ICS SCHNEIDER MESSTECHNIK

FD16-326

FD

Maximum pressure limiters for liquid gas installations

Pressure limiters of the FD series are constructed in accordance with the special directives for liquid gas engineering. All parts coming into contact with the medium are made of stainless steel 1.4104 and 1.4571. The pressure sensor was designed to be "self-monitoring", i. e. should the measuring bellows rupture, the pressure sensor switches off towards the safe side. The pressure sensor thus complies with "of special construction" in the sense of VdTÜV Memorandum "Pressure 100". Pressure limiters are used in intrinsically safe control circuits (Ex-protection Ex-i). By using an isolating amplifier, the control circuit is also monitored for line break and short circuit.

SIL 2 according IEC 61508-2

Technical data

Pressure connection External thread G 1/2 (pressure gauge connection) according to DIN 16 288 and internal thread G 1/4 to ISO 228 Part 1.

Switch housing 300
Die cast aluminium GD Al Si 12.

Protection class: IP 65

Mounting position: Vertically upright

Explosion protection Ex-i (only when used in conjunction with isolating amplifier).

Pressure sensor materials
Housing: 1.4104, Pressure bellows: 1.4571
All parts fully welded. Perbunan safety diaphragm (not in contact with medium).

Ambient temperature –25°C to +60°C.
At ambient temperatures below 0°C, ensure that condensation cannot occur in the sensor or in the switching device.

Max. medium temperature: +60°C.

Outdoor installations
Protect the device against direct atmospheric influences. Provide a suitable protective cover.

Max. permissible working pressure: 40 bar.

Switching pressure: 3–16 bar. Adjustable with the setting spindle after removing the terminal box.

Calibration
The **FD16-316** and **FD16-327** series are calibrated for rising pressure. This means that the adjustable switching pressure on the scale corresponds to the switching point at rising pressure. The reset point is lower by the amount of the switching differential. (See also page 23, 2. Calibration at upper switching point).

Interlock after cutout
Internal interlock on FD16–327.
Interlock defeat: after pressure reduction of approx. 2.5 bar by pressing the red button (with tool) on the scale side of the pressure switch.

External interlock on FD16–326.
Interlock defeat: After pressure reduction of approx. 0.5 bar. Press unlocking button in control cabinet.

Line break and short circuit monitoring
On types FD16–326 and FD16–327 used in conjunction with isolating amplifier, the control circuit is monitored for short circuit and line break. The resistor combination incorporated into the pressure switch ensures that a defined current flows at all times during normal operation. In the event of short circuit or line break, the current level changes and the relay drops out to the safe side.

Product Summary

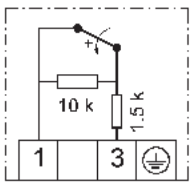
Type	Setting range	Switching differential (Tolerance)	Interlock pressure	Dimensioned drawing
				page 21 + 22
FD16–326	3 -16 bar	0,3 ... 1,0 bar	Extern	3 + 19
FD16–327	3 -16 bar	1,5 ... 3,0 bar	Intern	3 + 19

Defeat:
E = External, i.e. in control cabinet via relay with latching
I = Internal, i.e. locally at pressure limiter

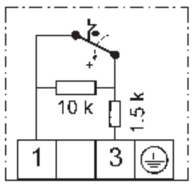
For the power supply circuit

U_i 14 V DC
R_i 1500 Ohm
C_i 1 nF
L_i 100 µH

Internal circuit



FD 16-326
Single pole change over switch with resistor combination for line break and short circuit monitoring.
(External interlock in control cabinet necessary).



FD 16-327
Single pole changeover switch with mechanical switching state interlock on reaching maximum pressure and with resistor combination for line break and short circuit monitoring.

Please note: FD pressure limiters must never be connected directly to mains voltage. They must only be used in conjunction with isolating amplifier.

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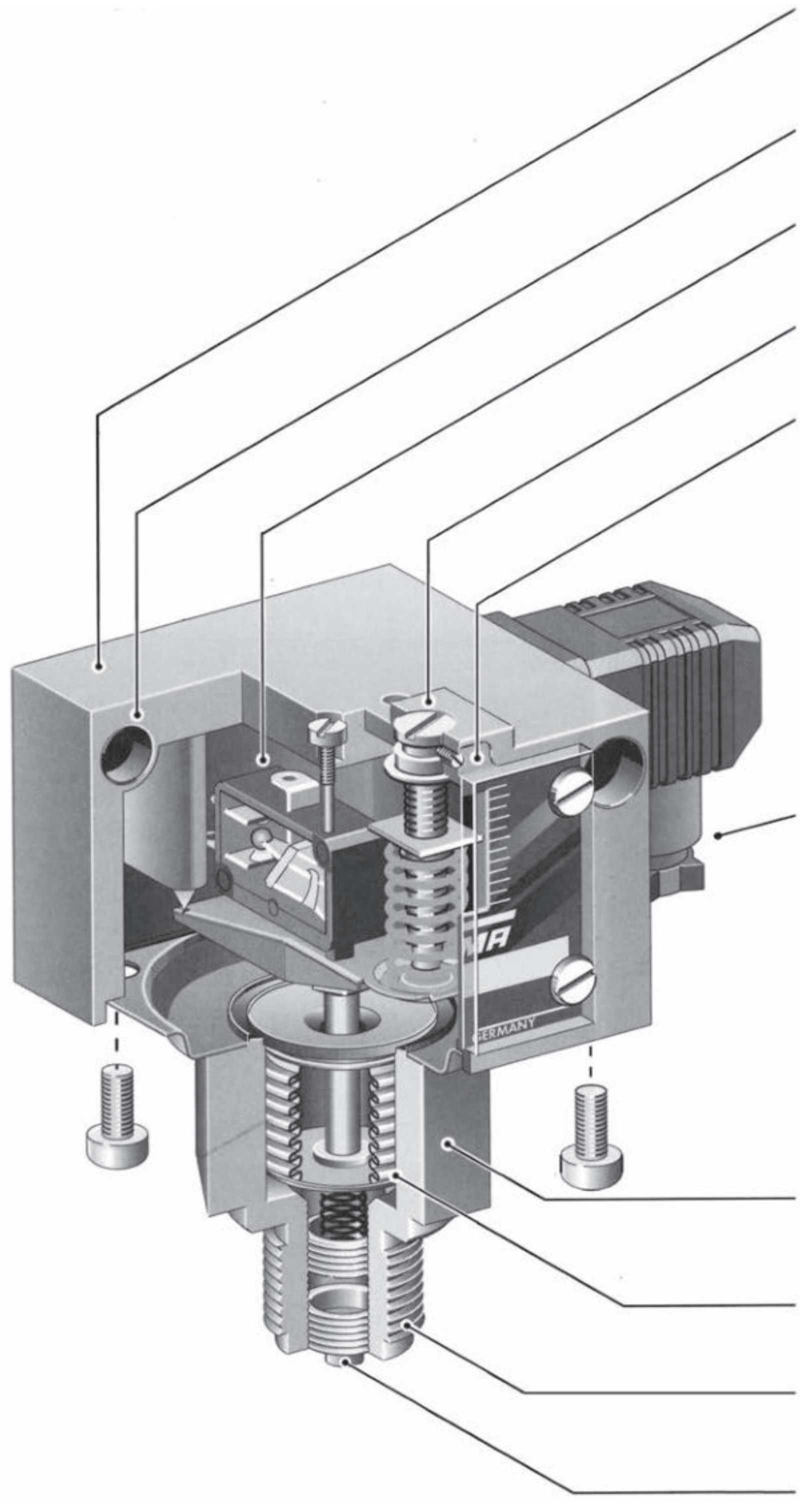
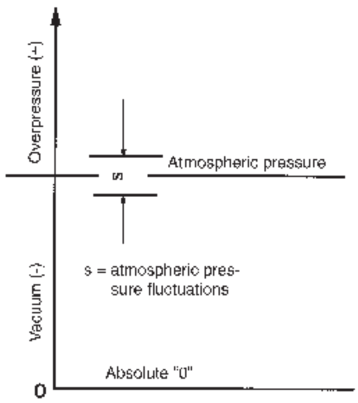
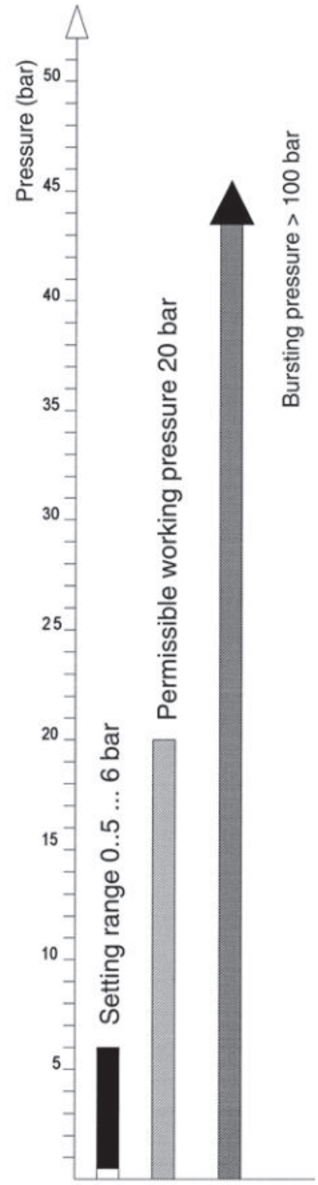
Mechanical pressure switches

Technical features / Advantages







Pressure data for a pressure switchbased on the example of DWR625:
Setting range: 0.5-6 bar
Perm. working pressure: 20 bar
Bursting pressure: >100 bar

Definitions

Pressure data

Overpressure Pressure **over** the relevant atmospheric pressure. The reference point is atmospheric pressure.

Vacuum Pressure **under** the relevant atmospheric pressure. The reference point is atmospheric pressure.

Absolute pressure Overpressure relative to absolute vacuum.

Differential pressure Difference in pressure between 2 pressure measuring points.

Relative pressure Overpressure or vacuum relative to atmospheric pressure.

Pressure data in all FEMA documents refers to relative pressure.

That is to say, it concerns pressure differentials relative to atmospheric pressure.
Overpressures have a positive sign, vacuums a negative sign.

Permissible working pressure (maximum permissible pressure)
The maximum working pressure is defined as the upper limit at which the operation, switching reliability and water tightness are in no way impaired (for values see Product summary).

Bursting pressure (test pressure)
Type-tested products undergo a pressure test certified by TÜV affirming that the bursting pressure reaches at least the values mentioned in the Product summary. During the pressure tests the measuring bellows are permanently deformed, but the pressurized parts do not leak or burst. The bursting pressure is usually a multiple of the permissible working pressure.

Setting range
Pressure range in which the cutoff pressure can be set with the setting spindle.

Pressure units

Unit	bar	mbar	Pa	kPa	MPa	(psi) lb/m²
1 bar	1	1000	10^5	100	0.1	14.5
1 mbar	0.001	1	100	0.1	10^{-4}	0.0145
1 Pa	10^{-5}	0.01	1	0.001	10^{-6}	$1.45 \cdot 10^{-4}$
1 kPa	0,01	10	1000	1	0.001	0,145
1 MPa	10	10^4	10^6	1000	1	145

In FEMA documents pressures are stated in **bar** or **mbar**.

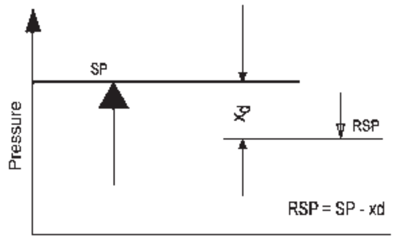
Important:
All pressure data refers to overpressures or vacuums relative to atmospheric pressure.
Overpressures have a positive sign, vacuums a negative sign.

Definitions

Switching differential

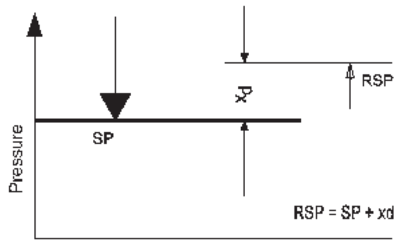
The switching differential (hysteresis) is the difference in pressure between the **switching point (SP)** and the **reset point (RSP)** of a pressure switch. Switching differential tolerances occur due to tolerances in the microswitches, springs and pressure bellows. Therefore the data in the product summaries always refers to average values. In the case of limiter functions the switching differential has no significance, as one is only interested in the switching point at which cutoff occurs, not the reset point. For a **controller function**, i. e. in the case of pressure switches used to switch a burner, pump etc. **on and off**, a pressure switch with an **adjustable switching differential** should be chosen. The switching frequency of the burner or pump can be varied by changing the switching differential.

Maximum pressure monitoring
RSP = SP – xd



SP = switching point RSP = reset point
xd = switching differential (hysteresis)

Minimum pressure monitoring
RSP = SP + xd



SP = switching point RSP = reset point
xd = switching differential (hysteresis)

Adjustable switching differential/ calibration

In the case of pressure switches with adjustable switching differential, the hysteresis can be set within the specified limits. The switching point (SP) **and** reset point (RSP) are precisely definable. When setting the pressure switch, the switching differential situation and the type of factory calibration must be taken into account. Some pressure switches (e.g. minimum pressure monitors of the DCM series) are calibrated under "falling" pressure, i.e. switching under falling pressure takes place at the scale value with the switching differential being above it. The device switches back at scale value + switching differential. If the pressure switch is calibrated under rising pressure, switching takes place at the scale value and the device switches back at scale value - switching differential (see direction of action). The calibration method is indicated in the data sheets.

Direction of action

In principle, any pressure switch can be used for both maximum pressure and minimum pressure monitoring. This excludes pressure limiters, whose direction of action (maximum or minimum) is predefined. The only thing to remember is that the scale reading may deviate by the amount of the switching differential. See example at bottom left: The scale value is 2.8 bar.

Maximum pressure monitoring

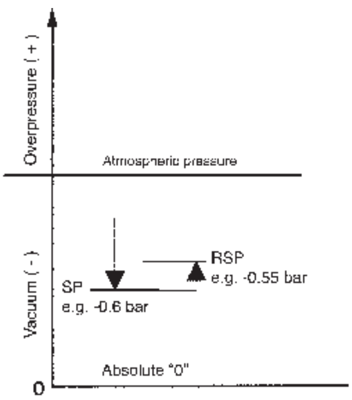
With rising pressure, switching takes place once the preset switching pressure is reached (SP). The reset point (RSP) is lower by the amount of the switching differential.

Minimum pressure monitoring

With falling pressure, switching takes place once the preset switching pressure is reached (SP). The reset point (RSP) is higher by the amount of the switching differential.

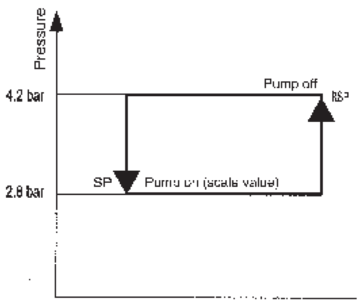
Direction of action in vacuum range

It is particularly important to define the direction of action in the vacuum range.
Rising does not mean a rising vacuum, but rising pressure (as viewed from absolute "0"). "Falling" pressure means a rising vacuum.
For example: Vacuum switch set to -0.6 bar falling means: Switching (SP) takes place under falling pressure (rising vacuum) at -0.6 bar. The reset point is higher by the amount of the switching differential (e.g. at -0.55 bar).



Setting a pressure switch

To define the switching point of a pressure switch exactly, it is necessary to determine the direction of action in addition to the pressure. "Rising" means that switching takes place at the set value when the pressure rises.
The reset point is then lower by the amount of the switching differential. "Falling" means exactly the opposite.



SP = switching point RSP = reset point

Please note when specifying the setting of a pressure switch:

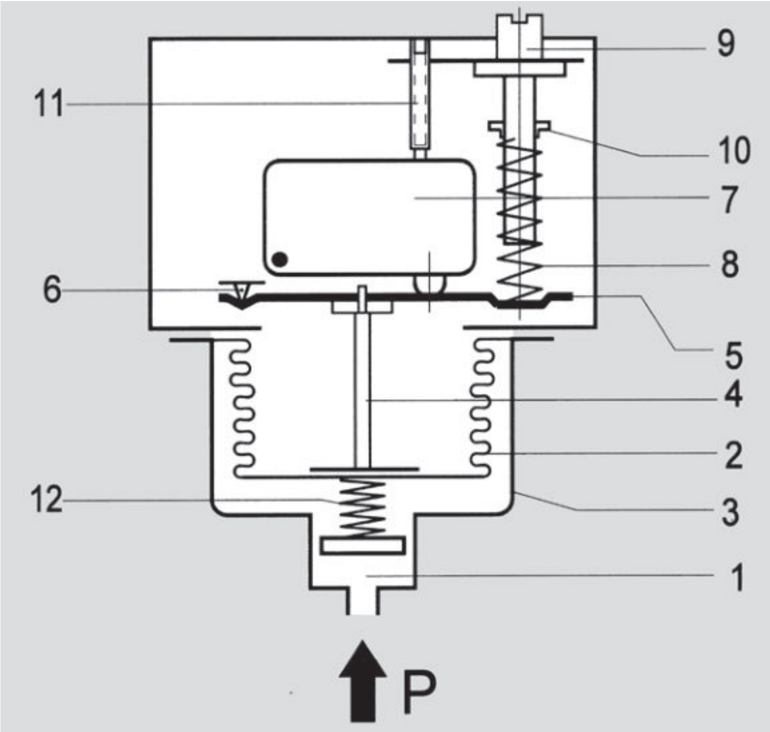
In addition to the switching point it is also necessary to specify the direction of action (falling or rising).

Example for selection of a pressure switch:

A pump is to be turned on at 2.8 bar and off again at 4.2 bar.
Chosen type: DCMV6 according to data sheet DCM. Setting: Scale pointer to 2.8 bar (lower switching point). Switching differential to 1.4 bar (set according to pressure gauge).
Cutoff point: 2.8 bar +1.4 bar = 4.2 bar.

Operating mode
The pressure prevailing in the sensor housing (**1**) acts on the measuring bellows (**2**). Changes in pressure lead to movements of the measuring bellows (**2**) which are transmitted via a thrust pin (**4**) to the connecting bridge (**5**). The connecting bridge is frictionlessly mounted on hardened points (**6**). When the pressure rises the connecting bridge (**5**) moves upwards and operates the microswitch (**7**). A counter-force is provided by the spring (**8**), whose pre-tension can be modified by the adjusting screw (**9**) (switching point adjustment). Turning the setting spindle (**9**) moves the running nut (**10**) and modifies the pre-tension of the spring (**8**). The screw (**11**) is used to calibrate the microswitch in the factory. The counter pressure spring (**12**) ensures stable switching behaviour, even at low setting values.

- **1** = Pressure connection
- **2** = Measuring bellows
- **3** = Sensor housing
- **4** = Thrust pin
- **5** = Connecting bridge
- **6** = Pivot points
- **7** = Microswitch or other switching elements
- **8** = Setting spring
- **9** = Setting spindle (switching point adjustment)
- **10** = Running nut (switching point indicator)
- **11** = Microswitch calibration screw (factory calibration)
- **12** = Counter pressure spring



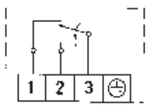
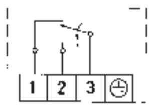
Pressure sensors
Apart from a few exceptions in the low-pressure range, all pressure sensors have measuring bellows, some made of copper alloy, but the majority of high-quality stainless steel. Measured on the basis of permitted values, the measuring bellows are exposed to a minimal load and perform only a small lifting movement. This results in a long service life with little switching point drift and high operating reliability. Furthermore, the stroke of the bellows is limited by an internal stop so that the forces resulting from the overpressure cannot be transmitted to the switching device. The parts of the sensor in contact with the medium are welded together without filler metals. The sensors contain no seals. Copper bellows, which are used only for low pressure ranges, are soldered to the sensor housing. The sensor housing and all parts of the sensor in contact with the medium can also be made entirely from stainless steel 1.4571 (DNS series). Precise material data can be found in the individual data sheets.

Pressure connection
The pressure connection on all pressure switches is executed in accordance with DIN 16288 (pressure gauge connection G 1/2A). If desired, the connection can also be made with a G 1/4 internal thread in accordance with ISO 228 Part 1.
Maximum screw-in depth on the G 1/4 internal thread = 9 mm.

Centring pin
In the case of connection to the G 1/2 external thread with seal in the thread (i.e. without the usual stationary seal on the pressure gauge connection), the accompanying centring pin is not needed.
Differential pressure switches have 2 pressure connections (max. and min.), each of which are to be connected to a G 1/4 internal thread.

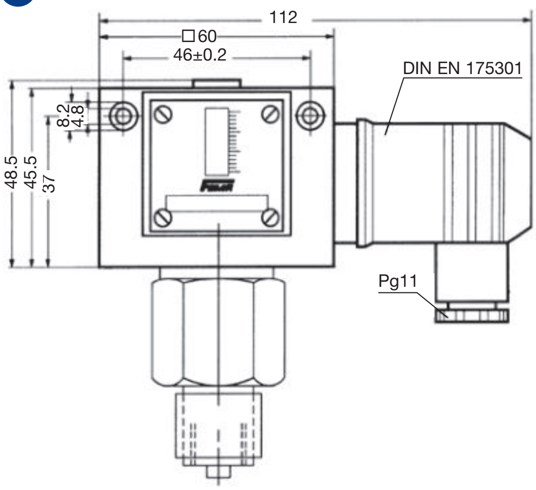
Principal technical data

Valid for all pressure of the DCM, VCM, VNM, DNM, DWR, DGM, DNS, DWAM, DWAMV and DDCM series that have a microswitch. The technical data of type-tested units may differ slightly (please refer to particular type sheet).

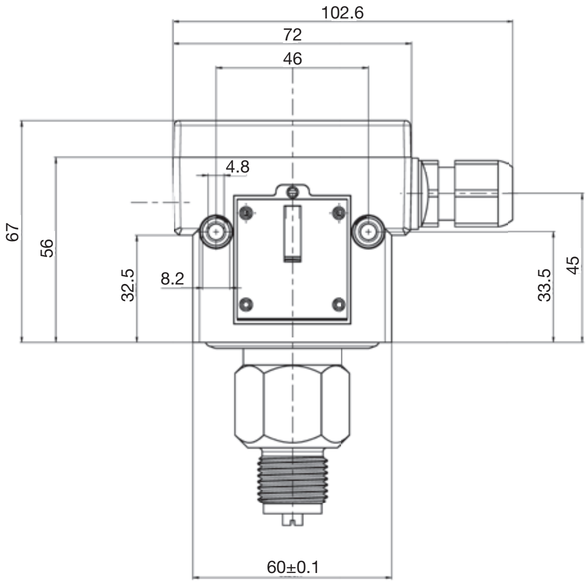
	Ex-i-version	Ex version (Ex-d)
	 …500	 …700
Switch housing	Die cast aluminium GDAlSi 12	Die cast aluminium GDAlSi 12
Pressure connection	G 1/2" external thread (pressure gauge connection) and G 1/4" internal thread. 1/4" internal thread for DDCM differential pressure switches	G 1/2" external thread (pressure gauge connection) and G 1/4" internal thread. 1/4" internal thread for DDCM differential pressure switches
Switching function and connection scheme (applies only to version with microswitch)	Floating changeover contact. With rising pressure single pole switching from 3–1 to 3–2 	Floating changeover contact. With rising pressure single pole switching from 3–1 to 3–2 
Switching capacity	max.: 100mA, 24VDC min.: 2mA, 5VDC	3 A at 250 VAC 2 A at 250 VAC inductive 3 A at 24 VDC 0.1 A at 250 VDC min. 2 mA, 24 VDC
Mounting position	Vertical	Vertical
Protection class (in vertical position)	IP 65	IP 65
Explosion protection Code	Ex II 1/2G Ex ia IIC T6 Ga/Gb Ex II 1/2D Ex ia IIIC T80 °C	Ex II 2G Ex d e IIC T6 Gb Ex II 1/2D Ex ta/tb IIIC T80 °C Da/Db
EC Type Examination Certificate Number	IBExU12ATEX1040	IBExU12ATEX1040
Electrical connection	Terminal connection	Terminal connection
Cabel entry	M 16 x 1.5	M 16 x 1.5
Ambient temperature	–25 to +60 °C (exceptions: DWAM series –20 to +60 °C DGM and FD series: –25 to +60 °C DCM4016, 4025, 1000, VCM4156: –15 to +60 °C)	–20 to +60 °C
Medium temperature	Max. 60 °C	Max. 60 °C
Relative humidity	15 to 95% (non-condensing)	15 to 95% (non-condensing)
Switching point	After removing switch housing cover	After removing switch housing cover
Hysteresis	Not adjustable	Not adjustable
Vacuum	Higher medium temperatures are possible provided the above limits for the switching device are ensured by suitable measures (e.g. siphon). All pressure switches can operate under vacuum. This will not damage the device.	
Repetition accuracy of switching points	< 1 % of the working range (for pressure ranges > 1 bar).	
Vibration resistance	No significant deviations up to 4 g.	
Mechanical durability (pressure sensor)	With sinusoidal pressure application and room temperature, 10 x 106 switching cycles. The expected life depends to a very large extent on the type of pressure application, therefore this figure can serve only as a rough estimate. With pulsating pressure or pressure impacts in hydraulic systems, pressure surge reduction is recommended.	
Electronical durability (microswitch)	100.000 switching cycles at nominal current 8 A, 250 VAC. A reduced contact load increases the number of possible switching cycles.	
Isolation values	Overvoltage category III, contamination class 3, reference surge voltage 4000 V. Conformity to DIN VDE 0110 is confirmed.	
Oil and grease-free	The parts of all pressure switches in contact with the medium are oil and grease free (except the HCD…and DPS…series). The sensors are hermetically sealed and contain no seals (also see ZF1979, special packing).	

Dimensioned drawings of switch housings (mm)

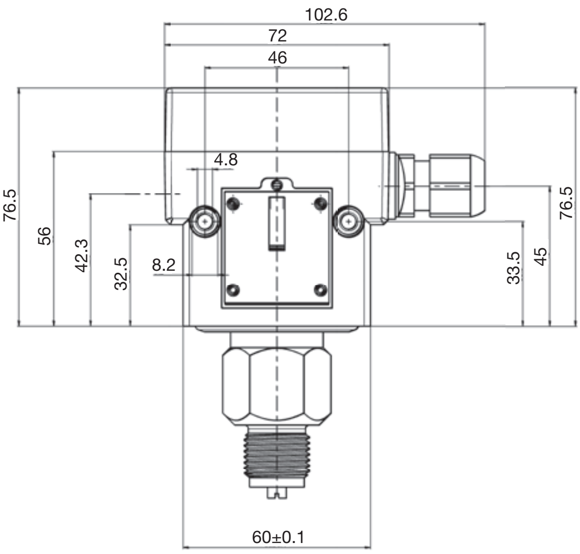
1 Housing 200 (plug connection)



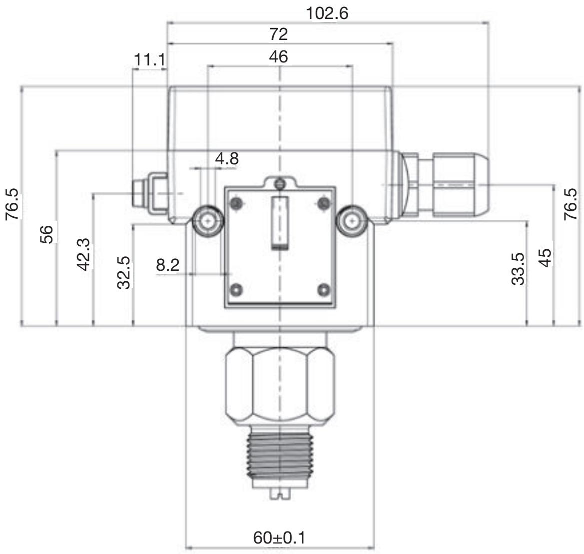
2 Housing 300 (terminal connection)



3 Housing 500 (terminal connection Ex-i)



4 Housing 700 (terminal connection Ex-d)



Dimensioned drawings of pressure sensors (mm)

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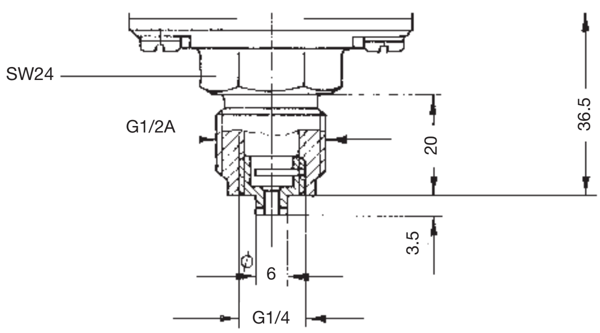

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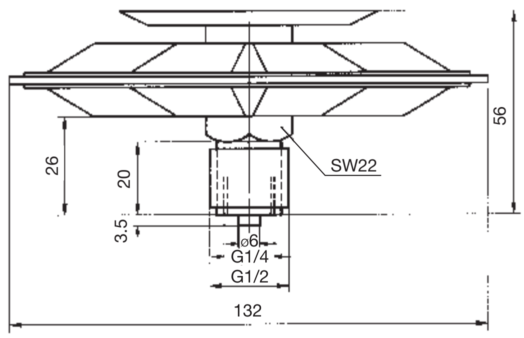

Dimensioned drawings of pressure sensors (mm)

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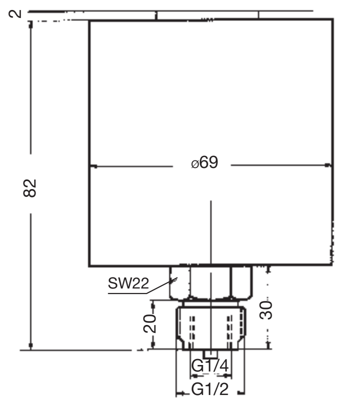

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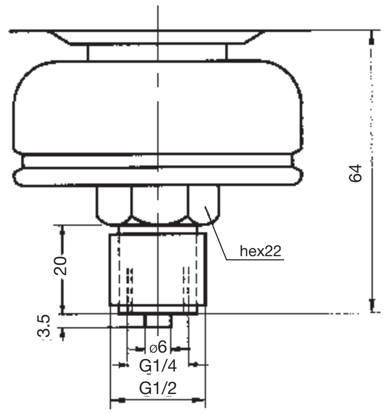

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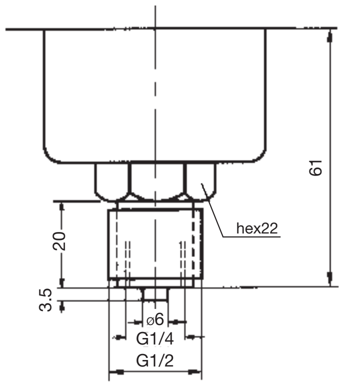

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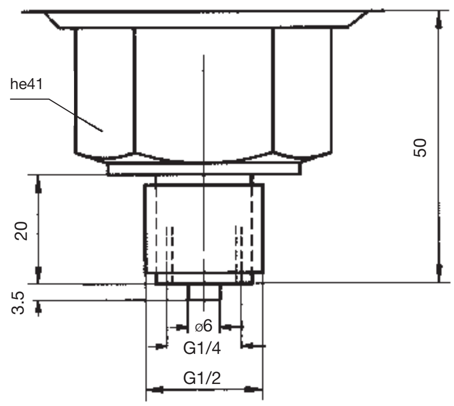
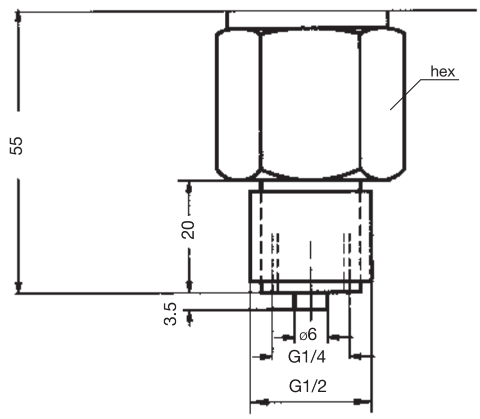
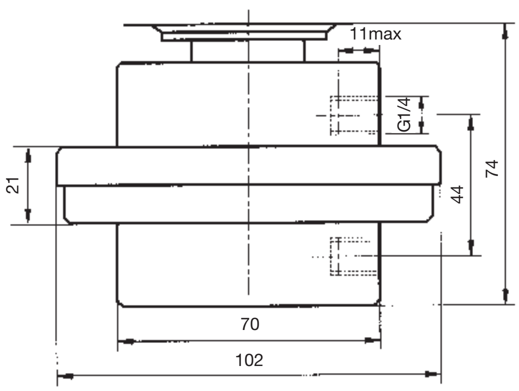


16–19



Dimensioned drawing	hex (mm)
16	22
17	24
18	30
19	32

20



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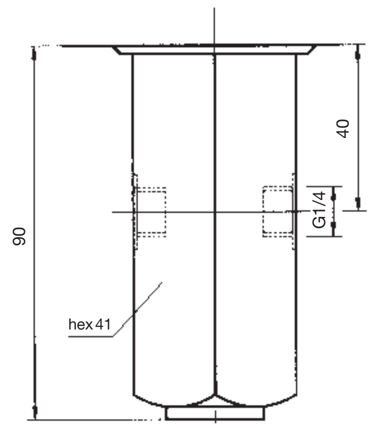


Service functions

Devices with service functions will be produced according to the customer's specifications.
The system requires that these product combinations are identified in such a way as to prevent any possibility of confusion. These combinations are characterised by a product code with the suffix "-S" on the packaging label as well as separate labels with barcodes for each service function.

Service functions	Plug connection 200 series	Terminal connection 300 series	Ex-i/ Ex-d
Adjustment according to customer's instruction:			
- one switching point	**ZF1970***	**ZF1970***	**ZF1970***
- two switching points or defined switching differential	**ZF1972***	**ZF1972***	**–**
Adjustment and lead sealing according to customer's instruction:			
- one switching point	**ZF1971***	**–**	**–**
- two switching points or defined switching differential	**ZF1973***	**–**	**–**
Labelling of units according to customer's instruction with sticker	**ZF1978**	**ZF1978**	**ZF1978**
Special packing for oil and grease-free storage	**ZF1979**	**ZF1979**	**ZF1979**
Test reports according to EN 10 204			
- Certificate 2.2 based on non specific specimen test	**WZ2.2**	**WZ2.2**	**WZ2.2**
- Inspection test certificate 3.1 based on specific test	**AZ3.1B1**	**AZ3.1B1**	**AZ3.1B1**
- Inspection test certificate for FV separating diaphragms	**AZ3.1-V**	**AZ3.1-V**	**AZ3.1-V**

*** Switching point adjustment:** Please specify **switching point and direction of action** (rising or falling pressure).

Service functions are available for the following type series (including Ex-versions):
Pressure switches: DCM, DNM, DNS, VNS, VCM, VNM, DDCM, DWR, DWAM, DWAMV, SDBAM, DGM, FD

Ordering devices with service functions

Example:
Ordering 1 DCM6, set at 4 bar rising, identified with code PSH008 as requested by the customer and acceptance test certificate 3.1.
The order confirmation contains:

1 DCM6-S ("S" is need for factory = following lines belong to this item)
1 ZF1970: set to 4 bar rising
1 ZF1978: PSH008
1 AZ3.1B1

Included items: Labels with barcodes on the packaging:
DCM6-S
ZF1970: set to 4 bar rising
ZF1978: PSH008
AZ3.1B1

Pack contents: 1 DCM6 (without "S" suffix) marked
1 ZF1970: set to 4 bar rising
1 ZF1978: PSH008
1 AZ3.1 B1 will be sent by extra post
1 Installation and operating instructions

Pressure switches "of special construction"

Definitions and information

Pressure monitoring and pressure limiting in

- **Steam boilers**
- **District heating systems**
- **Oil pipelines**
- **Liquid gas installations etc.**
- **Hot water heating systems**
- **Gas installations**
- **Firing systems**

is extremely important with regard to safety.

Component testing

Pressure monitoring devices for safety-critical applications must work reliably and be tested according to the relevant directives in each case. **The reliability of pressure monitors and pressure limiters must be certified by a component test** which is performed by the testing agencies responsible in each case (e.g. TÜV and DVGW). The following section deals with the FEMA product range for safetycritical pressure monitoring in thermal and process engineering systems.

Special construction

The term "of special construction" originates from the **VdTÜV Memorandum "Pressure 100", issue 07.2006,** which defines the requirements for **pressure monitors and pressure limiters for steam boilers and hot water systems**. Originally used only for pressure monitoring in the area of steam and hot water, the "special construction" characteristic is increasingly used as a quality and safety argument for other applications as well. The following section describes the requirements for pressure limiters "of special construction". Recommendations for the correct selection of pressure limiters are given by reference to safety analyses.

Definitions of the VdTÜV Memorandum "Pressure 100":

Pressure monitors (DW)
Pressure monitors are devices which switch off the heating system on exceeding and / or falling below a predefined pressure limit and release the heating system again only after a change in pressure.

Pressure limiters (DB)
Pressure limiters are devices which switch off the heating system on exceeding and / or falling below a predefined pressure limit and lock it to prevent automatic restarting.

Pressure limiters "of special construction" (SDB)
Pressure limiters "of special construction" perform the same tasks as pressure limiters. In addition they must satisfy the extended safety requirements of section 3.4 (of "Pressure 100").

Safe condition

According to DIN VDE 0660, Part 209, the safe condition of the system is reached if a cut-off command is present at the output contact which means that in the safe condition, the microswitch in the pressure limiter is actuated (opened) and the control circuit is interrupted. Series connected switching devices must react in the same way. The operating mode of the safety pressure limitation thus corresponds to the **closed circuit principle**.

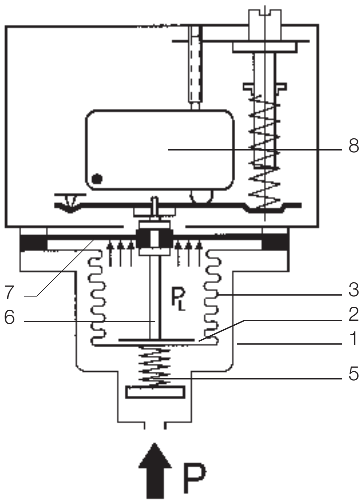


Fig. 1
Self monitoring maximum pressure limiter with safety diaphragm DWAM…, DWAMV…, SDBAM…

Additional requirements for pressure limiters "of special construction"

Section 3.4 of VdTÜV Memorandum "Pressure 100":
Pressure limiters "of special construction" **must, in the event of a breakage in the mechanical part of the measuring element, lead to cut-off and interlock of the heating**. This requirement is also fulfilled if the mechanical part of the measuring element is calculated for vibrating stress **or has withstood a test with 2 million operating cycles and the pressurized parts of the measuring element are made of corrosion-resistant materials**.
(Abbreviated except from VdTÜV Memorandum "Pressure 100").

Therefore there are two possible ways of meeting the requirements for pressure limiters "of special construction":
a) By a self monitoring pressure sensor which is designed so that a breakage in the mechanical part of the measuring element leads to cut-off to the safe side (see Fig. 1)
b) By certification of endurance testing with 2 million operating cycles during the component test (see Fig. 2)

a) Self monitoring pressure sensor with safety diaphragm (for maximum pressure monitoring only)
Fig. 1 is a crosssectional diagram of a pressure sensor which fulfils the "special construction" requirements. The measuring chamber is bordered by the housing (1), base (2) and measuring bellows (3). All parts are made of stainless steel and are welded together without filler metals. When the pressure rises the measuring bellows (3) moves upwards, supported by the back pressure spring (5). The setpoint spring installed in the switching device acts as a counter force. A transfer bolt (6) which transfers the pressuredependent movements of the measuring bellows (3) to the switching device located above is placed on the inside of the base. A plastic diaphragm (7), which is not in contact with the medium and in normal operation follows the movements of the measuring bellows but itself has no influence on the position of the bellows, is clamped in the upper part of the transfer bolt. On breakage of the measuring bellows (3), the medium can escape into the interior of the bellows. The medium pressure is now on the underside of the diaphragm (PL). An additional force is generated because of the far larger effective area of the diaphragm compared with the bellows, and this pushes the transfer bolt (6) upwards. This results in cut-off to the safe side. The cut-off condition thus achieved is normally interlocked electrically or mechanically, so that the system also remains cut off when the pressure drops again. The plastic diaphragm (7) is not a pressure-bearing part; it has no function in normal operation and is effective only if a leakage occurs to the measuring bellows. Safety diaphragms of the described design are permissible up to 32 bar. This should be sufficient for most applications.

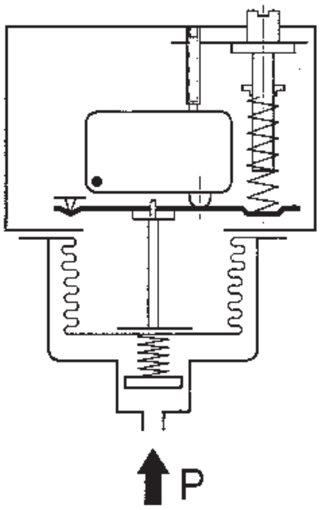


Fig. 2
Pressure limiter without safety diaphragm (not self monitoring for maximum pressure) DWR…

b) Pressure sensors with certification of 2 million operating cycles (DWR series)
In this design it is assumed that the pressure sensors which have withstood dynamic loading of 2 million operating cycles during component testing can be considered as reliable elements. They do not have an additional safety device in the sensor. Although the units are produced and tested with very great care, maximum pressure limiters without additional safety device can lead to dangerous conditions if errors which cannot be detected in the tests occur due to secondary effects. These may be caused by hole corrosion due to deposited metal particles on the (usually very thinwalled) bellows of the pressure sensor, material defects in the pressure bellows or a broken weld seam. Despite careful production and testing, a residual risk remains in the case of maximum pressure monitoring. It is ultimately up to the user and operator of the systems themselves to decide on the degree of safety to which pressure vessels should be monitored.

Pressure sensors without safety diaphragm are self monitoring when used in minimum pressure monitoring applications.

Safety analysis for maximum pressure monitoring

Observing the direction of action

The preceding description and safety considerations relate to the monitoring of maximum pressure. The safe side here means: The energy supply is cut off (e.g. burner is turned off) to avoid a further pressure rise. Minimum pressure monitoring requires an entirely different approach. The safe side here means: Preventing the pressure from falling further (for example: hotwater systems with external pressure retention or monitoring of water level in heating systems). Based on a safety analysis, a pressure limiter without safety diaphragm is clearly the best option. In the event of leakage in the sensor, "low pressure" is signalled and the system switches over to the safe side. A pressure sensor without safety diaphragm is therefore "of special construction" within the meaning of Memorandum "Pressure 100", if it is used as a minimum pressure limiter. On the other hand, it is clear from the above that pressure sensors with safety diaphragms, which offer considerable advantages in maximum pressure monitoring, should never be used for minimum pressure monitoring. Incorrect use can create a dangerous condition. It is therefore essential for users and planners to observe the direction of action when selecting pressure limiters.

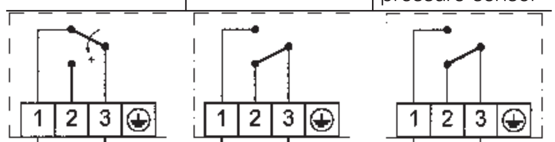
In summary it may be said:
Pressure limiters "of special construction" with safety diaphragms (self-monitoring pressure sensors) offer the highest degree of safety in maximum pressure monitoring. Such devices must not however be used for minimum pressure monitoring. Pressure limiters "of special construction" with certification of 2 million operating cycles are self monitoring in the case of minimum pressure monitoring, even without a safety diaphragm. In the case of maximum pressure monitoring, however, a residual risk remains.

Safety analysis for maximum pressure monitoring

If one considers the switch positions in the possible operating conditions, the difference compared with pressure sensors "of special construction" becomes clear. The left column shows normal operation in which the switch connects terminals 3 and 1. The cut-off condition when pressure is too high is shown in column 2. The control circuit is interrupted via terminals 3 and 1.
The difference in safety terms is clear from column 3, which shows the switch position in the event of a leak in the pressure sensor. With a safety-engineered sensor the control circuit is interrupted, whereas in the case of a sensor without a safety diaphragm the control circuit remains closed, and thus a "dangerous condition" can arise.

Devices with safety diaphragm (DWAM, DWAMV, SDBAM)
In pressure limiters "of special construction" which are equipped with **safety sensors**, different operating conditions occur in the following switch positions:

1	2	3
Normal operation	Limit exceeded	Leakage in pressure sensor

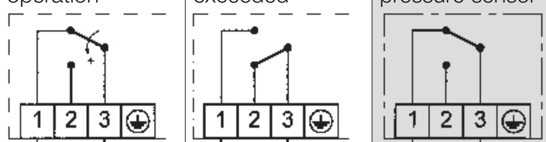


Control circuit closed	Control circuit interrupted	Control circuit interrupted

Device without safety diaphragm
"Special construction" must also be proven by an **endurance test with 2 million operating cycles**. In the case of breakage/leakage (e.g. material defect, fault in weld seams, hole corrosion), the system **does not cut off to the safe side (no self-monitoring).**

In the different operating conditions the following switch positions occur **in the case of maximum pressure monitoring**: In the event of leakage in the pressure sensor, the pressure monitors / limiters according to b) are not safe. A "dangerous condition" can arise.

Normal operation	Limit exceeded	Leakage in pressure sensor



Control circuit closed	Control circuit interrupted	Control circuit Dangerous condition!

Further observations and summary

Minimum pressure

All **minimum pressure monitors and minimum pressure limiters are self monitoring** within the meaning of "Pressure 100" (with or without safety diaphragm).

Pressure limiters must interlock the cut-off state
Memorandum "Pressure 100" specifies that pressure limiters must cut off and interlock against automatic restarting. For this purpose, pressure limiters are offered with integrated mechanical interlock (reclosing lockout). The direction of action is also important in the selection of the interlock. Depending on the direction of action it is necessary to determine whether the interlock should operate on rising (maximum pressure monitoring) or falling (minimum pressure monitoring) pressure.

External interlock is also possible
A pressure monitor can become a pressure limiter, if an electrical interlock is connected in series. The figures on page 22 show suggested interlock circuits for maximum pressure and minimum pressure monitoring. The direction of action must be observed when deciding the circuit. For the combination of pressure monitor with external interlock to be considered as a limiter "of special construction", the pressure monitor itself must satisfy the "special construction" requirements.

Other considerations

"Special construction" — not just for steam and hot water systems
According to current standards, pressure limiters "of special construction" are mandatory for steam boilers according to TRBS and for heating systems according to DIN EN12828. It is clearly advantageous to transfer the positive experience from pressure monitoring of steam boilers to other applications. In the interest of greater safety it is desirable to incorporate the requirements for pressure limiters "of special construction" used in safetycritical monitoring applications into other standards as well. This applies particularly to applications in the field of gas, which are covered by DIN EN1854, and liquid fuels, covered by DIN EN764-7.

For even greater safety:
Positive opening contacts
In maximum pressure monitoring, safety can be further increased through additional measures. The microswitches, normally equipped with a spring contact, can be fitted with **positive opening contact (to protect against contact sticking)**.

Line break and short-circuit monitoring
The power supply to the pressure limiter is monitored for short-circuit and interruption by an external isolating amplifier. In the case of faults in the power supply, the system cuts off to the safe side.
Ex-d and Ex-i versions, where applicable combined with sensors "of special construction", open up a wide range of possibilities in the field of Ex-applications for **process engineering systems and gas engineering**. See DBS-series.

Summary

It is apparent that safety can be improved significantly and numerous causes for the occurrence of dangerous conditions can be eliminated through the appropriate use of technical measures. However, it is also apparent that a residual risk remains. Careful planning and conscientious maintenance and testing of existing systems are absolutely essential for reliable pressure monitoring on pipelines and pressure vessels.

Standards – Directives – Component tests

VdTÜV Pressure 100

DVGW DIN EN1854

TÜV DIN EN764-7

TÜV, Pressure 100

PED 2014/68/EU

ATEX 2014/34/EU

IECEx

Steam and hot water
Pressure monitors and pressure limiters for steam and hot water in systems to DIN EN12828 and TRBS. Series DWAM, SDBAM and DWR.

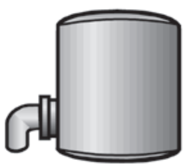
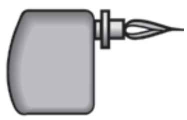
Fuel gases CE
Pressure monitors and limiters for fuel gases in accordance with DVGW work sheet G 260. Series DGM and DWR.

Liquid fuels
Pressure monitors and pressure limiters for liquid fuels (heating oil) Series DWR.

Safety-engineered pressure limiters
For safety critical pressure monitoring in liquid gas systems, chemical and process engineering systems.

Pressure Equipment Directive 2014/68/EU
Pressure monitors and limiters to DIN EN12952-11 and DIN EN12953-9

Ex -versions
For Ex-areas Zones 1 and 2, as well as 21 and 22 all pressure switches can be supplied in pressure proof encapsulated design.
All intrinsically safe devices are for the Ex-Zones 0, 1, 2, 20, 21 and 22.
For intrinsically safe control circuits (Ex protection class Ex-i), pressure switches with gold plated silver contact, and the blue terminals and cable entries customary in Ex-i areas can be supplied. In addition to the pressure switch, an isolating amplifier which transfers the control commands of the pressure switch from an intrinsically safe control circuit (Ex-i) to a non intrinsically safe active circuit is required

Medium	**Steam Hot water** 	**Fuel gases** DVGW work sheet G260 	**Liquid fuels** (fuel oil) 	**Pressure vessels** (e.g. for liquefied gas) 
Plant directives	**DIN EN 12828 + TRBS**			
Directives for component testing	**VdTÜV Pressure 100 + DIN EN 12952-11 + DIN EN 12953-9**	**DIN EN 1854 + DIN EN 13611**	**VdTÜV Pressure 100 + DIN EN 764-7**	**VdTÜV Pressure 100 + DIN EN 764-7**
Type series	**DWAM, SDBAM DWR...**	**DWR... DGM...**	**DWR...**	**FD... DWAM...**