USE AND MAINTENANCE MANUAL

CAMOZZI

Automation

SERIES AP
DIRECTLY OPERATED
PROPORTIONAL VALVES

Contents

Appendices

The products are in compliance with the requirements stated in the following EU directives:
- 2004/108 / EC (electromagnetic compatibility)

The products comply either fully, or for the applicable parts, with the following harmonised standards:
- EN 61000-6-2 (electromagnetic compatibility)
- EN 61000-6-4 (electromagnetic compatibility)
  and with the following technical standards:
- DIN 43650 (connector of both series)

Made in Italy

1. General recommendations

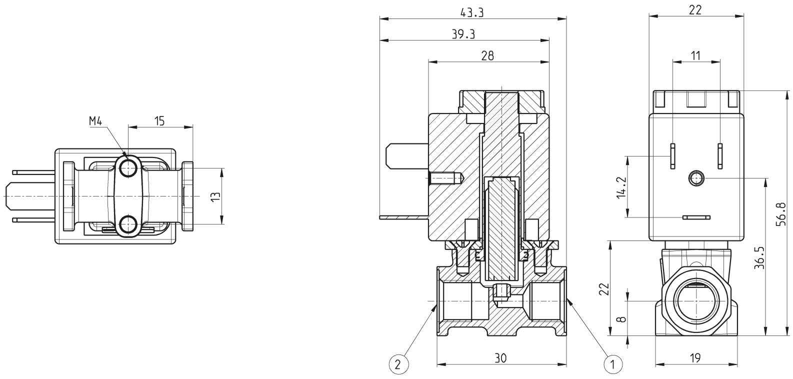
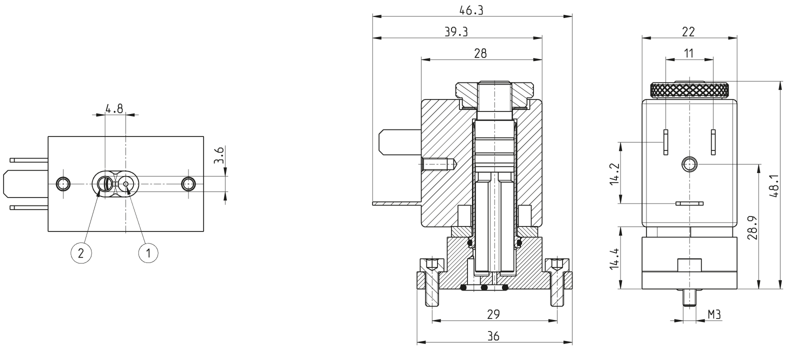
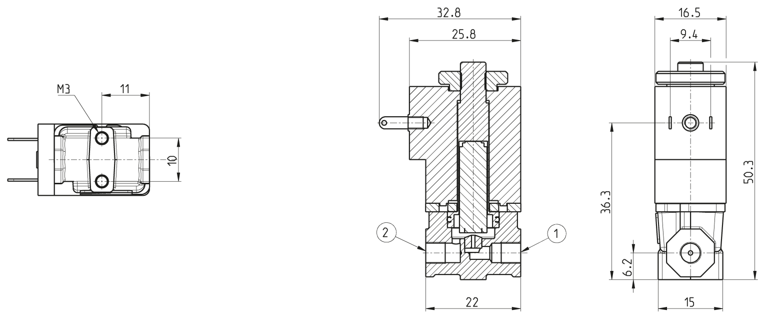
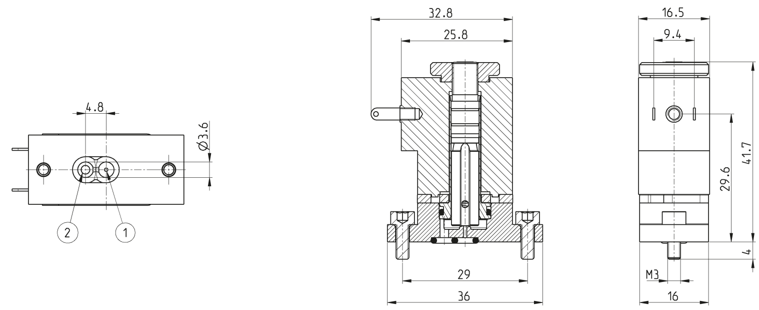
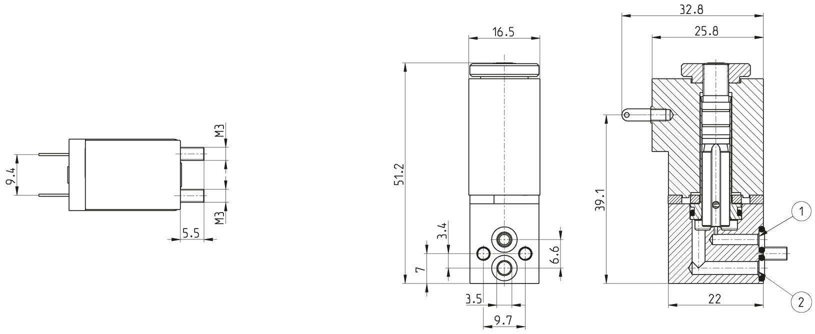
- Some dangers may be associated with the product only after it has been installed on the machine / equipment. It is the end user's responsibility to identify these hazards and reduce the risks associated with them.
- The products covered by this manual may be used in circuits that comply with EN ISO 13849-1.
- For information regarding the reliability of the parts, contact Camozzi.
- Carefully read the information in this document before using the product.
- Keep this document in a safe place and at hand for the entire life cycle of the product.
- Forward this document to any subsequent holder or user.
- The instructions contained in this manual must be followed in conjunction with the instructions and further information concerning the product described in this manual, which can be found at the following sources:
  - Website http://www.camozzi.com
  - Camozzi general catalogue
  - Technical assistance service
- Installation and commissioning may only be carried out by qualified and authorised personnel in accordance with these instructions.
- It is the responsibility of the system / machinery designer to select the most appropriate pneumatic part for the application in question.
- It is recommended to use special protective equipment to minimise the risk of injury to people.
- For any situation of use not covered by this manual and in situations where damage to property, people or animals could occur, contact Camozzi first.
- Do not make any unauthorised modifications to the product. In this case, any damage caused to people or animals is the responsibility of the user.
- All the safety regulations concerning the product must be complied with.
- Do not intervene on the machine / system until you have checked that working conditions are safe.
- Before installation or maintenance, make sure that the specifically provided safety lock positions are activated, then disconnect the power supply (if necessary) and disconnect the pressure supply to the system, exhaust all the residual compressed air in the system and disable the residual energy stored in springs, condensers, containers and gravity.
- After installation or maintenance, reconnect the system's pressure and power supply (if necessary) and check that the product is functioning properly and leak-free. In the event of a leak or malfunction, the product must not be put into operation.
- The product may only be put into operation according to the specifications indicated; if these specifications are not respected, the product may only be put into operation after authorisation by Camozzi.
- To reduce the noise caused by the air discharged from the part, use special silencers or direct the fluid into an area where, during normal operation, there are no workers.
- When designing the pneumatic circuit, limit the number of removable connections as much as possible. Provide flexible hoses of limited length. This limits the possibility of mechanical stress.
- If the system is not equipped with progressive air filling modules, sudden pressures may occur at the time of commissioning, which may cause the cylinders to move. Make sure that these cylinders are in the stroke end position or that they are not dangerous.
- Do not cover the devices with paint or other substances that may reduce heat dissipation.

2. General characteristics and conditions of use

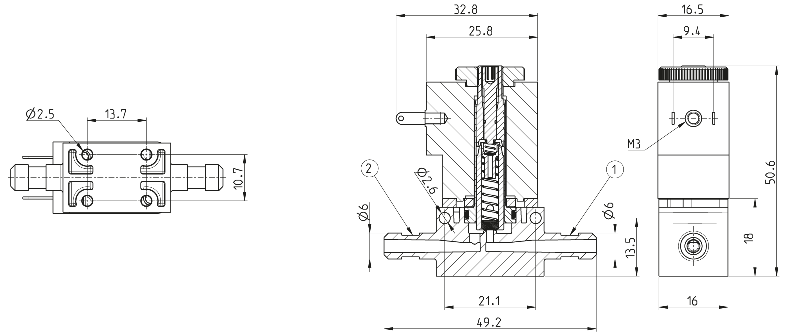
Mounting position	**Any position**			
Fluid / Fluid quality	Filtered compressed air and inert gases. All valves are suitable to be used with oxygen.			
Features	Nozzles 16mm version	Max operating pressure	Kv [Nl/min]	Kv [Nm³/h]
	0.8 mm 1.0 mm 1.2 mm 1.6 mm	10 bar 8 bar 6 bar 4 bar	0.3 0.45 0.57 0.78	0.018 0.027 0.034 0.047
	Nozzles 22 mm version	Max operating pressure	Kv [Nl/min]	Kv [Nm³/h]
	1.0 mm 1.2 mm 1.6 mm 2.0 mm 2.4 mm	10 bar 8 bar 6 bar 5 bar 4 bar	0.50 0.7 1.2 1.7 1.7	0.030 0.042 0.072 0.102 0.102
Room temperature	From 0°C to 60°C			
Materials	Body: Non-nickel-plated brass Technopolymer (PVDF) only for AP 16 mm Seals: NBR - FKM - EPDM			
Valve function	2/2 way NC			
IP protection class according to EN 60529	IP65 with Camozzi connector, types 126-800 and 122-800			
Threaded and non-threaded connections	16 mm: M5 - Hose adaptor for tube with internal Ø 5 mm - with bottom flange - with rear flange 22 mm: 1/8 "G - with bottom flange			
Power supply		DIRECT CURRENT		
		12 V coil	24 V coil	
	16 mm	40mA ÷ 260mA	20mA ÷ 130mA	
	22 mm	100mA ÷ 550mA	50mA ÷ 280mA	
		PWM		
		Frequency		
	16 mm	1000 Hz		
	22 mm	500 Hz		
Pneumatic supply	* Filtered air according to ISO class 7-4-4			
Electrical connection	16 mm: DIN EN 175301-803-C 22 mm: DIN 43650 B			

* Note: The flow regulation linearity of the Series AP valve is directly influenced by the inlet pressure, therefore the greater the stability of the inlet pressure regulation, the greater the linearity of the response.

2.1 Dimensions

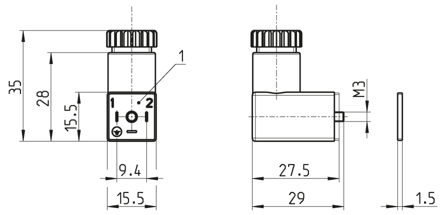
Proportional valves 22mm body with threaded ports	
Proportional valves size 22mm low flanged body	
Proportional valves 16mm body with threaded ports	
Proportional valves 16mm low flanged body	
Proportional valves 16mm rear flanged body	

Proportional valves
size 16mm
body in PVDF

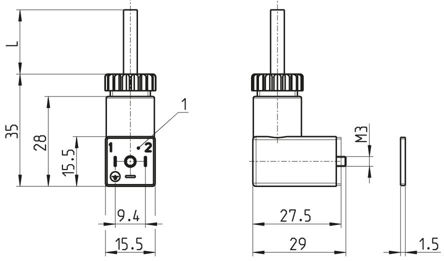


2.2 Connectors

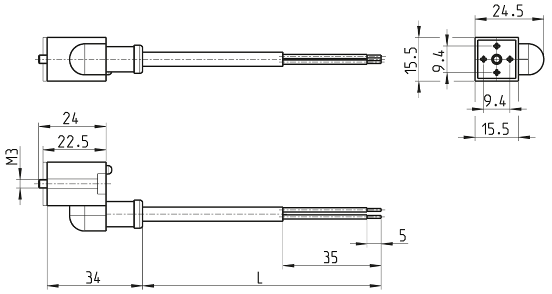
Connector Mod. 125-800
DIN 43650
pitch 9.4 mm
For size 16 mm only



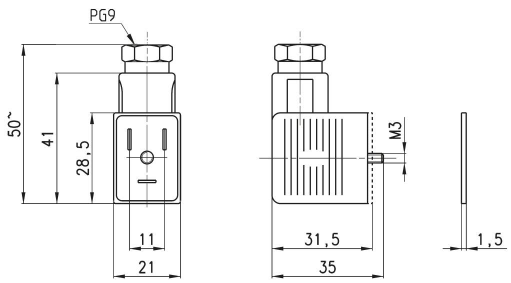
Connector Mod. 125-550
DIN 43650
pitch 9.4 mm with cable
For size 16 mm only



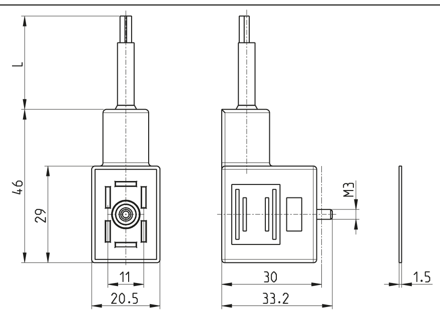
In-line connectors with cable
Mod. 125-553
For size 16 mm only



Connectors Mod. 122-800
DIN 43650
For size 22 mm only



Connectors Mod. 122-550
DIN 43650
with cable
For size 22 mm only

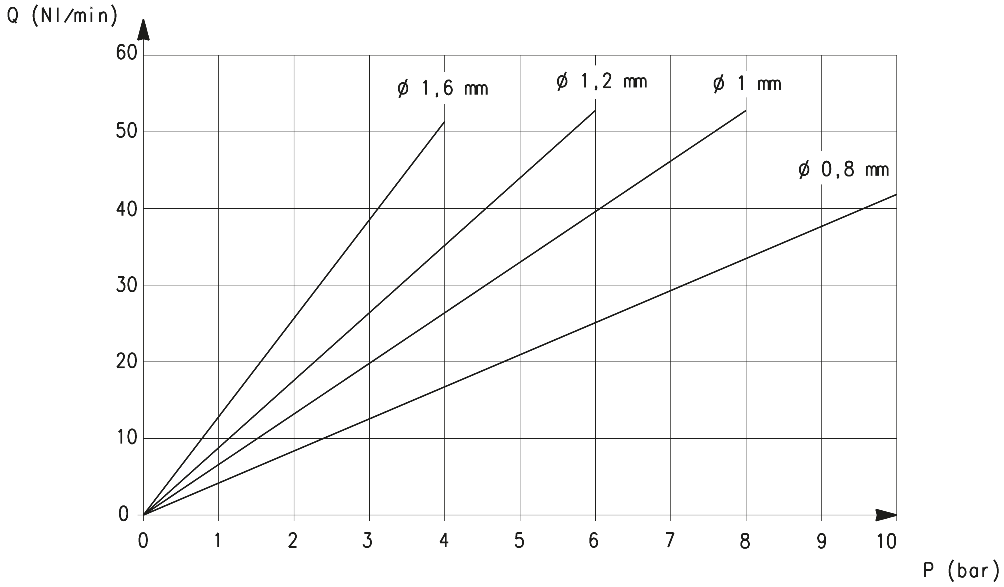


2.3 Maximum flow and response times

MAXIMUM FLOW AND RESPONSE TIMES - size 16mm

Maximum flow according to the inlet pressure

DIAGRAM LEGEND:
Q = flow (Nl/min)
I = current (A)

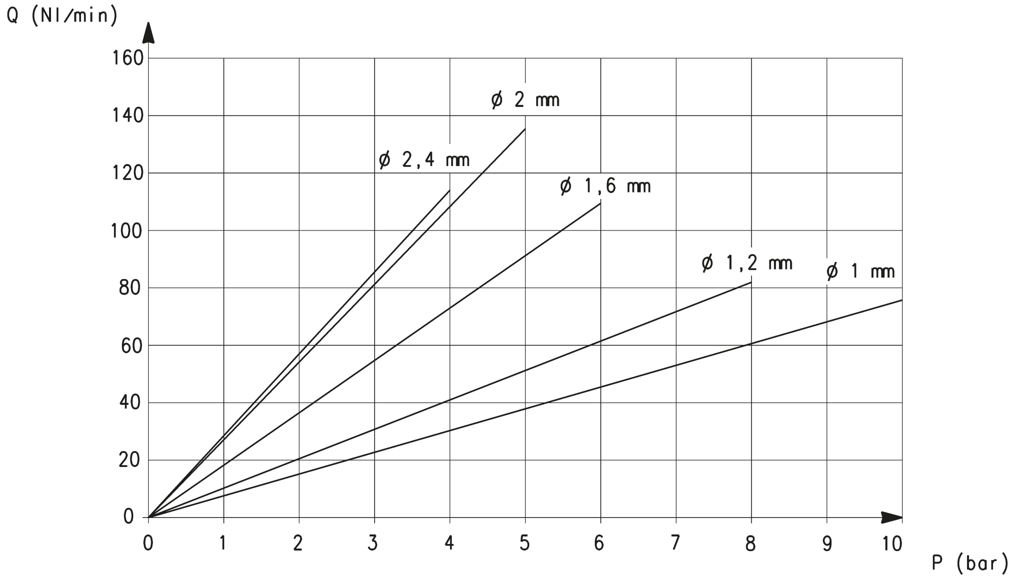


RESPONSE TIMES calculated according to the maximum flow at each operating pressure. [Electromechanical response time: 10 ms]							
ø	Pin [bar]	Load response time [ms]			Exhaust response time [ms]		
		0% - 10%	0% - 90%	10% - 90%	100% - 90%	100% - 10%	90% - 10%
0.8 mm	10	12	43	31	11	39	28
1 mm	8	12	42	30	11	38	27
1.2 mm	6	10	41	31	11	41	30
1.6 mm	4	10	40	30	11	40	29

MAXIMUM FLOW AND RESPONSE TIMES - size 22mm

Maximum flow according to the inlet pressure

DIAGRAM LEGEND:
Q = flow (Nl/min)
I = current (A)



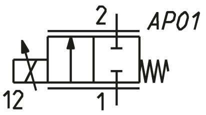
RESPONSE TIMES calculated according to the maximum flow at each operating pressure. [Electromechanical response time: 10 ms]							
ø	Pin [bar]	Load response time [ms]			Exhaust response time [ms]		
		0% - 10%	0% - 90%	10% - 90%	100% - 90%	100% - 10%	90% - 10%
1 mm	10	10	36	26	10	36	26
1.2 mm	8	10	45	35	12	38	26
1.6 mm	6	12	45	33	12	40	28
2 mm	5	12	42	30	11	34	26
2.4 mm	4	11	45	34	12	44	32

3. Installation and commissioning

- When unpacking, be careful not to damage the product.
- Check for any faults resulting from the transport or storage of the product.
- Sort the packaging materials so that they can be recycled or disposed of in accordance with the applicable regulations in your country.
- Before putting the part into operation, check that the specified characteristics and performance features correspond to those required.
- When installing the part, provide adequate protection against overpressure.
- Avoid sudden pressure changes in the circuit where the part is installed as much as possible.
- Make sure that the air discharged from the part is directed to an area where it cannot pose a hazard to the equipment and surrounding people.
- When installing the part, make sure that there is no danger from mechanical movement.
- Install the part in an area where set-up and maintenance are easy to perform and cannot pose a hazard to the operator.
- Prior to connecting the part to the tubes, make sure there are no burrs or other debris that could cause a malfunction.
- In the event of strong vibrations, provide special devices/systems capable of damping their effect on the component.
- Install dehumidifiers to prevent any rusting of internal parts.
- Make sure that, once the component has been installed, the air ducts are well connected to their respective fittings.
- If the valve is used to operate an actuator whose accidental movement could cause a danger, provide appropriate locking devices for the mobile part of the actuator.

Make sure that the connectors of the valves are correctly connected and secured.

Pneumatic symbol:
This symbol applies to all versions of the AP Series



Pneumatic connections of the valve 22 mm and 16 mm:
Respect the direction indicated on the label and position the inlet near number 1 and the outlet near number 2.

4. Use

- Make sure that the pressure of the compressed air distribution network and all operating conditions are within the permissible values.
- The product may only be put into operation according to the specifications indicated; if these specifications are not respected, the product may only be put into operation after authorisation by Camozzi.
- Observe the information on the identification tag.

The 2/2-way NC directly operated proportional solenoid valves with orifices ranging from 0.8 to 2.4 mm are designed to optimise and minimise friction and the stick slip effect.
The output flow is proportional to the control signal, in PWM or in current; no minimum operating pressure is required as these valves can also work with vacuum.

5. Troubleshooting and exceptional situations

Type of fault	Causes	Remedy
Leaking valve	Pressure outside the permissible ranges	Apply the correct amount of pneumatic power to the component
	Damaged seal	Complete valve replacement
	Dirt in the valve	Complete valve replacement

6. Limitations of use

- Do not exceed the technical specifications indicated in the " General characteristics " paragraph and in the Camozzi general catalogue.
- Do not install the product in areas where the air itself can cause hazards.
- Unless the product is specifically intended for such use, do not use the product in areas where direct contact with corrosive gases, chemicals, salt water, water or steam may occur.
- As far as possible, avoid installing the devices:
  - exposed to direct sunlight (shield them if necessary);
  - near heat sources or in areas subject to sudden changes in temperature;
  - near live parts that are not adequately insulated;
  - near conductors or electrical equipment with high alternating or impulsive currents (eddy current hazard)
  - near sources of high intensity electromagnetic waves (antennas) (danger of eddy currents and/or electric arcs).

7. Maintenance

- Improper maintenance may impair the proper functioning of the product and cause damage or injury to people.
- Check the conditions in order to prevent parts from suddenly being released, then disconnect the power supply and discharge residual pressure before intervening.
- Ensure that condensation is routinely removed from in-line filters.
- Discharge pressure from the entire system and from the actuator itself.
- Check the possibility of having the product serviced by a technical assistance centre.
- Never disassemble a pressurised unit.
- Isolate the product pneumatically, hydraulically and electrically before maintenance.
- Always remove accessories prior to maintenance.
- Always make sure to wear the correct Personal Protective Equipment required by local authorities and current legislation.
- Only use Camozzi original kits in case of maintenance or the replacement of worn parts and only have the operation carried out by authorised specialist personnel. Otherwise, the product's type-approval will be invalidated.

8. Ecological information

- At the end of the product's life cycle, we recommend sorting materials so that they can be recycled.
- Observe the disposal regulations applicable in your country.

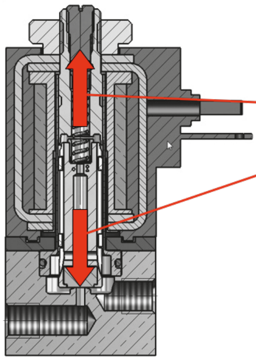
9. Proportional drive theory

Proportional solenoid valves, unlike classic on-off solenoid valves, provide an output signal that is proportional to the input signal: in other words, they provide an output flow that varies depending on the power supply signal.

The input signal, i.e., the power supply, can be managed through PWM or through a simple current control and must have the characteristics provided in chapter 9.3.

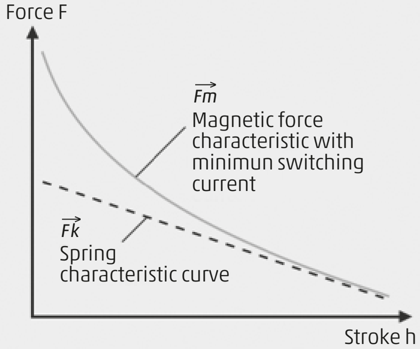
On a practical level, the special design of the internal valve parts, in particular the geometry of the movable core, the fixed core and the spring, allow to control the position of the former and therefore variable opening when the fluid passes through.

To achieve better understanding, let's now analyse the forces affecting a classical valve and a proportional valve, disregarding for a while the force generated by the fluid pressure.



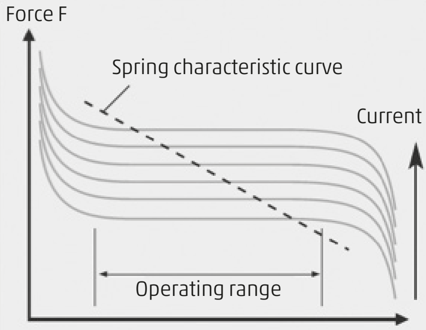
In a classic ON-OFF valve, $\vec{Fm}$ is always higher than $\vec{Fk}$; therefore, as soon as the coil generates a sufficient magnetic field, the magnetic force becomes much higher than the force of the spring in its rest position and the system therefore diverges towards a completely open position.

The following graph shows that the magnetic force $\vec{Fm}$ significantly increases with respect to the force of the spring as stroke length decreases (Stroke h: distance, fixed core - movable core); at every point of the graph, the magnetic force is higher than the spring force.



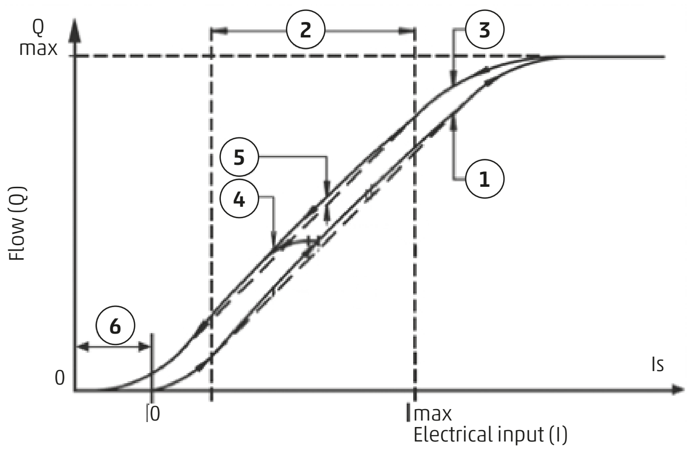
Magnetic force characteristics curves for shut-off valves

Differently, in a proportional valve a balance of forces is sought, which is ensured by the intersection of the two characteristic curves of spring and coil.
This balance therefore allows the core to stop in a certain position along its stroke: the resultant of the forces will be zero, the acceleration will be zero and therefore the speed will also be zero.



9.1 Characteristic parameters

When it comes to proportional valves, it is important to define some basic parameters.
It is possible to identify all of them by analysing the ideal graph of a proportional valve.



1 - Curve followed by the valve during opening
2 - Linear behaviour region
3 - Curve followed by the valve during closing
4 - Hysteresis
5 - Flow linearity
6 - Threshold

1 - CURVE FOLLOWED DURING OPENING
Flow rate trend of the valve, followed during the opening of the valve.

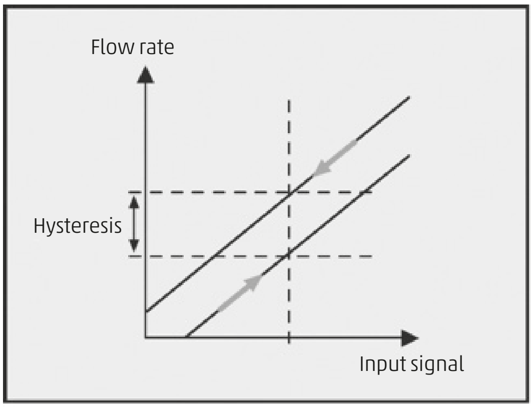
2 - LINEAR BEHAVIOUR REGION
The linear behaviour region is defined as the operating range of the valve where a change in the input signal corresponds linearly to a change in the output flow rate.

The trend of the characteristic curve is closely linked to the pressure, fluid temperature and conditions of use, therefore no specific curve is provided for the whole series of valves.

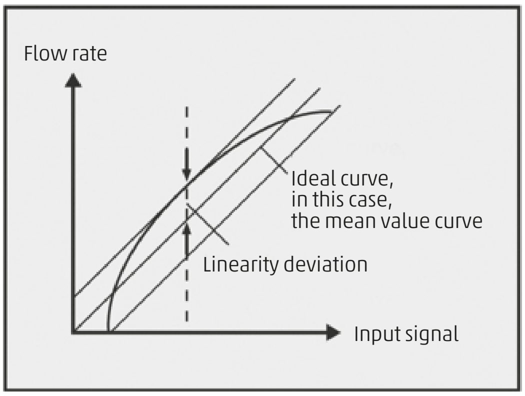
3 - CURVE FOLLOWED BY THE VALVE DURING CLOSING
Flow rate trend of the valve, followed during the closing of the valve.

4 - HYSTERESIS
Hysteresis is defined as a delay in a system's reaction to applied stresses. In the case under analysis, hysteresis is defined as the maximum difference between the flow rate at valve opening and the flow rate at valve closing, with the same input signal.

In other words, hysteresis is represented by a different flow rate value between valve opening and valve closing behaviour.



5 - LINEARITY
Linearity is defined as the maximum deviation of the measured values from the ideal straight line, expressed as a percentage of the maximum flow rate, excluding the initial and final sections of the curve.

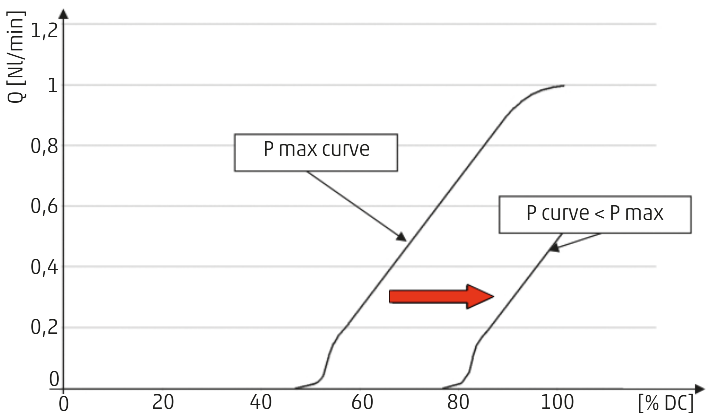


6 - THRESHOLD
The threshold is defined as the minimum value of the electrical signal that causes the valve to open.
In order to better understand the threshold concept and its importance, it is essential to consider its correlation with the operating pressure of the valve.

The threshold value is in fact closely linked to the operating pressure: the higher the pressure, the easier the valve will open and therefore the lower the threshold value.
In other words, less energy is required to move the mobile core, since the pressure acting under the poppet facilitates opening, generating a force in the same direction as the magnetic force and therefore in the opposite direction to the force generated by the spring.

It is important to note that the valve performance is reported at P max. Operating the valve at lower pressures does not result in a reduction in its performance in terms of hysteresis and repeatability, but reduces its performance in terms of threshold and maximum flow rate.

For this reason, it is possible to ask Camozzi for valves with a customised calibration for specific applications.



To fully describe the performance of a proportional valve, it is advisable to define another characteristic parameter, which cannot be identified on the graph.

REPEATABILITY
Repeatability is defined as the difference between two flow rate values (obtained on the same branch of the characteristic curve, for example at opening) for the same input signal, expressed as a percentage of full scale.

9.2 Flow rate

In order to determine the flow rate value for each condition of use, it is necessary to define a characteristic coefficient of the valve using the Kv parameter.

K v defines the flow rate of water (between 5° and 40°), expressed in l/min, through a valve with a differential pressure (pressure drop) of 1 bar. (The performance table also shows the Kv parameter [Nm3/h] to be consistent with the data reported for other products in the catalogue).

It should be noted that if only the value Kv [Nm3/h] is available, it is possible to convert this value into Kv using the following formula:

$$K_V = K_V \frac{1000}{60}$$

With this data it is possible to:
- calculate the flow rate through the valve, as a function of the pressure difference
- size the valve according to the flow rate and the pressure drop that will be accepted
- calculate the concentrated pressure drop of the valve, as a function of the flow rate and Kv

FOR CONVERTING UNITS OF MEASUREMENT AND USE OF THE FOLLOWING FORMULA, WATER WAS USED

$$Q = K_V \sqrt{P2 - P1} \qquad Q = K_V \sqrt{\frac{1}{P2 - P1}} \qquad \Delta P \left(\frac{Q}{K_V}\right)^2$$

Q	[l/min]	Flow rate
K_V	$\left[\frac{l}{min} \sqrt{\frac{1}{bar}} \right]$	Flow rate coefficient
P1	[Bar]	Valve inlet pressure
P2	[Bar]	Valve outlet pressure
ΔP	[Bar]	Pressure loss

NOTE: It is not important to use absolute or relative water pressure as all formulas are calculated from the differences.
The result, therefore, does not change when using absolute pressure or relative pressure.

Kv is normally expressed in l/min as reported at a pressure difference of 1 bar.

IN CASE OF AIR

If $P2 \geq \frac{P1}{2}$, i.e., in subsonic flow conditions

(air flow speed lower than the speed of sound)

$$Q_N = 28,6 \cdot K_V \cdot \sqrt{P_2 \cdot \Delta P} \cdot \sqrt{\frac{293}{273 + T}}$$

If $P2 < \frac{P1}{2}$, i.e., in sonic conditions

(flow rate sonic block and flow speed equal to the speed of sound)

$$Q_N = 14,3 \cdot K_V \cdot P_1 \cdot \sqrt{\frac{293}{273 + T}}$$

Q_N	[Nl/min]	Volumetric flow rate through the valve
K_V	$\left[\frac{l}{min} \sqrt{\frac{Kg}{dm^3 \cdot bar}} \right]$	Flow rate coefficient
P1	[Bar]	Absolute valve inlet pressure
P2	[Bar]	Absolute valve outlet pressure
ΔP	[Bar]	Pressure loss
T	[°C]	Inlet air temperature

9.3 Power supply

Proportional valves can be powered in two ways:
- Current or voltage
- Using PWM

POWER SUPPLY CURRENT / VOLTAGE

The valves can be supplied with variable current.
It is important to note that supplying direct current proportional valves implies a higher hysteresis value, due to greater internal static friction: indeed, in these conditions the mobile core can be considered as instantly stationary.
This implies that whenever a change in position is requested, the friction of first release must be overcome in order to pass from static to dynamic conditions, with evident consequences on the delay of response and therefore on the hysteresis.

NOTE: see the permitted current ranges on page 3.

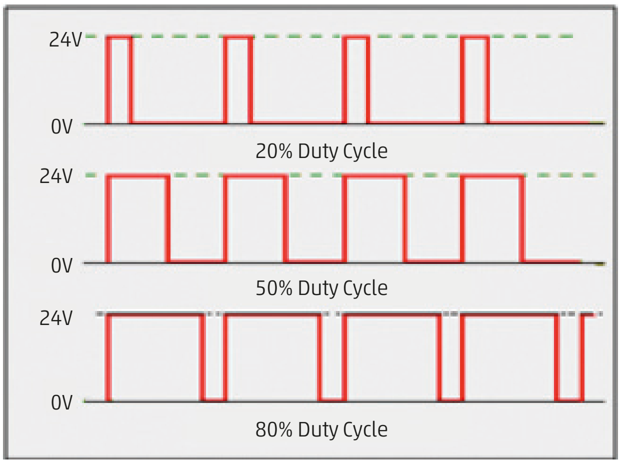
PWM POWER SUPPLY

Pulse Width Modulation (or PWM) is a type of digital modulation that allows a variable average voltage to be obtained depending on the ratio between the duration of the positive and negative (or zero) pulses.

Two concepts should be defined to understand PWM operation:
1) duty-cycle percentage
2) duty frequency

1) Duty-cycle percentage
Duty-cycle percentage is the percentage ratio between the time when the signal is positive and the total time of the observation period.
The duration of each pulse can be expressed in relation to the period between two successive pulses, implying the concept duty cycle .
A useful duty cycle equal to 0% indicates an impulse of zero duration, i. e., no signal, whereas a value of 100% indicates that the impulse ends when the next one starts.

Below are some representations of Duty Cycle values



2) Duty frequency
Once the duration of a period has been defined, the frequency is the number of times this period is repeated within one second.

NOTE ON PERFORMANCE

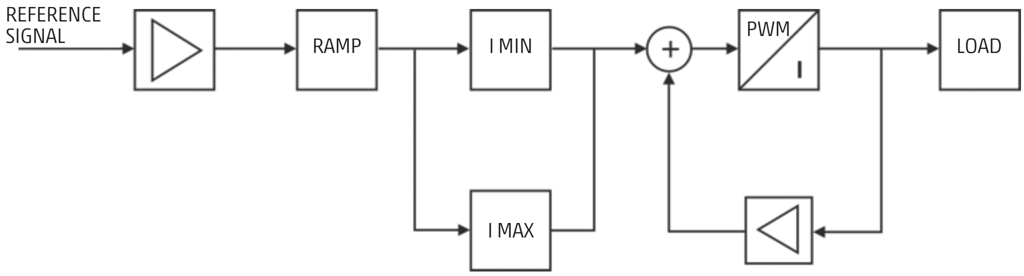
The PWM power supply significantly reduces the operating hysteresis of the valves, as the mobile core is constantly moving: a vibration of minimum amplitude (not perceptible on the adjusted flow rate value) makes it possible to use a dynamic friction coefficient and therefore have a more reactive valve response: for this reason, if it is not possible to supply the valve through electronics that manage the PWM directly, it is recommended to use the Series 130 accessory to obtain excellent performance.

9.4 Electronic control for Series 130 proportional valves

The electronic control device for proportional valves allows the control of any valve with a maximum current of 1 A.
It converts a standard input signal (0-10V or 4-20 mA) into a PWM signal to obtain a current that is proportional to the input signal at the solenoid output.

A supplied current control system makes it possible to compensate for variations due to solenoid heating or changes in supply voltage.

The maximum and minimum current supplied to the solenoid can be adjusted. The output signal can have a ramp progression adjustable between 0 and 5 s.



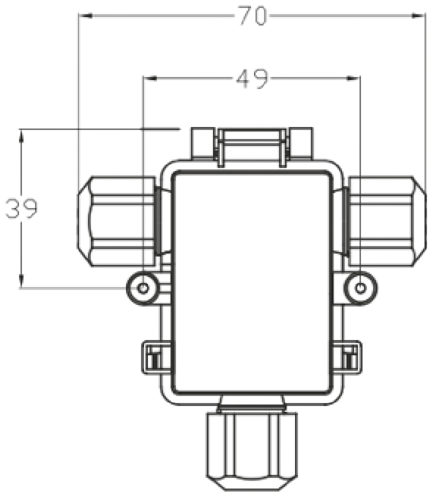
The device has a firmware dedicated to the proportional valve to be controlled to ensure optimal operation.

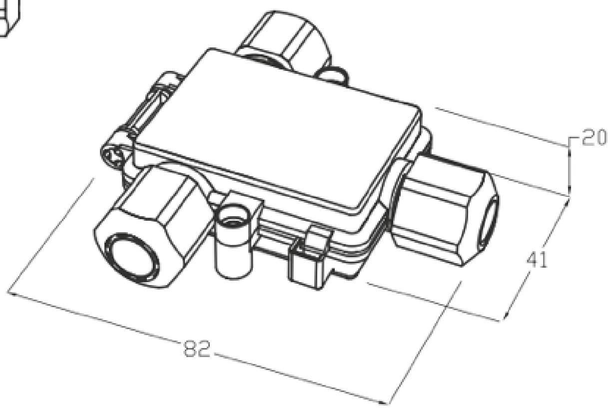
Therefore, check that the voltage, power and frequency characteristics of the PWM chosen at the time of ordering correspond to those of the valve to be controlled.

Coding example

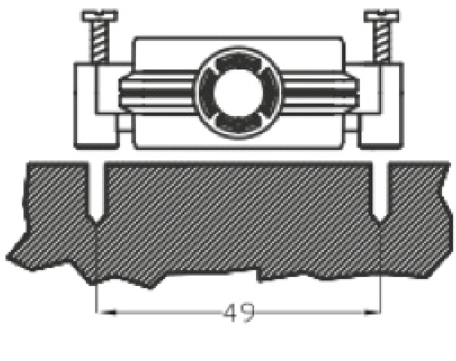
130 -	2	2	2
	Voltage	Power	PWM frequency
	2 = 24 V DC (P max 24W) 3 = 12 V DC (P max 12W) 4 = 6 V DC (P max 6 W) 5 = 11 V DC (P max 11 W)	1 = 3 W 2 = 6,5 W 3 = 3,2 W	1 = 120 Hz 2 = 500 Hz 3 = 1 KHz

DIMENSIONS AND APPEARANCE

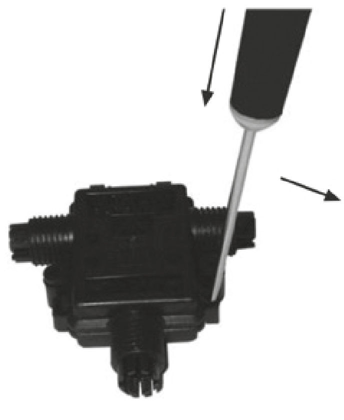




Fixing with screws



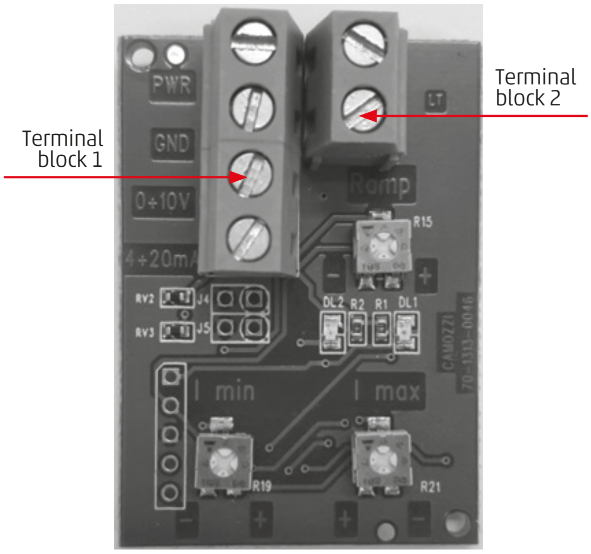
To open the box



Serie 130 - General characteristics and conditions of use	
Mounting position	In any position
Room temperature	0 ÷ 50°C
Power supply	6V ÷ 24 V DC (± 10%)
Consumption	~ 0,4 W (without valve)
Analog input	0 ÷ 10 V ; 4 ÷ 20 mA
Input impedance	> 30 KΩ with voltage input < 200 Ω with current input
Output	PWM 120 Hz ÷ 11,7 KHz (fixed, depending on the chosen valve)
Maximum current (valve)	1 A
Protections	Inversion of polarity, output short circuit
Cables	Outer sheath diameter: 5 ÷ 7.5 mm only with gasket or 4 ÷ 6 with adapter and gasket Conductor cross section: 26 ÷ 16 AWG / 0.13 ÷ 1.5 mm^2 Maximum L of power / signal cable: 10 m Maximum L of valve connection cable: 5 m
Container material	Polycarbonate
IP protection class according to EN 60529	IP 54
Electrical connections	Screw
Ramp function	Time adjustable from 0 to 5 s
Minimum current setting (Offset)	0% ÷ 40%
Maximum current setting	50% ÷ 100%

Power supply and connections:

It is essential to supply the device within the tolerance range of ± 10% within which the characteristics of the device and of the proportional valves piloted are guaranteed.



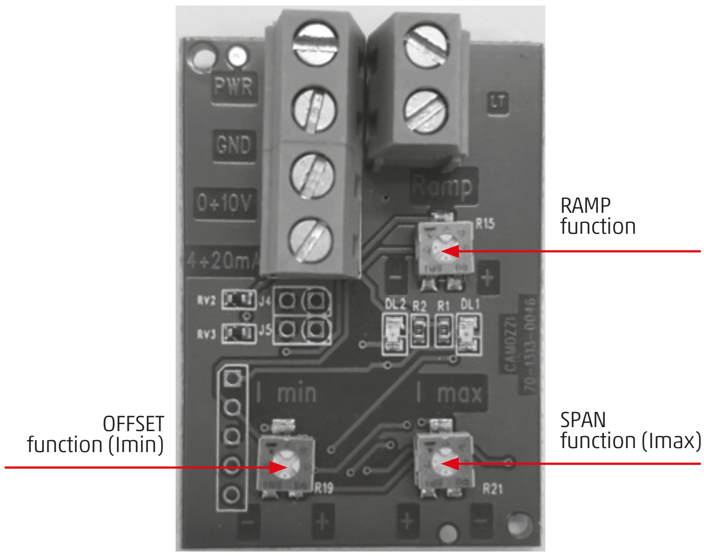
TERMINAL BLOCK CONNECTION 1
PIN 1: (PWR) +12 or +24 VDC (board power supply)
PIN 2: (GND) ground (board power supply) and reference ground of the input signal
PIN 3: (0÷10 V) input for variable voltage analog signal
PIN 4: (4÷20 mA) input for variable current analog signal

INPUT TYPE	PERMISSIBLE RANGE	EQUIVALENCE OF VALUES
Variable voltage	0÷10 Vdc	0 V = 0% 10V = 100%
Variable current	4÷20 mA	4 mA = 0% 20 mA= 100%

TERMINAL BLOCK CONNECTION 2
PIN 1: valve
PIN 2: valve

CONNECTORS (See chapter 2.2)
AP series 22 mm pitch: DIN 43650 B
AP series 16 mm pitch: DIN EN 175301-803-C

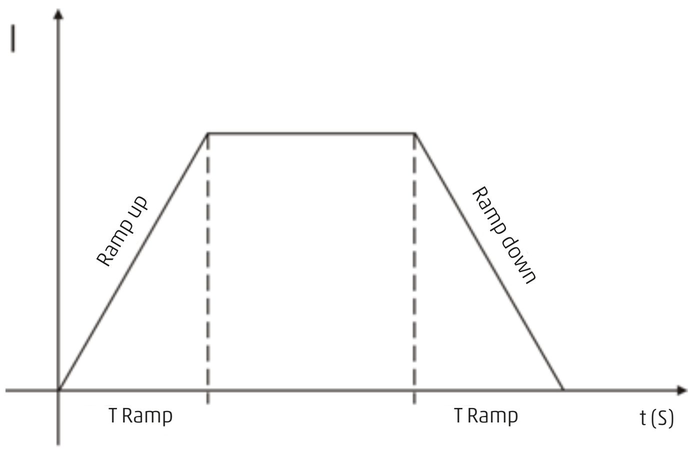
Device functionality:



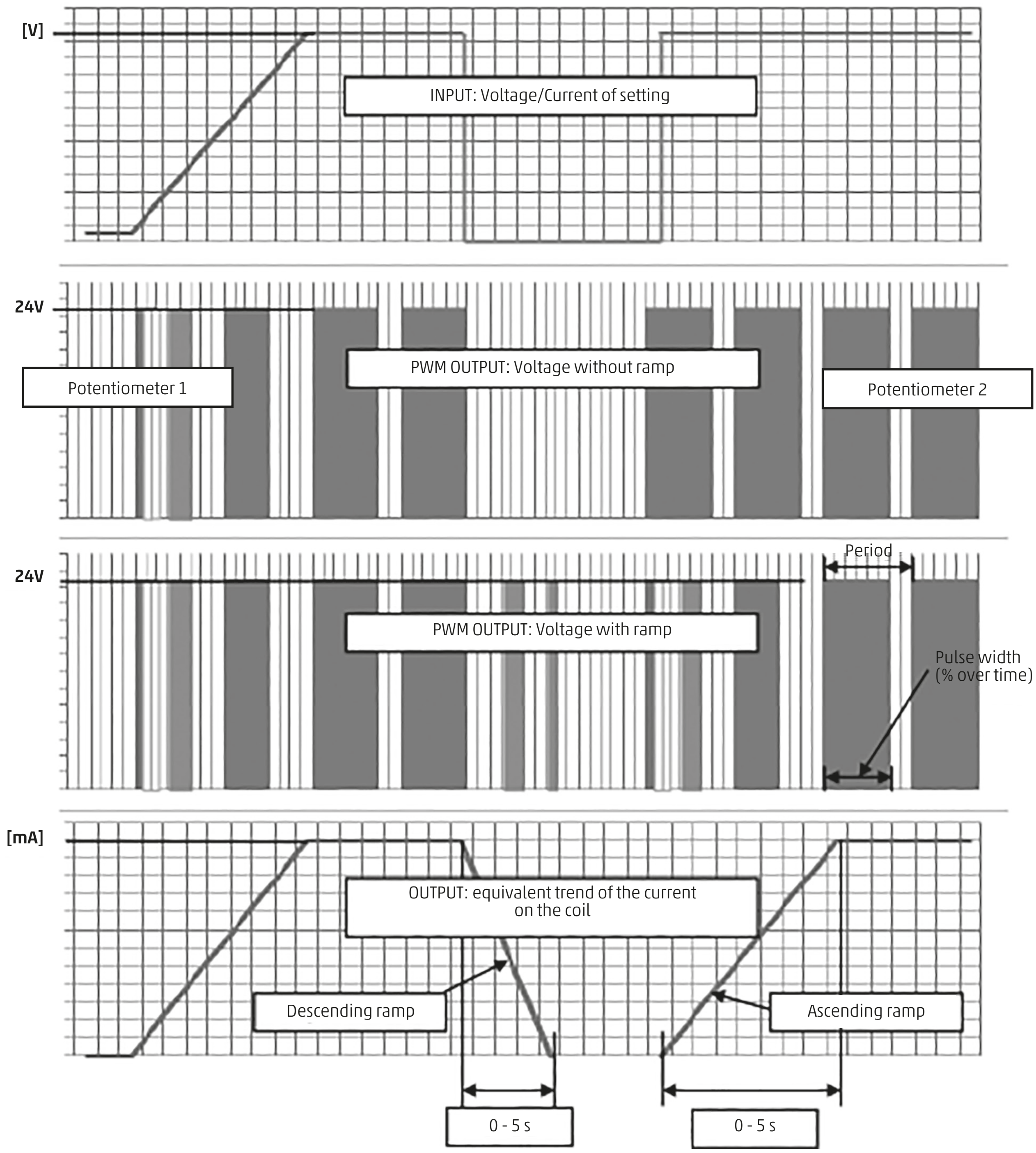
Ramp time calibration:

Ramp time is the time taken to pass from the minimum current value to the maximum current value supplied to the load and vice versa.
The time can be set to a minimum of 0 s (excluding the ramp) and a maximum of 5 s (maximum valve opening). The ramp time is increased by turning the RAMP trimmer clockwise.

Trimmer = RAMP
Default value = 0 s
Range = 0 s ÷ 5 s



The following is an example of the operating principle, with and without ramps



Minimum current calibration:

The setting for the minimum offset current allows the valve's insensitivity zone (dead band) to be cancelled.

The device allows the minimum current setting and therefore the valve opening even without the reference signal and with invalid reference signal (reference signal in current 4÷20 mA lower than 4 mA).
It is therefore necessary to ensure that the valve opening without the reference signal (or with a reference signal in current lower than 4 mA) does not cause damage to property or injury people during operation.

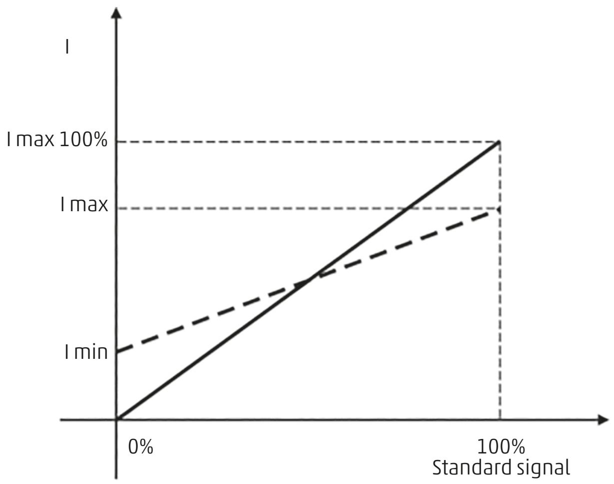
To adjust the minimum current, set the reference signal to the minimum and turn the trimmer I min clockwise until the valve opens.

Trimmer = I min
Default value = 0%
Range = 0% ÷ 40% of I max

Maximum current calibration:

The trimmer I max determines the maximum value of the current that is supplied to the valve with a 100% reference signal. The maximum current setting is therefore used to limit the maximum flow value of the valve being piloted. To reduce the valve current/maximum flow rate, turn the trimmer I max clockwise.

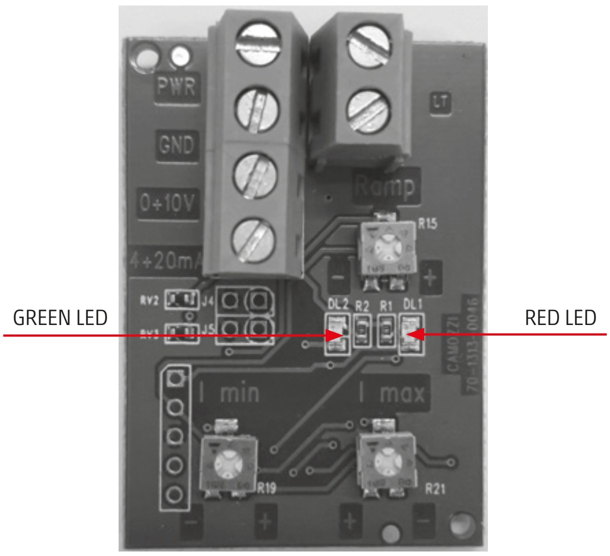
Trimmer = I max
Default value = 100%
Range = 100% ÷ 50% of I max



INDICATOR LEDs

The device is equipped with two LEDs, with the following functions:

Led	Behaviour	Meaning
Green	Turned off	No power supply
	Fixed on	Device powered correctly
	Flashing	Supply voltage out of range: check that the supply voltage corresponds to that of the chosen device and valve and check that it is not out of range V ± 10%
Red	Turned off	-
	Flashing	Invalid reference signal: check that the reference signal is within the range 0 ÷ 10 V or 4 ÷ 20 mA



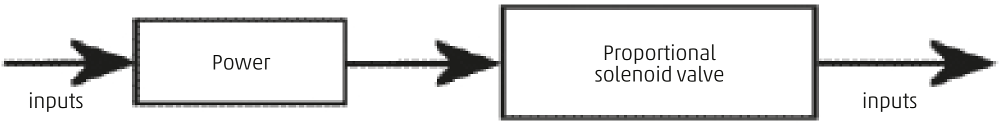
9.5 Open-loop and closed-loop operation

The automatic control of a given dynamical system aims to modify the behaviour of the system to be controlled (i.e., its outputs) by manipulating the input quantities.

An automatic control system can work essentially in two ways:
- as an open loop control
- as feedback or closed loop control

OPEN LOOP
The open loop control is based on an input processing performed without knowing the output value of the controlled system, as some properties of the system to be controlled are known.

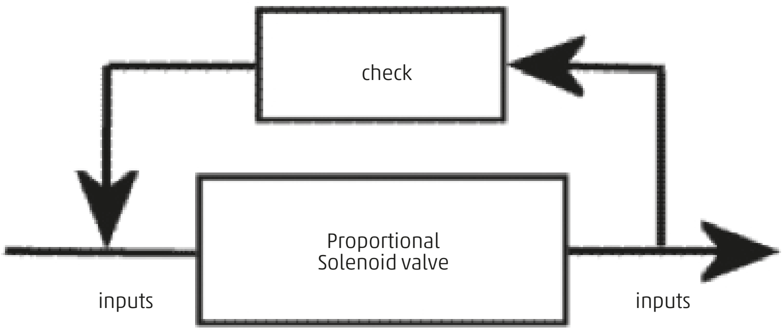
In this case, it is essential to have a good mathematical model that describes the behaviour of the system in a fairly precise way. The more exact the mathematical model on which the open loop control action is based, the more reliable this type of control is.



CLOSED LOOP

The closed-loop (or feedback loop) control is based on the presence of a feedback signal that is re-processed in order to adapt the output value, to make it constant over time.

The system is more complex but much more flexible than the first one and can stabilise a system that originally might not be so and still allows the tracking of a certain output signal with greater precision.
It is clear that, without going into the subject of feedback loop control strategies, a closed loop system will allow globally superior performance compared to open loop applications.



The Series AP proportional solenoid valves are designed and manufactured to have excellent performance even in open loop applications.

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