Safety manual for products complying with DIN EN 61508-2, Annex D
Series DG pressure switches

Technical Information · GB

4 Edition 02.16

elster
Thermal Solutions

Contents

1 Introduction

1.1 Scope of application

This manual sets out all necessary requirements to comply with Standards IEC 61508 and IEC 61511 on functional safety, and information on planning, installing, servicing and maintaining safety instrumented functions (SIF).

1.2 Responsibility for safety

Manufacturers and operators must ensure that the complete safety instrumented system in which the pressure switches are used is designed and operated correctly with regard to safety.

1.2.1 Manufacturer's obligations

- To design and build products to be safe
- To forward all necessary information to the operator of the complete system
- To comply with all regulations and directives which make safe commissioning possible

1.2.2 Operator's obligations

- To train all personnel working on the complete system
- To maintain safe operation of the complete system
- To comply with all regulations and directives relating to labour protection and industrial safety
- To ensure regular inspection of the complete system through strict compliance with all regulations regarding operation of the product

1.3 Definitions and abbreviations

FMEDA	Failure Modes, Effects and Diagnostic Analysis
HFT	Hardware Fault Tolerance
PFD_{AVG}	Average Probability of Dangerous Failure on Demand
SFF	Safe Failure Fraction
SIL	Safety Integrity Level: one of four discrete levels, which correspond to a value range, whereby Safety Integrity Level 4 is the highest level of safety integrity and Safety Integrity Level 1 is the lowest
SIF	Safety Instrumented Function
SIS	Safety Instrumented System
DC	Diagnostic Coverage (if diagnostics facilities exist)
PTC	Proof Test Coverage Factor, factor describing the probability of detecting dangerous failures by means of the proof test
PFH	Mean Probability of Dangerous Failure per Hour
$MTBF_{(D)}$	Mean Time between (Dangerous) Failures

1.4 Reference documents

- Technical Information DG
- Operating instructions DG..H, DG..N, DG..I
- Operating instructions DG..B, DG..U
- TÜV SIL Certificate
- TÜV PL Certificate
- TÜV report S3592013 E4
- FMEDA

1.5 Applicable standards

- DIN EN 61508, Parts 1–2 and 4–7:2011, Functional safety of electrical/electronic/programmable electronic safety-related systems
- DIN EN 61511, Parts 1 – 3:2005, Functional safety – Safety instrumented systems for the process industry sector
- DIN EN 1854:2010, DIN EN 13611:2015

2 Introduction

DG..U-3

Adjustable switching point

DG..H, DG..N

DG..H: switches and locks off with rising pressure. DG..N: switches and locks off with falling pressure. Manual reset.

DG..-6

With fitted socket pursuant to DIN EN 175301-803

DG..T

Hand wheel with "WC and mbar scale. NPT conduit for electrical connection.

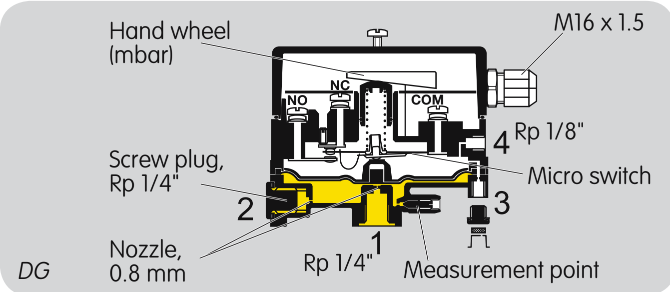
The gas pressure switch DG monitors extremely low pressure differentials and triggers switch-on, switch-off or switch-over operations if a set switching point is reached. The switching point can be adjusted using a hand wheel.

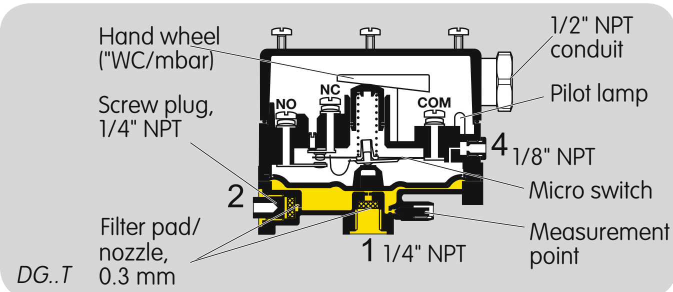
It monitors positive and negative gas pressures on various industrial gas and air appliances, such as boiler fan monitoring and differential pressure monitoring in firing, ventilation and air-conditioning systems.

The TÜV-tested special-design pressure switch is used as defined by VdTÜV Code of Practice “Druck 100/1” (Pressure 100/1) in firing installations for steam and hot-water generators in accordance with TRD 604, Para. 3.6.4, as well as class “S” for DG..B, DG..U and DG..I pursuant to EN 1854.

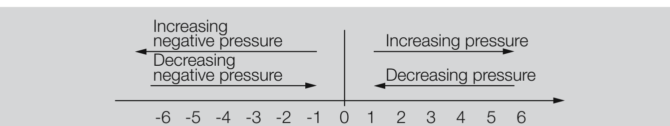
Type	Positive pressure	Negative pressure	Differential pressure
DG..B	Gas, air, flue gas or biomethane	–	–
DG..U, DG..T	Gas, air, flue gas or biomethane	Air or flue gas	Air or flue gas
DG..H, DG..N, DG..HT, DG..NT	Gas, air, flue gas or biomethane	Air or flue gas	Air or flue gas
DG..I	Air or flue gas	Gas, air, flue gas or biomethane	Air or flue gas
DG..S	NH_3 or O_2	–	–

2.1 Function





The pressure switch DG switches in the event of increasing or decreasing pressure. Once the set switching point is reached, a micro switch is activated in the DG which is designed as a change-over contact.



The switching pressure is adjusted using a hand wheel.

2.2 Positive pressure measurement

Positive pressure measurement is designed, for example, for checking the fan function or measuring the min./max. gas pressure.

The positive pressure is measured in the lower diaphragm chamber, port **1** or **2**.

The upper diaphragm chamber is ventilated via port **3** or **4**.

2.3 Negative pressure measurement

Negative pressure measurement (air, flue gas) is designed, for example, for monitoring a suction pressure blower. The negative pressure is measured in the upper diaphragm chamber, port **3** or **4**, and on DG..T via port **4**. The lower diaphragm chamber is ventilated via port **1** or **2**.

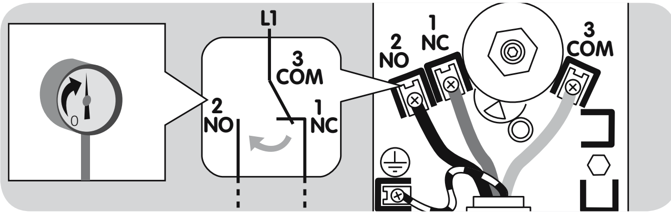
In the case of DG..I, the negative pressure (gas, air, flue gas or biogas) is measured in the lower diaphragm chamber, port**1** or **2**. The upper diaphragm chamber is ventilated via port **3** or **4**.

2.4 Differential pressure measurement

Differential pressure measurement is designed for safeguarding an air flow rate or for monitoring filters and fans, for instance.

DG..U, DG..H, DG..N: the higher absolute pressure is connected to port **1** or **2**, and the lower absolute pressure to port **3** or **4**. The remaining ports must be tightly plugged.

2.5 Connection diagram



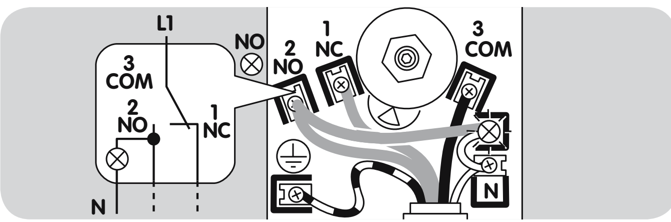
Contacts **3** and **2** close when subject to increasing pressure. Contacts **1** and **3** close when subject to falling pressure.

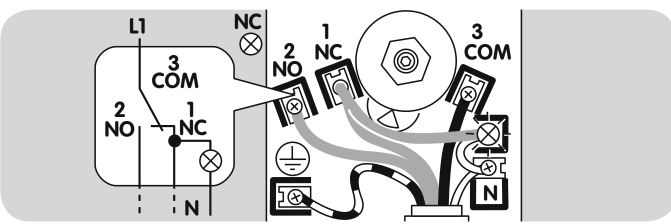
All DG models (except DG..N) switch with rising pressure. The contact switches from NC 1 to NO 2.

DG..N switches with falling pressure. The contact switches from NO 2 to NC 1.

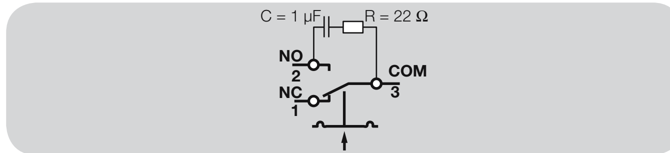
DG..H and DG..N are locked off in their switched state and can only be unlocked with a manual reset.

2.5.1 Blue pilot lamp for 230 V AC or 120 V AC



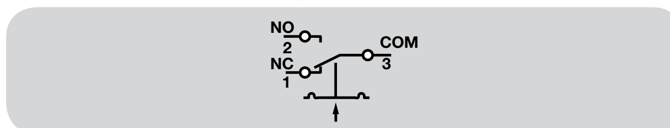


When using silicone tubes, only use silicone tubes which have been sufficiently cured. Vapours containing silicone can adversely affect the functioning of electrical contacts. In the case of low switching capacities, such as 24 V, 8 mA, for example, we recommend using an RC module (22 Ω, 1 μF) in air containing silicone or oil.



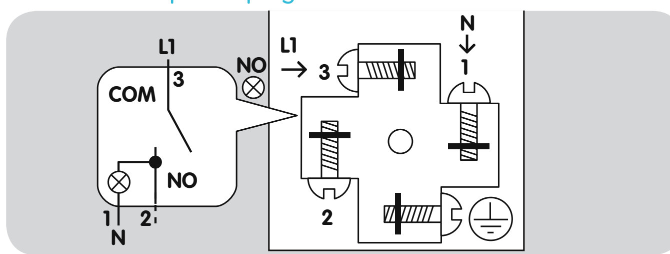
In the case of high humidity or aggressive gas components (H_2S), we recommend using a pressure switch with gold contact due to its higher resistance to corrosion. Closed-circuit current monitoring is recommended under difficult operating conditions.

2.5.2 All DG models (except DG..I)

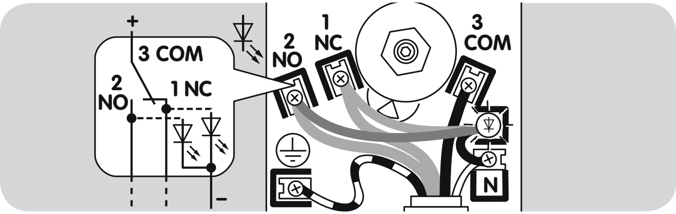


Contacts **3** and **2** close when subject to increasing pressure. Contacts **1** and **3** close when subject to falling pressure.

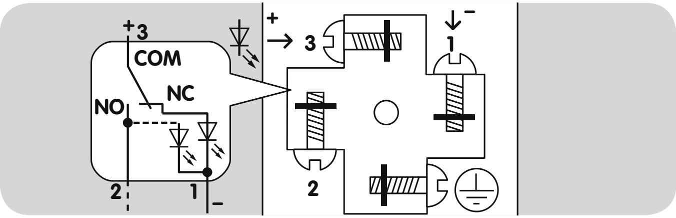
2.5.3 Pilot lamp with plug



2.5.4 Red/green pilot LED for 24 V DC/AC or 230 V AC



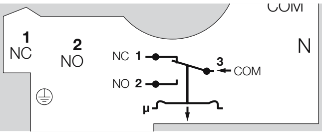
2.5.5 Pilot LED with plug



2.6 Wiring

If the DG..G has switched a voltage > 24 V and a current > 0.1 A at cos φ = 1 or > 0.05 A at cos φ = 0.6 once, the gold plating on the contacts will have been burnt through. It can then only be operated at this power rating or higher power rating.

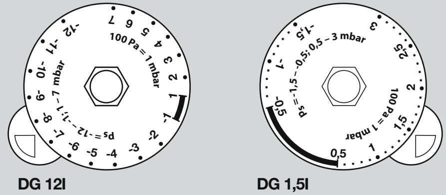
2.6.1 DG 18l, DG 120l, DG 450l



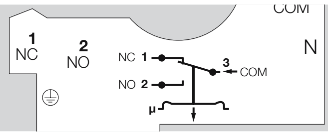
Contacts **3** and **2** close when subject to increasing negative pressure. Contacts **1** and **3** close when subject to falling negative pressure.

2.6.2 DG 1,5l and DG 12l

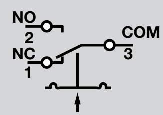
The connection of DG 1,5l and DG 12l depends on the positive or negative adjusting range.



In the negative adjusting range, the template which can be found in the unit displays the connection diagram.



In the positive adjusting range, remove the template and wire the unit as shown in the engraved connection diagram.



3 Information relevant to functional safety

3.1 Safety function

The safety function involves the safe closing and opening of the circuits COM-NO and COM-NC, depending on the available pressure, and ensuring external tightness.

3.2 Ambient conditions/Operating limits

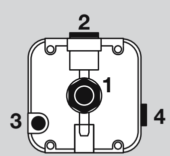
Housing pressure is max. ± 600 mbar against atmospheric pressure.

The operating and ambient temperatures are -20 to +80°C. The pressure switches are suitable for indoor use. Outdoor use is only permitted if a weather protection cover is used or a roof is installed to protect the device from the rain and sun.

3.2.1 Media

Gas type

Natural gas, town gas, LPG (gaseous), flue gas and biogas. Continuous operation at high temperatures (e.g. maximum ambient temperature) accelerates the ageing of elastomer materials and reduces the service life (please contact manufacturer). Ozone concentrations exceeding 200 µg/m^3 or gases containing more than 0.1 %-by-vol. H_2S accelerate the ageing of elastomer materials and reduce the service life.



Ports **3** and **4** are connected to the micro switch chamber. The port that is best protected against soiling (dust/humidity) is to be left open for ventilation (in the case of positive pressure measurement) to the atmosphere. If dust exposure in the environment is high, a filter pad, see “Accessories”, or a filter is to be used in the open port.

Combustion gas or a mixture of combustion gas and air must not be connected to port **3** or **4**.

In the case of high switching frequency (more than once per minute), it is also recommended to use a filter pad since the exchange of air with the environment considerably increases the risk of foreign particles entering the pressure switch and thus a malfunction can occur at low voltages and currents.

Condensation must not be allowed to get into the housing (if possible, install pipework with an ascending gradient). Otherwise, there is a risk of icing of condensation at subzero temperatures, the switching point shifting or corrosion in the device. This can lead to malfunctions.

Closed-circuit current monitoring is recommended if there is a risk of contact corrosion (too humid or aggressive surrounding air) or foreign particles in the surrounding air.

If they are equipped with suitable supply lines, pressure switches are able to monitor pressures in flue gas lines at high temperatures. It is just necessary to ensure that the hot medium does not enter the switch during a switching operation.

For this, the switching volume of the pressure switch is to be observed.

Volume per switching operation:
DG 6 – 50U, B, H, N, DL 5 – 50A, K = max. 9.5 cm^3,
DG 150 – 500U, B, H, N, DL 150A, K = max. 2.5 cm^3.

Requirement on the supply line

The volume of the supply line must be at least 1.2 times greater than the switching volume to ensure that the hot medium does not flow directly into the switching chamber. This accelerates ageing of the diaphragm and possible contact corrosion.

If there is a risk of condensation forming, the supply line must be installed with an upward gradient towards the pressure switch. Small line diameters are preferable (ID = 5 mm) to ensure that the humidity can condense in the long line and flow back into the furnace/chimney.

In the case of high switching frequency (more than once per minute), the volume of the line should be double that of the switching operation. Otherwise, there is a risk that there will not be enough time or volume available for cooling if the media from the hot furnace and the tube volume are mixed.

3.3 Design verification

A Failure Mode and Effects Analysis has been carried out to assess possible design-related failures and to classify these into safe and dangerous failures.

3.4 SIL suitability

The pressure switches are suitable for use in a safety-related system pursuant to IEC 61508 up to SIL 2. The pressure switches can also be used in a redundant version up to SIL 3, taking into account the minimum Hardware Fault Tolerance HFT = 1 required.

3.4.1 Characteristic values from the TÜV assessment

Determining the PFH_Dvalue, the λ_D value and the $MTTF_d$ value

$$PFH_D = \lambda_D = \frac{1}{MTTF_d} = \frac{0,1}{B_{10d}} \times n_{op}$$

3.4.2 Safety-specific characteristic values for DG

For SIL	
Suitable for Safety Integrity Level	SIL 1, 2, 3
Diagnostic coverage DC	0
Type of subsystem	Type A to EN 61508-2, 7.4.3.1.2
Operating mode	High demand mode pursuant to EN 61508-4:2001, 3.5.12
For PL	
Suitable for Performance Level	PL a, b, c, d, e
Category	B, 1, 2, 3, 4
Common cause failure CCF	> 65
Application of essential safety requirements	Satisfied
Application of tried-and-tested safety requirements	Satisfied
For SIL and PL	
	B_{10d} value
U = 24 V DC, I = 10 mA; U = 230 V AC, I = 4 mA	6,689,477 operating cycles
U = 24 V DC, I = 70 mA; U = 230 V AC, I = 20 mA	4,414,062 operating cycles
U = 230 V AC, I = 2 A	974,800 operating cycles
Hardware fault tolerance (1 component/switch) HFT	0
Hardware fault tolerance (2 components/switches, redundant operation) HFT	1
Safe failure fraction SFF	> 90 %
Fraction of undetected common cause failures β	≥ 2 %

The pressure switches are suitable for single-channel systems (HFT = 0) up to SIL 2/PL d, and up to SIL 3/PL e when two redundant pressure switches are installed in a double-channel architecture (HFT = 1), provided that the complete system complies with the requirements of EN 61508/ISO 13849.

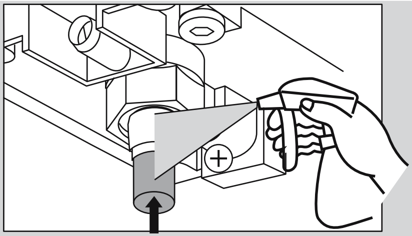
4 Installation and commissioning

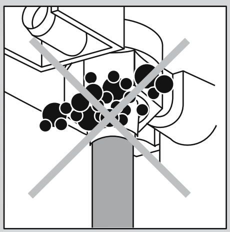
See operating instructions DG..H, DG..N, DG..I and notes in this safety manual

5 Operation and maintenance

5.1 Inspection interval

5.1.1 Tightness





Apply pressure to device and test the joints using leak detection spray. No bubbles should form.

5.1.2 Function test on installed pressure switches

There are three ways of testing installed pressure switches for correct functioning. Ensure that the measuring instruments used comply with the accuracy defined for the process variable which is critical for safety.

Checking the switching point by measuring the process variable which is critical for safety

Examples

Gas min. pressure switch

Safety-relevant function: should prevent the gas pressure from dropping so low that an unwanted air excess is generated during combustion.

Device used: DG 30B-3, hand wheel setting: 15 mbar.

System parameters: operating pressure is not measured (not important for this method), signal between COM and NO.

Test: measure the O_2 content in the flue gas, then slowly reduce the gas flow (manual valve). If there is too much O_2 (air excess), the DG should have switched off the system beforehand.

Flue gas differential pressure switch on the chimney

Safety-relevant function: the DG should prevent it being impossible to discharge the flue gases to the open air and should avoid incomplete combustion.

Device used: DG 6U-3, hand wheel setting: 5 mbar, was determined during commissioning of the system.

System parameters: operating pressure is not measured (not important for this method), signal between COM and NO.

Test: measure the CO content in the flue gas, then slowly close off the chimney. The DG should have switched off before incomplete combustion occurs.

5.1.3 Checking the switching point by measuring when installed

Gas max. pressure switch

Safety-relevant function: should prevent gas pressure from increasing and exceeding p_{max} of the other components used and thus impairing/preventing correct functioning. **Device used:** DG 150B-3, hand wheel setting: 100 mbar. **System parameters:** operating pressure is not measured (not important for this method), signal between COM and NC.

Test: connect the pressure gauge to the DG pressure test point, slowly adjust the regulator upstream of the DG so that the gas pressure increases. The DG switch-on point (COM-NO) should be reached before attaining p_{max} of the downstream components.

Gas min. pressure switch

Safety-relevant function: should prevent the gas pressure from dropping so low that incomplete combustion (formation of CO) occurs. A minimum of 40 bar is required to ensure proper functioning of the burners according to the information provided by the manufacturer.

Device used: DG 150U-3, hand wheel setting: 41.4 mbar. Hand wheel setting for the switch-off point is calculated as follows: SPHE = SPA + (S_{min} + (S_{max} - S_{min}) / (E_{max} - E_{min}) x (SPA - E_{min})) = 41.35 mbar

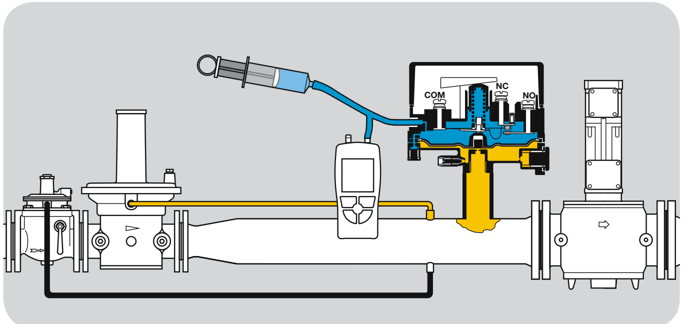
Type	Hand wheel adjusting range				Example		
	Switch-on point		Switching differential		Switch-off point	HS switching differential for hand wheel setting	SPHE hand wheel switch-on point
	E_{min}	E_{max}	S_{min}	S_{max}	SPA		
DG 50	2.5	50	0.8	1.5	40	1.35	41.35

All specifications in mbar

System parameters: the operating pressure is 55 mbar.

▼

Test:



the pressure is measured at the test point. In this example, it is 55 mbar. Then the open 1/8" port, which is usually used to measure atmospheric pressure, is attached to a syringe and connected measuring instrument. The plunger is then pushed in slowly and the reaction of the system is observed. If the pressure is around 15 mbar (p_S = 55 - 15 = 40 mbar), the DG should switch off (COM-NC) and the system should shut down.

Flue gas differential pressure switch on the chimney

Safety-relevant function: the DG should stop it being impossible to discharge the flue gases to the open air (bird's nest on chimney) and prevent incomplete combustion (formation of CO). A pressure differential of 5 mbar is required according to the information provided by the manufacturer.

Device used: DG 10U-3, hand wheel setting: 5.3 mbar for a switch-off point of 5 mbar.

System parameters: in normal operation, the pressure drops by 22 mbar due to the orifice, signal between COM and NO.

Test: a pressure of 22 mbar is measured at the test point. In this case, the line which leads to one of the 1/8" ports must be dismantled. The syringe and measuring instrument are connected to this port. The plunger is pushed in slowly and the DG should switch off at around 17.3 mbar. Signal at COM-NC.

Pressure switch should monitor fan pressure

Safety-relevant function: pre-purge to remove any air/gas mixture from the combustion chamber before ignition, then safeguarding of the combustion air. For this, the manufacturer specifies a switch-on point of 18 mbar.

Device used: DG 30B-3, hand wheel setting: 18 mbar.

System parameters: in normal operation, the fan generates a pressure of 28 mbar. In this case, the burner is not operating. It should only be checked whether the actual switching pressure is 18 mbar.

Test: connect pressure gauge to open 1/8" port. Then slowly pull out the plunger of the syringe (a vacuum is created in the blue area). The device should switch at around 18 mbar.

5.1.4 Checking the switching point or function check by rotating the hand wheel

This is the least precise method, see example at the end of the chapter. It only works if the operating pressure and switching point are within the setting range of the hand wheel.

Gas min. pressure switch

Safety-relevant function: should prevent the gas pressure from dropping so low that incomplete combustion (formation of CO) occurs. A minimum of 25 bar is required to ensure proper functioning of the burners according to the information provided by the manufacturer.

Device used: DG 50U-3, hand wheel setting: 26 mbar, switch-off point: 25 mbar.

Type	Hand wheel adjusting range – Switch-on point		Switching differential		Example – Switch-off point	Example – HS switching differential for hand wheel setting	Example – SPHE hand wheel switch-on point
	E_{min}	E_{max}	S_{min}	S_{max}	SPA		
DG 50	2.5	50	0.8	1.5	25	1.13	26.13

All specifications in mbar

System parameters: a pressure gauge installed in the system indicates a pressure of 40 mbar. Signal at COM-NC.

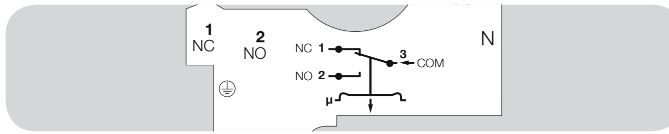
Test: the hand wheel is set to 50 mbar. The pressure switch should switch off (COM-NC). The hand wheel is then turned slowly in the “min.” direction. The DG should switch on at around 40 mbar.

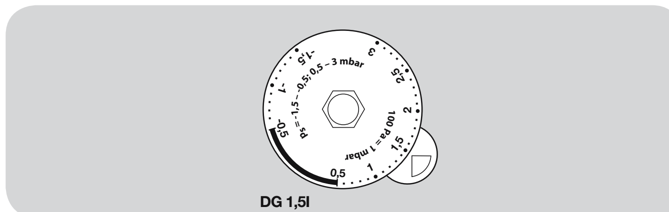
Gas vacuum sensor DG..I

Safety-relevant function: should prevent the biogas pressure in the digester from dropping below -0.8 mbar, otherwise the hood will be damaged and air can enter in the system.

Device used: DG 1,5I-3, hand wheel setting: -0.8 mbar. Contact assignment, see template.

System parameters: a pressure gauge installed in the system indicates a pressure of 1.1 mbar. Signal at COM-NC.





Test: turn hand wheel in the “Plus” direction as far as it will go (signal at COM-NO), then turn the hand wheel in the “Minus” direction until the signal changes to COM-NC (according to details on template). When simulated in a laboratory, this test produces the following results: signal at COM-NC (switch-off point) = 1.2 mbar, turn hand wheel back, switch-on point = 1.5 mbar.

Note: the contact assignment changes from the negative to the positive range, thus the switch-on point corresponds to the operating pressure in this test.

The switching point accuracy required can only be determined by the operator/project developer taking into account the entire system. The measuring method must also be based on this.

The measuring accuracy that can be achieved will be shown in the following examples.

5.1.5 Accuracy of the tests

Example:

$Gas_{min.}$ pressure switch, 3 pressure ranges which illustrate the varying accuracy of the methods compared to measurement to EN 1854.

$Gas_{min.}$ pressure switch, switch-off point should be 2 mbar, hand wheel setting = 2.2[1)], operating pressure = 5 mbar

DG6U-3	Hand wheel in mbar	Testing using test rig pursuant to EN 1854		Measurement using syringe method, operating pressure: 5 mbar		Estimation with hand wheel method, value read off on hand wheel	
		On	Off (actual)	Off*1	Off (actual)	On*2	Off*2
1st measurement	2.2	2.25	2.04	2.9	2.1	4.8	5.6
2nd measurement	2.2	2.24	2.04	3.2	1.8	4.8	5.6
3rd measurement	2.2	2.24	2.03	3.1	1.9	4.8	5.5

$Gas_{min.}$ pressure switch, switch-off point should be 30 mbar, hand wheel setting = 31.2[1)], operating pressure = 40 mbar

DG50U-3	Hand wheel in mbar	Testing using test rig pursuant to EN 1854		Measurement using syringe method, operating pressure: 40 mbar		Estimation with hand wheel method, value read off on hand wheel	
		On	Off	Off*1	Off (actual)	On*2	Off*2
1st measurement	31	33.0	32	8.9	31.1	39.0	40
2nd measurement	31	32.8	32	8.8	31.2	38.8	40
3rd measurement	31	32.9	32	8.9	31.1	39.0	40.5

1) Hand wheel setting: 2.2 or hand wheel setting: 31.2
see page 20 (Examples for calculating the switch-on point when a switch-off point of x mbar is required)

Gas$_{min.}$ pressure switch, switch-off point should be 100 mbar, hand wheel setting = 104, operating pressure = 130 mbar

DG150U-3	Hand wheel in mbar	Testing using test rig pursuant to EN 1854		Measurement using syringe method, operating pressure: 130 mbar		Estimation with hand wheel method, value read off on hand wheel	
		On	Off	Off*1	Off (actual)	On*2	Off*2
1st measurement	104	108.5	103.1	34	96	135	142
2nd measurement	104	108.5	103.1	34	96	136	143
3rd measurement	104	108.5	103.2	35	95	135	142

Gasmin. pressure switch, switch-off point should be 300 mbar, hand wheel setting = 310, operating pressure = 400 mbar

DG500U-3	Hand wheel in mbar	Testing using test rig pursuant to EN 1854		Measurement using syringe method, operating pressure: 400 mbar		Estimation with hand wheel method, value read off on hand wheel	
		On	Off	Off*1	Off (actual)	On*2	Off*2
1st measurement	313	320.0	309.0	98	302	395	410
2nd measurement	313	320.4	308.9	98	302	395	410
3rd measurement	313	320.0	309.0	99	301	393	408

Gasmax. pressure switch, switch-on point should be 25 mbar, hand wheel setting = 25 mbar, operating pressure = 15 mbar

DG50U-3	Hand wheel in mbar	Testing using test rig pursuant to EN 1854		Measurement using syringe method, operating pressure: 15 mbar		Estimation with hand wheel method, value read off on hand wheel	
		On	Off	ON*3	On (actual)	On*4	Off
1st measurement	25	25.98	24.97	10.9	25.9	15	16.5
2nd measurement	25	25.96	24.99	11	26	15	16.5
3rd measurement	25	26.05	24.98	10.9	25.9	15	16.5

*1 *Min. pressure switch*
Connect syringe with pressure gauge to the upper chamber, push plunger in slowly, read off pressure at switching instant. The pressure read off must now be deducted from the operating pressure (previously measured at the pressure test point) in order to determine the actual switch-off point.

*2 *Min. pressure switch*
Only the switching point in the operating pressure range can be tested using this method. In this case, the DG6U is switched on. Turn the hand wheel to the min. position (as far as it will go), then slowly turn it in the direction of the max. position until the switch-off point is reached. Then turn the hand wheel in the direction of the min. position and make a note of the switch-on point. The switch-on point corresponds to the operating pressure.

*3 *Max. pressure switch*
Connect syringe with pressure gauge to the upper chamber, pull plunger out slowly, read off negative pressure at switching instant. The pressure read off must be added to the operating pressure measured at the test point without a sign in order to determine the switching point.

*4 *Max. pressure switch*
Only the switching point in the operating pressure range can be tested using this method. In this case, the DG50U is switched off (signal at COM-NC). Turn the hand wheel slowly to the min. position until the pressure switch switches on (COM-NO). The switch-on point corresponds to the operating pressure.

Examples for calculating the switch-on point when a switch-off point of x mbar is required

Type	Hand wheel adjusting range Switch-on point		Switching differential		Examples		
					Switch-off point	HS switching differential for hand wheel setting	SPHE hand wheel switch-on point
	E_{min}	E_{max}	S_{min}	S_{max}	SPA		
DG 6	0.4	6	0.2	0.3	3	0.25	3.25
DG 10	1	10	0.25	0.4	5	0.32	5.32
DG 30	2.5	30	0.35	0.9	15	0.60	15.60
DG 50	2.5	50	0.8	1.5	40	1.35	41.35
DG 150	30	150	3	5	100	4.17	104.17
DG 400	50	400	5	15	200	9.29	209.29
DG 500	100	500	8	17	300	12.50	312.50

All specifications in mbar

$SPHE = SPA + (S_{min} + (S_{max}-S_{min}) / (E_{max}-E_{min}) \times (SPA-E_{min})$

6 Maintenance

The devices are maintenance-free. In order to ensure smooth operation, the tightness and function of the DG should be checked every year, or every six months if operated with biogas.

6.1 Repairs

If the test reveals that the pressure switch does not switch properly or is leaking, the device must be replaced. Repairs are not permitted.

6.2 Service life

The maximum designed lifetime under operating conditions is 10 years as of the date of production

plus max. 1/2 year in storage prior to first use, or once the given number of operating cycles has been reached, whichever is achieved first.

Feedback

Finally, we are offering you the opportunity to assess this "Technical Information (TI)" and to give us your opinion, so that we can improve our documents further and suit them to your needs.

Clarity

- ○ Found information quickly
- ○ Searched for a long time
- ◉ Didn't find information
  What is missing? ascasc
- ○ No answer

Comprehension

- ○ Coherent
- ○ Too complicated
- ○ No answer

Scope

- ○ Too little
- ○ Sufficient
- ○ Too wide
- ○ No answer

Use

- ☐ To get to know the product
- ☐ To choose a product
- ☐ Planning
- ☑ To look for information

Navigation

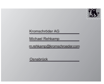
- ○ I can find my way around
- ○ I got "lost"
- ○ No answer

My scope of functions

- ○ Technical department
- ○ Sales
- ○ No answer

Remarks

ascascas



Contact

Elster GmbH
Postfach 2809 · 49018 Osnabrück
Strotheweg 1 · 49504 Lotte (Büren)
Germany
T +49 541 1214-0
F +49 541 1214-370
info@kromschroeder.com
www.kromschroeder.com

The current addresses of our international agents are available on the Internet: http://www.kromschroeder.de/Worldwide.20.0.html?&L=1

We reserve the right to make technical modifications in the interests of progress.

DG · Edition 02.16

03251429