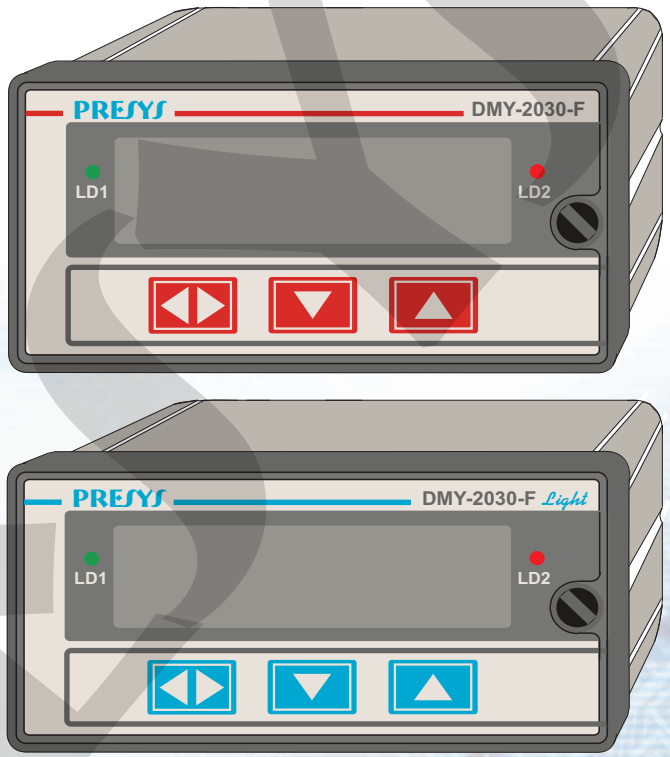
PRESYS®

Calibração NBR ISO/IEC 17025 CAL 0193

SISTEMA DE GESTÃO TÜVRheinland Brasil NBR ISO 9001 QUALIDADE

Empresa Nacional
Tecnologia 100% Brasileira



Frequency Digital Indicator

DMY-2030-F / DMY-2030-F *Light*

Technical Manual

PRESYS Instruments

CE Declaration of Conformity

Presys unit DMY-2030-F and DMY-2030-F *Light* has been designed to comply with the following European Standards:

EN 50081-1: 1992 Electromagnetic Compatibility - Generic emission standard.
EN 50081-2: 1994

EN 50082-1: 1992 Electromagnetic Compatibility - Generic immunity standard.
EN 50082-2: 1995 (Performance criterion B).

EN 61010-1: 1993 Safety Considerations

I have made all reasonable enquiries regarding the unit stated and their conformance to the EU, Low Voltage and EMC Directives. To the best of my knowledge and belief this unit conform to these directives.

This Declaration is controlled under an ISO 9001:2008 system certificated by TÜV Rheinland, certificate number CE, SIQ - 558 - Revision 11.

Signature 

Name R. W. Silva

Position Manager

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1.0 - Introduction

1.1 - Description

PRESYS DMY-2030-F and DMY-2030-F *Light* Indicators are microcontroller-based instruments which show process variables generated by frequency sensors such as magnetic pickups, tachogenerators, inductive, capacitive or optical proximity switches, intrinsic safety NAMUR type sensors (DIN-19234) etc.

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

DMY-2030-F Indicator is able to monitor two frequency inputs and DMY-2030-F *Light* Indicator monitors one frequency input for signals of sinusoidal, squared or triangular waveforms and all pulses with amplitude between 300mV$_{p-p}$ and 30V$_{p-p}$ (Volt peak-to-peak) or input from contact closures. The input frequency ranges from 0Hz to 30kHz. The indication on the display is user-configurable, which allows the process variable to be shown in engineering units (rpm, Hz, etc.).

All configuration data can be protected by password and are stored in non-volatile memory in case of an external power failure.

For each input there is a 24Vdc voltage source for frequency sensor excitation, isolated from outputs and with protection against short-circuit.

According to modularity design concept, the Indicators accept up to four output modules. The types of output are: retransmittion, SPDT relay, SPST relay and open collector voltage. The outputs are isolated from the inputs.

They accept 90 to 240Vac or 130 to 340Vdc (with any polarity) power supply.

The instruments have extruded aluminum case which avoids electrical noise, electromagnetic interference, radiofrequency interference, etc. and their robust construction makes them tough enough for the most hostile environment.

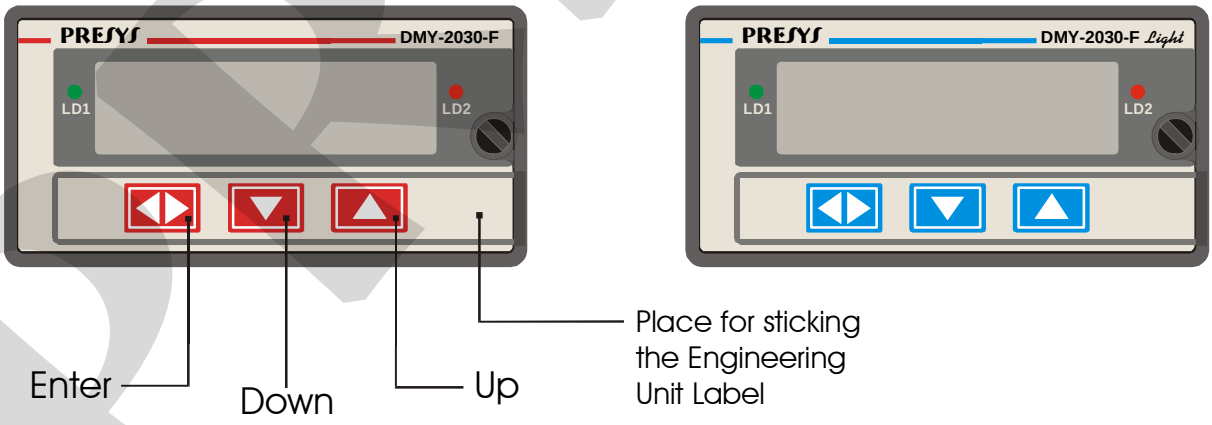


Fig. 1 - DMY-2030-F and DMY-2030-F *Light* Indicators front panels

The front panel of the instruments has a high visibility display configurable up to 4 ½ digits which can show the process variable from channel 1, channel 2 or from both channels in the scan mode for the DMY-2030-F Indicator, and only channel 1 for the DMY-2030-F *Light* Indicator. During configuration, the display shows mnemonics and parameter values. The couple of leds and the display can be used as alarm indications or can be associated with outputs, relays, open collectors or triacs. Therefore, there are up to seven alarm indications (four alarm modules, the display and two leds). The alarm outputs can be configured, independently, to operate in the latch mode, demanding the operator acknowledge by means of the front panel keys in order to deactivate the outputs after the process variable returns to normal condition.

Up to two retransmitter outputs are available for the DMY-2030-F Indicator and one retransmitter output for the DMY-2030-F *Light* Indicator to provide linear output signal of 4 to 20 mA, 1 to 5 V or 0 to 10 V directly proportional to the process variable measured. This signal allows the retransmittion of the variable to a distant location. In case only one analogic output is used, it is possible to use up to three alarm outputs and when using two analogic outputs, it is possible to use up to two alarm outputs.

1.2 - Order Code

DMY - 2030 - F / DMY - 2030 - F *Light* - ___ - ___ - ___ - ___ - ___ - ___ - ___
A B C D E F G

Field A — Output 1
- 0 Not used
- 1 4 to 20mA
- 2 1 to 5V
- 3 0 to 10V
- 4 SPST relay
- 5 Open collector voltage
- 6 Solid state relay

Field B — Output 2
- 0 Not used
- 1 4 to 20 mA (only for DMY-2030-F)
- 2 1 to 5 V (only for DMY-2030-F)
- 3 0 to 10 V (only for DMY-2030-F)
- 4 SPST relay
- 5 Open collector voltage
- 6 Solid state relay

Field C — Output 3
- 0 Not used
- 1 SPDT relay
- 2 Open collector voltage
- 3 Solid state relay

Field D — Output 4
Same code of output 3

Field E		Power Supply
	1	90 to 240 Vac or 130 to 340 Vdc (any polarity)
	2	24 Vdc
	3	12 Vdc
Field F		Communication
	0	Not used
	1	RS-232
	2	RS-485
	3	RS-422
Field G		Case Protection Grade
	0	General usage, protected place
	1	Front aspersion-proof
	2	Weather-proof

Note 1 - The input ranges, indication, relay usage as alarms and the alarm points are, among other things, items that the user can program through the front keys (if wanted, specify this information so that all the configuration can be made by **PRESYS**).

Note 2 - Other hardware and software features are available under previous consult.

Code Example:

1) DMY - 2030 - F - 0 - 0 - 1 - 1 - 1 - 0 - 0

This code defines a DMY-2030-F Indicator with two SPDT relays which can be used as high and low alarms, 90 to 240 Vac or 130 to 340 Vdc electric power supply, protected field usage.

1.3 - Technical Specifications

Inputs:

- Two frequency inputs (DMY-2030-F) or one frequency input (DMY-2030-F *Light*) for connection of frequency signals of sinusoidal, or triangular waveforms, pulses with amplitude between 300 mV_{p-p} and 30 V_{p-p} and input form contact closures. 70 V maximum DC voltage. Input impedance greater than 60 kΩ (sinusoidal, 1 kHz). Table 1 shows reading accuracy and display resolution according to frequency range.

Frequency Range	Accuracy	Resolution
0.0000 Hz - 3.0000 Hz	0.0002 Hz	0.0001 Hz
0.000 Hz - 30.000 Hz	0.002 Hz	0.001 Hz
0.00 Hz - 300.00 Hz	0.02 Hz	0.01 Hz
0.0Hz - 3000.0Hz	0.2Hz	0.1Hz
0Hz - 30000Hz	2Hz	1Hz

Table 1 - Reading accuracy and resolution.

Outputs:

- Analog output 4 to 20 mAdc, 1 to 5 Vdc, 0 to 10 Vdc, use of optional modules with plug-in fitting for up to two modules for DMY-2030-F and one module for DMY-2030-F *Light*, 300 Vac galvanically isolated from inputs and power supply.
- SPDT relays for alarm rated for 3A at 220 Vac, or up to 10A at 220 Vac under order (in this case, the alarm module is not plugged to a connector, but soldered to the board). It is possible to use up to 4 alarm modules (using the connectors of the two analog outputs). That is, in case of using one analog output, up to three alarm modules can be used, or when using two analog outputs, up to two alarm modules can be used.
- Logic signal, open collector transistor, 24 Vdc, 40 mA max. with isolation.
- Solid state relay rated for 2A at 250 Vac with isolation.

Serial Communication:

RS-232 or RS-485, with 50 Vdc isolation, as an optional module for connection in the CPU board.

Indication:

Standard indication of -9999 to 30000 range.

Configuration:

By front panel push-buttons and internal jumpers.

Scanning time:

71ms standard. The display is updated each 0.5 second.

Accuracy:

±0.5% of full scale for analog retransmitter output and 750Ω maximum load.

Stability at ambient temperature:

± 0.005% per °C of span referred to 25°C ambient temperature.

Power Supply:

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

Frequency sensors power supply:

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

Operating ambient:

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

Dimensions:

1/8 DIN (48 x 96mm) with 162mm depth, panel cut of 45 x 92mm.

Weight:

0.5kg approx.

Warranty:

One year.

2.0 - Installation

2.1 - Mechanical Installation

DMY-2030-F and DMY-2030-F *Light* Indicators front panel has 1/8 DIN size (48 x 96 mm).

They are fixed by the rails which press them against the back side of the panel.

After preparing a 45 x 92 mm cut in the panel, remove the rails from the Indicator and slide its rear through the cut until its front reaches the panel. Place the rails again in the Indicator from the back of the panel and tighten the screws as shown in Figure 2.

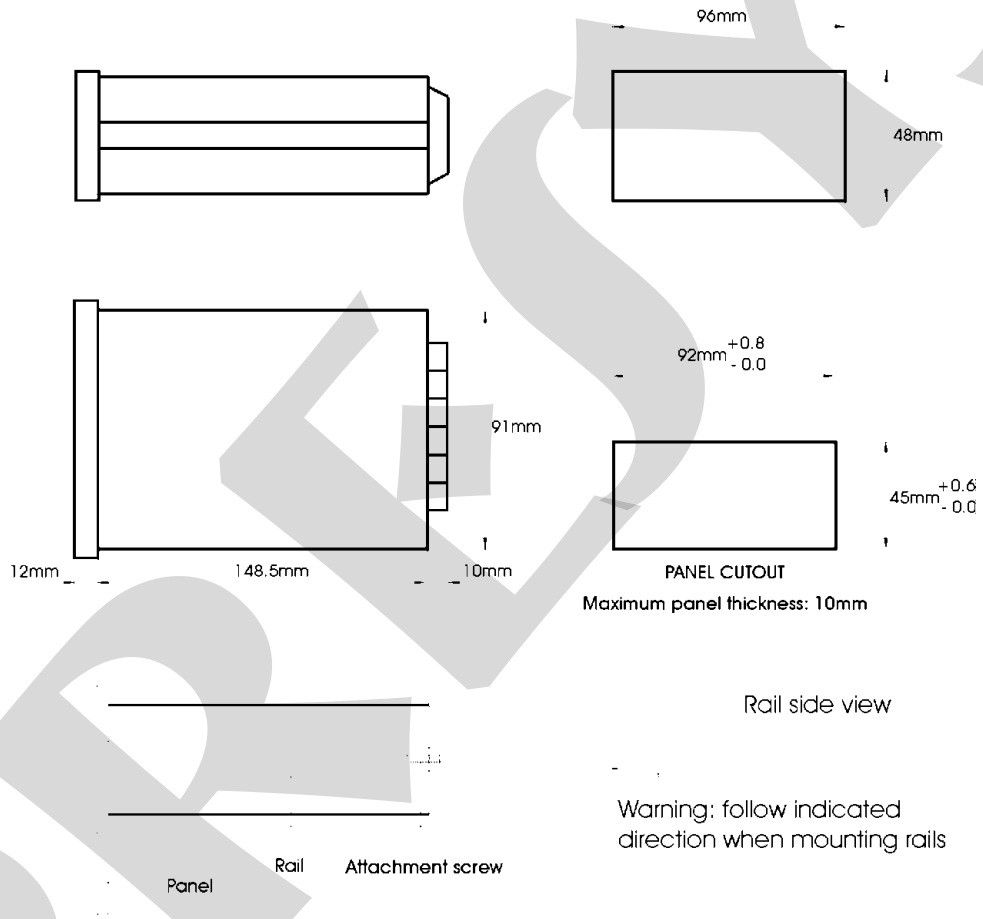


Fig. 2 - Dimensional drawing, panel cutout and side view

2.2 - Electrical Installation

DMY-2030-F and DMY-2030-F *Light* Indicators may be powered by voltage between 90 and 240Vac or 130 to 340Vdc, with 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.

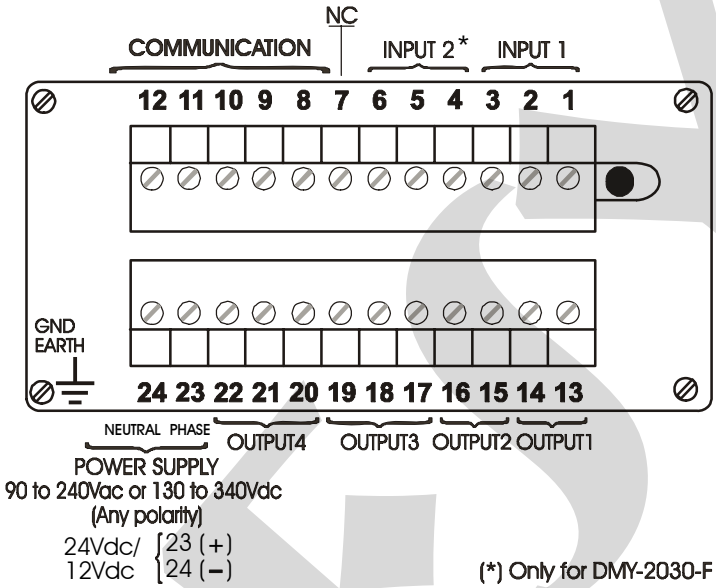


Fig. 3 - Indicator terminals

2.3 - Process Input Signal Connections

The Indicators accept the connection of pulses with amplitude between 300 mV_{p-p} and 30 V_{p-p} or contact closures to the frequency inputs.

The contact closure input is enabled by internal jumper (see section 4.2 on Hardware Configuration).

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 section.

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

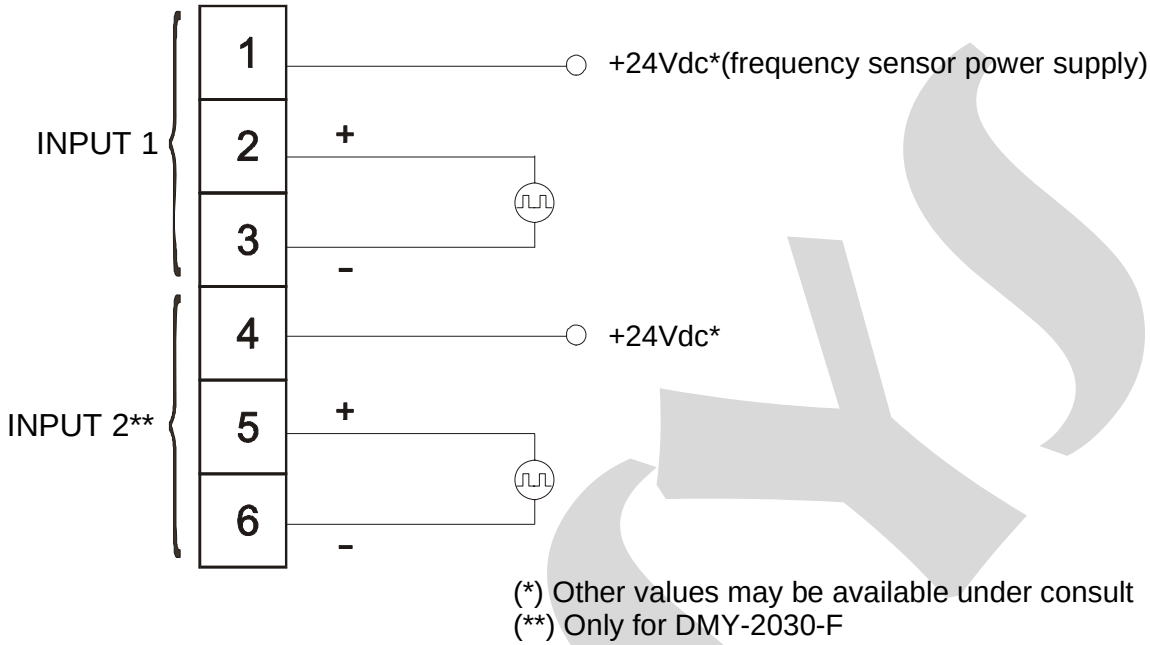


Fig. 4 - Input Connection Diagram

Frequency signals must be applied to terminals 2(+) and 3(-) for input 1 and to terminals 5(+) and 6(-) for input 2 (only for DMY-2030-F).

Terminal 1 is a voltage source for the frequency sensor used in input 1, when it is necessary to power the sensor. The voltage level is 24 Vdc referred to terminal 3. Terminal 4 is the voltage source for the sensor in input 2, with 24Vdc referred to terminal 6. The voltage level may be changed under consult. Terminal 7 has no function in the frequency instruments.

The inputs allow the connection of a 2-wire intrinsic safety NAMUR type sensor directly to the terminals (+) and (-) without the need of an external resistor, which requires the use of jumper JS1 for input 1 or JS2 for input 2 in the CPU Board. The sensor power supply voltage level and the internal resistor value R_v comply with DIN-19234: 550-1100 W and 8.2V (7.7-9.0V).

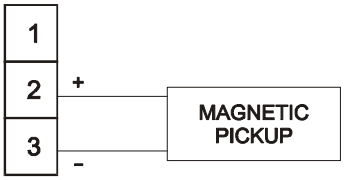
Figure 5 shows the possible sensor connections to input 1. In order to connect a sensor to input 2, use the terminals corresponding to those shown by the figure.

2.4 - Output Connection

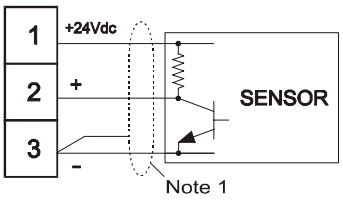
In the most complete version, the Indicators can be provided with up to four output signals: outputs 1 to 4. For DMY-2030-F, outputs 1 and 2 are used as retransmitter or alarm outputs and outputs 3 and 4 are used only as alarm outputs, while for DMY-2030-F *Light* output 2 is used only as alarm output.

In the case of outputs 1 (in both Indicators) and 2 (in DMY-2030-F) one can have six different types of outputs: retransmitter (4 to 20mA, 0 to 5Vdc or 0 to 10Vdc), SPST relay, open collector voltage and solid state relay.

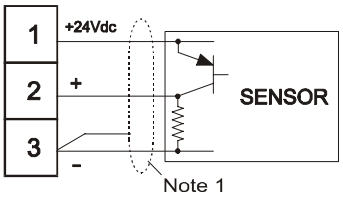
For outputs 2 (in DMY-2030-F *Light*), 3 and 4 (in both Indicators), there are three different types of outputs: SPDT relay, open collector voltage and solid-state relay. Figure 6 shows the Indicator outputs.



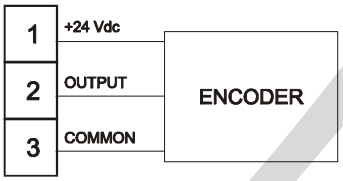
MAGNETIC PICKUP



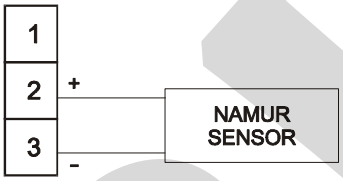
NPN OPEN COLLECTOR
OUTPUT SENSOR
(Inductive proximity switch ,
capacitive, optical sensors, etc.)



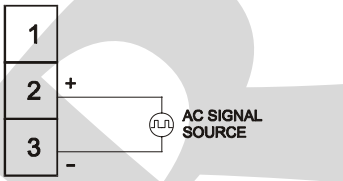
PNP OPEN COLLECTOR
OUTPUT SENSOR
(Inductive proximity switch,
capacitive, optical sensors, etc.)



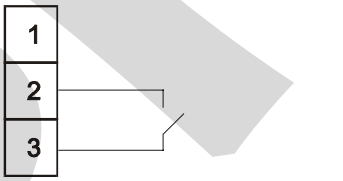
ENCODER
(use only one channel of the encoder
for frequency indication)



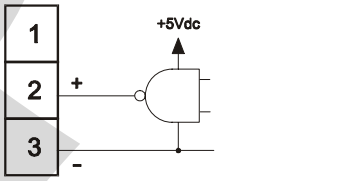
NAMUR SENSOR
(866 Ω internal pull-up connected
to the +8V source available when
using jumper JS1 for Input 1 or JS2
for Input 2 in the CPU Board)



TACHOMETERS,
GENERATORS,
INVERTERS, ETC.



CONTACT CLOSURE
(use jumper JS1 for Input 1 or JS2
for Input 2 in the CPU Board)

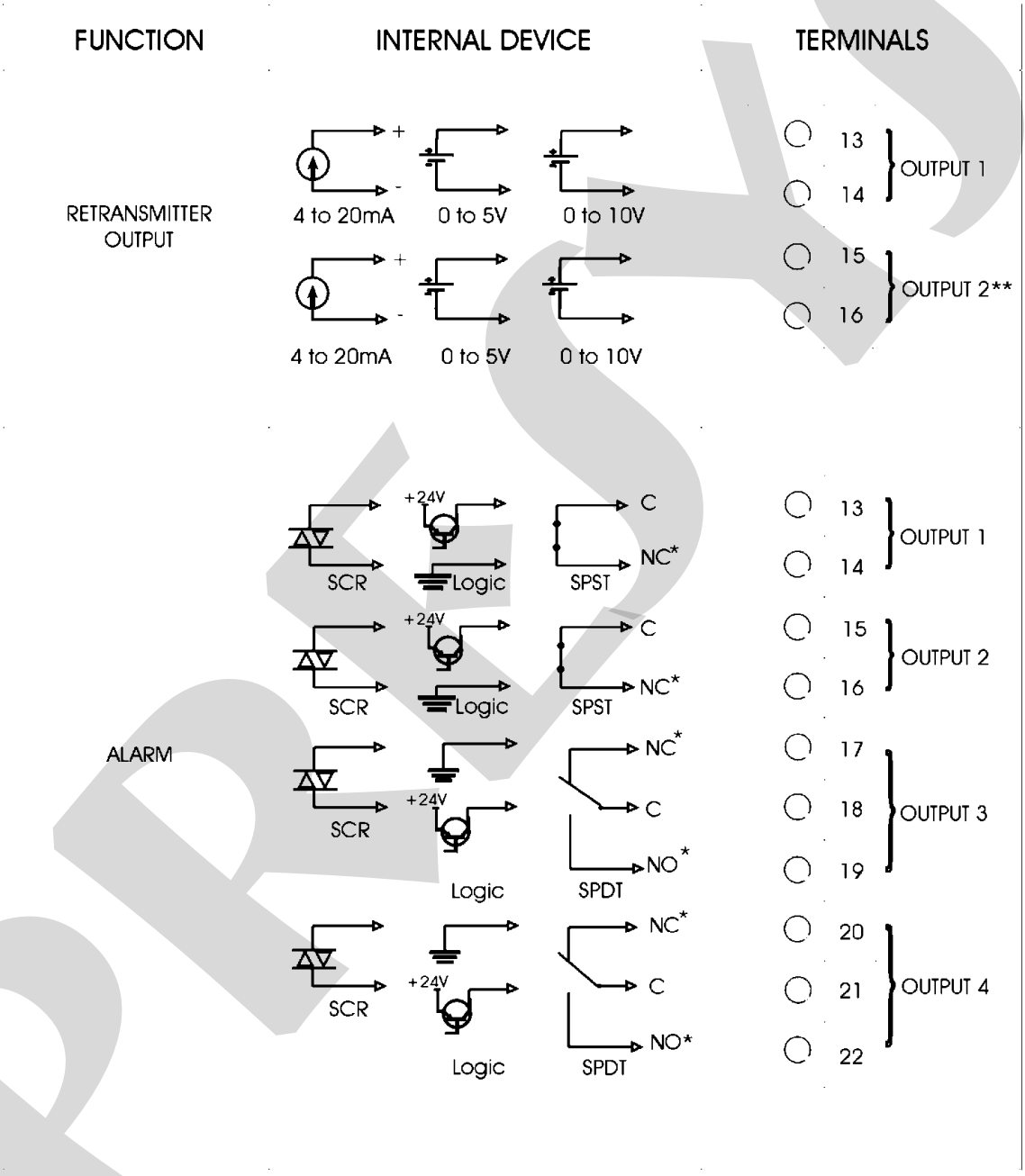


TTL

Note - For inductive proximity switches, connect the shield to the common terminal of the instrument (terminal 3 for input 1 and terminal 6 for input 2).

Fig. 5 - Sensor connection

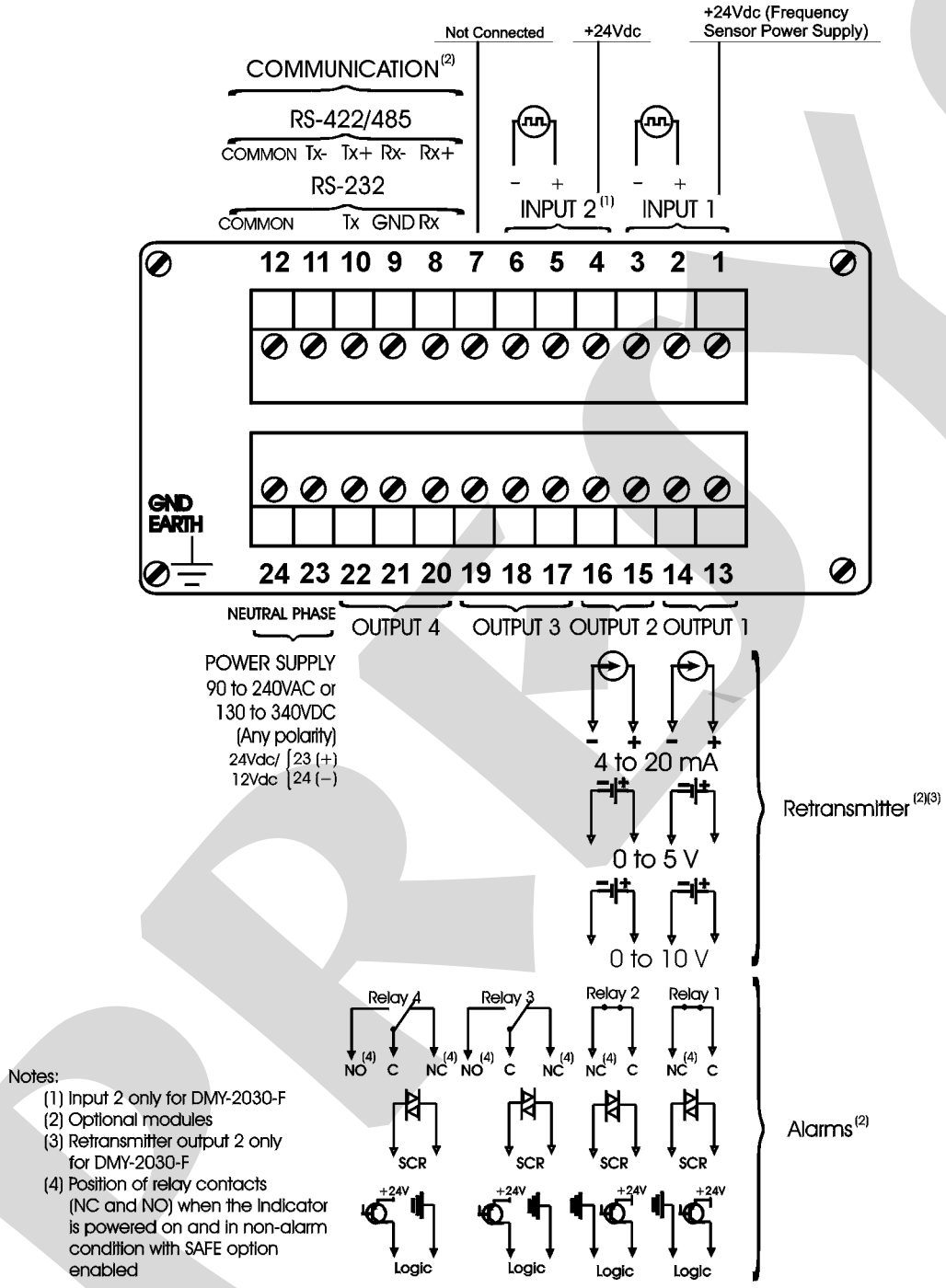
Note that the output terminals will present the signals only if the corresponding optional module is installed and the output is correctly configured. For the analog outputs, refer to section 3.2 on Configuration and 4.4 on Optional Module Connection for further details on installation and configuration of optional modules.



(*) Position of relay contacts when SAFE option is enabled (see section 3.2 on Configuration), the Indicator is powered on and in non-alarm condition. When the Indicator is powered off or in alarm condition with SAFE option disabled, the position of the relays changes.
(**) Retransmitter output 2 only for DMY-2030-F.

Fig. 6 - Output Connection

2.5 - Connection Diagram



Notes:
(1) Input 2 only for DMY-2030-F
(2) Optional modules
(3) Retransmitter output 2 only for DMY-2030-F
(4) Position of relay contacts (NC and NO) when the indicator is powered on and in non-alarm condition with SAFE option enabled

2.6 - Communication

DMY-2030-F and DMY-2030-F *Light* Indicators communicate with computers through RS-232 or RS-422/485 when the optional communication module is installed and the communication parameters are configured.

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

2.7 - Engineering Units

A label with several Engineering Units is supplied with each Indicator. Select the one corresponding to the variable shown on the display and stick it on the front panel of the Indicator.

3.0 - Operation

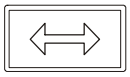
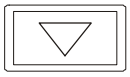
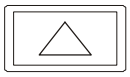
3.1 - Normal Operation

DMY-2030-F and DMY-2030-F *Light* Indicators have two modes of operation: normal operation and configuration mode.

During normal operation, the Indicators monitor the inputs, verify alarm conditions and activate the four outputs when necessary.

Configuration mode is used to select and configure all the Indicator parameters.

The normal operation mode, in which the Indicator is to be found most of the time, is called level zero. In this level, the three front panel keys have the following functions:

ENTER	Key		It changes from level zero to level 1 or asks the password, depending on the configuration.
DOWN	Key		It changes the channel shown on the display. If the display shows channel 1 (2), after pressing DOWN, the display will show the measured variable from channel 2 (1).
UP	Key		It shows the outputs configured as alarms which need acknowledgment to turn to normal state. (*)

(*) In order to view the monitored variable, continue to press the UP key. In case there are no activated relays with LATCHED function enabled, the **No.Ack.** message will be shown.

3.2 - Configuration

In order to access configuration mode the operator is required to provide a password which avoids a non-authorized person to change any critical parameters of the process.

So, when ENTER is pressed within the normal operation mode, one of the following events can happen, depending on the current configuration:

i) To access directly level 1 (GENERAL) of configuration mode, which indicates the instrument was not configured with a password system.

ii) To display the PASS warning, indicating that the instrument is provided with a password system (a key sequence or a value), according to Figure 7.

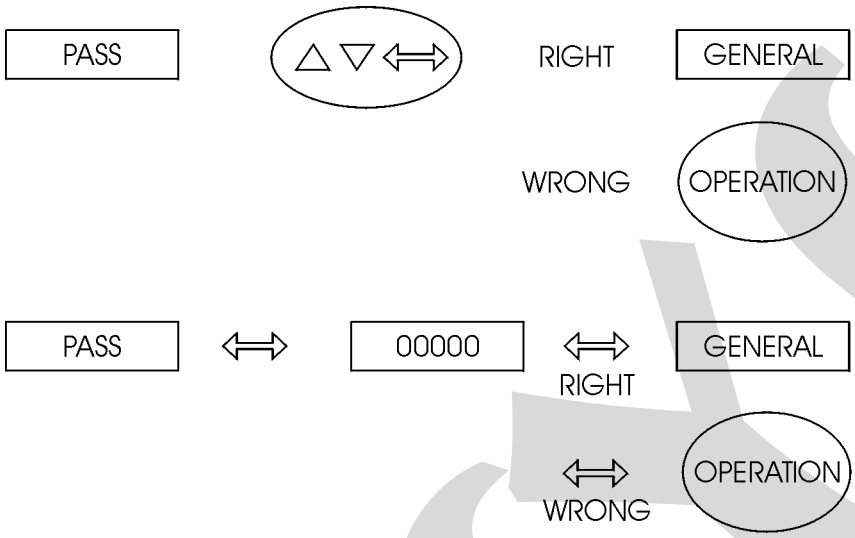


Fig. 7 - Password through key sequence or value

In case of a key sequence password, the user should press the UP, DOWN and ENTER keys (exactly in this order) to access the configuration levels.

For a value password, the user must press the ENTER key for a second time in order to view the number 00000 with the right end digit blinking. The position which is blinking indicates the digit in the number to be changed by the user with the UP and DOWN keys. Move to the digits on the left by pressing ENTER. After entering all digits, press ENTER again. If the password is correct level 1 is accessed; otherwise, it returns to normal operation (see Figure 7).

The user can choose also both password systems, key and value. In this case, if the user provides an incorrect sequence of keys, the display goes immediately to the value password system.

The password number may be chosen by the user (personal) or it could be used the number 2030. Note that the number 2030 is always accepted by the value password system, which helps the user in case he forgets his password. In order to enter a number for password or for any other parameter use the Indicator front panel keys with the following functions:

UP	key	Increases values being set
DOWN	key	Decreases values being set
ENTER	key	Changes position to the left digit

All configuration parameters are stored in the non-volatile memory and determine the normal operation of the instrument. With these parameters the user can adjust the instrument to his needs, when it is necessary to change the configuration from factory.

Configuration parameters are distributed in six hierarchical levels shown in Figure 8.

In order to move through the levels and access the parameters of any one of them, use the front panel key which have the following functions:

ENTER	key	Moves into the indicated level
UP	key	Moves to higher levels
DOWN	key	Moves to lower levels

Warning: In the diagrams below, the rectangles represent the display appearance after selection of the ENTER, UP and DOWN keys.

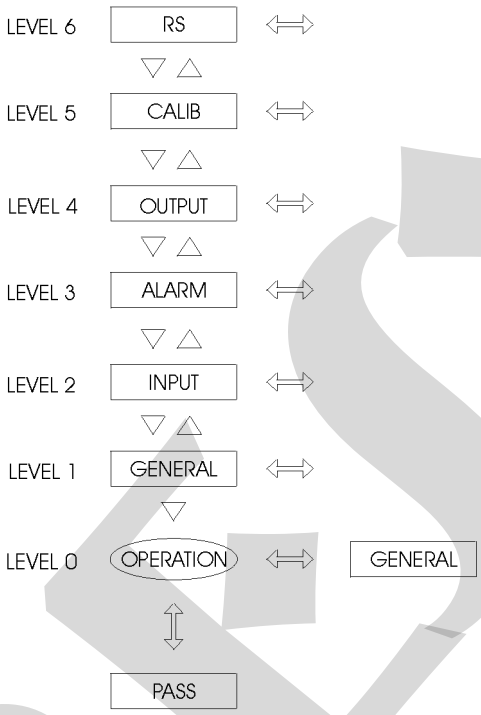


Fig. 8 - Parameter levels diagram

The hierarchical levels are presented in sequence. The options of each level are explained step by step with all their corresponding parameters.

Inside each level, the front panel keys have the following functions:

UP	key	Moves the options in increasing direction
DOWN	key	Moves the options in decreasing direction
ENTER	key	Confirm or advance options inside a level, if the display does not show ESC. When ESC is shown, it goes back one or more positions.

Level 1 - GENERAL

Level 1 presents the options: TAG, SOFT, PASS and INDIC (see Figure 9).

TAG - consists in an alphanumeric identification for the instrument. The procedure to enter the tag or any other parameter is the same as described previously for the password (refer to value password for the functions of the ENTER, UP and DOWN keys).

SOFT - shows software version.

PASS - allows the user to enable or disable the password system for accessing the configuration mode. The password system may be chosen as key sequence, a value (number chosen by the user and number 2030) or both. The correct key sequence is obtained by pressing the UP, DOWN and ENTER keys in this order.

INDIC - is an option for the visualization of the measured variables on the display. It allows the user to view the values of channels 1 and 2 only by pressing the UP and DOWN keys, or it sets the instrument to change automatically the indication of the measured variable of each channel. In the former case choose NO for TWO option, and for the latter case, choose YES (automatic scan mode) for TWO option and provide the exhibition times (given in seconds) for viewing each channel.

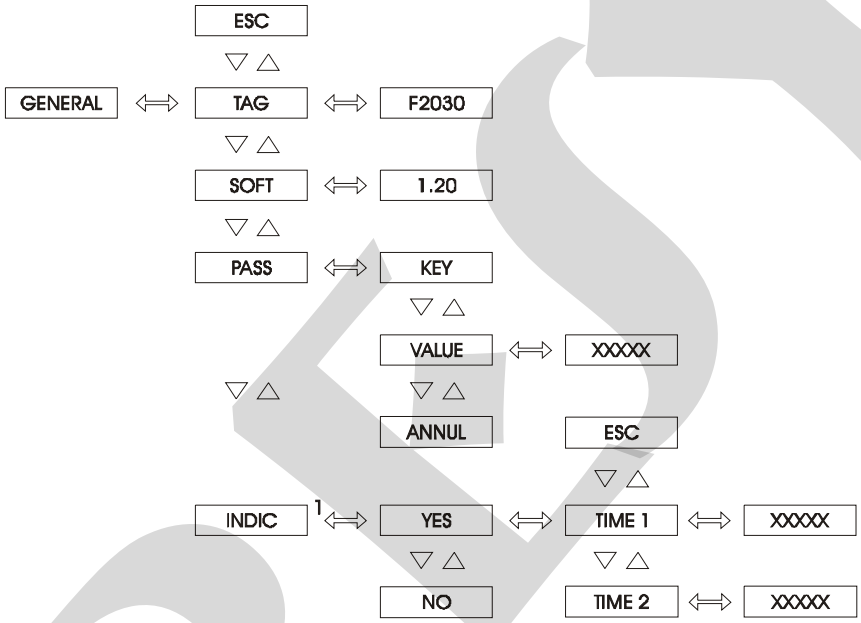


Fig. 9 - GENERAL level options

The table below refers to the ranges of the parameters shown in Figure 9.

Mnemonic	Parameter	Range	Factory Value	Units
TAG	instrument identification	————	F2030	————
SOFT	software version	————	1.20	————
VALUE	user password	-9999 to 30000	0	————
TIME1	channel 1 exhibition time	1 to 3000	5	seconds
TIME2	channel 2 exhibition time	1 to 3000	1	seconds

Level 2 - INPUT

Level 2 - Input allows the selection of the operation range of each input (given in Hz) and the association of 2 indication values, in engineering units, to the limits of the selected range. It is also possible to disable any input.

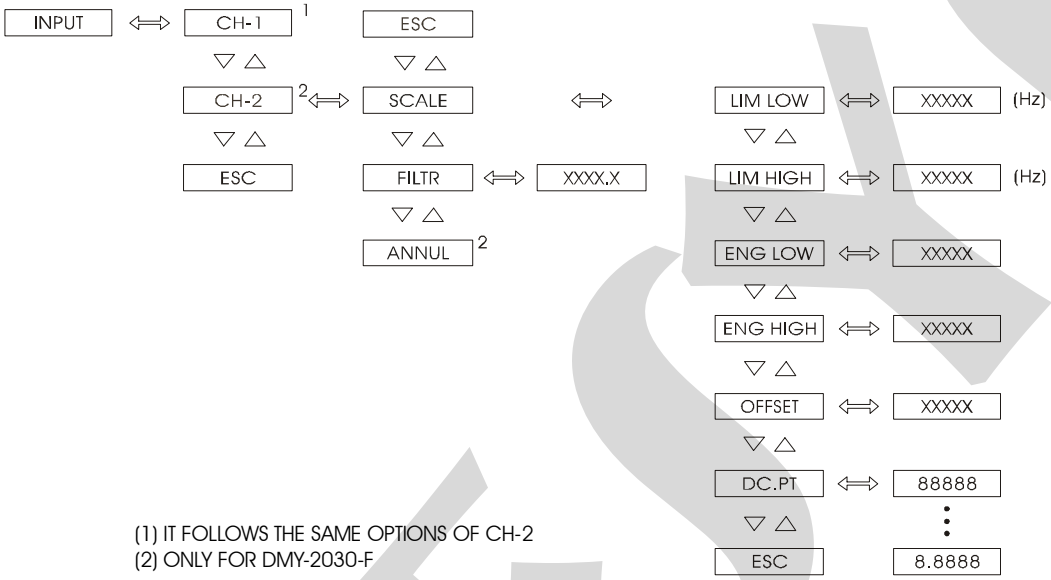


Fig. 10 - INPUT level options

The table below refers to the ranges of the parameters shown in Figure 10.

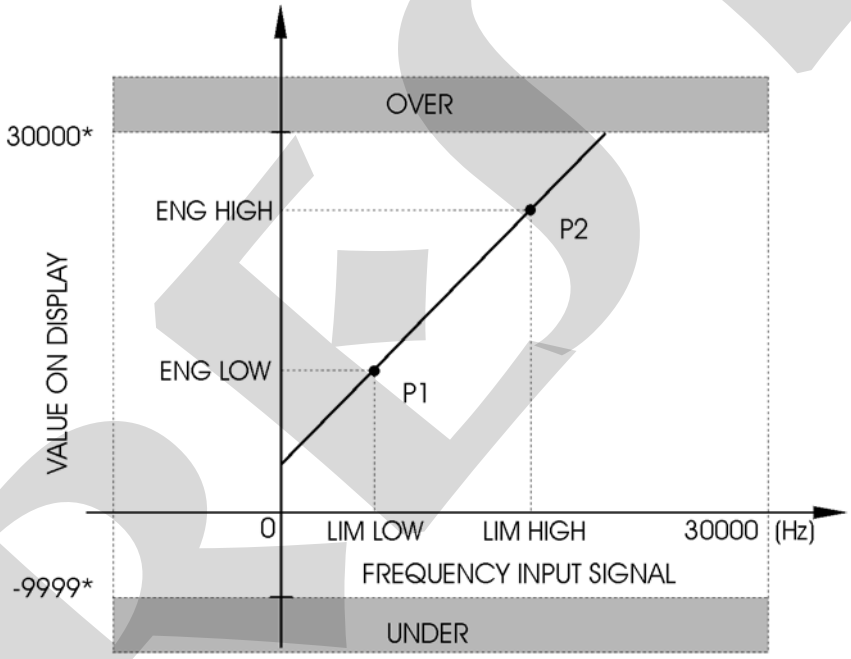
Mnemonic	Parameter	Range	Factory Value	Units
LIM LOW	input signal associated with Eng Low	0 to 30000	0	Hz
LIM HIGH	input signal associated with Eng High	0 to 30000	1000	Hz
ENG LOW	display indication associated with Lim Low	-9999 to 30000	0	EU*
ENG HIGH	display indication associated with Lim High	-9999 to 30000	1000	EU
OFF SET	constant added to display indication	-9999 to 30000	0	EU
FILTER	time constant of 1st order digital filter	0.0 to 25.0	0.0	seconds

(*) EU - Engineering Unit

The operation range of each input must be configured (in Hz) through Lim Low and Lim High parameters in SCALE option. Lim Low is configured with the minimum input frequency (in Hz, without decimal point) and Lim High is (generally) the maximum frequency of the range.

The indication on the display is configured by defining 2 points: P1 (Lim Low and Eng Low) and P2 (Lim High and Eng High). The value configured for Eng Low will be indicated on the display when the frequency input signal corresponds to the minimum frequency of the operation range configured (Lim Low). In the same way, Eng High will be generally the indication of the maximum frequency of the range (Lim High).

Observe the boundaries of the parameters Eng High and Eng Low and also the resolution of the instrument when defining the decimal point position. The line defined by P1 and P2 is not confined in the interval P1-P2, see Figure 11.



(*) BOUNDARIES OF ENG HIGH AND ENG LOW PARAMETERS.

Fig. 11 - Input Configuration

DC.PT places the decimal point on the display for readout in Engineering Unit (EU) of each channel.

OFSET (as shown on the display) - allows the user to enter an off-set value in Engineering Units to be added to the measured variable.

FILTER - this parameter provides the time constant of a first order digital filter associated to the selected input. In order to leave the signal without filter set this parameter to zero.

ANNUL disables the reading of the corresponding input. In operation level, the NONE mnemonic is indicated for a disabled input. In order to enable the input to return to its normal operation, just confirm one of the parameters Lim Low, Lim High, Eng Low or Eng High in SCALE option from INPUT level. From the operation level, go to the INPUT configuration level, enter the SCALE option and select one of the parameters above; the value of the parameter will start blinking, then confirm it by pressing ENTER.

The examples below illustrate the configuration of Lim Low, Lim High, Eng Low, Eng High and DC.PT parameters according to the specifications found in some of the most common applications of the frequency Indicator.

Example 1: Frequency indication in Hz. For a 0 to 400Hz operation range and 0.0 to 400.0Hz indication, configure the input as: Lim Low = 0, Lim High = 400 (Hz), DC.PT = 888.8, Eng Low = 0.0 and Eng High = 400.0 (Hz).

Example 2: Frequency indication in Hz. For a 0 to 300Hz operation range and 0.00 to 300.00Hz indication, configure the input as: Lim Low = 0, Lim High = 300, DC.PT = 888.88, Eng Low = 0.00 and Eng High = 300.00 (Hz).

Example 3: Frequency indication in rpm. The conversion of the frequency *f* between Hz and rpm is accomplished by:

$$f\,(\text{rpm}) = 60 \times f\,(\text{Hz})$$
or
$$f\,(\text{Hz}) = f\,(\text{rpm}) / 60.$$

For a 0 to 400 Hz operation range and 0 to 24000 rpm (= 60 × 400) indication, configure the input as: Lim Low = 0, Lim High = 400 (Hz), DC.PT = 88888 (no decimal point), Eng Low = 0 and Eng High = 24000 (rpm).

Example 4: Measurement of the revolution frequency of a toothed wheel with a magnetic pickup sensor. The relationship among the sensor output frequency *f*, the toothed wheel revolution frequency f_R and the number of teeth N is given by:

	f_R in Hz	**f_R in rpm**
***f* in Hz**	$f_R = f / N$	$f_R = 60 \times f / N$
***f* in rpm**	$f_R = f / (60 \times N)$	$f_R = f / N$

For a 0 to 1650 Hz operation range from the magnetic pickup, a toothed wheel with N = 11 and 0 to 9000 rpm (= 60 x 1650 / 11) indication, configure the input as: Lim Low = 0, Lim High = 01650 (Hz), DC.PT = 88888 (no decimal point), Eng Low = 0 and Eng High = 09000 (rpm).

Example 5: Measurement of revolution frequency with an encoder (one channel). The relationship among the encoder output frequency *f*, its shaft revolution frequency f_R and the number of pulses per revolution N is given by:

	f_R in Hz	**f_R in rpm**
***f* in Hz**	$f_R = f / N$	$f_R = 60 \times f / N$
***f* in rpm**	$f_R = f / (60 \times N)$	$f_R = f / N$

For a 0 to 5000 Hz operation range from an encoder with 100 pulses per revolution and 0 to 3000.0 rpm (= 60 × 5000 / 100) indication, configure the input as: Lim Low = 0, Lim High = 05000 (Hz), DC.PT = 8888.8 (one decimal place), Eng Low = 0.0 and Eng High = 3000.0 (rpm).

Example 6: Measurement of revolution frequency with a tachogenerator. The relationship among the output frequency *f* of a tachogenerator with N poles and its shaft revolution frequency f_R is given by:

	f_R in Hz	**f_R in rpm**
***f* in Hz**	$f_R = 2 \times f / N$	$f_R = 120 \times f / N$
***f* in rpm**	$f_R = f / (30 \times N)$	$f_R = 2 \times f / N$

For a 0 to 500 Hz signal operation range from a tachogenerator with 8 poles and 0 to 7500 rpm (= 120 × 500 / 8) indication, configure the input as: Lim Low = 0, Lim High = 500 (Hz), DC.PT = 88888 (no decimal point), Eng Low = 0 and Eng High = 07500 (rpm).

Example 7: Flow measurement with use of a magnetic pickup sensor in order to detect the passing blades of a turbine set in motion by the fluid. The flow is determined by the sensor pulse frequency *f* and by the number of pulses per volume of fluid passing through the turbine, N / V (in pulses/liter or pulses/m^3, for instance):

	***flow* in Volume/s**	***flow* in Volume/min**
***f* in Hz**	$flow = f \times (V / N)$	$flow = 60 \times f \times (V / N)$
***f* in rpm**	$flow = f \times (V / N) / 60$	$flow = f \times (V / N)$

For a 0 to 10000Hz operation range from the magnetic pickup, a rate of 100 pulses per 5 m^3 of fluid and 0 to 500.0 m^3/s (= 10000 × 5 / 100) indication, configure the input as: Lim Low = 0, Lim High = 10000 (Hz), DC.PT = 8888.8 (one decimal place), Eng Low = 0.0 and Eng High = 0500.0 (m^3/s).

Level 3 - Alarms

The Indicators have up to seven alarm devices: four of them are the outputs 1, 2, 3 and 4 used as alarm outputs which are relay 1, relay 2, relay 3 and relay 4. The other three devices are the couple of leds, LED 1 and LED 2, and the display which can operate independently from the relays. In this case, the INDEP option is selected. If the DEPEN option is selected for the leds and display, their operation is associated to that of the relays.

Each alarm module can perform up to four types of alarm: low-alarm for channel 1, high-alarm for channel 1, low alarm for channel 2 and high-alarm for channel 2. When configuring the seven independent alarm devices for the indication, there are up to 28 setpoint alarms (SP) and their hysteresis (HYST).

Once the alarm configuration is established (CONF option), it is possible to view or change only the values of alarm setpoints. Press the UP key while CONF option is shown in order to have a quick access to the setpoints of all alarms already configured. The mnemonics of alarm setpoints have a code which is explained through the two following examples:

S1.H.r1	Channel 1 high-alarm setpoint associated with relay 1.
S2.L.L1	Channel 2 low-alarm setpoint associated with led 1.

LATCHED - configures each relay to be deactivated only after the end of the alarm condition and the operator has performed the acknowledge of the alarm. The acknowledgment of the alarm condition is performed within the normal operation mode by pressing the UP key until it is shown the mnemonic corresponding to the relay one is looking for. Note that it will be shown only the relays configured with latch operation which require acknowledgment in order to return to normal state. After reaching the relay, press the ENTER key. If there is no alarm condition for this relay, it will change its state. Continue pressing the UP key to return to operation mode.

DELAY - causes each relay to be activated only after a certain time interval defined by the user. Figure 12 below illustrates the delay operation for a high-alarm.

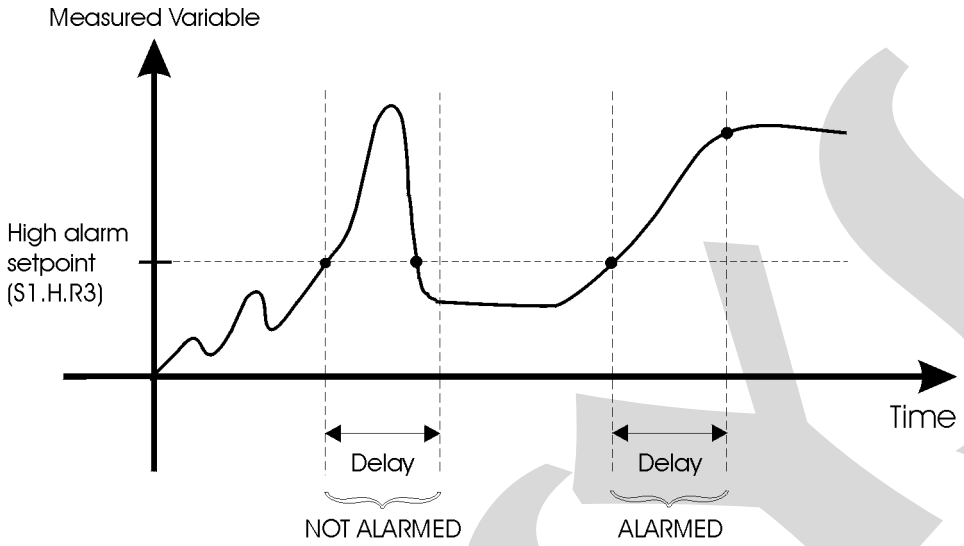


Fig. 12 - Relay with delay

SAFE - provides safety to relays. The safety condition means the relays are powered on when the instrument is on and there is no alarm condition, and the relays are powered off when in alarm condition or in case of power failure.

Note: When replacing an analog output module (see level 4 - Output) by a relay module in the same position on the Power Supply Board, disable the output before installing the relay, otherwise it will be activated and deactivated continuously.

The table below refers to the ranges of the parameters shown in Figure 13.

Mnemonic	Parameter	Range	Factory Value	Units
SP	alarm setpoint	-9999 to 30000	25.0 - low-alarm 75.0 - high-alarm	EU
HYST	alarm hysteresis	0 to 250	1.0	EU
DELAY	delay for activating the relay	0.0 to 3000.0	0.0	seconds

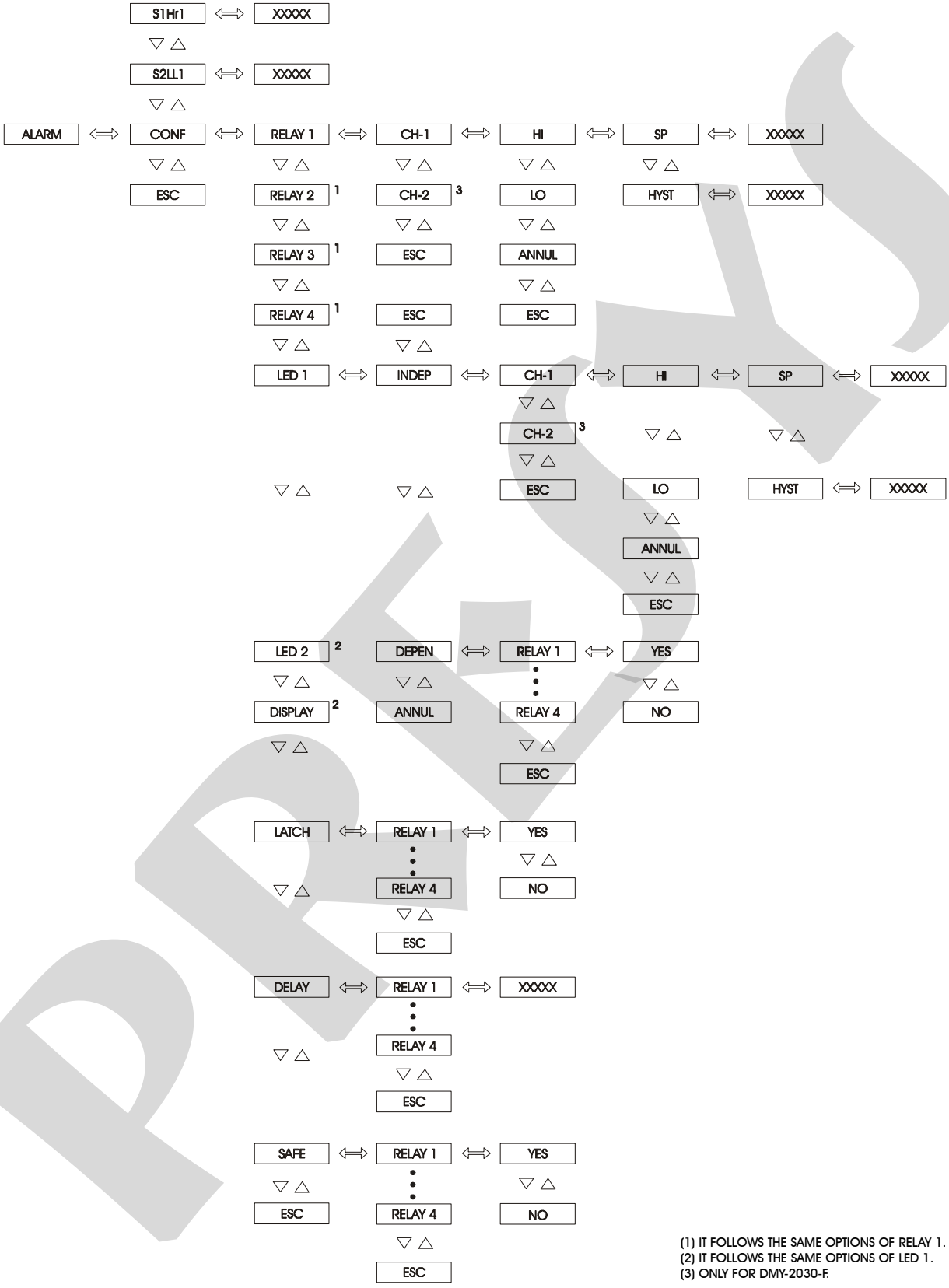


Fig. 13 - ALARM level options

Level 4 - Output

Level 4 allows the configuration of up to two analog outputs (refer to Figure 14).

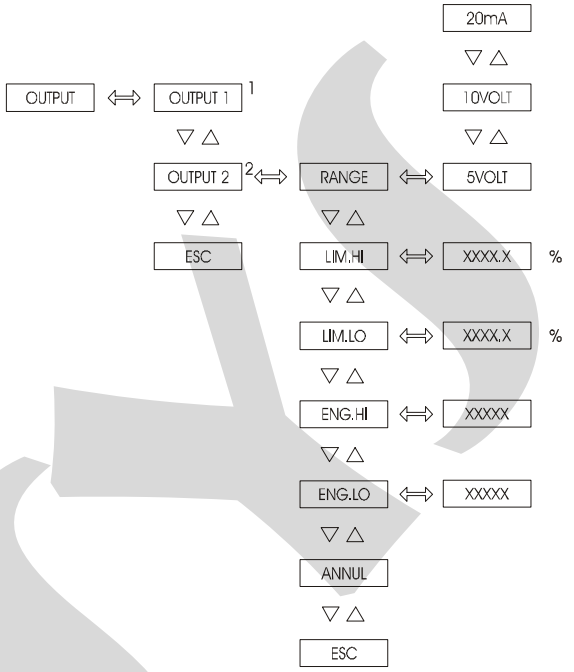


Fig. 14 - OUTPUT level options

The table below refers to the ranges of the parameters shown in Figure 14.

Mnemonic	Parameters	Range	Factory Value	Unit
LIM LOW	output signal associated with Eng Low	0.0 to 100.0	0.0	%
LIM HIGH	output signal associated with Eng High	0.0 to 100.0	100.0	%
ENG LOW	display indication associated with Lim Low	-9999 to 30000	0	EU
ENG HIGH	display indication associated with Lim High	-9999 to 30000	1000	EU

The analog output is enabled only after selecting the range of output retransmission from the RANGE mnemonic.

RANGE - selects the range of retransmission output as 20mA, 5V or 10V. The relation between the engineering unit and electric signal generated in the terminals is defined in the same way as shown for the input scale configuration. Define two points P1 (Eng Low, Lim Low) and P2 (Eng High, Lim High) as it is illustrated in Figure 15. Eng Low is the indication in the display in engineering units associated with the electric signal Lim Low, and Eng High is the indication in display in engineering units associated with the electric signal Lim High. Note that Lim Low and Lim High are defined in percentage of output range and that the output signal saturates in these points.

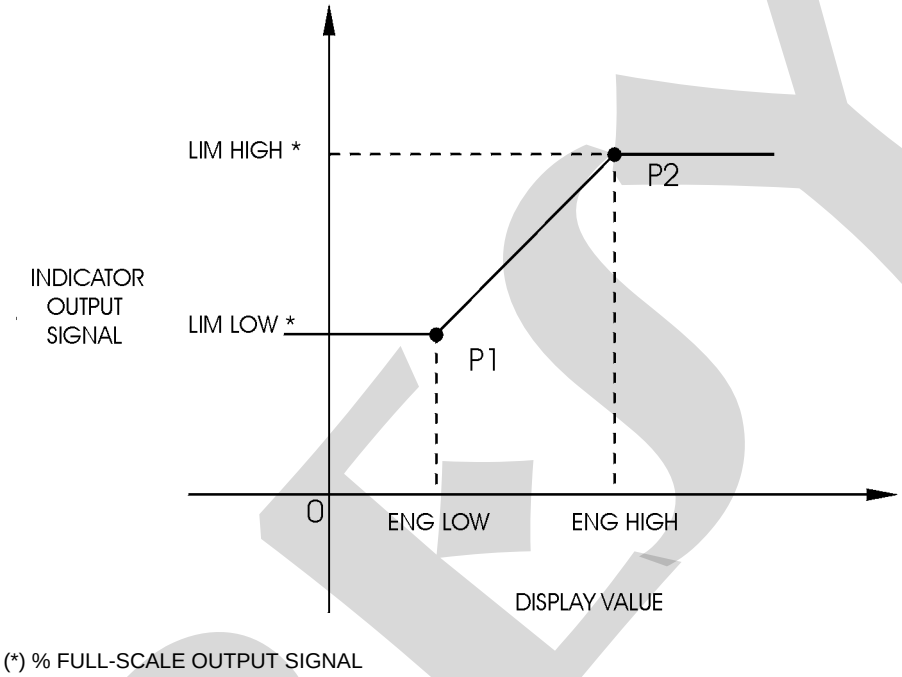


Fig. 15 - Analog output configuration

Level 5 - Calibration

Level 5 is described on section 4.5 on Calibration.

Level 6 - RS

Refer to the communication manual.

4.0 - Maintenance

4.1 - Indicator Hardware

The Indicator maintenance requires the user to have access to the hardware of the instrument. The Indicator 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 right side of the front panel. Loosen this screw and pull the Indicator front panel in order to remove the instrument from the case.

The Display Board is located in the Indicator front panel. The front panel has four internal staples in its four corners which keep together CPU and Power Supply Boards. The CPU and Power Supply Board are fixed by a spacer. Follow the instructions below to open the set:

i) Remove the screw which fixes the spacer placed near the edge of the CPU and Power Supply Boards.

ii) Turn the Indicator so that the display is on the opposite side for reading.

iii) Displace carefully the holder at the right top corner of the front panel so that the Power Supply Board can be loosen.

iv) Move the Power Supply Board to the right and open the boards according to Figure 16.

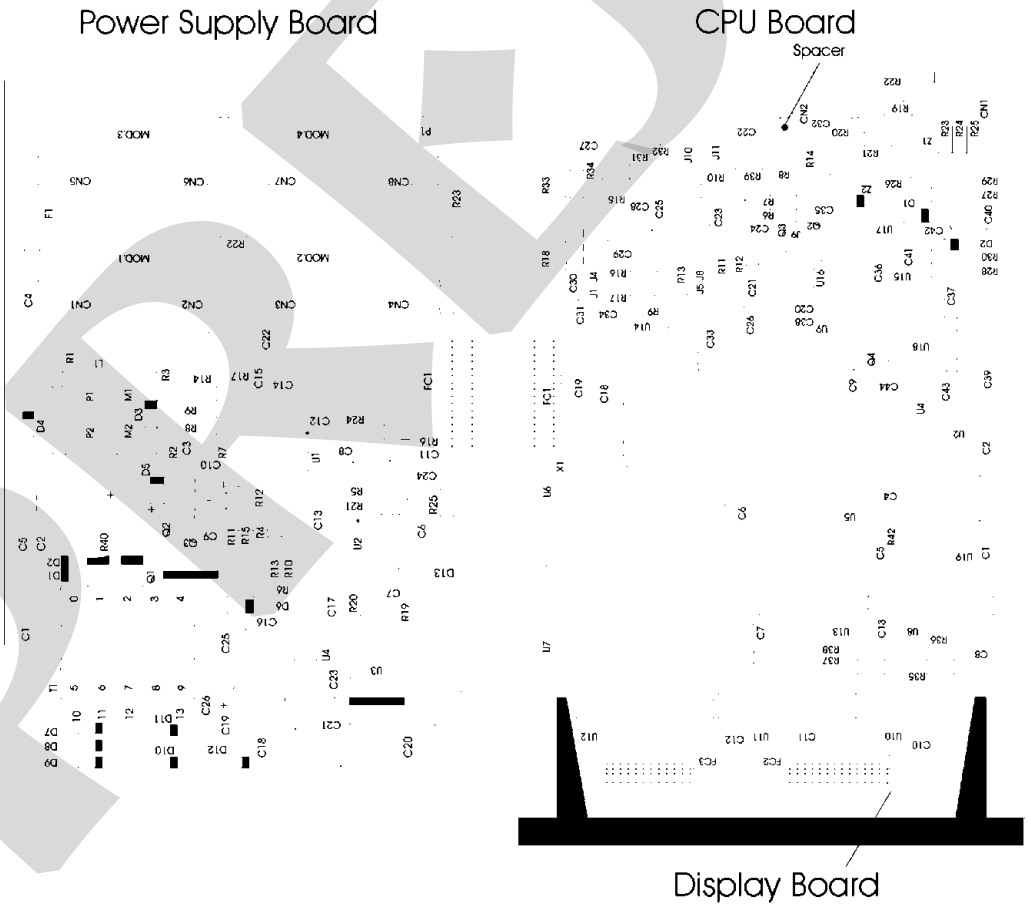


Fig. 16 - Indicator hardware

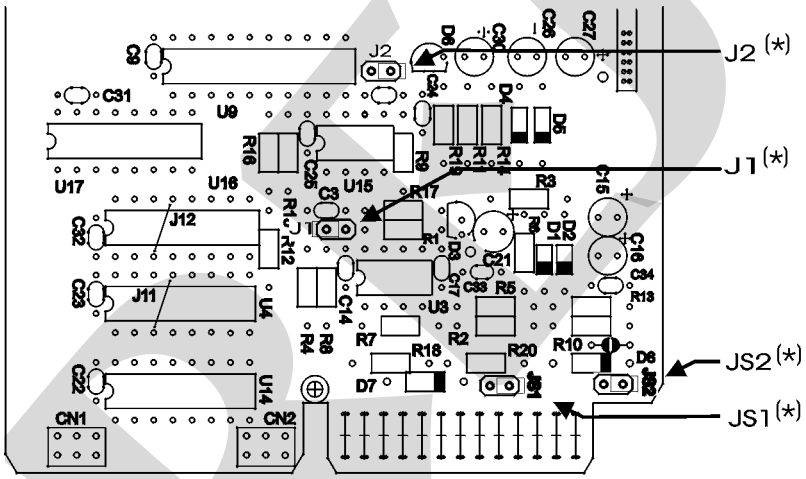
4.2 - Hardware Configuration

The software configuration level of input (level 2 - Input) must be complemented by hardware configuration, through internal jumpers.

There is one selection plug-in jumper associated to each input: J1 for input 1 and J2 for input 2. When the jumper is plugged, the instrument is configured to receive amplitude pulses from 3.5 V_{p-p} to 30 V_{p-p}.

This resource is useful to eliminate unstable indications due to the plant electrical noise. The factory sets up each selection jumper to be plugged in only one pin (false position), so that the instrument input operates within the 300 mV_{p-p} to 30 V_{p-p} range. In case one notices an unstable indication, for instance, when viewing the 0 Hz indication with an opened sensor or a stopped axis, plug the jumper corresponding to this channel.

Jumpers JS1 and JS2 are used when the inputs are connected to sensors with contact closure or to a NAMUR sensor. Otherwise, for input signals generated by other frequency sensors, such as magnetic pickups, keep JS1 and JS2 placed on false positions as shown below.



(*) The instrument is provided with jumpers J1, J2, JS1 and JS2 placed in false positions.

Fig. 17 - Position of the Selection Plug-in Jumpers

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. The jumpers may be localized on the front or the back side of the board, depending on its version.

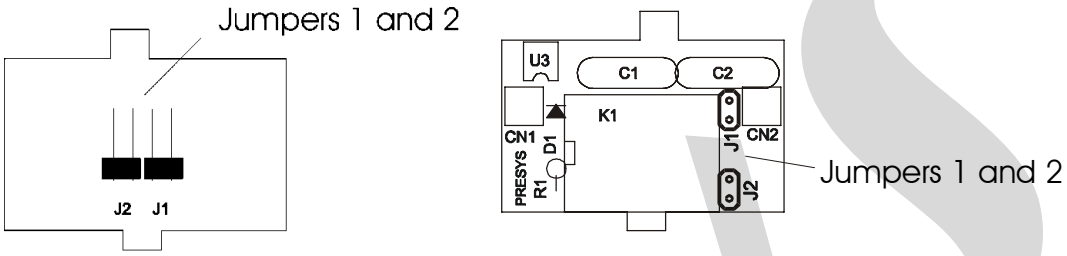


Fig. 18 - Jumpers for selection of snubbers on the relay board

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).

- 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 Connection

DMY-2030-F and DMY-2030-F *Light* Indicators accept up to four output devices and communication, which must have the corresponding optional modules installed in the instrument. Open the Indicator as shown in section 4.1 in order to access four connectors in the Power Supply Board and one connector in the CPU board (refer to Figure 19).

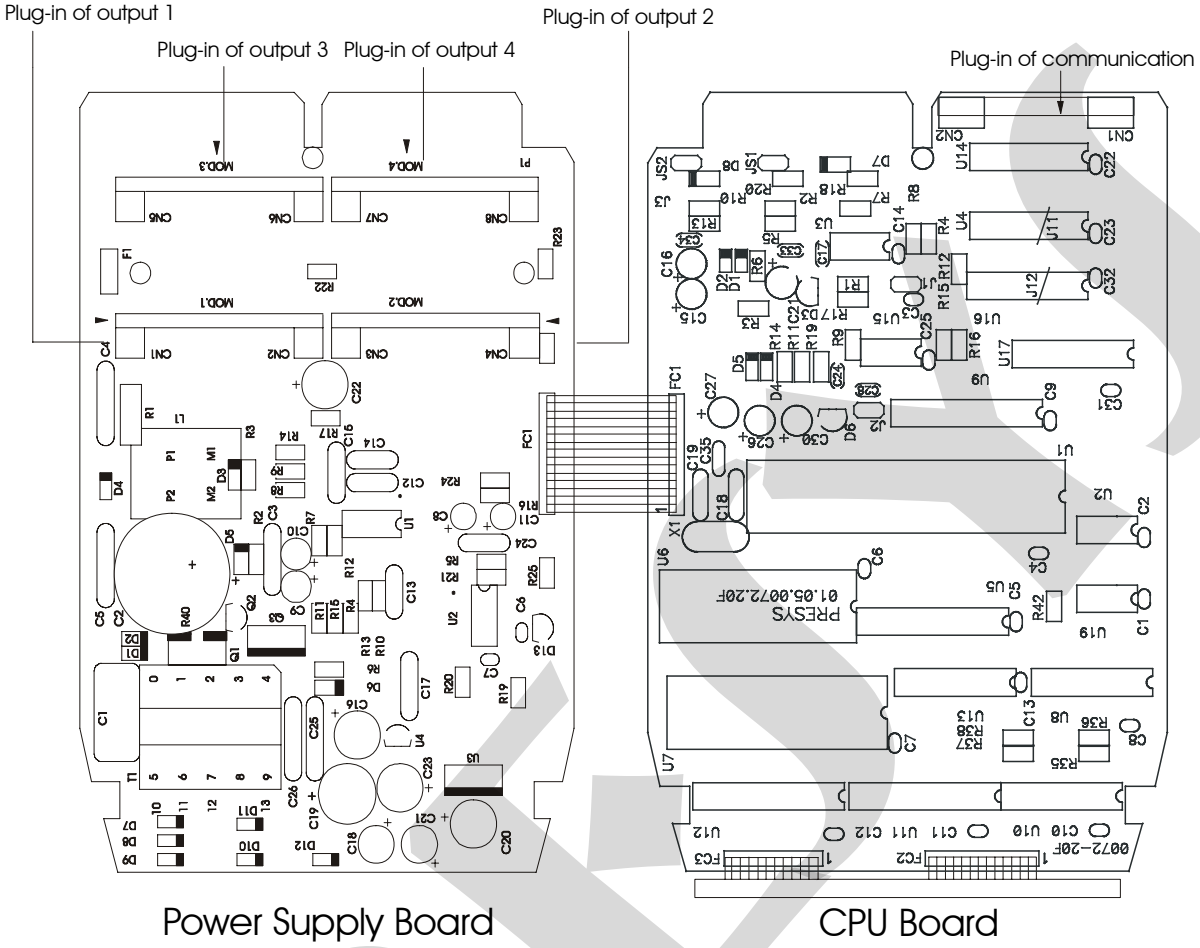


Fig. 19 - Optional module connectors

The connectors in the Power Supply Board are called MOD 1, MOD 2, MOD 3 and MOD 4, and are associated, in this order, with the signals of output 1, output 2, output 3 and output 4 in the Indicator output terminals as shown in Figure 3. The connector for the communication module is placed in the CPU Board and has no label. Any optional module must be always installed with the component side in the direction of the Display Board, as shown in Figure 20.

Fig. 20 - Installation of optional modules

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

When output 1 is required to be a retransmitter output (4 to 20mA, 1 to 5V or 0 to 10V), connect the optional analog output module in the connector called MOD 1. If another retransmitter output is needed, connect the second module in the connector called MOD 2.

The output 1 retransmits the measured variable from input 1 while output 2 retransmits the measured variable from input 2.

The optional analog output module has two connectors for installation of jumpers: J1 and J 2, as shown in Figure 21.

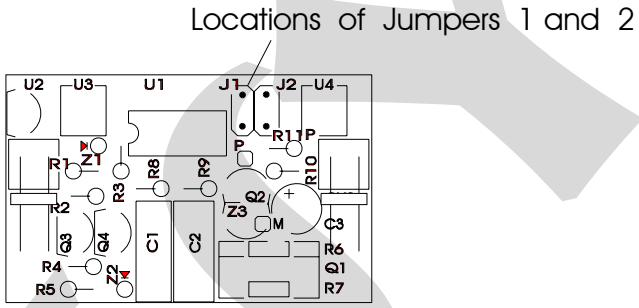


Fig. 21 - Place of jumpers in analog output board

In order to configure the optional analog output module as a retransmitter output for 4 to 20mA, 1 to 5V or 0 to 10V, install the jumper according to table 2.

Retransmitter Output Type	Jumpers	
4 to 20mA*		
1 to 5V	J1	
0 to 10V		J2

Table 2 - Jumper for retransmitter output type configuration

(*) In case of 4 to 20mA current retransmitter output, keep the jumper out of the instrument or put it on only one pin of the connector, as shown in Figure 17.

Outputs 1 and 2 as alarm outputs

If output 1 or output 2 is required to operate as alarm, connect the optional module in the connectors called MOD 1 and MOD 2, respectively. The output type depends on the optional module installed in MOD 1 and MOD 2: SPST relay, the solid state relay and the open collector voltage. The alarm output type and the optional module code are listed in table 3.

Alarm Output Type	Optional Module Code
SPST Relay	MALRE - 20
Solid state relay	MALRS - 20
Open collector voltage	MSD - 20

Table 3 - Types of alarm output for outputs 1 and 2

Outputs 3 and 4 as alarm outputs

Outputs 3 and 4 are used as alarms when the optional modules corresponding to connectors MOD 3 and MOD 4 are installed. There are three types of alarm output available: SPDT relay, solid state relay and open collector voltage. The alarm output type and the optional module correspondence are shown in table 4.

Alarm Output Type	Optional Module Code
SPDT Relay	MALRE - 20
Solid state relay	MALRS - 20
Open collector voltage	MSD - 20

Table 4 - Alarm output types for outputs 3 and 4

4.5 - Calibration

The outputs of DMY-2030-F and DMY-2030-F *Light* Indicators are accurately calibrated in factory and do not need periodic calibration in normal conditions. There is no need for calibrating the frequency inputs because the input reading is accomplished by a microcontroller with an accurate timebase.

When output calibration is required, follow this procedure below.

Disconnect the process signals of I/O terminals.

Before calibrating the instrument, keep it turned on for at least 30 minutes for warm up.

Output Calibration

For the output calibration, follow this procedure for retransmitter outputs 1 and 2.

The retransmitter outputs are calibrated with the aid of a calibrator which reads the output signal. The accuracy and precision of the calibrator must be at least two times better than the specifications of the Indicator output.

Check if the jumpers on the optional output modules are placed according to the type of output to be calibrated (0 to 5V, 0 to 10V or 0 to 20mA).

To perform the calibration, enter level 5 of Calibration. The calibration level has a password system which avoids someone to enter this level accidentally and damage any calibration parameter. **The password for entering this level is number 5.**

Figure 22 shows the output calibration options in level 5 of Calibration.

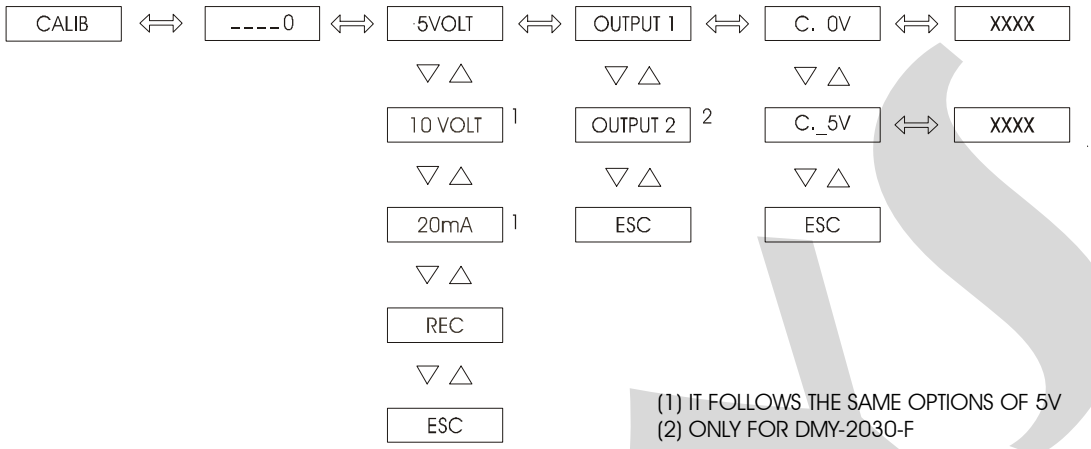


Fig. 22 - Calibration Level Options

Once the correct password is provided, select the output to be calibrated. Choose the type of output (0 to 20 mA, 0 to 5 V or 0 to 10 V) and press ENTER.

The display will show the mnemonic related to the first point of calibration. There are only two points for output calibration.

For current output, the mnemonics are related to 0 and 20mA electric signals. For voltage output, the mnemonics are related to 0 and 5 V or 0 and 10 V signals.

Press ENTER after the display shows the mnemonic related to the first or second point of calibration, so that the display shows a value corresponding to the output signal. Then use the UP and DOWN keys to set the output value read by the external calibrator equal to the electric level indicated by the mnemonic. After the output value is set, press ENTER. **During the first point calibration (0mA, 0V) be careful not to saturate the output signal.**

After calibrating the two points, the calibration process will be finished.

It is possible to calibrate only one point without rendering invalid the other one 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.

Return to factory calibration

The Indicator stores the factory calibration parameter values on the non-volatile memory, which may be recovered at any time.

In case of a bad performance of the instrument due to an incorrect calibration, use the REC option (see Figure 22).

REC - is the option that allows to recover the factory calibration.

Enter level 5 of Calibration and select the REC option by pressing ENTER in order to recover the values from factory.

4.6 - Hardware Maintenance Instructions

Before sending the instrument back to factory check the following probable causes of a malfunctioning Indicator.

Instrument with error indication on display

After turning the instrument on, it tests RAM and E2PROM integrity.

When at least one of these components presents some problem the display shows the following error codes:

Err. 01 - RAM error

Err. 02 - E2PROM error

In case of RAM error, turn the instrument off and on to check if the error message is displayed again. If the error remains, return the instrument to factory.

When there is E2PROM error, press the ENTER key and configure the instrument again. Turn the instrument off and on to check if the error message is displayed again. If the error remains, return the instrument to factory.

During configuration the display can show the Err.03 error message.

This error can happen when trying to assign a different configuration (analog output or alarm) to an output already configured and enabled. In order to avoid this case, do not forget to disable relays 1 and 2 before enabling analog outputs 1 and 2 and vice-versa.

Note: When configuring a relay module as an analog output, the relay will be activated and deactivated continuously.

Instrument with the display out

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

Verify the integrity of fuse F1 of 2.0 A placed in the Power Supply Board as shown in Figure 16. Due to its package it is necessary to check the fuse continuity in order to detect if it is broken.

Instrument malfunction

Check if the Indicator is configured correctly by software and hardware (internal jumpers).

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

Check if the voltages on flat cable 1 as shown in Figure 23 are close to the values in table 5 and if they reach the CPU Board.

Test points on flat cable 1	Voltage
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 5 - Inspection points of voltage on flat cable 1

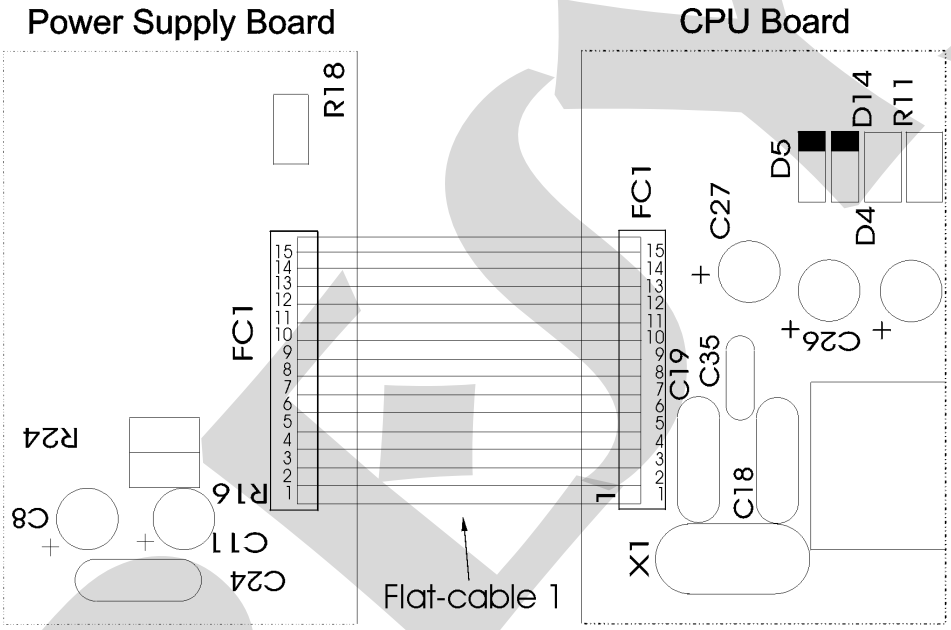


Fig. 23 - Voltage test points of the Indicator

If the cause of the problem was not discovered, the Indicator must be sent to factory.

4.7 - List of Components

Display Board

Code	Components	Reference
01.05.0050-20	Display board - DMY-2030-F	----------
01.07.0002-21	Display 19mm	DP 1,2,3,4,5
01.04.0007-21	Diode 1N4007	D 3,4
01.07.0004-21	Led 3mm (green)	D 2
01.07.0005-21	Led 3mm (red)	D 1
01.09.0013-21	Transistor BC 327	Q 1,2,3,4,5
01.02.0273-21	Resistor 470R 5%	R 1,2
01.15.0003-21	Push-button	CH 1,2,3

Power Supply Board

Code	Components	Reference
01.05.0046-20	Power Supply Board	----------
01.01.0029-21	LM 2940CT - 5.0 V	U3
01.01.0003-21	LM1458N	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
01.02.0122-21	Fuse 2A	F1
01.01.0028-21	78L24	U4
01.04.0005-21	Reference Diode LM336/5V	D13
01.04.0007-21	Diode 1N4007	D1,2,3,4
01.04.0008-21	Diode 1N4936	D5,6,7,8,9,10,11,12
01.03.0009-21	Ceramic Disc Capacitor 100 pF x 100V	C12,13,14
01.03.0036-21	Ceramic Multilayer Capacitor 0.01µF x 63V	C24
01.03.0035-21	Ceramic Multilayer Capacitor 0.1µF x 63V	C6,7
01.03.0039-21	Polyester Capacitor 0.1 µF x 250 V	C3
01.03.0022-21	Polyester Capacitor 0.01 µF x 100 V	C15,17
01.03.0041-21	Polyester Capacitor 0.01 µF x 250 V	C4,5
01.03.0038-21	Radial Electrolytic Capacitor 10 µF x 16 V	C8,11
01.03.0042-21	Radial Electrolytic Capacitor 22 µF x 25 V	C9,C10
01.03.0027-21	Radial Electrolytic Capacitor 100 µF x 25 V	C18,21
01.03.0043-21	Radial Electrolytic Capacitor 100 µF x 35 V	C16,22
01.03.0044-21	Radial Electrolytic Capacitor 220 µF x 10 V	C20,23
01.03.0076-21	Radial Electrolytic Capacitor 33µF x 400V	C2
01.03.0002-21	Radial Electrolytic Capacitor 1000µF x 16V	C19
01.03.0068-21	Polyester Capacitor 4n7 x 400V	C25, 26
01.03.0071-21	Polyester Capacitor 0.1µ x 400V	C1
01.02.0105-21	Resistor 18R x 2W	R1
01.02.0135-21	Resistor 1R 1%	R 15
01.02.0006-21	Resistor 20R 1%	R 6
01.02.0167-21	Resistor 221R 1%	R 10
01.02.0272-21	Resistor 270R 1%	R 4
01.02.0273-21	Resistor 470R 1%	R 17, 18, 22, 23
01.02.0019-21	Resistor 1K 1%	R 16, 24
01.02.0183-21	Resistor 2K32 1%	R 13
01.02.0242-21	Resistor 4K7 1%	R 8, 12
01.02.0031-21	Resistor 4K99 1%	R 25
01.02.0038-21	Resistor 10K 1%	R 5, 20, 21
01.02.0108-21	Resistor 15K4 1%	R 19
01.02.0042-21	Resistor 17K8 1%	R 7
01.02.0043-21	Resistor 20K 1%	R 11
01.02.0274-21	Resistor 27K 1%	R 14
01.02.0113-21	Resistor 47K 1%	R 3
01.02.0054-21	Resistor 150K 1%	R 9
01.02.0217-21 01.02.0056-21	Resistor 267K+200K 1%	R 2
01.06.0003-21	Transformer 110/220Vac	T1
01.06.0018-21	Coil	L1
01.13.0004-21	Connector	CN1,2,3,4,5,6,7,8

CPU Board

Code	Components	Reference
01.05.0072-20	CPU board	----------
01.01.0056-21	LM 392N	U 3, 15
01.01.0016-21	EPROM 27C512	U 7
01.01.0017-21	RAM 6516	U 6
01.01.0044-21	E2PROM X25043 / X5043	U 19
01.01.0011-21	TC4040BP	U 14, 17
01.01.0019-21	4051	U 4, 16
01.01.0021-21	74HC02	U 13
01.01.0022-21	74HC138	U 8
01.01.0023-21	74HC365	U 10
01.01.0024-21	74HC373	U 5, 9, 11, 12
01.01.0057-21	P80C51FA	U 1
01.16.0001-11	Crystal 11.0859MHz-20	X 1
01.04.0009-21	Zener Diode BZX79 / C2V4	D 1, 2, 4, 5
01.04.0032-21	Zener Diode 1N4745 (16V x 1W)	D 7, 8
01.04.0021-21	Reference Diode LM336 / 2.5V	D 3, 6
01.03.0007-21	Ceramic Disc Capacitor 10pF x 100V	C 3, 24
01.03.0034-21	Ceramic Disc Capacitor 33pF x 50V (4mm)	C 18, 19
01.03.0011-21	Ceramic Multilayer Capacitor 220pF x 63V	C 33, 34
01.03.0035-21	Ceramic Multilayer Capacitor 0.1µF x 63V	C1,4,5,6,7,8,9,10,11,12,13, 14,22,23,25,31,32
01.03.0038-21	Radial Electrolytic Capacitor 10µF x 16V (85700)	C 21, 30
01.03.0066-21	Radial Electrolytic Capacitor 4.7µF x 35V (85700)	C 15, 16, 26, 27
01.03.0010-21	Ceramic Disc Capacitor 180pF x 100V	C 17, 28
01.02.0171-21	Resistor 866R 1%	R 18,20
01.02.0025-21	Resistor 2K49 1%	R 6, 14
01.02.0038-21	Resistor 10K 1%	R 2,4,10,12,35,36,37,38
01.02.0040-21	Resistor 15K 1%	R 7, 15, 42
01.02.0045-21	Resistor 34K8 1%	R 17, 19
01.02.0113-21	Resistor 47K 1%	R 8, 16
01.02.0052-21	Resistor 100K 1%	R 3, 5, 11, 13
01.02.0069-21	Resistor 1M 1%	R 1, 9
01.13.0043-21	Socket 14 x 14-28 pins (SPT 0BC)	U 7
01.13.0005-21	Connector QUAD (MCI 21J03)	CN 1, 2
01.17.0013-21	Connector 180° 1 x 2	J 1, 2, JS 1, 2
01.14.0011-21	Flat-Cable 12 ways	FC 3
01.14.0010-21	Flat Cable 13 ways	FC 2
01.14.0026-21	Flat Cable 15 ways	FC 1

I/O Terminal Board

Code	Components	Reference
01.05.0049-20	I/O Terminal Board	----------
01.13.0002-21	Terminal Block	CN1,2
01.13.0003-21	Board-to-board Connector	P1,2

Analog Output Board

Code	Components	Reference
01.05.0055-20	Analog Output Board	----------
01.01.0060-21	OP200GP	U 2
01.01.0065-21	Optocoupler LTV817	U 1,3

01.09.0006-21	TIP 117	Q 1
01.09.0015-21	Transistor BC 337	Q 2
01.09.0021-21	Transistor BF 245A	Q 3
01.04.0030-21	Zener Diode BZX 79/C3V3	Z 1
01.04.0011-21	Zener Diode BZX79/C3V9	Z 3
01.04.0005-21	Reference Diode LM 336 / 5.0 V	Z 2,4
01.03.0042-21	Radial Electrolytic Capacitor 22µF x 25 V	C 1
01.03.0035-21	Ceramic Multilayer Capacitor 0.1µF x 63 V	C5,6
01.03.0011-21	Ceramic Multilayer Capacitor 220pF x 63V	C4,7
01.03.0050-21	Tantalum Capacitor 1µF x 35V	C 2, 3
01.02.0008-21	Resistor 49R9 1%	R 4
01.02.0010-21	Resistor 100R 1%	R 5
01.02.0013-21	Resistor 249R 1%	R 10,11
01.02.0115-21	Resistor 402R 1%	R 13
01.02.0024-21	Resistor 2K 1%	R 9
01.02.0029-21	Resistor 4K02 1%	R 2
01.02.0038-21	Resistor 10K 1%	R 3
01.02.0047-21	Resistor 49K9 1%	R 7,8
01.02.0059-21	Resistor 301K 1%	R 12
01.02.0069-21	Resistor 1M 1%	R 6
01.02.0109-21	Resistor 3K3 5%	R 14
01.02.0080-21	Resistor 4K7 5%	R 1
01.17.0001-21	Connector 180º 2x2	J 1,2
01.17.0004-21	Connector 90º 2x2	CN 1,2
01.17.0002-21	Jumper	----------
01.06.0004-21	Coil for Analog Output DMY/TY/DCY	----------

Alarm Board

Code	Components	Reference
01.05.0052-20	Alarm Board	----------
01.01.0033-21	Optical coupler 2502	U3
01.04.0001-21	Diode 1N4002	D1
01.03.0039-21	Polyester Capacitor 0.1 µF x 250 V	C1,2
01.02.0114-21	Resistor 270R 5%	R1
01.02.0072-21	Resistor 100R 5%	R2
01.12.0001-21	Relay 24 V	K1
01.17.0004-21	Right Angle Pitch Header 2x2	CN3,4

4.8 - List of Recommended Spare Components

Display Board
Display DP1, 2, 3, 4, 5

Power Supply Board

IRF 822	Q3
UC 3842	U1
Fuse 2A	F1
LM 1458N	U2

CPU Board
4051 U14

Engineering Units Label
Code 02.10.0003.21

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