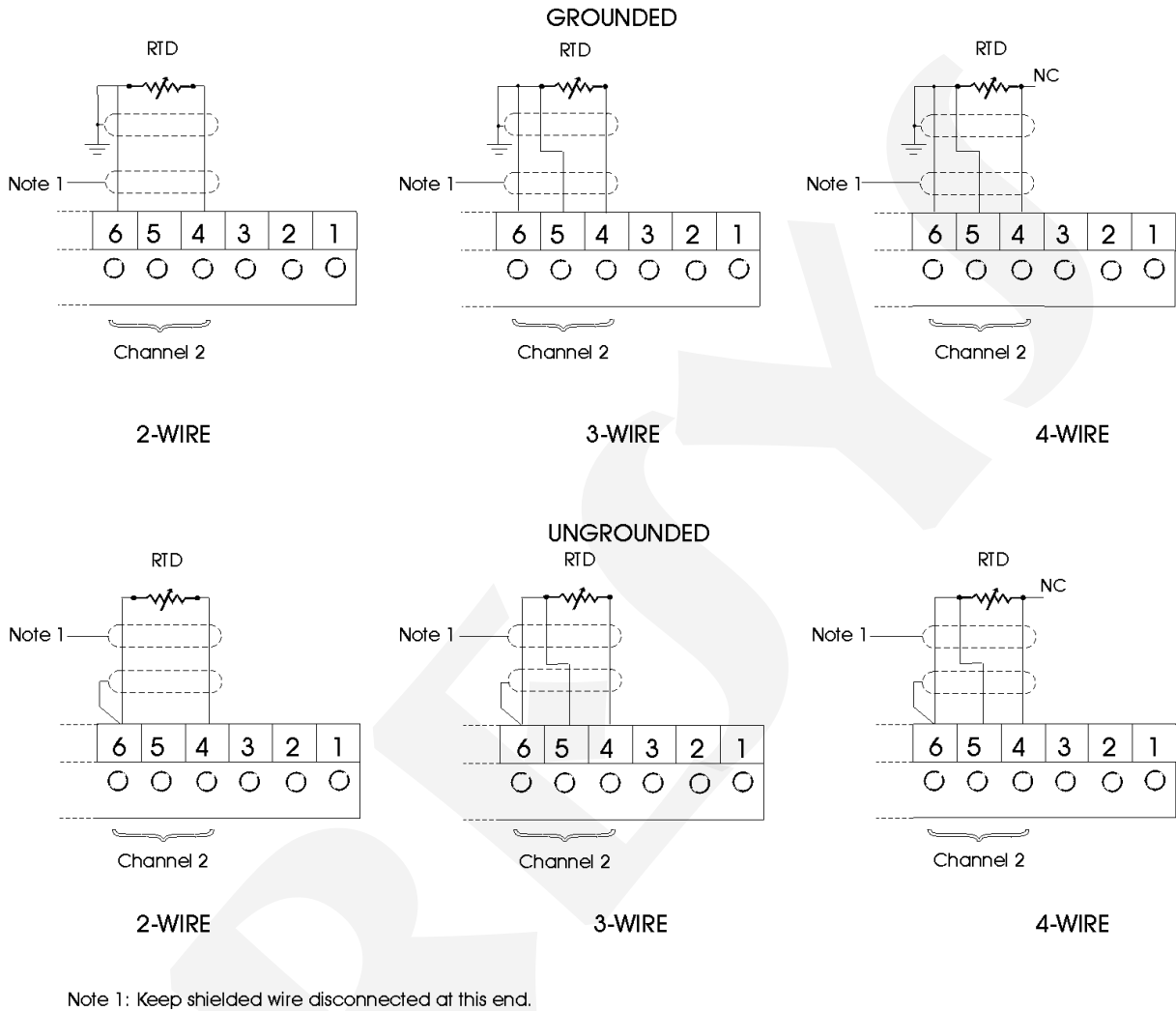### 2.3.3 - Milliampere Input

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

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Two-wire Transmitter
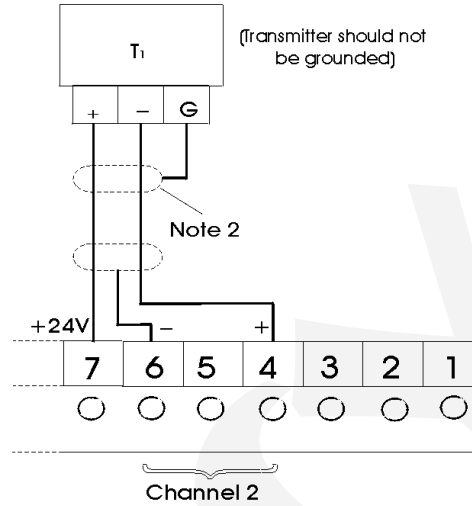
4-wire Transmitter
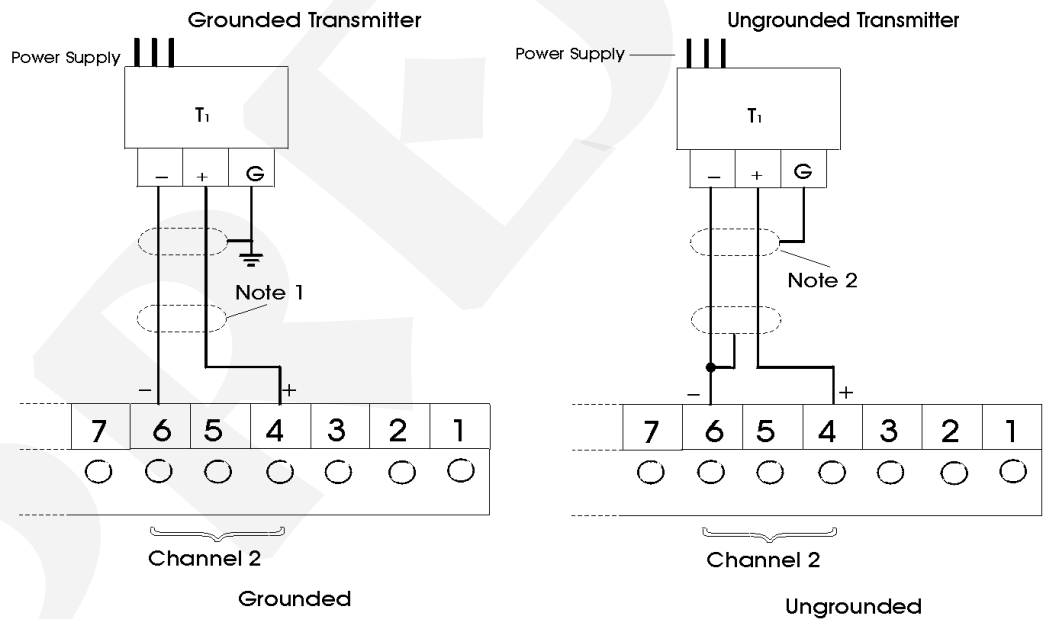
Note 1: Keep shielded wire disconnected at this end.

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

Fig. 6 - Current source Connection

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2.3.4 - mV or V Input

Either a 0 to 55mVDC or a 0 to 5VDC voltage must be applied between terminals 5(+) and 6(-) of input 2. A 0 to 10VDC voltage must be applied between terminals 4(+) and 6(-) of input 2. These connections are illustrated in figure 7.
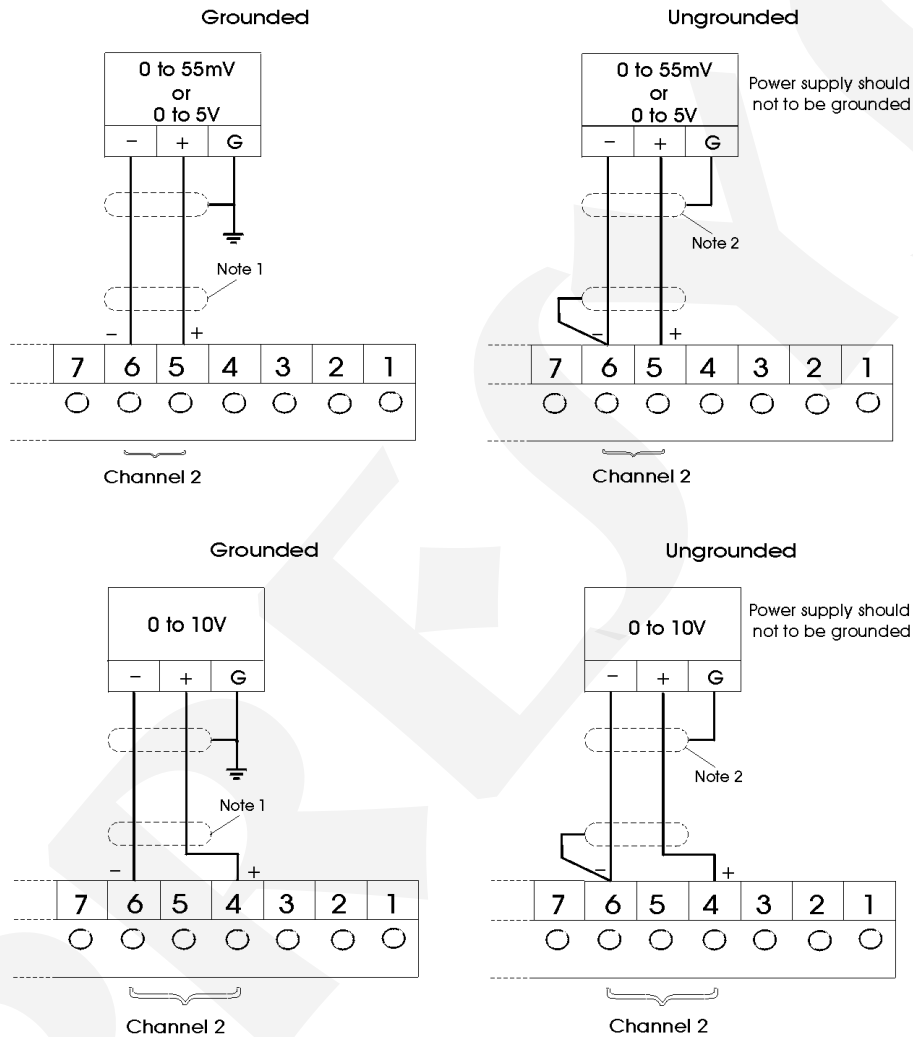

Note 1: Keep shielded wire disconnected at this end.
Note 2: Connect shielded wire to power supply ground terminal. If ground terminal non-existent keep shielded wire disconnected at this end.

Fig. 7 - Voltage Source Connection

2.4 - Control and Alarm Output Signal Connection

In the most complete version the Controller 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. Output 2 can be used as control or alarm output, depending on the Controller software configuration established by the user. Outputs 3 and 4 can be used as alarm outputs. A maximum of three alarm outputs can be provided.

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In 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 Controller.

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 4.4 on Optional Module Connection for further details on installation and configuration of optional modules.

CONTROL MODE	INTERNAL DEVICE	TERMINALS
Current Output (1) Voltage Output (1) Time proportioning (1) ON - OFF (1)	4 to 20mA 0 to 5V 0 to 10V SCR +24V Logic SPST	13 14 } OUTPUT 1 13 14 } OUTPUT 1
Current Output (2) Voltage Output (2) Time proportioning (2) ON - OFF (2)	4 to 20mA 0 to 5V 0 to 10V SCR +24V Logic SPST	15 16 } OUTPUT 2 15 16 } OUTPUT 2

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

Fig. 8 - Control Output Connections

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FUNCTION	INTERNAL DEVICE	TERMINALS
Alarm	SCR — +24V — Logic — SPST — C, NC*	15, 16 — OUTPUT 2
Alarm	SCR — +24V — Logic — SPDT — NC*, C, NO*	17, 18, 19 — OUTPUT 3
Alarm	SCR — +24V — Logic — SPDT — NC*, C, NO*	20, 21, 22 — OUTPUT 4

(*) Relay contact states shown are valid for SAFE option selected (see section 3.2 on Configuration), Controller powered on and non-alarm condition. Position of the contacts are changed in alarm condition (with SAFE option selected) or when the instrument is turned off.

Fig. 9 - Alarm Output Connections

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2.5 - Connection Diagram

Transmitter Power Supply
TPS +24V

Current 4-20mA
Voltage 0 to 10V

COMMUNICATION

Thermocouple
0 to 50 mV
0 to 5V

RS-422/485

COMMOM Tx- Tx+ Rx- Rx+

RTD

RS-232

COMMOM Tx GND Rx

INPUT 2

12 11 10 9 8 7 6 5 4 3 2 1

PRESSURE INPUT 2
OPTIONAL (4)

PRESSURE INPUT 1 (4)

CONNECTION

1/4" NPT or
1/4" OD TUBE

GND EARTH

24 23 22 21 20 19 18 17 16 15 14 13

NEUTRAL LINE

OUTPUT 4 OUTPUT 3 OUTPUT 2 OUTPUT 1

POWER SUPPLY
90 to 240VAC or
130 to 340VCC
(any polarity)

24Vdc/ 23 (+)
12Vdc 24 (−)

Relay 4   Relay 3   Relay 2   Relay 1

(3)   (3)   (3)   (3)
NO C   NC NO C NC NC C NC C

+24V   +24V   +24V   +24V

Logic   Logic   Logic   Logic

SCR   SCR   SCR   SCR

Alarm   Alarm

4 to 20 mA

0 to 5 V

0 to 10 V

Control (2)   Only for
or alarm   control (1)

Note:
(1) Referring to the first control loop.
(2) Referring to the second control loop.
(3) Position of relay contacts (NC and NO) when the controller is powered on and in non-alarm condition with SAFE option enabled.
(4) Indication of maximum pressure allowed for the channel.

2.6 - Communication

DCY-2057 Controller communicates with computers through RS-232 or RS-422/485 and with use of a MODBUS protocol communication software, when the optional communication modules are installed and the communication parameters are configured.

Specific information on communication and signal connection are described in the communication manual.

2.7 - Engineering Units

A label with several 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 Controller.

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3 - Operation

3.1 - Normal operation

The DCY-2057 Controller has two modes of operation: 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 Controller receive the input signals, compare them with the setpoints and automatically generate through control algorithms the output signals which adjust the input signals to the setpoints.

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 Controller front panel. When in the manual mode the green LED, indicating the manual state, is on.

The Controller normal mode, in which it operates most of the time, will be named zero level. In this level the upper display can show: denomination of setpoint 1 (SP 1), denomination of output 1 (OUT1), denomination of setpoint 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 setpoint 1 (V_SP 1), the value of output 1 (V_OUT 1), the value of setpoint 2 (V_SP2) and the value of output 2 (V_OUT 2). Whenever the Controller is powered on, it starts 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 the display presentation possibilities at the operation level.

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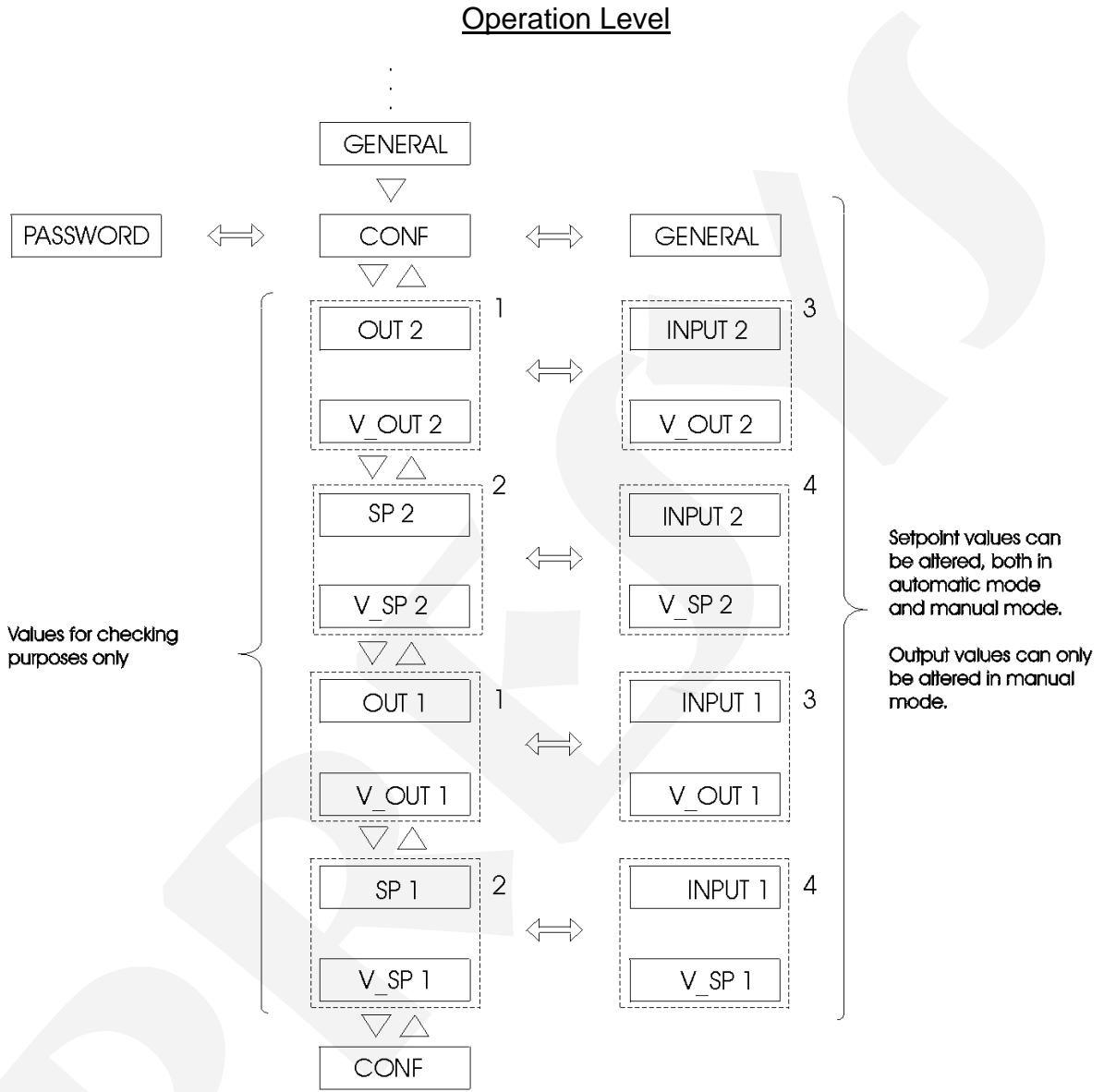
Operation Level

ENT2, SP2 and OUT2 are not shown when channel 2 is disabled

Fig. 10 - Options for Operation Level
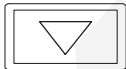

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The display shows 4 types of configuration for each channel. The configuration screens on the previous figure are identified by the numbers 1, 2, 3 and 4 for channel 1.

Upon changing to manual mode (green LED on) 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 off) the configuration screen switches to type 4. In this case, the setpoint can be immediately altered by the UP and DOWN keys.

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

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

A/M	Key	[A/M]	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 (Setpoint 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.

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3.2 - Configuration

The DCY-2057 Controller 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.
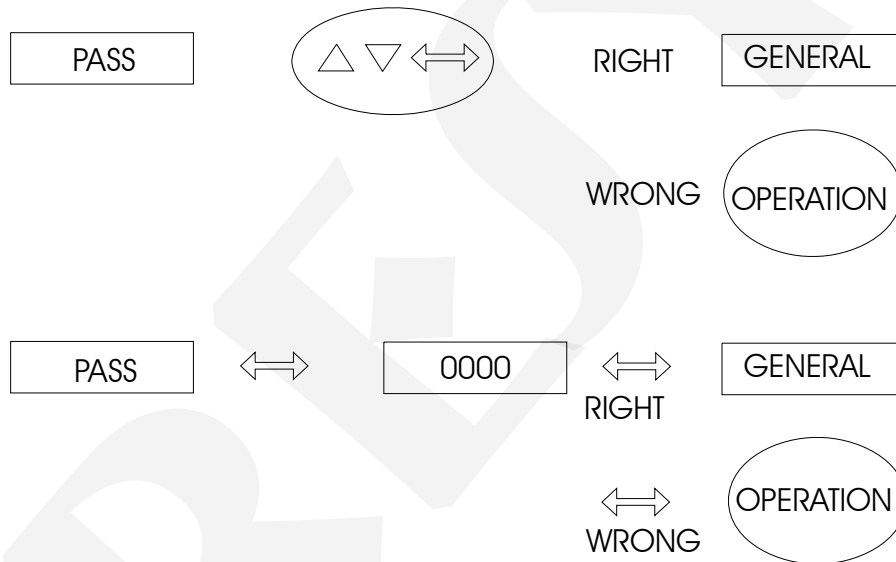
Fig. 11 - Password system by key and by value

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).

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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 number 2057. Note that in the case of password by value the number 2057 is 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-2057 Controller is factory configured and the user is not expected to enter the configuration mode.

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

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Note: in the following diagrams, the Controller displays are represented by rectangles in response to the selection ENTER, UP and DOWN keys.
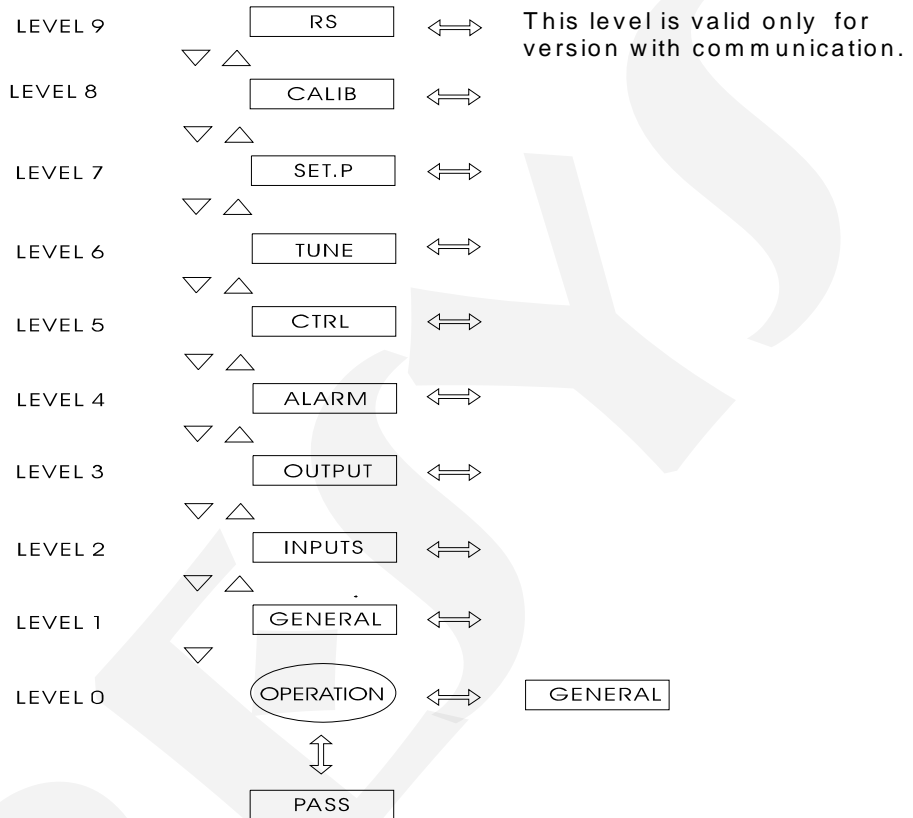
Fig. 12 - Diagram of parameter levels

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

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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 a numerical 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 number 2057) 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 setpoint/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 setpoint between the minimum setpoint value (SP1L, SP2L) and the maximum setpoint 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.

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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).
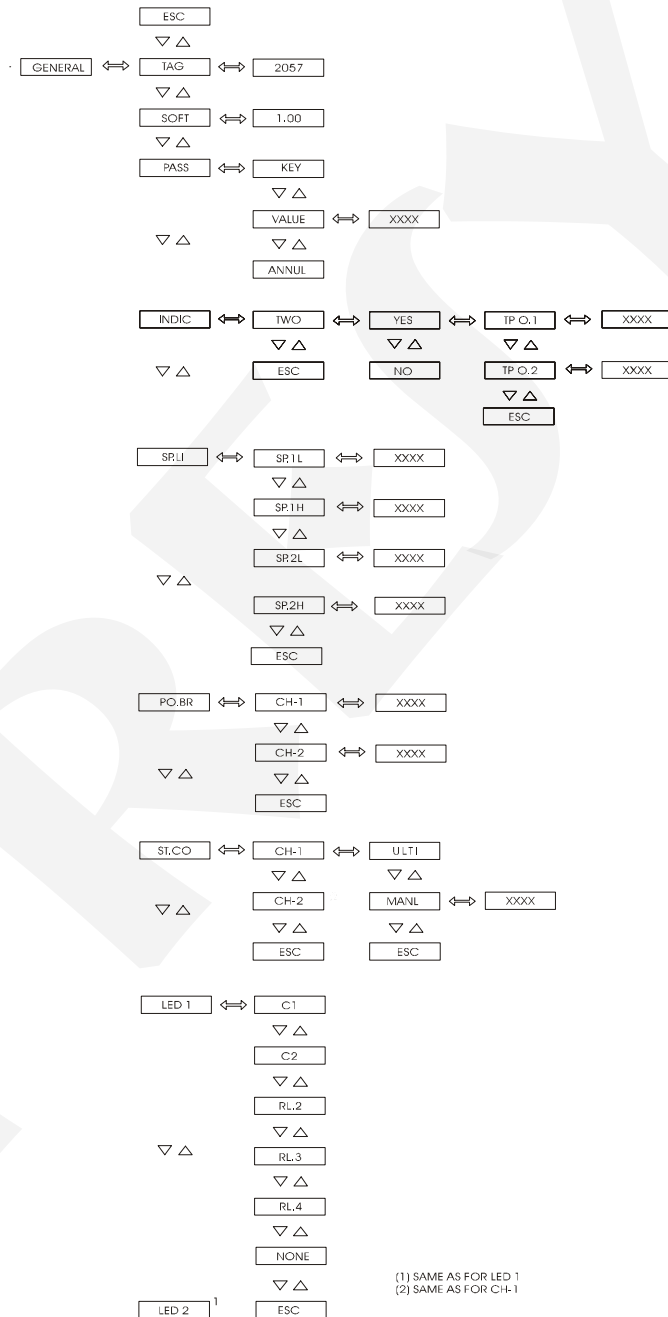
Fig. 13 - GENERAL Level Options

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

Mnemonic	Parameter	Adjustable Span	Factory Value	Unit
TAG	instrument identification	-999 to 9999	2057	-------------
SOFT	software version	-------------	1.00	-------------
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 SP2L	setpoint lower limit	-999 to 9999	0	EU
SP1H SP2H	setpoint 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 Input Level allows to enable or disable (by means of the ANNUL option) the sensor type of each channel. The sensor type for input 1 is pressure and for input 2 it can be chosen as pressure (in case the pressure sensor is installed) or a universal standard analogic input (terminals 4, 5 and 6). The sensor type for input 2 is chosen by the customer when specifying the order code.

There are three input types: pressure, temperature (TC or RTD) and linear inputs (0 to 55mV, 0 to 10V, 0 to 20 mA) as illustrated in figure 14.

4 to 20mA input belongs to the 20mA option.
1 to 5VDC input belongs to the 5VDC option.

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ESC
▽ △
RTD3W
▽ △
RTD2W
▽ △
TC-S
▽ △
B.OUT ⟺ DOWN   TC-R
▽ △   ▽ △
▽ △   UP   TC-E
▽ △
UNIT ⟺ ℃   TC-T
▽ △   ▽ △   ▽ △
ESC   ESC   °F TC-K
▽ △   ▽ △   ▽ △
TEMP * ⟺ TYPE ⟺ TC-J   ESC
▽ △   ▽ △
PRESS ⟺ UNIT ⟺   PSI
▽ △
20mA *   ▽ △
▽ △   ATM
55mV *   ▽ △
▽ △   INH₂O
ESC   ▽ △
▽ △   KGC
INPUTS ⟺ CH-1 ¹ ESC 10V * ▽ △
▽ △   ▽ △   ▽ △   MH₂O
CH-2 ⟺ SENSOR ⟺ 5V *   ▽ △
                         INHG
▽ △   ▽ △
SCALE ⟺ DIRECT ⟺ YES   MMHG
▽ △   ▽ △
NO ⟺ LIM LOW ² ⟺ XXXX % CMHG
ESC   LIM HIGH ² ⟺ XXXX % ▽ △
                         BAR
ENG LOW ² ⟺ XXXX   ▽ △
▽ △   MBAR
ENG HIGH ² ⟺ XXXX   ▽ △
▽ △   KPA
FILTER ⟺ XXXX   SQRT ² ⟺ NO ▽ △
▽ △   MMH₂O
ANNUL   ▽ △
YES ⟺ CUT-OFF ⟺ XXXX

OFSET ⟺ XXXX
▽ △
CJC ³ ⟺ NO
▽ △
INT

DEC.PT ⟺ 8888
▽ △   ⋮
ESC   8.888
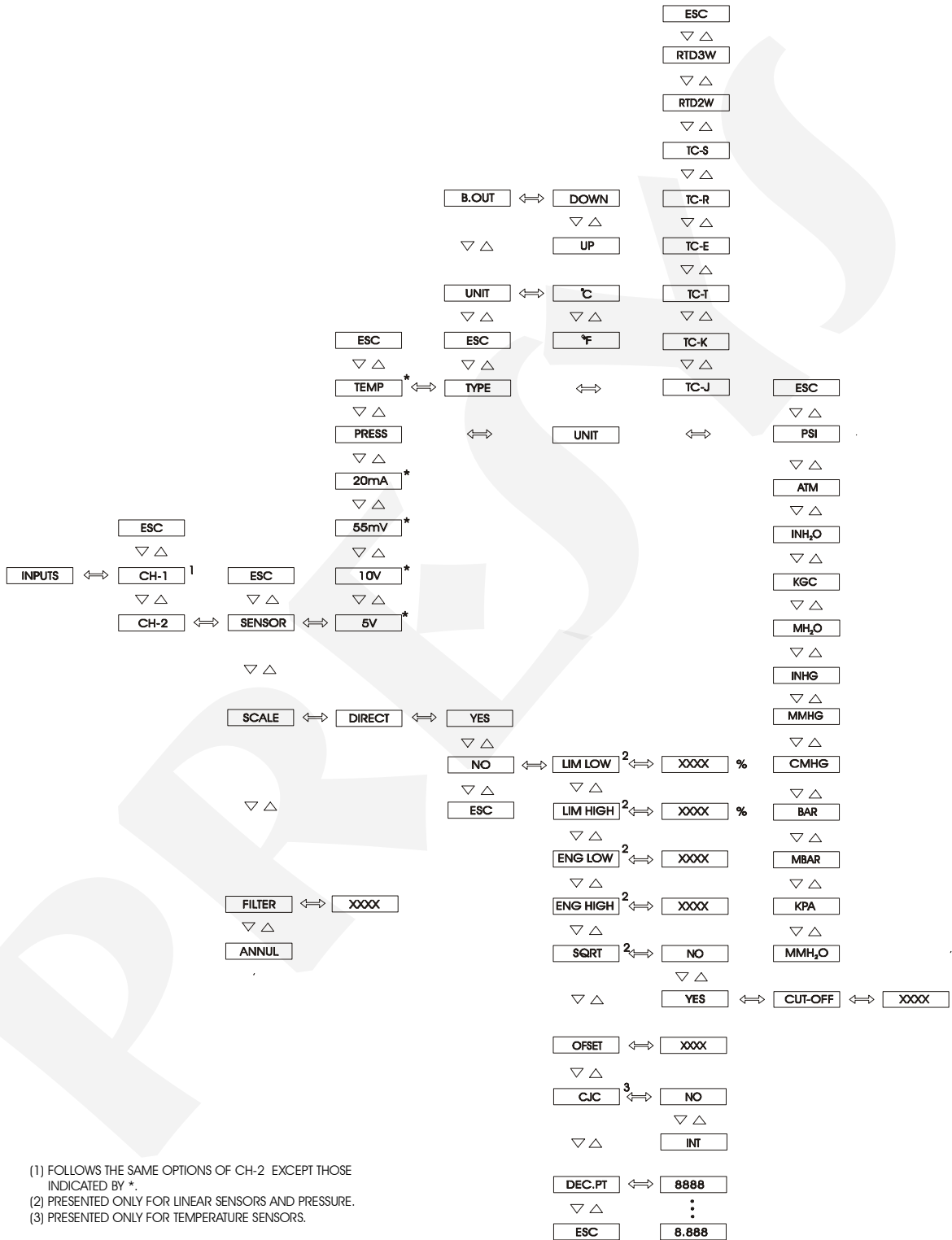
(1) FOLLOWS THE SAME OPTIONS OF CH-2 EXCEPT THOSE INDICATED BY *.
(2) PRESENTED ONLY FOR LINEAR SENSORS AND PRESSURE.
(3) PRESENTED ONLY FOR TEMPERATURE SENSORS.

Fig. 14 - INPUT Level Options

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DIRECT - enables a user-configurable scale for the pressure sensor. When YES is selected, the indication scale on display is the own scale of the pressure sensor (for instance: 0 to 5.000 psi; 0 to 250.0 psi, etc.). In case the NO option is selected to the direct mode, it takes the scale configured by the user, by means of the Lim Low, Lim High, Eng Low and Eng High mnemonics. For example, in a process where pressure varies from 3 to 15 psi and one requires the indication to show 0 to 100.0%; it is necessary to configure: Lim Low = 20.0%, Lim High = 100.0% Eng Low = 0.0% and Eng High = 100.0%. Note that Lim Low and Lim High are expressed as % of the sensor full scale (which is 15 psi in this example). The NO option belongs both to pressure sensors and linear ones.

UNIT - is the option which allows automatic conversion between several pressure units available (psi, atm, inH_2O, kgf/cm^2, mH_2O, inHg, mmHg, cmHg, bar, mbar, kPa and mmH_2O) to mesure the input signal as pressure. It also selects °C or °F for temperature indication.

The UNIT option is only effective when the DIRECT mode is selected (YES) for pressure. In the scale mode for pressure indication (NO is atributed to the DIRECT mnemonic), the UNIT option has no effect on the indication on display.

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

When selecting a linear input or pressure sensor, one must configure its scale (SCALE option). Define two points P1(Lim Low, Eng Low) and P2(Lim High, Eng High), as illustrated in figure 15. Lim Low represents the value of the electrical signal
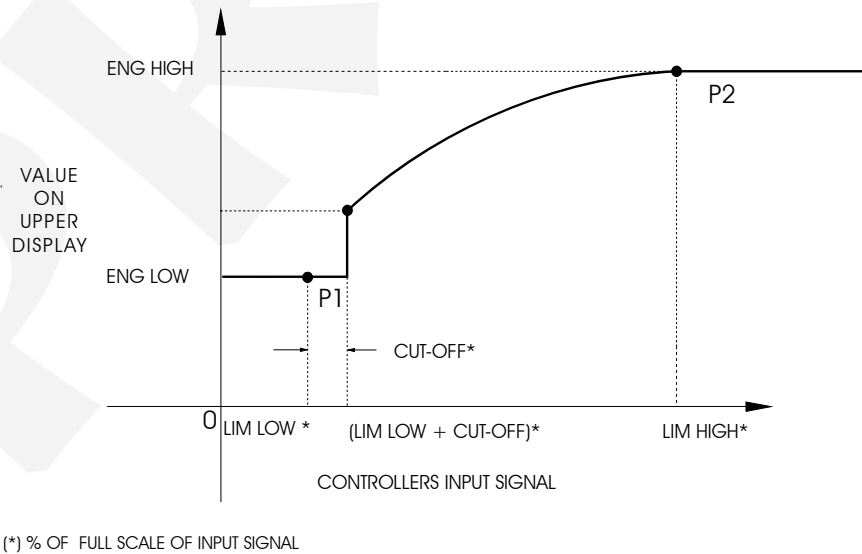

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given in % of full scale associated to the Eng Low indication on the display, and Lim High corresponds to the value of the electrical signal given in % of full scale associated to the Eng High indication on the display.

(*) % OF FULL SCALE OF INPUT SIGNAL.
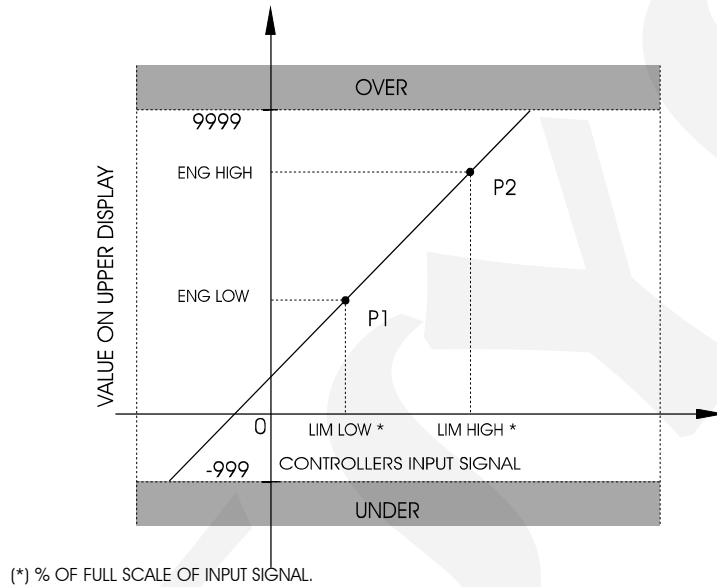
Fig. 15 - Linear Input Configuration

SQRT - allows presenting on the display the squared root of the Controller input signal on the upper display. The Cut-Off parameter given in % of the input signal makes input values below (Lim Low + Cut Off) be shown as Lim Low. See figure 16.

(*) % OF FULL SCALE OF INPUT SIGNAL

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 pressures and 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 case of temperature sensor failure (thermocouple or RTD) or break of the connection wire, the display indicates burn-out. In such cases, the UP option for this parameter activates the high alarms and the DOWN option activates the low alarms. When occurring the burn-out with the Controller in the automatic mode, it is automatically switched to the manual mode and the output changes to the value defined for PO.BR parameter. When occurring the burn-out with the Controller in the manual mode, it remains in manual mode and the output continues with the value adjusted by the operator, not changing to PO.BR value. When the Controllers leave the burn-out condition, they return to the mode in which they were operating prior to occurrence of 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.

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(1) FOLLOWS THE SAME OPTIONS FOR OUTPUT 2
(2) SAME AS 5V OPTION
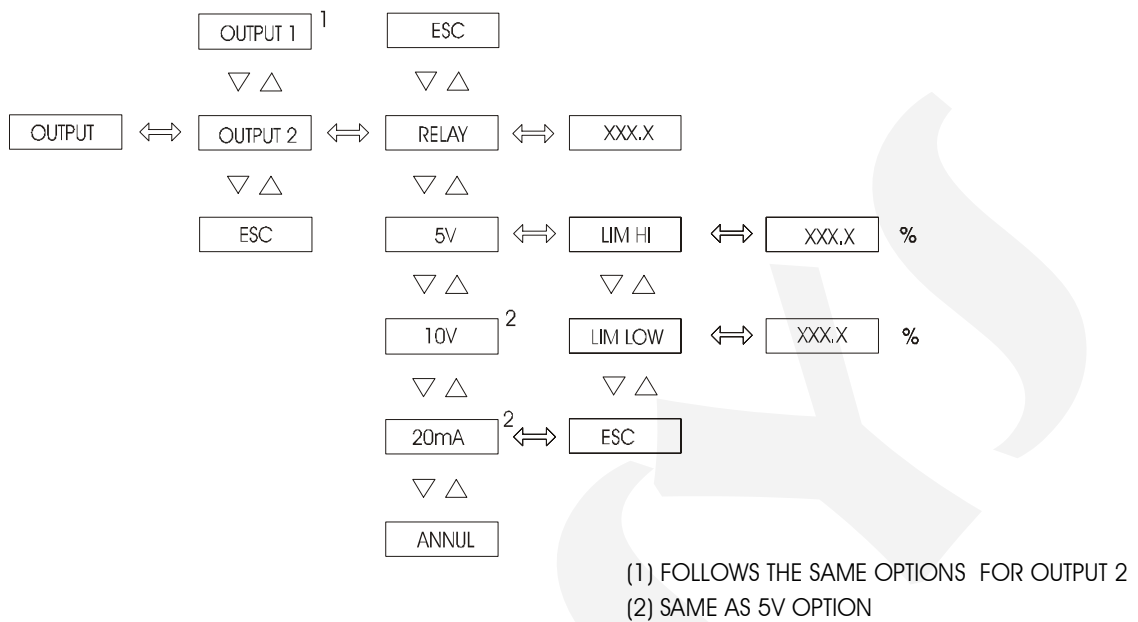
Fig. 17 - OUTPUT Level Options

The adjustable parameter ranges shown on figure 17 are 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) for outputs 1 and 2.	1.0 to 120.0	10.0	s

The control output will only be enabled after the output type is selected with the values are assigned to the related parameters.

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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 and 2 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 setpoint (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 setpoint determining the lower and higher points where the deviation alarms occur. The alarm relays are only enabled after the user has selected the setpoint 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.
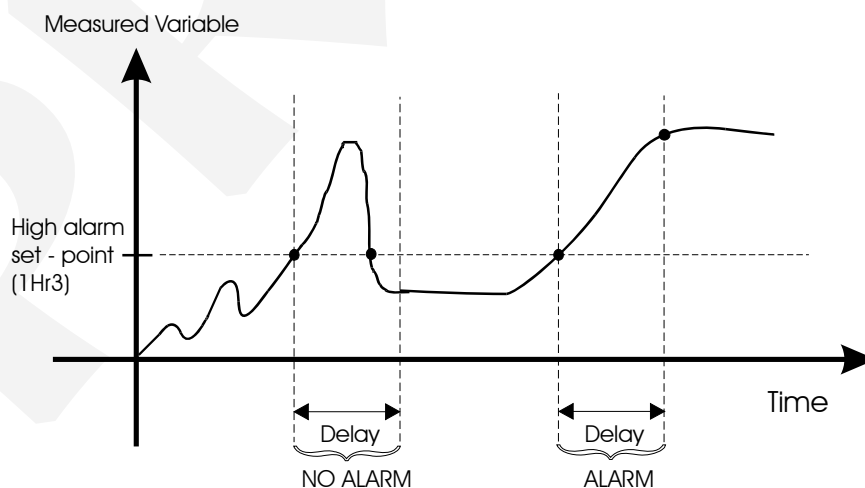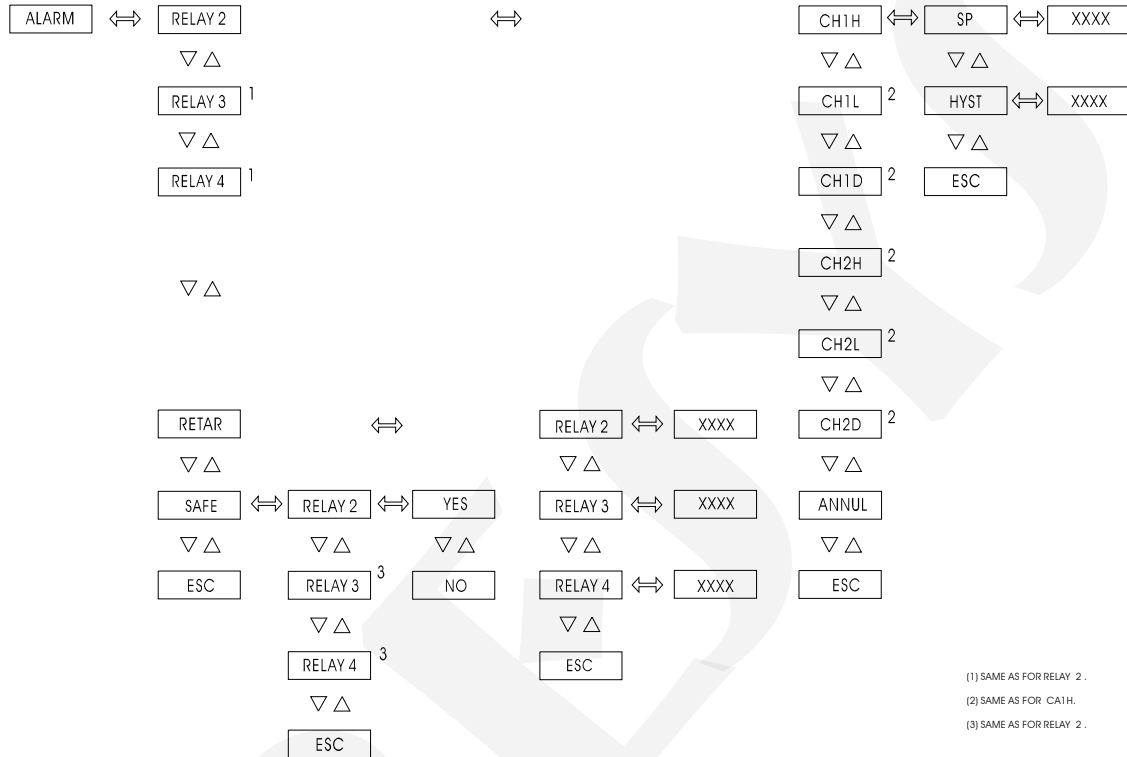

Fig.18 - Relay with delay

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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 ranges shown on figure 19 are given below.

Mnemonic	Parameter	Adjustable Span	Factory Value	Units
SP	low or high alarm setpoint	-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 setpoint	1 to 9999	75.0	EU

Warning: When changing an analogic output module (see Level 3 - Outputs) by an alarm relay to be plugged to the same connectors on the Power Supply Board, disable the analogic output before installing the relay so that it does not switch continuously.

3.2.5 - Level 5 - Control

The DCY-2057 Controller 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-2057 Controller include:

* PID Control with voltage or current output.

* PID Control with relay output (time proportioning).

* 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:

* Ratio Control.

* Cascade Control.

* Remote Setpoint Input Control.

* Programmable Setpoint Control.

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(1) FOLLOW THE SAME OPTIONS FOR CTRL1.
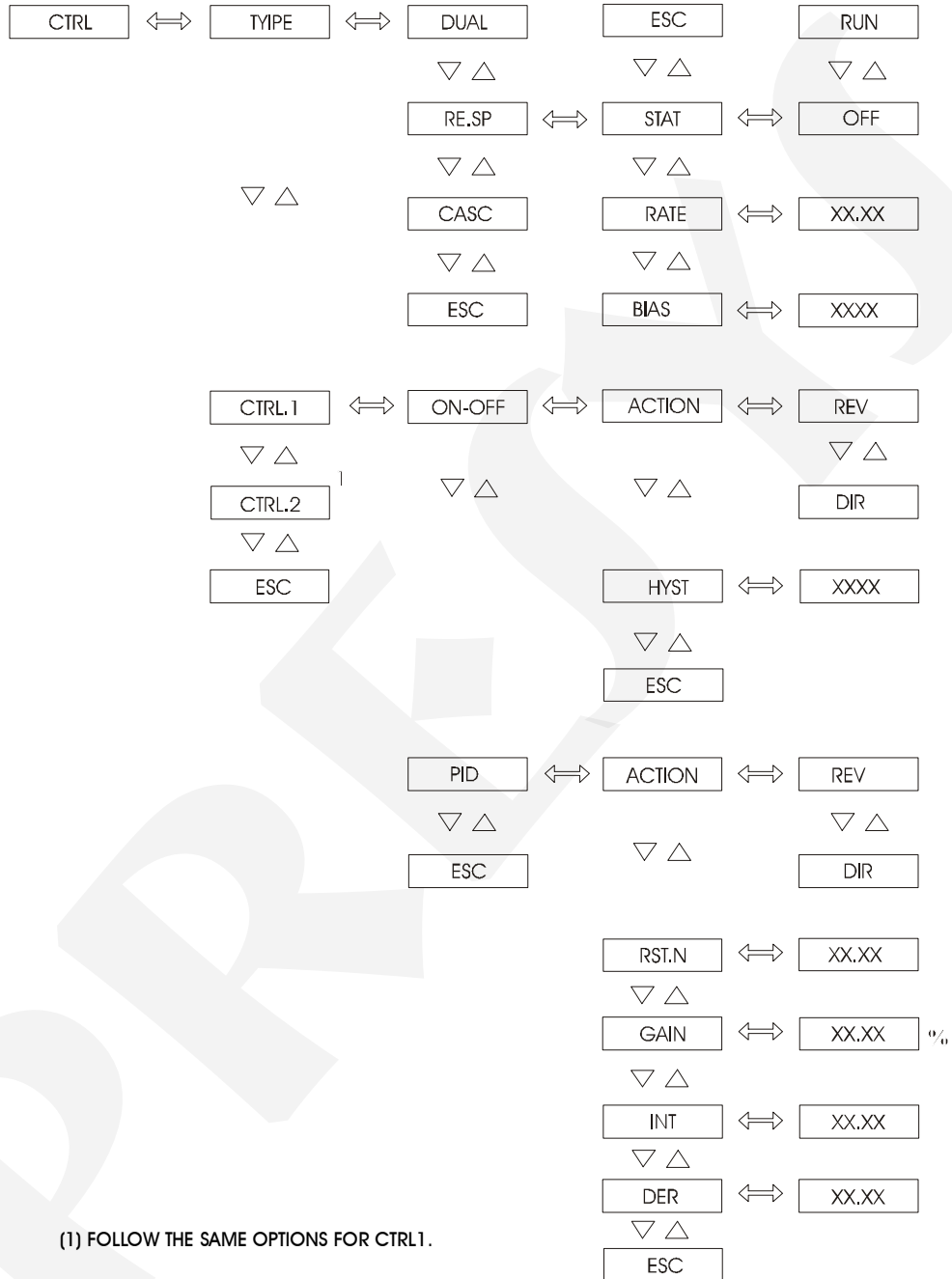
Fig. 20 - CONTROL Level Options

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Note that to have a single-loop Controller changed into a dual-loop Controller it is only necessary to add the optional 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-2057 Controller the upper and lower displays always show the controlled variable and the setpoint/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.
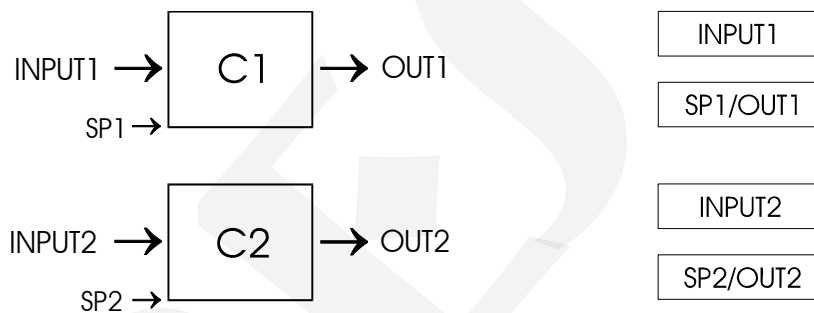
Fig. 21 - Conceptual block diagram of control blocks and displays
for the dual option

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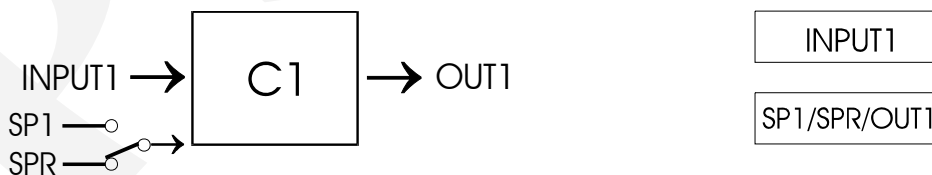

Fig.22 - Conceptual block diagram of control block and display
for a remote setpoint

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When the remote setpoint 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 setpoint 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 setpoint. This is an option which allows a quick changeover between a local and a remote setpoint.

Input 2 on the Controllers, receiving the remote setpoint 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. For the DCY-2057 Controller, control block 1 will act as the master Controller and its output will provide the slave Controller with the setpoint which will be the control block 2, as illustrated on figure 23, below.
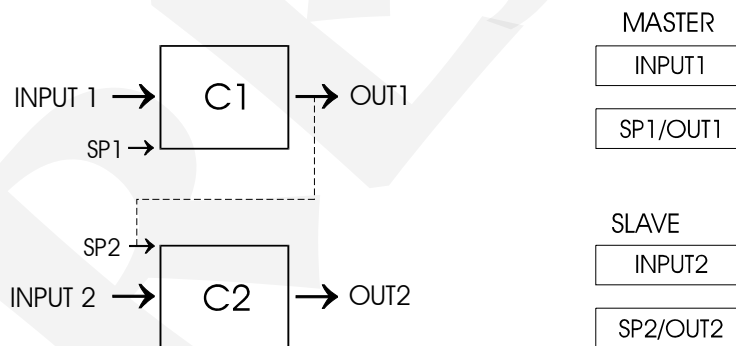
Fig. 23 - Conceptual block diagram of the control blocks and
display for the cascade control

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

CTRL1, CTRL2 - represent control blocks 1 and 2; they may be associated with the various control modes described below. CTRL2 is presented only when channel 2 is enabled.

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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 setpoint 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 setpoint value plus the hysteresis (upper limit) and switched to ON when the variable falls below the setpoint 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 setpoint value plus the hysteresis (upper limit) and switched to OFF when the variable falls below the setpoint minus the hysteresis (lower limit). The ON/OFF control mode with reverse action is illustrated on figure 24 below.
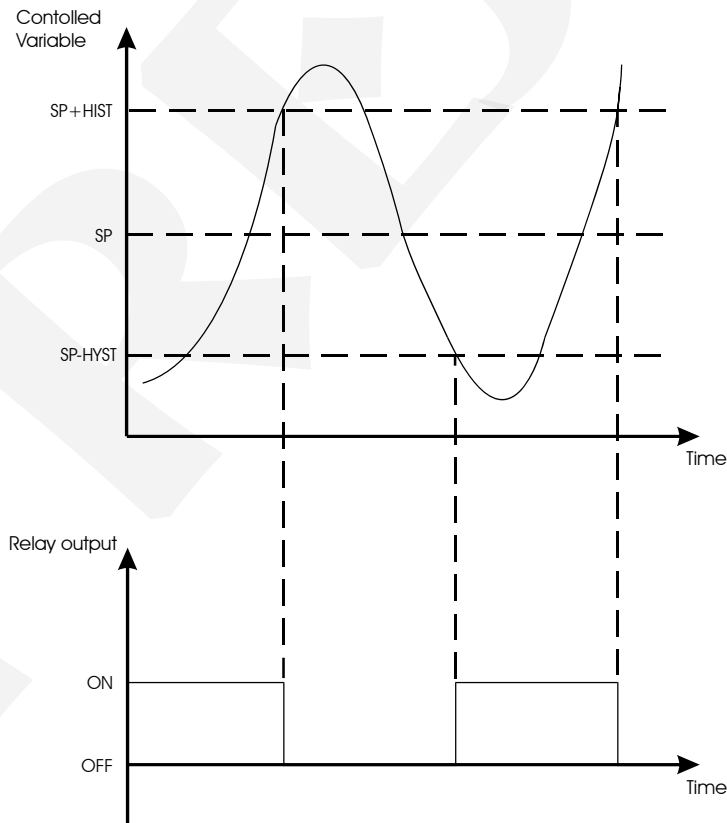

Fig. 24 - ON-OFF control with reverse action

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<u>PID control</u>

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 setpoint (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 setpoint (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 setpoint (SP) and to the controlled variable (Y) through the following equation described in continuous time:

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

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 setpoint (SP).

In reverse action, the negative sign is valid before the derivative and the error (E(t)) is taken as setpoint (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 setpoint and the controlled variable to establish the output signal.

RSTM - this is the Controller manual reset stated as an offset aggregated to the Controller 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 setpoint 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 setpoint control. While an error persists between the setpoint 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

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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-2057 Controller the deviate is applied to the controlled variable; this inhibits the derivative action whenever the setpoint 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 setpoint 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

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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.

The adjustable parameter ranges shown on figure 20 are 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

3.2.6 - Level 6 - Tune

The DCY-2057 Controller 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-2057 Controller is 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 setpoint, as is usually the case when the instrument is switched on) and on demand (the controlled variable is close t the setpoint, 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 setpoint is not enabled; STATE should be switched off.

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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.

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 25. 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.

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.

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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.
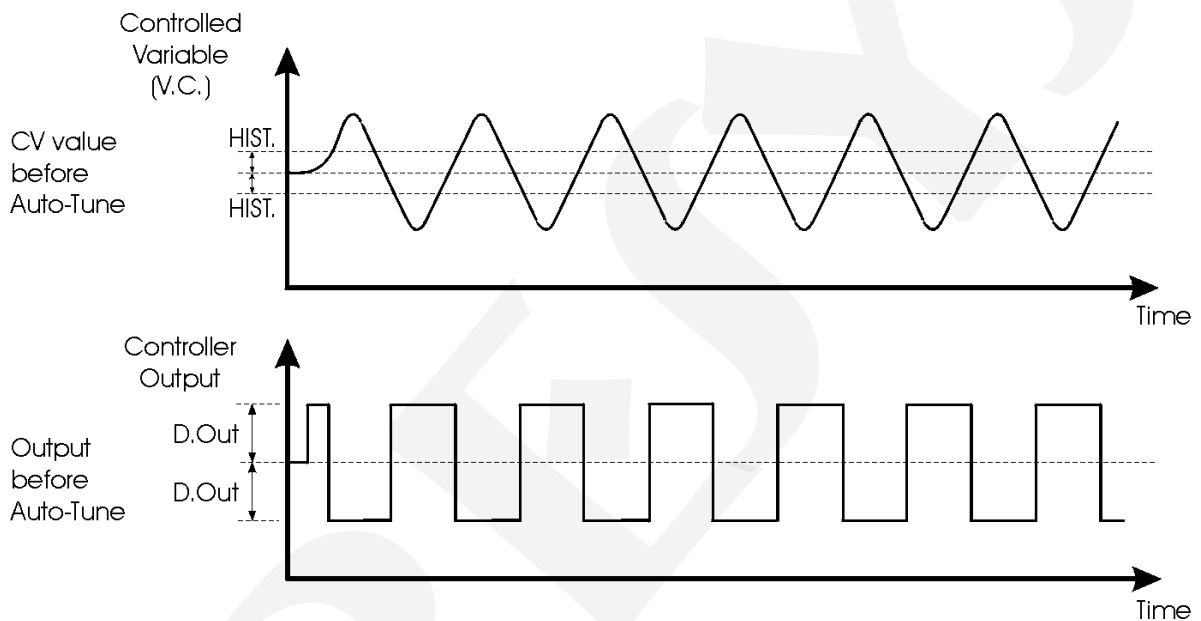
Fig. 25 - Process variable and control output for on demand auto-tune

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 25.
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 26).

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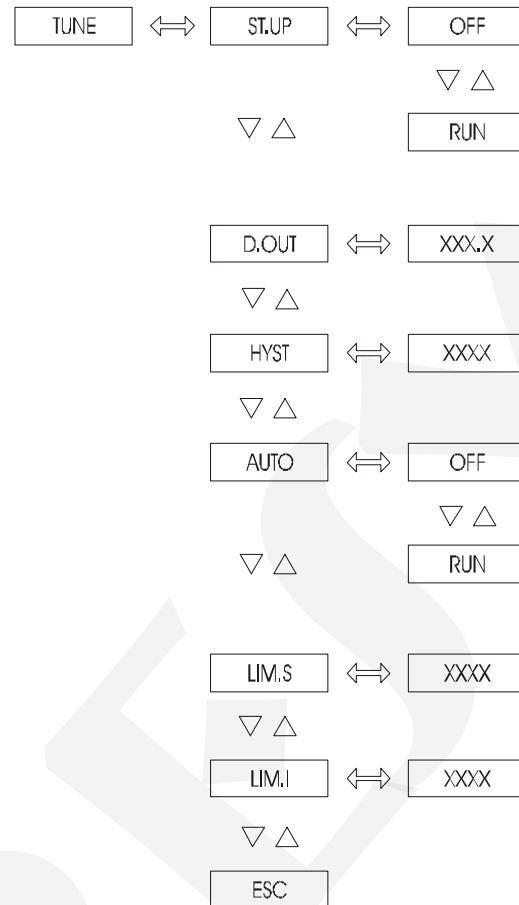
Fig. 26 - TUNE Level Options

The adjustable parameter ranges shown on figure 26 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

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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 27). 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.
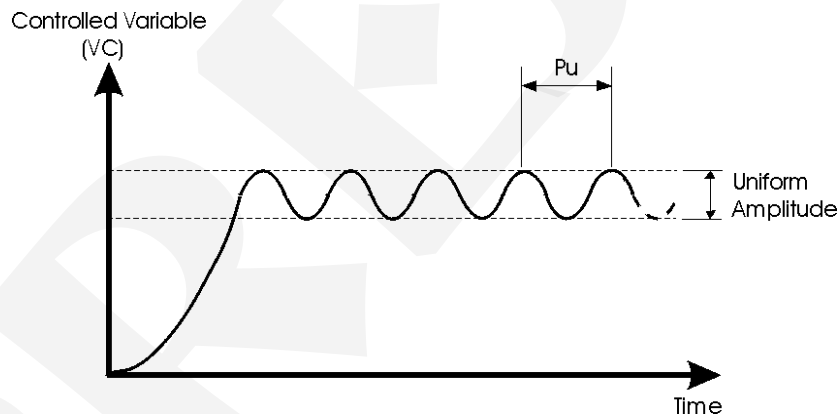
Fig. 27 - Steady state oscillation

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

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3.2.7 - Level 7 - SetP (Programmable Setpoint)

The DCY-2057 Controller 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 28 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 setpoint.
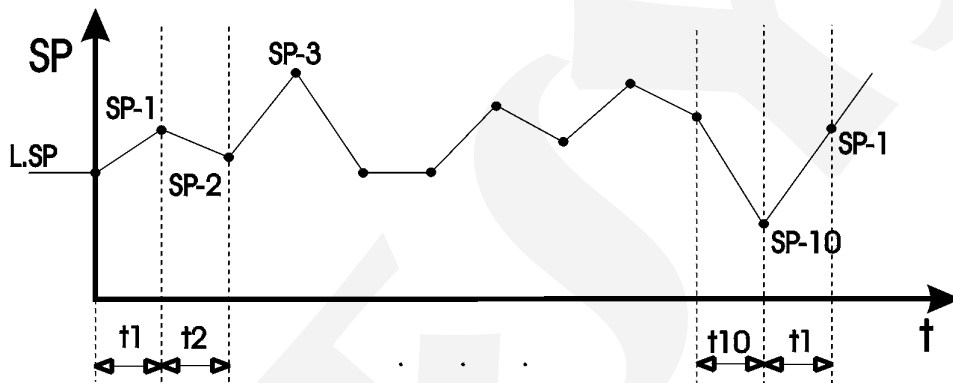
Fig. 28 - Evolution of the programmable setpoint

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The options of level 7 are shown on figure 29, below.
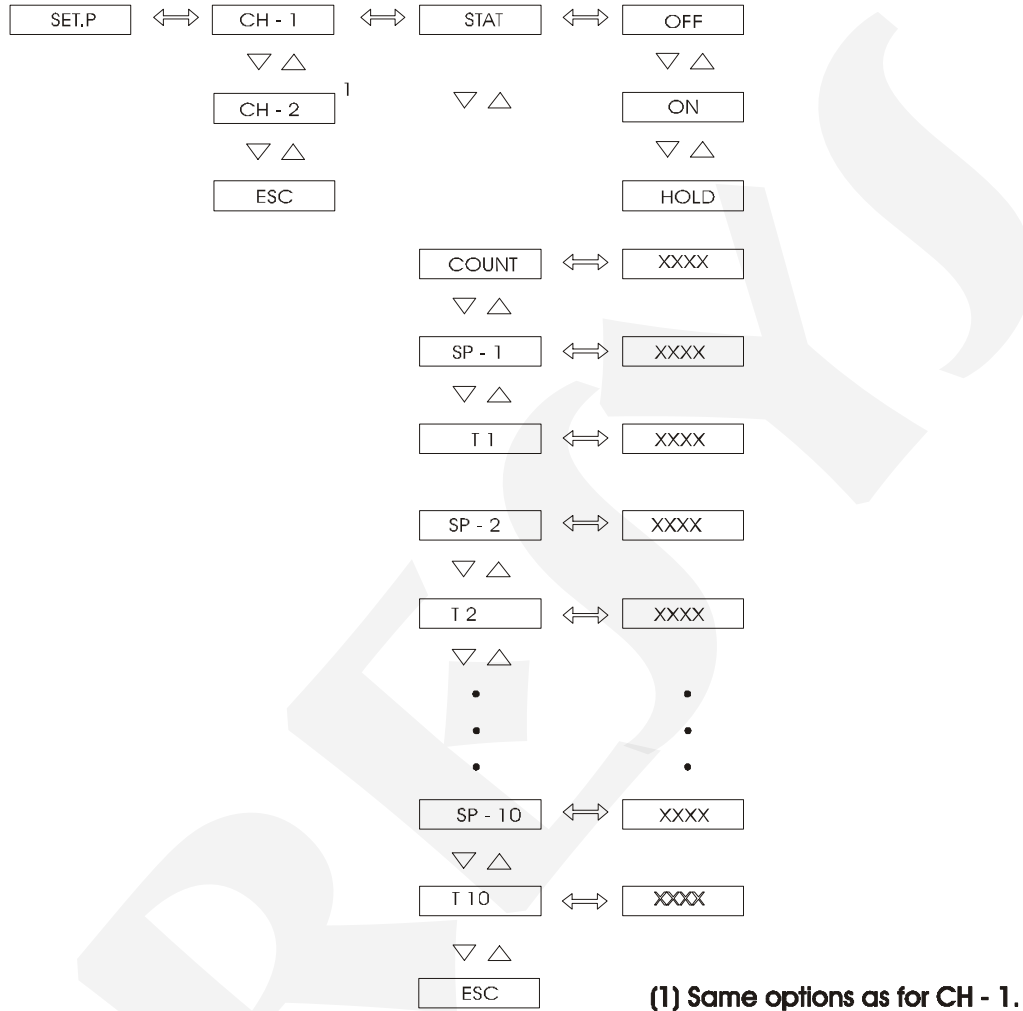
Fig. 29 - Programmable Setpoint Level Options

STAT (State) - it allows the user to activate the programmable setpoint (ON), disable the programmable setpoint (OFF) or to indefinitely suspend (SUSPENDED) setpoint execution; in that case, the setpoint value remains stationary at the setpoint 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.

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COUNT - this is the parameter programmed by the user which determines the number of times the setpoint sequence should be repeated. If COUNT is programmble at 250 the programmable setpoint is continuously executed. While the programmable setpoint 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 setpoint cycles will be executed or how many cycles are left before the end of the programmable setpoint execution.	1 to 250	1	repeats
SP-1, SP-2, ... SP-10	setpoint value	-999 to 9999	5000	EU
t1, t2, ... t10	time to reach the setpoint	0 to 9999	0	minutes

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

Itis not uncommon that one might require a sequence of setpoint ramps alternating with dwell segments. The dwell segment is easily obtained by assigning the same value to two adjacent setpoints. Therefore, if we wish the setpoint 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.

Setpoint 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 setpoint level 7 and note the value of COUNT parameter.

3.2.8 - Level 8 Calibration

Level 8 is described in section 4.5 on Calibration.

3.2.9 - Level 9 - RS

Refer to the communication manual.
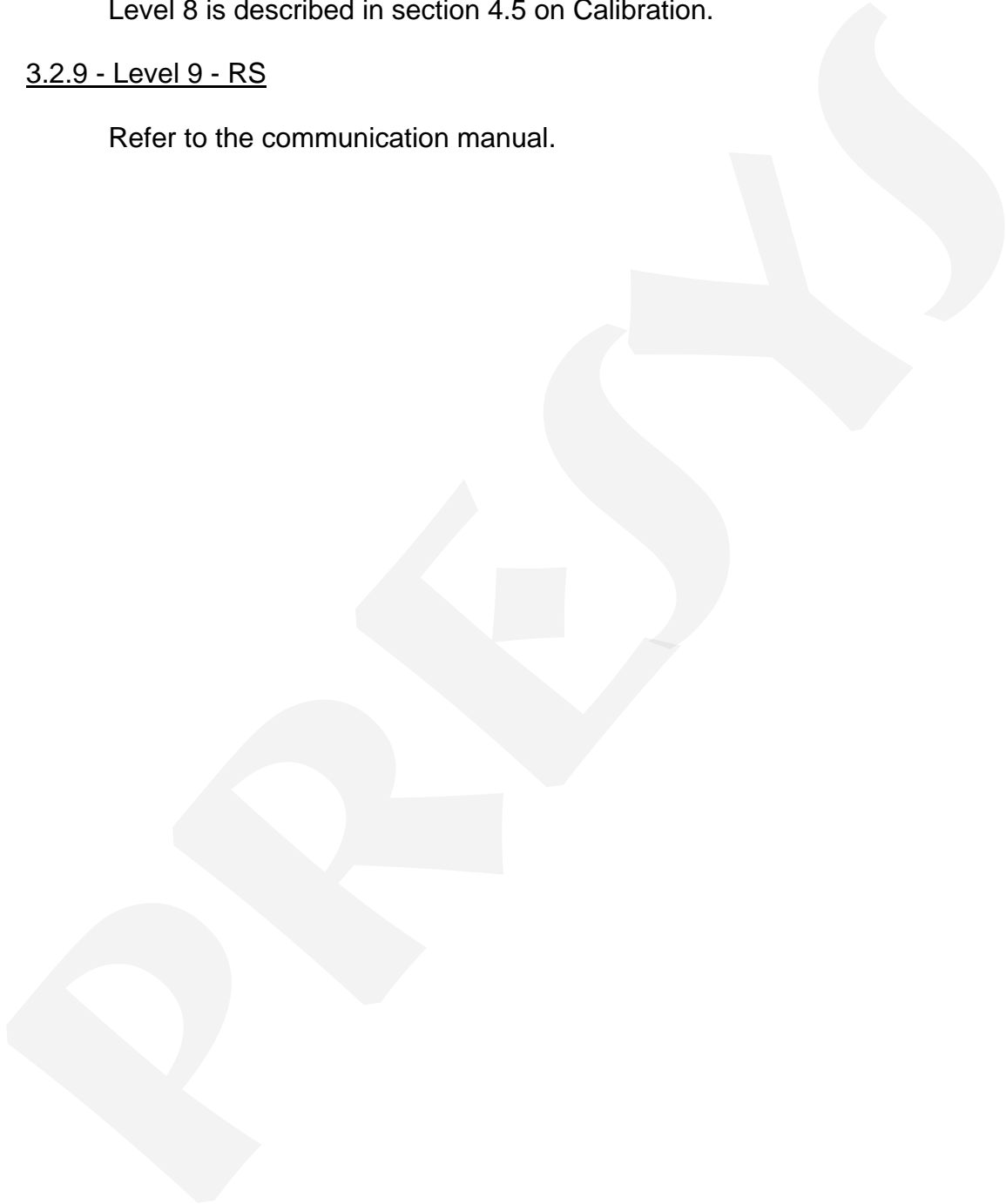
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4.0 - Maintenance

4.1 - Controller Hardware

The Controller maintenance requires the user to have access to the hardware of the instrument. The Controller hardware consists of three main boards: Display Board, CPU Board and Power Supply Board. The three -board system is fixed to the aluminum case by a screw on the lower part of the front-panel. Loosen this screw and pull the Controller front-panel in order to remove the instrument from the case.

The Display Board is located on the Controller front panel. The front panel is provided with four internal retaining brackets located on the four corners which keep the CPU Board and the Power Supply Board attached together. A spacer is screwed between the CPU Board and the Power Supply 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 30.

Power Supply Board   CPU Board
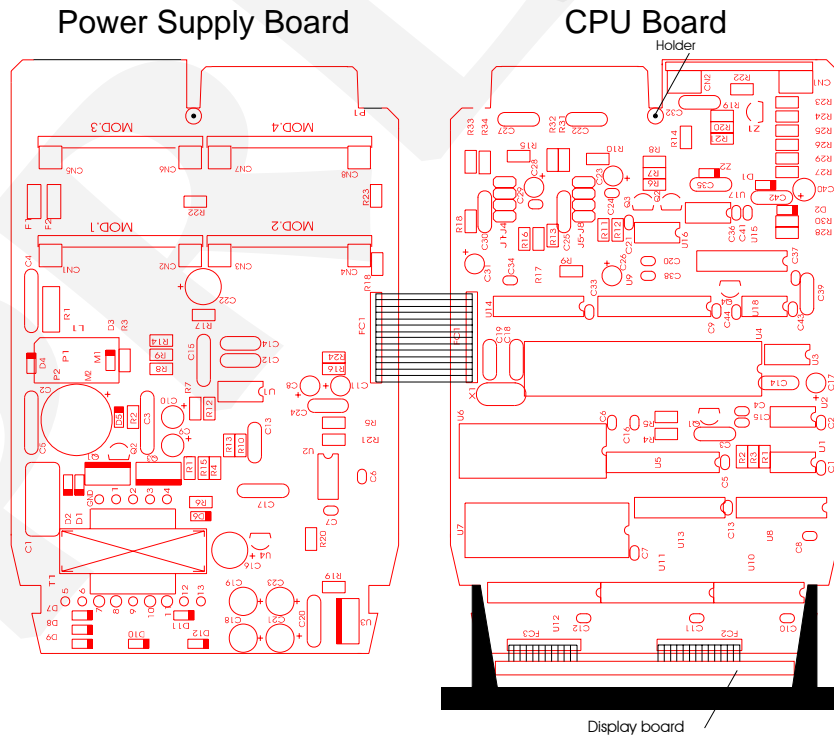
Fig. 30 - Controller Hardware

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4.2 - Hardware Configuration

This section applies only to DCY-2057 Controllers which do not have a pressure sensor installed in input 2. In this case, input 2 is an universal standard analogic input which must be configured according to the explanation given below.

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

There are four places for the installation of jumpers for channel 2: J1, J2, J3 and J4. They are located on the CPU Board as illustrated on figure 31.
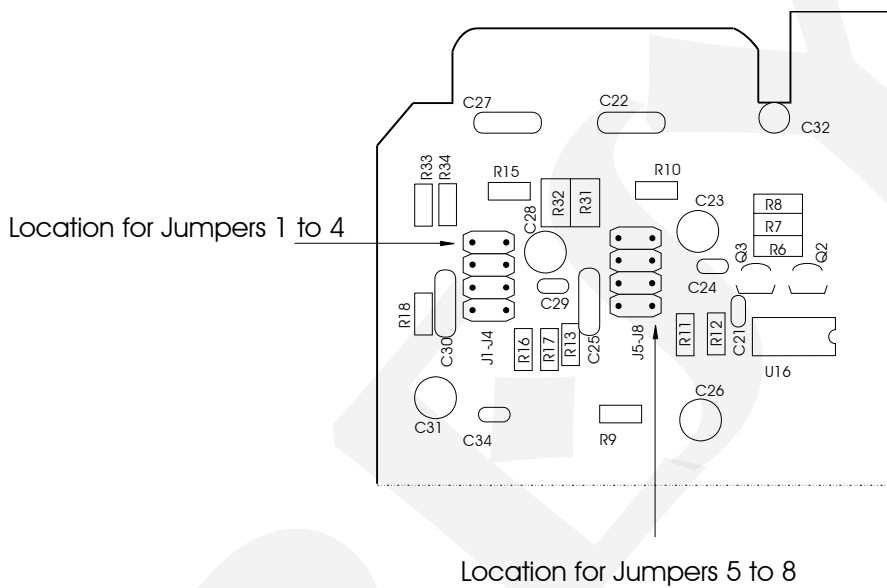
Fig. 31 - Location of Jumpers on the CPU Board

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			
Thermocouple	J1			J4
Voltage (0 to 55mV)	J1			J4
Voltage (0 to 5V)	J1			J4
Voltage (0 to 10V)*			J3	
2-wire or 3-wire RTD	J1	J2		
Current (0 to 20mA)			J3	J4

Table 2 - Configuration jumpers per type of input

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 (*) 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 32.
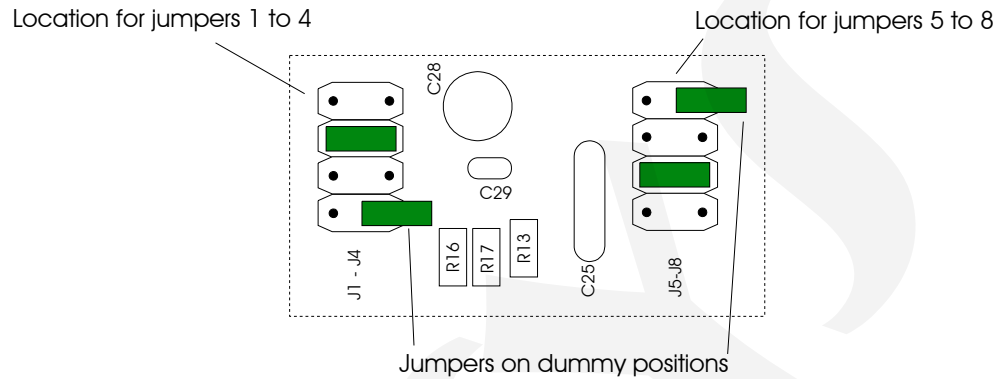
Fig. 32 - Jumpers on dummy positions for a 0 to 10V input

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 localized on the back of the relay board. 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.
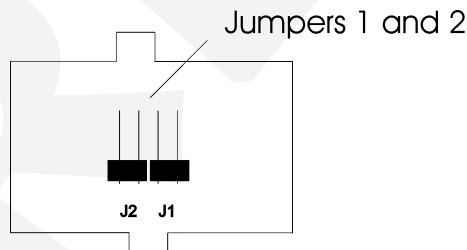
Fig. 33 - Jumpers for selection of snubbers on the relay board

Alarm and control relays are extremely critical in control and safety of industrial processes. In order to ensure the expected relay behaviour, 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 occurence of elecrical 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).

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• 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 mantain a 4.5mAac/9.0mAac current when connected to a 120VAC/220VAC circuit. This current is enough, in certain casses, 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-2057 Controller 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 Supply Board, plus one plug-in connection on the CPU Board (see figure 34).

Power Supply Board   CPU Board
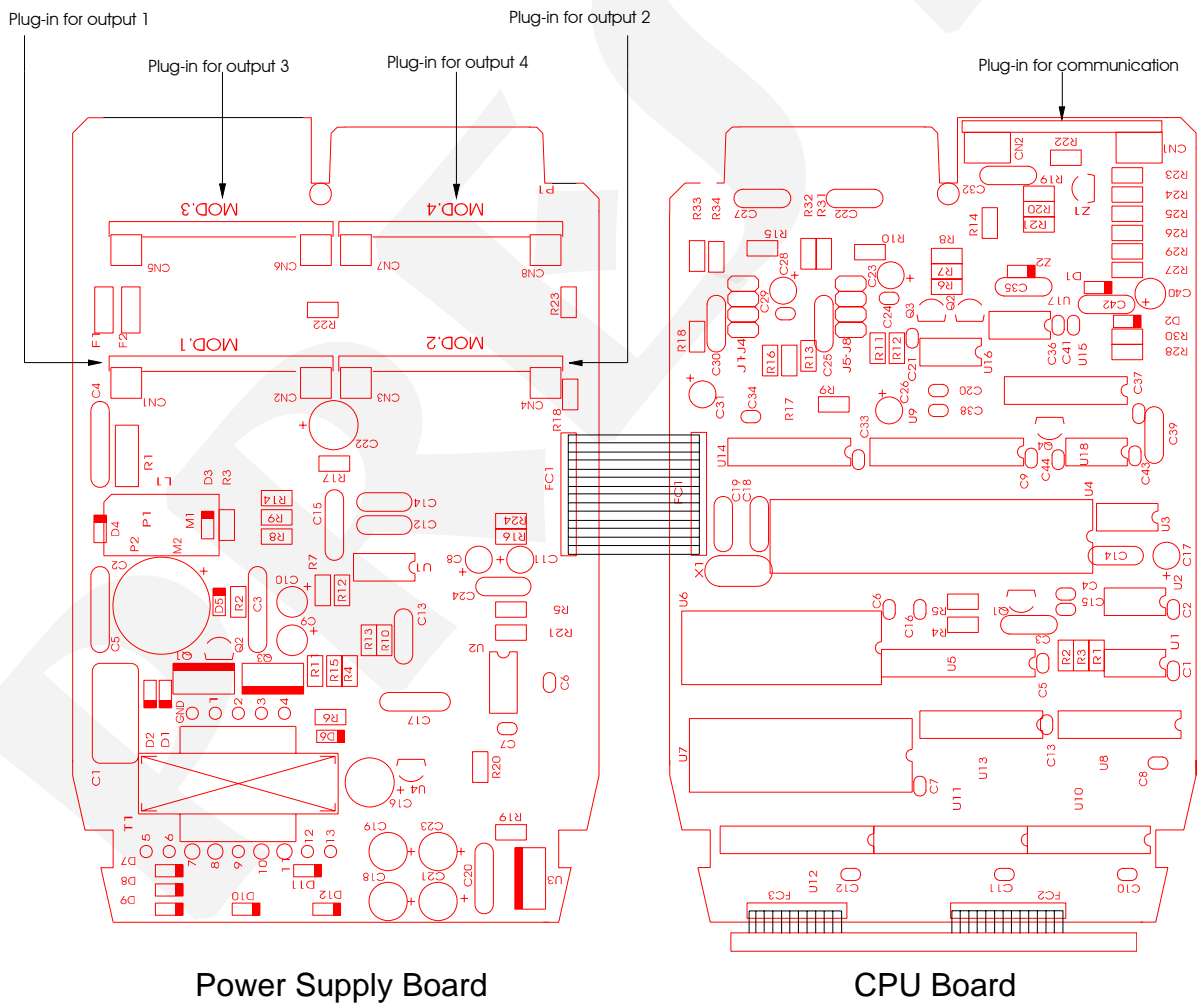
Fig. 34 - Optional Module Connections

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The plug-in connections on the Power Supply 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 Board and have no denomination. Any optional module should always be installed with the component side facing the instrument display, as illustrated on figure 35.
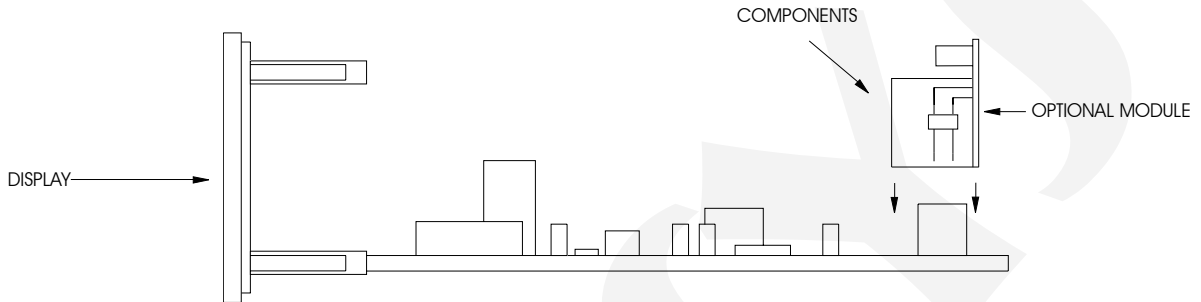
Fig. 35 - Optional Module Installation

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 36.
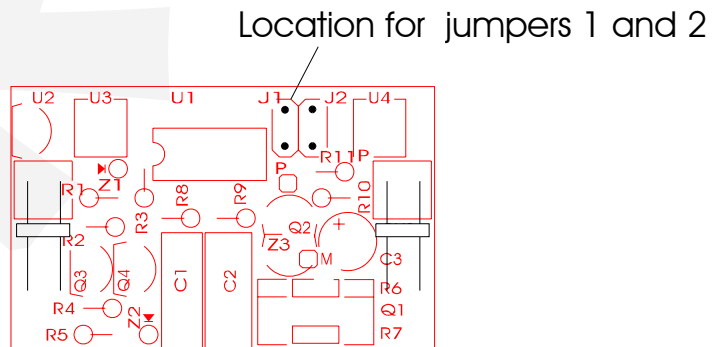
Fig. 36 - Jumper locations on the analog output board

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.

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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 32.

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

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4.5 - Calibration

The DCY-2057 Controller is 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 Controller 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 8. 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 Controller 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.

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It is possible to calibrate only one point without rendering invalid the other points already calibrated, in case the calibration of this point was not carried out properly.

In order to return to normal operation move back through the hierarchical levels until reaching level zero.

Figure 37 shows the input and output calibration options for calibration level 8.

(1) SIMILAR TO 5V (INPUT), SEE TEXT.
(2) SIMILAR TO 5V (OUTPUT), SEE TEXT.
(3) FOLLOWS THE SAME OPTIONS OF OUTPUT 1.
(4) FOLLOWS THE SAME OPTIONS OF CH-1.
(5) FOR A 5PSI SENSOR.
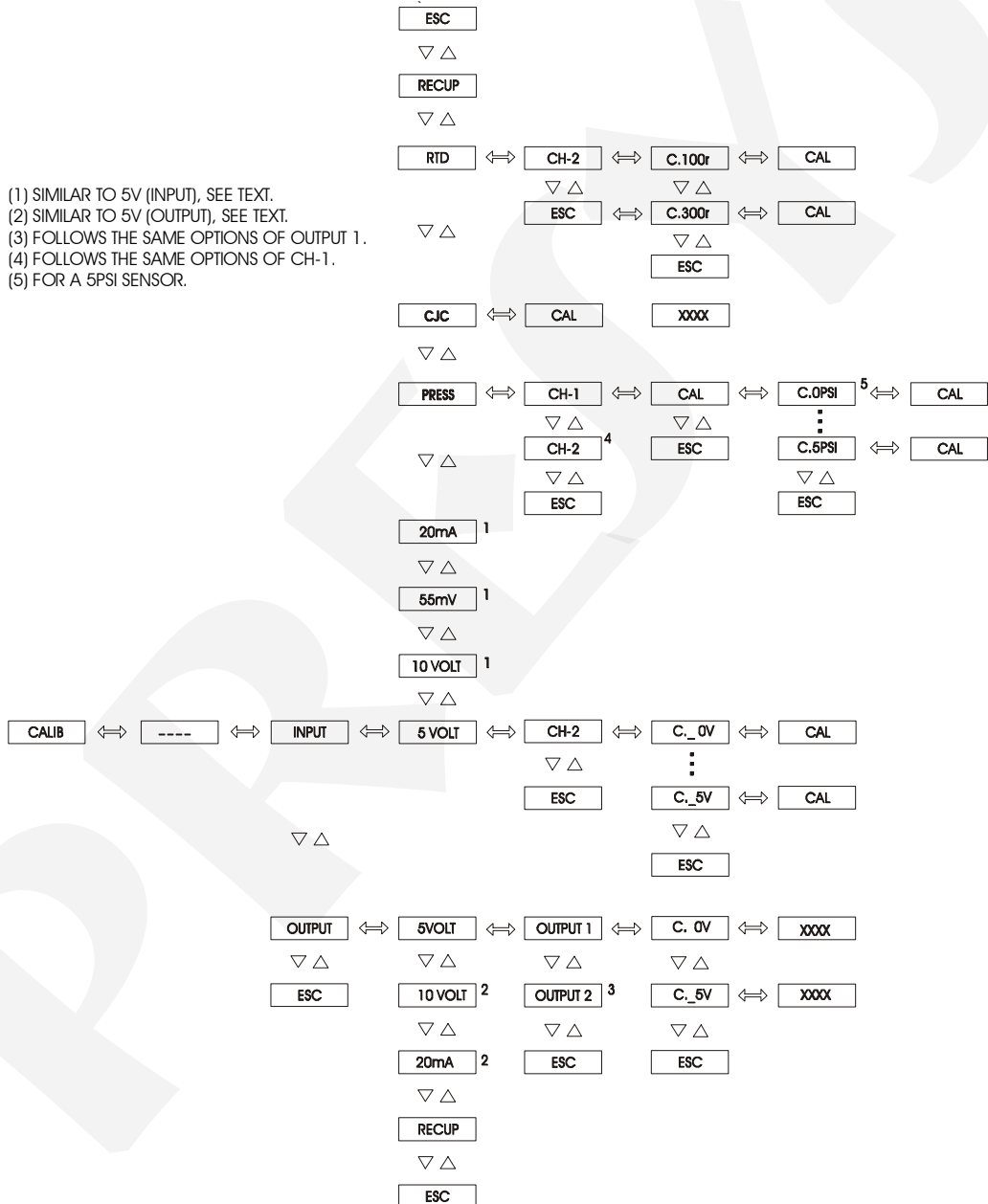
Fig. 37 - Calibration Level Options

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Calibration of Pressure Input

In order to calibrate the pressure input apply the proper pressure to the sensor to be calibrated.

References given in psi / mmH_2O are listed below for each type of sensor.

- 250 mmH_2O Sensor

Reference	Mnemonic
0.00 mmH_2O	0 mmH_2O
50.00 mmH_2O	50 mmH_2O
100.00 mmH_2O	100 mmH_2O
150.00 mmH_2O	150 mmH_2O
200.00 mmH_2O	200 mmH_2O
250.00 mmH_2O	250 mmH_2O

- 1 psi Sensor

Reference	Mnemonic
0.0000 psi	0psi
0.2000 psi	0.2psi
0.4000 psi	0.4psi
0.6000 psi	0.6psi
0.8000 psi	0.8psi
1.0000 psi	1.0psi

- 5 psi Sensor

Reference	Mnemonic
0.0000 psi	0psi
1.0000 psi	1psi
2.0000 psi	2psi
3.0000 psi	3psi
4.0000 psi	4psi
5.0000 psi	5psi

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- 15 psi Sensor

Reference	Mnemonic
0.000 psi	0psi
3.000 psi	3psi
6.000 psi	6psi
9.000 psi	9psi
12.000 psi	12psi
15.000 psi	15psi

- 30 psi Sensor

Reference	Mnemonic
0.00 psi	0psi
6.00 psi	6psi
12.00 psi	12psi
18.00 psi	18psi
24.00 psi	24psi
30.00 psi	30psi

- 100 psi Sensor

Reference	Mnemonic
0.00 psi	0psi
20.00 psi	20psi
40.00 psi	40psi
60.00 psi	60psi
80.00 psi	80psi
100.00 psi	100psi

- 250 psi Sensor

Reference	Mnemonic
0.00 psi	0psi
50.00 psi	50psi
100.00 psi	100psi
150.00 psi	150psi
200.00 psi	200psi
250.00 psi	250psi

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- 500 psi Sensor

Reference	Mnemonic
0.00 psi	0psi
100.00 psi	100psi
200.00 psi	200psi
300.00 psi	300psi
400.00 psi	400psi
500.00 psi	500psi

- 1000 psi Sensor

Reference	Mnemonic
0.0 psi	0psi
200.0 psi	200psi
400.0 psi	400psi
600.0 psi	600psi
800.0 psi	800psi
1000.0 psi	1000psi

Voltage Input Calibration (0 to 55mV)

In order to calibrate the voltage input at 0 to 55mV connect an accurate DC voltage source to channel 2 (terminals 5(+) and 6(-)). It is required 2 voltage references listed in table 5.

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

Table 5 - Required voltages for the calibration
of voltage input 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 voltage source to channel 2 (terminals 5(+) and 6(-)). It is required 2 voltage references listed in table 6.

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

Table 6 - 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 voltage source to channel 2 (terminals 4(+) and 6(-)). It is required 2 voltage references listed in table 7.

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

Table 7 - 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 current source to channel 2 (terminals 4(+) and 6(-)). It is required 2 current references listed in table 8.

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

Table 8 - 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, 0 to 5V calibrate the 0 to 55mV input and the 0 to 5V input both from channel 2 (terminals 5(+) and 6(-)) as detailed in tables 5 and 6. Upon calibration completion in mV and V, access the mnemonic CJC within the option ENTR in calibration level 8 (see figure 37).

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

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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.

Then return to normal operation mode moving back until 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 9 between terminals 4 and 5 with terminals 5 and 6 short-circuited.

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 9 - 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 Controller themself.

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

The hardware configuration of the input should be the same as that of the output (0 to 5V, 0 to 10V or 0 to 20mA) since the Controller themself will be measuring the output signal. Therefore, check that the configuration of the internal jumpers in the optional Output Module and in the CPU Board match the corresponding input and output types.

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

Make the connections listed in table 10 according to which output and output type should be calibrated.

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

Table 10 - 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 moving back until level zero.

Returning 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.

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4.6 - Hardware Maintenance Instructions

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 output 2 is configured as a control output and an attempt is made to configure it as an alarm relay (relay 2), or vice-versa. To prevent this from happening, make sure to disable the related control output 2 prior to enabling the alarm relay 2.

Note: In case there is an alarm relay module configured as analogic output, the relay switches continuously.

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) the display will show the following error message: Err.4.

Instrument display out

Check if power supply voltage is provided to terminals 23 and 24 of the Controller.

Verify the integrity of fuse F1 of 2.0 A placed in the Power Supply Board as shown in figure 34. Due to its package it is necessary to check the fuse continuity in order to detect if it is broken.

Instrument malfunction

Check that if the Controller is correctly configured both in terms of software and hardware (internal jumpers).

Examine if the optional modules are connected in the right spots.

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Check if the voltages on flat cable 1 as shown in figure 38 are close to values in table 11 and if they reach the CPU Board.

Points of Flat-cable 1	Voltages
Between point 1(-) and point 2(+)	5V
Between point 9(-) and point 8(+)	8V
Between point 9(-) and point 1(+)	0V
Between point 9(-) and point 10(+)	- 8V
Between point 9(-) and point 13(+)	24V
Between point 12(-) and point 11(+)	5V

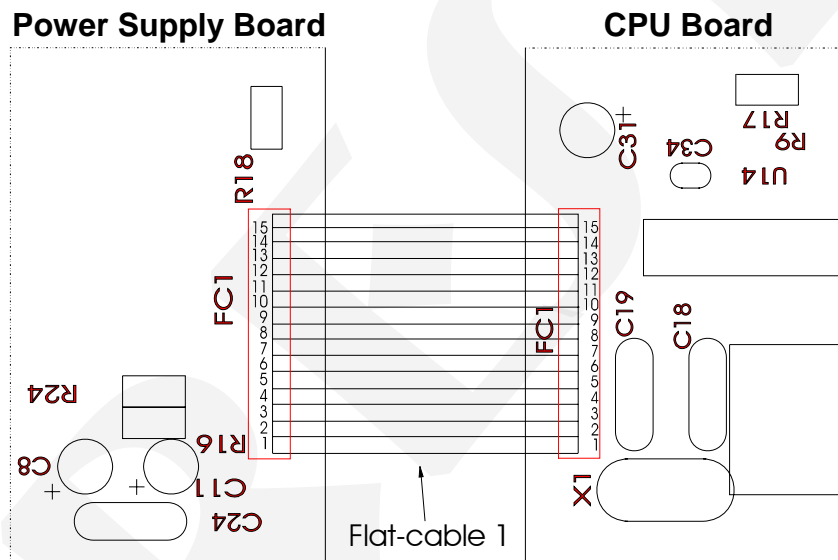Table 11 - Inspection points of voltage on flat cable 1

Fig. 38 - Voltage test points of the Controller

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

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4.7 - List of Components

Display Board

Code	Components	Reference
01.05.0056-20	Display Board - DCY 2057	---------------------
01.07.0002-21	Display 14mm	DP1,2,3,4,5,6,7,8
01.04.0001-21	Diode 1N4002	D1,2
01.07.0004-21	Led 3mm (Green)	D3
01.07.0005-21	Led 3mm (Red)	D4,5
01.09.0013-21	Transistor BC 327	Q1,2,3,4,5,6,7,8
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 Supply Board	---------------------
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
01.09.0020-21	IRF 822	Q3
01.02.0099-21	Fuse 1 A	F1
01.01.0028-21	78L24	U4
01.04.0007-21	Diode 1N4007	D1,2,3,4
01.04.0008-21	Diode 1N4936 / 1N4937	D 5,6,7,8,9,10,11,12
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	C 8,11
01.03.0042-21	Radial electrolytic capacitor 22 uF X 25 V	C 9,10
01.03.0027-21	Radial electrolytic capacitor 100 uF X 25 V	C 18,21
01.03.0043-21	Radial electrolytic capacitor 100 uF X 35 V	C 16,22
01.03.0044-21	Radial electrolytic capacitor 220 uF X 10 V	C 20,23
01.03.0045-21	Radial electrolytic capacitor 22 uF X 350 V	C 2
01.03.0002-21	Radial electrolytic capacitor 1000µF x 16V	C 19
01.03.0068-21	Polyester capacitor 4n7 x 400V	C 25,26
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

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Code	Components	Reference
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 Board

Code	Components	Reference
01.05.0048-20	CPU 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

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Code	Components	Reference
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
01.05.0061-20	I/O terminal board - DMY-2017	------------------
01.01.0026-21	AD 706	U2,3
01.09.0015-21	Transistor BC 337	Q1
01.04.0005-21	Reference Diode LM 336 / 5.0 V	D1
01.04.0027-21	Zener Diode BZX 79C11	D2
01.03.0035-21	Multilayer ceramic capacitor 0.1µF x 63 V	C3,5,7,9
01.03.0011-21	Multilayer ceramic capacitor 220pF x 63V	C1,2,12,13,15
01.03.0037-21	Polyester capacitor 0.1µF x 100V	C4,6,8,10,11
01.02.0017-21	Resistor 619R 1%	R18,28
01.02.0019-21	Resistor 1K 1%	R3,4,12
01.02.0029-21	Resistor 4K02 1%	R9
01.02.0043-21	Resistor 20K 1%	R10,11,23,24
01.02.0069-21	Resistor 1M 1%	R2,13,17,25
01.13.0003-21	Connector EDGE 26	P1,P2
01.13.0002-21	Terminals	CN1,CN2
01.09.0027-21	Terminals	CN1,CN2
01.09.0028-21	Terminals	CN1,CN2

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 22 uF X 25 V (85049)	C1

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Code	Components	Reference
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

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4.8 - List of Recommended Spare Components

<u>Display Board</u>
Display DP1, 2, 3, 4, 5, 6, 7, 8

<u>Power Supply Board</u>
IRF 822	Q3
UC 3842	U1
Fuse 1A	F1
LM 1458N	U2

<u>I/O Terminal Board</u>
AD 592	U1

<u>CPU Board</u>
4051	U14
Presys SY-02	U15
Reference diode LM-336/ 5V	Z1

<u>Technical Manual</u>
Code 02.10.0008-21

<u>Engineering Units Card</u>
Code 02.10.0003.21