SIEMENS


# THYRIPOL – reliable, efficient, flexible

Static excitation system for increased availability and dynamic performance

siemens.com/thyripol

# THYRIPOL excitation systems
## Reliable, efficient, flexible

**The world runs on energy! Today's energy market is fast moving, diverse and complex! And all over the world, we are facing the same core challenges: efficient use of resources, economic efficiency, climate protection and reliable power generation!**

**Siemens is providing the products and solutions to address these core challenges in every energy market around the world! Whatever the challenge or whatever the requirements – Siemens can provide the answers.**
**With our products, solutions and expertise, we are creating a future with affordable, clean and reliable energy for everybody! Enabled by Siemens and you!**

The energy demand around the world is on the rise as a result of population growth and the increasing standard of living. With the objective of reducing the usage of limited resources and environmental stress, the percentage of renewable energies is increasing at an overproportional rate. This results in high demands for reliability, ruggedness and flexibility of power stations to insure a fast supply of energy, which impacts the generator excitation system as one of the core components when it comes to power generation.

THYRIPOL static excitation systems from Siemens have been consequentially developed for continuous duty in power stations. They have clearly demonstrated their high reliability and ruggedness in operation for over 40 years. Siemens has incorporated its many years of experience as developer, manufacturer and operator of power stations in the development of innovative excitation systems. The modular design as well as the use of the well-proven industrial components play a significant role in achieving the outstanding reliability and reducing maintenance costs.

With THYRIPOL, Siemens is offering the optimum excitation system for gas, steam and hydroelectric power stations.

**Advantages**

- 19" LCD touchscreen with simple and intuitive user navigation
- Device-specific parameter list
- Customized parameter lists for fault diagnostics and maintenance
- Differentiated authorization levels for operation, maintenance and commissioning
- Modular design for simple component replacement
- Data logger and online trace to register and track important system events
- System can be remotely diagnosed

Gas and steam turbine power station Irsching Block 4, Germany:
561 MW, THYRIPOL static excitation system from Siemens

Hydroelectric power station Tucurui, Brazil: 23 x 390 MVA,
11 THYRIPOL static excitation system from Siemens

**Benefits**

- Increased flexibility when engineering systems to address specific requirements
- Shorter commissioning times based on system-specific preconfiguration in the factory
- Shorter maintenance times
- Increased level of process reliability
- Shorter service times
- Safety management system for fault messages and monitoring
- Higher availability and shorter service times

Gas and steam turbine power station Bugok, South Korea:
2 x 205 MVA, 1 x 207 MVA,
3 THYRIPOL static excitation systems from Siemens

# The modular design
## Individual – just like your requirements

**The type range of THYRIPOL has a modular structure which makes it possible to be individually adapted to address the widest range of requirements. This allows the integration of individual components in an existing plant or a complete system in a true "plug & play" fashion.**

THYRIPOL excitation systems stand out as a result of their compact design and facilitate space-saving solutions with their high power density.

This means that when it comes to modernization projects, THYRIPOL excitation systems can be installed in the same footprint as previous systems.

THYRIPOL excitation systems offer a variety of electrical and mechanical features that can be selected via options to adapt to your plant configuration.

| Type range, continuous excitation current | | | Symbolic representation (front view) |
|---|---|---|---|
| without redundancy | with N-1 redundancy | with N-2 redundancy | Open-loop / closed-loop control cabinet, Converter cabinet, Connection cabinet |
| up to 2,200 A | up to 2,200 A | – | 600 600 600 — Width 1,800 mm |
| up to 4,500 A | up to 2,400 A | – | 600 600 900 — Width 2,100 mm |
| up to 5,100 A | up to 5,100 A | up to 4,500 A | 600 600 900 600 — Width 2,700 mm |
| up to 6,800 A | up to 6,800 A | – | 600 600 900 900 600 — Width 3,600 mm |
| – | up to 6,800 A | up to 6,800 A | 600 600 900 900 600 600 — Width 4,200 mm |
| up to 7,700 A | – | – | 600 600 900 900 900 600 — Width 4,500 mm |
| – | up to 7,700 A | – | 600 600 900 900 900 600 600 — Width 5,100 mm |

Static excitation system: Rated supply voltage up to 950 V
Depth = 1,120 mm, max. height = 2,520 mm

# The inner values
## That's what really matters

| | |
|---|---|
| **Type** | Modular, sealed cabinet systems |
| **Converter module type** | SINAMICS DCM |
| **Redundancy** | • Open-loop and closed-loop control<br>• Converter module<br>• Converter fan<br>• Power supply |
| **Power range** | Static excitation system:<br>• Continuous excitation current: 1,375 to 7,700 A<br>• Rated supply voltage: 575 to 950 VAC |
| **Application areas** | • Steam turbine power plants<br>• Gas turbine power plants<br>• Hydroelectric plants<br>• Phase shifters |
| **Voltage controller** | • According to IEEE421.5 model ST6B, including limiters<br>• Power system stabilizer<br>• Reactive power control<br>• Power factor control |
| **Additional features** | • Maintenance during operation<br>• Current balancing control of parallel power converters (patent pending)<br>• Ambient temperature: 0 to 50 °C<br>• Degrees of protection: IP32 to IP43<br>• Noise in operation: 72 dBA / 50 Hz, 75 dBA / 60 Hz |
| **Operation, open-loop and closed-loop control** | • Closed-loop control dynamic response: rise time < 10 ms<br>• Generator voltage and current actual value sensing: 50 µs / 16 Bit<br>• Eight analog outputs, adjustable via parameters<br>• Siemens platform concepts are used: SINAMICS, SIMATIC<br>• Remote diagnostics |

**User interface**

- Based on SIMATIC Panel PC
- User-friendly local display and HMI device for the excitation system and starting frequency converter
- Access levels for operation, maintenance, commissioning
- Trend recording
- Graphically supported diagnostics

**Power unit**

- Based on SINAMICS DCM
- Can be easily replaced while the system is in operation

**Optional auxiliary cabinet**

Shown here:

- Black start

Other examples:

- Matching transformer for a second supply
- Test excitation
- Field flashing
- AC overvoltage protection

**AC input connection cabinet**

- Circuit breaker on the input side
- Connection cabinet for connecting all power cables from the excitation transformer

**Sensors**

- Actual value sensing of field variables and associated processing

**De-excitation system**

- The energy in the excitation winding is dissipated using an ohmic de-excitation resistor
- DC overvoltage protection (SICROWBAR)

**Open-loop / closed-loop control cabinet**

- SINAMICS DCM Control Modules
- SIMATIC S7
- Generator actual value sensing
- Power supply units for the electronics

**Converter fan**

- Redundant fan
- Can be easily replaced while the system is in operation

# Ready and compatible on all sides
# The philosophy behind THYRIPOL

**The philosophy behind THYRIPOL is just as simple as it is convincing: A smart combination of standard components that have an extremely high reliability and have been tried and tested thousands of times is better than a specialized product.**

## An overview of your advantages:

**Short delivery time**

Generally, an individually configured THYRIPOL excitation system can be installed in your plant in just a few months.

**Flexible configuration**

The wide range of options makes it possible to easily adapt a standard product to address specific customer requirements.

**User-friendly operation**

The 19 inch HMI device has access levels for operation, maintenance and commissioning. The user interface is consistently standardized for all system functions, and can be intuitively used after a brief introduction. Trend recording, graphically supported diagnostics and the transparent menu structure simplify monitoring of operation and internal system components.

**Short commissioning times**

Commissioning time and costs are reduced by using a device-specific parameter list and by being able to display all important system variables on the SIMATIC panel PC.

**High operational reliability**

A multitude of limitation functions guarantee safe and reliable operation of the generator within the limits of its power characteristics. The comprehensive monitoring and diagnostic functions can be used locally or remotely from the plant control system.

**Compact footprint**

The compact and modular design represents an enormous advantage, especially for retrofit projects.

**Closed-loop current symmetrizing control**

The closed-loop current symmetrizing control integrated as standard guarantees that the power units are efficiently utilized.

**Integrated power system stabilizer (PSS)**

The power system stabilizer reduces oscillations in the generator active power output, taking into consideration IEEE421.5 type PSS2B or PSS3B.

**Efficient product lifecycle management**

Siemens guarantees the availability of support and spare parts for the complete product lifecycle and 10 years beyond this. The time and costs associated with repairs and upgrades can be kept to a minimum by using standard Siemens components.

**Traceability**

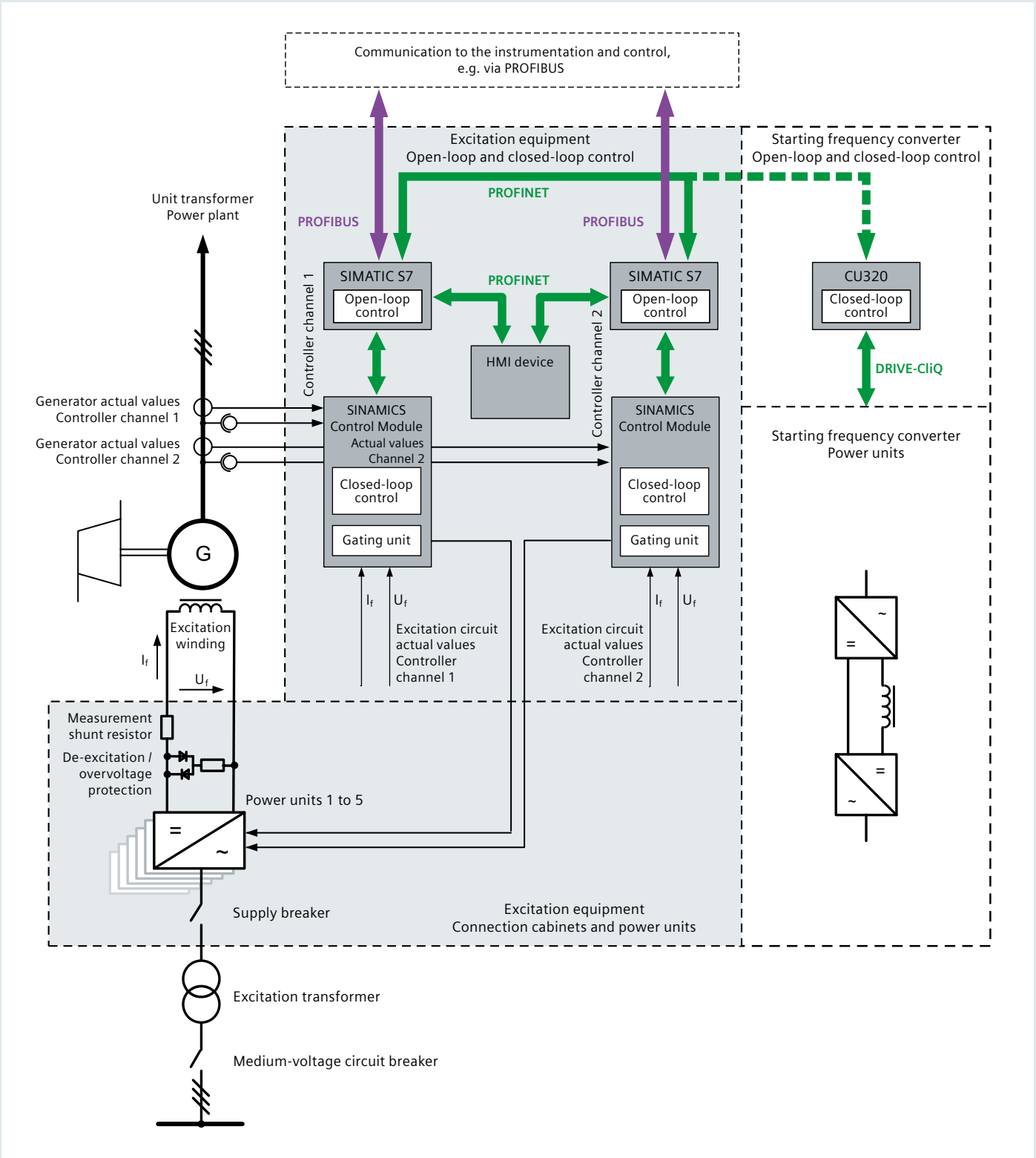
Every operator action and change to the configuration or parameters are logged in the system.

**Integrated data logger in the user interface**

The data logger is continually active and records values and status in the background. Data is stored in a 10 ms cycle in form of a ring memory. When a fault occurs, after the post-trigger time has expired, the complete content of the ring memory is archived on the operator panel.

**Industrial communication protocols**

Communication with the plant control system is either established via PROFIBUS DP, PROFINET / Ethernet, Modbus or a hardwired connection. The standard Siemens products used stand out as a result of their high performance and excellent reliability.




THYRIPOL architecture – block diagram

# The redundancy concept
## For high reliability and availability

**The system availability can be significantly increased by redundant use of components. While operating the plant, unscheduled outages can be avoided as key components can be easily replaced.**

The redundancy configurations that can be combined on a component level basis cover the highest requirements regarding operational reliability and availability.

The following components can also be easily replaced while the system is operational.

### Converter module

The number of power converters is determined by the generator excitation requirements and the desired redundancy.

### Two-channel design

- Open-loop and closed-loop control
- Gating unit
- Actual value sensing
- Power supply

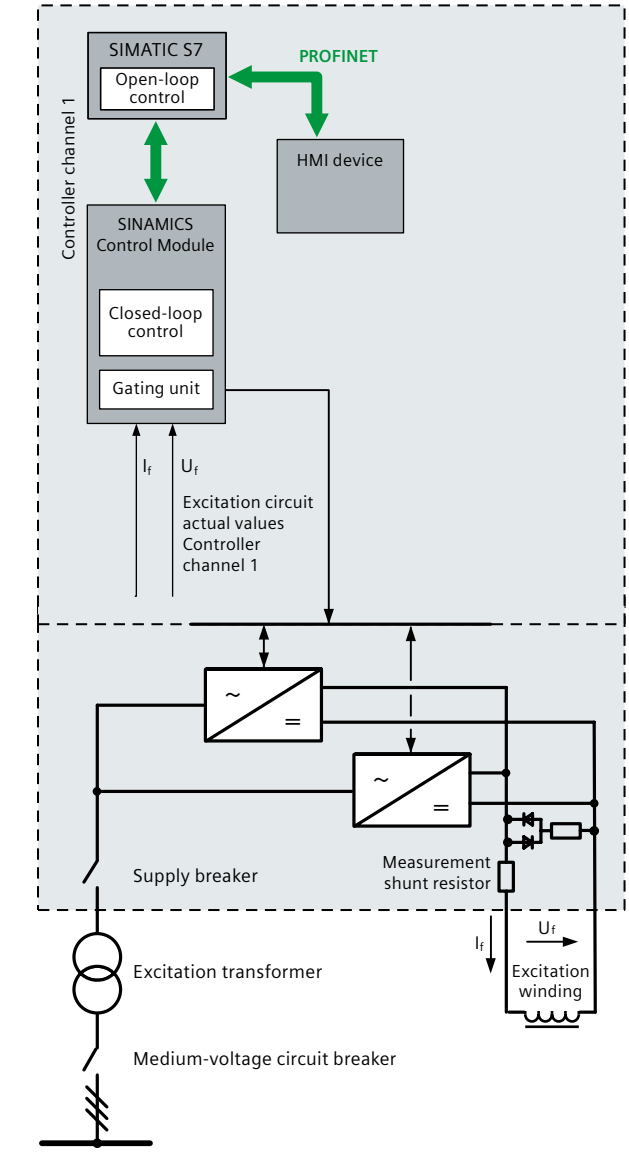
### Converter fan

- Two fans per converter module

Replacing the converter module while the system is operational

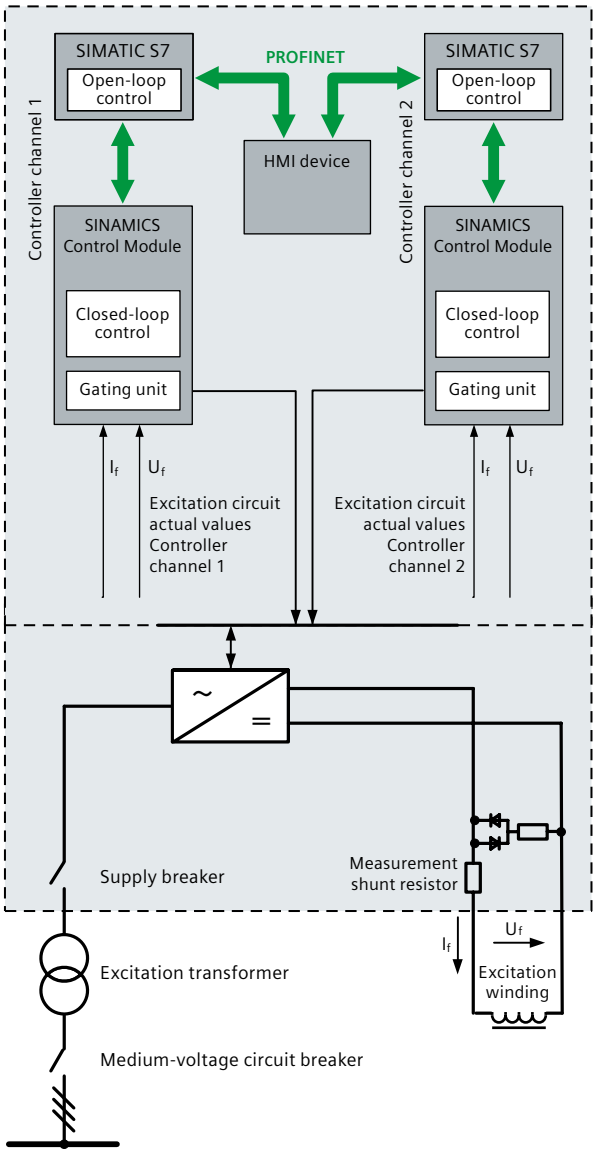
Replacing one of the two converter fans while the system is operational

**Examples of possible configurations to achieve redundancy**

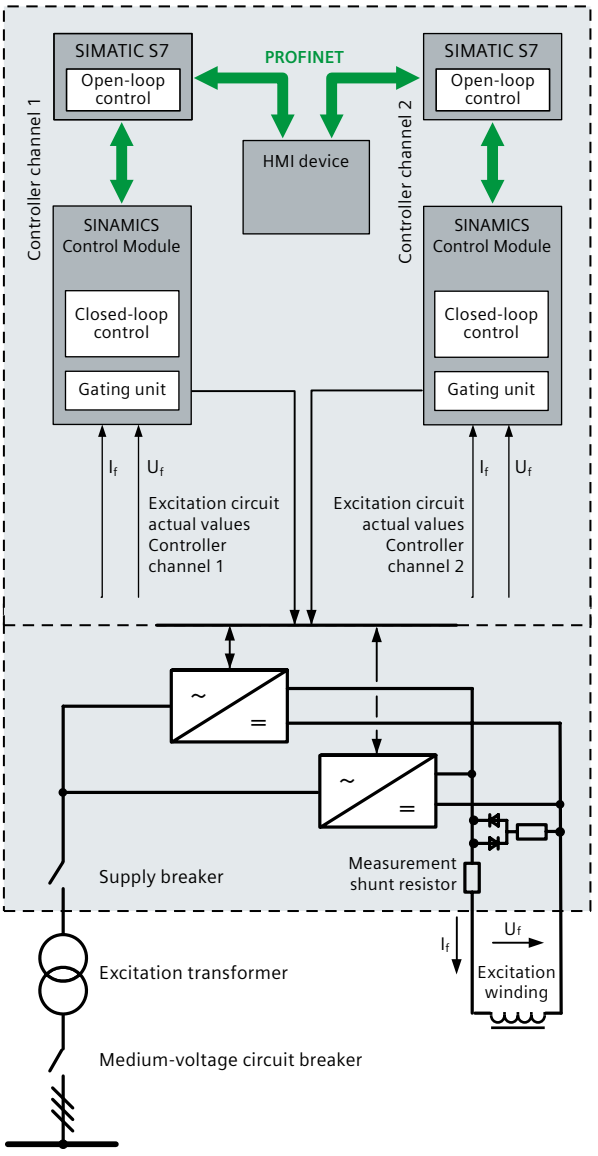



Single-channel open-loop and closed-loop control with redundant converter module

| Advantages | Benefits |
| --- | --- |
| Individual redundant configuration | Higher degree of flexibility when configuring the system |
| Maintenance activities while the system is operational | Increased process reliability and system availability |
| Simple component replacement | Short maintenance times and low service costs |




Two-channel open-loop and closed-loop control with one converter module

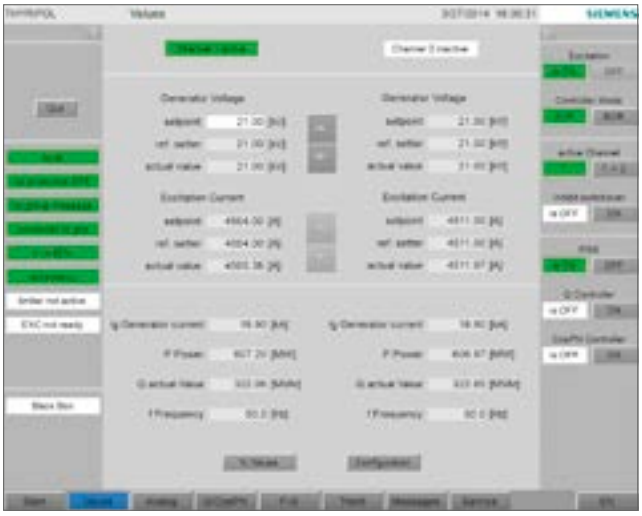



Two-channel open-loop and closed-loop control with redundant converter module

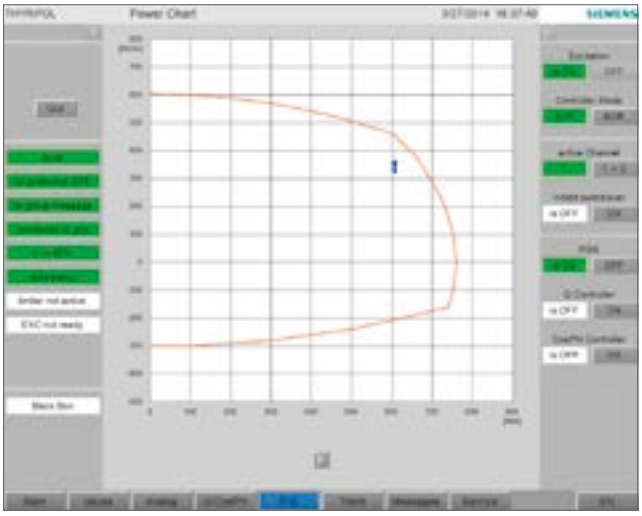
# Operating control
## User-friendly transparency

**The intuitive user interface runs on a SIMATIC panel PC to visualize, operate and commission THYRIPOL excitation systems.**

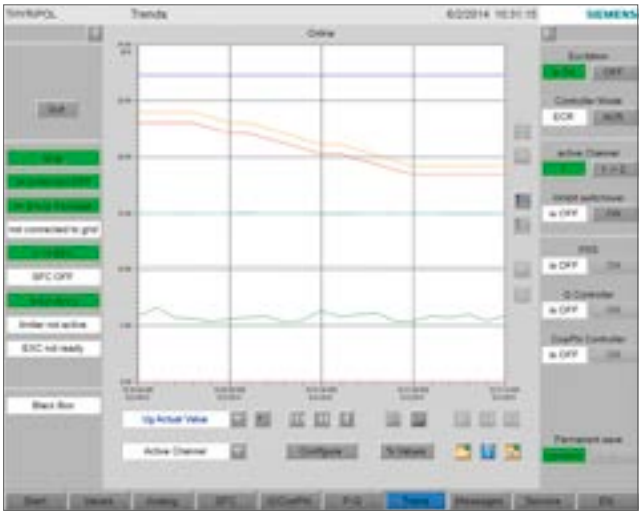
**Using the HMI device, all of the necessary components of the static excitation system can be accessed via the parameter system. This means that THYRIPOL systems can be parameterized to address specific requirements.**



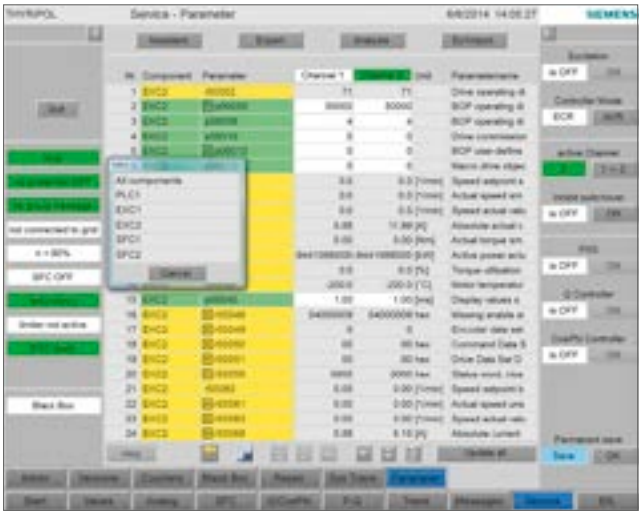
Setpoint input in local operation and display of the status of both channels



Display of the operating point in the generator capability curve



Trend recording



Parameter list

### Operating modes

- Generator voltage control (AUTOMATIC mode)
- Excitation current control (MANUAL mode)
- Power factor control
- Reactive power control
- Reactive power sharing between several generators in a power plant

### Automatic operation – voltage controller operation

- Setpoint control
- Underexcitation limiting
- Overexcitation limiting
- Surge excitation limiting
- Stator current limiting
- U/f limiting
- Reactive droop compensation
- Power system stabilizer function

### Protection and monitoring functions

The THYRIPOL excitation system is equipped with comprehensive protection and monitoring functions for the internal components.

- Converter protection using monitoring systems:
  - Fuse monitoring and / or current monitoring
  - Line monitoring – undervoltage, phase failure and frequency
  - Power supply voltage monitoring
  - Circuit breaker monitoring
  - Fan monitoring
  - Semiconductor failure
- Failure of the open-loop or closed-loop control components
- Internal hardware monitoring functions
- Overvoltage protection in the field circuit (crowbar)

# The compact unit
# Everything in just one cabinet system

**A starting frequency converter can be integrated in the static excitation system to create a compact unit for use in gas-powered power plants. This means that Siemens can supply a complete cabinet system as a space-optimized solution for gas turbine applications.**

Starting frequency converters are used to accelerate the turbine of a turbo set to the required ignition speed – or to drive it at certain speeds. While the starting frequency converter operates the generator in the motoring mode, the excitation equipment regulates the generator terminal voltage to adapt it to the output voltage of the starting frequency converter.

Starting frequency converters as part of THYRIPOL compact systems are based on rugged, air-cooled LCI medium-voltage converters with DC link reactor from the Siemens SINAMICS GL150 product series. The starting frequency converter power rating is selected depending on the turbine type.

The open-loop control and monitoring unit of the starting frequency converter is integrated in the open-loop and closed-loop control cabinet of the excitation system. The starting frequency converter is controlled exclusively from the excitation system.

### Cross starting with compact unit

Using this function, the starting frequency converter of the compact system is able to start up adjacent turbo generator units in conjunction with the corresponding excitation system.

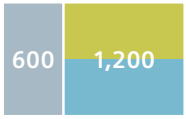
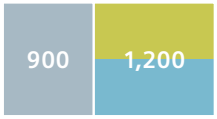
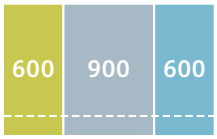
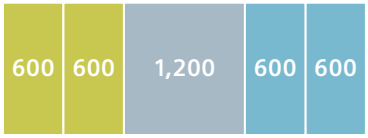
### Black start

Using the black start function, the compact unit can be started using an auxiliary supply and a second power supply, for example from a diesel generator.

### Cooldown and emergency turning, washing and purging

Using the starting frequency converter, additional special operating modes can also be implemented. For example, where the gas turbine is operated at certain speeds and with certain load cycles.

Starting frequency converter

| Type range, starting power | | Symbolic representation (top view) | |
|---|---|---|---|
| Horizontal stack | Vertical stack | Line-side converter / Reactor cabinet / Machine-side converter | |
| up to 1.9 MW 1) | – |   | Width 1,800 mm / Depth 1,120 mm |
| up to 5 MW | – |   | Width 2,100 mm / Depth 1,120 mm |
| – | up to 6 MW |   | Width 2,100 mm / Depth 1,120 mm or 1,320 mm |
| – | up to 7.5 MW |   | Width 3,000 mm / Depth 1,320 mm |
| – | up to 9 MW |   | Width 3,600 mm / Depth 1,320 mm |

1) On request

Height = 2,680 mm

## Static excitation system

## Additional information:

**www.siemens.com/thyripol**

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