Grid Solutions

F35-145 kV DUAL GAS

Gas-Insulated Substation
145 kV, 40 kA, 3150 A, 50/60 Hz Compatible with SF_6 or g^3 gas

Grid Solutions at GE Vernova has more than 50 years of experience in the design, material selection, development, engineering, manufacturing, and servicing of gas-insulated substations (GIS).

Our F35-145 Dual Gas GIS bay – compatible with either SF_6 or g^3 gas – meets the challenges of electrical networks up to 145 kV for following applications: offshore and onshore wind power generation, distribution, infrastructure, and industrial applications

Reduced carbon footprint

The F35g-145 kV is available in a fully SF_6-free version using our g^3 technology, one of the company's alternative technologies to SF_6, allowing for a 99% CO2-eq reduction of the gas contribution to global warming. While it has the same dimensions, performance and ratings as SF_6 GIS, the F35g-145 advanced sealing system and improved tightness provide a significantly lower carbon footprint compared to its SF_6 equivalent.

The integration of low-power instrument transformers (LPITs), also known as digital voltage and current transformers, further contributes to decarbonization of the F35 Dual Gas GIS and reduces the need for strategic raw material consumption.

Modular and Versatile

- Applicable in offshore and industrial substations as well as space constrained zones such as urban areas
- High modularity enables complex layouts in a compact arrangement

Lowest Cost of Land and Civil Works

- Compact GIS bay with a width of only 800 mm. Dimensions with SF_6 or g^3 gas are the same
- Up to 3 bays assembled, wired, tested, and shipped directly to site
- Simple on-site testing due to the disconnecting function of voltage transformers and surge arresters

GE VERNOVA

The path to Decarbonization

- The F35g-145 kV SF_6-free GIS is part of our GRiDEA portfolio of solutions designed to accelerate the decarbonization of the grid
- Lower carbon footprint over a 40-year substation life cycle compared to the use of SF_6 products
- The gas contribution to global warming is reduced by 99% using our g^3 gas as compared to SF_6
- Same GIS footprint with SF_6 or with g^3
- Tightness system improved by design with a reduction of the total sealing length by a factor of two in comparison to the previous version

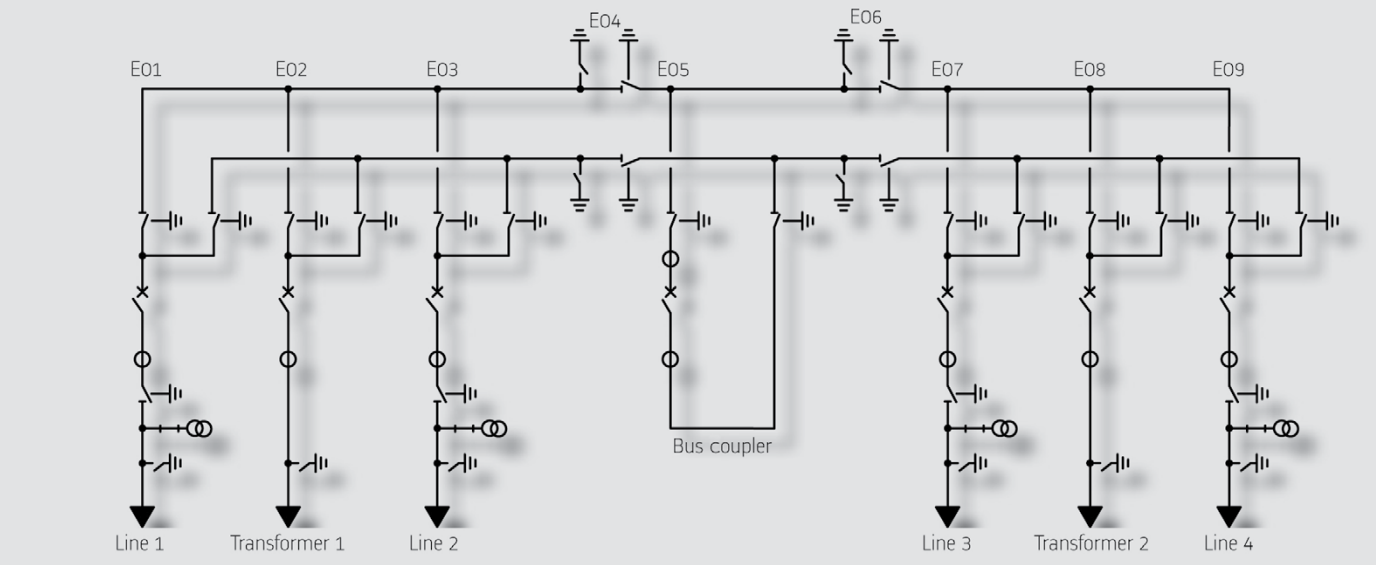
Digital Native GIS

- Mechanically engineered to reach the accuracy required with advanced monitoring and control solutions
- Digital power sensing using low-power instrument transformers

Easy Upgrades

- Bays are completely factory-assembled, wired and tested before shipment
- Easily make the switch to SF_6-free whenever you're ready
- Compact design that's applicable to all substations, including extensions of existing substations
- State-of-the-art maintenance isolating device for separation of the surge arresters and/or voltage transformers avoiding gas operation or disassembly during on-site testing

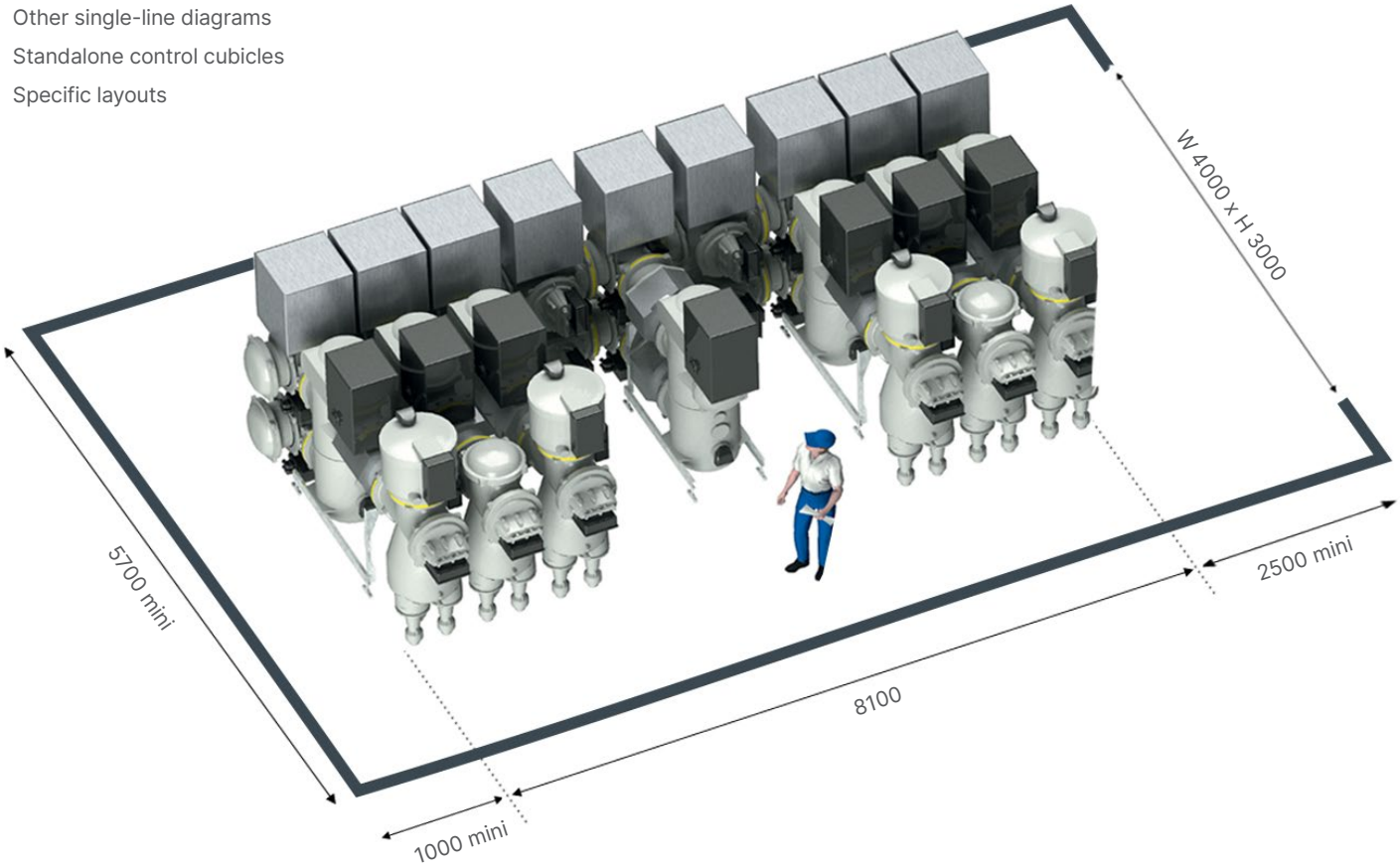
F35 - 145 kV, 40 kA, 3150 A - Double busbar diagram



Bay width: 800 mm

Also available:

- Other single-line diagrams
- Standalone control cubicles
- Specific layouts



Available with SF_6 or g^3

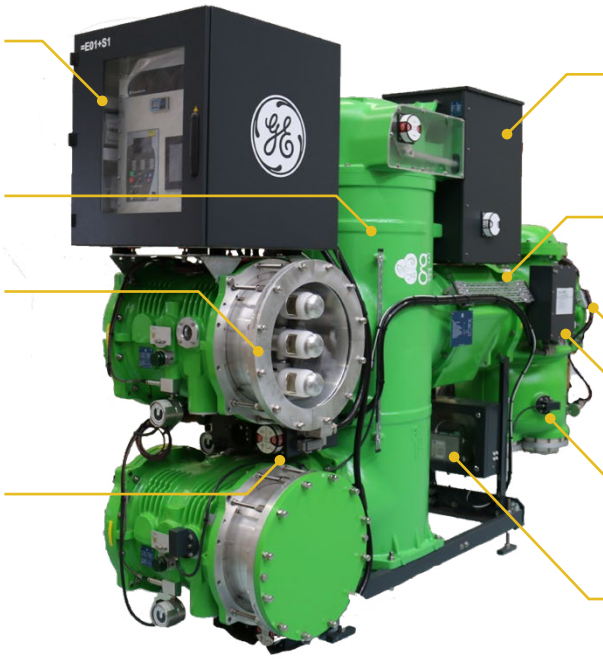
F35 Universal Bay: same design, no matter what you choose

Local Control Cubicle:
Conventional or Digital, Embedded or Standalone can include a merging unit, voltage detection display, gas management interface, bay control unit including protections

Circuit-breaker

Single or double busbar

Busbar disconnector and earthing switch



Spring-drive: single or three-pole operation

Optional: digitally controlled switching

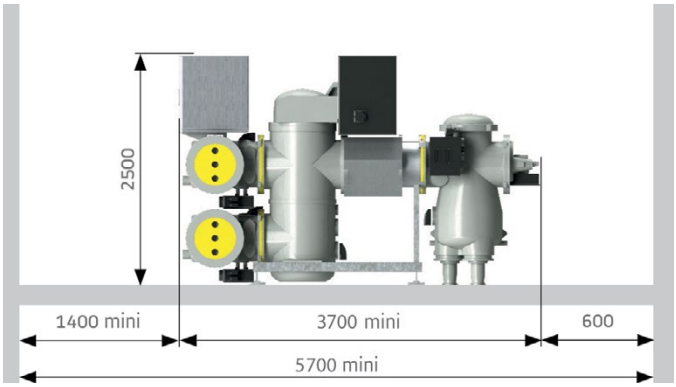
Combined voltage and current sensors:
Conventional or digital. Available with additional conventional core for billing function

Optional voltage detection of incoming feeder

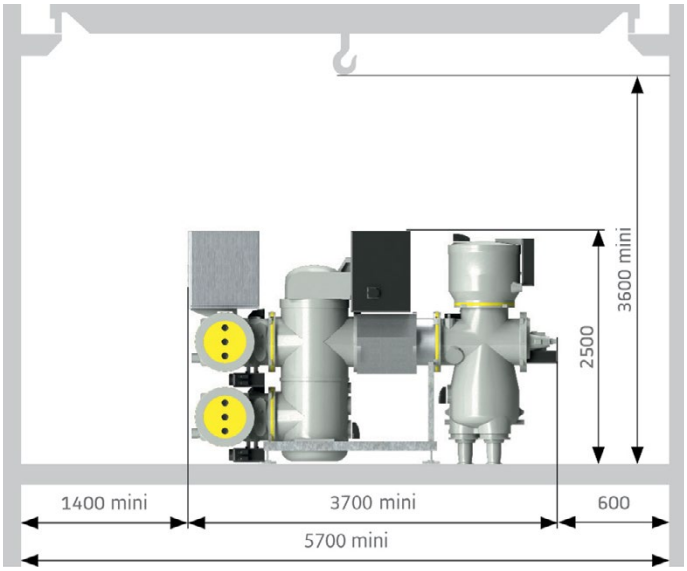
Combined disconnector and earthing switch

Cable box

PDbox:
Partial discharge monitoring



Digital Bay



Conventional bay

Always the same compact design

Digital Native GIS

A new product design approach

Digital native equipment is mechanically engineered to reach the accuracy required with advanced monitoring & control solutions to meet new grid constraints.

Our F35-145 Dual Gas GIS is designed with sustainability in mind, ready to connect and operate fast and effectively to simplify your sourcing and operational experience and finally, get rid of complexity.

Built upon our new dual gas GIS, the digital native F35 natively integrates sensors by default allowing easy plug-in of all our latest generation digital devices. In addition, the low-voltage controlled cubicle is assembled, pre-configured and fully factory-tested with the GIS Bay.

The standardized digital native GIS brings numerous advantages such as:

- Reduced supply chain complexity
- Reduced delivery time
- Connection error prevention
- Reduced erection and commissioning costs
- Simplified integration into the protection and control scheme through IEC 61850
- Improved flexibility
- Accurate data based on built-in physical sensors that feed the asset performance management system

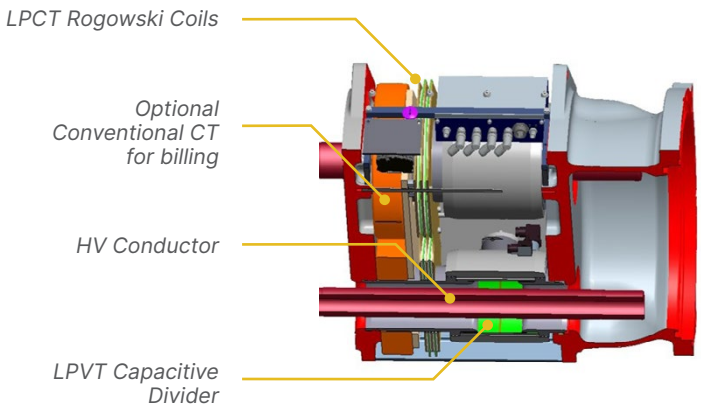
Fully in accordance with IEC 61850, the digital native F35 Dual Gas GIS supports the next trend in substation automation and cyber-security.

Low Power Instrument Transformers (LPIT)

Current and Voltage measurement on F35-GIS can be conventional and/or digital. With LPITs, the translation from primary to secondary measurement uses Rogowski or capacitive sensors, demonstrating high level accuracy, and high flexibility. The full digital components chain is available from sensors on the primary equipment to the control room, according to IEC 61869.

First LPITs on our GIS have been in operation since 2005 in compliance with IEC 61850 protocol.

The first F35g GIS (with g³ gas) embedding LPIT was energized in 2019.



Combined current and voltage transformer including an optional conventional core for billing function

F35 Dual Gas Digital Solutions

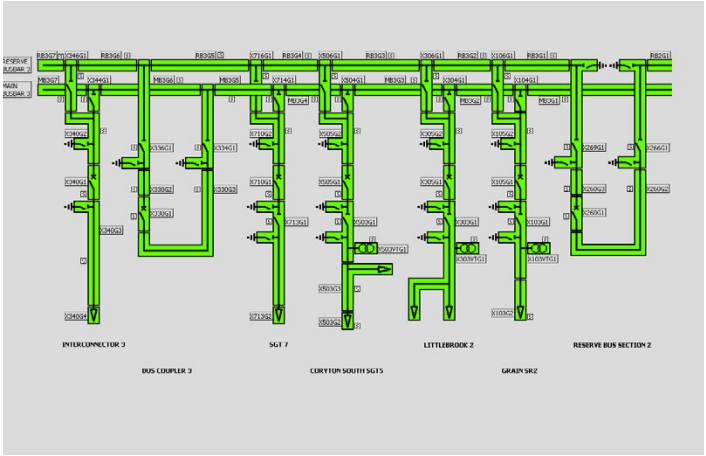
BWatch condition monitoring

BWatch is our solution for GIS digital condition monitoring. It uses the latest generation of EMC resistant digital gas sensors to continuously measure gas pressure and temperatures to track changes in density. It also helps reduce gas emissions down to 0.1% per year. It provides this information remotely and forecasts refilling needs prior to reaching threshold levels that will impact GIS operation.

Main Functions:

- Gas density monitoring and anticipation
- Gas temperature monitoring and alarms management
- Circuit-breaker and disconnector monitoring
- Internal arc fault location
- Data analysis for optimized asset management

40,000 compartments are monitored with BWatch.



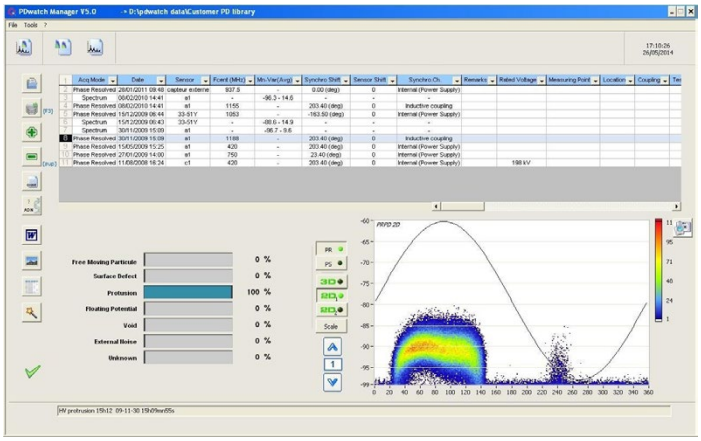
HMI supervision

Partial Discharge Monitoring - PDWatch

When partial discharges occur, they generate electromagnetic waves that propagate throughout the switchgear. Grid Solutions' PDWatch monitors these waves in the pressurized gas. It can be installed on F35-GIS and it monitors partial discharges via expert analysis of Ultra High Frequency (UHF) signals during commissioning, operation and maintenance.

Accuracy of data is secured thanks to band scanning, external noise discrimination, factory and site calibration of the system. The self-healing optical communication provides high reliability. Data interpretation is made easy for operating teams with a user-friendly HMI and expert tool.

Grid Solutions has vast field experience, with 1,600 GIS bays equipped to date.



Time domain acquisition for pattern recognition with «PDWatch manager»

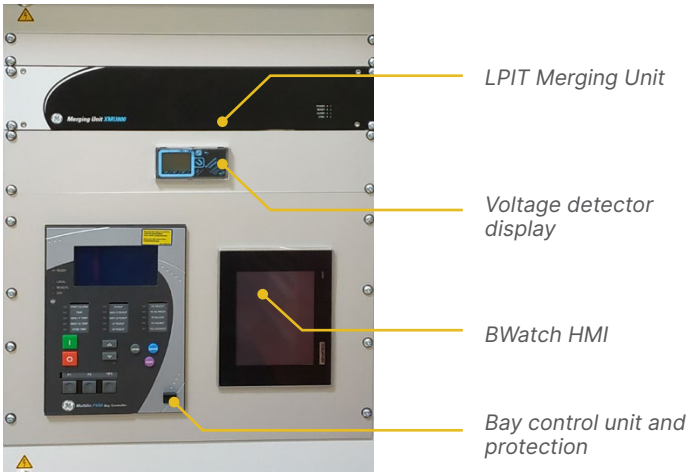
Local Control Cubicle

A full set of possibilities are available for F35's local control cubicle:

- Embedded or standalone
- Conventional or digital or a mix of both technologies

The advantages of digital control cubicle are numerous:

- Reduced cabling
- Compact cubicle
- Late specification of requirements possible
- Bay Control Unit (BCU) offers flexible configuration capabilities, advanced communication and functionality
- Significant savings in installation costs
- Centralized maintenance



Digital Local Control Cubicle

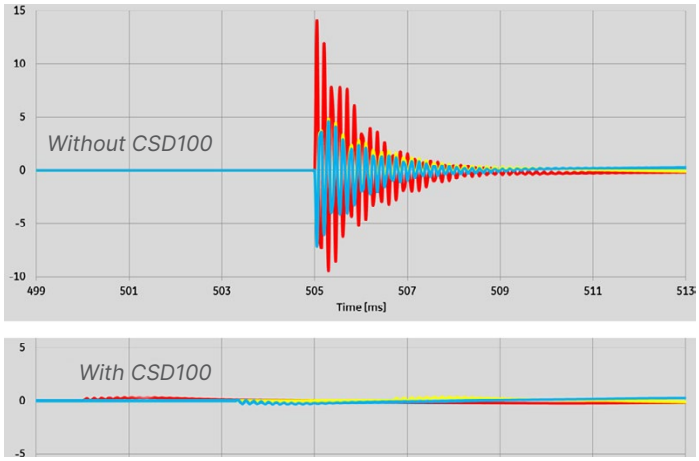
Controlled Switching - CSD100

F35 can be equipped with digital controlled switching combined with a single-pole operated circuit breaker.Optimizing the closing and opening of a circuit breaker is of the utmost importance because random switching can result in high transient overvoltages and/or high inrush currents.

These transients generate stresses on the substation and network equipment, leading to accelerated aging - or the worst case scenario - flashover of the HV apparatus.

APPLICATION	TARGET
Transmission lines	Reduce overvoltages (switching-on) Eliminate current zero missing
Power transformers	Eliminate inrush current (switching-on)
Shunt reactors	Eliminate current re-ignition (switching-off)
Capacitor banks	Eliminate inrush current (switching-on)

3,000 circuit-breakers are controlled with CSD100, GE Vernova's controlled switching solution.



Inrush current limitation for shunt capacitor banks

	CONVENTIONAL SF_6 BAY	CONVENTIONAL g^3 BAY	FULLY DIGITAL SF_6 BAY	DIGITAL AND GREEN BAY
Gas				
SF_6	●		●	
g^3		●		●
Voltage and Current Measurement				
Conventional Voltage and Current Transformers	●	●		
Digital current Transformer (LPIT)			○	○
Digital voltage Transformer (LPIT)			○	○
Combined digital current and voltage transformer (LPIT)			●	●
Billing conventional CT associated with LPIT			○	○
Local control cubicle				
Conventional interlock	●	●		
Digital interlock with Bay Control Unit			●	●
Monitoring and Asset Management				
Conventional density switch	●	●		
BWatch digital condition monitoring			●	●
PDWatch online			●	●
PDWatch portable			○	○
Control				
Three-pole operated circuit-breaker	●	●	●	●
Single-pole operated circuit-breaker	○	○	○	○
RPH controlled switching device	○	○	○	○
Additional functions				
Voltage detection on feeder when used of combined CT / VT	○	○	●	●
Surge arrester	○	○	○	○
Voltage Transformer Disconnecting linksw	○	○	○	○
Bay Dimensions				
Width x Depth x Height (mm)		800 × 3,700 × 2,500		

● Standard offering
○ Optional

Technical Specifications

GENERAL RATINGS		
Insulating and switching gas	g^3	SF_6
Reference electrotechnical standards	IEC	IEC/IEEE
Rated voltage	145 kV	145 kV
Withstand voltages		
- Short-duration power-frequency, phase-to-earth / across isolating distance	275 / 315 kV	275 / 315 kV
- Lightning impulse, phase-to-earth / across isolating distance	650 / 750 kVp	650 / 750 kVp
Frequency	50 Hz	50 / 60 Hz
Continuous current	up to 3150 A	up to 3,150 A
Short-time withstand current	40 kA	40 kA
Peak withstand current	108 kAp	108 kAp
Duration of short-circuit	3 s	3 s
Installation	indoor/outdoor	indoor/outdoor

CIRCUIT-BREAKER RATINGS		
First-pole-to-clear factor	1.5 / 1.3	1.5 / 1.3
Short-circuit breaking current	40 kA	40 kA
Short-circuit making current	108 kAp	100 / 108
Operating sequence	O - 0.3 s - CO - 3 min - CO / CO - 15 s - CO	O - 0.3 s - CO - 3 min - CO / CO - 15 s - CO
Drive type (three-phase)	pure-spring	pure-spring
Mechanical endurance	class M2	class M2
Capacitive switching	class C2	class C2

DISCONNECTOR AND LOW-SPEED EARTHING SWITCH		
Capacitive current switching	0.1 A	0.1 A
Bus-transfer current switching capability	2520 A / V	2520 A / V
Mechanical endurance	class M2	class M2

MAKE-PROOF EARTHING SWITCH		
Making current capability	108 kAp	108 kAp
Switching capability - electromagnetic coupling	80 A / 2 kV	80 A / 2 kV
Switching capability - electrostatic coupling	2 A / 6 kV	2 A / 6 kV
Mechanical endurance	class M1	class M1

Gas Data*

The functioning of this equipment relies upon SF_6 or a gas mixture based on CO_2/O_2 and 5% of an additive, C_4F_7N (also known as C4-FN or Iso-C_3F_7CN), a fluorinated greenhouse gas, which helps preserve dimensions and performance equivalent to those of SF_6 equipment while reducing the gas carbon footprint.

	SF_6	g^3	
		C_4F_7N additive**	g^3 gas mixture
Average mass of gas/mixture in the equipment (kg)*	63.2	7.53	32.4
GWP_{100} of gas/mixture (CO_2-equivalent)	24,300	2,750	560
CO_2-eq of gas/mixture in the equipment ($t_{co2\text{-}eq}$) *	1536	20.7	20.7

* For information purposes only considering a typical GIS arrangement (double busbar cable bay). It varies depending on the equipment considered.
** This component's physical properties are essential to g^3.

For more information, visit
gevernova.com/grid-solutions

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