COMPONENTS FOR PNEUMATIC AUTOMATION

®

PNEUMAX
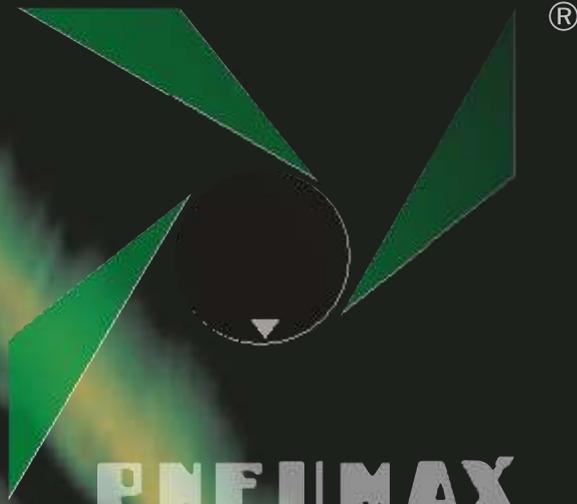
521
FIVE TO ONE

ELECTRONIC PROPORTIONAL REGULATORS

CONTENTS:

REASONS FOR THE DEVELOPMENT
- Description
- Field of application

PRODUCT PRESENTATION
- Product range
-
FEATURES
- Constructional principle
- Functional diagram
- Definitions
- Functional
- Constructional
- Overall dimensions
- Fixing possibilities
- Installation/Operation
- Product configuration
- Operating parameters
- Serial communication

CODING
- Coding key
- Accessories

REASONS FOR THE DEVELOPMENT

Description

Modern industrial applications require increasingly high performances from their pneumatic components. For example, the speed and thrust of a pneumatic cylinder, or the torque of a rotary actuator may need to be varied. These parameters often need to be modified dynamically while an operation is running.

Traditional solutions based upon pneumatic valves supplied with different pressures often take up excessive amounts of space. An alternative solution is a regulator that can vary pressure over time.

This type of regulator is known as an electronically controlled proportional regulator.

Three sizes have been designed, with flow rates of 7, 1,100 and 4,000 Nl/min.

Size "O" is specifically dedicated to those applications where the circuit air volume is small or for use as control device for large size piloted pressure regulators.

Application fields.

Typical applications will include the necessity to dynamically control the force of an actuator, be it thrust or torque.

Examples include: Closing systems, painting systems, tensioning systems, packaging systems, pneumatic braking systems, force control for welding grippers, thickness compensation systems, balancing systems, laser cutting, pressure transducers for the control of modulating valves, test benches for system testing, force control for buffers on polishers, etc.

Product presentation

Product range

The supply and exhaust connections are on one side of the regulator and the working port is on the opposite side. The two remaining sides carry G1/8 ports that are blanked off with removable plugs, these can be used to connect a pressure gauge or as an outlet port.

The control solenoid valves, the pressure sensor, and the management electronics are placed in upper part of the regulator.

The electronic management system is the same for all three sizes.

The new proportional regulator range has all the features that were only optional on the previous model.

When placing your order it is only necessary to specify the type of control signal, Voltage (**T**) or current (**C**), and the pressure range required.

The new proportional regulator has these main features::
- 3 1/2 digit display
- 3-pushbutton keyboard
- RS-232 serial port supplied as standard
- voltage or current analog input
- voltage analog output (values selected from keyboard)
- current analog output (values selected from keyboard)
- digital output
- 7 pressure values that are settable and selectable via 7 digital inputs
- outlet pressure settable by value corresponding to the binary code of the logic statuses of 8 digital inputs

In addition to the wide range of optional features present on the previous model, we have added the ability to manage the proportional regulator via digital input; all these functions are offered as standard on all versions of the regulator.

The three button keyboard provides easy access to view or change parameters (without the need to switch the regulator off and on again).

The RS-232 serial connection permits the direct control of the regulator from a PLC or PC. It is possible to change parameters, check status and also set the outlet pressure.

The range of all three analogue values: control signal, current analogue output and voltage analogue output, can be selected using the appropriate parameters.

The 24 VDC digital output signal is protected against overloads and short circuits. It is possible to set the upper and lower warning thresholds in a differentiated manner. The new proportional regulator can also be without using analogue signals, by simply connecting PLC switches or outputs to the digital inputs of the regulator.

The supply voltage is 24 VDC. There are two operating modes that make use of digital inputs. The first assigns a parameter to each digital input in which the desired output pressure has been stored. When the 24 VDC signal is applied to an input the regulator sets the output pressure to the value stored in the corresponding parameter. The second mode which uses digital inputs uses an 8 bit binary combination. To set the outlet pressure the value of the pressure is calculated as a binary number and applied to the digital inputs with the same binary combination (supply 24 VDC to the reference pin).

⚠ This second operating mode is available only in voltage-controlled regulators.

SIZE 0   SIZE 1   SIZE 3

FEATURES

Construction Principle

The Pneumax proportional regulator is based on a mechanical device with a balanced double shutter. One shutter controls the orifice between the supply and operating connections, while the other shutter controls the orifice between the operating and exhaust connections. The two shutters are controlled by a rod connected to a diaphragm. The pressure in the diaphragm pilot chamber is governed by two off 2/2 10mm solenoid valves. One valve is used to pressurise the chamber, the other to vent pressure away.
This control system allows the capacity of the valves to be controlled by varying the frequency at which the switching voltage is applied.

The electronic part of the regulator comprises a 165-bit microprocessor with a 12-bit digital analogue converter and a pressure transducer.
The incoming reference signal is analysed by the microprocessor, which in turn initiates switching of the solenoid valves. At the same time, the pressure transducer sends the microprocessor an analogue signal of the pressure value detected in the circuit downstream of the regulator. This signal is compared with the reference signal and when the required value is reached the solenoid valves are no longer operated. If this equilibrium is altered, either through a change in the output pressure value or a variation of the input reference signal the microprocessor intervenes to restore the equilibrium.
If the value of the reference signal decreases, the venting solenoid valve is opened to decrease the pressure in the pilot chamber, resulting in the opening of the of the exhaust path until the new equilibrium is achieved.
If the value of the reference signal increases, the pressurising solenoid valve is opened to increase the pressure in the pilot chamber, resulting in the opening of the supply path until the new equilibrium is achieved.

Functional diagram
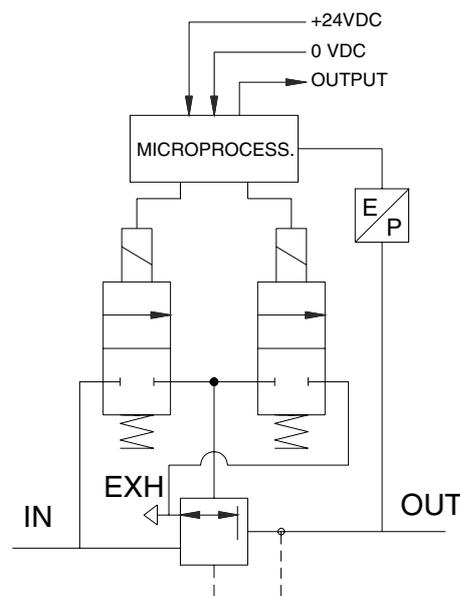
FEATURES

CLOSED LOOP diagram (internal control circuit)

The proportional regulator is known as a CLOSED LOOP regulator because a pressure transducer in the circuit transmits a continuous analog signal to the microprocessor, which compares the reference value with the detected value and supplies the control solenoid valves accordingly.

```
                         ┌─────────────────────┐
                         │  REFERENCE SIGNAL   │
                         └─────────────────────┘
                                   │
        CONNECTOR                  ▼
                         ┌─────────────────────┐
                         │   MICROPROCESSOR    │◄──────────┐
                         └─────────────────────┘           │
                                   │                        │
                                   ▼                        │
                         ┌─────────────────────┐            │
                         │  SOLENOID VALVES     │            │
                         │    MANAGEMENT        │     ┌──────────────┐
                         └─────────────────────┘     │  TRANSDUCER  │
                                   │                 └──────────────┘
                                   ▼                        ▲
                         ┌─────────────────────┐            │
                         │     PRESSURE         │            │
                         │   MANAGEMENT IN      │            │
                         │ BALANCING CHAMBER    │            │
                         └─────────────────────┘            │
                                   │                        │
                                   ▼                        │
                         ┌─────────────────────┐            │
                         │   PRESSURE OUTP      │────────────┘
                         └─────────────────────┘
   REGULATOR OPERATING            │
         PORT                     ▼
```
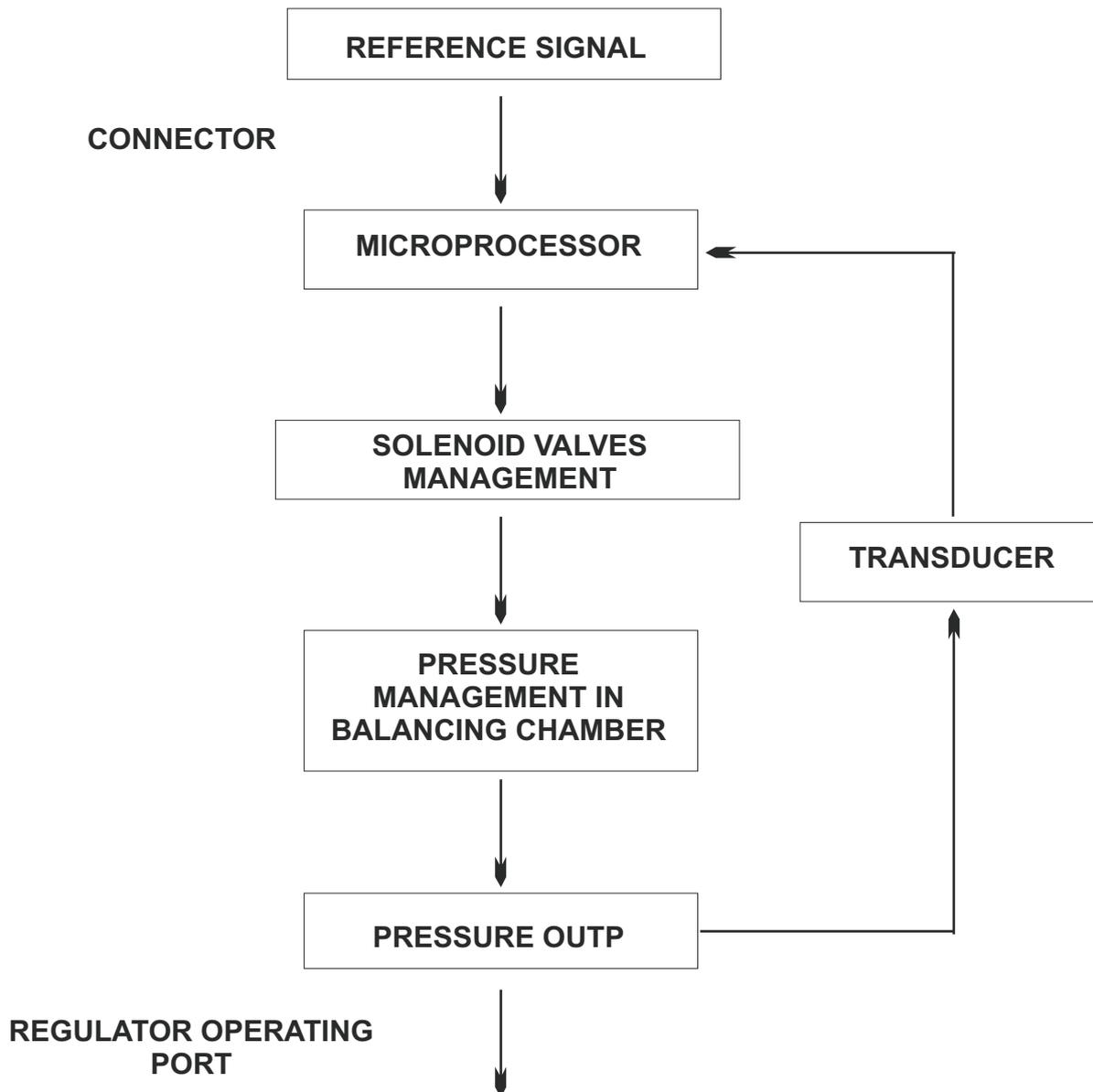
FEATURES

Definitions

Linearity

This is a percentage value referring to the operating bottom scale that defines the maximum deviation that is possible between the ideal curve and the actual curve.

Example: As the linearity of the regulator is defined as being ±1% of the bottom scale (FS) and the bottom scale is defined as 10 bar, maximum error will be ±0.1 bar.
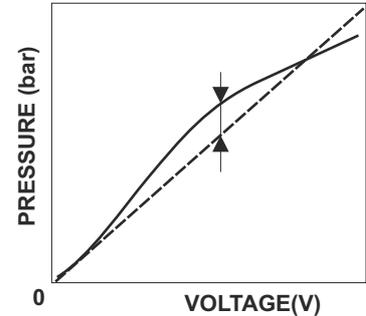
Hysteresis

This is the percentage value referring to the operating bottom scale that defines the maximum deviation that is obtained on the outlet pressure with the same reference value.

The friction is due to friction between the mechanical components that make up the regulator and depends on whether the original values a smaller or larger.

Example:
As the hysteresis of the regulator is ±0.5% of the bottom scale (FS) and the bottom scale is 10 bar, maximum error will be ±0.05 bar.
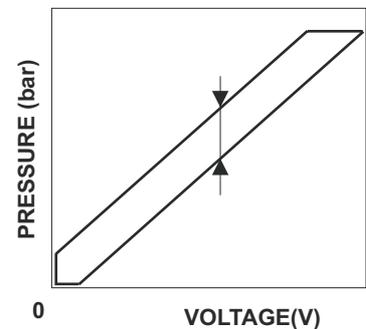
Repeatability

This is the percentage value referring to the operating bottom scale that defines the maximum error detected during several readings taken consecutively in the same operating conditions (this error is normally generated by the hysteresis of the internal components).

Example:
As the hysteresis of the regulator is ±0.5% of the bottom scale (FS) and the bottom scale is 10 bar, maximum error will be ±0.05 bar.
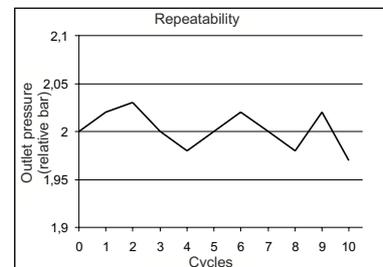
Sensivity

Percentage value referring to the operating bottom scale that defines the the minimum variation of the reference signal to which a variation in the pressure value downstream corresponds.

Example:
As the regulator has sensitivity that is ±0.5% of the bottom scale (FS) and the bottom scale is 10 bar, the pressure variation downstream will occur for each variation in the reference signal above 0.05 Volt
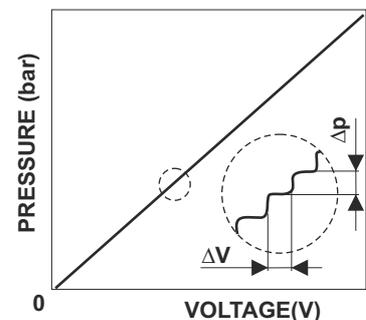
FEATURES

	Fluid		Air filtered at 5 micron and dehumidified		
Pneumatic	Minimum inlet pressure		Desired outlet pressure + 1 bar		
	Maximum inlet pressure		10 bar		
	Outlet pressure		Order code	0009	0005	0001
			Pressure value	0 ÷ 9 bar	0 ÷ 5 bar	0 ÷ 1 bar
	Nominal flowrate from 1 to 2 (6 bar Δp 1 bar)		**Size 0**	**Size 1**	**Size 3**
			7 Nl /min	1.100 Nl /min	4.000 Nl/min
	Discharge flowrate (at 6 bar with 1 bar overpressure)		7 Nl /min	1.300 Nl /min	4.500 Nl/min
	Air consumption		< 1 Nl/min	< 1 Nl/min	< 1 Nl/min
	Supply connection		M5	G 1/4	G 1/2
	Operating connection		M5	G 1/4	G 1/2
	Exhaust connection		ø1,8	G 1/8	G 3/8
	Maximum fitting tightening		3 Nm	15 Nm	15 Nm

Electric	Supply voltage		24VDC ± 10% (stabilised with ripple <1%)	
	Standby current consumption		55 mA	
	Current consumption with solenoid valves on		145 mA	
	Reference signal	Voltage	*0 ÷ 10 V *0 ÷ 5 V *1 ÷ 5 V	
		Current	*4 ÷ 20 mA *0 ÷ 20 mA	
	Input impedance	Voltage	10 KΩ	
		Current	250 Ω	
	Voltage analog output		*0 ÷ 10 V *0 ÷ 5 V	
	Current analog output		*4 ÷ 20 mA *0 ÷ 20 mA	
	Digital inputs		24V DC ± 10%	
	Digital outputs		24 V DC PNP (max. current 50 mA)	
	Connector		D-sub 15 poles	

Functional	Linearity	< ± 0,3 % F.S.
	Hysteresis	<0,3 % F.S.
	Repeatability	< ± 0,3 % F.S.
	Sensitivity	< ± 0,3 % F.S.
	Assembly position	Indifferent
	Protection grade	IP65 (with casing fitted)
	Ambient temperature	-5° ÷ 50°C / 23° ÷ 122°F

Constructional	Body		Anodised aluminium	
	Shutters		Brass with vulcanised NBR	
	Diaphragm		Cloth-covered rubber	
	Seals		NBR	
	Cover for electrical part		Technopolymer	
	Springs		AISI 302	
	Weight		**Size 0**	**Size 1**	**Size 3**
			168 gr.	360 gr	850 gr

* Selectable by keyboard or by RS-232

FEATURES
Overall dimension
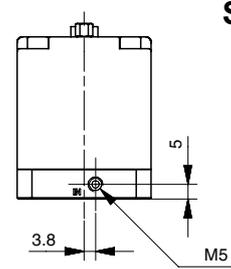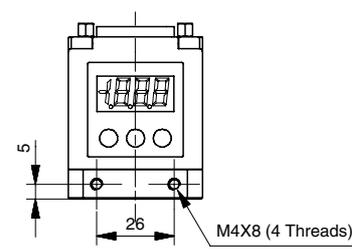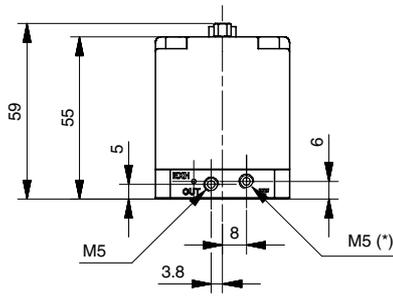
SIZE 0

59
55
5
6
M5
8
M5 (*)
3.8

5
26
M4X8 (4 Threads)

5
IN
3.8
M5

45
45

* = External feedback input connection
(available only on the external feedback version)

SIZE 1

101
96
M5 (*)
20
OUT
G1/4"

13.5
26
M4X8 (4 Threads)

45
45

EXH
G1/8"
28.5
12
IN
G1/4"

* = External feedback input connection
(available only on the external feedback version)

SIZE 3

128
124
M5 (*)
27
OUT
G1/2"

18
26
M4X8 (4 Threads)

EXH
G3/8"
41
16
IN
G1/2"

62
62
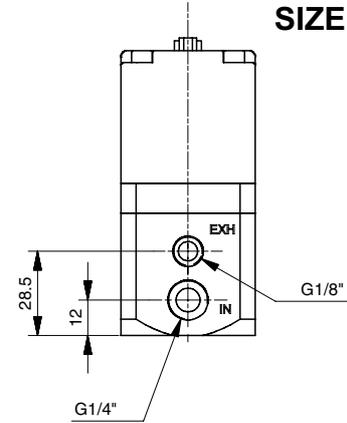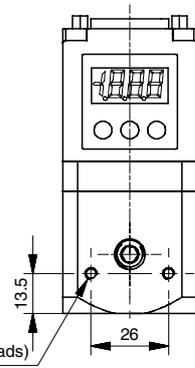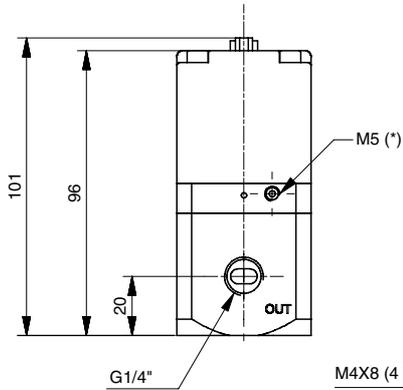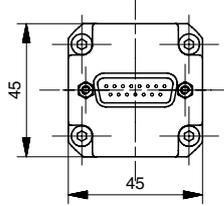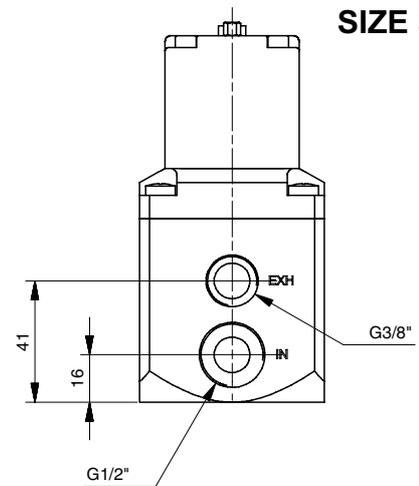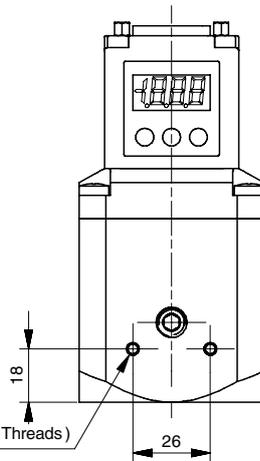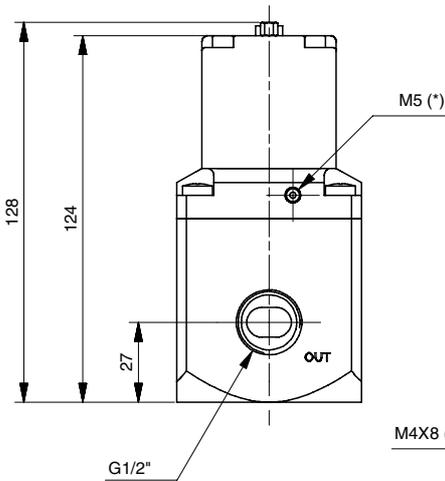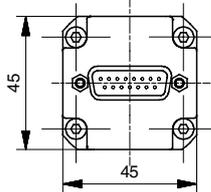
* = External feedback input connection
(available only on the external feedback version)
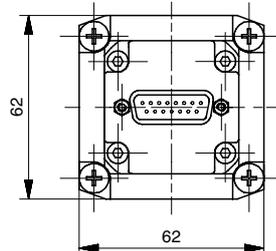
FEATURES
Mounting options

In addition to mounting direcly using the M4 tappings on the body, the 170M5 bracket may also be used, as show below:
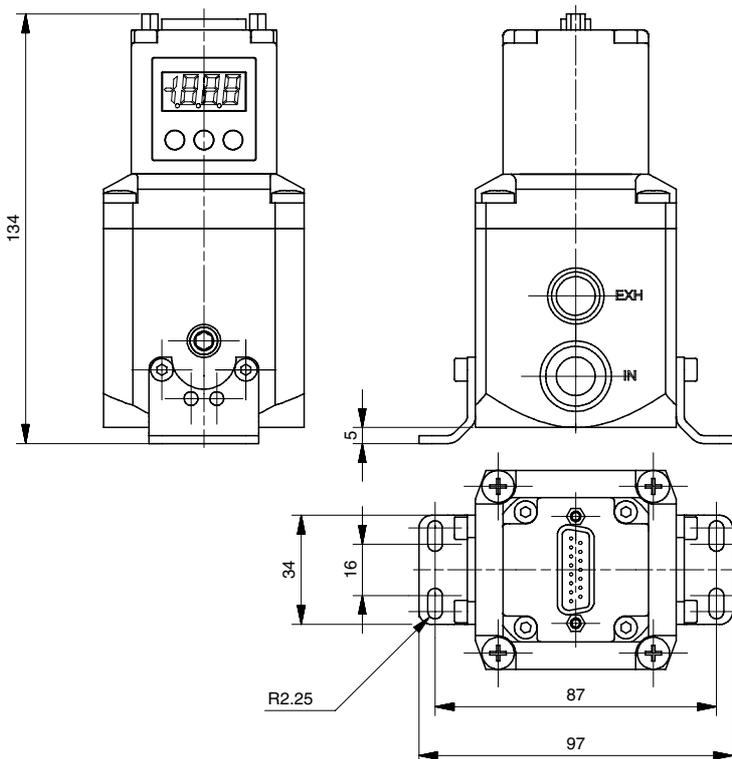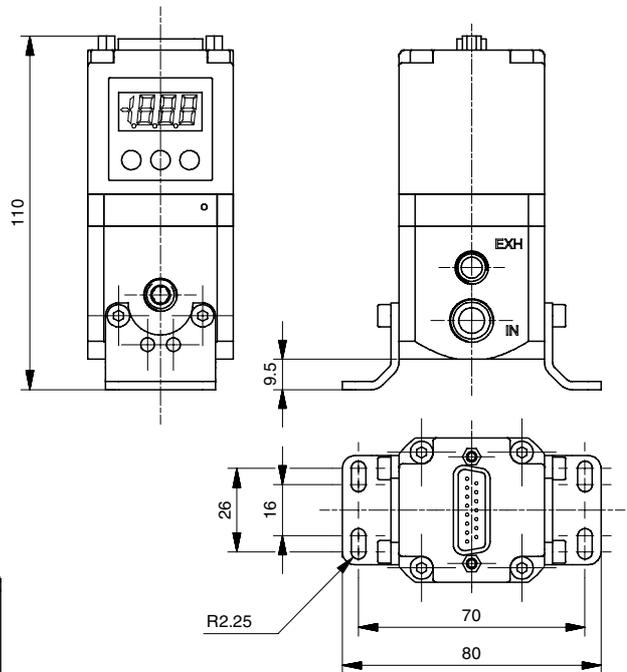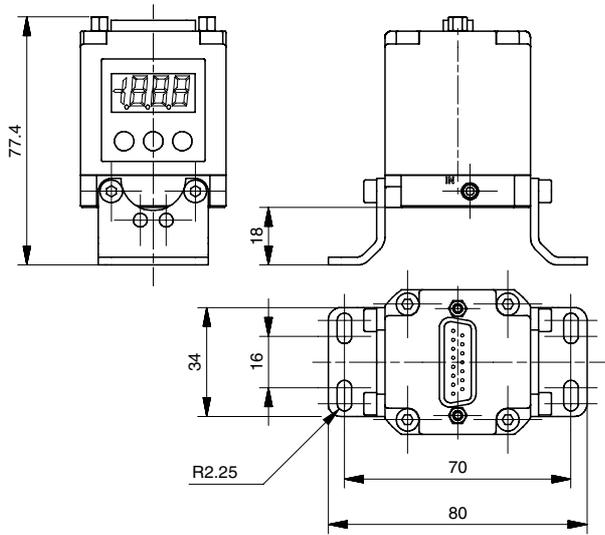
FEATURES

Installation/Operation

PNEUMATIC CONNECTION

The compressed air is connected by means of M5 threaded holes (for size 0 regulator), G ¼" threaded holes (for size 1 regulators) and G ½" threaded holes (for size 3 regulators) on the body.
Before making the connections, eliminate any impurities in the connecting pipes to prevent chippings or dust entering the unit. Do not supply the circuit with more than 10 bar pressure and make sure that the compressed air is dried (excessive condensate could cause the appliance to malfunction) and filtered at 5 micron. The supply pressure to the regulator must always be at least 1 bar greater than the desired outlet pressure.
If a silencer is applied to the discharge path the unit's response time may change; periodically check that the silencer is not blocked and replace it if necessary.

ELECTRICAL CONNECTION

For the electrical connection a SUB-D 15-pole female connector is used (to be ordered separately). Wire in accordance with the wiring diagram shown below.
Warning: INCORRECT CONNECTIONS MAY DAMAGE THE DEVICE

NOTES ON OPERATION

If the electric supply is interrupted, the outlet pressure is maintained at the set value. However, maintaining the exact value cannot be ensured as it is impossible to operate the solenoid valves.
In order to discharge the circuit downstream, zero the reference, make sure that the display shows a pressure value equal to zero and then disconnect the electric power supply.
A version of the device is available that exhausts the downstream circuit when the power supply is removed. (Option "A" at the end of the ordering code).
If the compressed-air supply is suspended and the electric power supply is maintained a whirring will be heard that is due to the solenoid valves; an operating parameter can be activated (P18) that triggers the regulator protection whenever the requested pressure is not reached within 4 seconds of the reference signal being sent. In this case the system will intervene to interrupt the control of the solenoid valves. Every twenty seconds, the unit will start the reset procedure until standard operating conditions have been restored.

**TOP VIEW
OF THE REGULATOR
CONNECTOR**
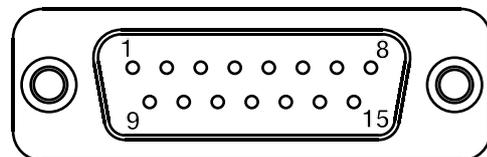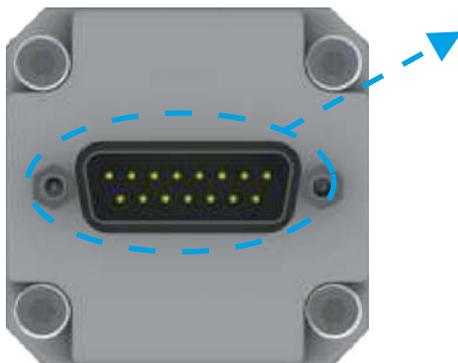
CONNECTOR PIN:
1 = DIGITAL INPUT 1
2 = DIGITAL INPUT 2
3 = DIGITAL INPUT 3
4 = DIGITAL INPUT 4
5 = DIGITAL INPUT 5
6 = DIGITAL INPUT 6
7 = DIGITAL INPUT 7
8 = ANALOG INPUT / DIGITAL INPUT
9 = SUPPLY (24 VDC)
10 = DIGITAL OUTPUT (24 VDC PNP)
11 = ANALOG OUTPUT (CURRENT)
12 = ANALOG OUTPUT (VOLTAGE)
13 = Rx RS-232
14 = Tx RS-232
15 = GND

FEATURES

Display features

The proportional regulator has a 3 1/2 digit display and a three-pushbutton touchpad by means of which information on regulator status can be displayed and the functional and operating parameters can be set.

Using the display in "standard" mode

When the regulator is switched on, the display shows the outlet pressure value detected by the internal transducer. This value can be displayed in 3 different measuring units (Bar - PSI - MPa) that can be selected by the user.

If the right-hand key (▲) is pressed during normal operation of the regulator, the desired pressure value appears.

This value is expressed in the unit of measurement that has been set by the user. As the pressure regulator has 5 different modes for managing the reference signal, if during normal operation the left-hand key (◄) is kept pressed the display will show a letter and a number alternately. The letter indicates the reference source that the regulator is using whilst the number indicates the reference value

Display letter	Meaning	Value
	Analog input	Volt/mA
	RS-232	Bar hundredths(e.g. 122)
	Keyboard	Bar (e.g. 1.22)
	Digital input	0 to 7
	Binary input[1]	0 to 255
	Levels set by binary codification	0 to 7

(1) N.B. This option is available only for regulators with voltage analog input (letter T in seventh digit of order code).

Setting desired pressure value from display

If the regulator is configured to use the keyboard of the display as the reference source, press the central key (SET) for 2 seconds to set the desired pressure directly. In particular, the display shows the currently set pressure value, with the last digit on the right flashing (modifiable digit).

Press the right-hand key (▲) to increase the value of the flashing digit and press the left-hand key (◄) to move to the following digit. Repeat the operation for all the characters (the selected character will be recognisable by the flashing). Once the desired value has been set, press key (**SE**T) to save it permanently to the memory.

If the entered value is acceptable (it belongs to the preset use range and is not in conflict with the value of other parameters), the display confirms that the value has been entered by flashing twice (it switches off and lights up again twice to indicate the set value).

If the entered value is not acceptable (outside limits set by manufacturer or in conflict with other parameters) the display shows an error signal.

If the entered value is less than the lower limit the message **ELo** appears and the device proposes the minimum permitted value.

If the entered value is greater than the upper limit the message **EHi** appears and the device proposes the maximum permitted value.

FEATURES

Using the display in "modify parameters" mode

To enter "**modify parameters**" mode, press the left-hand (◄) and right-hand (▲) keys simultaneously for 2 seconds.
If the password is not enabled, the user accesses the first parameter directly. If the password is enabled the message PSv appears on the display followed by the request to enter the value of the password:
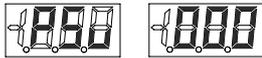
To enter the value of the password, proceed in this manner: press the right-hand key (▲) to increase the value of the flashing digit and then press the left-hand key (◄) to move to the next digit. Repeat the operation for all the characters (the selected character flashes).
N.B.: the fourth character can have only the values 0 and 1. 0 is displayed when the point at the bottom on the left is switched on:

Once the desired value has been set, press the key (SET). If this is correct, you will enter the parameter configuration menu directly. If the password has not been entered correctly the message EEE will appear on the display and it will not be possible to access the parameter configuration menu. The device will thus return to "standard" mode.

Defining parameters

The proportional regulator can be fully customised to meet the needs of the end user.
In particular, the device associates with its operating configuration variable details that can be accessed directly via the display or RS-232 serial port. These are from now on defined as PARAMETERS.
By varying the parameters it is possible to intervene on the following regulator features:
insensitivity
unit of measurement of the pressure displayed on the display
pressure values corresponding to the minimum and maximum value of the analog signal
defining the range of the outlet analog signal
defining the intervention thresholds of the digital output
Choosing the reference source
setting the pressures corresponding to the digital inputs
activating the protection for the solenoid valves
enabling password and corresponding value
speed of convergence on the desired pressure.

Modifying parameters

Once the user has entered the parameters configuration menu (with the previously described procedure), the display is as follows:
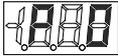
P identifies the parameter selection mode whilst the number displayed on the right indicates the parameter number.

Press the right-hand key (▲) to change the parameter number from (P0) to (P22). Each time the key is pressed the number increases by 1; if the key is kept pressed the parameter number increases automatically.

Once you have identified the parameter that you wish to display or modify, press the key **(SET)** to access it.

After the key **(SET)** has been pressed the display shows the current value of the selected parameter and enables it to be modified. Depending on the type of parameter, 1 or more characters may be displayed. The procedure for modifying the values is the same as for entering the password: it is possible to modify just one character at a time (the flashing character) by pressing the right-hand key (▲). On the other hand, if the left-hand key (◄) is pressed, the active character is changed (for those parameters that have more than one character).

Once the value to be assigned to the parameter has been set, press the key **(SET)** to confirm the selection made.

If the entered value is acceptable (it belongs to the preset use range and is not in conflict with the value of other parameters) the display confirms that the value has been entered by flashing twice (it switches off and switches on again twice to indicate the set value). A parameter that has been modified in this way is said to have been CONFIRMED.

When flashing stops the regulator returns to the parameter selection (it again displays the message "P X", X being the last parameter to have been modified).

If the entered value is not acceptable (outside the limits set by the manufacturer or in conflict with other parameters) the display shows an error message.

If the entered value is less than the lower limit the message **ELo** appears and the device proposes the minimum permitted value.

If the entered value is greater than the upper limit the message **EHi** appears and the device proposes the maximum permitted value.

N.B.: the proposed values are not automatically confirmed. To confirm, press the key **(SET)**.

By proceeding in this way (parameter selection, subsequent modification and confirmation) it is possible to modify the value of all the parameters.

Once all the values have been modified, in order to enable all the modified values to be saved and to return to the standard operating mode, press the right-hand (▲) and left-hand (◄) keys simultaneously for about two seconds.

The regulator confirms the change of operating mode by showing this symbol on the display for about half a second.
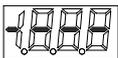
Warning

- Whilst the regulator is in **"modify parameters"** mode outlet pressure is not adjusted, so it cannot be guaranteed that desired pressure corresponds to the outlet pressure.
- Whilst the regulator is in **"modify parameters"** mode RS-232 communication is disabled.
- Press the two keys (◄) (▲) to leave **"modify parameters"** mode:
  all the CONFIRMED parameters are saved to the permanent memory and are thus maintained even after switch-off.
  Analogue and digital output are not updated therefore it is not possible to ensure they are correct;
- In order to leave **"modify parameters"** mode without saving any modified parameter (not even confirmed parameters) wait for two minutes to elapse without pressing any key. Alternatively, switch off the regulator and switch it on again.
- If the regulator is switched off whilst it is in **"modify parameters"** mode no modified parameter is saved to the permanent memory even if it has already been confirmed.

List of parameters

PARAMETER 0   Desired pressure from keyboard

Defines the desired regulator outlet pressure value

Default value	Unit of measurement	Range
0	Bar	From minimum pressure (P3) to maximum pressure (P4)

Warning: This parameter becomes active only if the parameter (P10) is set at 2.
Minimum pressure (P3) and maximum pressure (P4) are the operating range. If these values are subsequently modified and the desired pressure value is outside this new range, the device will set the desired pressure (P0) **automatically** at the nearest permitted value

PARAMETER 1   Insensitivity

Defines the minimum deviation between desired pressure and outlet pressure beyond which the regulator intervenes.

Default value	Unit of measurement	Range
0.03	Bar	From 0.02 to 0.20 with Parameter 22 at 0 - 1 - 2 From 0.01 to 0.20 with Parameter 22 at 3

If the difference between outlet pressure and desired pressure exceeds or falls below the (P1) parameter value the regulator intervenes to increase or decrease the outlet pressure until the set value is reached.

Warning: the smaller the set insensitivity value, the smaller the tolerated deviation will be. In this way, the regulator intervenes much more frequently to control the solenoid valves, generating small variations in outlet pressure.

PARAMETER 2   Display unit of measurement

Defines the unit of measurement that will be used on the display to show outlet pressure and desired pressure during operation in "standard" mode.

Default value	Unit of measurement	Range
0	/	From 0 to 2

Value	Meaning	Displayed value
0	Bar	0.00
1	PSI	000
2	MPa	00.0

Warning: All the other parameters linked to pressure (P0), (P1), (P3), (P4), (P8), (P9), from (P11) to (P17) are measured in bar.

PARAMETER 3   Minimum pressure

Defines the (minimum) outlet pressure value corresponding to the minimum value of the reference signal. The range varies according to the model of transducer used.
Minimum pressure must be at least 1 bar less than maximum pressure

Product code	Default value	Unit of measurement	Range
17#E2N.#D.0009.#	0.00	Bar	From 0.00 to 8.90
17#E2N.#D.0005.#	0.00	Bar	From 0.00 to 4.90
17#E2N.#D.0001.#	0.00	Bar	0.90

PARAMETER 4   Maximum pressure

Defines the (maximum) outlet pressure value corresponding to the maximum value of the reference signal.
The default value and the range vary according to the model of transducer used.
Maximum pressure must be at least 1 bar greater than minimum pressure

Product code	Default value	Unit of measurement	Range
17#E2N.#D.0009.#	9.00	Bar	From 0.10 to 9.00
17#E2N.#D.0005.#	5.00	Bar	From 0.10 to 5.00
17#E2N.#D.0001.#	1.00	Bar	From 0.10 to 1.00

PARAMETER 5   Selecting analog input value

Defines the range of the analogue input signal managed by the proportional regulator (pin 8 of the 15-pole connector

Default value	Unit of measurement	Range
0	/	From 0 to 3

The meaning of the parameter changes according to the model's type of analogue reference. The model can easily be identified by the letter **T** or **C** of the order code, and indicates that the analogue reference is a voltage (**T**) or current (**C**) controlled signal.

Valore	**T** Voltage	**C** Current
0	0-10 V	4-20 mA
1	0-5 V	0-20 mA
2	1-5 V	0-20 mA
3	User set	User set

PARAMETER 6   Voltage analog output

Defines the range of the voltage analogue output (pin 12 of the 15-pole connector). The two limits of the range are the value of the voltage-controlled analogue output corresponding to minimum and maximum outlet pressure. The output will assume all intermediate values in proportion to the outlet pressure.

Default value	Unit of measurement	Range
0	/	From 0 to 3

Value	Meaning
0	0-10 V (9 V at 9 bar)
1	0-5 V (4.5 V at 9 bar)
2	0-10 V (10 V at 9 bar)
3	1-5 V (5 V at 9 bar)

PARAMETER 7   Current analog output

Defines the range of the current analogue output (pin 11 of the 15-pole connector). The two limits of the range are the value of the current-controlled analogue output corresponding to minimum and maximum outlet pressure. The output will assume all intermediate values in proportion to the outlet pressure.

Default value	Unit of measurement	Range
0	/	From 0 to 1

Value	Meaning
0	4-20 mA
1	0-20 mA

PARAMETER 8   Lower threshold for digital output

The digital output provides an indication that the outlet pressure corresponds to the desired pressure. It is activated when outlet pressure falls within a range defined by a lower threshold and an upper threshold, both of which can be modified by the user.
The digital output is active if the outlet pressure is greater than the desired pressure less the lower threshold and is less than the desired pressure plus the upper threshold.
Example: Desired pressure: 3 bar, lower threshold: 0.5 bar, upper threshold: 0.8 bar
The digital output is active if the outlet pressure is between 2.5 bar (3 - 0.5) and 3.8 bar. (3 + 0.8) (pin 10 of the 15-pole connector)

Default value	Unit of measurement	Range
0.50	Bar	From 0.10 to 1.00

PARAMETER 9   Upper threshold for digital output

See description of parameter (P8) (pin 10 of the 15-pole connector)

Default value	Unit of measurement	Range
0.50	Bar	From 0.10 to 1.00

PARAMETER 10   Reference source

Defines the reference source that the regulator has to use to set outlet pressure. Option 4 is available only for voltage-controlled regulators (letter T in seventh digit of order code).

Default value	Unit of measurement	Range
0	/	From 0 to 5

Value	Meaning
0	Analogue input
1	RS-232
2	Keyboard
3	Digital-level inputs
4	Binary-code inputs
5	Digital-level inputs with Binary code

0   The regulator sets outlet pressure using the analogue signal (voltage or current) coming from the 15-pole supply connector   at pin 8.

1   The regulator sets outlet pressure using the command coming from the serial port RS-232

2   The regulator sets outlet pressure directly from the keyboard. The parameter (P0) is used to set pressure.

3   The regulator sets outlet pressure via the digital inputs (pin from 1 to 7 of the 15-pole connector). Each of the 7   inputs   is matched by a parameter (e.g. Input 1 Parameter P11 - Input 2 Parameter P12 etc.). By default, all the parameters from P11 to P17 are set at 0, if input 3 is activated (+24 VDC) and parameter P13 is 0, outlet pressure will be set   at 0. If 2 or more inputs are simultaneously active, the outlet pressure will correspond to that of the input with a lower number.

E.g. If input 2 and input 5 are active, outlet pressure will be that set by parameter P12

4   The regulator sets outlet pressure via the binary code from 0 to 255 consisting of the logic status of the digital   inputs   (pin from 1 to 8 of the 15-pole connector) Pin 8 of the connector thus has a dual function: it can be used as an analogue input (e.g. 0-10V) or as a digital input (most significant digit of the binary code).

Warning: this option is available for regulators with voltage analogue inputs (letter "**T**" in seventh digit of order code).
- Verify and ensure that to pin n.8 has been connected only the analogue signal or the digital signal

5   Value 5 has been added as an alternative to value 3. When value 3 is selected up to 7 command signals are needed, which correspond to the 7 parameters (P11 - P17). When value 5 is selected only 3 electric signals are needed, because there is correspondence between Parameters P11 - P17 and the binary coding consisting of the logic state of the signals. The regulator sets outlet pressure via the binary coding from 0 to 7 consisting of the logic state of the first digital inputs (pin from 1 to 3 of the 15 pole connector). Combination 0 corresponds to 10 bar pressure.

Pin n. 1	Pin n. 2	Pin n. 3	Desidered pressure
0	0	0	0 bar
1	0	0	Parameter P11
0	1	0	Parameter P12
1	1	0	Parameter P13
0	0	1	Parameter P14
1	0	1	Parameter P15
0	1	1	Parameter P16
1	1	1	Parameter P17

Method for calculating status of inputs

This formula is used to calculate the binary number to be coded with the logic status of the inputs:

$$255 \times \left(\frac{\text{Desired pressure - Minimum pressure}}{\text{Maximum pressure - Minimum pressure}} \right)$$

E.g.: maximum pressure= 5.25 bar; minimum pressure= 3.46 bar; desired pressure= 4.12 bar
Decimal number = 255 x (4.12 - 3.46) / (5.25 - 3.46) = 94
The decimal number then has to be converted into a binary number: 94(decimal) = 01011110(binary)
The status of the 8 inputs must thus be as follows:

Input number	8	7	6	5	4	3	2	1
Logic status	0	1	0	1	1	1	1	0
Decimal equivalent	128	64	32	16	8	4	2	1

In this case the user thus has to raise inputs 2,3,4,5, 7 and has to lower inputs 1,6 and 8

PARAMETER 11 to 17

Define the regulator outlet pressure desired when the corresponding input is active (pin from 1 to 7 of the 15-pole connector)

Default value	Unit of measurement	Range
0.00	Bar	From minimum pressure (P3) to maximum pressure (P4)
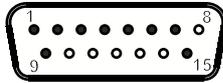
CONNECTOR PIN:
1 = INPUT 1
2 = INPUT 2
3 = INPUT 3
4 = INPUT 4
5 = INPUT 5
6 = INPUT 6
7 = INPUT 7

Input	Parameter
1	11
2	12
3	13
4	14
5	15
6	16
7	17

Warning: These parameters become active only if the parameter (P10) is set at 3 (reference source via digital-level inputs).

Minimum pressure (P3) and maximum pressure (P4) are the operating range. If this range is subsequently modified and some pressure values assigned to a level are outside this new range the device will **automatically** set the pressure at the nearest permitted value.

PARAMETER 18   Protection mode

If during operation in "standard" mode the desired pressure cannot be reached (for example, there is no compressed-air supply or it is insufficient) or the discharge conduit is blocked or closed, the regulator continues to work on the solenoid valves to try to reach the desired pressure. This parameter allows the automatic switch-off of the control solenoid valves for up to 20 seconds to be enabled.

This function is used to safeguard the solenoid valves over time.

The protection is triggered if the desired pressure is not reached and the outlet pressure does not undergo significant variations within a 4-second control of the solenoid valves.

A significant variation is defined as a variation that is greater than the defined insensitivity value, parameter P1. After the 4 seconds have elapsed in which the regulator attempts to reach the desired pressure, the protection is triggered. This protection switches off the solenoid valves for a maximum of 20 seconds.

If the 20 seconds have elapsed or if during the 20 seconds during which the solenoid valves are switched off the required pressure (reference) varies or the outlet pressure varies the regulator will again start to control the solenoid valves for another 4 seconds, trying to reach the desired pressure.

If this does not occur, the protection is reactivated.

From this point on 4 seconds of controlling the solenoid valves and 20 seconds of switch-off alternate cyclically.

When the protection is activated, the message **P18** appears on the display alternating with the messages **EHi** or **ELo** indicating that the regulator is not reaching the desired pressure due to filling (**ELo** lack of air) or pressure discharge difficulties (**EHi** discharge conduit blocked).

Default value	Unit of measurement	Range
0	/	From 0 to 1

Value	Meaning
0	Deactivated
1	Activated

PARAMETER 19   Enabling password request

Set this parameter at 1 to enable the password request: this will be requested whenever an attempt is made to access "modify parameters" mode.

Default value	Unit of measurement	Range
0	/	From 0 to 1

Value	Meaning
0	Password deactivated
1	Password activated

By setting this parameter to 1 the protective password will be switched on, the password will be requested every time that the user will try to access the "**SET UP**" menue.

Attention: before enabling the password verify and , if necessary, modify parameter P20

PARAMETER 20   Password value

This parameter is the password. If the password request (parameter P19) is enabled, this value must be entered whenever an attempt is made to access "modify parameters" mode.

N.B.: the fourth character can have only the values 0 and 1.

0 is displayed when the point at the bottom on the left is switched on:

Default value	Unit of measurement	Range
000	/	From 000 to 1999

PARAMETER 21   Default value

Restores all user configuration parameters to default values.

In order to activate the command that restores parameters to values set by manufacturer, enter the value "333" on the display and confirm the entry.

Warning: all changes made previously will be lost (except for parameters P19 and P20)

PARAMETER 22   Intervention mode

Defines the mode for converging on the desired pressure that the regulator should use

Default value	Unit of measurement	Range
0	/	From 0 to 4

Value	Meaning
0	Standard mode
1	Efficient mode
2	Accurate mode
3	Sensitive mode
4	Fast mode*

*Fast mode was specifically designed for size 0 regulators, in order to have the maximum speed in filling the circuit.
We suggest to use this mode only with size 0 regulators.

Every intervention mode characterises in a particular way the proportional regulator behaviour.

In particular:
- Standard mode is trade-off between speed and accuracy.

- Efficient mode controls solenoid valves to allow a bigger change of outlet pressure. This grants
A lower time to fill / empty a volume. It is a specially suitable if there is a big volume to manage or if
The inlet airflow is low. As a result of the high fill/empty speed the desired pressure can
occasionally be exceeded for a short time.
- Accurate mode controls solenoid valves to manage outlet pressure more softly. It is particularly
Suitable if there is a little volume to manage or if the inlet airflow is high. This mode is slower than others.

- Sensitive mode tracks the desired pressure with more frequent changes. It is particularly suitable if a constant outlet pressure is required when the downstream pressure varies due to the application (e.g. working with an inconsistent flow rerquirement).

N.B. Each mode may be better suited to an application than the others. The parameters to consider are: Inlet airflow, the volume to be managed, speed and accuracy. We suggest testing each mode on an application to establish which is the most suitable.

PARAMETER 23   Reference value of minimum pressure

Defines the analogue signal corresponding to minimum pressure.
Attention: Used only when Parameter 5 is set at 3

Default value	Unit of measurement	Range
0 0	V mA	From 0 to 9 for voltage control From 0 to 19.9 for current control

PARAMETER 24   Reference value of maximum pressure

Defines the value of the analogue signal corresponding to maximum pressure.
Attention: Used only when Parameters 5 is set at 3

Default value	Unit of measurement	Range
9 0.9	V mA	From 1 to 10 for voltage control From 0.1 to 20 for current control

PARAMETER 25   Linear progression time

Inserts a linear progression during the transition between two outlet pressures when the digital inputs state changes. This value represents the time occurred to make this change.

Attention: Used only with Parameter 10 set at 3 or at 5
Attention: To activate this time it's needed to activate digital input 8.

Default value	Unit of measurement	Range
1	100ms	From 1 to 100 (From 0.1 to 10 seconds)

AUTOMATIC RESOLUTION OF POSSIBLE CONFLICTS BETWEEN SET PARAMETERS

The regulator does not permit desired pressures - parameters (P0), (P11), (P12), (P13), (P14), (P15), (P16), (P17) and the desired serial pressure to be set outside the operating range (pressure range) defined by the parameters (P3) and (P4).

Warning: make sure that the parameters (P3) and (P4) have been entered correctly as the regulator will **automatically** modify any desired pressure that is outside the operating range. The value assigned will correspond to the nearest permitted value

RS-232 serial communication

General description

All models of the proportional regulator feature the RS-232 serial port that enables a direct connection between the regulator and a computer or a PLC (provided with a serial port) to be established.
The regulator has a set of commands that enable all the previously described parameters to be read and modified (except for parameters P0, P19, P20 and P21).
In addition to this, serial communication can be used to send a reset command to the regulator, read and set the desired pressure and read the outlet pressure

Warning: to use the serial port as a reference, set parameter P10 at 1

When the proportional regulator is in "standard" mode it is in receiving status: it does not send any message independently because it is waiting for a command to arrive. As soon as the regulator receives a message on the RS-232 port this message is decoded, the required command is run and a reply is sent.

Warning: "modify parameters" mode disables the RS-232 communication

How to set the serial port
The following set of communication parameters must be used for the RS-232 transmission:

Baud Rate:	4,8 Kb
Parity:	none
Data bit :	8
Stop bit :	1

Communication protocol

The communication protocol Pneumax uses only hexadecimal notation.
N.B.: all the numbers used in this section are hexadecimally coded.
In order to indicate that this notation is being used the suffix *(h)* will be added to all the numbers.

In order to interact with the proportional regulator, commands defined by the parent company must be sent.
The command has this structure:

LE OC PP D1 D2

Key:
LE (always sent) = length of message: number of bytes sent, including LE
OC (always sent)= operating code: defines the operation that the regulator has to perform
PP (not always sent)= parameter: defines which parameter is read or written
D1-D2 (not always sent)= Data : define the value of the parameter

N.B.: the regulator always sends a reply to each command.
The structure of the reply is the same as the command, with the sole difference that the proportional regulator adds 80*(h)* to the corresponding operating code to indicate that the command has been understood**.**

Operating codes

The following table indicates the managed operating codes

Operating code	Operation
01*(h)*	Reset
0D*(h)*	Reading a parameter
61*(h)*	Writing a parameter
21*(h)*	Writing the desired pressure (hundredths of a bar)
22*(h)*	Setting the desired pressure (hundredths of bar)
2F*(h)*	Reading desired pressure (hundredths of a bar)
3F*(h)*	Reading outlet pressure value (hundredths of a bar)
4F*(h)*	Desired pressure and reference source reading

Commands list

After declaring all the operating codes, in order to create a command it is sufficient to structure the sent packet according to the rules defined previously (just include the length of the packet, choose the action to perform on a particular parameter and choose the parameter).

There follows the complete list of the messages managed by the regulator with the corresponding replies. Note that, as mentioned previously, the operating code of the reply is the same as that of the command with the addition of 80*(h)*

Operation	From PLC to regulator	Reply of regulator
Reset	02*(h)* 01*(h)*	02*(h)* 81*(h)*
Reading parameter	03*(h)* 0D*(h)* PP*(h)*	05*(h)* 8D*(h)* PP*(h)* NN*(h)* NN*(h)*
Writing parameter	05*(h)* 61*(h)* PP*(h)* NN*(h)* NN*(h)*	05*(h)* E1*(h)* PP*(h)* NN*(h)* NN*(h)*
Writing desired pressure	04*(h)* 21*(h)* NN*(h)* NN*(h)*	04*(h)* A1*(h)* NN*(h)* NN*(h)*
Setting desired pressure	04*(h)* 22*(h)* DD*(h)* DD*(h)*	04*(h)* A2*(h)* DD*(h)* DD*(h)*
Reading desired pressure	02*(h)* 2F*(h)*	04*(h)* AF*(h)* NN*(h)* NN*(h)*
Reading outlet pressure	02*(h)* 3F*(h)*	04*(h)* BF*(h)* NN*(h)* NN*(h)*
Desired pressure and reference source reading	02*(h)* 4F*(h)*	05*(h)* CF*(h)* RR*(h)* VV*(h)* VV*(h)*

Key:
PP = parameter number - from 0(h) to 16(h)
NN NN = parameter contents
RR = reference source (Parameter P10)
DD DD = desired pressure
VV VV = reference value

When the regulator receives a correct writing command the contents of the NN NN parameter is saved automatically to the permanent memory (EEPROM).

Warning: the manufacturer of the microcontroller declares that in extremely critical operating conditions the number of writings guaranteed in EEPROM for the technical features of your product is equal to 100.000. When constant changes in pressure are required, it is possible to use command 22(h), which sets the desired pressure but does not write it in the EEPROM.

The parameters are the same as those defined in the previous pages, see the section "List of Parameters" for explanations of their contents, default values, ranges etc..

N.B.: the Reset command (operating code 01) is the equivalent of the regulator hardware switching off.

Warning: the reading and writing value of the pressure is always expressed in hundredths of a bar (in hexadecimal notation).

Example 1: Writing desired pressure
Regulator outlet pressure of 4.25 bar is desired. The command to be sent to the regulator must be:
4,25 bar = 425 hundredths of a bar = 01A9*(h)*

Command = 04*(h)* 21*(h)* 01*(h)* A9*(h)*
Reply = 04*(h)* A1*(h)* (21*(h)* + 80*(h)*) 01*(h)* A9*(h)*

Example 2: Writing desired pressure
Let it be assumed, for example, that outlet pressure from the regulator is 6.35 bar.
The command for reading its value must be:
Command = 02*(h)* 3F*(h)*
Reply = 04*(h)* BF*(h)* (3F*(h)* + 80*(h)*) 02*(h)* 7B*(h)*

027B*(h)* = 635 hundredths of a bar = 6,35 bar

Warning: Minimum pressure (P3) and maximum pressure (P4) are the operating range. If these values are subsequently modified and the desired pressure value is outside this new range, the device will set the desired pressure **automatically** at the nearest permitted value.

Error messages

If the regulator receives a command that it recognises and which does not contain errors it responds with a message in which the operating code is increased by 80(h).
If, on the other hand, the regulator receives a command that it does not recognise or which contains errors, it responds with a message in this form:

                              03 94 EC
Key:

            03 = Length of message
            94 = Operating code of error message.
            EC = Error message code

Error code (EC)	Description
01	Regulator in "modify parameters" mode: command ignored
02	Operating code unknown
03	Value outside range
04	Limit value in conflict with reference
05	Maximum pressure and minimum pressure in conflict
07	Parameter inexistent

N.B.: controls for entering parameters from keyboard are also implemented for serial communication; if, for example, an attempt is made to write a minimum pressure value that is greater than the maximum pressure value, a message will be received in response containing the relative error code (05).

ORDER CODES

Code structure

17_E2N. _ . D . ____ . _

VARIANT :

    = Standard version

E   = External pressure feedback

A   = Exhaust downstream pressure
      when power supply is removed

PRESSURE RANGE :

0001= Range 0 - 1 bar

0005= Range 0 - 5 bar

0009= Range 0 - 9 bar

MANAGEMENT :

C= Current signal (4-20 mA / 0-20 mA)

T= Voltage signal (0-10 V / 0-5 V / 1-5 V)

SIZE :

0= Size 0

1= Size 1

3= Size 3

Electric connectors order code

5300.F15. _ . _

VARIANTS :

00= Only connector + casing IP65

03= Connector + cable, 3 metres

05= Connector + cable, 5 metres

VERSION :

00= straight

90= output 90°

Order code: fixing bracket

170M5

PNEUMAX S.p.A.

LURANO (BG) - ITALY

Certified
Quality System

SQS

ISO 9001:2008
ISO 14001:2004
OHSAS 18001:2007
Reg. No. 10677