Insulating gas density monitoring

Proven expertise for the power grids industry

trafag
sensors controls

Photo by kind support of Siemens Energy

Global manufacturers trust in Trafag

Gas-insulated switchgear, circuit breakers, transmission lines, transformers etc.

Hitachi Energy (former ABB)
GE Grid Solutions
Hyundai Electric
Mitsubishi Electric
Siemens Energy
Hyosung Heavy Industries
Toshiba Energy Systems
Iljin Electric

Index

Trafag – the high-tech sensor company

Trafag, a Swiss-based company founded in 1942, is supported by a broad sales and service network in over 40 countries across the world. This allows Trafag to offer customers personalised and competent advice and ensures the best possible service. High-performance development and production departments not only guarantee the fast and reliable delivery of our high-quality and high-precision products, but also ensure that customisations can be implemented in a short time.

Density monitoring solutions with maximum accuracy

Trafag stands for precise, robust and maintenance-free instruments, developed for the monitoring of SF_6 and alternative insulating gases in the field of high- and medium-voltage switchgear. Trafag guarantees outstandingly accurate, highly shock-resistant instruments that operate in the widest temperature range on the market.

Competent and customer-oriented

Technological competence, manufacturing expertise and customer orientation form the three cornerstones of Trafag as a company. Trafag is a completely independent company with headquarters in Bubikon, Switzerland, and further manufacturing companies in Germany, Czech Republic and India. One-fifth of its employees are involved in the fields of research and development, production technology or applications engineering.

Application and solution-oriented

The direct availability of these resources enables Trafag to be extremely flexible in the areas of development and production as well as in its perception and implementation of customer requirements. Thanks to modular engineering, Trafag can efficiently adapt its standard products to the specific needs of customers.

Market-oriented and always within reach

Trafag maintains an active presence in over 40 countries. A great number of customers in diverse industrial sectors such as high voltage technology, mechanical engineering, hydraulics, engine manufacturing, shipbuilding or railway technology appreciate the cooperation offered by our technically competent customer advisory service.

Adaptable and efficient

The ability to develop and manufacture its strategically important components in-house means that Trafag can both mass-produce and manufacture on a small scale at short notice. Rigorous quality management in accordance with ISO 9001, state-of-the-art production facilities under clean room conditions and stringently monitored production processes ensure that Trafag products meet the highest quality standards.

With kind support of TransnetBW GmbH

Trafag's dedicated expertise

Pre-sales application and configuration support

Technical experts help to find the most suitable product for the specific application.

Highest quality standards in automated production processes

A well-harmonized automation standard, complemented by manual operations performed by highly skilled personnel, provides the foundation for Trafag's leading quality and performance. Trafag density monitors and sensors are produced under increased purity requirements and are then thoroughly tested. Each device leaves the factory with a test certificate that the customers can access at any time.

After-sales support

Trafag provides true end-to-end service and advice throughout the product life cycle. Many business relationships have existed for decades.

Product portfolio history

Trafag has more than four decades of experience in gas density monitoring

The development of a temperature-compensated pressure switch in 1978 marked the beginning of the era of Trafag's density portfolio. An ingenious combination of a pressure switch with thermostat components made it possible to enter the density monitoring market of SF_6 insulation gas in high-voltage switchgear. In 1987, Trafag developed the pioneering gas density monitor with reference gas chamber, a product with unsurpassed accuracy, vibration resistance and durability to this day. A metal bellows system plays the central role in this mechanical product. In 1994, Trafag bridged the gap of continuous gas density measurement and introduced the first electronic density sensor.

1978

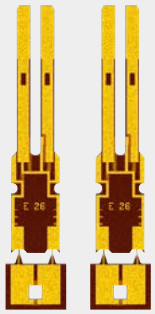
Trafag introduces the first density monitor with pressure switches for the international market.

1987

Invention of the reference chamber principle that has become industry standard and introduction of density monitor type 87x0 with up to 3 microswitches.

1994

Invention of the oscillating quartz sensing element and introduction of the first electronic density sensor.



2003

Introduction of the 8774 density sensor with current-loop output. Later the portfolio was extended with the 8775 type featuring a digital RS485/Modbus output.

2006

Introduction of the 87x6 density monitor series with up to four microswitches. The portfolio was subsequently extended with the 87x8 series for use in Arctic climate zones.

2008

Introduction of the 90° (radial) process connection and the low-pressure indication dial.

2010

Introduction of the 878x hybrid density monitor with current-loop output and the 879x hybrid density monitor with RS485/ Modbus output, providing both switchpoint monitoring and continuous density measurement in a single device.

2014

Introduction of the 87x7 density monitor series with up to three microswitches.

2017

Introduction of the integrated density monitor test valve.

2020

Introduction of the integrated insulating gas test and re-filling valve.

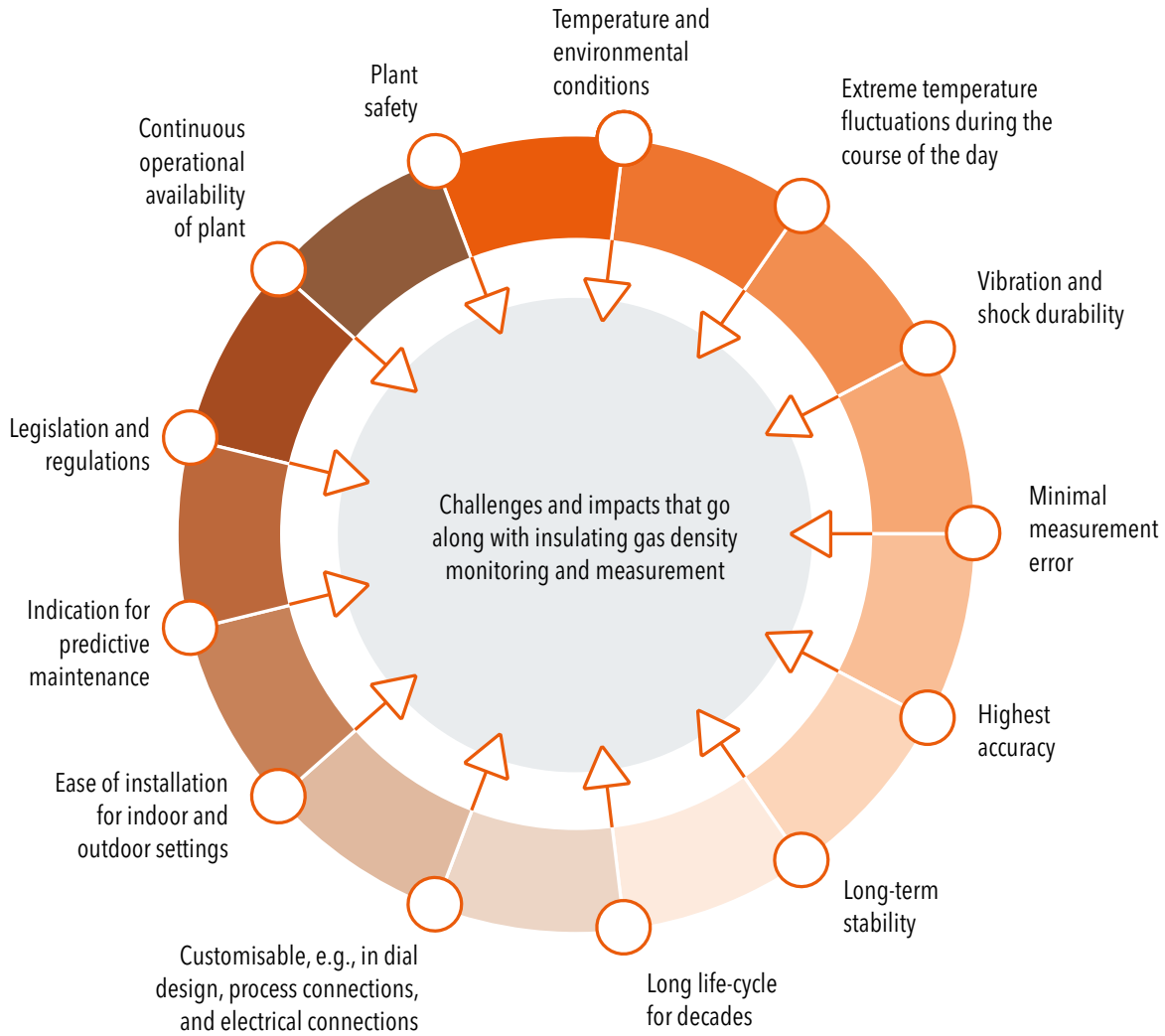
2026

Introduction of the 87x9 platform, establishing the next generation of gas density monitoring solutions with a modular architecture designed for future insulating gases, enhanced usability, and long-term platform scalability.

High-voltage power grid applications for gas density measuring and monitoring

Challenges and impacts for maximum safety and accuracy

Most current conduction parts of high-voltage switchgear, circuit breakers and transmission lines are mounted in pressure compartments filled with efficient insulation gases. Sulphur hexafluoride (SF_6) gas is commonly used. Alternative insulation-gas mixtures, that are less harmful to the climate, steadily grow in market share. The insulation strengths of these gases depend basically on the gas density. As the dielectric strength capability of gas-insulated systems is obtained by the gas density, these compartments are filled to several hundred kPa pressure to prevent internal arcing and short circuits even over short distance.



Gas density monitoring plays a key role in plant availability and safety

The operational reliability and safety of high-voltage gear is only guaranteed when the appropriate level of gas density is maintained within the compartments. Leakage would compromise the safety of the switchgear and violate environmental regulations. SF_6 is a strong greenhouse gas and must therefore not leak into the environment. Strict regulations regarding SF_6 emissions such as Regulation (EU) 2024/573 on fluorinated greenhouse gases, require measures to prevent and detect gas leakage and support effective monitoring of SF_6-containing equipment. This is done with gas density monitors and gas density sensors to trigger safety-related alarms or switching processes and to transmit the status to a data network.
Therefore, continuous density measurement adds several advantages to monitoring of safety alarm trigger points. Real-time data allows analysis of the operational availability of the plant and the implementation of inspection windows or predictive maintenance measures.

Highest environmental resistance required

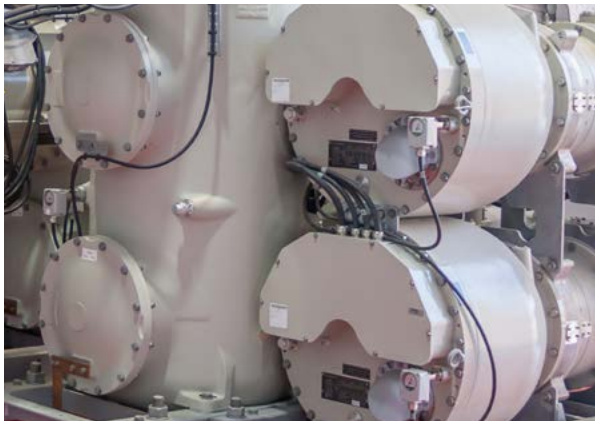
Gas-insulated systems are often installed outdoors. Temperatures between –40°C and +50°C are quite common. In arctic climate zones even temperatures down to –60°C are imposed on the equipment. In addition, massive temperature fluctuations, even between day and night, plant shock and vibration have an impact on density monitor and related accessories. However, a long life cycle of density monitoring equipment for several decades is required.

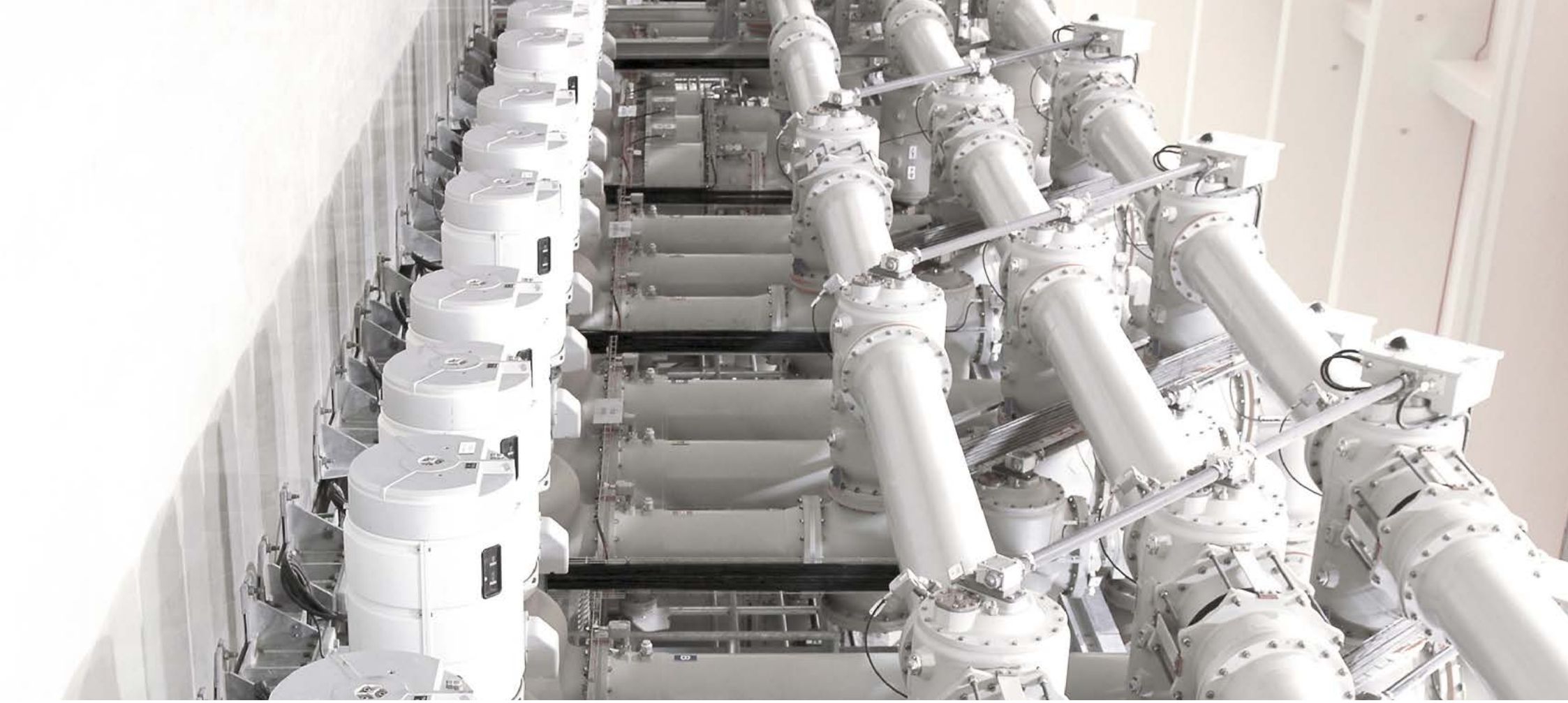
Superior gas density reference chamber and quartz tuning fork principle

Gas density is often indirectly determined by the gas pressure using manometers or pressure sensors. As the pressure in a hermetically closed volume varies enormously with temperature, such devices need temperature compensation, resulting in a source of error. Trafag provides two leading technologies for direct monitoring and measuring of insulating gas density offering the most reliable solutions on the market. Mechanical monitors determine the gas density directly by the reference chamber principle. Gas density sensors employ the electronic quartz tuning fork technology to measure density directly. Both technologies are combined in Trafag's hybrid density monitors.

Typical applications for SF_6 and alternative insulating gas monitoring

- Gas-insulated switchgear (GIS) and switching stations
- Circuit breakers (generator, live and dead tank)
- Gas-insulated transmission lines (GIL)
- Gas-insulated transformers (GIT)





Gas-insulated switchgear (GIS) 400 kV, Qatar 2009 © Hitachi Energy

Gas density monitoring of alternative insulating gases in SF_6-free switchgear

Alternative insulating gases, or alternative gases for short, are replacing sulphur hexafluoride (SF_6), which has been commonly used in gas-insulated switchgear for many years because sulphur hexafluoride is considered a powerful greenhouse gas. The Trafag product range for gas density monitoring in high-voltage switchgear offers full compatibility with the more environmentally friendly alternative insulating gases.

Although the physical properties of SF_6 make it well suited for use in gas-insulated switchgear, it is also a powerful greenhouse gas with a massive Global Warming Potential (GWP). For this reason, Regulation (EU) 2024/573 on fluorinated greenhouse gases introduces a progressive phase-out of SF_6 in new electrical switchgear through application-specific restrictions and promotes the adoption of more environmentally friendly alternatives. SF_6 is increasingly being replaced by more environmentally friendly alternative insulating gases. The alternative gases can be divided into two main groups: C_4FN-based insulating gases and air-based mixtures (technical air). The gases in both groups are lighter than SF_6 and have a lower insulating capacity at the same pressure. The chambers of gas-insulated switchgear are therefore filled with significantly more pressure in order to achieve the same insulating properties.

Gas density monitors for alternative insulating gases

The proven reference chamber measuring principle of the Trafag gas density monitors is adopted unchanged for alternative gases. Due to the higher pressures required for alternative gases, the entire measuring system has now been qualified for a measuring range of up to 13 bar (absolute pressure). The main difference to gas density monitors for SF_6 lies in the filling of the reference chamber. This is filled with a gas mixture that represents the isochoric gradient of the alternative gas, i.e. the gradient of the line of the same specific volume (= density) in the pressure-temperature diagram. The switching points and the scaling of the display are adjusted to the effective values of the alternative gas.

Gas density sensors for alternative insulating gases

In addition to being suitable for the higher pressures, the sensor system must also be calibrated for the lower density of the gases. The unique measuring principle of Trafag gas density sensors, which measures the density directly – without detour via pressure and temperature – is suitable for measuring the density of all types of gases. Only the gas-mixture-specific sensor parameters must be determined once by measurement. These parameters are required for the precise linearization of the output signal and for conversion to pressure at 20 °C, in the case of digital sensors (RS485/Modbus). These parameters are uploaded into the internal chip during the manufacture of the density sensors before calibration.

Operating principles

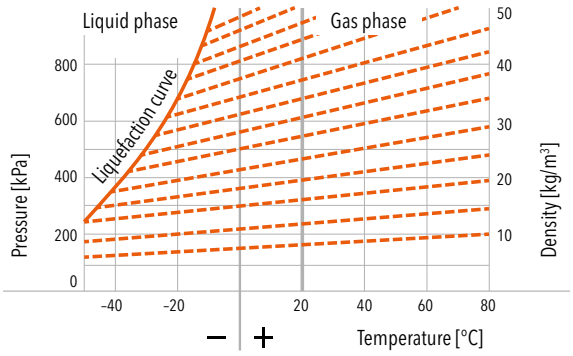
Gas density monitoring with reference gas comparison

The reference gas comparison principle was invented by Trafag in mid 1980s and was continuously improved. Today, it is the leading standard for temperature-compensated insulating gas density monitoring in applications with high demands for reliability, accuracy, and longevity.

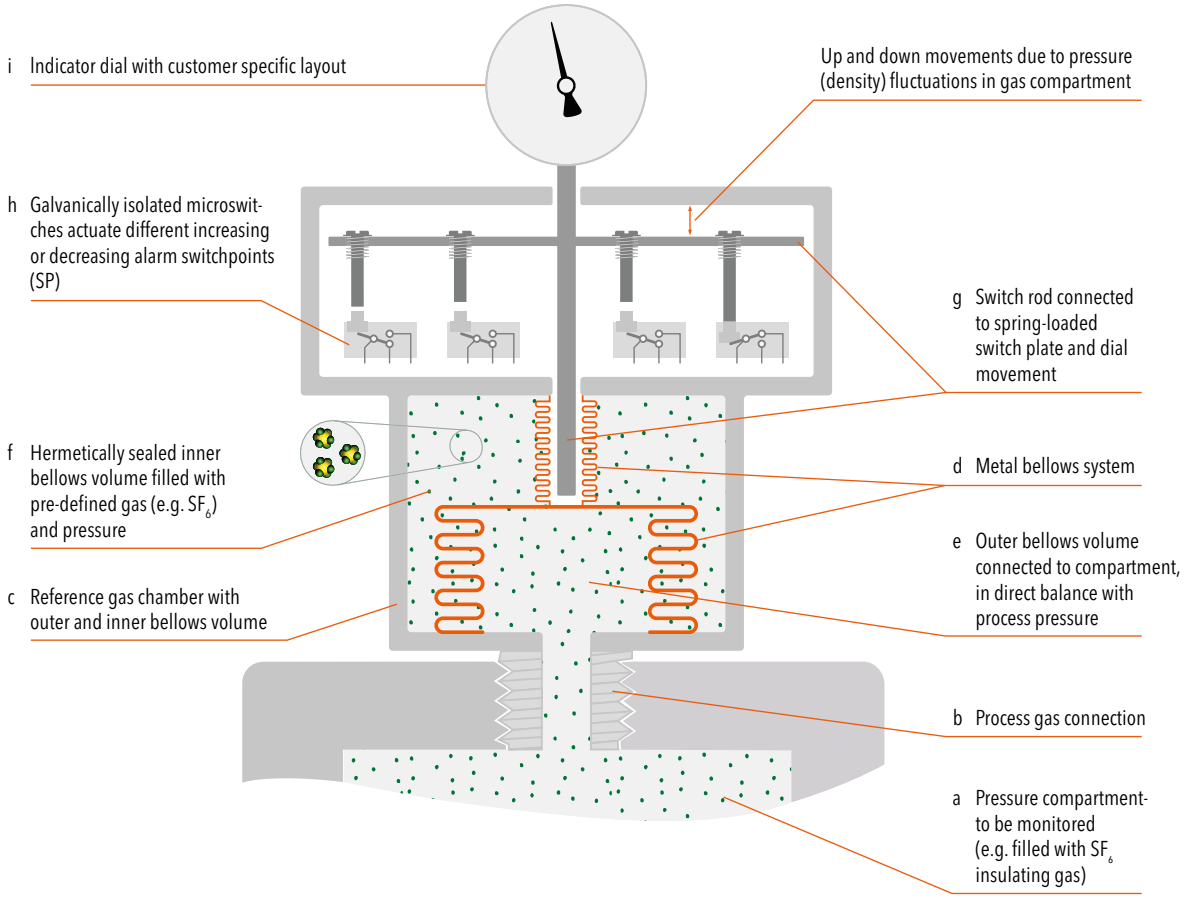
Necessity for temperature-independent density monitoring

Density measurement in pressurised, gas-insulated compartments is all about physics. Pressure, density and temperature are in a certain relationship to each other. The relationship is defined by isochores (constant-volume process) for each specific insulation gas. The insulating performance of a gas-insulated compartment is achieved through a defined density which results in a certain pressure at a given temperature. In a closed and tight compartment, the overall density always remains constant, but temperature variations lead to a variation of the system pressure.

Vapour pressure curve: Lines of equivalent gas density of SF_6



Lines exemplary representing constant SF_6 gas density (isochores): Changes in pressure and temperature with constant volume.



Absolute monitoring principle (temperature-compensated due to reference principle)

A density monitor is typically directly mounted to the pressure compartment of the high-voltage equipment (a) via a customizable process connection (b). Trafag density monitors are based on a reference chamber (c) incorporating a metal bellows system (d), which is pre-pressurized with the customer-specific insulating gas. The metal bellows system allows a direct temperature coupling of the pressure compartment gas and the gas filling in the reference chamber. Ambient temperature changes affect the pressure (isochoric change) in the gas compartment to the same extent as they affect the pressure in the reference chamber. Therefore, the effect of temperature on insulating gas pressure is inherently compensated and a very precise insulating gas pressure @ 20°C (equalling the density), at any temperature, is indicated on a dial face (i). No false alarm is triggered due to temperature-induced pressure changes. Reference gas chamber and pressure compartment are both hermetically sealed systems. Ambient pressure has no influence on the operating principle. Therefore, it is an absolute monitoring principle.

Bellows system actuates microswitches

The pressure, more specifically the density of the insulating gas compartment is compared via the outer bellows volume (e) with the pre-defined density of the hermetically sealed inner bellows volume (f) of the reference chamber. If the density of the gas compartment alters, the bellows system actuates via a switch rod and a spring-loaded switch plate (g) up to four independent microswitches (h). Each microswitch can be factory-calibrated either to increasing or decreasing pressure alarm. That means when the density drops below pre-defined switchpoint (SP) settings, the microswitch contacts gradually close or open. The switchpoint accuracy is factory tested at -25°C, +20°C and 50°C.

Supporting measures for demanding outdoor applications

If the local, environmental effects hamper a direct temperature coupling of pressure compartment (a) and reference gas chamber (c), e.g. outdoor installation with diurnal solar radiation or rapidly changing or extreme weather conditions, specifically designed thermal covers maintain the necessary equality between pressure compartment and reference gas chamber.

Practical example:

Filling pressure (density) of insulating gas compartment: 6.1 bar abs. @ 20°C, pure SF_6

SP1: 5.7 bar abs. @ 20°C, decreasing warning switchpoint for compartment re-filling

SP2: 5.5 bar abs. @ 20°C, decreasing lock-out alarm switchpoint

SP3: 5.5 bar abs. @ 20°C, redundant decreasing lock-out alarm switchpoint

SP4: 6.4 bar abs. @ 20°C, increasing high-alarm switchpoint for compartment overpressure

Factory pre-pressurised inner bellows volume of reference chamber: 5.7 bar abs. @ 20°C, SF_6, hermetically sealed, according to SP1

If the insulating gas compartment pressure (a,e) drops due to leakage, the hermetically sealed inner bellows volume pressure (f) gains impact towards the dropping compartment pressure. The switch rod with the switch plate (g) move down.

While the pressure drops below switchpoint 1 (SP1) at 5.7 bar abs. @ 20°C, the first microswitch changes over and induces first alarm. Usually, the first alarm indicates that the pressure compartment must be re-filled.

If the pressure drops further, in the example below 5.5 bar abs. @ 20°C, then usually two more, redundant microswitches change over (SP2 and SP3). By default, these switchpoints are used as emergency stop; the operational safety of the system is no longer guaranteed. A fourth microswitch (SP4) e.g. can be used to monitor undesired overpressure conditions during re-filling routines of the pressure compartment. If the pressure rises above 6.4 bar abs. @ 20°C, the microswitch changes over and induces high-alarm.

Reference gas comparison is deployed in the following Trafag devices:

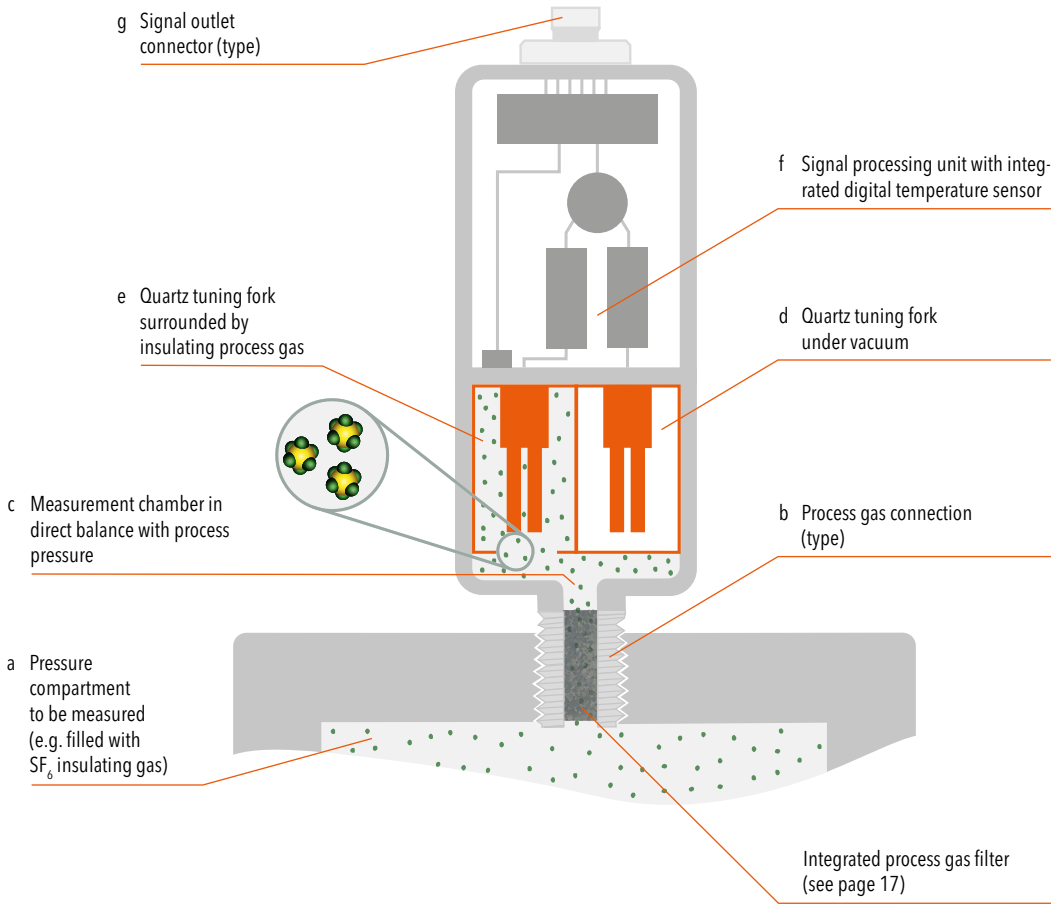
- Gas density monitor platform 87x9 — see page 20/21
- Gas density monitors 87x6 / 87x8 — see page 28/29
- Hybrid gas density monitors 878x / 879x — see page 30/31

Electronic absolute gas density measurement with quartz tuning fork

Trafag introduced the quartz tuning fork density measurement technology in the mid 1990s. It is the choice where continuous and long-term drift-free density measurement and data acquisition is required. The tuning fork technology is commonly known from its use as the time-frequency standard in clocks. Exposing an oscillating tuning fork to gases of different density leads to a shift and a damping of its resonance frequency. It is a direct density measurement principle.

The density sensor is mounted to the pressure compartment (a) via a customizable process connection (b). Thus, density in the insulating gas compartment and the sensor measurement chamber (c) is in balance. Trafag density sensors use the physics by comparing the constant resonant frequency of a quartz oscillator under vacuum (d) with the resonant frequency of an identical quartz surrounded by the insulating process gas (e).

Gas of different density affects the pre-set resonant frequency of the process gas surrounded quartz tuning fork. The response time for the detection of density changes is less than 10ms. The shift of the resonant frequency is proportional to the density of the insulating process gas. The digital processing unit features an additional temperature sensor (f). The measurement signal is provided on selectable outlet connectors (g).



Electronic gas density measurement with quartz tuning fork is deployed in the following Trafag devices:

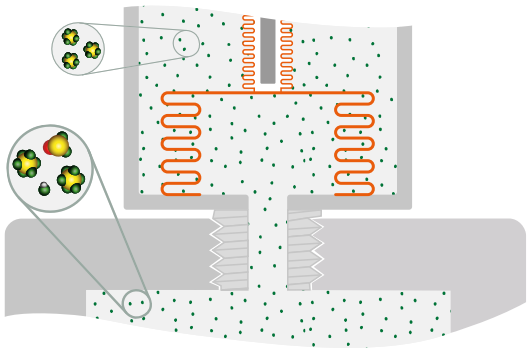
- Gas density sensors 8774 and 8775 see page 26 / 27
- Hybrid gas density monitor 8729 and 8739 see page 20
- Hybrid gas density monitor 878x and 879x see page 30

Countermeasures against aggressive SF_6 by-products

SF_6 is inert during normal use. When electrical discharges occur within SF_6 filled gas compartments, mechanical abrasion, toxic and material-aggressive by-products can emerge. The two main by-products that may occur are hydrofluoric acid and thionyl fluoride. Both can cause long-term damage to improperly selected materials. Abrasion particles can cause sensing element degradation. Trafag deals with it by using suitable materials and additional integrated process gas filters.

Countermeasures for devices with reference gas comparison

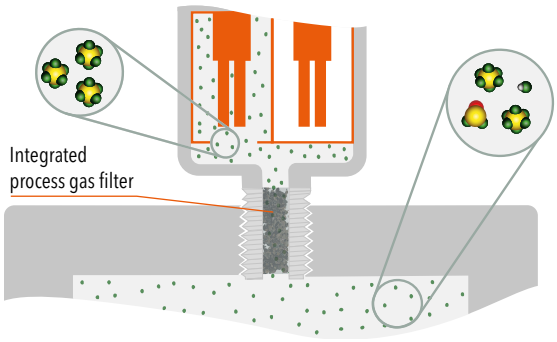
Materials for process gas connection, reference gas chamber and bellows system are specifically selected to withstand hydrofluoric acid and thionyl fluoride. High-alloyed stainless steels 1.4404, 1.4435, 1.4571 (AISI316L, AISI316Ti) are used.



Reference gas chamber, bellows system and process connection are made of stainless steel.

Countermeasures for devices with quartz tuning fork technology

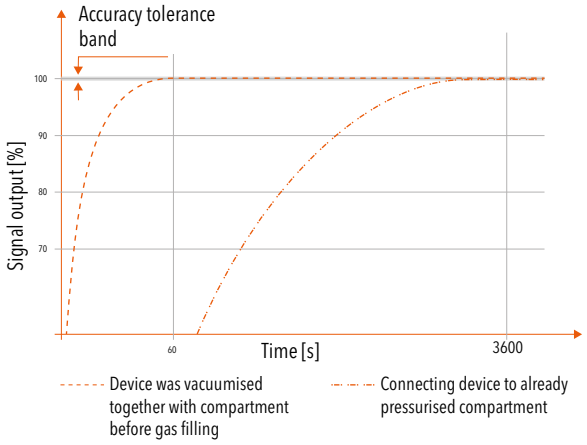
The quartz tuning fork requires advanced countermeasures to repel ingress of aggressive by-products that may occur in insulating gases. Materials for the process gas connection and measurement chamber are specifically selected. High-alloyed stainless steel 1.4435 (AISI316L) is used. An additional integrated process gas filter protects from fine abrasion particles and absorbs corrosive gases.



Measurement chamber and process connection are made of stainless steel. A process gas filter protects from aggressive by-products.

Response time of the integrated process gas filter of the density sensor

During normal operation, insulating gas density changes are detected in less than 10 ms. The integrated filter element induces a transient response time after installation and initial insulating gas filling. Therefore, a minimised time period for gas equalization between process compartment and the sensor's measurement chamber occurs.



Transient initial response time which is required after installation and gas filling for the sensor signal output to reach accuracy tolerance band.

Product range overview

Monitoring and measurement devices

Trafag's product range of gas density measuring devices is divided into three different product groups: The mechanically working Gas Density Monitor (GDM), the electronic Gas Density Sensor (GDS) and the Hybrid Gas Density Monitor (HGDM), monitoring both mechanically and electronically. All three types have one thing in common: They are suitable for SF_6 and the complete range of alternative insulating gases.

					
Type	GDM 8719	HGDM 8729/8739	GDM 87x6/87x8	HGDM 878x/879x	GDS 8774/8775
Temperature-compensated switching	✓	✓	✓	✓	–
Large dial	✓	✓	–	–	–
Optional service valves	✓	✓	✓	✓	–
Suitable for SF_6 and alternative gases	✓	✓	✓	✓	✓
Continuous density measurement for condition-based and preventive maintenance	–	✓	–	✓	✓

With the kind support of Swiss Grid

Gas Density Monitor Platform 87x9

The new Trafag standard in gas density monitoring

The 87x9 platform is Trafag's unified solution for gas density monitoring in SF_6 and alternative insulating gas applications. It combines proven mechanical density monitoring with a sealed reference chamber and scalable platform variants for different monitoring requirements.

At the heart of the platform is Trafag's density-based measuring system with a sealed reference gas chamber. The system is mechanically temperature-compensated by design and ensures that switching behavior reflects the actual dielectric condition of the gas compartment, not ambient pressure fluctuations or local temperature effects.

The platform includes the 8719 mechanical gas density monitor as well as hybrid variants with an additional independent continuous measurement path. This enables deterministic mechanical switching for safety-related functions and, where required, analog or digital density signals for trend monitoring, leak detection, documentation, remote supervision, and condition-based maintenance.

With gas-specific variants, flexible connection geometries, modular service functions, and integrated connection technology, the 87x9 platform is designed for reliable operation, efficient installation, and long-term use in evolving gas-insulated equipment.

SF_6-free reference chamber

SF_6-free gas density monitor

The advanced measuring system of the 87x9 generation is based on the same reference chamber principle as the models of the proven 87x6 generation (see page 28). Both the manufacturing processes and the critical elements of the design have been preserved. But the new reference chamber is no longer filled with the same insulating gas as the switchgear, but with a mixture of nitrogen and CO_2, which reflects the isochoric (constant volume) behavior of the system gas. When calibrating the measuring system, the switching points and the scaling of the display are precisely matched to the values of the effective insulating gas in the system.

Key benefits

- Unified platform for SF_6 and alternative insulation gas mixtures
- Precise temperature-compensated switching – accurate switching across the full specified temperature range
- Hybrid versions with continuous density signals for monitoring, diagnostics, and documentation
- Large, clear display – easy readability of the safety-relevant operating range
- Modular installation geometry for flexible installation positions
- Optional integrated service valves reduce gas handling and leakage risk

Technical data

Monitoring principle	Absolute pressure measuring system with sealed reference gas chamber No influence due to ambient pressure fluctuations Fully temperature-compensated by design
Platform variants	Mechanical gas density monitor 8719 Hybrid variants with mechanical switching and continuous density measurement Hybrid density monitor 8729 (4 … 20 mA output signal) and 8739 (Modbus)
Gas applications	SF_6 and alternative insulation gas mixtures Device variant selected and calibrated according to gas type, mixture ratio, nominal density, and operating pressure range
Monitoring range	0 … 1300 kPa abs. @ 20 °C
Monitoring output	Floating change-over contact, SPDT Optional analog or digital density signal depending on hybrid variant
Sensor output	8729: 4 … 20 mA current loop 8739: Gas density [kg/m³], normalized gas pressure [kPa abs. @ 20°C], Gas temperature [K], gas pressure [kPa abs.] @ temperature variable
Quantity of switchpoints	Up to 5 microswitches for mechanical variants Up to 4 microswitches for hybrid variants
Switchpoint accuracy @ 20 °C	±10 kPa max.
Switching span	Up to 250 kPa
Ambient temperature	-40 °C … +80 °C -60 °C … +80 °C with arctic temperature capability option
Protection	IP65 and IP67
Service functions	Optional integrated service valves for testing, gas sampling, evacuation, and filling
Electrical connection	Integrated connection technology with pre-assembled plug-in connections

Data sheet 8719	www.trafag.com/H72623
Data sheet 8729	www.trafag.com/H72624
Data sheet 8739	www.trafag.com/H72626
Instructions	www.trafag.com/H73623

Easier to read thanks to large display

The large display of the 87x9 gas density platform offers excellent readability across the entire measuring range. The display range is not scaled linearly, but divided into different areas according to their importance in operation and for reading: The operating range, which is crucial for system safety, has the largest proportion of the scale, while the low-pressure and intermediate ranges appear correspondingly reduced.

Operating range

The operating range of the display covers the gas density range in which the system is operated. The reading scale offers a high resolution and reading accuracy here. It ranges from just below the lowest alarm switching point to just above the overpressure alarm switching point.

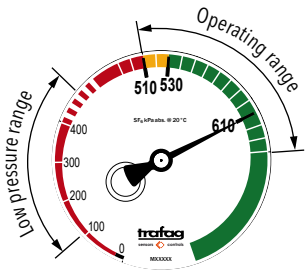
Low pressure range

The low-pressure range extends from vacuum to an absolute pressure approximately 4 bar. The scale enables good readability in those low-pressure measuring ranges that are relevant for transportation and storage pressures – usually between 1.5 and 2 bar absolute pressure – as well as for evacuating the gas compartment.

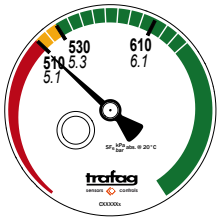
Intermediate range

The range between the operating and low-pressure ranges is not important for maintenance or operation. It has therefore been reduced to the technically necessary minimum on the display scale.

If pressure monitoring is not necessary during transportation and storage, the partial range indicator dial without the low-pressure range can be used. For further simplification, the scaling of the display can be omitted completely, so that a distinction is only made between the green-marked operating range and the red-marked range outside.



Full-range indicator dial according to customer specifications



Partial indicator dial with sectors according to customer specifications

Indicator dial with two colour sectors without markings


B-35-T-1

Integrated test and service valve for gas density monitors

Additional test and service valves integrated into the gas density monitors simplify the safety-related inspection of the switching contacts and maintenance during continuous operation, and filling valves with a large cross-section enable the gas tank to be filled or emptied quickly. To ensure optimum accessibility, the process and electrical connections are offered in various arrangements, i.e. with angles of 0°, 90°, 180° and 270°.

Direct access to the gas compartment of the switchgear is required for the maintenance and inspection of gas density monitors in gas-insulated high-voltage switchgear. For this purpose, additional valves are often installed between the system and the gas density monitor. The main disadvantages of these separate valves, apart from the costs, are the additional connection points, which can lead to leakage, and the increased space requirement. As the importance of maintenance and testing is increasing and at the same time network operators are expecting ever greater efficiency, Trafag offers optional integrated valves for the current gas density monitors and hybrid gas density monitors: Test valves to check the compartment switching points of the gas density monitor as well as service valves for sampling and refilling of insulating gas and filling valves with a large cross-section to quickly fill or empty the entire insulating gas. The test valve and the service or filling valve can also be integrated into the gas density monitor in combination.

Simple, safe and efficient maintenance processes thanks to integrated valves

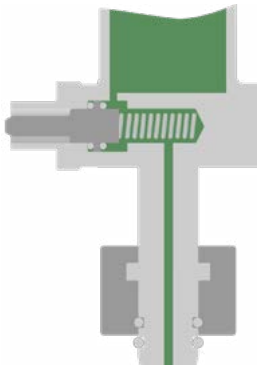
Without a test valve, the gas density monitor would have to be removed from the system to check the switching points. Every disassembly and assembly process involves the risk of components being mixed up, incorrectly connected or damaged during transportation to the test equipment. All these risks are eliminated by integrating the valve directly into the gas density monitor.

The more compact design, enabled by the patented direct integration of valves into the gas density monitor for checking switching points, gas sampling, refilling insulating gas, and directly emptying and filling gas compartments, not only saves installation space and improves accessibility but also shortens the overall assembly length. This reduces the distance between the mass of the gas density monitor and its mounting point, resulting in a shorter lever arm to the vibrating masses. This is particularly important during switching operations that can generate strong vibrations. By minimizing the mechanical load on the gas density monitor, the integrated valve design reduces the risk of wear, damage, and malfunctions such as contact bounce.

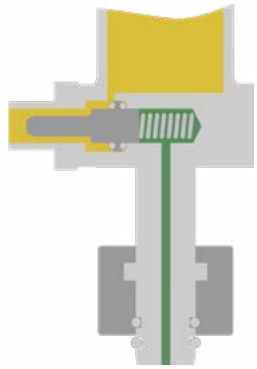
In addition to the insulating gas SF_6, more environmentally friendly alternative insulating gases are increasingly being used in high-voltage switchgear. This transition is driven by Regulation (EU) 2024/573 on fluorinated greenhouse gases, which introduces a progressive phase-out of SF_6 in new electrical switchgear through application-specific restrictions and promotes the use of low-global-warming-potential (low-GWP) alternatives where technically feasible. To prevent confusion, the cover caps of the valves integrated in the Trafag gas density monitors are marked in the usual colors: Orange for SF_6, green for alternative insulating gases C_4FN and blue for air mixtures. Just like the gas density monitor itself, the valves are also designed for a specific gas, both in terms of pressure resistance (alternative insulating gases require a significantly higher pressure than SF_6 for equivalent insulating properties) and the sealing materials used. Trafag offers a safe and elegant solution for the reliable operation and efficient maintenance of high-voltage switchgear with the patented direct integration of valves in the gas density monitor for checking the switching points, for sampling, for refilling insulating gas and for emptying and filling the gas compartments.

Integrated test valve

The integrated test valve allows the switching points of the density monitor to be checked when installed. An external test device can be connected via a standardised DN8 connection. For the test procedure, the valve closes the opening to the gas chamber and opens the connection to the DN8 connection. Once the test of the switching points of the density monitor and, if applicable, the signal of the density sensor installed in the hybrid density monitor has been completed, the valve is switched back to the normal position and the line to the DN8 connection is closed again. The test device can now be removed.



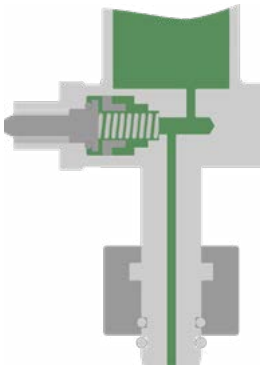
Normal operation



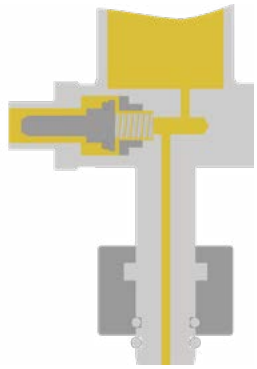
Monitor test mode

Integrated maintenance valve DN8
Integrated filling valve DN20

The integrated maintenance valve DN8 is used, if samples of the insulating gas need to be taken for maintenance purposes or gas in the compartment needs to be refilled. By opening the valve, the connection to the compartment is established while the connection to the gas density monitor is maintained. Once the maintenance work has been completed, the valve is reset to its normal operating state and the external modules can be disconnected. The integrated filling valve DN20 provides the same functionality as the maintenance valve DN8, but with a massively larger flow cross-section for initial filling and replacing the entire insulating gas in the compartment.



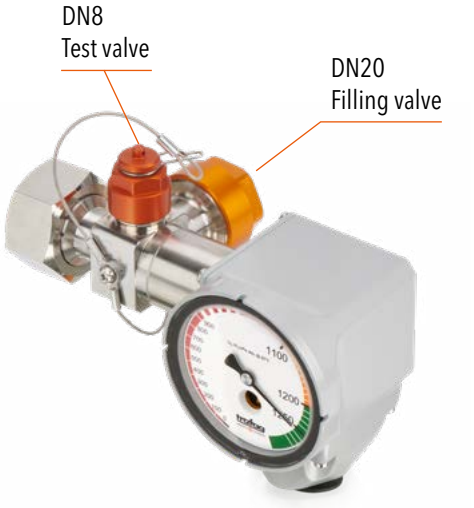
Normal operation



Process gas test and re-fill mode

Combined variants of test valves and filling valves

In addition to the individual valve variants, Trafag also offers the combined integration of test valve and filling or refilling valve, as in most systems, in addition to refilling or complete filling and maintenance work that affects the insulating gas in the system, the density monitors must also be checked. The combined valves integrated directly into the connection of the density monitor even save additional connection points.
Both the individual valves and the combinations can be ordered in various different arrangements to ensure optimum accessibility to the connections and the density monitor itself, depending on the installation position.



trafag sensors controls

Gas Density Sensor 8774

Continuous density measurement with current loop output

The sensor type 8774 is specifically designed for density measuring of insulation gases. This unique patented sensor technology enables the power industry to realise comprehensive trend analysis and data acquisition in gas-insulated pressure compartments. It measures directly and continuously the gas density providing an analogue current output. Trend analysis helps to detect possible leakages sooner, provides data for preventive maintenance measures and therefore facilitates compliance with greenhouse gas regulations.

Technical data

Measuring principle	Oscillating quartz sensor
Measuring range	0 ... 60 kg/m^3 0 ... 1250 kPa abs. @ 20°C
Sensor output	4 … 20 mA current loop
Measuring accuracy	± 1.0 % FS typ.
Ambient temperature	-40°C ... +80°C
Protection	IP65 and IP67

Data sheet	www.trafag.com/H72507
Instructions	www.trafag.com/H73507

Key benefits

- Real-time measurement of SF_6 and alternative gases
- Standard 4 … 20 mA output linearized for density or pressure @ 20°C (no conversion formula needed)
- Suitable for outdoor and indoor applications
- Long-term drift stability with reliable performance over decades
- Maintenance-free

Gas Density Sensor 8775

Continuous density measurement with digital RS485/Modbus output

The digital sensor type 8775 is specifically designed for density measuring of insulation gases. It is intended for integration into Modbus sensor networks. This unique patented sensor technology enables the power industry to realise comprehensive trend analysis and data acquisition, which helps to detect possible leakages sooner, provides data for preventive maintenance measures and therefore facilitates compliance with greenhouse gas regulations.

Key benefits

- Stable, real-time measurement of SF_6 and alternative gases
- Digital RS485/Modbus (RTU) output
- Suitable for outdoor and indoor applications
- Long-term drift stability with reliable performance over decades
- Maintenance-free

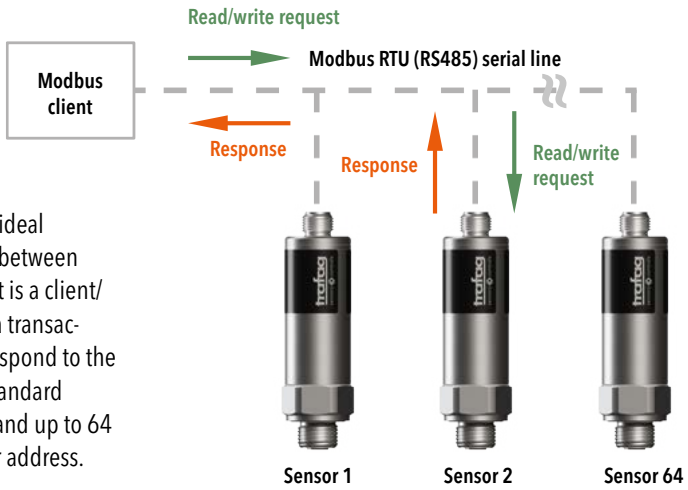
Technical data

Measuring principle	Oscillating quartz sensor
Measuring range	0 ... 60kg/m³ 0 ... 1250 kPa abs. @ 20°C
Sensor output	Gas density [kg/m³], normalized gas pressure [kPa abs. @ 20°C], gas temperature [K], gas pressure [kPa abs.] @ temperature variable
Measuring accuracy	± 1.0 % FS typ.
Ambient temperature	-40°C ... +80°C
Protection	IP65 and IP67

Data sheet	www.trafag.com/H72519
Instructions	www.trafag.com/H73519

Modbus communication setting

The open available Modbus protocol is the ideal communication layer for transmitting data between electronic devices over serial RS485 lines. It is a client/server protocol. One client controls the data transactions with multiple servers (sensors) that respond to the client's requests (read or write data). In a standard Modbus serial network, there is one client and up to 64 servers (sensors), each with a unique server address.



Gas Density Monitor 87x6 / 87x8

Density monitoring with highest switchpoint accuracy in harsh environments

The mechanical, self-acting gas density monitor 87x6 is based on the superior reference gas principle which is temperature-compensated by design. It therefore meets standards of demanding applications over a wide temperature range. The arctic monitor 87x8 is based on the same measurement principle and reliably keeps the liquefaction alarm status until it returns to normal condition.

Today's full range of insulating gas mixtures can be monitored. This precise and maintenance-free density monitor is equipped with high-performance microswitches and is reliable in operation over decades for indoor and outdoor applications.

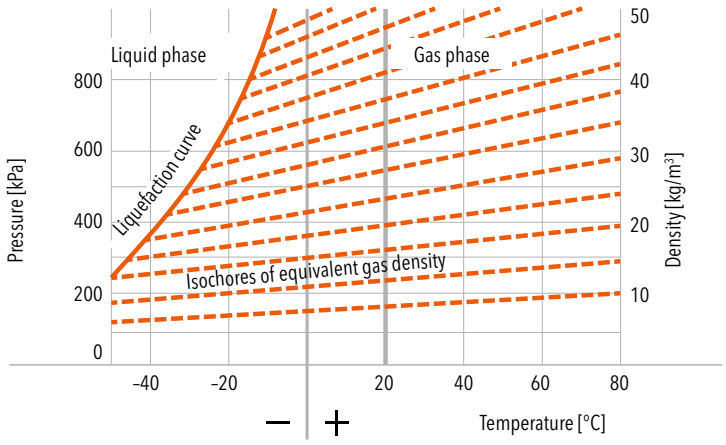
Key benefits

- For SF_6 and a variety of alternative mixed gases
- Exact switching accuracy at all temperatures
- No contact bouncing, high shock and vibration stability, ideal for GIS/GIL
- Indoor and outdoor use
- Maintenance- free operation

Technical data

Monitoring principle	Absolute pressure measuring system with sealed reference gas chamber, fully temperature compensated by design
Monitoring range	0 ... 1250 kPa abs. @ 20°C
Monitoring output	Floating change-over contact (SPDT)
Quantity of switchpoints	1 ... 4 microswitches
Switchpoint accuracy @ 20°C	± 8 kPa max.
Ambient temperature	87x6: -40°C… +80°C 87x8: -60°C… +80°C
Protection	IP65 and IP67

Data sheet 87x6	www.trafag.com/H72511
Data sheet 87x8	www.trafag.com/H72513
Process connections	www.trafag.com/H72502
Instructions	www.trafag.com/H73511

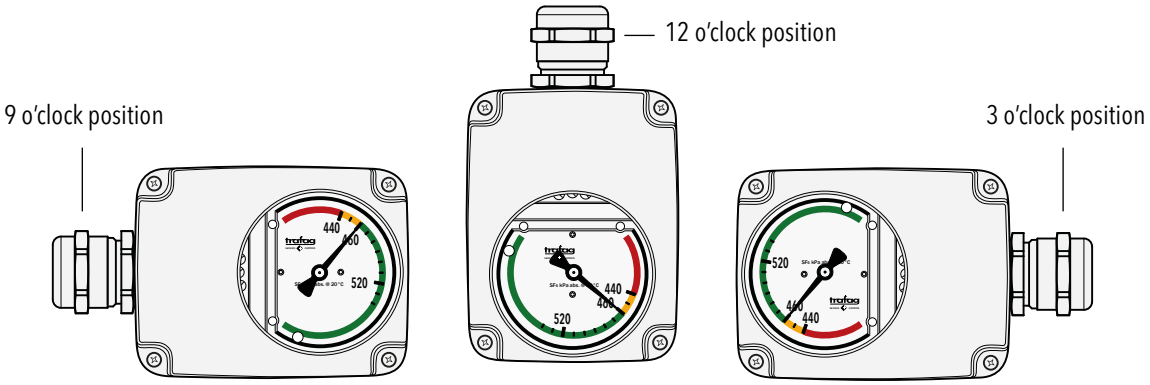


Arctic climate presents the highest requirements to gas compartment and density monitoring. The main safety aspect is the alarm when the insulating gas may liquefy.

Low temperatures can lead to liquefaction of process gas. Liquefaction causes a rapid pressure drop that can temporarily trigger an alarm switchpoint. Gas density monitor 87x8 keeps the alarm status until the alarm trigger level is exceeded again while returning to normal condition.

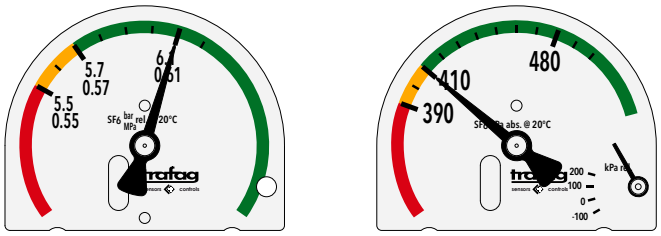
Flexible dial customization

Trafag provides maximum flexibility in customization for the indicator dial with a full variety of colour codings and pressure units including dual range indication. This also includes rotated dial orientation by 90°/180°/270° to provide best readability for restricted installations.



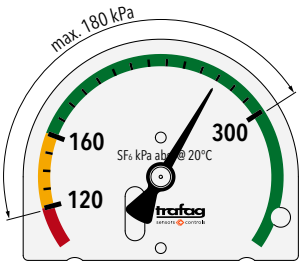
Optional low-pressure indication

An optional low-pressure indicator monitors conditions aside normal operation e.g. while compartment is filled with transport pressure or being vacuumed.

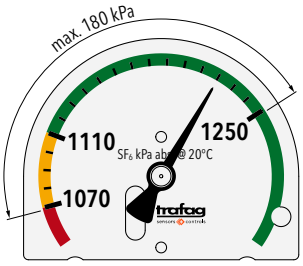


Maximum switchpoint range

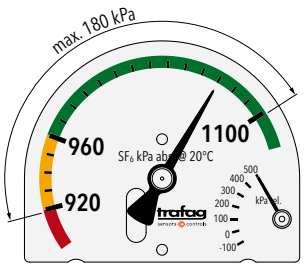
Trafag gas density monitors offer a wide switchpoint adjustment range. Depending on the application, switchpoints can be configured across the available pressure range while maintaining a maximum distance of up to 180 kPa at 20°C between the lowest and highest switchpoint. An optional low-pressure indicator is available for additional monitoring.



Lowest switchpoint setting



Highest switchpoint setting



Highest switchpoint setting with low-pressure indicator

Hybrid Gas Density Monitors 878x / 879x

Combined density monitoring with current loop or digital RS485/Modbus output

The hybrid gas density monitor combines self-acting monitoring with high-performance microswitches and continuous density measurement of insulating gases in one device. It covers demanding applications and maintains the highest accuracy over a very wide temperature range. Trend analysis helps to detect possible leakages sooner, provides data for preventive maintenance measures and therefore facilitates compliance with greenhouse gas regulations. This precise and maintenance-free hybrid density monitor is reliable in operation over decades for indoor and outdoor applications.

Technical data

Monitoring principle	Absolute pressure measuring system with sealed reference gas chamber, fully temperature compensated by design
Measuring principle	Oscillating quartz sensor
Monitoring range	0 ... 1250 kPa abs. @ 20°C
Measuring range	0 ... 56.1 kg/m³ 0 ... 1250 kPa abs. @ 20°C
Output signal	Floating change-over contact (SPDT)
Quantity of switchpoints	1 ... 3 microswitches
Sensor output	878x: 4 … 20 mA current loop 879x: Gas density [kg/m³], normalised gas pressure [kPa abs. @ 20°C], gas temperature [K], gas pressure [kPa abs.] @ temperature variable
Switchpoint accuracy @ 20°C	± 8 kPa max.
Measuring accuracy	± 1.0 % FS typ.
Ambient temperature	-40°C ... +80°C
Protection	IP65 and IP67

Key benefits

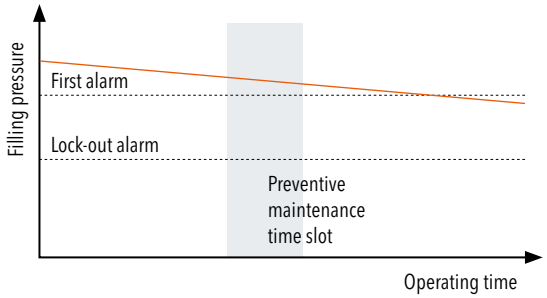
- For SF_6 and a variety of alternative mixed gases
- Exact switching accuracy across the full measurement range
- Continuous drift-free density monitoring
- Easy integration with 4 ... 20 mA or RS485/Modbus output
- High shock and vibration stability
- Zero maintenance operation for indoor/outdoor use

Data sheet 878x	www.trafag.com/H72515
Data sheet 879x	www.trafag.com/H72517
Process connections	www.trafag.com/H72502
Instructions	www.trafag.com/H73515

Why monitor insulating gas density continuously?

Continuous gas density measurement provides early insight into the condition of gas-insulated equipment. Instead of waiting until an alarm threshold is reached, it reveals gradual changes in gas density that may indicate small leaks or deteriorating operating conditions.

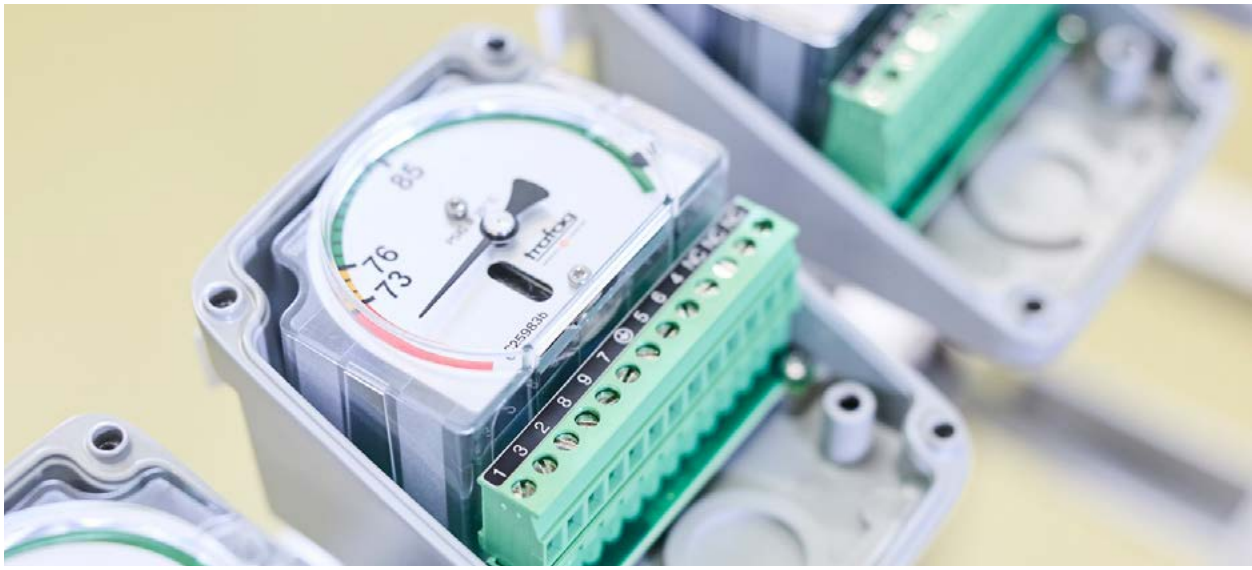
This trend information creates a valuable maintenance window, allowing service to be planned before critical alarm levels are reached. While switching contacts remain essential for safety by triggering alarms at predefined thresholds, continuous monitoring adds the operational intelligence needed for predictive maintenance, improved asset reliability, and optimized service planning.



Density measurement is provided via 2-wire current loop output or RS485/Modbus. It provides essential trend information of potential gas losses or gear status and therefore allows to determine preventive maintenance measures.

Why is low sensor drift important?

Continuous monitoring is only as reliable as the stability of the measurement. Even a small sensor drift can accumulate over years of operation, making it difficult to distinguish between actual gas loss and changes caused by the sensor itself. A low-drift gas density sensor ensures that long-term trends remain accurate and trustworthy, enabling early leak detection, reducing false maintenance actions, and supporting reliable condition-based asset management.



Reliable quality

Worldwide represented, globally trusted, Swiss based

Subsidiaries

Austria
Czech Republic
France
Germany
Great Britain
India
Italy
Japan
Poland (Joint Venture)
Switzerland (Headquarters)
Spain
USA

Representatives

Albania
Argentine Republic
Australia
Belgium
Bolivia
Bosnia
Brazil
Canada
Chile
China
Colombia
Costa Rica
Croatia
Cyprus
Denmark
Ecuador
El Salvador
Estonia
Finland
Greece
Guatemala
Honduras
Hungary
Iceland
Indonesia
Israel
Korea
Latvia
Lithuania
Macedonia
Malaysia
Mexico
Montenegro
Netherlands
New Zealand
Nicaragua
Norway
Panama
Paraguay
Peru
Philippines
Portugal
Romania
Serbia
Singapore
Slovakia
South Africa
Sweden
Taiwan
Thailand
Turkey
Ukraine
United Arab Emirates
Uruguay
Vietnam

Subject to change 07/2026 H70558-cigre26

Coordinates of representatives can be found at www.trafag.com/trafag-worldwide

Download brochure
www.trafag.com/H70558

Trafag sensors & controls
Switzerland

Industriestrasse 11
8608 Bubikon

+41 44 922 32 32
www.trafag.com