Innovative SF\textsubscript{6} lifecycle solutions
For over 60 years, WIKA Alexander Wiegand SE & Co. KG has been a renowned partner and competent specialist for any task in the field of pressure and temperature measurement. On the basis of steadily growing efficiency, innovative technologies are applied when developing new products and system solutions. The reliability of the products and the readiness to face all challenges of the market have been the key factors for WIKA achieving a leading position in the global market.

Within the WIKA group of companies, 9,000 employees are dedicated to maintaining and improving pressure and temperature measurement technology. Over 500 experienced employees within the sales department consult customers and users competently on a partnership basis.
Applications

High voltage/medium voltage

Examples of SF₆ gas-filled components in electricity transmission and distribution

- Switchgear (GIS)
- Disconnectors
- Switch-disconnectors
- Circuit breakers (Live & Dead Tank)
- Transducers
- Transmission lines (GIL)
- Transformers (GIT)
- Ring main units (RMU)
Facts about SF$_6$ gas

SF$_6$ gas, the strongest known greenhouse gas

In the atmosphere, SF$_6$ gas is undesirable due to its high global warming potential and it was listed, along with five other gases, in the Kyoto Protocol.

Its climatic impact is 22,800 times greater than that of carbon dioxide, and its residence time in the atmosphere is approximately 3,200 years. Worldwide there are strict regulations that demand emission reductions in SF$_6$ gas.

In the EU, the F-gas regulation, (EC) No. 517/2014 on the limitation of greenhouse gas emissions, came into force in 2014. In this, the general requirements for the specific handling of SF$_6$ gas and other fluorinated gases (F-gases) were established.

Gas losses from SF$_6$ gas-filled components are both an environmental problem as well as a safety risk, with the associated production or plant shutdown and/or costly service call-outs.

In Germany, the producers of SF$_6$ gas and the manufacturers and operators of gas-filled switchgear have thus joined forces and signed a voluntary undertaking including emission limits.

The current state of the art for SF$_6$ gas-filled equipment is mature and is constantly evolving to take account of climate-related problems.

### Characteristics

- Chemical name: Sulphur hexafluoride
- Colourless, odourless, non-toxic, non-flammable, chemically inert
- High dielectric strength, almost 3 x higher than air or N$_2$
- Climate-effecting CO$_2$ equivalent: 22,800
- Lifetime in the atmosphere: 3,200 years

### Applications

For over 50 years, SF$_6$ gas has been used successfully in various industrial applications.

Most of the SF$_6$ volume is used in switchgear and switch-disconnectors in electricity transmission and distribution. Further high-voltage applications can be found in particle accelerators, radar systems and X-ray systems. In the medical field, SF$_6$ gas is used in MRI instruments, in eye surgery and other applications.

In medium and high-voltage switchgear of the electricity grid operators, the gas acts as an extremely efficient insulation medium and operates as the arc quenching during the switching process. The gas provides the ideal solution due to its high dielectric strength and its ability for recombination. Due to its superior properties in comparison with other media, such as air or nitrogen, switchgear can be built with much more compact dimensions.
Quality made by WIKA

Through the continual extension of the product and service portfolio, WIKA is in a position to offer targeted SF₆ gas solutions. For this, WIKA works very closely together with the manufacturers of gas-insulated equipment.

The products vary widely in their order quantities (1 ... >1,000 pieces/lot), size (valves ... handling device) and application area. Despite the resulting challenges to sales, production and logistics, we always deliver the same high WIKA quality. With the WIKA production system with Kaizen activities in manufacturing and administration, we follow a flexible and adaptable business strategy.

Customer orientation is at the center of all our efforts. Through the targeted efforts of WIKA’s quality management, we have succeeded in minimising the error rate of the SF₆ product division. SF₆ gas measuring instruments from WIKA are 100% function-tested and leak-tested. Thus, components that come into contact with SF₆ gas feature a lasting low leak rate, with the stainless steel components welded to high standards. At WIKA, even the sealing of the case to the process connection is rigorously implemented with a welded design. The result is a robust and durable product, that you can always rely on.

WIKA SF₆ gas Center of Excellence

WIKA offers more than 30 years of experience in the development and series production of SF₆ instrumentation. Currently, well over 1.5 mio. WIKA measuring instruments around the world are taking care of SF₆ equipment safety in the transmission and distribution of electricity.

Milestones company division SF₆ gas

- 1976 Introduction of the first gas density monitor with temperature compensation
- 1990 Introduction of the first gas density monitor with an external temperature sensor
- 1992 The first generation of “Online Monitoring” with a gas density transmitter
- 2000 Introduction of the first gas density indicators, gas density switches and gas density monitors for medium-voltage systems
- 2004 Introduction of a gas density switch with small drift
- 2005 Introduction of the second generation of “Online Monitoring” with a gas density transmitter with field case
- 2009 Acquisition of the SF₆ division of the gas analysis specialists G.A.S. in Dortmund
- 2010 Extension of the portfolio with valves and gas handling instruments
- 2013 Introduction of digital SF₆ condition transmitters of the “Smart Grid” generation
- 2015 Recognition as testing and certification body for personnel certification in the handling of SF₆
- 2016 Introduction of the new generation of groundbreaking handling instruments

- > 24 mio. euros turnover worldwide
- Production facilities in Klingenberg (Germany) and Suzhou (China)
- Over 100 employees worldwide in the SF₆ products division
Comprehensive solutions for SF$_6$ gas applications

Companies that are involved in the lifecycle of SF$_6$ gas-filled equipment, include gas suppliers, equipment manufacturers, utilities, operators and service providers.

Designing for a service life of up to 40 years requires both the use of high-quality components and an adequate maintenance strategy. WIKA is the only company to offer a product portfolio and comprehensive application experience for the entire SF$_6$ lifecycle - everything from one source. Our customers can thus access in-depth know-how - from planning to the disposal of SF$_6$ gas-filled equipment.
## Products and services

### Instrumentation

The monitoring of the SF₆ condition serves for plant safety.

**Product variants:**
- Mechanical gas density indicators
- Mechanical gas density monitors with alarm contacts
- Mechanical gas density switches without display
- Gas density transmitters with analogue output
- Condition transmitter, digital output

### Connecting parts

For the filling or evacuation procedure for SF₆ tanks, reliable connection technology is required in order to prevent gas leakage and to enable efficient operation. WIKA connecting parts fulfil the highest customer requirements, and include valves, couplings, hoses and other components.

### Filling and handling equipment

The service operations for the evacuation and filling of SF₆ tanks, or the processing of contaminated SF₆ gas, must be carried out with the appropriate equipment and by trained personnel. The WIKA product portfolio for filling and handling equipment covers everything to do with the handling of SF₆ gas.

### Analytic and detection instruments

The plant safety of SF₆ gas-insulated equipment is reduced significantly through low concentrations of SF₆ decomposition products. In operation, these arise through arcing in moist or impure SF₆ gas. WIKA offers a complete product line for gas analytics, including accessories.

Leakage detection instruments enable accurate detection and quantification of leakage points. The timely detection and sealing of the smallest of leaks reduces environmental impact and saves on the refilling of leaked gas quantities.

### Service, consulting and training

In order to identify potential for improvement in the SF₆ lifecycle, in-depth knowledge about SF₆ characteristics and legislation is required. During seminars and trainings WIKA will provide information on current laws and standards. In addition, practical knowledge of how to handle these requirements will also be provided.

As an accredited inspection and certification body, WIKA offers advanced training courses in accordance with the relevant EU directives. After the final examination, you will obtain the qualification required for the handling of SF₆.

Besides, you will be supported on issues such as safety, transport, calibration and maintenance services as well as gas analyses in laboratory.
SF₆ instrumentation ensures plant safety

For safety reasons, the filling volume of SF₆ gas is defined for each gas compartment and monitored using an SF₆ density measuring instrument.

WIKA’s gas density determination is made with pressure measurement that has been specifically adapted to the ‘real gas’ behaviour of SF₆ gas by compensating for the effects of temperature changes. Measurement uncertainties, resulting from the fluctuating ambient pressure, are also eliminated by the hermetically sealed case.

Should the gas density decrease due to leakage, defined alarm contacts in the gas density monitor provide a warning or, if the lower limit is reached, shut the plant down.

Modern plant monitoring in the era of the “Smart Grid” requires the use of gas density transmitters with analogue or digital signal output. The transmitters allow a more precise, continuous and central signal monitoring.

The signals or data packets sent are permanently monitored by SCADA systems with integrated data storage and data processing.

In addition to the gas density measurement, the GDHT-20 multi-sensor can provide pressure, temperature and humidity signals in Modbus® protocol.

Alongside the instrumentation, WIKA offers analytic and handling products.
Proactive plant monitoring and service for high-voltage switchgear

The online monitoring of SF₆ gas with trend analysis reduces the risk of failure and the operating costs. The continuous visibility of the plant status enables operators to move away from the previously used preventive or reactive maintenance strategies. In the future, the electricity grid operators will be able to implement a condition-based SF₆ gas service and maintenance strategy. Unnecessary work within defined maintenance cycles is eliminated. Thus, the number of service calls for fault rectification and the associated plant downtime is reduced significantly. If a leak is detected with the gas density measuring instrument, its exact location can be determined with the portable SF₆ detection instrument and repairs undertaken.

Analysis

With the help of WIKA gas analytic instruments, the condition of the SF₆ gas in the plant can be determined directly in the field. Within 5 to 10 minutes, directly on site, the user is in the position to decide whether the equipment needs repair. Depending on the instrument version, the quality parameters of purity, humidity and concentration of decomposition products are measured. Operation is very simple, since after the connection of the gas chamber, the measurement must simply be started manually. The automatic flow control provides for precise and reproducible results. Following the measurement, the result is compared to the applicable benchmarks in accordance with IEC or CIGRE, and, depending on the instrument version, can be saved.

Handling

Filling and handling equipment can be used for the filling, refilling and preparation of SF₆ gas. Depending on the application, equipment is used in manufacture, installation and maintenance. The size of the switchgear depends on the volume of the gas compartment being worked upon. Depending on the customer requirements, the operation and form of the equipment varies.
SF₆ gas-filled plant are often exposed to harsh conditions, including, for example, extreme temperature fluctuations, strong winds, high humidity and ambient pressure changes. In the face of this, to ensure optimal operational safety of the plant, the correct interpretation of the gas density measurement is of central importance. WIKA’s SF₆ density measuring instruments are especially durable.

<table>
<thead>
<tr>
<th>Long-term advantages</th>
<th>Technology</th>
<th>WIKI product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant indication with temperature changes</td>
<td>Temperature compensation</td>
<td>□ Density monitor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Density indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Density switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Density transmitter</td>
</tr>
<tr>
<td>No condensation problems on the window</td>
<td>Hermetically sealed case</td>
<td>□ Density monitor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Density indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Density switch</td>
</tr>
<tr>
<td>No influence due to altitude or atmospheric pressure</td>
<td>Hermetically sealed case</td>
<td>□ Density monitor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Density indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Density switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Density transmitter</td>
</tr>
<tr>
<td>Measuring system will not leak or corrode</td>
<td>□ Welded measuring system from 316L stainless steel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Helium leak rate</td>
<td>□ Density monitor</td>
</tr>
<tr>
<td></td>
<td>&lt; 1 x 10⁻⁸ mbar x l/s</td>
<td>□ Density indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Density switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Density transmitter</td>
</tr>
<tr>
<td>Reliable switch point setting</td>
<td>Fixed setting through laser-welded point</td>
<td>□ Density monitor</td>
</tr>
<tr>
<td>Sealed, tamper-resistant case</td>
<td>Case secured with weld spot</td>
<td>□ Density monitor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ Density indicator</td>
</tr>
</tbody>
</table>
Temperature compensation of pressure measuring instruments

The principle reason for pressure changes in SF₆ gas-filled plant is changes in the ambient temperature. With known gas pressure and temperature, the gas density can be calculated exactly.

In the diagram on the left, the black horizontal line represents the actual gas density. The green line shows the rising pressure due to rising temperature measured with a standard pressure gauge. So that the correct gas density may be determined using a pressure measuring instrument, the pressure increase resulting from the rise in temperature must be compensated in the indication.

In the diagram on the right, the temperature-compensated pressure indication, corresponding to the gas density of the gas tank, is shown.
Temperature compensation principles

**Bimetal: Density monitor and density indicator**

A bimetal between the movement and the measuring tube converts temperature changes into changes in length. The indication on the dial is constant, despite the temperature-induced pressure variations. Only declining pressure due to loss of gas is displayed.

**Metal bellows: Density monitor with external temperature sensor**

The temperature compensation with external capillary sensor enables temperature measurement directly in the tank.
Reference chamber: Density switch

A chamber filled with SF₆ gas serves as a reference. With environmental influences, the reference chamber behaves the same as the tank and thus does not cause any change in the switch condition.

Electronic sensor: Density transmitter

A pressure transmitter specifically developed for SF₆ density measurement delivers a temperature-compensated output signal.
# Product overview for SF$_6$ instrumentation

The components and processes for manufacturing WIKA’s SF$_6$ measuring instrument family have proven themselves in the widest variety of industries and applications. With the help of WIKA’s extensive modular system for measurement technology, the instruments have been specifically designed and optimised for SF$_6$ gas applications. This results in synergies that benefit the customer in the long run. With the wide range of instrument variants, different customer requirements are served, in terms of equipment, measurement parameters, measuring ranges, accuracy and alarm functionality.

## Mechanical and mechatronic measuring instruments

<table>
<thead>
<tr>
<th>Model</th>
<th>GDI</th>
<th>GDM-63</th>
<th>GDM-100</th>
<th>GDS-MV, GDS-HV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model designation</td>
<td>Gas density indicator NS 63 and NS 100</td>
<td>Gas density monitor NS 63</td>
<td>Gas density monitor NS 100</td>
<td>Gas density switch, medium, high voltage</td>
</tr>
<tr>
<td>Output</td>
<td>–</td>
<td>max. 2 switch contacts</td>
<td>max. 3 switch contacts</td>
<td>max. 4 switch contacts</td>
</tr>
<tr>
<td>Special features</td>
<td>■ Bimetal compensation</td>
<td>■ Bimetal compensation</td>
<td>■ Bimetal compensation</td>
<td>■ Reference chamber compensation</td>
</tr>
<tr>
<td></td>
<td>■ Dial layout to customer requirements</td>
<td>■ Magnetic snap-action contacts</td>
<td>■ Magnetic snap-action contacts</td>
<td>■ Micro switch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>■ Dial layout to customer requirements</td>
<td>■ Dial layout to customer requirements</td>
<td>■ High switching accuracy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>■ Variant -TS with external temperature sensor</td>
<td></td>
</tr>
<tr>
<td>Data sheets</td>
<td>SP 60.21, SP 60.03</td>
<td>SP 60.70</td>
<td>SP 60.02, SP 60.04</td>
<td>SP 60.32, SP 60.30</td>
</tr>
</tbody>
</table>
Mechanical and mechatronic gas density measurement

While gas density indicators only show the temperature-compensated filling status on a marked colour dial, gas density monitors offer additional alarm signals at pre-defined switching thresholds for equipment monitoring. Offering only the switching function, gas density switches complete the portfolio for this sector.

Electronic gas density and gas condition measurement

The analogue and digital transmitters provide continuous signals or data packets for evaluation in the SCADA control rooms of modern transformer and distribution stations. Through the combination of transmitter and gas density monitor, in addition to the signal redundancy, it is possible to read the status of the SF₆ gas - on site and in the control room.

Electronic measuring instruments

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GD10</td>
<td>Gas density transmitter</td>
</tr>
<tr>
<td>GDT-20</td>
<td>Transmitter for gas density, temperature and pressure with Modbus® output</td>
</tr>
<tr>
<td>GDHT-20</td>
<td>Transmitter for gas density, temperature, pressure and humidity with Modbus® output</td>
</tr>
<tr>
<td>GDM-100-TI/TA</td>
<td>Gas density monitor with additional analogue output (GDM-100 + GD10)</td>
</tr>
<tr>
<td>GDM-100-TI-D</td>
<td>Gas density monitor with Modbus® output (GDM-100 and GDT-20)</td>
</tr>
<tr>
<td>4 ... 20 mA</td>
<td>Max. 3 switch contacts + 4 ... 20 mA</td>
</tr>
<tr>
<td>Modbus® RTU via RS485</td>
<td>Modbus® RTU via RS485</td>
</tr>
<tr>
<td>SP 60.10, SP 60.11, SP 60.12, SP 60.13</td>
<td>SP 60.09, SP 60.14, SP 60.05, SP 60.06, SP 60.23</td>
</tr>
</tbody>
</table>

- Electronic compensation
- Various connection variants: Field case -F, cable -C, connector -L
- Variants with temperature sensor FT or transmitter F2
- Calculation of the gas density values
- Up to 247 transmitters on one master
- Calculation of the gas density or gas humidity values
- Up to 247 transmitters on one master
- Optionally available with adapter or measuring chamber
- Variants with integrated GD10 gas density transmitter TI or built-in transmitter TA
- On-site display with switch contacts and digital output
- Online monitoring with high measurement accuracy
- Live availability of pressure, temperature and gas density measured values
Periodic checking of leakage detection systems

Gas density monitors and gas density transmitters warn the plant operator in case of leaks and the associated loss of the insulation gas.

As a result of the significant contribution to operational safety offered by gas-insulated instruments and within the meaning of the sustainable climate protection, many plant operators already check their gas density monitors on a regular basis.

With the entry into force of the regulation (EU) No. 517/2014 on fluorinated greenhouse gases, under specific conditions these regular checks have become mandatory. WIKA offers blocking solutions that allow you to check your leakage detection system even when it is installed. The entire check can also be carried out in form of a service supplied by us - whether in laboratory or on site.
Model BCS10

The robust modular calibration system model BCS10 serves for the inspection of SF₆ gas density measuring instruments. Both pressure-based mechanical measuring instruments and electronic measuring instruments can be checked quickly and easily.

The combination of precision digital pressure gauge and test pump allows you to accurately set the measuring point as well as the measured value representation in different units. The calibration system model BCS10 is delivered in a robust service case made of plastic.

Connecting parts

WIKA developed special connecting parts in order to combine a secure checking of gas density monitors and transmitters with an efficient handling. The self-sealing DN20 connection ensures a high gas flow during filling and evacuation of the plant and prevents the gas from escaping unintentionally. With the help of a blocking mechanism, the gas density monitor can be safely disconnected from the gas compartment. A special wrench is necessary for actuating the system, so that an unintentional actuation can be avoided. The self-sealing connection for the gas density monitor prevents any loss of the insulating gas when the measuring instrument is dismounted. If the gas density monitors are used in combination with a test connection, the checking can also be carried out when the instrument is installed.

If no test connection is available on the gas density monitors or transmitters, this connection can be retrofitted using an adapter. It will be positioned between the measuring instrument and the gas compartment. Depending on the requirement, the connection threads can also be changed or adapted. The shut-off valve allows the measuring instrument to be safely disconnected from the gas compartment. The checking of the instrument can be carried out through the DN8 connection without dismounting.

Service

The WIKA calibration van compliant to DIN EN ISO/IEC 17025 allows us to check your instruments directly on site. Alternatively, you can also send your instruments to our calibration & service centre. All operations will be carried out by certified service technicians.
Online monitoring

Electronic transmitters form the foundation for a continuous and high-precision real-time monitoring of your SF₆ gas-filled plant. These are the essential prerequisites for a reliable and early leakage detection. The SF₆ transmitter portfolio has been specifically designed for this purpose. In this regard, all devices rely on standardised interfaces. Analogue transmitters emit the gas density as current signal (4 ... 20 mA). Digital transmitters combine high-precision sensors for pressure, temperature and humidity with a standardised digital interface.

From this, the transmitter calculates the values for gas density and dew point. Due to the RS485 interface and the use of the widely used Modbus® protocol, these transmitters can be employed virtually anywhere and can also be used for retrofitting to existing plant. Thanks to the advanced technology, up to 247 sensors can be queried from a single BUS master. The effort and costs for the installation are thus reduced to a minimum.

A gas management system based on WIKA’s advanced SF₆ sensor technology enables:

- Real-time remote monitoring
- Early detection of the smallest leaks
- Attributing emissions to a measuring point
- Real-time-creation of online trends and analyses
- Optimised and exact filling of plant
- Documentation of emission rates
- Change from time-based maintenance to condition-based maintenance
Connecting parts

A suitable connection technology is essential for conducting the SF₆ gas from one gas compartment to another without losses and in an efficient manner.

Self-sealing valves prevent the gas from escaping unintentionally. The two-stage sealing principle with O-ring and metal contour seal enables safe connection and disconnection under pressure. Suitable hoses avoid that the gas is emitted into the atmosphere.

Different nominal widths and materials are available for various applications - on request, also with the material certificate. In addition to valves and hoses, adapters and protection caps are also included in the standard range of products.

We produce customer-specific designs or assemblies.

To ensure a long-term reliable quality, all connecting parts have a robust design, are produced with high-quality materials and are checked against leaks.

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**Model** | GCV | GCC | GCA | GCF | GCP | GCH | GCK | GCM
---|---|---|---|---|---|---|---|---
**Function** | Valve | Coupling valve | Adapter | Solder and weld connection | Protection cap | Hose | Gas connection kit | Combina-tion valve
**Nominal diameter** | DN6 ... DN20 | DN6 ... DN20 | DN6 ... DN20 | DN6 ... DN20 | DN6 ... DN20 | DN6 ... DN40 | – | –
**Materials** | Al, SS, brass | Al, SS, brass | Al, SS, brass | Al, SS, brass | Al, SS, brass | SS, rubber | Al, SS, brass | Al
**Data sheets** | SP 61.12, SP 61.13, SP 61.14 | SP 61.12, SP 61.13, SP 61.14 | SP 61.12, SP 61.13, SP 61.14 | SP 61.12, SP 61.13, SP 61.14 | SP 61.12, SP 61.13, SP 61.14 | SP 61.15 | SP 61.16 | SP 61.11

Sectional illustration: GCC-20 and GCV-20 in uncoupled state

Sectional illustration: GCC-20 and GCV-20 in uncoupled state
Gas analysis

Discharges during switching operations in SF₆ gas-filled plant lead, over time, to increased concentrations of toxic and highly corrosive decomposition products.

The formation of decomposition products is dependent on the amount of air and humidity reactants in the SF₆ gas during the discharge. These contaminants (air, humidity and decomposition products) prevent the continued safe operation of the switchgear. In particular, the decomposition products strongly attack and corrode the surfaces within the tank. This progressively reduces the dielectric strength of the insulation materials in the switchgear. The use of gas analysis instruments is absolutely necessary to monitor the concentration of harmful decomposition products, thus ensuring long-term plant safety.
With energy input during plant operation, the otherwise stable SF$_6$ gas decomposes into reactive and corrosive products such as SF$_4$ and other compounds (see illustration “Formation of decomposition products”). From the reactants of air and humidity in the gas, further decomposition products are formed.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Stability in air</th>
<th>End products</th>
<th>usual Limit values [ppmv]</th>
<th>Odour</th>
</tr>
</thead>
<tbody>
<tr>
<td>S$<em>2$F$</em>{10}$ Disulphur decfluoride</td>
<td>stable</td>
<td>SF$_4$, SF$_6$</td>
<td>0.01</td>
<td>acrid</td>
</tr>
<tr>
<td>SF$_4$ Sulphur tetrafluoride</td>
<td>fast decay</td>
<td>HF, SO$_2$</td>
<td>0.3</td>
<td>acrid, sour</td>
</tr>
<tr>
<td>SOF$_4$ Sulphuryl fluoride</td>
<td>stable</td>
<td>SO$_2$F$_2$</td>
<td>0.3</td>
<td>odourless</td>
</tr>
<tr>
<td>SOF$_2$ Thionyl tetrafluoride</td>
<td>stable</td>
<td>SOF$_4$</td>
<td>0.5</td>
<td>sour</td>
</tr>
<tr>
<td>SiF$_4$ Silicon tetrafluoride</td>
<td>fast decay</td>
<td>SiO$_2$, HF</td>
<td>0.5</td>
<td>pungent</td>
</tr>
<tr>
<td>SO$_2$ Sulphur dioxide</td>
<td>stable</td>
<td>SOF$_2$, SF$_4$</td>
<td>1.0</td>
<td>acrid</td>
</tr>
<tr>
<td>SOF$_2$ Thionyl fluoride</td>
<td>slow decay</td>
<td>HF, SO$_2$</td>
<td>1.5</td>
<td>acrid, pungent</td>
</tr>
<tr>
<td>HF Hydrogen fluoride</td>
<td>stable</td>
<td>SiF$_4$</td>
<td>2.0</td>
<td>sour</td>
</tr>
<tr>
<td>SF$_6$ Sulphur hexafluoride</td>
<td>stable</td>
<td>SiF$_4$</td>
<td>1,000</td>
<td>odourless</td>
</tr>
</tbody>
</table>

**Quality directives**

The IEC and CIGRE organisations develop criteria and limit values for SF$_6$ gas. These specify the limits at which a contamination exists, and how the correct handling of the SF$_6$ gas used in switchgear should be made.

The permissible standard values are stated in IEC 60480, the “Guidelines for the checking and treatment of sulphur hexafluoride (SF$_6$)”.

**Maximum concentration of contaminants in SF$_6$ gas for re-use (in accordance with IEC 60480):**

- Air and/or CF$_4$: 3 %
- Gaseous decomposition products: 50 ppmv
- Humidity: Dew point: -23 °C (filling pressure < 200 kPa abs.) or -36 °C (filling pressure > 200 kPa abs.)
Detection instruments

Leakage in switchgear can cause high maintenance costs and, depending on the size, can quickly become a safety risk. Thus, gas leaks must be pinpointed promptly and reliably and then eliminated.

Leak location

IR-Leak 2,000 ppm

The IR-Leak, with a measuring range of 2,000 ppm, is the ideal measuring instrument for locating the leak on site and to make a quantitative measurement of it.

Thus specific repair measures can be taken. The leak location using infrared spectroscopy is neither distorted by humidity or common volatile organic compounds, nor by wind.

Emission monitoring

IR-Monitor with optional Multi-Sampler

Stationary measuring instrument for the monitoring of the concentration of SF₆ gas in the ambient air to guarantee occupational safety in enclosed spaces.

The instrument continually checks the room air with a non-dispersive infrared sensor. Via a high-volume alarm, there is an immediate warning of any hazardous gas concentrations in the air. Usually, samples are taken continuously, close to gas tanks or gas-insulated switchgear, from which large quantities of SF₆ gas could escape within a short period of time.

Most of these areas are physically separated or too large for a central measuring point. With the help of the multiplexer, up to 10 measuring points can be monitored with a single emission monitor. Thus the instrument scans through all active sampling boxes at a predefined interval.
**Leak test**

**Tracer and IR-Leak 50 ppmv**

Measuring instruments specifically for the measurement of small SF$_6$ concentrations to detect the smallest of leaks.

The quantitative gas measurement of SF$_6$ gas in the air is carried out reliably and reproducibly even at the smallest quantities. The technology used is based on photo-acoustic infrared spectroscopy. The SF$_6$-Tracer achieves a very high accuracy with a detection rate of 6 ppb. The IR-Leak, with 50 ppmv, has a detection rate of 0.6 ppmv.

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**Infrared technology measuring principle**

**Non-dispersive infrared technology**

\[
A = -\lg \frac{\Phi}{\Phi_0} = \varepsilon \cdot c \cdot l
\]

- $A$: Absorption
- $\Phi$: Light intensity after absorption of SF$_6$ gas
- $\Phi_0$: Light intensity without absorption
- $\varepsilon$: Extinction coefficient
- $c$: Concentration
- $l$: Length of the irradiated chamber (sample gas chamber)
### Product overview for SF₆ analysis

#### Quality measurement

<table>
<thead>
<tr>
<th>Model</th>
<th>GA20</th>
<th>GA40</th>
<th>GA50</th>
<th>GA25</th>
<th>GA10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model designation</td>
<td>SF₆-Humiditor</td>
<td>SF₆-Hygrometer</td>
<td>SF₆-Purity-Meter</td>
<td>SF₆-Aciditor</td>
<td>SF₆-Breaker-Analyser</td>
</tr>
<tr>
<td>Parameters</td>
<td>Dew point</td>
<td>Dew point</td>
<td>SF₆ percentage</td>
<td>SO₂ concentration</td>
<td>Dew point SF₆ percentage</td>
</tr>
<tr>
<td>Special features</td>
<td>■ Polymer sensor</td>
<td>■ High-accuracy chilled mirror</td>
<td>■ Sensor measures the velocity of sound</td>
<td>■ Electrochemical sensor</td>
<td>■ SF₆ quality measurement in modular design</td>
</tr>
<tr>
<td>Data sheet</td>
<td>SP 62.03</td>
<td>SP 62.07</td>
<td>SP 62.10</td>
<td>SP 62.04</td>
<td>SP 62.01</td>
</tr>
</tbody>
</table>

#### Quality measurement

<table>
<thead>
<tr>
<th>Model</th>
<th>GA11</th>
<th>GFTIR-10</th>
<th>GA05</th>
<th>GA45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model designation</td>
<td>SF₆-Q-Analyser</td>
<td>FTIR-Analyser</td>
<td>MV Pressure-Regulator</td>
<td>SF₆-Recovery-Bag</td>
</tr>
<tr>
<td>Parameters</td>
<td>Dew point SF₆ percentage</td>
<td>SO₂, HF, H₂S, CO concentration</td>
<td>SO₂, HF, SOF₂, SOF₂, SO₂F₂, S₂F₁₀, SiF₄, CO, COS, CF₄, C₂F₆, C₃F₈ concentration</td>
<td>--</td>
</tr>
<tr>
<td>Special features</td>
<td>■ SF₆ quality measurement with pump-back function</td>
<td>■ Laboratory measuring system with spectrometer, PC and software</td>
<td>■ Pressure increase for low process pressures</td>
<td>■ Space-saving as foldable</td>
</tr>
<tr>
<td>Data sheet</td>
<td>SP 62.11</td>
<td>SP 62.17</td>
<td>SP 62.14</td>
<td>SP 62.08</td>
</tr>
</tbody>
</table>
## Leak location/leak test

<table>
<thead>
<tr>
<th>Model</th>
<th>GIR-10</th>
<th>GA65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model designation</td>
<td>SF₆-IR-Leak</td>
<td>SF₆-Tracer</td>
</tr>
<tr>
<td>Parameters</td>
<td>0 ... 50 ppmₚ</td>
<td>6 ... 60,000 ppbᵥ</td>
</tr>
<tr>
<td></td>
<td>0 ... 2,000 ppmᵥ</td>
<td></td>
</tr>
<tr>
<td>Special features</td>
<td>■ Non-dispersive infrared sensor</td>
<td>■ High-precision photo-acoustic infrared spectroscopy</td>
</tr>
<tr>
<td></td>
<td>■ Portable battery-operated instrument</td>
<td>■ Extensive programme of accessories</td>
</tr>
<tr>
<td></td>
<td>■ Switchable to leak rate</td>
<td></td>
</tr>
<tr>
<td>Data sheet</td>
<td>SP 62.02</td>
<td>SP 62.13</td>
</tr>
</tbody>
</table>

## Emission monitoring

<table>
<thead>
<tr>
<th>Model</th>
<th>GA35</th>
<th>GA33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model designation</td>
<td>SF₆-IR-Monitor</td>
<td>Multi-Sampler</td>
</tr>
<tr>
<td>Parameters</td>
<td>0 ... 2,000 ppmᵥ</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special features</td>
<td>■ Non-dispersive infrared sensor</td>
<td>■ Multiplexer for model GA35 and GA38 emission monitors</td>
</tr>
<tr>
<td></td>
<td>■ Up to 10 measuring points possible with GA33</td>
<td>■ Instrument variants for 5 or 10 measuring points</td>
</tr>
<tr>
<td></td>
<td>■ Adjustable intervals</td>
<td>■ Adjustable intervals</td>
</tr>
<tr>
<td>Data sheet</td>
<td>SP 62.06</td>
<td>SP 62.16</td>
</tr>
</tbody>
</table>
Filling and handling equipment for SF₆ gas are the central tools for the maintenance of gas-insulated equipment. Both for the installation as well as for the maintenance of gas-insulated equipment in electricity transmission and distribution, WIKA delivers the complete product range of efficient filling and handling equipment.

The core processes are the initial filling, gas processing and refilling of SF₆ equipment. Here, the insulating or quenching gas is either filled in or extracted from the gas compartments. Furthermore, the instruments support the plant operator with the recording of the SF₆ gas volumes and emissions, as is prescribed in the F-gas regulation (EU), No. 517/2014, for specified equipment.

### Portable instrument series

<table>
<thead>
<tr>
<th>Model</th>
<th>GPF-10</th>
<th>GVC-10</th>
<th>GTU-10</th>
<th>GWS-10</th>
<th>GVP-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model designation</td>
<td>Portable SF₆ filter unit</td>
<td>Portable SF₆ vacuum compressor</td>
<td>Portable SF₆ transfer unit</td>
<td>Portable SF₆ gas cylinder scale</td>
<td>Portable vacuum pump</td>
</tr>
<tr>
<td>Process</td>
<td>Filtration</td>
<td>SF₆ extraction</td>
<td>SF₆ filling</td>
<td>Weighing of SF₆ gas</td>
<td>Air evacuation</td>
</tr>
<tr>
<td>Description</td>
<td>Filtering out of particles, humidity and decomposition products</td>
<td>In order to extract SF₆ gas compartments up to a residual pressure of 5 mbar abs., the model GVC-10 vacuum compressor is combined with the model GTU-10 transfer unit</td>
<td>SF₆ gas compartments are directly filled from the gas cylinder or the SF₆ gas is stored in a gas cylinder. During storage of the SF₆ gas, the compressor can liquefy the gas in the storage vessel</td>
<td>Measuring the gas cylinder weight before and after the filling/extraction</td>
<td>Preparation for filling following plant maintenance</td>
</tr>
<tr>
<td>Data sheet</td>
<td>SP 63.11</td>
<td>SP 63.13</td>
<td>SP 63.07</td>
<td>SP 63.09</td>
<td>SP 63.12</td>
</tr>
</tbody>
</table>
Criteria for plant definition

1. How much SF₆ gas should be transferred and in what time? ▶️ Air flow or mass flow
2. Which container should be installed? ▶️ Tank or gas cylinder
3. Which equipment should be maintained? ▶️ Hose lengths and connecting parts
4. Which operating concept? ▶️ Automatically programmed control or manual control
5. Into which region will the plant be delivered? ▶️ Applicable standards
6. Where will the plant be used? ▶️ Indoor or outdoor switchgear

In accordance with the above definition, WIKA can offer standard plant or – with special processes and further definition – engineer special plant.

Filling stations

<table>
<thead>
<tr>
<th>Model</th>
<th>GFU08</th>
<th>GFU10</th>
<th>GPU2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model designation</td>
<td>SF₆ filling cart</td>
<td>SF₆ handling and filling equipment</td>
<td>SF₆ storage vessel</td>
</tr>
<tr>
<td>SF₆ storage vessel</td>
<td>Gas cylinder</td>
<td>Gas tank</td>
<td>Gas cylinder/gas tank</td>
</tr>
<tr>
<td>Data sheet</td>
<td>SP 63.08</td>
<td>SP 63.01</td>
<td>SP 63.16</td>
</tr>
</tbody>
</table>
Due to the climatic effects described earlier, SF₆ gas is an important topic worldwide, on which there is a need for action to eliminate emissions. The consequences are governmental controls with the requirement for verification of the SF₆ filling volumes in plant. In the seminars, WIKA informs about the applicable regulations coupled with practical knowledge for the selection and operation of the right equipment.

We offer many different topics:
- Basics
- Rules and regulations
- Emission monitoring
- Density measurement and humidity measurement
- Connecting parts
- Filling and handling equipment
- Analysis
- Detection
Imagine you could bring together certified experts from the field of SF₆ lifecycle management and gain insight into best practices. Imagine you could get a demonstration of instruments from the field of lifecycle management of SF₆ gas-insulated switchgear from the manufacturer themselves.

To ensure a higher transfer of knowledge, the SF₆ trainings also include a practical part or are illustrated with live demonstrations.

Consulting or training can be carried out within our own company training centre or on site at your premises.

**Repair and maintenance service**

Depending on the level of work required, we can offer our customers a repair and maintenance service, either at WIKA or on site.

**Commissioning service**

On request, we also undertake the commissioning of new instruments for our customers. This usually involves a detailed functional testing and detailed instruction and training of operating personnel.

**Rental service**

Should our customers only require analytic and measuring instruments for a specific period of time or a first test, these can be rented from us.

**Analysis service**

Thanks to our experience, we are also able to offer a comprehensive analysis service to our customers. Using non-destructive measurement methods, an identification and precise qualification of the main decomposition products of SF₆ gas can be made. This is also possible, through our experts, for highly corrosive SF₆ samples. Furthermore, we are also available for the analysis and detection of any leakages you may have.

**Consulting**

Due to our presence worldwide, with over 43 subsidiaries, and through our personnel with specialist training in the handling of SF₆ gas, we are able to provide you with advice and assistance. Do you require further information or have a specific inquiry? Then simply contact us at SF6-sales@wika.com
EU regulation No. 517/2014 on fluorinated greenhouse gases replaced the previous (EC) 842/2006 with effect from 1 January 2015. The new regulation stipulates training measures for personnel who carry out work in connection with sulphur hexafluoride ($\text{SF}_6$ gas).

In particular, this work includes:

- Installation, service, maintenance, repair or shutdown of gas-insulated electrical switchgear
- Performing leak testing on plant that fall under the F-gas regulation
- Recovery of $\text{SF}_6$ gas

As a testing and certification body recognised by the Bavarian environment agency, WIKA offers competence training with subsequent examination, so personnel can be certified across all of Europe. The training and certification is carried out in accordance with the EC 305/2008 European regulations as well as the chemicals climate protection regulation.

Certified WIKA instructors pass on their extensive know-how for daily, practical application. Among those we train are installers, service technicians and maintenance personnel.

---

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Worldwide consulting

Around the globe, WIKA employees are available to you for SF₆ gas applications. Our engineers and service technicians offer you the best solutions for your application from a diverse portfolio.

With well over a million WIKA measuring instruments in the field, the SF₆ density monitoring of plant within the electricity transmission and distribution is assured.

Within the WIKA SF₆ gas academy, our customers gain practical information and training on this complex subject.

In our academy, we educate and train customers on site or within our subsidiaries. Wherever you are located, we can assist you.