ELECTRONIC PROPORTIONAL REGULATORS
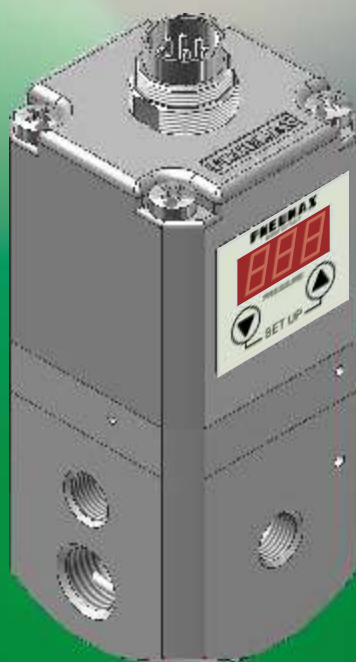
TECHNICAL NEWS NT2002/002

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GENERAL

Description

Modern industrial applications require high performance pneumatic components. Taking cylinders and rotary actuators as our example, it is necessary to be able to control the parameters that determine their speed, thrust and torque.
If these parameters need to be changed dynamically while the machine is running, traditional solutions based on pneumatic solenoid valves with different inlet pressures, require space and complicated circuits.
An alternative solution is a regulator that can dynamically alter the value of the pressure or flow rate (electro-pneumatic regulator).

We have developed a new line of electro-pneumatic regulators (E/P regulators) that will be included in Catalogue 3 to complete our range of Air Service Units.
Three sizes will be available, with flow rates from 1,000 Nl/min up to 4,000 Nl/min.
Electronic features offer the ability to alter the set pressure varying the voltage (0-10 Volt) or current signals (4-20 mA) and optional accessories include: LED display, analog output of the pressure value (voltage or current), and RS232 serial port.

In this brochure we will specifically discuss the Size 1 E/P regulator.

Application fields

Typical uses will involve the necessity to dynamically control the force of an actuator, be it thrust or torque.
Examples include :
Closing systems, paint plant systems, tensioning systems, packaging devices, braking systems with pneumatic control, welding clamps, thickness compensating systems, balancing systems, laser cutting device, etc.

PRODUCT INTRODUCTION

Range

The aesthetic style of these regulators is generally consistent for all available options.
On one face we have put the supply and exhaust ports, and on the opposite face we have the outlet port.
The adjacent faces have plugged G1/8 gauge ports that are connected to the outlet port, these can be used as an alternative outlet.
On the top there is an 8 pin circular connector for the electrical supply.

The only noticeable difference is the presence, or lack, of the LED display.
When the display is not installed, a label with the schematic symbol is used instead.

Basic version
(without display)

Version with display

PRODUCT INTRODUCTION

Identification

There are many versions available, defined by the ordering code.

The first choice is for the input signal:
Voltage signal (0-10V)
Current signal (4-20 mA)

The second choice governs the following options :
Display card
Analogue output card (voltage signal 0-10 V)
Display card + analogue output card (voltage signal 0-10 V)
Analog output card (current signal 4-20 mA)
Display card + Analogue output card (current signal 4-20 mA)
Digital output card
Display card + digital output card
RS232 card
Display card + RS232 card

CHARACTERISTICS

Functional Details

The E/P regulator is based on a mechanical base including a double balanced poppet valve. One valve (supply poppet) closes the orifice that connects inlet and outlet ports while the second one (exhaust poppet) closes the orifice that connects the outlet port to the exhaust.
These poppets are connected to the diaphragm by a rod.
On the top of the diaphragm there is a pilot chamber, which is pressurised by two, 2/2 solenoid valves controlled in PWM (Pulse Width Modulation). This technique enables variation in solenoid valve flow through changes in the frequency of commutation.
One solenoid valve is used to provide pressure to (fill valve), and the second is used to exhaust pressure (vent valve) from the pilot chamber.

PRESSURE

OUTLET PRESSURE
VARIATION

VOLTAGE

MODULATION
FREQUENCE
VARIATION

TIME
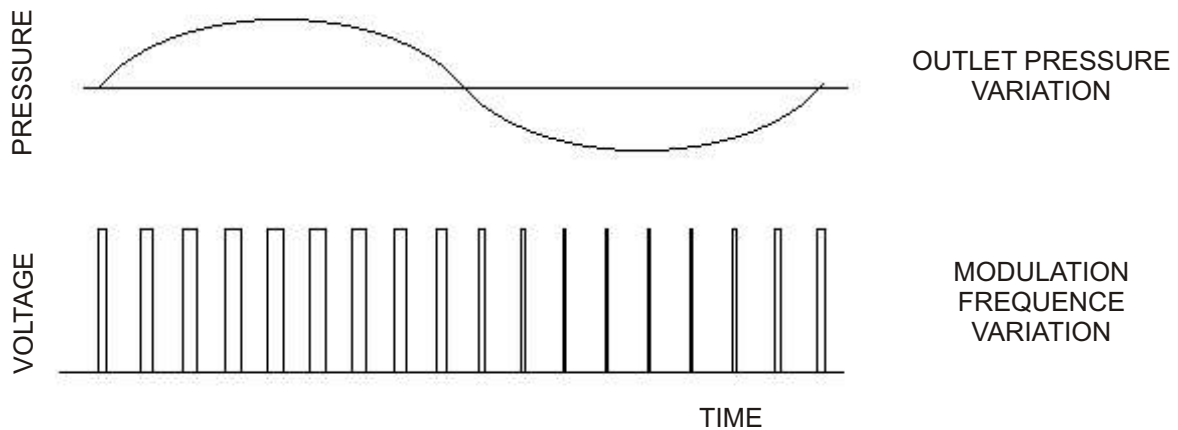
The electronics comprise an 8 bit microprocessor and pressure transducer.
The incoming reference signal is analyzed by the microprocessor, which drives the solenoid valves with PWM. Simultaneously, the pressure sensor sends the analog signal of the pressure value into the downstream circuit. This is then compared with the reference signal, and when the required value is reached the solenoid valves will be de-energized.

If the equilibrium between the two signals is altered, for instance when the set pressure is altered or if the reference signal changes in value, within a few milliseconds the microprocessor drives the solenoid valves once more, trying to recreate the balance condition.
If the reference signal decreases, the microprocessor opens the vent valve to reduce the pressure in the pilot chamber; the diaphragm then moves up opening the exhaust poppet until the pressure on the downstream port equates to the reference value.
If the reference signal increases, the microprocessor open the fill valve to increase the pressure in the pilot chamber, the diaphragm then moves down opening the supply poppet valve until the pressure on the downstream port equates to the reference value.
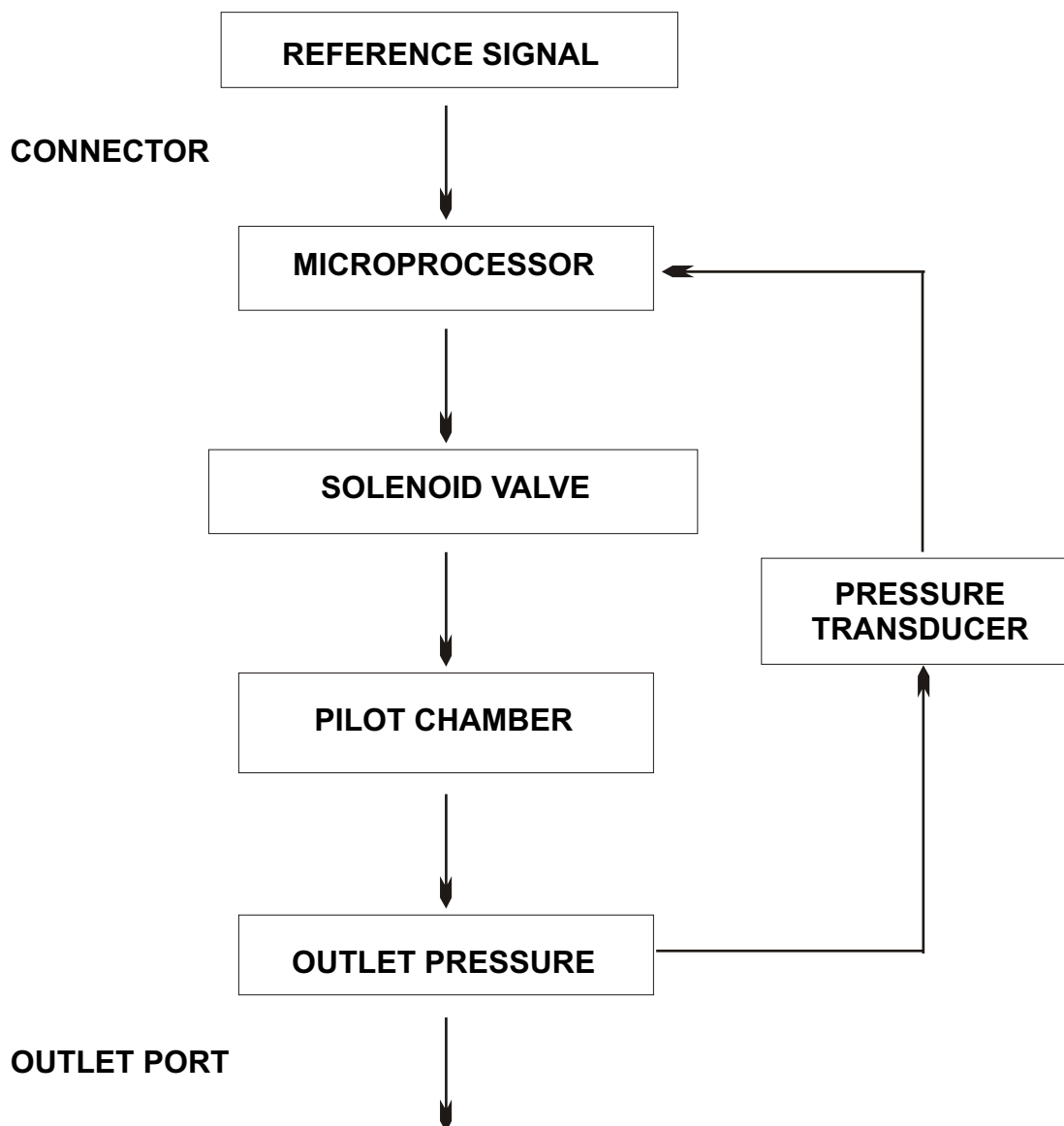
CHARACTERISTICS

Functional scheme

ELECTRONIC CIRCUIT

DISPLAY

VENT SOLENOID VALVE

FILL SOLENOID VALVE

PILOT CHAMBER
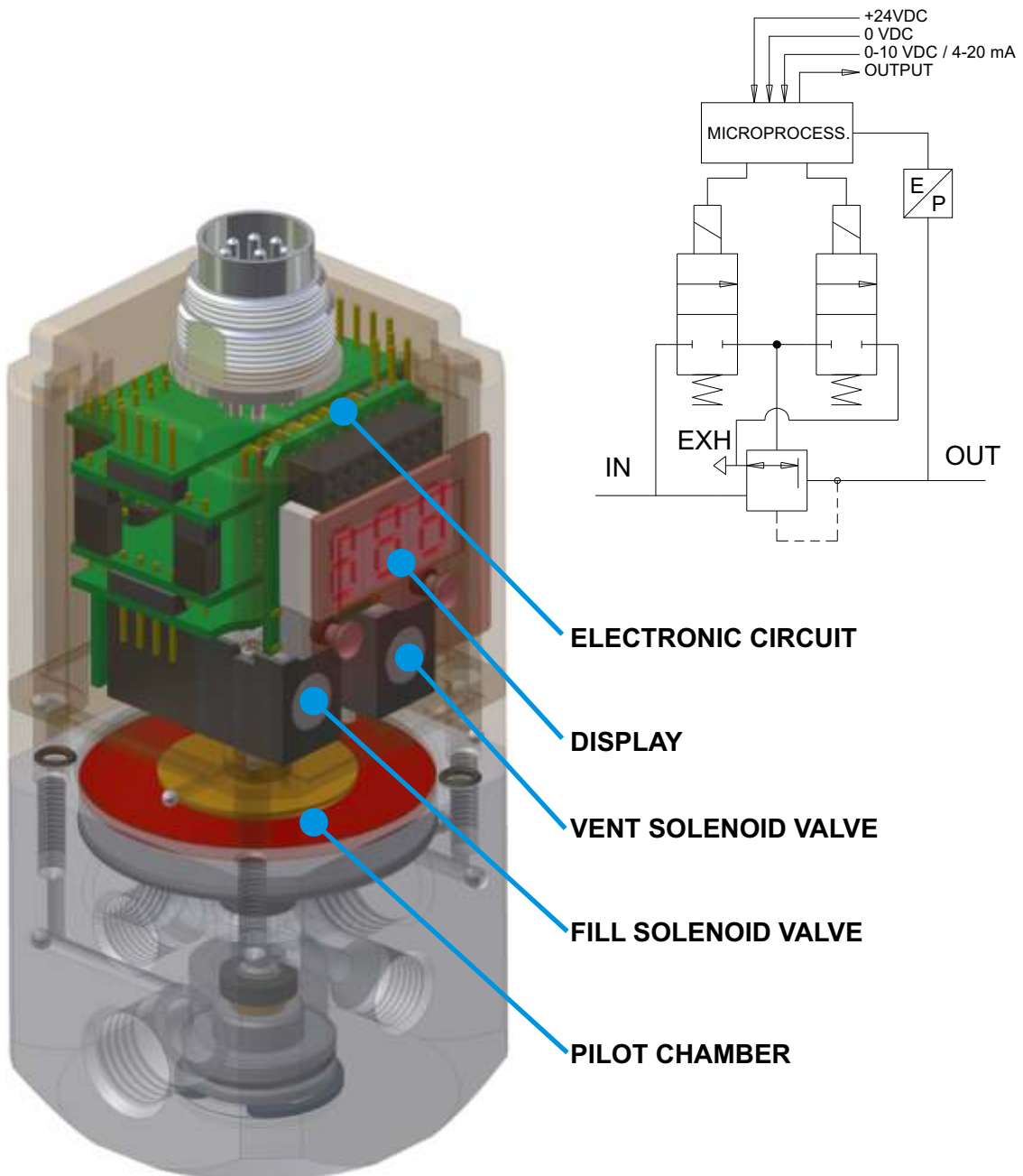
CHARACTERISTICS

CLOSED LOOP scheme (internal command circuit)

E/P regulator is based on a CLOSED LOOP system, so called because the pressure transducer sends an analog signal to the microprocessor, which compares that value with the reference signal applied at the connector and makes decisions based on that analysis.

```
                    ┌─────────────────────┐
                    │   REFERENCE SIGNAL  │
                    └─────────────────────┘
                               │
  CONNECTOR                    ▼
                    ┌─────────────────────┐
                    │    MICROPROCESSOR   │◄─────────────┐
                    └─────────────────────┘              │
                               │                         │
                               ▼                         │
                    ┌─────────────────────┐              │
                    │    SOLENOID VALVE   │       ┌──────────────┐
                    └─────────────────────┘       │   PRESSURE   │
                               │                  │  TRANSDUCER  │
                               ▼                  └──────────────┘
                    ┌─────────────────────┐              ▲
                    │    PILOT CHAMBER    │              │
                    └─────────────────────┘              │
                               │                         │
                               ▼                         │
                    ┌─────────────────────┐              │
                    │   OUTLET PRESSURE   │──────────────┘
                    └─────────────────────┘
                               │
  OUTLET PORT                  ▼
```
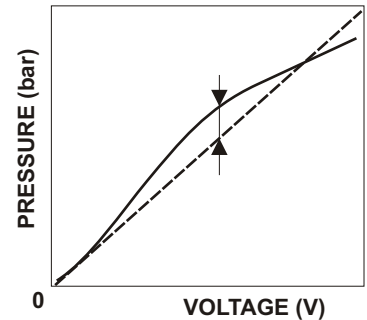
CHARACTERISTICS

Definitions

Linearity

Percentage value with reference to the full span that defines the maximum difference between the ideal and true curve
Example:
If the regulator has linearity of less than or equal to ±1% and the working range is 10 bar, the maximum error will be ±0,1 bar.
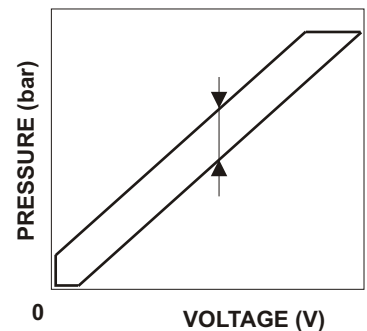
Hysteresis

Percentage value with reference to the full span, that defines the maximum error on the outlet pressure given the same reference signal. This error is caused by friction between the mechanical parts of the regulator.
Example:
If the regulator has a repeatability of less than or equal to ±0,5% and the working range is 10 bar, the maximum error is ±0,05 bar.

Repeatability

Percentage value with reference to the full span that defines the maximum error, on a pre-set value, detected during consecutive tests in the same working conditions (this error is usually generated by the hysteresis of the internal components)
Example:
If the regulator has a repeatability of less than or equal to ±0,5% and the working range is 10 bar, the maximum error on the pre-set value is ±0,05 bar.
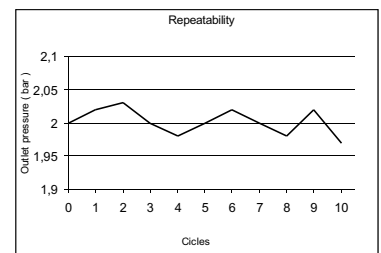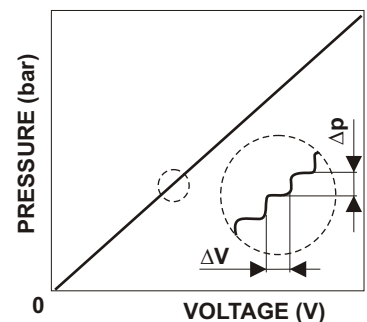
Sensitivity

Percentage value with reference to the full span, that defines the maximum error on the outlet pressure given the same reference signal. This error is caused by friction between the mechanical parts of the regulator.
Example:
If the regulator has a repeatability of less than or equal to ±0,5% and the working range is 10 bar, the maximum error is ±0,05 bar.

CHARACTERISTICS

Functional

| Fluid		20µ filtered dry air
Minimum inlet pressure		Set press.+(1 bar / 0,1 Mpa / 14,5 psi)
Maximum inlet pressure		10 bar / 1 Mpa / 145 psi
Ambient Temperature		-5° ÷ +50°C / 23° ÷ 122°F
Outlet pressure		0,2÷9 bar / 0,02÷0,9 Mpa / 3÷130 psi
Nominal Flow rate from port 1 a 2 (at 6 bar ∆p 1 bar)		1.100 Nl/min.
Flow rate from port 2 to 3 (at 6 bar with overpressure of 1 bar)		1.300 Nl/min.
Air consumption		< 1 Nl/min.
Inlet port thread		G 1/4"
Outlet port thread		G 1/4"
Exhaust port thread		G 1/8"
Max. fitting torque force		15 Nm
Weight		360 g.
Mounting position		Any
Power supply		24 VDC ±10%
Current consumption		< 0,12 A
Input signal	Voltage	0-10 VDC
	Current	4-20 mA
Input impedance	Voltage	10 k Ω
	Current	250 Ω
Output signal (analog)	Voltage	0-10 VDC
	Current	4-20 mA
Output signal (digital)		PNP output (max 10 mA)
Linearity		$\leq \pm 1\%$
Hysteresis		$\leq \pm 1\%$
Repeatability		$\leq \pm 1\%$
Sensibility		$\leq \pm 1\%$
Output pressure display	Accuracy	$\leq \pm 3\%$
	Minimum unit	0,1 bar / 0,01 Mpa / 1 psi
Electrical connection		8 pin DIN 45326 connector
Enclosure		IP 65

Materials

Body	Anodized Aluminium
Poppet valves	Brass with vulcanized NBR rubber
Diaphragm	NBR
Seals	NBR
Cover	Technopolymer
Spring	AISI 302

CHARACTERISTICS

Dimensions

109

96

20

G 1/4"
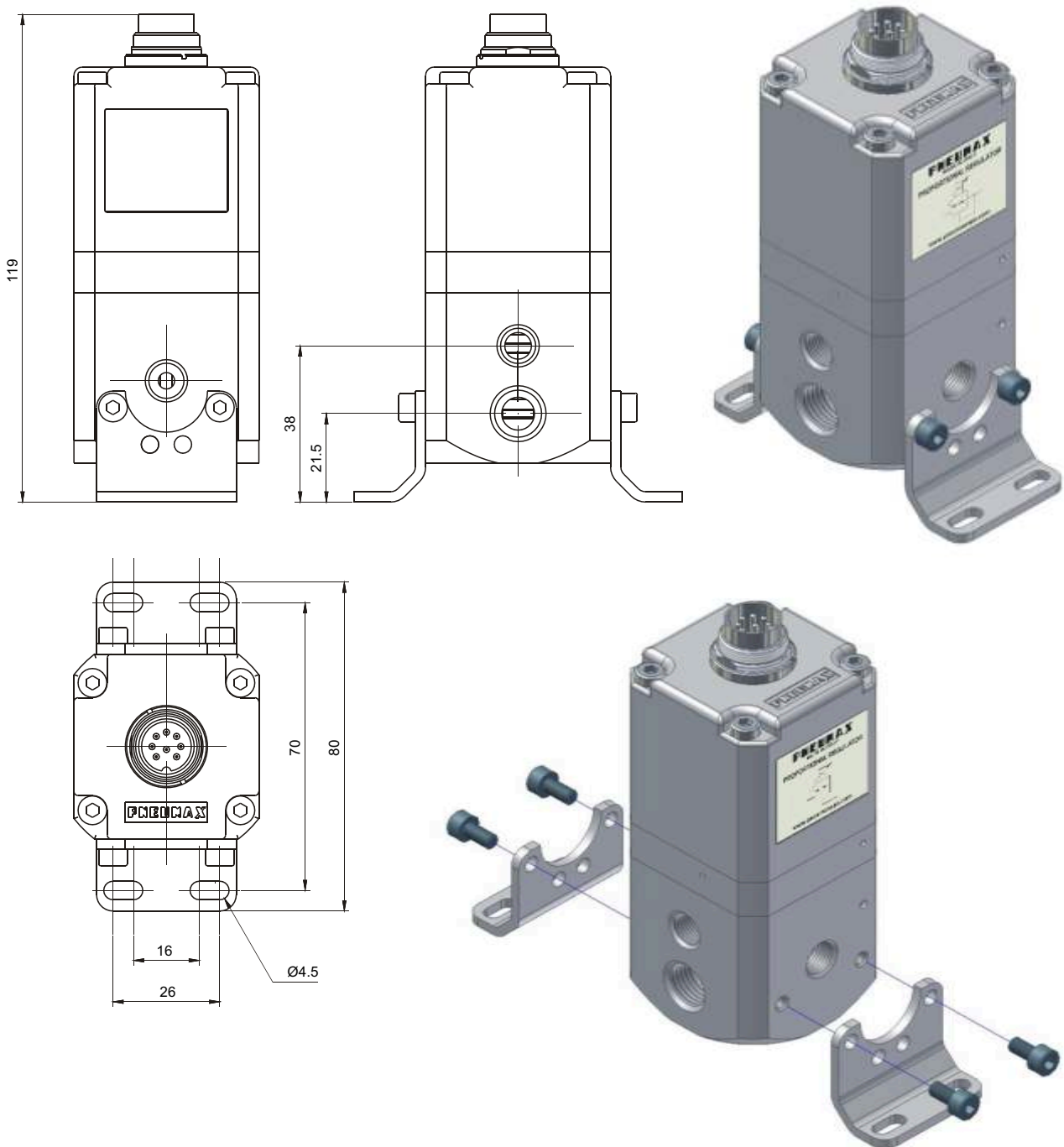
26

13.5

M4x8 (4 hole)

28.5

12

G 1/8"

G 1/4"

45

45
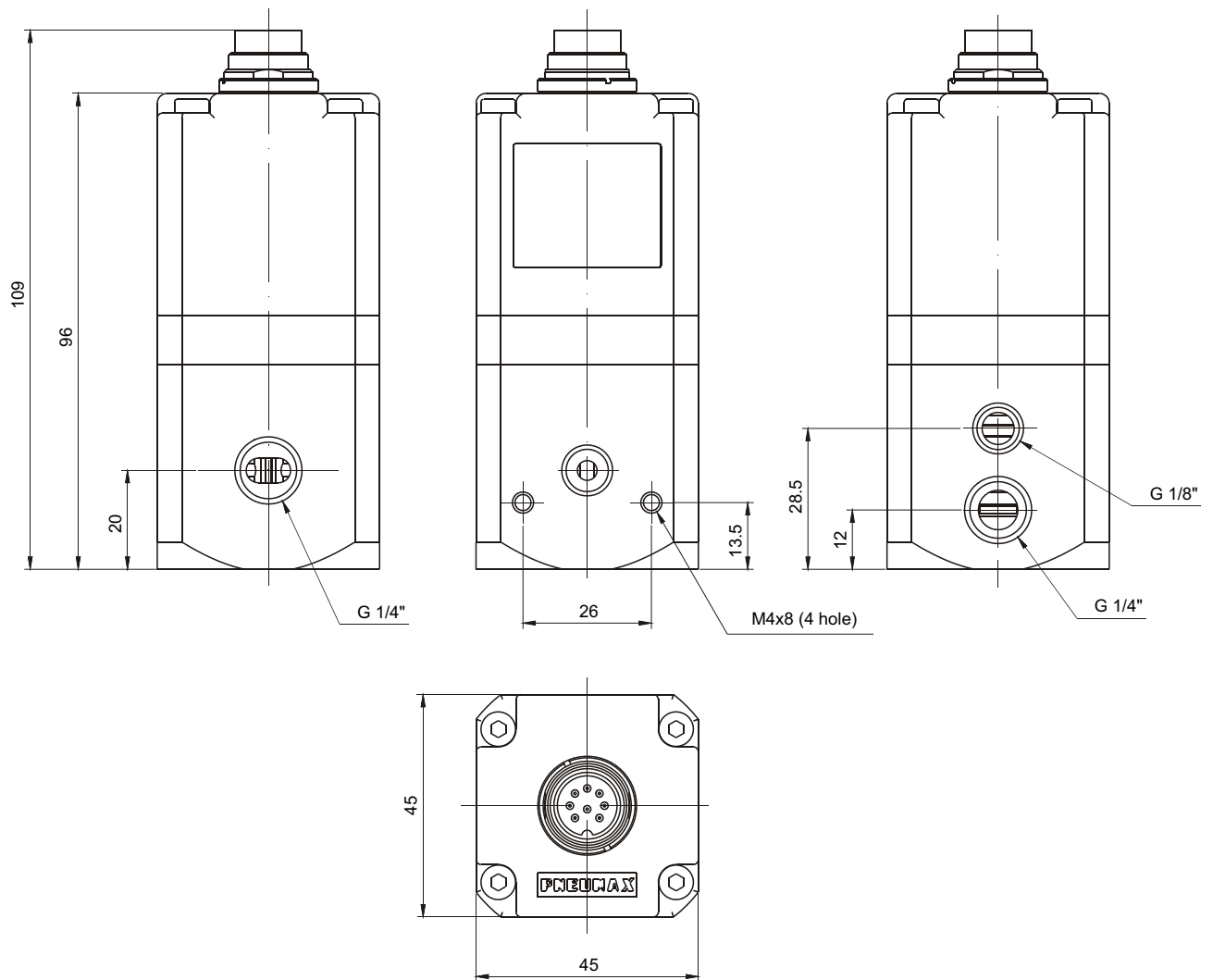
CHARACTERISTICS

Mounting options

The E/P regulator can be mounted using the M4 fixing hole in the body or, alternatively, with the fixing bracket (part number 170M5) as shown below.

CHARACTERISTICS

Installation / Functionality

PNEUMATIC CONNECTION

Pneumatic connection is made by the G1/4" threaded ports in the body.
Remove all residual dirt present in the pipes before connecting them to the regulator to avoid contamination of the regulator.
We recommend that the air supply does not exceed 10 bar, is dried and filtered to a minimum of 20 microns (excessive presence of water can cause malfunction of the regulator).
The inlet pressure should always be at least 1 bar higher than the outlet pressure.
When using a silencer on the exhaust port, it is possible that the response time of the device can deteriorate; periodically examine the silencer to ensure fouling doesn't reduce the flow rate, eventually replace with a new one.

ELECTRICAL CONNECTION

Electrical connection is made by an 8 pin female circular connector to DIN 45326 (SUPPLIED SEPERATELY)
Wire the electrical connection following the schematic below.
(INCORRECT WIRING CAN CAUSE DAMAGE)

FUNCTIONALITY NOTES

If the power supply is interrupted while the inlet pressure is still applied, downstream pressure will be maintained. However, the output pressure is held only temporarily and is not guaranteed. To exhaust the downstream circuit, remove the power supply only after the inlet pressure is turned off (using a 3/2 valve before the unit).
If supply pressure is interrupted and power supply is still on the internal solenoid valve will continue to operate and a humming noise may be generated.
On the display version, it is possible to specify a parameter that de-energizes the solenoid valve if the downstream pressure doesn't reaches the reference value within five seconds. In this case the microprocessor will start a restore procedure every twenty seconds in an attempt to create standard working conditions.

TOP VIEW OF THE CONNECTOR
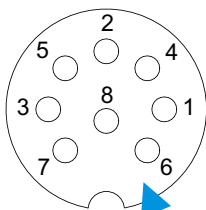
PIN CONNECTOR:
1= GND
2= SUPPLY (+24 VDC)
3= INPUT SIGNAL (0-10 V / 4-20 mA) [NOTE 1]
4= OUT +10 VDC
5= GND
6= OUTPUT SIGNAL (0-10 V / 4-20 mA) / DIGITAL / TX RS232 [NOTE 2]
7= RX RS232 [NOTE 3]
8= GND (FOR Rs232)

NOTE 1 :
SELECTED DURING THE ORDER

NOTE 2 :
IF THE RELEVANT CARD IS PRESENT (PRESENCE OF ONE CARD EXCLUDES THE OTHERS)

NOTE 3 :
IF RS232 CARD IS PRESENT

CHARACTERISTICS

Display configuration menu
When using an E/P regulator complete with display, it is possible to access the operational parameters of the device as well as seeing the pressure value, by using the two push buttons on the front.

The following paragraphs detail the information available and all the relevant settings.

During the standard operation, pressing the left button will display the reference value (value in pressure).

How to enter and exit the configuration menu

To enter
To enter **SET-UP** mode it is necessary to keep both buttons pressed while applying a power supply. When the configuration menu is active a letter will be displayed on the left identifying the parameter, and a number will be displayed on the right that identifies the parameter value (see picture below).
Every time the left button is pushed the parameter on the left will change, and every time the right button is pushed the value on the right will change.

To exit
To exit from **SET-UP** mode it is necessary to hold the left button and then push the right button.
On exiting the configuration menu, all data will be stored permanently in the memory of the regulator. The display will again show the pressure value of the downstream circuit.

NOTE
All the parameters are stored permanently, to modify them it is necessary to repeat the procedure described above or through the RS232 serial port (if the option card is included).

BUTTONS
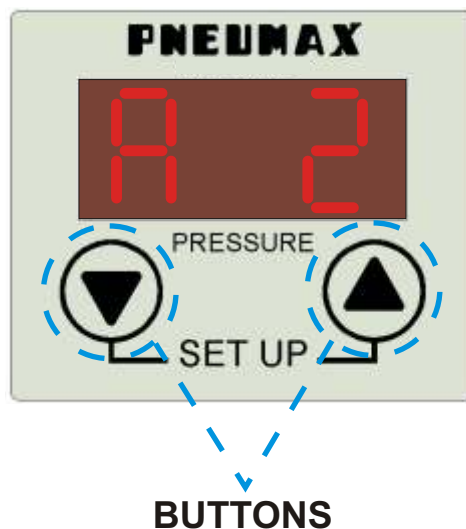
CHARACTERISTICS

Operational parameters

PARAMETER B (PRESSURE THRESHOLD)
Defines the minimum variation in pressure at which the regulator starts to work.

PARAMETER	VALUE	SIGNIFICANCE		
B	1	±0,039 bar	±0,566 psi	±0,0039 MPa
	2	**±0,078 bar**	**±1,131 psi**	**±0,0078 MPa**
	3	±0,117 bar	±1,697 psi	±0,0117 MPa
	4	±0,156 bar	±2,262 psi	±0,0156 MPa
	5	±0,195 bar	±2,828 psi	±0,0195 MPa
	6	±0,234 bar	±3,393 psi	±0,0234 MPa
	7	±0,273 bar	±3,959 psi	±0,0273 MPa
	8	±0,312 bar	±4,524 psi	±0,0312 MPa
	9	±0,351 bar	±5,090 psi	±0,0351 MPa

PARAMETER C (PRESSURE MEASURE UNITS)
Defines the units of pressure shown on the display.

PARAMETRO	VALUE	SIGNIFICANCE	DIGIT POSITION
C	**0**	**bar**	**00.0**
	1	PSI	000
	2	MPa	0.00

PARAMETER D (MINIMUM PRESSURE)
Defines the minimum pressure value that corresponds to 0V, (in case of voltage signal, or 4 mA, in case of current signal), of the reference signal.

PARAMETER	VALUE	SIGNIFICANCE		
D	**0**	**0 bar**	**0 psi**	**0 MPa**
	1	1 bar	15 psi	0,1 MPa
	2	2 bar	29 psi	0,2 MPa
	3	3 bar	44 psi	0,3 MPa
	4	4 bar	58 psi	0,4 MPa
	5	5 bar	73 psi	0,5 MPa
	6	6 bar	87 psi	0,6 MPa
	7	7 bar	102 psi	0,7 MPa
	8	8 bar	116 psi	0,8 MPa

PARAMETER E (MAXIMUM PRESSURE)
Defines the maximum pressure value that corresponds to 10V, (in case of voltage signal, or 20 mA, in case of current signal), of the reference signal.

PARAMETER	VALUE	SIGNIFICANCE		
E	1	1 bar	14,5 psi	0,1 MPa
	2	2 bar	29, psi	0,2 MPa
	3	3 bar	43,5 psi	0,3 MPa
	4	4 bar	58, psi	0,4 MPa
	5	5 bar	72,5 psi	0,5 MPa
	6	6 bar	87, psi	0,6 MPa
	7	7 bar	101,5 psi	0,7 MPa
	8	8 bar	116, psi	0,8 MPa
	9	**9 bar**	**130,5 psi**	**0,9 MPa**

CHARACTERISTICS

Operational parameters

PARAMETER F (REFERENCE SIGNAL SOURCE)
Defines the source of the reference signal used to set the pressure.

PARAMETER	VALUE	SIGNIFICANCE
F	0	Reference signal comes from 0-10 V signal
	1	Reference signal comes from RS232 port
	2	Reference signal set by the display see: How to set the pressure by the display

How to set the pressure by the display
If the value of the parameter F is set on 2 (pressure set by the display) only a power supply (24VDC) is required.
While the E/P regulator is in working conditions, push left button, keep it pushed and then push the right one. On the display the first digit on the left will start to flash (for a maximum of 6 seconds). Pushing the right button will now increase the value of the first digit on the left by 1 unit, push the left button to move to the next digit (digit in the middle) and follow the same procedure used for the first digit. Repeat again for the last digit on the right.
Once the pressure is set, wait for 6 seconds, and the device will return to standard working conditions.
If a wrong pressure value is set (out of range) the display will show an error message (E0.3) for some seconds and then the previous pressure will be restored.
If the set pressure is inside the pressure range, the regulator will change the pressure to the new value.

Note: the reference value will also be maintained if the power supply is switched off.

PARAMETER H (PROTECTION FEATURE)
This is a function included into the software that de-energizes the control valves whenever, after a certain period, the downstream circuit does not reach the set pressure.
(e.g. when the supply pressure is not present while the power supply is still on).

PARAMETER	VALUE	SIGNIFICANCE
H	**0**	**Protection not activated**
	1	Protection activated

ERROR CODES
In cases of incorrect or conflicting set parameters, the display show an error code as described below.

E0.3 : Value out of range (this error is shown when the display is set to a pressure value that is not within the working range)

E0.4 : Conflict between the working range and reference value (this error is shown when, after setting a pressure via the display, a working range which doesn't include the set value is entered into the configuration menu.

E0.5 : Conflict between maximum and minimum pressure (this error is shown when the value of the parameter D is great or equal to the value of parameter E in the configuration menu.

NOTE
Values in grey are the default settings of the product.

ORDER CODES

Order code key

Order code for regulator

171E2B. _ . _ . ___

PRESSURE RANGE :
0005 = 0.2 - 5 bar
0009 = 0.2 - 9 bar

VARIANTS :
A = Basic version
B = Basic version + Display
C = Basic version + OUT 0-10V (Voltage)
D = Basic version + Display + OUT 0-10V (Voltage)
E = Basic version + OUT 4-20mA (Current)
F = Basic version + Display + OUT 4-20mA (Current)
H = Basic version + Display + Digital OUT
L = Basic version + RS232 card
M = Basic version + Display + RS232 card

TYPE :
C = Current signal (4-20 mA)
T = Voltage signal (0-10 V)

Order code for electrical connector

5300.F08. _ . _

VARIANTS :
00 = Connector only
03 = Connettor + 3 m. cable
05 = Connettor + 5 m. cable

VERSION :
00 = Straight
90 = 90° angle

Order code for fixing bracket

170M5