

SF₆ Gas Density Monitoring



The energy sector is and will remain one of the growth sectors of the future. The thirst for energy of our civilisation is constantly growing. This is why the energy sector constantly has to cope with new demands. Alternative energy sources such as photovoltaics, wind energy and combined heat and power plants have to be integrated into the energy grid increasingly in order to supplement and partially replace the traditional energy sources.

The future belongs to “smart grid” – intelligent energy grids with many decentralised sources and at the same time comprehensive powerful availability for the electric mobility. Intelligent grid management, which connects and disconnects sources and consumers in line with the demand, can only obtain the required flexibility with compact circuit-breakers that have the interconnectivity capacity for online monitoring.

SF₆ gas is the key to compact systems that, as hermetically capsuled modules, isolate the functional devices of the switchgear from the environment. The excellent insulation and spark extinguishing properties of the gas minimise the internal switching wear of the system. SF₆ gas insulated switchgears impress with high availability and decades of maintenance-free operation. This places high demands on gas density monitoring, which must function reliably in the climatic conditions of all installation locations. From –50 °C in Siberia up to +70 °C in control rooms at the equator or in mining.

In this brochure you will find a selection of measuring instruments and monitoring devices, which have been developed especially for the specific requirements in different applications with SF₆ gas and SF₆/N₂ gas mixtures. You are looking for an instrument for a special field of application? We are pleased to help you selecting the best instrument for your application. Do not hesitate to contact us!

Content

Facts about SF ₆	5
Technologies	6
Mechanical Instruments	7
Electromechanical Instruments	9
Electronic Instruments	10
Software	12
Custom-made Products	13
Certificates & Approvals	14
Service	15

Industry Expertise

Applications and Application Fields of our Products at a Glance



Shipbuilding Industry



Energy



Chemistry and Petrochemistry



Water and Waste Water



Oil and Gas



Food Industry



Pharmaceutical Industry



Refrigeration Engineering



Rail Cars



Fire Extinguishing/Fire Protection



Engineering



Semiconductor Industry



SF₆ Gas Density Monitoring

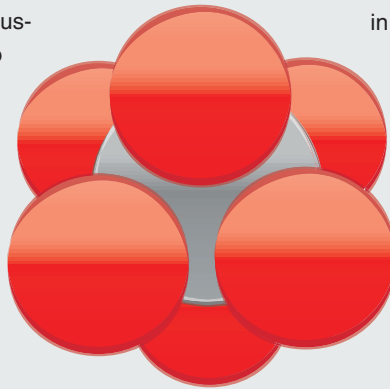


Facts about SF₆

Sulphur Hexafluoride SF₆

SF₆ is a synthetic gas. The inert gas is colourless and odourless, non-toxic and non-combustible. However, according to the Kyoto protocol it is one of the main six greenhouse gases and thus it is to be surveyed.

Its unique electrical properties predetermine SF₆ gas and its blends with N₂ for switchgear construction up to over 1,000,000 volts. Even in low and medium voltage switchgears, SF₆ gas insulated systems are becoming increasingly popular due to the advantages offered by gas insulation.



On the one hand, a minimum gas density is required in order to guarantee the safe functioning of a switchgear. On the other hand, it should be insured to avoid emissions into the atmosphere. It is necessary to monitor the gas-insulated chambers of each switchgear, to trigger safety-related alarms or switching processes and to transmit the current status to a data network.

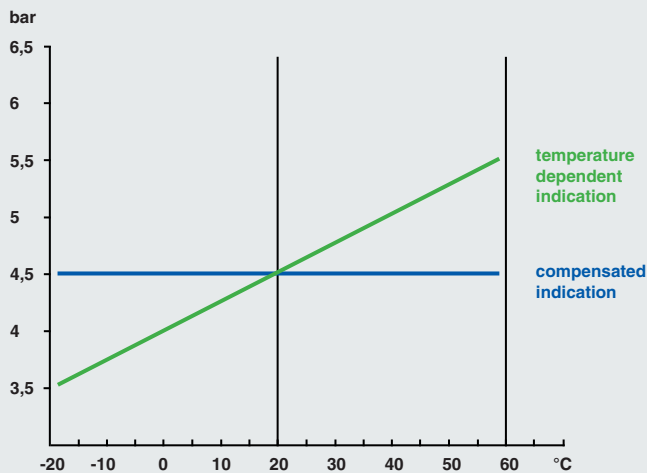
Main Fields of Application

- ◆ Gas-insulated switchgears (GIS)
- ◆ High-voltage systems
- ◆ Medium-voltage systems
- ◆ Gas-insulated transmission lines (GIL)
- ◆ Isolators (breakers)
- ◆ Transducers
- ◆ Transformers
- ◆ Circuit breakers
- ◆ Load switches
- ◆ Ring main units (RMU)



Temperature Compensation

The dielectric strength and arc extinguishing capability of gas-insulated systems is determined by the gas density. This must by no means fall below the planned minimum value, as this would result in an explosive destruction of the system. Gas-insulated systems are often installed outdoors and are subject to fluctuating environmental influences. Temperatures between -40 °C and $+70\text{ °C}$ are not uncommon. Special solutions can also be realised beyond this range.



If the gas density remains constant in the isochoric system, the system pressure changes with the ambient temperature. This is why classical contact pressure gauges and pressure transmitters are not suitable for gas density monitoring. In order to be able to switch reliably in case of leakage, the devices have to be temperature compensated. The reference temperature for this is usually $+20\text{ °C}$. The measured value is compensated in such a way that the indication always corresponds to the situation of $+20\text{ °C}$ at any temperature in the range.

Principles of Gas Density Measurement

Mechanical

Bourdon tube pressure gauge

Pressure measuring instruments with uncompensated indication

Measurement of the instantaneous SF_6 gas pressure. With simultaneous knowledge of the gas temperature (thermometer required), the gas density at reference temperature $+20\text{ °C}$ can be inferred.

Gas density indicator

Pressure measuring instruments with compensated indication

The measuring principle allows an ideal temperature compensation with only one calibration pressure. **Bimetal-compensated indication for reference temperature $+20\text{ °C}$.**

Electromechanical

Gas density monitor

Pressure measuring instruments with compensated indication and additional electrical accessory

A density indicator with additional electrical accessory allows permanent gas density monitoring and triggering of alarms.

Bimetal-compensated indication and switching function for reference temperature $+20\text{ °C}$.

Electronic

Gas pressure and gas density transmitter

All-in-One

A permanent measurement of pressure and temperature of the SF_6 gas allows compensation of the complete SF_6 characteristic diagram by means of an integrated microprocessor.

Bourdon Tube Pressure Gauges

Pressure gauges with uncompensated indication

Measurement of the actual SF₆ gas pressure at instantaneous gas temperature. With simultaneous knowledge of the gas temperature, the gas density and the gas pressure at reference temperature +20 °C can be inferred by means of tables or special scales.

» Wetted parts and case made of stainless steel «

◆ Non-corrosive, temperature- and weather-resistant

» 100 % helium leak detection «

◆ Leakages of the measuring system are excluded

» Special scales «

◆ Dial design according to customer specifications

» Crimped-on ring case «

◆ Case closed tamper-proof

◆ Hermetical tightness, even at extreme temperatures



RChgG 63 – 3 rm



RChgG 100 – 3
special connection with flange

Case	stainless steel	
Ring	crimped-on ring stainless steel	
Case filling	RChg	without case filling,
	RChgG	with glycerin or silicone oil
Accuracy class/ nominal case size	1.6	NCS 63 mm
	1.0	NCS 100, 160 mm
Wetted parts	stainless steel, gas-shielded arc welding, leakage rate < 10 ⁻⁹ mbar l/s	
Rated temperature*	-20 / +60 °C	
Pressure ranges	0 – 2.5 mbar to 0 – 1600 bar	
Process connection	NCS 63	G ¼ B
	NCS 100, 160	G ½ B
	flange and special connections	
Model overview	1000	

* others upon request

Gas Density Indicator

Pressure gauges with compensated indication

The indication of the actual SF₆ gas pressure is adjusted on the basis of the device temperature, which should correspond to the gas temperature, so that the gas pressure is indicated, which would prevail in the gas-filled compartment at same gas density and reference temperature +20 °C. The bimetal compensation is dimensioned to a reference isochore of the SF₆ gas, the so-called calibration pressure p_c, which corresponds to the nominal filling pressure p_f of the gas-filled compartment.

» Wetted parts and case made of stainless steel «

◆ Non-corrosive, temperature- and weather-resistant

» 100 % helium leak detection «

◆ Leakages of the measuring system are excluded

» Special scales «

◆ Dial design according to customer specifications

» Crimped-on ring case «

◆ Case closed tamper-proof
◆ Hermetical tightness, even at extreme temperatures

» Bimetal compensation «

◆ Indication adjustment for reference temperature +20 °C for SF₆ gas or SF₆/N₂ gas mixtures



RChg 63 – 3 r SF6	
Case	stainless steel
Ring	crimped-on ring stainless steel
Case filling	RChg without case filling
Accuracy class	1.0 at operating temperature +20 °C 2.5 at operating temperatures –20 / +60 °C
Nominal case size	63 mm
Wetted parts	stainless steel, gas-shielded arc welding, leakage rate < 10 ⁻⁹ mbar l/s
Rated temperature*	–20 / +60 °C
Pressure ranges	spans 1.6 to 16 bar gauge or absolute pressure
Process connection	G ¼ B, flange and special connections
Position of connection	bottom, 9 o'clock, 12 o'clock, 3 o'clock or lower back, centre back connection

RChg 100 – 3 SF6	
Case	stainless steel
Ring	crimped-on ring stainless steel
Case filling	RChg without case filling RChgG glycerin or silicone oil RChgN nitrogen
Accuracy class	1.0 at operating temperature +20 °C 2.5 at operating temperatures –20 / +60 °C
Nominal case size	100, 160 mm
Wetted parts	stainless steel, gas-shielded arc welding, leakage rate < 10 ⁻⁹ mbar l/s
Rated temperature*	–20 / +60 °C
Pressure ranges	spans 1.6 to 16 bar gauge or absolute pressure
Process connection	G ½ B, flange and special connections
Position of connection	bottom, 9 o'clock, 12 o'clock, 3 o'clock or lower back connection

* others upon request

Gas Density Monitor

Pressure gauges with compensated indication and additional electrical accessory

A gas density monitor is a density indicator, which is extended by electrical limit switches with magnetic contacts. The bimetal compensation is dimensioned to a reference isochore of the SF₆ gas, the so-called calibration pressure p_c, which in this application typically corresponds to the first switch point in falling direction. Calibration pressure, switch point adjustment and scale according to customer specification.

» Option: lightning impulse withstand voltage 7 kV «

- ◆ Increased safety against excess voltage
- ◆ Increased clearance and creep distances



» Electrical switching device «

- ◆ Up to 3 magnetic contacts, switching function: breaking or making contact or combination of both according to customer specification

» Laser secured switch points «

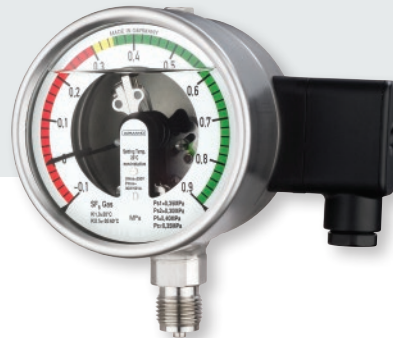
- ◆ Increased mechanical shock resistance

» Bimetal compensation «

- ◆ Indication adjustment for reference temperature +20 °C for SF₆ gas or SF₆/N₂ gas mixtures

» Crimped-on ring case «

- ◆ Case closed tamper-proof
- ◆ Hermetical tightness, even at extreme temperatures



RChgN 63 – 3 SF6	
Case	stainless steel
Ring	crimped-on ring stainless steel
Case filling	RChgN nitrogen
Accuracy class	1.0 at operating temperature +20 °C 2.5 at operating temperatures –20 / +60 °C
Nominal case size	63 mm
Wetted parts	stainless steel, gas-shielded arc welding, leakage rate < 10 ⁻⁹ mbar l/s
Rated temperature*	–20 / +60 °C
Pressure ranges	spans 2.5 to 16 bar gauge or absolute pressure
Process connection*	G ¼ B
Position of connection*	lower back connection
Limit switch	max. 2 contact switches max. breaking capacity 30 V / 50 V A, max. 1 A, max. switching voltage 250 V

RChgOe 100 – 3 SF6	
Case	stainless steel
Ring	crimped-on ring stainless steel
Case filling	RChg without case filling RChgOe silicone oil RChgN nitrogen
Accuracy class	1.0 at operating temperature +20 °C 2.5 at operating temperatures –20 / +60 °C
Nominal case size	100 mm
Wetted parts	stainless steel, gas-shielded arc welding, leakage rate < 10 ⁻⁹ mbar l/s
Rated temperature*	–20 / +60 °C, –40 / +40 °C
Pressure ranges	spans 2.5 to 16 bar gauge or absolute pressure
Process connection	G ½ B, M20x1.5, G ¾ B flange and special connections
Position of connection	bottom, 9 o'clock, 12 o'clock, 3 o'clock or lower back connection
Limit switch	max. 3 contact switches max. breaking capacity 30 V / 50 V A, max. 1 A, max. switching voltage 250 V
Data sheet	1902

* others upon request

Gas Pressure and Gas Density Transmitter

All-in-One – from $-40\text{ }^{\circ}\text{C}$ to $+60\text{ }^{\circ}\text{C}$

The DIGPTMvSF6 combines a hermetically sealed, welded stainless steel pressure measuring cell, a platinum temperature sensor and a microcontroller with 2 switching outputs, an RS 485 interface and 2-wire functionality 4...20 mA in one device. An adjustable electronic low-pass suppresses switching errors due to mechanical shock, triggered by switching operations of the switchgear. Device address, switching functions and switch points, software low-pass, offset and scaling can be administered by the user via the USSCOM software.

DIGPTMvSF6



« All-in-One »

- ◆ Analogue: 2-wire 4...20 mA
- ◆ Digital: RS 485
- ◆ Pressure switch: 2 separate switches, freely programmable

« 2 sensors: pressure and temperature »

- ◆ Permanent pressure and temperature measurement of the SF₆ gases allows a precise calculation of the gas density and gas pressure at $+20\text{ }^{\circ}\text{C}$ by means of a microprocessor

« Precision in the entire measuring range »

- ◆ Accuracy of 0.5 % over the entire specified measuring range from $-40\text{ }^{\circ}\text{C}$ to $+60\text{ }^{\circ}\text{C}$
- ◆ Calibration pressure no longer required

« Non-corrosive and robust »

- ◆ Laser-welded stainless steel version – hermetically sealed
- ◆ EMC proof enclosure (EMC immunity with dual industrial standard)
- ◆ High degree of protection (IP67), optionally IP68 (bare cable end)

« Software »

- ◆ Parametrisation of the switch points and switching functions, low-pass, units
- ◆ Indication of measured value and sensor temperature
- ◆ Configuration backup and restore



DIGPTMvSF6

Case	stainless steel, welded with process connection
Measuring cell	piezoresistive measuring cell: stainless steel, internal diaphragm: stainless steel
Accuracy class	≤ 0.5 in the rated temperature range (including non-linearity, hysteresis and non-repeatability)
Output signal	analogue: 2-wire 4...20 mA, digital: RS 485
Voltage supply	12 to 24 V DC ($\pm 25\%$), reverse polarity protected
Switching outputs	2 PNP switches 0.2 A, for ohmic, capacitive and inductive load, short-circuit proof
Rated temperature	$-40 / +60\text{ }^{\circ}\text{C}$
Pressure ranges	0 – 60 g/l gas density (0 – 8.87 bar abs. gas pressure) SF ₆ at $+20\text{ }^{\circ}\text{C}$ 0 – 10 bar abs. gas pressure (0 – 68.9 g/l gas density) SF ₆ at $+20\text{ }^{\circ}\text{C}$ Compensation only for gas phase!
Process connection*	G $\frac{1}{2}$ B, stainless steel
Rupture safety	>100 bar
Data sheet	9891

* others upon request

Combination of Gas Density Monitor and Transmitter



combination with gas density transmitter enables cross-linking via RS 485, electrical output signal 4...20 mA and additional switching function

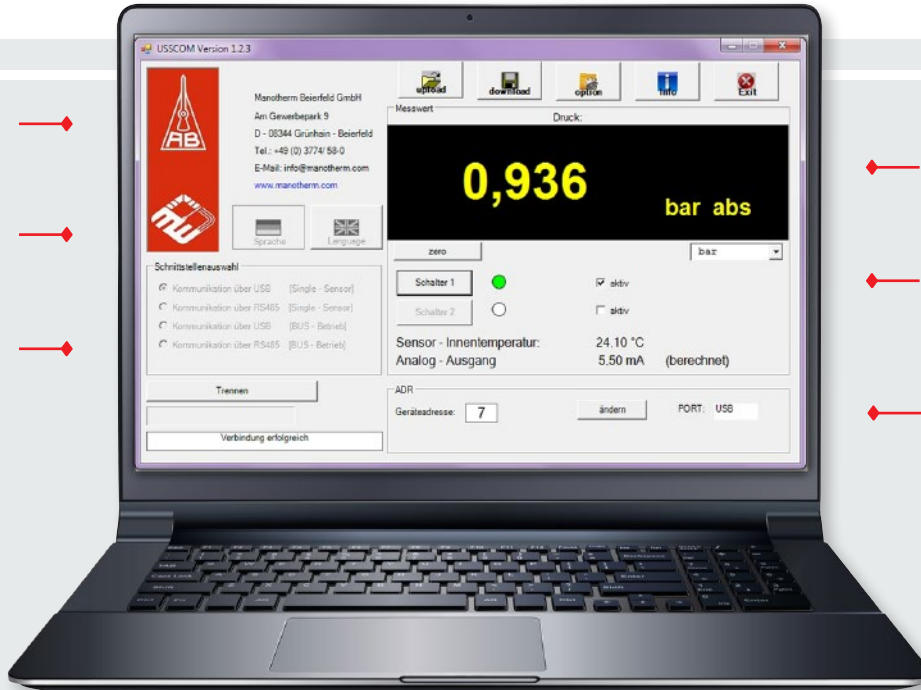
on-site display and switching functions, like gas density monitor (see page 9)

» 2 independent measuring principles increase the reliability and safety «

Digital Indication

All instruments parameters at a glance

With our USSCOM software, you can adjust the DIGPTMvSF6 transmitters available at the RS 485 according to your requirements, display the measured values in different units as well as view information on the device.



Configuration backup and restore

Menus are self-explanatory and have tooltips

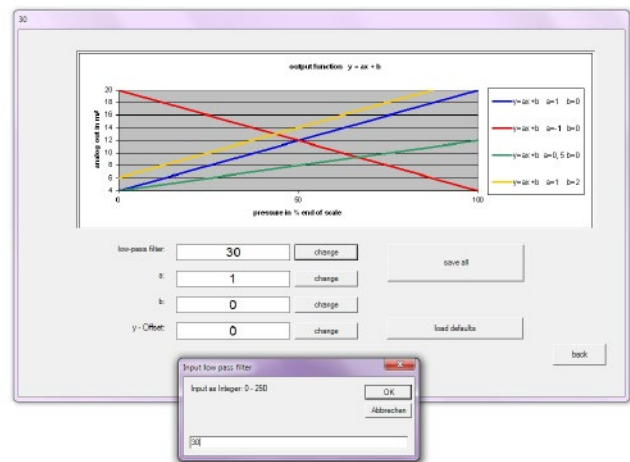
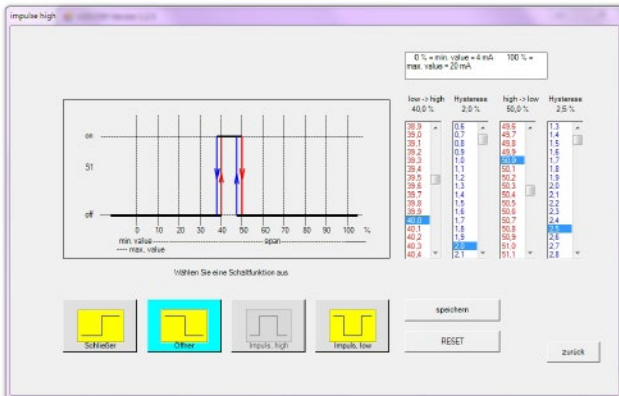
Cross-linkability with RS 485 (up to 254 interfaces possible)

Indication digital value of the measurand

Activation and deactivation of the switches 1 and 2

Pressure units changeover, temperature indication, power indication

Menu Switch Configuration



Adjustment of switching functions, switch points and switching hysteresis, see also B50

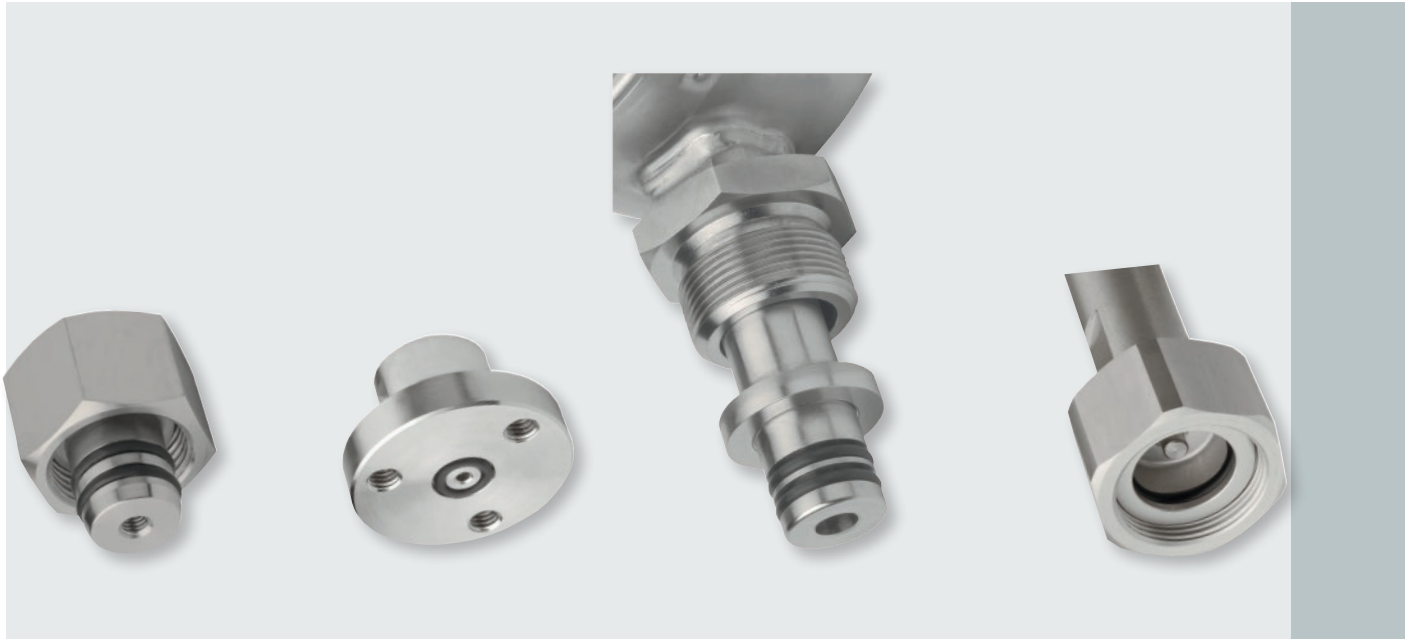
Adjustment of software low-pass (electronic restrictor), see also B50

We Manufacture According to Customer's Specification

Process connections

Our scope of delivery includes a large number of process connections in a wide variety of standards and nominal widths. Do you need a different connection? This is no problem for us! We will be pleased to find a solution according to your specification. Please feel free to contact us!

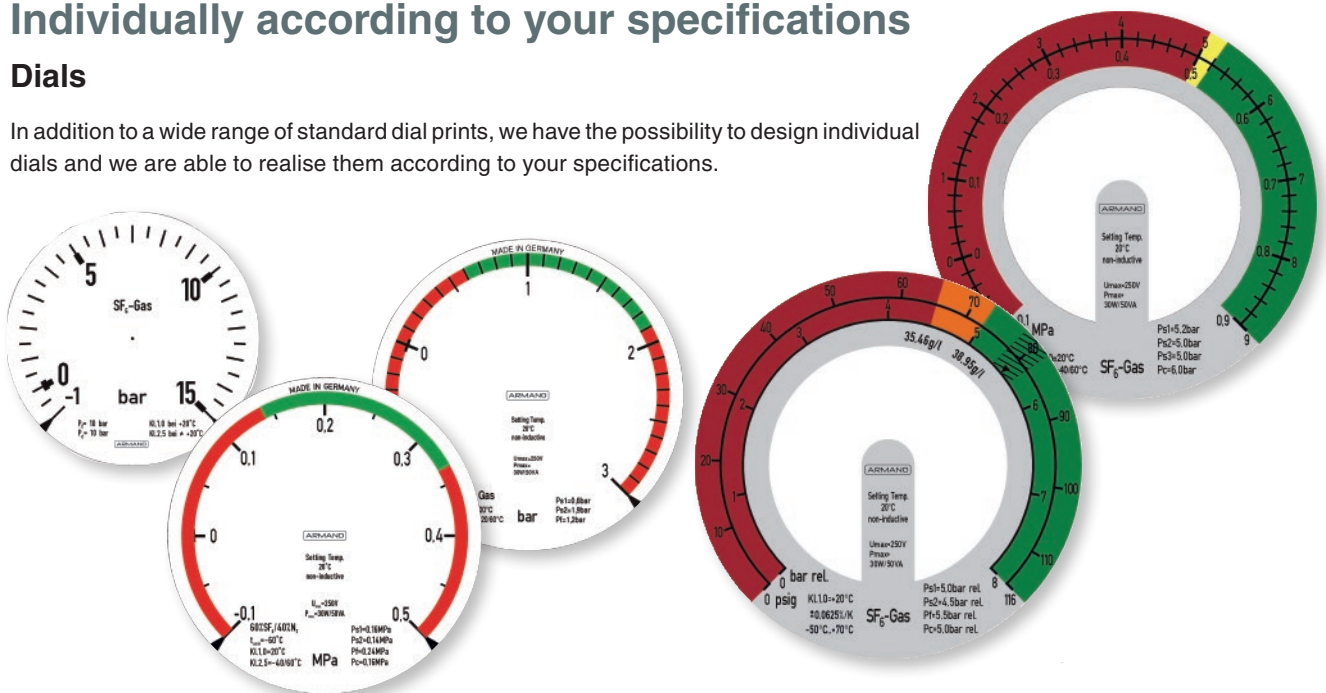
Examples of Process Connections



Individually according to your specifications

Dials

In addition to a wide range of standard dial prints, we have the possibility to design individual dials and we are able to realise them according to your specifications.



Certificates and Approvals

A high quality standard is a matter of course for us! Not only our company is certified according to the highest quality standards, our products are manufactured according to varied regulations and approved for the most part as well. The ARMANO Messtechnik GmbH is certified according to DIN EN ISO 9001.



SIL 2
SIL 3

Any Questions?

We are pleased to offer our help and answer any of your questions and provide background information on our pressure gauges and thermometers. We can only optimise the measuring instrument for your specific case of application when receiving exact, complete information on the process or a precise specification of the required measuring system. Please do not hesitate to contact our staff, who will support you in filling out our check lists, which are also available upon request.

» We have prepared check lists for you
to help you with the specification of your instruments «

» PDF versions for printing at
www.armano-messtechnik.com «

Checklist Thermometers		Checklist Pressure Gauges		Checklist SF6 Gas Density Monitors (NCS 100)	
Inquiry / Project / Order No. _____ Name / Address / Phone / E-Mail _____ Application (short description) _____ Temperature range from _____ to _____ °C <input type="checkbox"/> °F <input type="checkbox"/> dual scale: _____ special scale, logo, dial inscription, etc.: _____ Ambient temperature at temperature measuring device _____ °C constant, or min. _____ Ambient temperature at the capillary line _____ °C constant, or min. _____ Outdoor use <input type="checkbox"/> yes <input type="checkbox"/> no		ARMAND Heading 1 – 4, 6 Inquiry / Project / Order No. _____ Name / Address / Phone / E-Mail _____ Application (short description) _____ Medium <input type="checkbox"/> liquid <input type="checkbox"/> gaseous Operating pressure static _____ bar / dynamic from _____ to _____ bar / frequency _____ Outdoor use <input type="checkbox"/> yes <input type="checkbox"/> no Ambient temperature from _____ °C to _____ °C Medium temperature from _____ °C to _____ °C Pulsation <input type="checkbox"/> yes <input type="checkbox"/> no Vibration <input type="checkbox"/> yes <input type="checkbox"/> no Measuring system <input type="checkbox"/> Bourdon tube <input type="checkbox"/> horizontal diaphragm <input type="checkbox"/> vertical diaphragm <input type="checkbox"/> diaphragm Accuracy class <input type="checkbox"/> 0.25 <input type="checkbox"/> 0.6 <input type="checkbox"/> 1.0 <input type="checkbox"/> 1.6 <input type="checkbox"/> 2.5 others: _____ Case material <input type="checkbox"/> alloy steel, black <input type="checkbox"/> stainless steel <input type="checkbox"/> plastic others: _____ Case model <input type="checkbox"/> bezel ring (see PN) <input type="checkbox"/> bayonet ring <input type="checkbox"/> crimped-on ring <input type="checkbox"/> screw <input type="checkbox"/> safety <input type="checkbox"/> snap-in window <input type="checkbox"/> square case <input type="checkbox"/> process <input type="checkbox"/> instrument glass <input type="checkbox"/> laminated safety glass <input type="checkbox"/> polycarbonate <input type="checkbox"/> acrylic glass others: _____ Window _____ Blow-out <input type="checkbox"/> yes <input type="checkbox"/> no		ARMAND Heading 1 Inquiry / Project / Order No. _____ Name / Address / Phone / E-Mail _____ Application (short description) _____ Construction Type (see drawings in data sheet 1902) Position of connection <input type="checkbox"/> bottom <input type="checkbox"/> back <input type="checkbox"/> lateral right <input type="checkbox"/> lateral left Position plug connector <input type="checkbox"/> right <input type="checkbox"/> back Back flange <input type="checkbox"/> yes <input type="checkbox"/> no Front flange <input type="checkbox"/> yes <input type="checkbox"/> no Connection thread <input type="checkbox"/> G 1/8 <input type="checkbox"/> G 1/4 <input type="checkbox"/> M20x1.5 <input type="checkbox"/> or _____ Configuration / Case Filling <input type="checkbox"/> unfilled <input type="checkbox"/> filled with silicone oil <input type="checkbox"/> filled with nitrogen Pressure Range <input type="checkbox"/> -0.1 / +0.9 MPa <input type="checkbox"/> other unit _____ <input type="checkbox"/> other pressure range (min. 0.25 MPa) _____ Temperature Compensation Range <input type="checkbox"/> -20 / +60 °C (-4 / +140 °F) <input type="checkbox"/> -40 / +40 °C (-40 / +104 °F) <input type="checkbox"/> or _____	



Precision is our Passion · Reliability our Principle

ARMANO

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