LD, LDM

Tightness Control Device

LD, LDM

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Description

The LD/LDM tightness control device is designed to verify the absence of inadmissible leaks in gas trains composed by automatic shutoff valves. The check can be performed before the ignition of the gas burner or after its stop.
This device is used in industrial firing processes and in forced draught burners, when power is higher than 1200 kW, according to EN 13577-2 and EN 676.

Features

Microcontroller technology

Easy-to-see status of the device through high visibility LEDs

Easy accessible reset button

Adjustable test time to meet the plant needs

Adjustable test instant

Available Ex-proof version with metal enclosure for installation in Zone 2 and 22 (ATEX)

Available with integrated pressure switches and/or integrated auxiliary valves

Designed and manufactured according to EN 1643

WARNING

This control must be installed in compliance with the rules in force.

Functioning

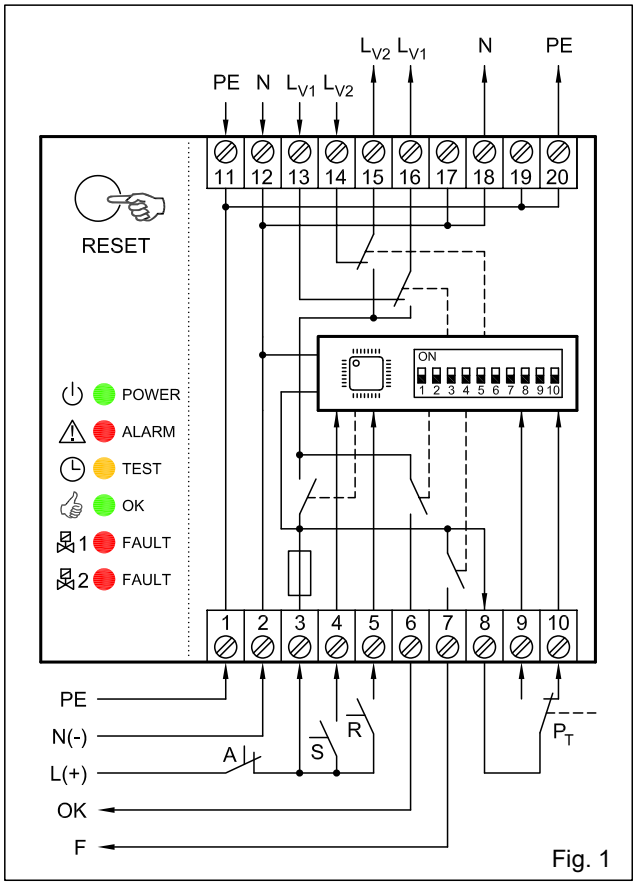


Fig. 1

Legend Tab.1

L, N	Electrical power
A	Safety interlock
S	Start-up signal
R	Reset signal
OK	Pass signal
F	Fault signal
V_1	First safety valve
V_2	Second safety valve
V_D	Auxiliary discharge valve
V_F	Auxiliary filling valve
P_1	Inlet pressure
P_2	Outlet pressure
P_T	Test pressure
P_L	Low test pressure
P_H	High test pressure
P_D	Discharge pressure
P_F	Filling pressure
P_{ATM}	Atmospheric pressure
V_T	Test volume
Q_M	Maximum flow rate
q_L	Leakage rate
t_P	Test period
t_O	Valve opening time
t_A	Self test time
$t_C = t_A+2t_O+2t_P$	Total cycle time

LD1

Basic version is composed by electronic control only (Fig.1).

This device, coupled to an external pressure switch, checks the pressure in the test volume V_T (yellow color in Fig.2), detecting potential leaks from shutoff valves.

The test is performed in two steps:

1 The upstream valve is tested discharging the test volume and monitoring the pressure increasing (pressure switch on NO contact).

2 The downstream valve is tested filling the test volume and monitoring the pressure decreasing (pressure switch on NC contact).

Pressure set up of the switch is usually half of inlet pressure ($P_T=P_1/2$).

The operational steps of charging and discharging test volume are done by the valves V1 e V2.

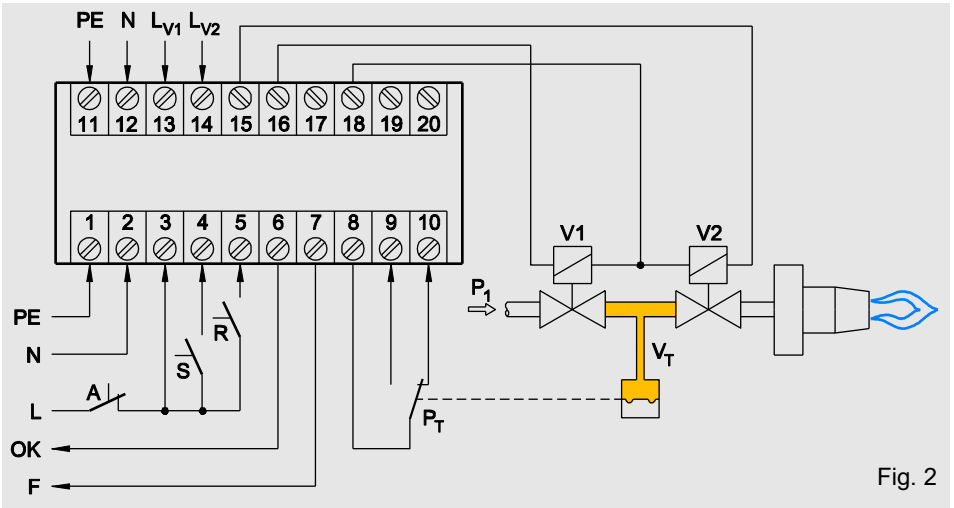


Fig. 2

LD3

Version with two integrated auxiliary valves for supply/discharge operations of the test volume V_T (Fig.3).

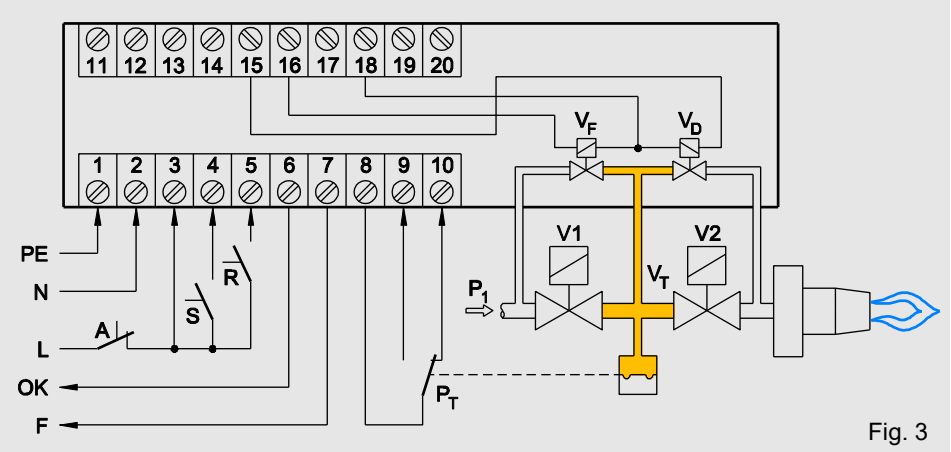


Fig. 3

LDM2

Version with metal enclosure and integrated pressure switch (Fig.4).

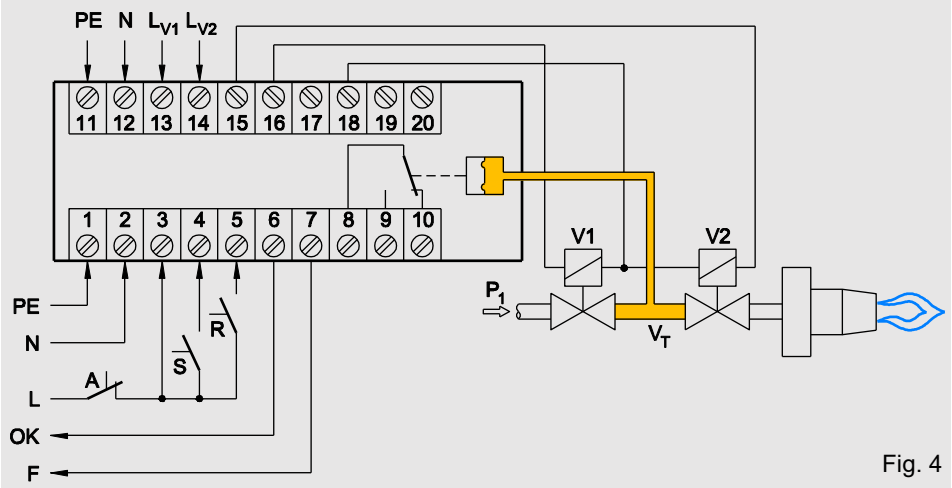


Fig. 4

LDM4

Version with metal enclosure, integrated pressure switch and auxiliary valves (Fig.5).

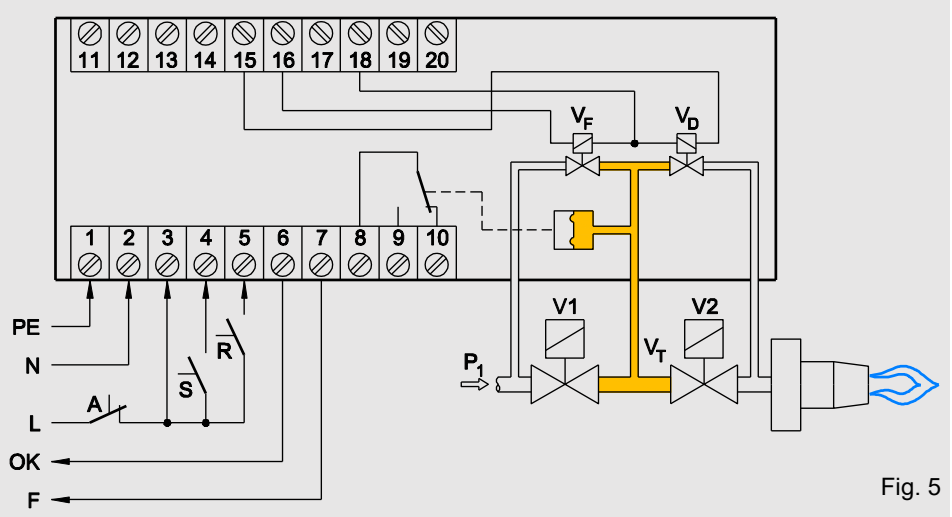
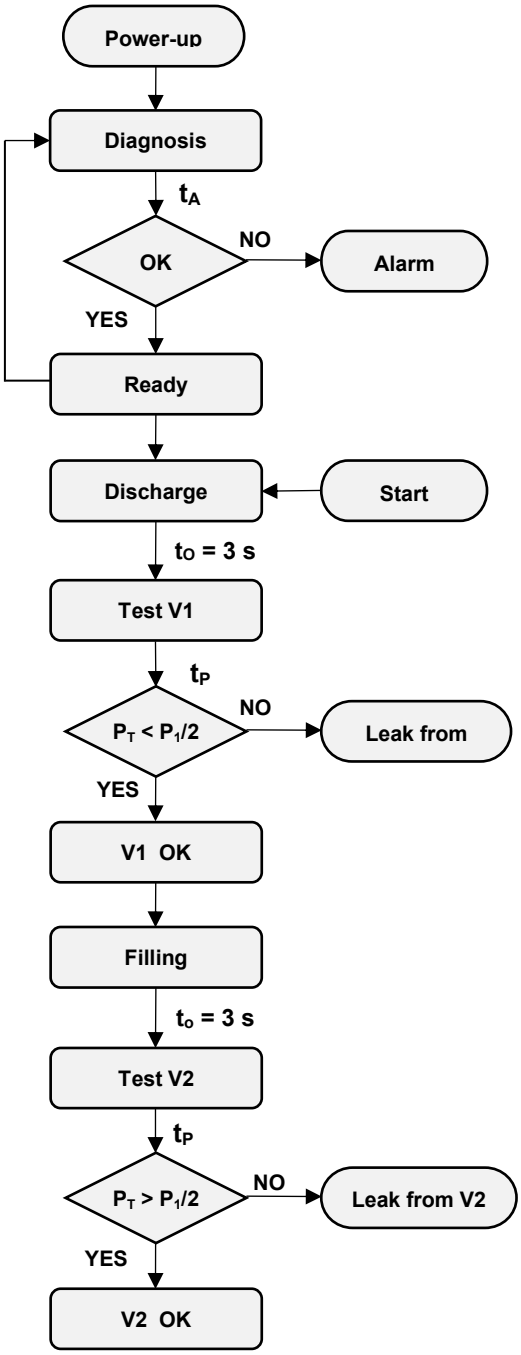


Fig. 5

Working cycle



Led Fault V2 *Led Fault V1* *Led OK* *Led Test* *Led Alarm* *Led Power* STEP DESCRIPTION	1	2	3	4	5	6
Power-up Power supplied to terminal 3. Device runs a self-check (lasting t_A)	●	●	●	●	●	●
Alarm A problem has occurred. Signal F (fault) is sent to the control unit. The working cycle stops. Led2 is blinking according to the type of problem (see alarm table).		◉				
Ready No faults occurred. Device is ready to receive the command S (start).	●					
Discharge Start signal S is received. Device opens V2 to discharge test volume. (time t_O = 3 s).	●		◉			
Test V1 Device shuts V2 off and test for V1 begins (lasting t_P).	●		◉			
Leak from V1 An unacceptable leak from V1 is detected. Signal F (fault) is sent to the control unit. Cycle stops.		●			●	
V1 OK The valve V1 is tight.	●		◉			
Filling Device opens V1 to fill the test volume (time t_O = 3 s).	●		◉			
Test V2 Device shuts V2 off and test for V2 begins (lasting t_P).	●		◉			
Leak from V2 An unacceptable leak from V2 is detected. Signal F (fault) is sent to the control unit. Cycle stops.		●				●
V2 OK The valve V2 is tight. OK signal is sent to the control unit.	●			●		

Tab. 2

● LED switched on
◉ LED blinking

Applications

In addition to the basic diagram shown in Fig. 2-5, other connections are possible.

System with 2 safety valves and 2 pressure switches (Fig.6).

In the case of a large test volume, in order to reduce the testing time, two pressure switches can be used and set with different pressure values P_L and P_H.
When the tightness test is finished with positive result, the OK enable signal is sent to the burner control, which can now open the V1 and V2 valves.

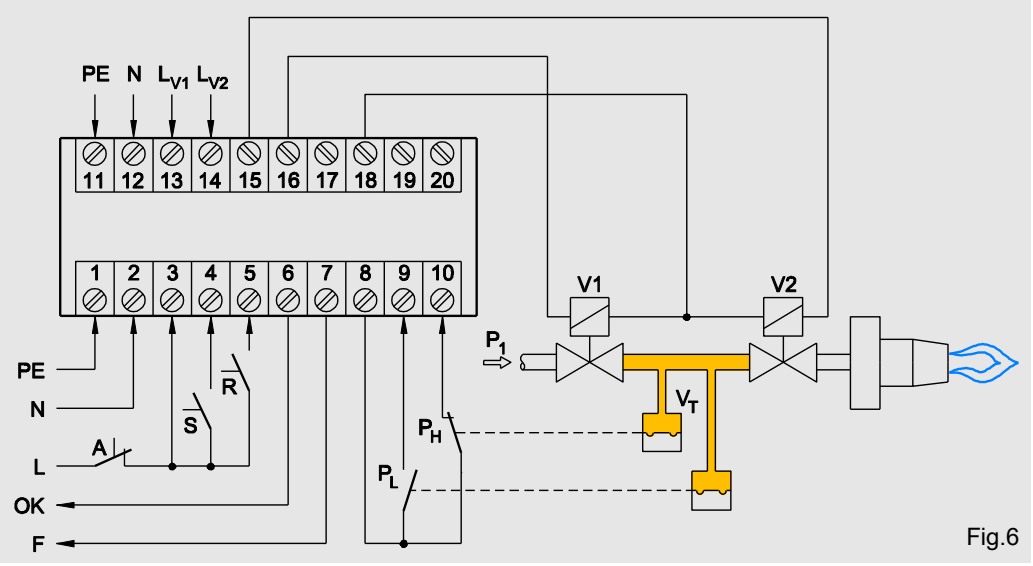


Fig.6

System with 2 safety valves and a auxiliary valve for the discharge (Fig.7).

If the second valve V2 is a slow opening type, it is necessary to install an auxiliary valve with fast opening V_D for the discharge into the combustion chamber (or in the atmosphere).
The device checks the tightness of the valves V1 and V2 and the auxiliary valve V_D. When the tightness test is finished with positive result, the OK enable signal is sent to the burner control, which can now open the valve V2.

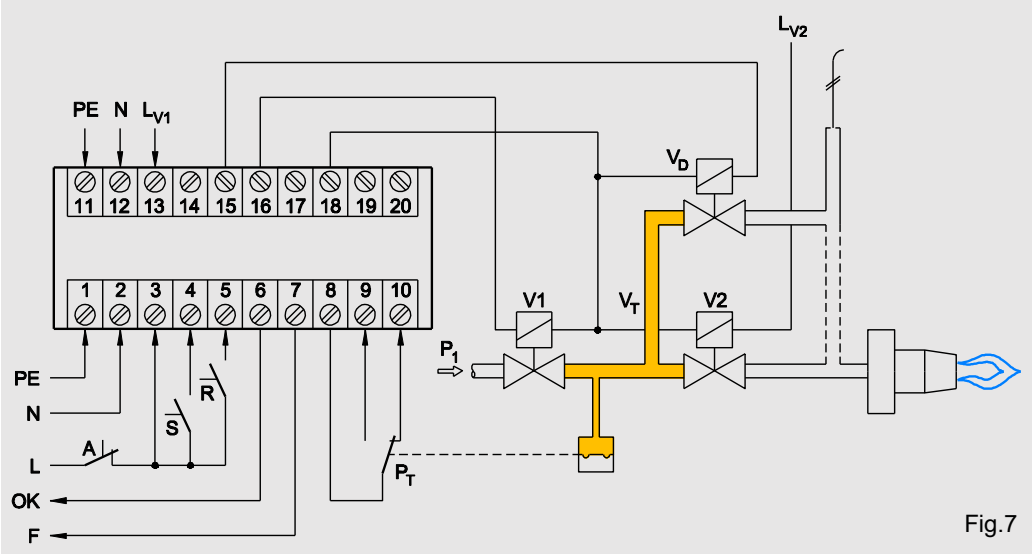


Fig.7

Multiple burner system with 2 safety valves installed in series and auxiliary valves for the filling and discharge (Fig.8).

The device checks the tightness of the main valve V1, the auxiliary valves V_F and V_D and the safety valves of each burner.
When the tightness test is finished with a positive result, the OK enable signal opens the main valve V1 and it is sent to the burner control, to enable the opening of the valves of each burner.

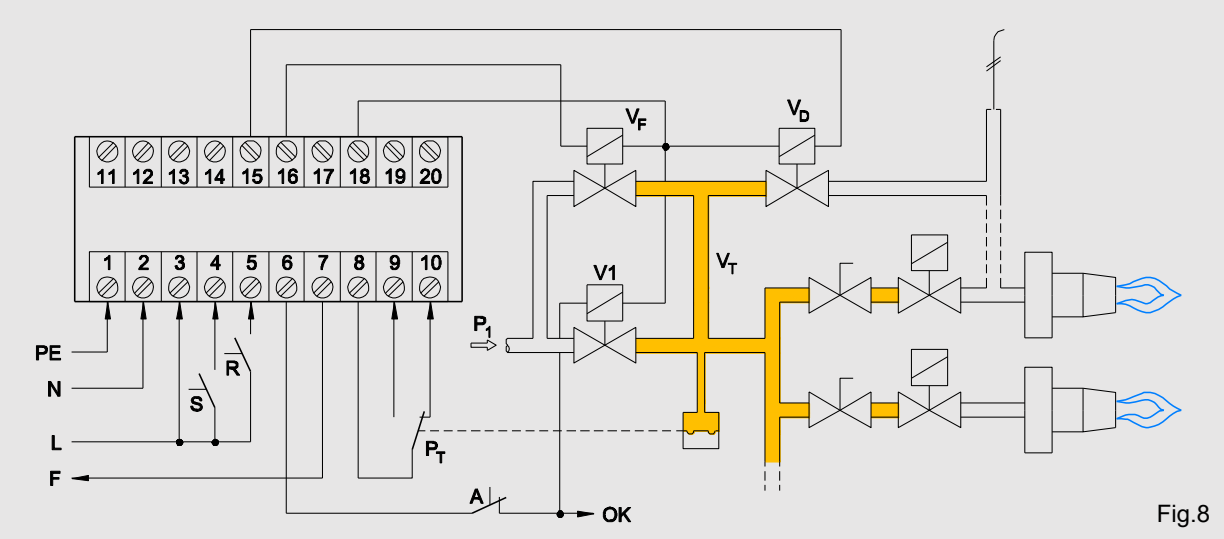


Fig.8

Multiple burner system with 3 safety valves installed in series (Fig.9)

If the main valves V1 and V2 are slow opening is necessary to install the V_F and V_D auxiliary valves for filling and discharging of the test volume V_T.
The device checks the tightness of the main valves V1 and V2 and the auxiliary valves V_F and V_D. The valve V2 can only be tested if the downstream pressure is approximately equal to the atmospheric pressure and the volume of this chamber is at least equal to 5xV_T.
To this purpose the V_K valve is opened by the Start-up signal to relieve the pressure at the value which is adjusted with the pressure switch P_2 (it must be calibrated so as to detect minimum increases of pressure). When the tightness test is finished with positive result, the OK signal disables the V_K valve (via the K normally closed contact), opens the valves V1 and V2 and, at the same time, enables the control units of each burner located downstream.

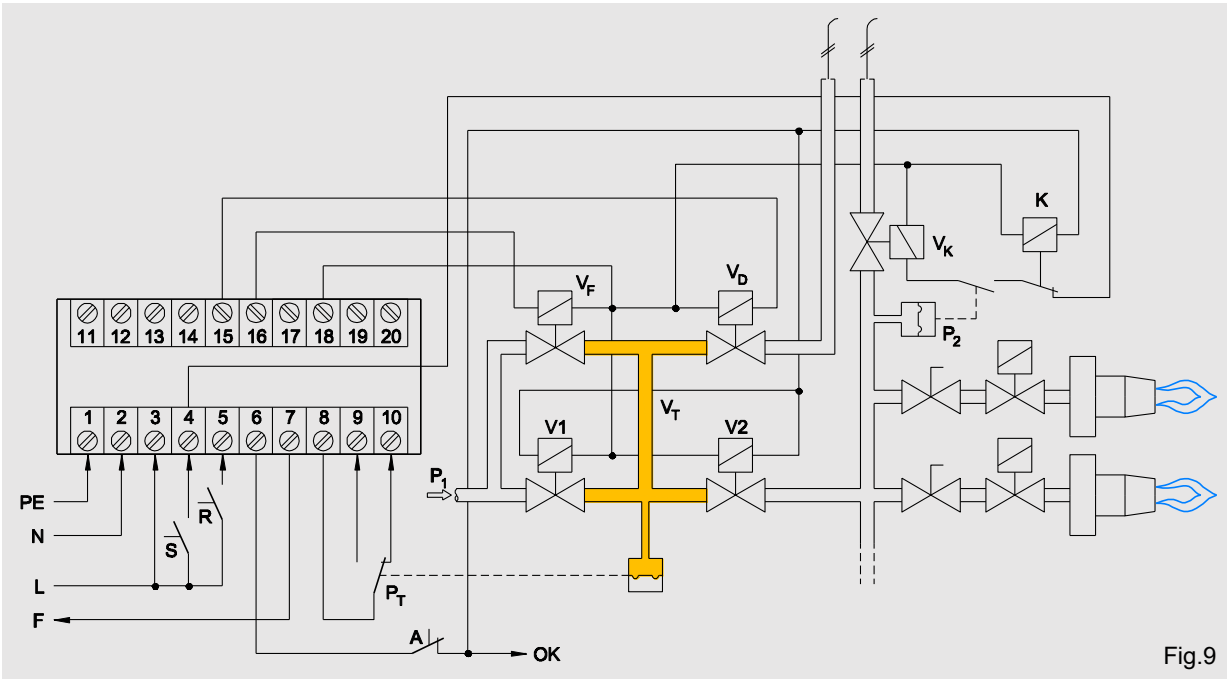


Fig.9

Sizing and adjustments

Leakage rate

According the EN 1643 standard the system shall prevent the opening of the valves when the leakage rate exceeds 0,1% of the burner heat input, starting over 50 dm^3/h.

Recommended leakage limit is 200 dm^3/h.

Example 1: with a burner capacity of 100 m^3/h, the maximum leakage rate is 100 dm^3/h. If the burner capacity is 30 m^3/h, the maximum leakage rate would be 50 dm^3/h.

The effective leakage rate in dm^3/h is given from the following equation (EN 13611):

$$q_L = \frac{3600 \cdot \Delta P_T \cdot V_T}{P_{ATM} \cdot t_P}$$

where:

ΔP_T is the difference between the initial and the final test pressure [mbar]
V_T is the test volume [dm^3]
P_{ATM} is the atmospheric pressure [mbar]
t_P is the test period [s]

From the above equation we can derive the duration of the test period required to detect the maximum permissible leakage:

$$t_P = \frac{3600 \cdot \Delta P_T \cdot V_T}{P_{ATM} \cdot q_L}$$

Adjustable test time

The test period t_P can be adjusted by means of the DIP1-9, increasing the sensitivity of the device: the longer the test period, the smaller the leakage detected.

The switch of a DIP to ON is equal to an equivalent time, according to following table:

1	2	3	4	5	6	7	8	9
10 s	20 s	30 s	40 s	50 s	60 s	70 s	80 s	90 s

Tab.3

If no DIP is switched to ON at power up, the device goes into lockout and an alarm is raised. Multiple DIP selections are not admitted.

According the EN 1643 standard, during the program sequence the gas may be discharge into the combustion chamber if the maximum release volume does not exceed 0,083% of the burner heat input, for each switching sequence. This means that the opening time to discharge can not exceed 3 seconds (t_O).

Example 1: with a burner capacity of 100 m^3/h, it is allowed the discharge into the combustion chamber of maximum 83 dm^3 of gas.

The total duration of the test is given by the sum then $2t_O+2t_P$, except when the device is powered-up and the self-test time t_A shall be considered.

When the main valves are the slow opening type, a minimum start rate is required in order to carry out tightness test. Otherwise, additional valves shall be used. The LD3 is provided with integrated auxiliary valves for this purpose.

Test volume

Test volume V_T consists of inner volume of one valve (outlet chamber of V1 plus inlet chamber of V2) plus pipe volume. A quick calculation of the test volume is possible through following table.

Tab. 4

Nominal diameter	Valve volume [dm^3]	Pipe volume [dm^3/m]
DN 10	0,07	0,1
DN 15	0,07	0,2
DN 20	0,12	0,3
DN 25	0,12	0,5
DN 32	0,47	0,8
DN 40	0,47	1,4
DN 50	0,62	2,0
DN 65	2,6	3,4
DN 80	2,6	5,0
DN 100	5,0	8,0
DN 125	17,2	12,4
DN 150	17,2	17,8
DN 200	31,7	31,4

Examples of calculation

Example 3: *2 valves DN50 with 20 cm of pipe*
Nominal flow rate 40 m^3/h
P1 = 100 mbar

V_T = 0,62 + 0,2 x 2 = 1,02 dm^3

q_L = 50 dm^3/h (minimum)

$$t_P = \frac{3600 \cdot 50 \cdot 1{,}02}{1013 \cdot 50} = 3{,}6s$$

Set the smaller test period: 10 s (DIP1=ON).

Example 4: *2 valves DN100 with 2 m of pipe*
Nominal flow rate 400 m^3/h
P1 = 200 mbar

V_T = 5,0 + 2 x 8,0 = 21 dm^3

q_L = 200 dm^3/h (recommended)

$$t_P = \frac{3600 \cdot 100 \cdot 21}{1013 \cdot 200} = 37{,}3s$$

Set the next highest value: 40 s (DIP4=ON).

Pressure switch adjustment

When a single pressure switch is used, it should be set to half the inlet pressure ($P_T=P_1/2$). This allows the same sensitivity for both the test of V1 (upward pressure) and the test of V2 (downward pressure). Note that the upward intervention point of a pressure switch is slightly different from the downward one.

During the discharge the pressure in the test section must drop to a value close to atmospheric pressure ($P_D \cong P_{ATM}$), allowing the recovery of the pressure switch. If this does not occur (for example when the volume of the test section is very high), the device goes into *wait* mode (yellow LED steady on) and after 60 seconds it repeats the discharge. After three unsuccessful attempts the device enters in the lock-out state and an alarm is raised.

If at the end of the discharge P_T is slightly below $P_1/2$, the test starts anyway. But, in this case negligible leakages of V1 can lead P_T overcome $P_1/2$, activating the pressure switch, and the device will signal a fault. For this reason, after installation it is advisable to check the actual values of P_T.

Similarly, during the filling the pressure in the test section must rise to a value close to the inlet pressure ($P_F \cong P_1$), allowing the activation of the pressure switch. If this does not happen the device waits as described above.

The diagram of Fig. 10 shows the sequence of operation in the case of using a single pressure switch.

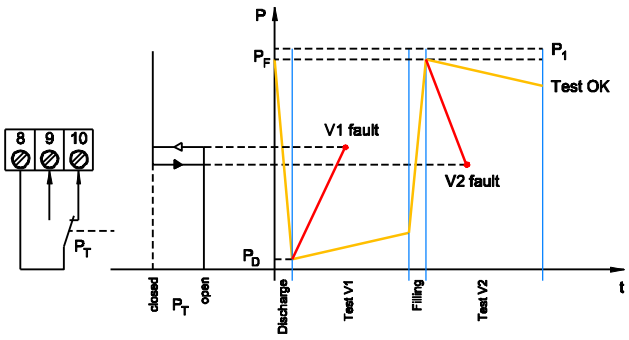


Fig. 10

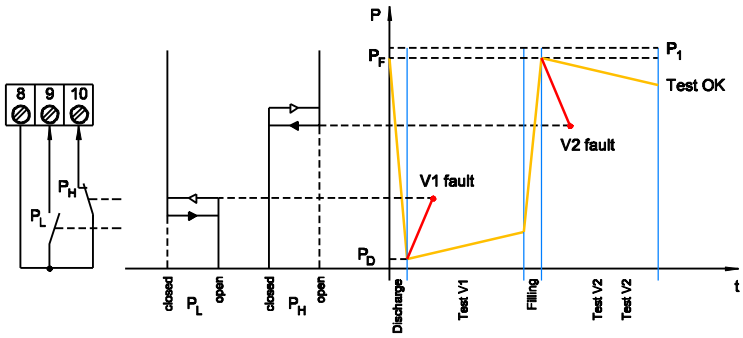


Fig. 11

If the time t_P, calculated as described above, is too high for the burner operating cycle, it is possible to connect two pressure switches. This allows to set different thresholds for V1 and V2, and then to set shorter test times (Fig. 11).

Example 5: *2 valves DN100 with 4 m of pipe*
Nominal flow rate 600 m³/h
P1 = 500 mbar

V_T = 5,0 + 4 x 8,0 = 37 dm³

q_L = 200 dm³/h (recommended)

$$t_P = \frac{3600 \cdot 250 \cdot 37}{1013 \cdot 200} = 164s$$

Using a single pressure switch, the test period should be higher than the maximum adjustable time (90 s).

The alternative is to use two pressure switches with the following thresholds:

P_L = 50 mbar e P_H = 450 mbar

In this case ΔP = 50 mbar for both the pressure switches, and

$$t_P = \frac{3600 \cdot 50 \cdot 37}{1013 \cdot 200} = 32,9s$$

Set the next highest value: 40 s (DIP4=ON).

Adjustable test instant

The system can be instructed about the moment to start the tightness test by using the DIP10. The test can be done either before the ignition of the burner or after its stop. In this last case the system is ready for the following ignition when the start signal (S) comes from the burner control unit.

Mode 1.

	10
OFF	■
ON	

The device is switched on by applying voltage to terminal 3. When is applied the start signal (S), the test cycle starts. If the valves are tight the green LED4 is switched on and the OK signal is provided to the burner control (Fig.12). If a leakage is found on either the valve V1 or V2, the related red LED5/6 is switched on and the fault signal (F) is provided to the burner control (Fig.13)

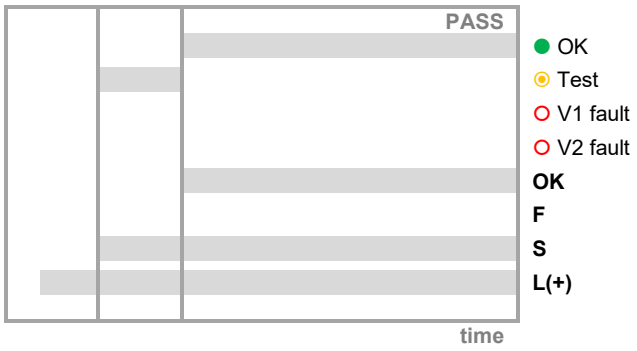


Fig.12

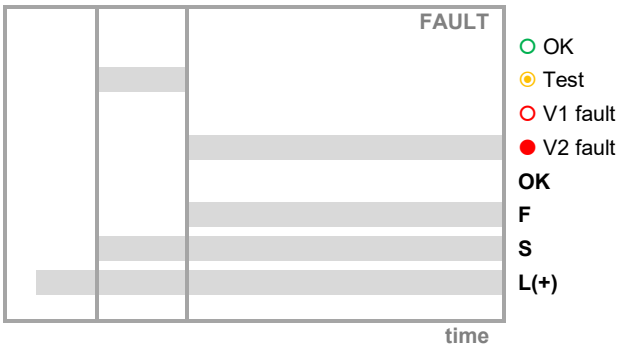


Fig.13

Mode 2.

	10
OFF	
ON	■

The device is switched on by applying voltage to terminal 3. The test cycle is started automatically without waiting for the start signal (S). If the valves are tight the green LED4 is switched on, but the OK signal is not provided to the burner control as long as it is not received the start signal (Fig.14). When the burner operating cycle is finished, the start signal is turned off and the device immediately starts a new test cycle. If a leakage is found on either the valve V1 or V2, the related red LED5/6 is switched on and the fault signal (F) is provided to the burner control (Fig.15).

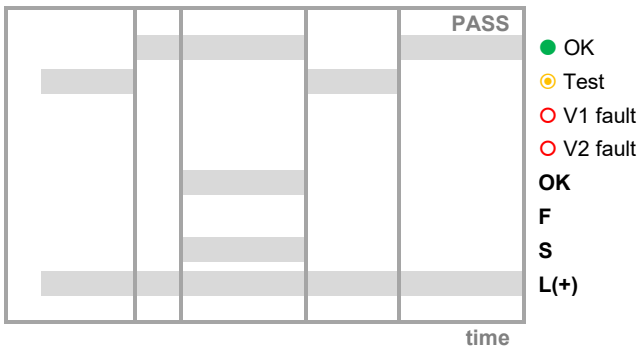


Fig.14

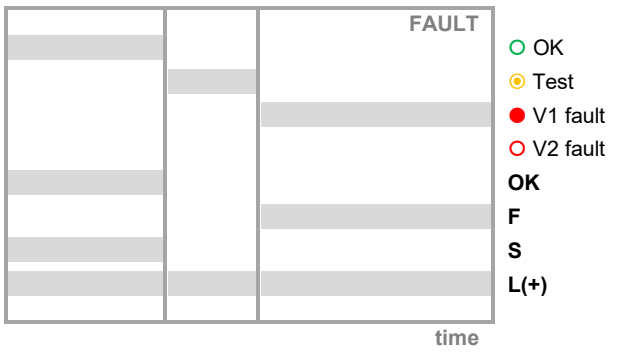


Fig.15

Fault state

Device is driven to fault state when one of the following events occur:

- an inadmissible leak is detected from one valve
- discharge/filling operation has failed after three attempts
- a fault or an abnormal condition has been detected during the self-diagnosis.

The fault state is saved by the device and persists when electrical power is shut down (non-volatile lock-out).

Reset can be performed remotely by applying voltage to terminal 5, or keeping the manual reset button pressed for at least 3 seconds. The remote unlock can be made up to five times in 10 minutes. When this limit is reached, the device must be unlocked by means of the manual reset button only.

A fault or redundancy error that causes the microcontrollers to lock-out cannot be stored (volatile lock-out) and requires a device restart.

Alarms chart

Tab.5

Alarm No.	LED2 ●	Description	Possible cause
1	1 Flashing	Pressure switch	Pressure switch missing Pressure switch wiring is wrong Polarity of main voltage 24VDC is reversed
2	2 Flashing	Anomalous voltage at output OK or FAULT (6, 7) during boot or ready state	Incorrect electrical wiring Relay defective
3	3 Flashing	Anomalous voltage at input V1 or V2 (13, 14) during boot or ready state	Incorrect electrical wiring Attempt to open the valves without the OK enable signal activated Relay defective
4	4 Flashing	Inconsistency voltage at output OK or FAULT (6, 7) during test, ok or leak state	Relay defective
5	5 Flashing	Inconsistency voltage at output V1 o V2 (15, 16) during test, ok or leak state	Relay defective
6	6 Flashing	Discharge of test volume failed after 3 attempts	Discharge valve defective or not connected Filling valve with very high leakage Pressure switch not adjusted properly Pressure switch terminals are reversed
7	7 Flashing	Filling of test volume failed after 3 attempts	Filling valve defective or not connected Discharge valve with very high leakage Test volume not sealed Pressure switch not adjusted properly
8	8 Flashing	Error in signal RESET (terminal 5)	Remote signal RESET always active
9	9 Flashing	Error in reading the memory at start-up	Press Reset button. If the error persists return the unit to the manufacturer for inspection
10	10 Flashing	Test period undefined	No test period selected or wrong selection
	Steady on	Redundancy test failed	Restart the device. If the error persists return the unit to the manufacturer for inspection

n-Flashing (2 per second) followed by a longer pause (2 seconds)

Troubleshooting

No Led is lit although mains voltage is applied
- Fuse is blown - Mains voltage too low - L1 and N are reversed - Power circuit failure
The downstream burner control unit does not start
- L1 e N are reversed
The test is running without the Start signal
- Mode 2 is set up (dip10=ON)
Yellow Led steady on
- Waiting 60s: filling or discharge failed. After three unsuccessful attempts the device enters in the lock-out state and an alarm is raised.

Tab.6

Technical specifications

Tab. 7

Voltage	230VAC 50/60Hz 110-120VAC 50/60Hz 24V DC
Voltage tolerance	-15% / +10%
Power absorption	10 VA (1W for 24V DC) Integrated valves 2x21 VA
Ambient temperature	-15°C / +60°C
Enclosure	IP54 (LD) IP65 (LDM)
Cable gland	PG9 for cable Ø6 / 8 mm PG16 for cable Ø10 / 12 mm
Wires cross-section	2,5 mm^2 max
Fuse	4 A replaceable 8 A non-replaceable
Output signals	4 A max. resistive 2 A max. inductive
Reset	Applying mains voltage Reset button
Test period	10 s / 90 s adjustable
Filling/ Discharge time	3 s
Max. Working pressure	500 mbar (50 kPa)
Connections	Rp 1/4
Gas type	Non-aggressive gases included in the 1, 2 and 3 families (EN 437)
Integrated pressure switch	Comply with EN 1854
Integrated solenoid valves	Comply with a EN 161, class A
Weight	LD1 450 gr LDM2 1200 gr LD3 1600 gr LDM4 2100 gr

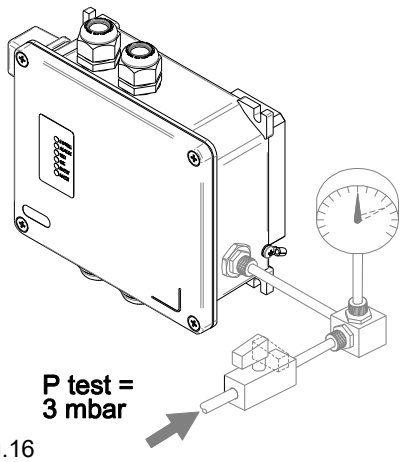


Fig.16

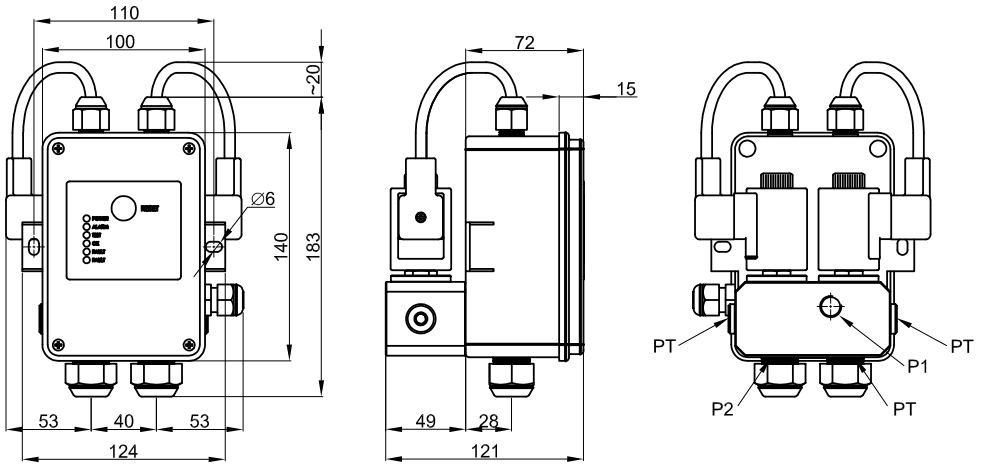
The unit can be provided in Ex-Proof version for use in Zones 2 and 22, according to 2014/34/EU Directive (ATEX):

category	II 3G, II 3D
protection mode	Ex nR IIA T4 Gc X (restricted breathing enclosure) Ex tc IIIC T135°C Dc X

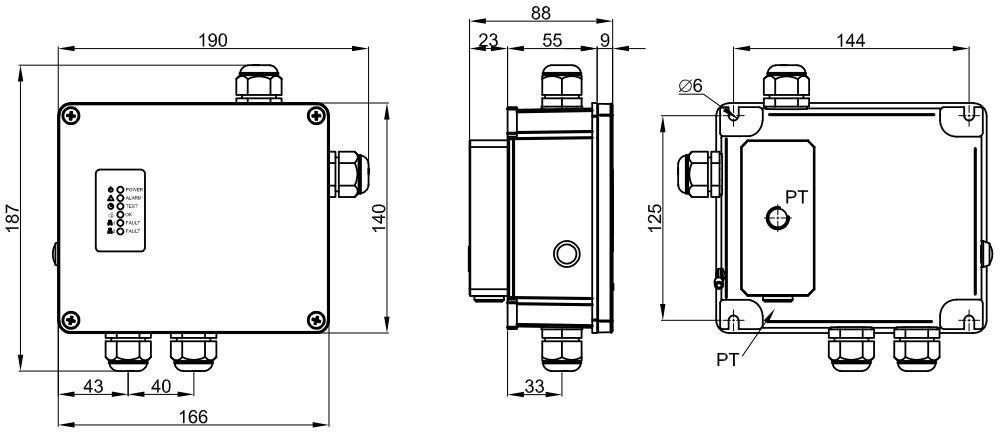
This version is provided with a 1/8" test port. After closing of the cover, a restricted breathing test of the enclosure shall be performed (see the instructions sheet for ATEX installations).

Overall dimensions

LD1
LD3



LDM2



LDM4

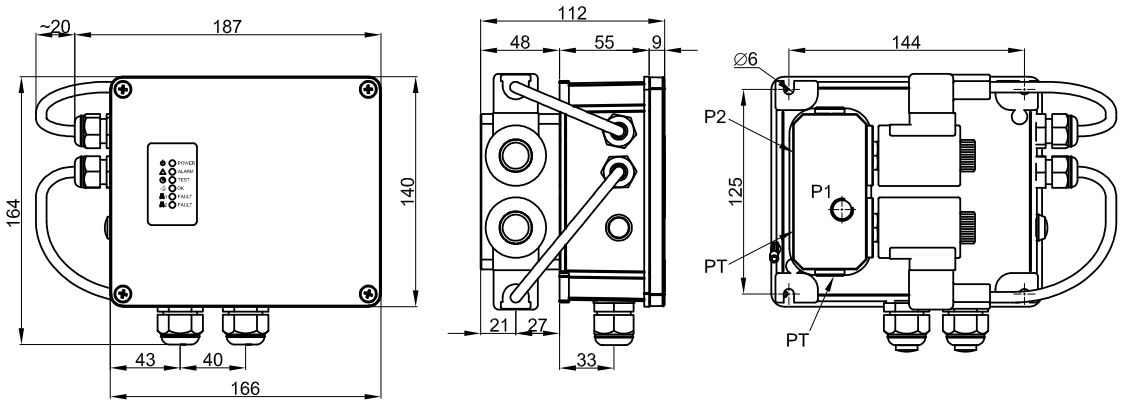
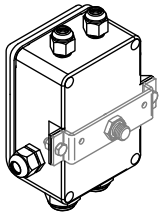
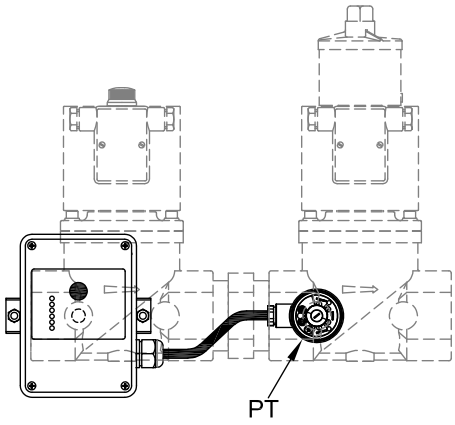


Fig. 17

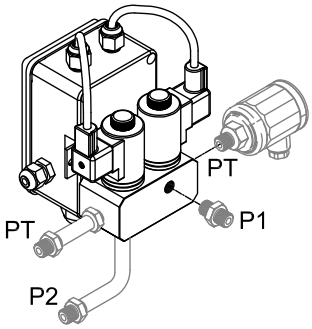
Installation

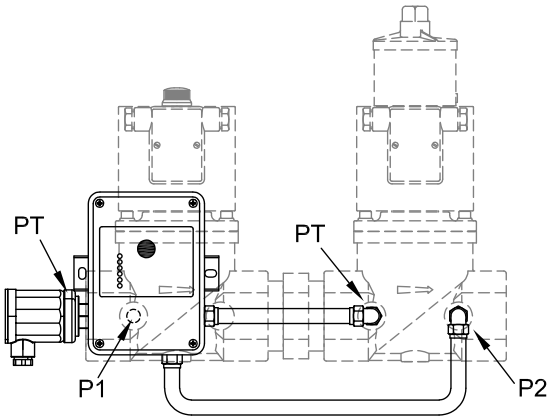
LD1



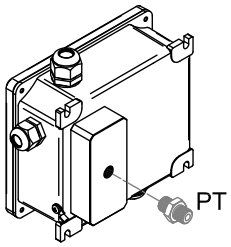


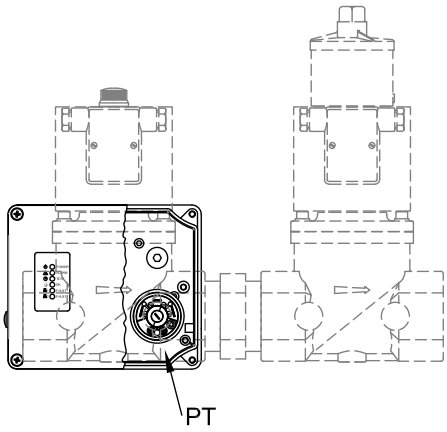
LD3



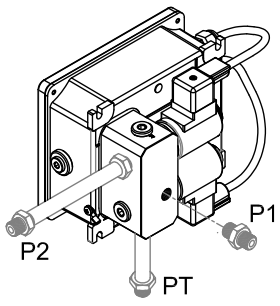


LDM2





LDM4



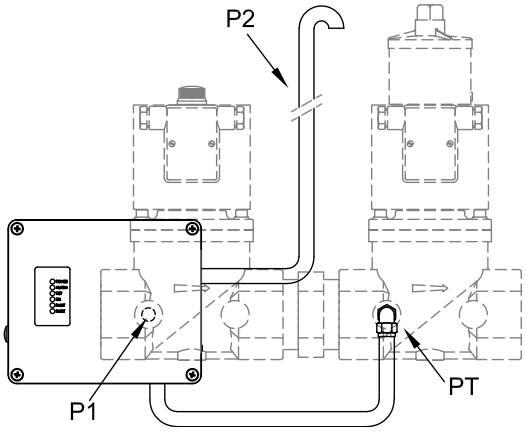


Fig. 18

Ordering information

Tab.8

	LDM	4	00	A	64	.	X

Model

LD	plastic enclosure
LDM	metal enclosure

Type

LD1	electronic board only
LD3	integrated solenoid valves [1]
LDM1	electronic board only
LDM2	integrated pressure switch
LDM3	integrated solenoid valves [1]
LDM4	integrated pressure switch and solenoid valves [1]

Solenoid valves wiring

00	integrated solenoid valves
01	1 input - 2 outputs with cable gland

Voltage

A	230V 50/60Hz
B	110-120V 50/60Hz
C	24V DC

Pressure switch (LDM only)

61	5-20 mbar
62	10-50 mbar
63	25-100 mbar
64	50-250 mbar
65	100-500 mbar

Special versions

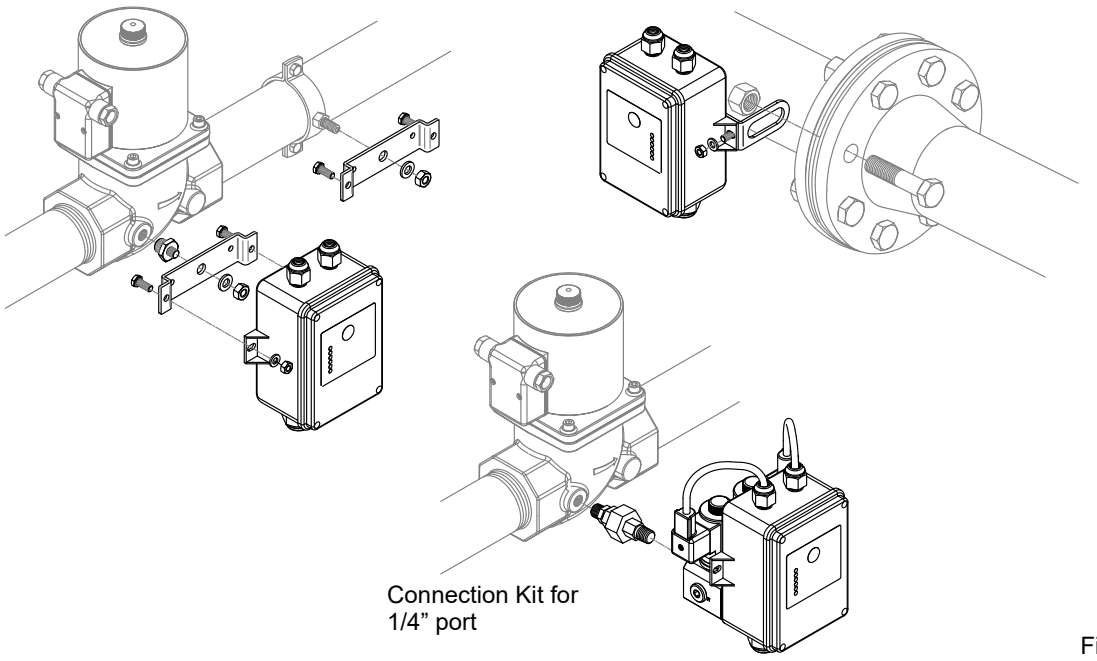
J	Aggressive gases
X	Ex-Proof

([1]) For test volume V_T up to 20 dm^3.

Accessories

Bracket for connection on 1/4” port or on pipe holder

Bracket for connection on bolt M16



Connection Kit for 1/4” port

Fig. 19

Standards and approvals

The product complies with the essential requirements of the following European Directives and their amendments:

CE

2014/30/EU (Electromagnetic Compatibility)
2014/35/EU (Low Voltage Directive)
2014/34/EU (ATEX) when shown upon the product
2011/65/EU (RoHS II)

The product complies with the requirements of EN 13577-2:2024 section 4.3.7 and gives an equivalent level of safety according to EN 1643:2023.

Sistema di Gestione della Qualità certificato secondo la norma UNI EN ISO 9001.

The information in this document contains general descriptions of technical options available and based on current specifications.
The company reserves the right to make changes in specifications and models as design improvements are introduced, without prior notice.
Visit Elektrogas website for updates and further details.

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