

Sensgear®

Born connected

Added transparency, enhanced productivity and advanced intelligence

[siemens-energy.com/sensproducts](https://www.siemens-energy.com/sensproducts)

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Introduction

Transmission equipment is always positioned at critical nodes in the grid. It can deliver a lot of information if sensors used get connected. While monitoring equipment can provide a lot of information already, the focus of Sensgear® is more than sheer asset management, it supports active management of the grid.

Just imagine: Gas-insulated switchgears or circuit breakers let you know their current status in near-real time via an online application. This means you can take better decisions, optimize the management of your grid, which results in more flexibility and more economic operation.

Enhance productivity with health index, health index prediction, and a reduction of unplanned downtime.

Additionally, Sensgear® will come with F-gas reporting functionality, meaning operators can reduce costs to comply with regulations. They also obtain a notification even before a critically low alarm level – good for the environment and the operator, as penalties can be avoided. Thanks to its artificial intelligence powered data analytics, Sensgear® increases the efficiency and sustainability of your assets and operations.

Beneficial applications

- Preventive detection of suspicious & critical assets thereby reducing the risk of unplanned outages
- Early warning and push notification on mobile devices before it gets critical
- Reduced manhours on equipment with less costs & time for travel and SF₆ controlling at site
- Cost savings for unplanned SF₆ leakage repairs
- Less risk contingencies and penalties for SF₆ emissions
- Mechanical lifetime trending and projection
- Fleet coverage in a unified manner
- Artificial intelligence powered analysis
- Comprehensive visualization tools to support further decision making

Sensgear are part of the Sens-Family and are easily connectable to Sensarrester, Sensformer and Sencoil.

From data collection to value and performance increase

Data collection on devices

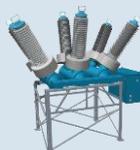
GPS / GSM antenna
+ fleet view
(GPS based mapping)
+ weather information

Gas density
+ monitoring actual gas density and remote gas alarming
+ gas density trending

Auxiliary / limit switch
+ monitoring of switching position and mode condition
+ counting of operation cycles

Cabinet temperature
+ cabinet condition monitoring: functioning of anti-condensation & low-temperature heater

Ambient temperature
+ temperature range adherence



Connectivity



Cloud platform



Sensgear



Basic KPIs



Status manager



Fleet view



Notification app

Sensgear Advanced Trending



AI gas alarm prediction



Circuit breaker idle time



F-gas inventory & reports



Mechanical life-time trend



Data download

Sensgear Advanced Overload



Overload management*

Runs on desktop & mobile devices

Diagram 1 Sensgear® system overview

*upcoming for 8VN1 Blue GIS 145 kV

Sensgear® hardware and sensors

Sensgear® equipment is delivered pre-equipped with all necessary hardware. The IoT gateway is pre-configured and pre-installed on the device. It comes with GPS and local weather information, as well as the following measurement: gas density, temperature, circuit breaker counter and position & readiness.

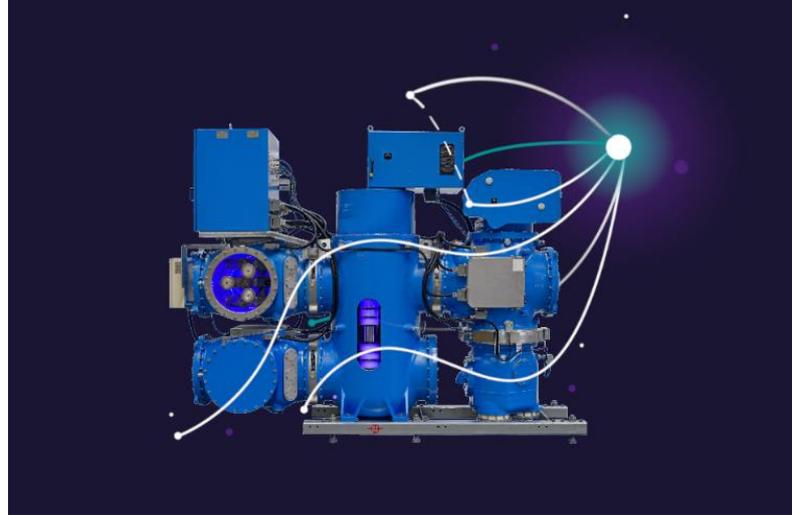
Hardware and sensors have the renowned reliability of Siemens Energy products: sensors are well-proven, integrated and reduced to the essentials; there is no local analytics hardware. Furthermore, the connectivity is based on a “read-only” concept without any influence on the protection and control of the device.

All connectivity levels are based on the same platform, so that a fleet can consist of basic Sensgear® equipment, as well as Sensgear® with advanced features (see diagram 1).

Sensgear® features at a glance

Sensgear® comprises the following transmission products:

- Gas-insulated switchgear, circuit breakers and instrument transformers
- Connectivity via GSM (GPRS/EDGE/3G) or LAN/WAN
- Data transmission with 1min/batch with up to 1 sample per second
- Cybersecurity concept designed considering the various security standards such as NERC -CIP, ISO and IEC 27001
- Web and mobile interface, providing instant information like equipment details, fleet location, trend visualization, alarm information, etc.
- Open platform for co-creation of software applications/ customer use cases
- Secure cloud-based data storage with SHA1 based integrity checks and 2-level user authentication
- Compliant with all relevant standards (e.g. EMC Directive 2014/30/EU, IEC/EN 60529 and IEC/EN 61010 IEC/EN 61000, IEC/EN 60068) (see diagram 1).



Sensgear® Advanced next level of our digital portfolio

The basic Sensgear® portfolio provides additional remote transparency for operators, service and asset management. Sensgear® advanced now upgrades this functionality to enhance productivity using a digital twin. Moreover, the upgrade offers the chance to benefit from advanced intelligence by using artificial intelligence.

The main features of Sensgear® Advanced are as follows:

F-gas reports – just one mouse-click away

SF₆ as the strongest greenhouse gas and widely used, requires special attention. Operators are obliged to frequently visit the equipment and report on inventory and emissions. Emissions are more and more connected to penalties.

The reporting requirements and costs rise continuously. Sensgear® advanced products, such as SF₆-gas-insulated switchgear (GIS) and SF₆-gas-circuit-breakers now offer an integrated F-gas reporting, providing remote inventory measurement per gas-compartment, SF₆-and CO₂ emission calculation, reporting periods and summaries.

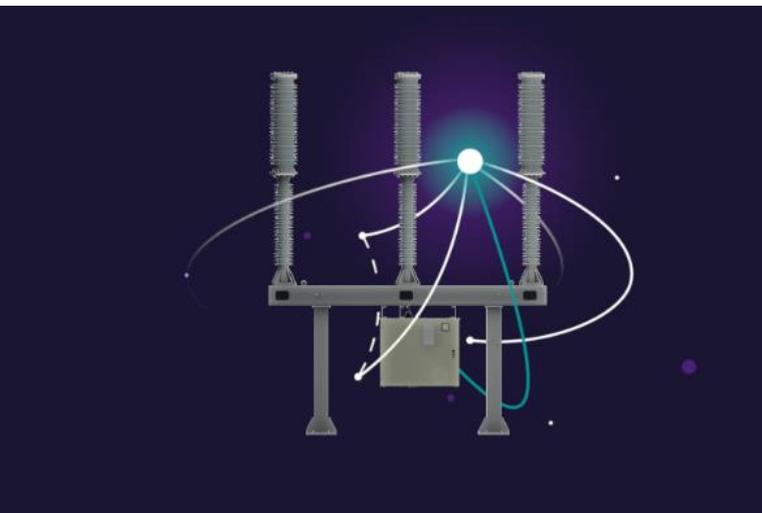
Gas density trending & prediction applying artificial intelligence to optimize gas monitoring

Conventional trending models require long data history (weeks) before performing linear interpolation. Faster and more accurate gas trending is achieved by applying neural networks to compensate sensor data with regard to weather influences. The AI model requires less historical data (days).

Circuit breaker idle time and mechanical life trending

Electrical switching equipment are designed to withstand a specific number of mechanical operations and to operate without any faults as long as the mechanical switching capacity is not exhausted.

Sensgear® advanced provides a record of the executed mechanical switching operations and calculate the remaining mechanical switching capacity (in units and years). The used and remaining mechanical switching capacity is shown in an comprehensive way to enable further decision making.



In addition, Sensgear® advanced keeps track of the circuit breaker idle time, provide a status of switching readiness, and make a recommendation on when to conduct the next switching operation.

Additional features

- Raw data download
- Runs on desktop and mobile devices
- Notifications
- Alarms and warnings before it gets critical

The principles of the thermal digital twin are described on the example of a GIS: For each GIS-module the original 3D digital twin with the respective geometrical, chemical/physical and thermodynamic properties is generated. A 3D power loss simulation is done for each module and combination of modules.

The simulated module combinations are built in real and validated in a temperature rise-type test with temperature sensors on all critical parts. Additional short time overload tests were performed to validate the overload approximation of the thermal grid method. The measurement and the simulation show high conformance.

Benefits for the grid operators are higher performance and more transmitted power:

- Transparency on thermal utilization of the switchgear and its modules based on digital thermal twin and ambient temperature: virtual sensors
- Indication of temporary overload current capabilities without reducing reliability and lifetime
- More transmitted power through temporary overload current
- Prediction of temporary overload current capabilities based on ambient temperature prediction deducted from weather forecast
- Cost reduction potential re-dispatch

“We are leveraging the power of a cloud platform and data in a substation environment. The next step for Sensgear is to enhance intelligence with digital twin operation. This will allow operators to actively overload switchgear, based on real and virtual sensor information.”

Dr. Ulf Katschinski, Siemens Energy's Vice President of the Switching Products & Systems business unit

Increase power transmission by active overload management based on digital twins

The grid and operators of the 21st century face new challenges: fluctuating power generation by renewables and increasing and fluctuating electricity demand, require a grid and products which are flexible to avoid congestions. Current and voltage are the key physics to be managed. Current causes conductor temperature rise depending on the resistance of the material. The limiting factor is the absolute temperature of the used materials.

Therefore, the knowledge and influencing of the material temperatures are key.

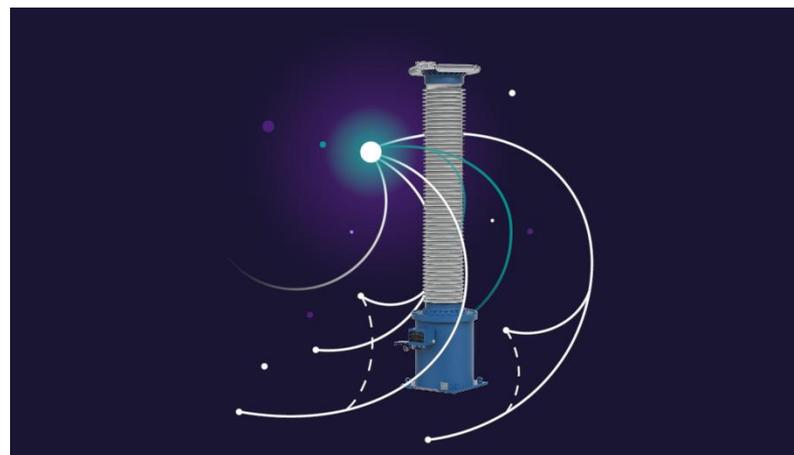
Mechanical, electrical, and thermal digital twins are used to optimize product design, testing, production and operation. Until today, those digital twins are not actively used in operation.

Sensgear® advanced now combines operational data with the digital twin operation from development, virtual operation simulation and factory testing to manage congestions actively. This enables grid operators to transmit additional power through higher current for a certain period of time depending on ambient temperature.

Data handling and security

We fully understand the importance of the ever increasing cybersecurity requirements. As one of the main founders of the Charter of Trust we ensure that we comply with state-of-the-art security and encryption technologies such as ISO / IEC 27001. For data transmission to cloud storage, an end-to-end encryption is used. Each Sensgear® product has a unique ID, which is also used for encryption. The transmission is via HTTPS with 256-bit TSL encryption.

We also comply with state-of-the-art data handling and management guidelines to ensure that data from different customers is strictly separated and secured in the cloud.





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