

# DWAM, DWAMV, SDBAM

## Pressure monitors / pressure limiters



DWAM1

These series are particularly suitable for maximum pressure monitoring in steam and hot-water systems. The pressure switch is "of special construction", with a self-monitoring pressure sensor, built in accordance with Pressure Equipment Directive PED 97/23/EC.



It can be used as a pressure monitor or a pressure limiter for maximum pressure monitoring (systems in accordance with TRD 604 DIN EN12828) systems in accordance with DIN EN12952-11 and DIN EN12953-9 and is available with or without adjustment.

**SIL 2 according IEC 61508-2**

### Technical data

#### Pressure connection

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

#### Switching device

Rugged housing (200) made of seawater-resistant diecast aluminium.

#### Materials

Pressure bellows: Material no. 1.4571  
Sensor housing: Material no. 1.4104  
Switch housing: GD Al Si 12 according to DIN 1725

#### Mounting position

Vertically upright and horizontal.

Ambient temperature at switching device  
-20 to +70°C.

#### Medium temperature -20 to +70°C.

The maximum medium temperature at the pressure sensor must not exceed the permitted ambient temperature at the switching device. Temperatures may reach 85°C for short periods. Higher medium temperatures are possible provided the upper limit at the switching device is ensured by suitable measures (e.g. siphon).

#### Mounting

Directly on the pressure line (pressure gauge connection) or on a flat surface with two 4 mm Ø screws.

#### Calibration for maximum pressure switch

The pressure monitors and safety pressure limiting devices are calibrated so that, **under rising pressure**, switching takes place at the defined switching pressure. The reset point under falling pressure is lower by the amount of the switching differential, or, in the case of pressure limiting devices, by the fall in pressure specified in the table. The scale value corresponds to the upper switching point.

#### Switching differential

See Product Summary.

#### Contact arrangement

Single-pole changeover switch.

Switching capacity	250 VAC (ohm)	250 VDC (ohm)	24 VDC (ohm)
Normal	8 A	5 A	0.3 A

#### Sealing P2

Generally available for SDBAM limiters.

#### Bursting pressure

For all types ≥ 100 bar.  
Verified by TÜV test.

### Component tested for

#### Steam

Systems according to TRD 604

#### Hot water

Systems according to DIN EN12828

VdTÜV Memorandum "Pressure 100"

### Testing basis

### Function

Pressure monitor / Pressure limiter

### Directing of action

#### For maximum pressure monitoring only

"Of special construction" (self-monitoring sensor with safety diaphragm)

### Sensor

### Product Summary Maximum pressure monitoring (↑) (for other pressure ranges see DWR series)

Type	Setting range	Switching differential (mean values)	Max. permissible pressure	Dimensioned drawing
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#### Pressure monitors without differential adjustment for max. pressure monitoring

page 21 + 22

DWAM06	0.1...0.6 bar	0.04 bar	5 bar	
DWAM1	0.2...1.6 bar	0.05 bar	5 bar	1 + 15
DWAM6	1.2...6 bar	0.2 bar	10 bar	
DWAM625	1.2...6 bar	0.25 bar	20 bar	
DWAM16	3...16 bar	0.4 bar	20 bar	1 + 19
DWAM32	6...32 bar	1.2 bar	45 bar	

#### Pressure monitors with differential adjustment for max. pressure monitoring

DWAMV1	0.2...1.6 bar	0.12...0.6 bar	5 bar	1 + 15
DWAMV6	1.2...6 bar	0.4...1.5 bar	10 bar	
DWAMV16	3...16 bar	0.8...2.5 bar	20 bar	1 + 19
DWAMV32	6...32 bar	2.5...6.0 bar	45 bar	

#### Pressure limiters for maximum pressure monitoring (with internal interlock)

Pressure change for unlocking				
SDBAM1	0.2...1.6 bar	0.12 bar	5 bar	
SDBAM2,5	0.4...2.5 bar	0.15 bar	5 bar	1 + 15
SDBAM6	1.2...6 bar	0.4 bar	10 bar	
SDBAM625	1.2...6 bar	0.6 bar	20 bar	
SDBAM16	3...16 bar	0.8 bar	20 bar	1 + 19
SDBAM32	6...32 bar	3.0 bar	45 bar	

\* If a downstream external interlock is added, DWAM... pressure monitors can also be used as pressure limiters (see page 51).

- Sealing device P2 is included for SDBAM limiters and can also be retrofitted to pressure monitors on request. See sealing P2.
- DWAM... also available in Ex-i equipment. See DBS series.

#### Minimum pressure controls

- Minimum pressure monitor: DWR... page 50
- Minimum pressure limiter: DWR...-206 page 56



DWAM6-576

## DBS

### Pressure monitors / pressure limiters

In many aspects, safety-engineered pressure limiters offer a higher degree of safety compared with normal pressure switches and are therefore especially suitable for chemical process engineering and thermal installations in which safety is an especially critical factor in pressure monitoring. Pressure switches can also be used in Ex-zones (zone 0, 1, 2 and 20, 21, 22) and, in all cases, require an isolating amplifier. The isolating amplifier is also responsible for

monitoring lines for short-circuit and line break and therefore offers an additional safety advantage – even in non-Ex-zones. For Ex-applications, the isolating amplifier must be installed outside the Ex-zone. The lines between the isolating amplifier and the pressure switch are monitored for short-circuit and line break.



**SIL 2 according IEC 61508-2**

#### Technical data

##### Greater safety

- in process engineering and chemical installations,
- in gas and liquid gas installations

##### Basic features:

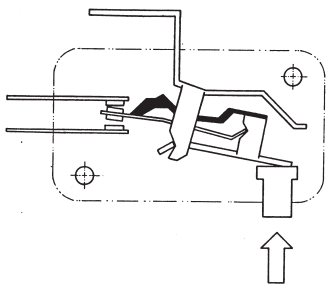
- "Of special construction" according to VdTÜV Memorandum "Pressure 100"
- Line break and short-circuit monitoring-between pressure switch and isolating amplifier
- Suitable for Ex areas (zone 0, 1 & 2 or 20, 21 & 22) (explosion protection Ex-ia)
- Degree of protection IP 65
- Plastic-coated housing (chemical version)

##### Options:

- Limiter with internal interlock

##### Type-specific features:

- Self-monitoring sensors
- Positive opening microswitches
- Gold-plated contacts
- TÜV, DVGW component tests



#### Safety requirements for pressure limiters

Pressure limiters "of special construction" (DBS) must fulfil additional safety requirements, i.e. breakage or leakage in the mechanical part of the sensor must lead to shutdown to the safe side. The pressure limiter must respond as if the system pressure had already exceeded the maximum limit. The control circuit for the pressure limiter must also be considered from the point of view of safety, as short-circuits in the supply lines or other faults in the control current circuit can lead to dangerous conditions.

#### Switching element with positive opening operation and gold-plated contacts

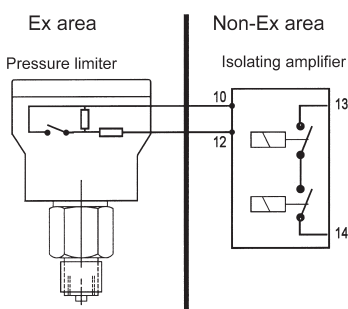
The microswitch is equipped with positive opening operation. Rather than transmitting the plunger force via a spring, which is the usual method with most microswitches, this newly developed microswitch has an additional lever which transmits the movements of the pressure bellows positively to the contact lever. If the spring breaks, the contact lever is moved directly.

#### Line break and short-circuit monitoring in the control circuit

The resistor connected in series with the switching contact limits the current to a defined value with the switch closed. In the event of short-circuit in the area between the isolating amplifier and the series resistor, the current rises above the predetermined limit value, the relay of the isolating amplifier drops out, the output current circuit is interrupted and thus the safe condition is achieved. In the event of a line break, the current flow is interrupted, the relay drops to the safe side and interrupts the output current circuit (safety sequence). Furthermore, the isolating amplifier is designed so that, if faults occur in the electronics (conductor interruption, component defect etc.) and in the resulting situations, the safe shutdown condition is assured. These characteristics of the safety-engineered isolating amplifier, including line break and short-circuit monitoring, satisfy the requirements of DIN/VDE 0660, Part 209.

#### Connection diagram

For pressure monitoring in Ex areas, the isolating amplifier must be installed outside the Ex-zone. The pressure limiter has an intrinsically safe control current circuit (Ex-ia). This arrangement is suitable for zones 0, 1 and 2, 20, 21 and 22.



# Safety-engineered maximum pressure monitors

## Technical data

### Pressure connection

External thread G 1/2 (pressure gauge connection) according to DIN 16 288.

### Switch housing 500

Diecast aluminium GD Al Si 12.  
Aluminium housing coated with resistant plastic.

Degree of protection IP 65.

### Ex protective category

Ex-ia (only when used in conjunction with suitable isolating amplifier).

Component testing See table on page 46.

### Pressure sensor materials

Housing: 1.4104  
Pressure bellows: 1.4571  
All parts fully welded.

Ambient temperature DWAM: -20°C to +60°C, DWR: -25°C to +60°C.

At ambient temperatures at or below 0°C, ensure that condensation cannot occur in the sensor or in the switching device.

Max. temperature of medium at sensor + 60°C.

### Outdoor installations

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

### Max. working pressure

See Product Summary

### Switching pressure setting

Adjustable with the setting spindle after removing the terminal box.

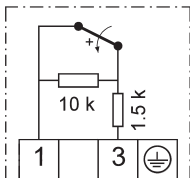
### Mounting

With suitable weld-on connections and union nuts or with pressure gaugescrew union G 1/2.

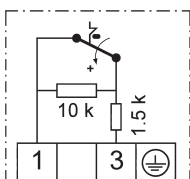
### Power supply circuit

U<sub>i</sub> 14 V DC  
R<sub>i</sub> 1500 Ohm  
C<sub>i</sub> 1 nF  
L<sub>i</sub> 100 µH

### Connection diagrams



...576



...577

## Maximum pressure monitors

Sensor "of special construction", self-monitoring via safety diaphragm, type-tested according to VdTÜV Memorandum "Pressure 100". **SIL2 according IEC 61508-2**

Type	Setting range	Switching differential (mean values)	Max. permissible pressure	Dimensioned drawing
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page 21 + 22

<b>DWAM06-576</b>	0.1...0.6 bar	0.04 bar	5 bar	
<b>DWAM1-576</b>	0.2...1.6 bar	0.05 bar	5 bar	
<b>DWAM2,5-576</b>	0.4...2.5 bar	0.07 bar	5 bar	2 +
<b>DWAM6-576</b>	1.2...6 bar	0.2 bar	10 bar	15
<b>DWAM625-576</b>	1.2...6 bar	0.25 bar	20 bar	
<b>DWAM16-576</b>	3...16 bar	0.4 bar	20 bar	2 +
<b>DWAM32-576</b>	6...32 bar	1.2 bar	45 bar	19

### Versions:

#### ZF 577: Maximum pressure limiter (with internal interlock)

Microswitch not positive opening, contacts: silver alloy other equipment like DWAM...576

## Maximum pressure monitors

Sensor "of special construction" made from stainless steel. (Component testing with 2 million operating cycles). Component tests: VdTÜV Memorandum "Pressure 100", DIN EN1854 (fuel gases), DIN EN764-7, systems in accordance to DIN EN12952-11 and DIN EN12953-9.

**SIL 2 according ICE 61508-2**

Type	Setting range	Switching differential (mean values)	Max. permissible pressure	Dimensioned drawing
------	---------------	--------------------------------------	---------------------------	---------------------

page 21 + 22

<b>DWR06-576</b>	0,1...0,6 bar	0,04 bar	6 bar	2 +
<b>DWR1-576</b>	0,2...1,6 bar	0,06 bar	6 bar	15
<b>DWR3-576</b>	0,2...2,5 bar	0,1 bar	16 bar	2 +
<b>DWR6-576</b>	0,5...6 bar	0,2 bar	16 bar	18
<b>DWR625-576</b>	0,5...6 bar	0,25 bar	25 bar	2 +
<b>DWR16-576</b>	3...16 bar	0,5 bar	25 bar	17
<b>DWR25-576</b>	4...25 bar	1,0 bar	63 bar	2 +
<b>DWR40-576</b>	10...40 bar	1,3 bar	63 bar	16

### Versions:

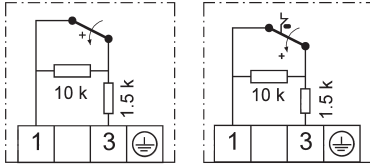
#### ZF 577: Maximum pressure limiter (with internal interlock)

Microswitch not positive opening, contacts: silver alloy other equipment like DWR... 576

### Calibration

Devices of the **DWR-576** and **DWAM-576** 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. Celebration at upper switching point).

**Technical data**
**Switching element**  
 See table opposite.

**Connecting diagrams**


...574

...575

The other technical data correspond to the devices for maximum pressure monitoring (page 51).

**For the power supply circuit:**
 $U_j$ : 14 V DC  
 $R_i$ : 1500 Ohm  
 $C_i$ : 1 nF  
 $L_i$ : 100  $\mu$ H

**Safety-engineered minimum pressure monitors**

Sensor "of special construction made from stainless steel. (self-monitoring and component testing with 2 million operating cycles). Component tests: VdTÜV Memorandum "Pressure 100", DIN EN3398 (fuel gases) DIN EN764-7, systems in accordance to DIN EN12952-11 and DIN EN12953-9

**SIL2 according IEC 61508-2**

Type	Setting range	Switching differential (mean values)	Max. permissible pressure	Dimensioned drawing
				page 21 + 22
<b>DWR06-574</b>	0.1...0.6 bar	0.04 bar	6 bar	2 +
<b>DWR1-574</b>	0.2...1.6 bar	0.06 bar	6 bar	15
<b>DWR3-574</b>	0.2...2.5 bar	0.1 bar	16 bar	2 +
<b>DWR6-574</b>	0.5...6 bar	0.2 bar	16 bar	18
<b>DWR625-574</b>	0.5...6 bar	0.25 bar	25 bar	2 +
<b>DWR16-574</b>	3...16 bar	0.5 bar	25 bar	17
<b>DWR25-574</b>	4...25 bar	1.0 bar	63 bar	2 +
<b>DWR40-574</b>	8...40 bar	1.3 bar	63 bar	16

**Calibration**

 The **DWR-574** series is calibrated for falling pressure. This means that the adjustable switching pressure on the scale corresponds to the switching point at falling pressure. The reset point is higher by the amount of the switching differential. (See also page 23, 1. Calibration at lower switching point).

**Versions:**
**ZF 575: Minimum pressure limiters (with internal interlock)**

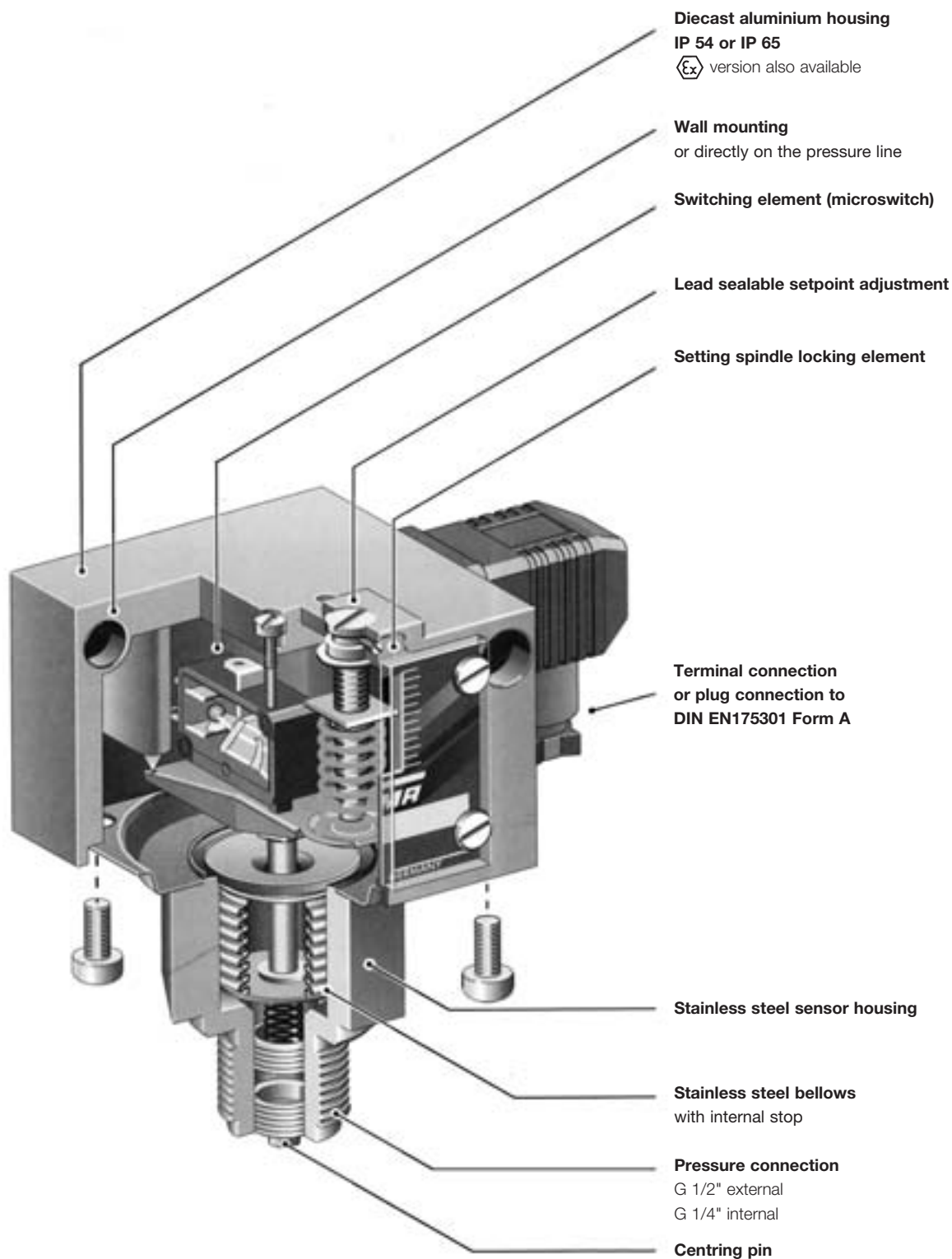
 Switching contacts: silver alloy  
 other equipment like DWR... 574

**Features of safety-engineered pressure monitors and pressure limiters**

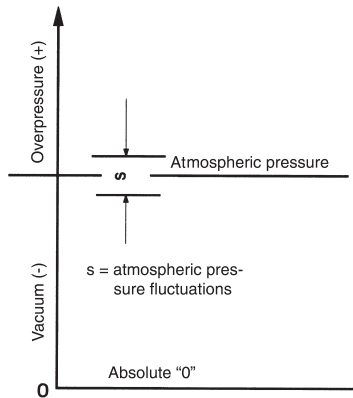
Devices	Component testing	Features							Options
	1 = VdTÜV Memorandum "Pressure 100" 2 = DIN EN1854 3 = DIN EN764-7 4 = DIN EN12952-11/DIN EN12953-9	Resistor combination for line break and short-circuit monitoring	Ex-ia-version for intrinsically safe control circuits	Self-monitoring pressure sensor	Plastic-coated housing	Chemical version	Positive opening microswitches	Gold-plated contacts	Limiter with internal interlock Chemical version
<b>Maximum pressure monitoring</b>									
FD16-326	1 + 3	■	■	■			■	■	
FD16-327	1 + 3	■	■	■					■
DWAM...576	1 + 4	■	■	■	■	■		■	
DWAM...577	1 + 4	■	■	■	■				■
DWR...576	1 + 2 + 3 + 4	■	■		■	■	■	■	
DWR...577	1 + 2 + 3 + 4	■	■		■				■
<b>Minimum pressure monitoring</b>									
DWR...574	1 + 2 + 3 + 4	■	■		■			■	
DWR...575	1 + 2 + 3 + 4	■	■		■				■

# Mechanical pressure switches

Technical features / Advantages



## 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.

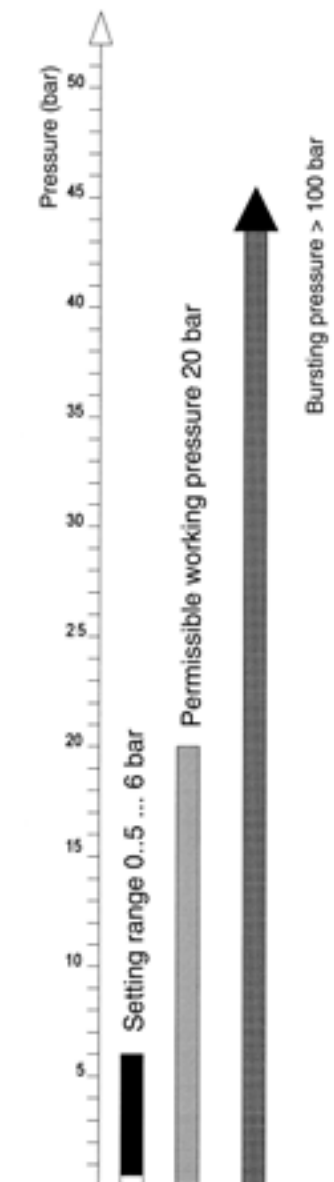
#### Setting range

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

#### Pressure units

Unit	bar	mbar	Pa	kPa	MPa	(psi) lb/m <sup>2</sup>
<b>1 bar</b>	1	1000	10 <sup>5</sup>	100	0.1	14.5
<b>1 mbar</b>	0.001	1	100	0.1	10 <sup>-4</sup>	0.0145
<b>1 Pa</b>	10 <sup>-5</sup>	0.01	1	0.001	10 <sup>-6</sup>	1.45 · 10 <sup>-4</sup>
<b>1 kPa</b>	0,01	10	1000	1	0.001	0,145
<b>1 MPa</b>	10	10 <sup>4</sup>	10 <sup>6</sup>	1000	1	145

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



#### Pressure data for a pressure switch based on the example of DWR625:

Setting range: 0.5-6 bar  
Perm. working pressure: 20 bar  
Bursting pressure: >100 bar

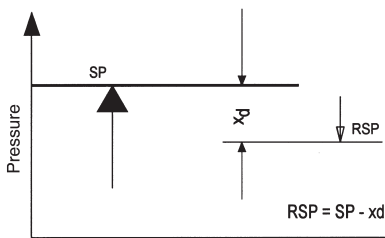
#### Important:

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

# Definitions

## Maximum pressure monitoring

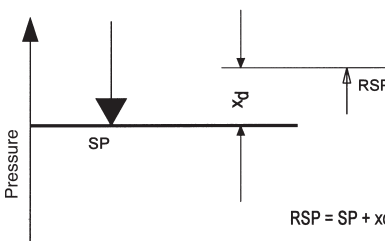
$$RSP = SP - xd$$



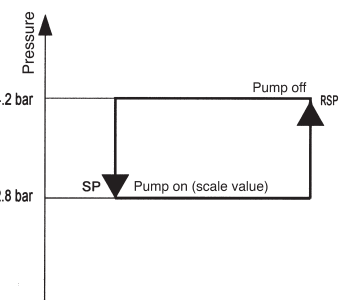
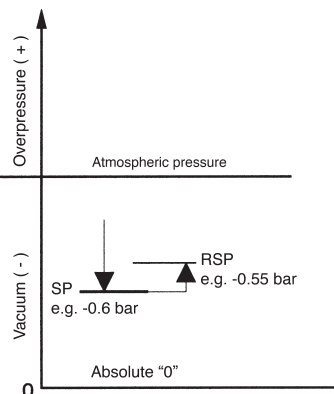
SP = switching point RSP = reset point  
xd = switching differential (hysteresis)

## Minimum pressure monitoring

$$RSP = SP + xd$$



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



SP = switching point RSP = reset point

## 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.

## 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.

## 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.

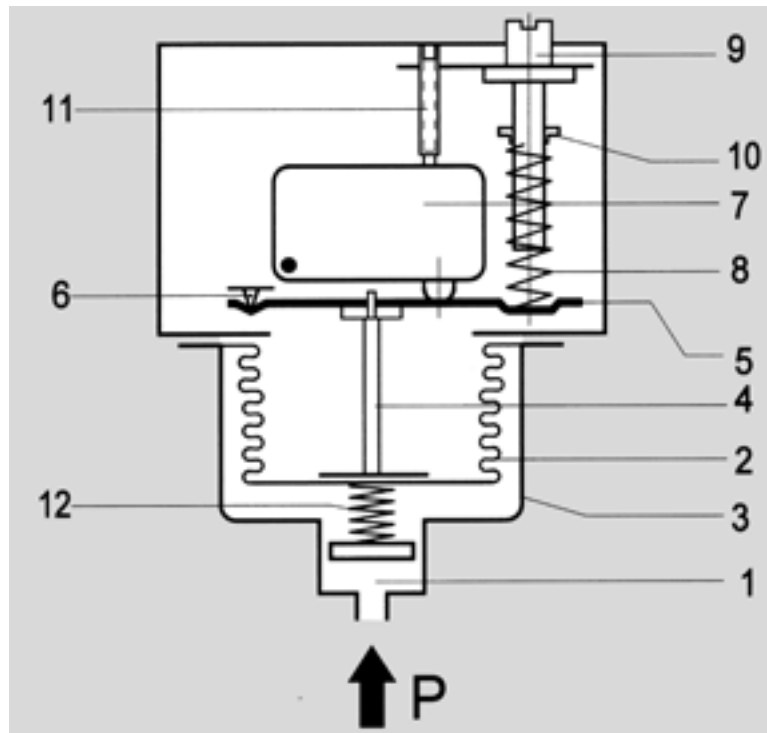
Chosen type: DCMV6 according to data sheet DCM. Setting: Scale pointer to 2.8 bar (lower switching point). Switching differential to 1.4 bar (set according to pressure gauge).

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

Standard version

Plug connection

Terminal connection



<b>Switch housing</b>	Diecast aluminium GDAISi 12	Diecast aluminium GDAISi 12
<b>Pressure connection</b>	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
<b>Switching function and connection scheme</b> (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.
<b>Switching capacity</b> (for microswitches with a silver contact)	8 A at 250 VAC 5 A at 250 VAC inductive 8 A at 24 VDC 0.3 A at 250 VDC min. 10 mA, 12 VDC	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
<b>Mounting position</b>	Preferably vertical (see technical data sheet)	Vertical
<b>Protection class</b> (in vertical position)	IP 54 Plug connection	IP 65 Terminal connection
<b>Electrical connection</b>	Pg 11	M 16 x 1.5
<b>Cabel entry</b>	-25 to +70 °C (exceptions:	-25 to +70 °C (exceptions:
<b>Ambient temperature</b>	DA series -20 to +70 °C DGM and FD series: -25 to +60 °C DCM4016, 4025, 1000, VCM4156: -15 to +60 °C)	DA series -20 to +70 °C DGM and FD series: -25 to +60 °C DCM4016, 4025, 1000, VCM4156: -15 to +60 °C)
<b>Switching point</b>	Adjustable using the setting spindle (for 300 device: after removing switch housing cover)	Adjustable using the setting spindle once the switch housing cover is removed
<b>Hysteresis</b>	Adjustable or not adjustable (see Product Summary)	Adjustable or not adjustable (see Product Summary)
<b>Medium temperature</b>	Max. 70 °C, briefly 85 °C	Max. 70 °C, briefly 85 °C
<b>Relative humidity</b>	15 to 95 % (non-condensing)	15 to 95 % (non-condensing)
<b>Vacuum</b>	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 (exception DCM1000).	
<b>Repetition accuracy of switching points</b>	< 1 % of the working range (for pressure ranges > 1 bar).	
<b>Vibration resistance</b>	No significant deviations up to 4 g.	
<b>Mechanical durability</b> (pressure sensor)	With sinusoidal pressure application and room temperature, 10 x 10 <sup>6</sup> 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.	
<b>Electronical durability</b> (microswitch)	100.000 switching cycles at nominal current 8 A, 250 VAC. A reduced contact load increases the number of possible switching cycles.	
<b>Isolation values</b>	Overvoltage category III, contamination class 3, reference surge voltage 4000 V. Conformity to DIN VDE 0110 is confirmed.	
<b>Oil and grease-free</b>	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).	

## Principal technical data

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

Ex-ia-version



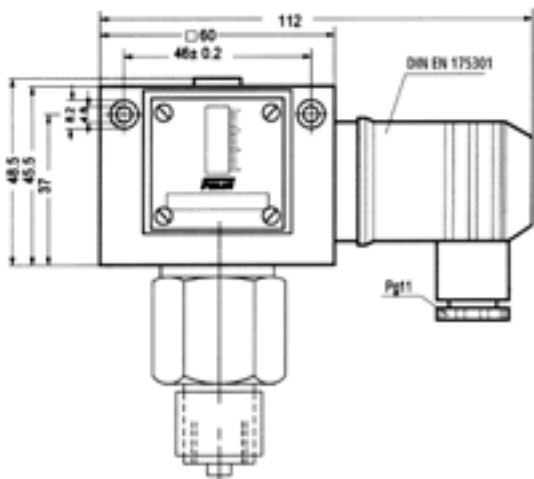
Ex version (Ex-d)



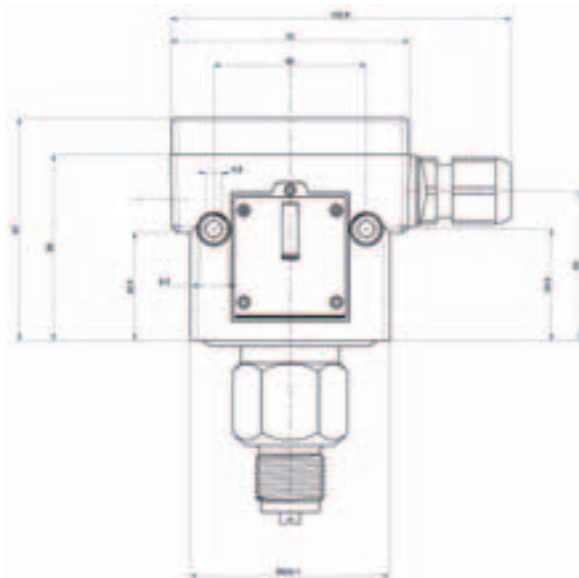
<b>Switch housing</b>	Diecast aluminium GDAISi 12	Diecast aluminium GDAISi 12
<b>Pressure connection</b>	G 1/2" external thread (pressure gauge connection) and G 1/4" internal thread. 1/4" internal thread for DDCM differential pressure switches	G 1/2" external thread (pressure gauge connection) and G 1/4" internal thread. 1/4" internal thread for DDCM differential pressure switches
<b>Switching function and connection scheme</b> (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
<b>Switching capacity</b>	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
<b>Mounting position</b>	Preferably vertical (see technical data sheet)	Vertical
<b>Protection class</b> (in vertical position)	IP 65	IP 65
<b>Explosion protection Code</b>	Ex II 1/2G Ex ia IIC T6 Ga/Gb Ex II 1/2D Ex ia IIC T80 °C	Ex II 2G Ex d e IIC T6 Gb Ex II 1/2D Ex ta/tb IIC T80 °C Da/Db
<b>EC Type Examination Certificate Number</b>	IBExU12ATEX1040	IBExU12ATEX1040
<b>Electrical connection</b>	Terminal connection	Terminal connection
<b>Cable entry</b>	M 16 x 1.5	M 16 x 1.5
<b>Ambient temperature</b>	-25 to +60 °C (exceptions: DA 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
<b>Medium temperature</b>	Max. 60 °C	Max. 60 °C
<b>Relative humidity</b>	15 to 95 % (non-condensing)	15 to 95 % (non-condensing)
<b>Switching point</b>	After removing switch housing cover	After removing switch housing cover
<b>Hysteresis</b>	Not adjustable	Not adjustable
<b>Vacuum</b>	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 (exception DCM1000).	
<b>Repetition accuracy of switching points</b>	< 1 % of the working range (for pressure ranges > 1 bar).	
<b>Vibration resistance</b>	No significant deviations up to 4 g.	
<b>Mechanical durability</b> (pressure sensor)	With sinusoidal pressure application and room temperature, 10 x 10 <sup>6</sup> 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.	
<b>Electronical durability</b> (microswitch)	100.000 switching cycles at nominal current 8 A, 250 VAC. A reduced contact load increases the number of possible switching cycles.	
<b>Isolation values</b>	Overvoltage category III, contamination class 3, reference surge voltage 4000 V. Conformity to DIN VDE 0110 is confirmed.	
<b>Oil and grease-free</b>	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

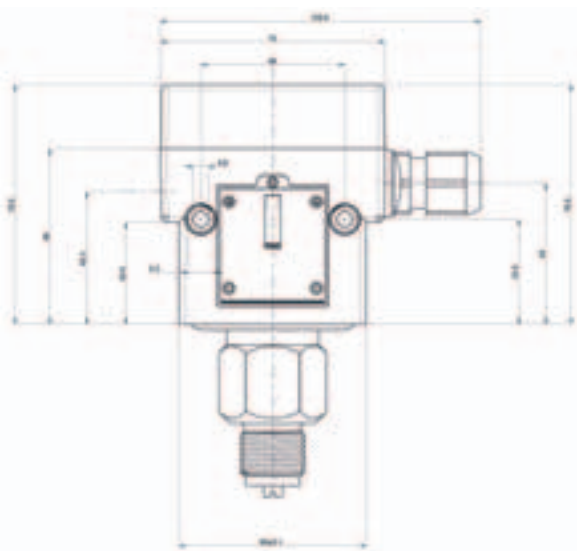
1 Housing 200 (plug connection)



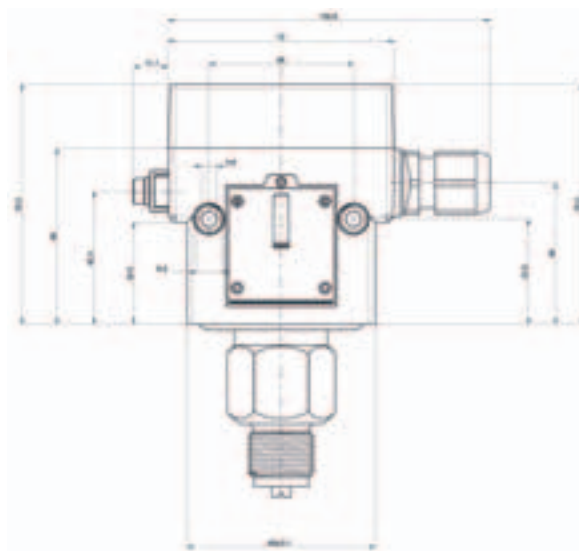
2 Housing 300 (terminal connection)



3 Housing 500 (terminal connection Ex-ia)

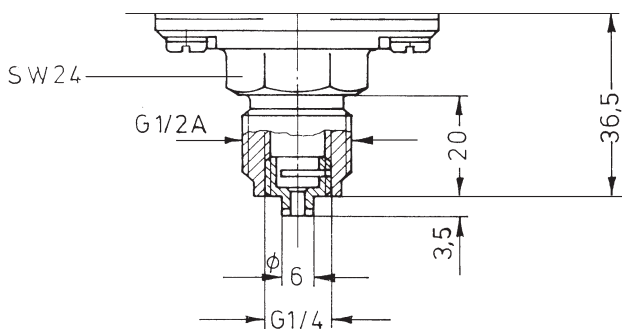


4 Housing 700 (terminal connection Ex-d)

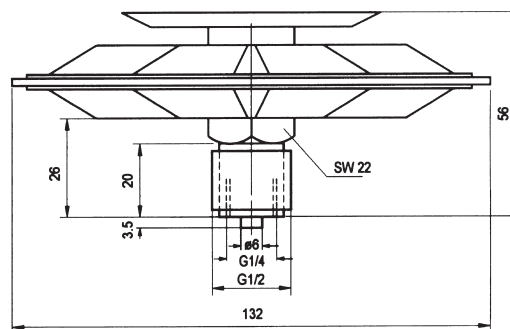


## Dimensioned drawings of pressure sensors

10

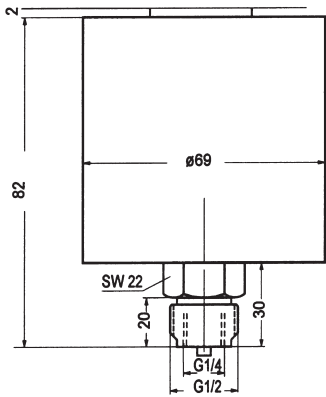


11

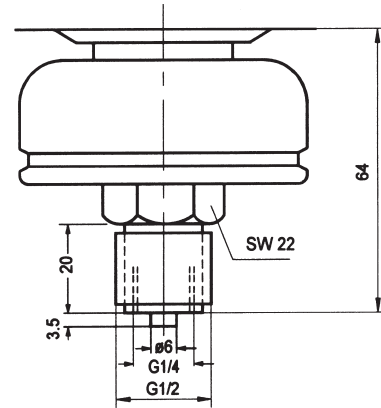


# Dimensioned drawings of pressure sensors

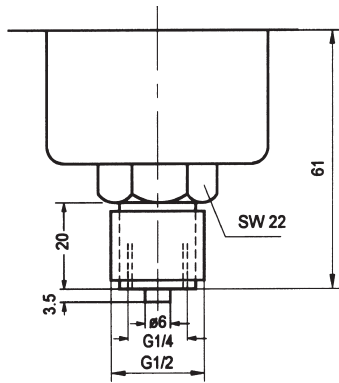
12



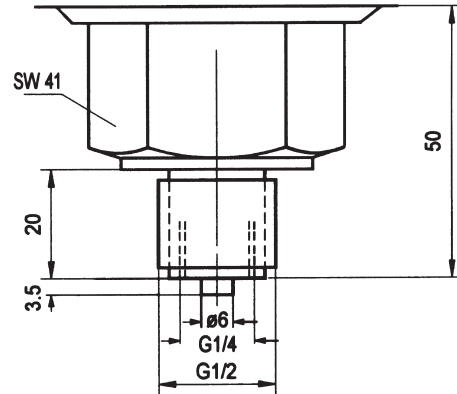
13



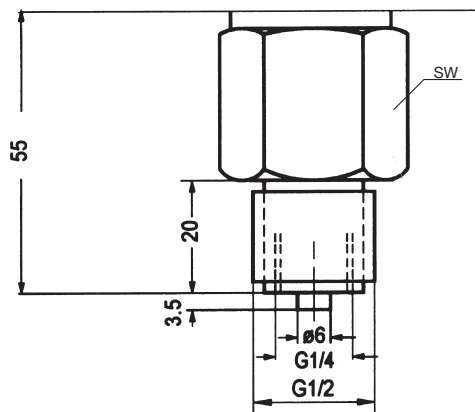
14



15

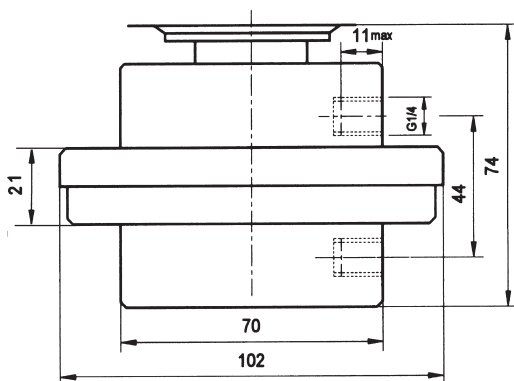


16-19

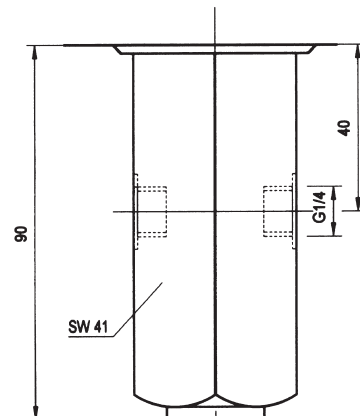


Dimensioned drawing	SW
16	22
17	24
18	30
19	32

20



21



# Setting instructions

## Factory calibration of pressure switches

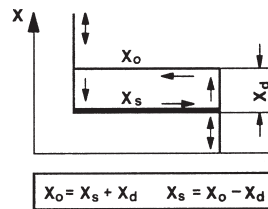
In view of tolerances in the characteristics of sensors and springs, and due to friction in the switching kinematics, slight discrepancies between the setting value and the switching point are unavoidable. The pressure switches are therefore calibrated in the factory in such a way that the setpoint adjustment and the actual switching pressure correspond as closely as possible in the middle of the range. Possible deviations are equally distributed on both sides.

The device is calibrated either for falling pressure (calibration at lower switching point) or for rising pressure (calibration at higher switching point), depending on the principal application of the type series in question.

Where the pressure switch is used at other than the basic calibration, the actual switching point moves relative to the set switching point by the value of the average switching differential. As FEMA pressure switches have very small switching differentials, the customer can ignore this where the switching pressure is set only roughly. If a very precise switching point is needed, this must be calibrated and checked in accordance with normal practice using a pressure gauge.

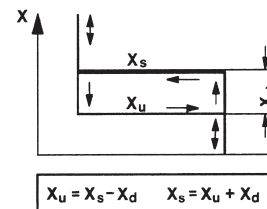
### 1. Calibration at lower switching point

Setpoint  $x^s$  corresponds to the lower switching point, the upper switching point  $x^o$  is higher by the amount of the switching differential  $x^d$ .



### 2. Calibration at upper switching point

Setpoint  $x^s$  corresponds to the upper switching point, the lower switching point  $x^u$  is lower by the amount of the switching differential  $x^d$ .

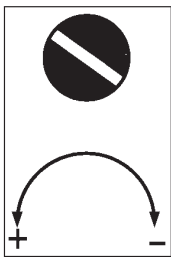


The chosen calibration type is indicated in the technical data for the relevant type series.

## Setting switching pressures

Prior to adjustment, the securing pin above the scale must be loosened by not more than 2 turns and retightened after setting. The switching pressure is set via the spindle. The set switching pressure is shown by the scale.

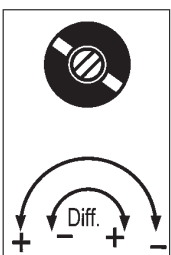
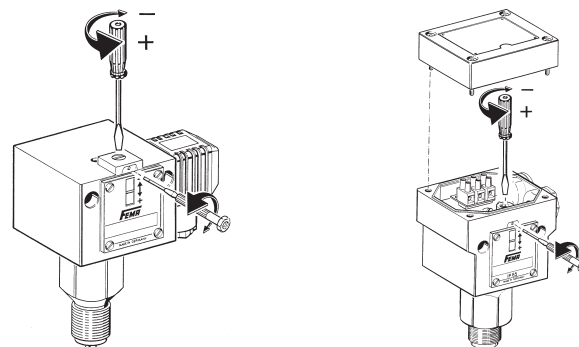
To set the switching points accurately it is necessary to use a pressure gauge.



Clockwise:  
lower switching  
pressure

Anticlockwise:  
higher switching  
pressure

Direction of action of setting spindle



Clockwise:  
greater diffe-  
rence  
Anticlockwise:  
smaller diffe-  
rence

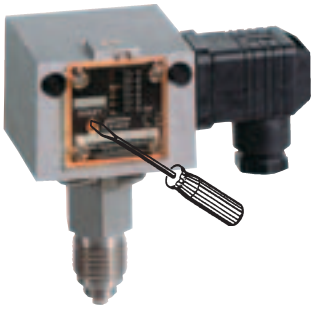
With pressure switches from the DWAMV and DWR...-203 series, the direction of action of the differential screw is reversed.

### Changing the switching differential (only for switching device with suffix "V", ZF203)

By means of setscrew within the spindle. The lower switching point is not changed by the differential adjustment; only the upper switching point is shifted by the differential. One turn of the differential screw changes the switching differential by about 1/4 of the total differential range. The switching differential is the hysteresis, i.e. the difference in pressure between the switching point and the reset point.

### Lead sealing of setting spindle (for plug connection housing 200 only)

The setting spindle for setting the desired value and switching differential can be covered and sealed with sealing parts available as accessories (type designation: P2) consisting of a seal plate and capstan screw. The sealing parts may be fitted subsequently. The painted calibration screws are likewise covered.



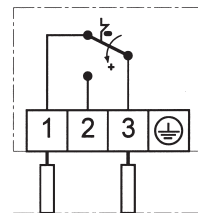
## Pressure switch with switching state locking (reclosing lockout)

In the case of limiter functions, the switching state must be retained and locked, and it may be unlocked and the system restarted only after the cause of the safety shutdown has been eliminated. There are two ways of doing this:

### 1. Mechanical locking inside the pressure switch

Instead of a microswitch with automatic reset, limiters contain a "bi-stable" microswitch. If the pressure reaches the value set on the scale, the microswitch trips over and remains in this position. The lock can be released by pressing the unlocking button (identified by a red dot on the scale side of the switching device). The lock can operate with rising or falling pressure, depending on the version. **The device can only be unlocked when the pressure has been reduced (or increased) by the amount of the predefined switching differential.** When selecting a pressure limiter, it is necessary to distinguish between maximum and minimum pressure monitoring. Ex-d versions cannot be equipped with internal locking.

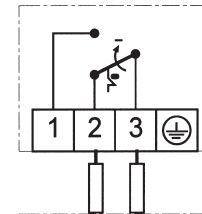
#### Maximum pressure limitation



Switching and interlocking with rising pressure. Additional function ZF205.

Connection of control current circuit to terminals 1 and 3.

#### Minimum pressure limitation



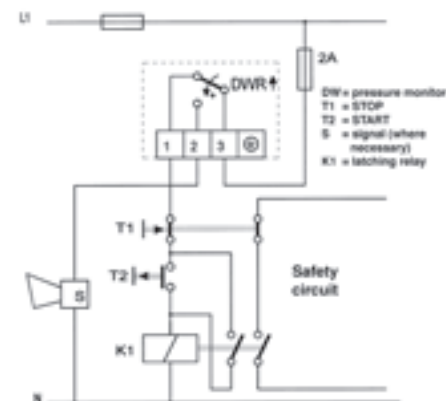
Switching and interlocking with falling pressure. Additional function ZF206.

Connection of control current circuit to terminals 2 and 3.

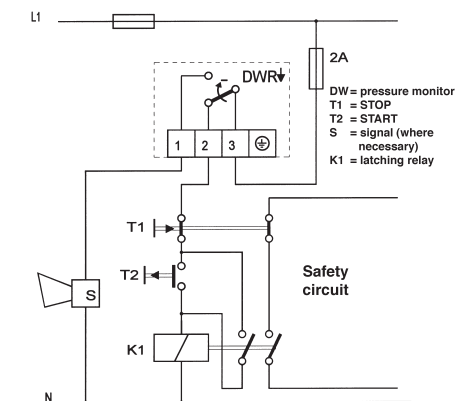
### 2. External electrical interlock in the control cabinet (suggested circuits)

A pressure monitor (microswitch with automatic reset) can also be used as a limiter if an electrical interlock is added. For pressure limitation in steam and hot water boilers, an external interlock is only permitted if it has been ascertained that the pressure monitor is "of special construction".

#### Maximum pressure limitation with external interlock



#### Minimum pressure limitation with external interlock



Where the above lock circuit is used, the requirements of DIN 57 116/VDE 0116 are met if the electrical equipment (such as contactors or relays) of the external interlock circuit satisfy VDE 0660 or VDE 0435.

## Explanation of type designations – type codes

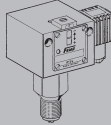
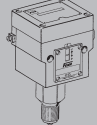
The type designations of FEMA pressure switches consist of a combination of letters followed by a number denoting the setting range. Additional functions and version variants are indicated by an extra code which is separated from the basic type by a hyphen. Ex versions (explosion protection Ex-d) are identified by the prefix "Ex" in front of the type designation.

Basic version (based on the example of DCM series) <b>DCMXXX</b>	With additional function <b>DCMXXX-YYY</b>	Ex version <b>Ex-DCMXXX</b>
--	---	--------------------------------

DCM	—————▶	Series code (e. g. DCM)
XXX	—————▶	Codes for pressure range
YYY	—————▶	Code for additional function
Ex	—————▶	Code for Ex-version

Switch housing version	
DCMXXX	Basic version with plug connection housing
DCMXXX-2...	Basic version with plug connection housing
DCMXXX-3...	Terminal connection housing (300)
Ex-DCMXXX	Ex-d switching device (700)
DCMXXX-5...	Ex-ia version (500)

### Which additional function goes with which pressure switch?

	Plug connection, 200 series 			Terminal connection, 300 series 					
	203	213	217	301 351	307	513	574 576	575 577	Ex-d
DCM/VCM	• <sup>1</sup>	•	• <sup>1</sup>	•	• <sup>1</sup>	•			•
VNM/DNS/VNS	•	•	•	•	•	•			•
DWAM		•		•		•	•	•	
DDCM		•	• <sup>2</sup>	•	• <sup>2</sup>	•			•
DWR	•	•		•		•	•	•	•
DGM		•		•		•	•	•	•

• available

<sup>1</sup> except DCM4016, DCM4025, VCM4156 and DCM1000

<sup>2</sup> except DDCM252, 662, 1602, 6002

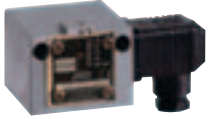

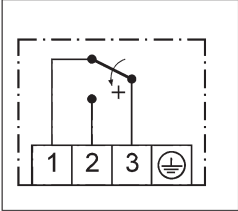
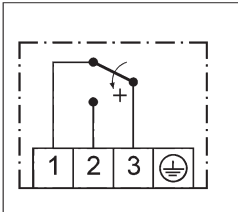
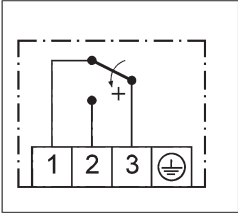
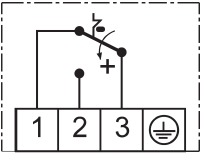
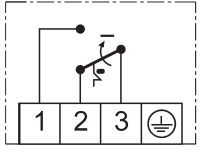
**Combination of several additional functions not possible!**

**Ex versions (Ex-d) can only be supplied in basic form.**

**Additional functions are not possible.**

# Pressure switches and pressure monitors

## Additional functions / Connection schemes

	Plug connection, 200 series (IP 54)	Terminal connection, 300 series (IP 65)	Connection scheme
<b>Standard version (plug connection)</b> Microswitch, single pole switching, switching differential not adjustable			
<b>Terminal connection housing (300)</b>		ZF301	
<b>Unit with adjustable switching differential</b>	ZF203		
<b>Maximum pressure limiter with reclosing lockout</b> <b>Interlocking with rising pressure</b> see DWR series	ZF205		
<b>Minimum pressure limiter with reclosing lockout</b> <b>Interlocking with falling pressure</b> see DWR series	ZF206		



	Plug connection 200 series (IP 54)	Terminal connection 300 series (IP 65)	Connection scheme	
<p><b>Two microswitches</b>, switching in parallel or in succession. Fixed hysteresis, only possible with terminal connection housing.</p> <p><b>State the hysteresis</b> (not possible with all pressure switches).</p>		<b>ZF307</b>		
<p><b>Two microswitches, 1 plug</b> switching in succession, adjustable hysteresis.</p> <p><b>State the switching scheme *</b> (not possible with all pressure switches).</p>	<b>ZF217 *</b>		<p>Connection scheme selection, see page 26</p>	
<p><b>Gold-plated silver contact</b>, single pole switching (not available with adjustable switching differential).</p> <p><b>Switching capacity:</b> max. 24 VDC, 100 mA, min. 5 VDC, 2 mA</p>	<b>ZF213</b>			
<p><b>Switch Housing with surface protection</b> (chemical version)</p>		<b>ZF351</b>		

The prices shown are additional prices compared to the basic device of the 200 series (plug connection).

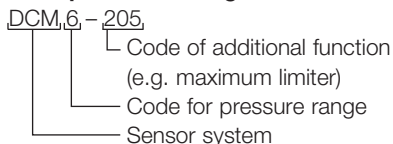
\* Connection schemes for switching schemes, see page 26.

Please state when ordering!

Example for ordering: DCM10-217A-S.

Additional text: switching scheme A4

**Example for ordering:**



**How to order:**

Pressure switch  
DCM6-205  
or DCM6 with ZF205

# Pressure switches and pressure monitors

## Additional functions for Ex-ia-equipment



DWAM6-576

- Housing (500) with terminal connection (IP 65), "blue" cable entry and terminals.
- Also available with resistor combination for line break and short-circuit monitoring (with isolating amplifier).

### ! Important:

All pressure switches with the ZF5... additional functions listed here can only be operated in combination with a suitable isolating amplifier.

### i Additional information:

Our pressure switches and thermostats are considered to be "simple electrical equipment" within the meaning of standard EN60079-11: 2007. Testing is not mandatory for this type of equipment.

### Additional functions for Ex-ia-equipment

Ex II 1/2G Ex ia IIC T6 Ga/Gb

Ex II 1/2D Ex ia IIIC T80 °C

### Connection scheme

#### Gold-plated contact

single pole switching, fixed hysteresis,  
not adjustable

#### Switching capacity:

max. 24 VDC, 100 mA, min. 5 VDC, 2 mA

#### For the power supply circuit:

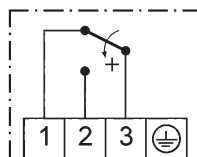
$U_i$  24 V DC

$I_i$  100 mA

$C_i$  1 nF

$L_i$  100  $\mu$ H

#### ZF513



Versions with resistor combination for line break and short-circuit monitoring in control current circuit, see DBS series, pages 50–52:

#### For the power supply circuit:

$U_i$  14 V DC

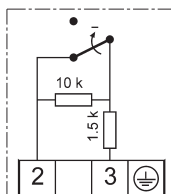
$R_i$  1500 Ohm

$C_i$  1 nF

$L_i$  100  $\mu$ H

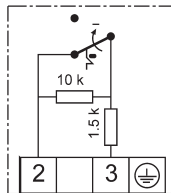
Normally closed contact with resistor combination, for **minimum pressure monitoring**, gold-plated contact, plastic-coated housing (chemical version).

#### ZF574



Normally closed contact **with reclosing lockout** and resistor combination, for **minimum pressure monitoring**, plastic-coated housing (chemical version).

#### ZF575



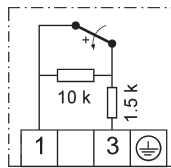
see

DBS series

pages 50–52

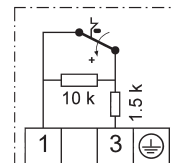
Normally closed contact with resistor combination, for **maximum pressure monitoring**, gold-plated contact, plastic-coated housing (chemical version).

#### ZF576



Normally closed contact **with reclosing lockout** and resistor combination, for **maximum pressure monitoring**, plastic-coated housing (chemical version).

#### ZF577



## 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
<b>Adjustment according to customer's instruction:</b>			
one switching point	ZF1970*	ZF1970*	ZF1970*
two switching points or defined switching differential	ZF1972*	ZF1972*	-
<b>Adjustment and lead sealing according to customer's instruction:</b>			
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	AZ3.1	AZ3.1	AZ3.1
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
- 1 ZF1970: set to 4 bar rising
- 1 ZF1978: PSH008
- 1 AZ3.1

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

Pack contents: 1 DCM6 (without "S" suffix) marked  
1 ZF1970: set to 4 bar rising  
1 ZF1978: PSH008  
1 AZ3.1  
1 Installation and operating instructions

TÜV  
DVGW



## 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 safety-critical 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**.

### 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":

- 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)
- By certification of endurance testing with 2 million operating cycles during the component test (see Fig. 2)

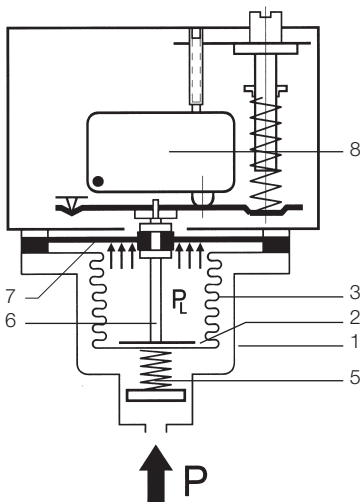
#### a) Self-monitoring pressure sensor with safety diaphragm (for maximum pressure monitoring only)

Fig. 1 is a cross-sectional 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 counterforce. A transfer bolt (6) which transfers the pressure-dependent 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.

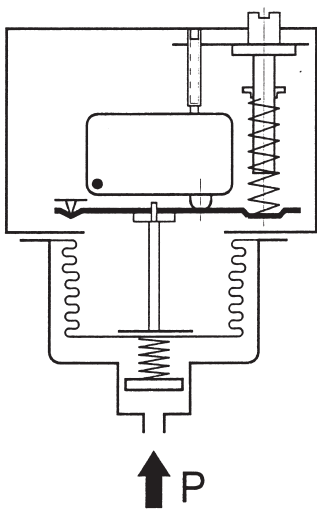
#### b) Pressure sensors with certification of 2 million operating cycles (DWR series)

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 thin-walled) 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.



Self-monitoring maximum pressure limiter with safety diaphragm DWAM..., DWAMV..., SDBAM...



Pressure limiter without safety-diaphragm (not self-monitoring for maximum pressure) DWR...

# 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:

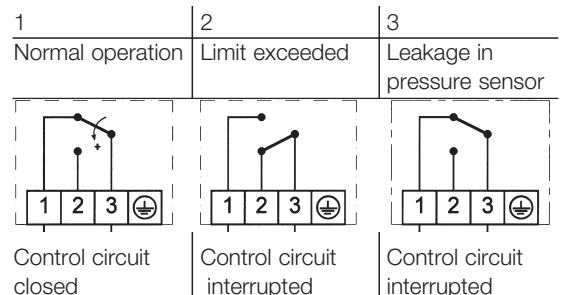
Pressure limiters "of special construction" with safety diaphragms (self-monitoring pressure sensors) offer the highest degree of safety in maximum pressure monitoring. Such devices must not however be used for minimum pressure monitoring. Pressure limiters "of special construction" with certification 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:

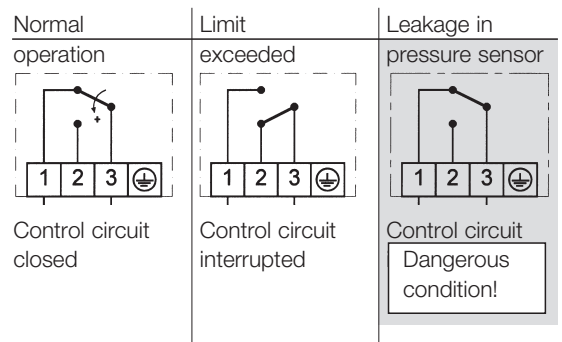


### Device without safety diaphragm

"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.



## 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 TRD 604 and for heating systems according to DIN EN12828. They are considered to be failsafe elements within the meaning of TRD 604 and can therefore be used on installations in 24-hour operation and 72-hour operation (for further information see TRD 604). 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 safety-critical 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-ia 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

### Steam and hot water

Pressure monitors and pressure limiters for steam and hot water in systems to DIN EN12828 and TRD 604. Series DA and DWR.

**DVGW**  
DIN EN1854

### Fuel gases $\text{CE}$

Pressure monitors and limiters for fuel gases in accordance with DVGW Worksheet G 260. Series DGM and DWR.

**TÜV**  
DIN EN764-7

### Liquid fuels

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

**TÜV, Pressure 100**

### Safety-engineered pressure limiters

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

**PED 97/23/EC**

### Pressure Equipment Directive 97/23/EC

Pressure monitors and limiters to DIN EN12952-11 and DIN EN12953-9

**ATEX 94/9/EC**

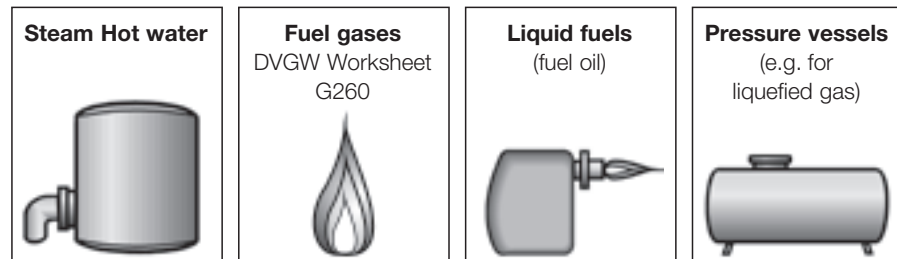
### $\text{Ex}$ -versions

For Ex-areas Zones 1 and 2, as well as 21 and 22 all pressure switches can be supplied in pressure-proof encapsulated design.

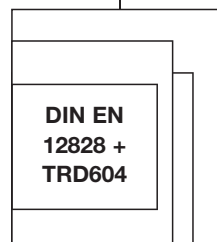
All intrinsically safe devices are for the Ex-Zones 0, 1, 2, 20, 21 and 22.

For intrinsically safe control circuits (Ex degree of protection Ex-ia), pressure switches with gold plated silver contact, and the blue terminals and cable entries customary in Ex-ia 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-ia) to a non-intrinsically safe active circuit is required

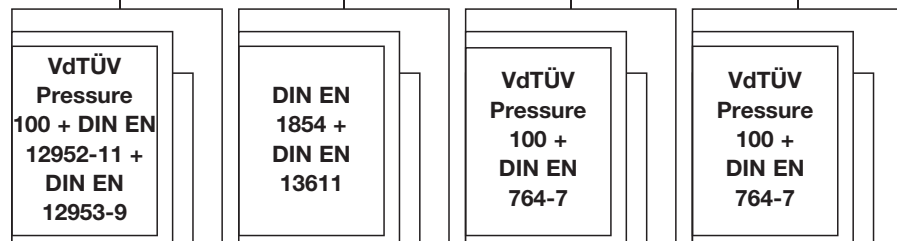
Medium



Plant directives



Directives for component testing



Type series





## Selection according to function and application



Pressure monitor



Pressure limiter with internal interlock

Application / Function	Steam and hot water systems to TRD 604 and DIN EN12828	Fuel gases to DVGW-Worksheet G 260	Heating oil and other liquid fuels	Other media (check compatibility with the materials used)
<b>Pressure monitoring</b> <b>Pressure regulation</b> (e.g. burner or pump control)	DWAM... DWAMV... DWR... DWR...-203	DGM... DWR... DWR...-203	DWR... DWR...-203	DWAM... DWAMV... DWR... DWR...-203
<b>Maximum pressure limitation</b> with internal interlock	SDBAM... DWR...-205	DGM...-205 DWR...-205	DWR...-205	SDBAM... DWR...-205
with external interlock	DWAM... DWR...	DGM... DWR...	DWR...	DWAM... DWR...
<b>Minimum pressure limitation</b> with internal interlock	DWR...-206	DGM...-206 DWR...-206	DWR...-206	DWR...-206
with external interlock	DWR... DWR...	DGM... DWR...	DWR...	

...The code number for the pressure range must be inserted here (see datasheets). A final number of 2... (e.g. DWR...-205) means a plug connector according to DIN EN175301.

### DWR series

The DWR series covers all the applications mentioned above.

### DWAM-, DWAMV-, SDBAM-series (self-monitoring sensor)

DWAM, DWAMV and SDBAM are **only suitable for maximum pressure monitoring**. They offer **additional safety** due to the **safety diaphragm (selfmonitoring sensor)**. They are TÜV-tested for steam and hot water, but thanks to the self-monitoring sensor can also be recommended for other, **particularly safety-critical applications** (e.g. in process engineering).

Sensors of the DWR series are self-monitoring when used in minimum pressure monitoring applications.

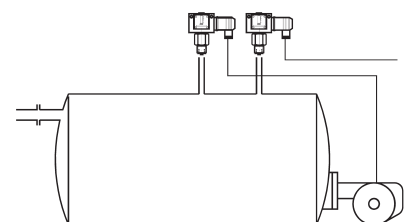
## Equipment of a boiler with pressure monitor and pressure limiter

**Pressure monitor for burner control:** **DWAM... or DWR...** (without adjustable switching differential)  
or  
(better, because switching differential adjustable) **DWAMV... or DWR...-203**

**Pressure limiter for safety monitoring:** **SDBAM... or DWR...-205** (with internal interlock, unlocking button on the pressure limiter)  
or  
**DWAM... or DWR...** (with external interlock in the control cabinet)  
Suggested connection for the external interlock, see page 18.

Pressure monitor  
DWAM...  
or DWR...

Pressure limiter  
SDBAM... or  
DWR...-205



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