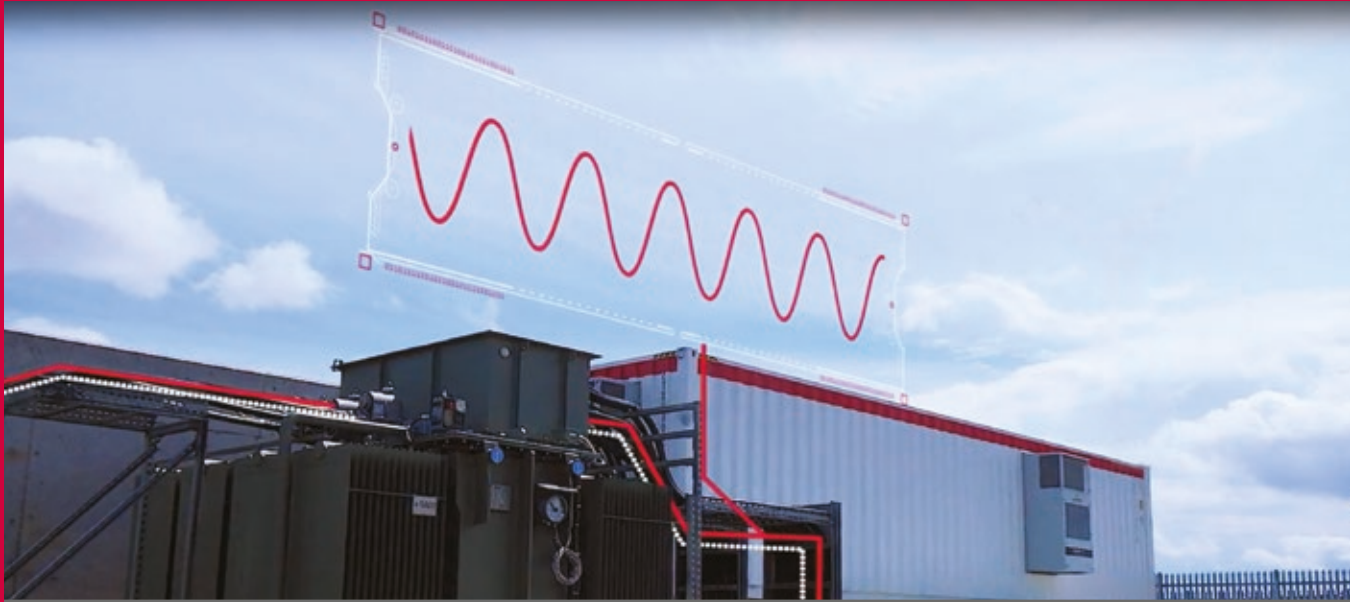


INGEGRID STATCOM



Static Synchronous Compensator

up to 100 MVAR

Ingeteam

Static Synchronous Compensator

water & air cooled

INGEGRID™ STATCOM

The most reliable and versatile solution for reactive power control and power quality improvement

INGEGRID™ STATCOM converters are designed for applications where reactive power control is needed to meet the requirements of national grid codes or where voltage must be regulated to improve the stability of the power grid.

These requirements are increasingly important safeguarding the reliability and availability of weak industrial plant grids and also for maximising the power transmission capacity of the existing transmission and distribution lines.

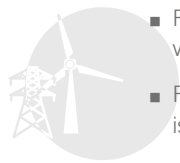
INGEGRID™ STATCOM converters are a key element safeguarding the reliability and availability of weak industrial plant grids; they minimise the impact of large consumption in localized areas that, in some cases, could be far from the main power generation plants.

In addition to reactive power control, INGEGRID™ STATCOM converters are also used for advanced grid control functions aimed at improving power quality. In that sense, compensation of voltage unbalances and active harmonic filtering are among the most relevant control functions with a common and successful implementation in real applications.

Based on a modular design, INGEGRID™ STATCOM converters are available in a wide range of both power and voltage, adapted to the standards of each country or adapted to the requirements of the application, thanks to the flexibility of the power converters integrated in the solution.

Common installation cases

In power generation and transmission



- For compliance with the grid codes of each country thanks to dynamic control of grid voltage and power factor, which are provided at the common connection point (PCC).
- For transmission and distribution grids where the reduction of voltage unbalances is required.

In mining and industry



- For grid stabilisation and harmonic elimination in plants with electric arc furnaces (EAF).
- In mining and cement plants: where there are high-consumption applications such as grinding mills, mine elevators, ventilation and pumping systems, the dynamic reactive power compensation stabilises the grid during the start-up and shutdown of large motors, thus improving plant reliability.





User benefits



Compliance with grid **connection codes** for solar and wind farms



Reduced system **losses** and **increased productivity**



Fast **return** on **investment**



Reduced maintenance **costs** and **longer plant life**



Increasing the **capacity** of the energy transmission and distribution grid

Static Synchronous Compensator

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How does a STATCOM work?

A STATCOM is a grid-connected device based on a voltage-source converter (VSC) that is capable of sinking or sourcing reactive power, thus allowing a constant control of the grid in the system.

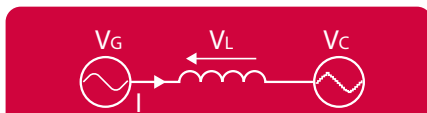
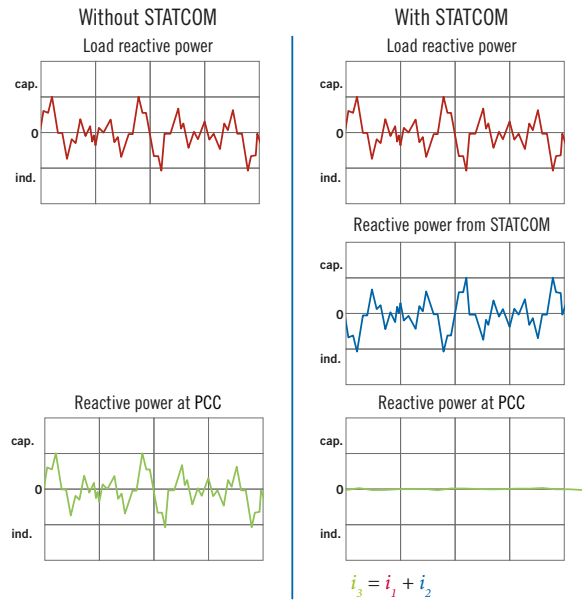
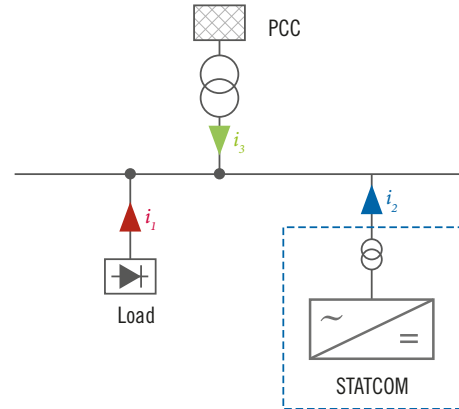
INGEGRID™ STATCOM converters are designed to provide instantaneous reactive power in case grid stabilisation is necessary, or to absorb the excess reactive power from the grid in order to ensure its stability.

The use of INGEGRID™ STATCOM converters can be combined with fixed capacitor banks and reactors, thus joining their advantages in order to increase the capacity of the system.

VSC-based STATCOM converters feature IGBT semiconductors in a 3-level NPC topology for MV Converters and in 2-level topology for LV converters.

Furthermore, the DC link features long-life polypropylene capacitors.

The above mentioned topologies use advanced modulation techniques to synthesise any type of current waveform to the STATCOM output, using the fast switching speed of the IGBTs controlled by the CCU (Converter Control Unit).



| Mode | Waveform / Phasor | Description |
|---------------------------|-------------------|---|
| Capacitive operation mode | | In this operation mode, the STATCOM performs as a capacitor whose capacitive reactance is variable. |
| Inductive operation mode | | In this operation mode, the STATCOM performs as an inductor whose inductive reactance is variable. |

V_G Grid voltage **V_C** STATCOM voltage **V_L** Impedance voltage

Why Ingeteam?

flexible + customized

One of Ingeteam's cornerstones and hallmarks by which our clients recognise us is our flexibility and ability to customise our products, services and solutions which, together with the high standards of quality in our products, make INGEGRID a leading reference in the major sectors where we are present.

Flexibility: Adapting ourselves to design requirements, adapting our products to specific applications, offering flexible service and support whenever and wherever our clients need it.

Customization, taking the main element of any INGEGRID™ equipment which is the BPM (Basic Power Module) or power module. Ingeteam's design and engineering department adapts the final product to comply with each client's specific requirements, without compromising reliability or robustness and increasing usability and optimisation for each application. We not only manufacture devices but also adapt them to offer the best solution in a wide range of sectors including the metals sector, industry, mining, and oil & gas. Perhaps this is why over 90% of our clients rate us as being flexible and as providing highly-customizable solutions. These two cornerstones are complemented with demanding quality standards which all of our products are subjected to, allowing Ingeteam to offer:



More than 45 years' experience in power converters

Over 45 years' experience in power electronics for applications in a wide range of sectors including energy generation, industry, mining and the marine sector have created an extensive, solid knowledge base. This enables our design and engineering department to advise our clients on the best option and adapt equipment and software to each particular application, thus offering custom-made solutions.



Load tests of all equipment at rated current

With the aim of including the latest advances in power electronics in INGEGRID™ equipment, Ingeteam boasts the largest power electronics laboratory in southern Europe and one of the biggest in the world. The testing and validating facilities cover a surface area of 13.000 m² with a capacity for testing equipment over 40MVA and with voltages up to 6.6 kV and a team of international engineers and researchers.

Hence, Ingeteam offers combined or specific tests, besides the routine tests carried out on all INGEGRID™ equipment.



Manufactured 100% in Europe

Ingeteam designs and manufactures the entire INGEGRID™ range in its logistics and manufacturing centres in Europe. Ingeteam always works with mainly European leading brands and directly controls the entire manufacturing process to thus ensure the final quality of its products.

Hence, the flexibility, development capacity, customisation and quality of our products are key points which make our clients consider us as technological partners..

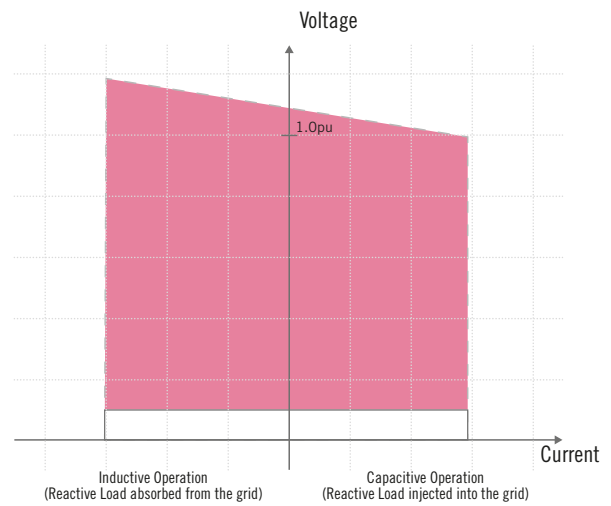
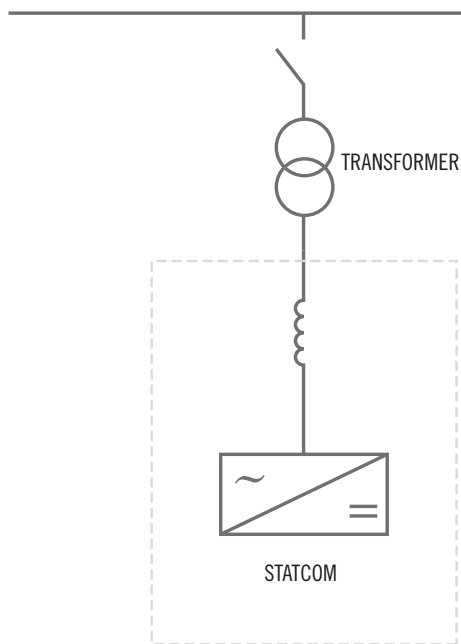
Static Synchronous Compensator

water & air cooled

Applications and topologies

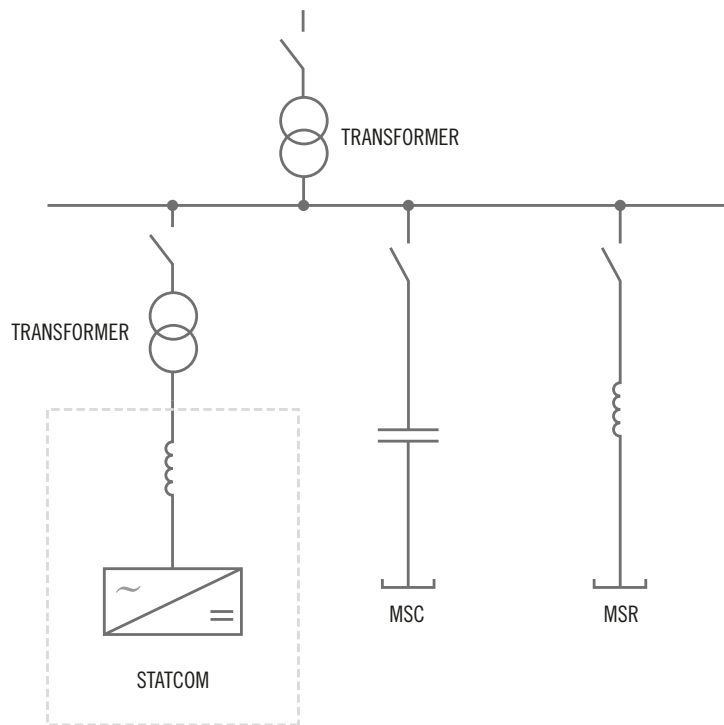
STATCOM compact solutions

Compact STATCOM solutions are composed only of the power electronics converter INGEGRID™ STATCOM, which will operate either by sinking or sourcing reactive power from the grid. In addition to controlling the flow of reactive power exchanged with the grid, said solution — with no need for additional components — is capable of providing the advanced control functionalities described in this catalogue.



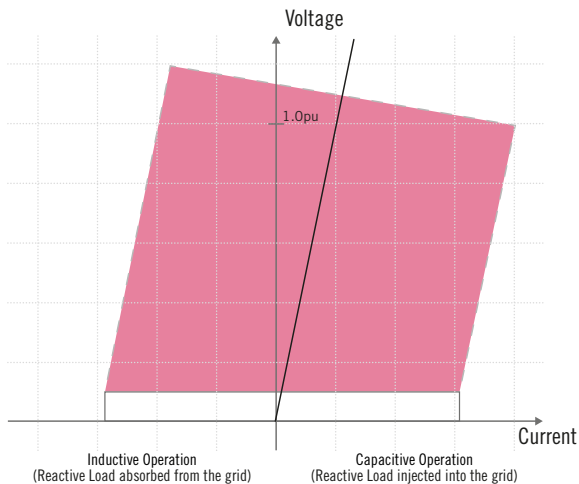
STATCOM hybrid solutions

STATCOM hybrid solutions, in addition to the power converter INGEGRID™ STATCOM, include capacitor and/or reactor banks, which allow the reactive power range provided by the solution to be increased. This type of solutions is common in applications where the need for reactive power compensation presents a tendency towards capacitive (use of capacitors) or inductive (use of reactors) values. The dynamic variations of reactive power are controlled by the power electronics converter.



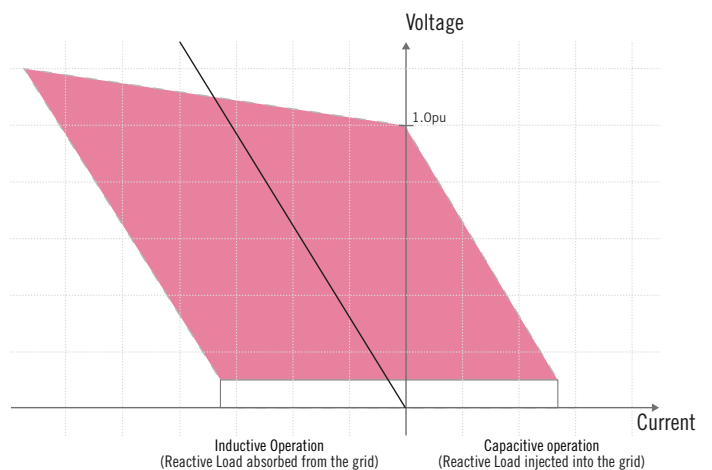
MSC

Hybrid STATCOM + Fixed Capacitor bank Solution



MSR

Hybrid STATCOM + Fixed Inductance bank Solution



MSC Mechanically switched capacitors MSR Mechanically switched reactors

Static Synchronous Compensator

water & air cooled

INGEGRID™ STATCOM

Air cooled | 3 Level NPC - HV-IGBTs

Control Cabinet and fans

Cooling System

- High efficient design.
- Redundant variable speed fans (optional).
- Low noise level.
- Air input filters.

High quality enclosure

- Full front access.
- Protection degree from IP21 to IP42.

Converter Control Unit

- Powerful CPU for regulation & control with an integrated PLC logic.
- Remote diagnostics, monitoring and control via Web Application without an extra software.
- Extra accessible cabinet for Control Components.
- Modular and scalable Control Topology.
- Robust and certified control design.

Extra features included as Standard

- Insulation monitoring system.
- UPS system and galvanic isolation with external cabling to ensure maximum control operability.



Input Cabinet

Grid user friendly

- Standard input filter included.

Accessible input cabinet

- For control and power cabling.
- Top and bottom cabling

Connections

- Separated control cabling, power cabling, PE (Protection Earth) and PG (Power Ground).

Safety

- Door Interlock System.
- Ground Switch and keys sequence for full security, including control interlock.



Power Cabinet

3-Level Voltage Source Inverter using HV-IGBT power semiconductors.

Human Machine Interface (HMI) on door

- Powerful and easy to use interface.
- Remote and local control available.

Basic Power Modules

- Based on 4.5 kV HV-IGBTs.
- Easy access, maintenance and replacement.
- Fiber optic control cable.

Power Management Module

- integration in the Power Cabinet, isolated from basic control electronics via Fiber Optic.

Key and control Interlocked earthing switch Compact & Modular

Pre-charge Module

Emergency Pushbutton



Static Synchronous Compensator

water & air cooled

INGEGRID™ STATCOM

Water cooled | 3 Level NPC - HV-IGBTs

Control cabinets

Touch screen for local control [HMI]

- Powerful, user-friendly interface.
- Remote and local accessible control.

Control Unit

- Powerful CPU for regulation and control, with a built-in PLC for basic control logic.
- Remote diagnostics, monitoring and control via a web application without the need to install any additional software.
- Easily accessible cabinet and main components.
- Modular and scalable control topology.
- Robust and certified control design.



Cooling cabinet

Cooling outlet

- Highly-efficient design.
- Redundant cooling pumps.
- Internal air / water exchanges. Virtually no losses to the surrounding air.

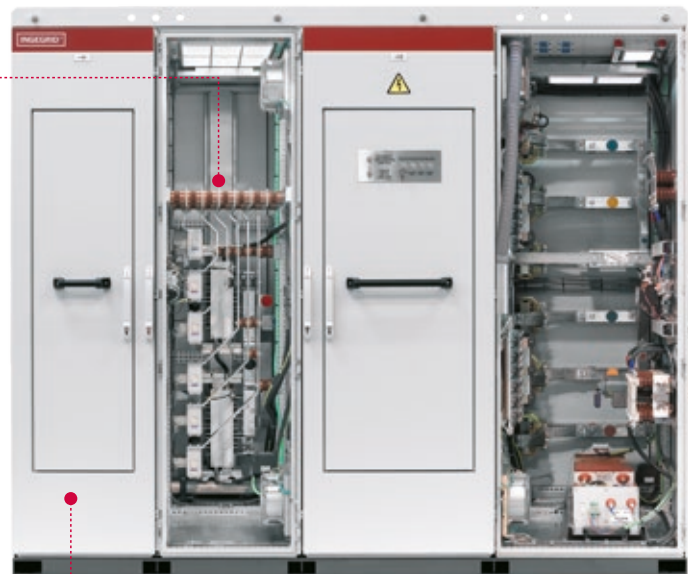
Safety

- Grounding switch, key interlocks, and door locks included for maximum safety.
- Emergency stop button.

Input cabinet

Input cabinet

- Easily-accessible cabinets for control and power cabling.
- Available with top and/or bottom cable access.



High-quality enclosure

- Front access for all user and maintenance actions.
- Protection level from IP42 to IP54.



Power cabinet

AFE inverter with 3L-NPC topology based on HV-IGBT semiconductors Basic power modules [BPM]

- Based on HV-IGBTs.
- Easy access, maintenance and exchange.
- Arc flash detection [optional].

Power control module

- Integration in the Power Cabinet, isolated from basic control electronics via Fiber Optic.

Internal Air/Water Exchangers

- It mimizes the need for Air Conditioner in the electric rooms due to the reduced heat loss.

Key and control Interlocked earthing switch Compact & Modular

Pre-charge Module

Emergency Pushbutton

Static Synchronous Compensator

water & air cooled

INGEGRID™ STATCOM

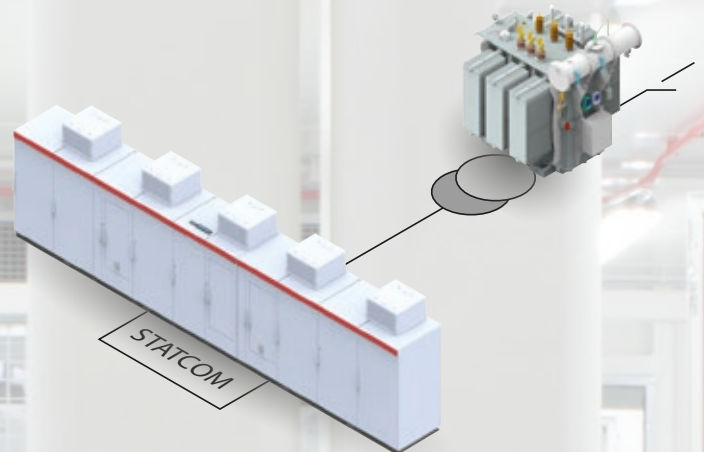
The full range of INGEGRID™ STATCOM is based on a modular design concept that supports up to 4 converters connected in parallel.

On the other hand, the modular design guarantees service continuity, even if one of the medium voltage inverters fails, since, thanks to the isolation switches (optional) included in the converters, said inverter could be isolated from the rest, thus allowing to continue operating under partial load conditions, which maximises the availability of the system.

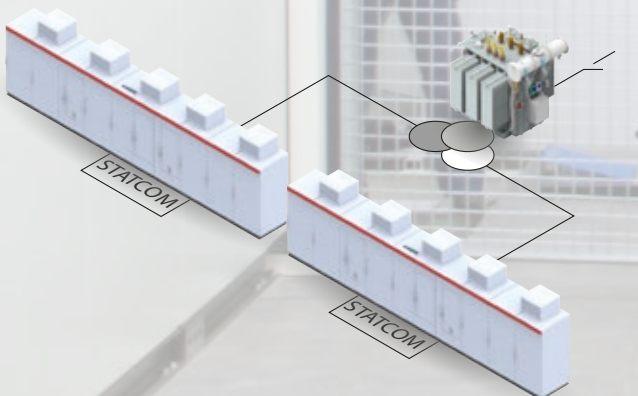
The low voltage converters that make up INGEGRID™ LV STATCOM solutions are three-phase converters which feature LV IGBT semiconductors in 2-level topology.

The medium voltage converters that make up the INGEGRID™ MV STATCOM solutions are three-phase converters that feature HV-IGBT semiconductors in 3L-NPC topology.

SINGLE SECONDARY TRANSFORMER CONFIGURATION



DOUBLE SECONDARY TRANSFORMER CONFIGURATION




The integration of INGEGRID™ converters range in the customer's plant is generally carried out in containerised solutions, which are specially designed to withstand the most demanding environmental conditions. In addition, they can also be installed in electrical rooms.

The INGEGRID™ STATCOM converters are managed by the Converter Control Unit (CCU), a programmable electronic device designed and manufactured by Ingeteam, whose tasks are controlling the converter and carrying out fast protection actions.

The connectivity of the STATCOM with the exterior (customer's SCADA, central plant controllers or WEB interfaces, among others), offers a wide set of diagnostic and service tools integrated in the STATCOM controller.

The software tool package supplied with the equipment enables immediate and advanced remote support, including complete configuration, operation and real-time recording of operating data.

Ingeteam brings decades of experience in power conversion to the design of INGEGRID™ STATCOM converters, which combine the latest advances in control of converters, with next generation semiconductors and the highest quality passive components.

| | INGEGRID™ LV800 | INGEGRID™ MV100A | INGEGRID™ MV100W | INGEGRID™ MV900 |
|----------------------------------|---|--|---|---|
| | | | | |
| Power Range | 4 - 9 MVar | 7 - 28 MVar | 10 - 50 MVar | 30 - 100 MVar |
| Output Section | 2 level inverter (IGBTs) | NPC 3 level inverter (HV-IGBTs) | NPC 3 level inverter (HV-IGBTs) | NPC 3 level inverter (HV-IGBT) |
| Converter Cooling | Water | Air | Water | Water |
| Supply Voltage | 600 V AC | 3650 V AC | 2750 V AC | 5500 V AC |
| Supply V Tolerance | ±10% | ± 10% | ± 10% | ± 10% |
| Supply Frequency | 50/60 Hz (±5%) | 50/60 Hz (±5%) | 50/60 Hz (±5%) | 50/60 Hz (±5%) |
| Efficiency at 100% at rated load | 0.96 to 0.97 (Depending on the topology) | 0.96 to 0.97 (Depending on the topology) | 0.97 to 0.98 (Depending on the topology) | 0.96 to 0.97 (Depending on the topology) |
| Main Options | Chopper, different communication modules, isolation switch and other. | Chopper, different communication modules, isolation switch and other.  | Chopper, different communication modules, isolation switch and other. | Chopper, different communication modules, isolation switch and other. |

Regulation & Control

| | |
|-----------------------------------|---|
| STATCOM control modes | Reactive Power Control, Power Factor Control*, Voltage Control, Droop Control, Active Filter for Harmonic Mitigation (application dependent), Voltage Unbalance Control, Flicker reduction, <i>Fault Ride Through</i> functionality |
| Reactive current rise time | Sub-cycle |
| Converter protections | Overload, Passive components / ambient over-temperature, Grid Under/Over Voltage, Instant Overcurrent, Time Overcurrent, Ground Fault, Under/Over Frequency, Power Electronics internal errors (IGBT / Drivers), Power Electronics over-temperature, Cooling faultTransformer oil/core/winding over temperature** |
| Monitoring features | Remote Access, Application SCADA-HMI, Embedded Data Recorder in STATCOM controller. |

* Power Factor control mode may require additional external measurements, for example total voltage and current measurements at substation level.

** Available when the power transformer is under Ingeteam scope of supply.

Static Synchronous Compensator

water & air cooled

Control Features

In order to analyse the potential, architecture and adaptability of the control system offered by INGEDRIVE™ equipment, the following three areas need to be considered:

HMI and Operator Panel

The whole INGEDRIVE™ family has powerful, user-friendly interface tools developed for parametrisation, commissioning, use and maintenance and for users of all levels, using the following:

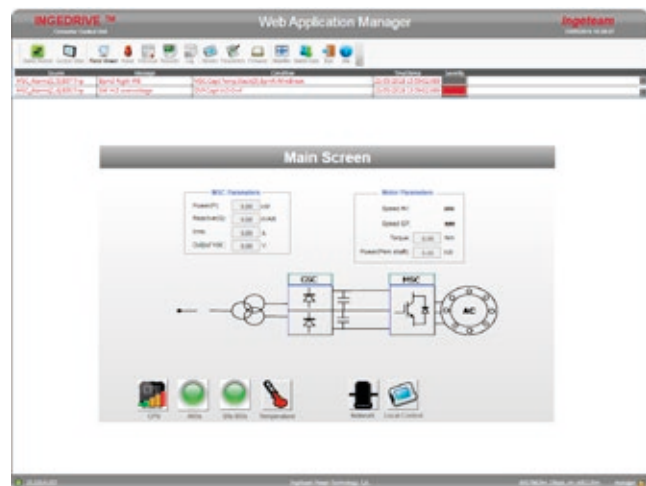
- Web Application: Embedded in the CPU with functional features such as software updating, alarms log, parametrisation, with user level definition.
- Operating panel: user-friendly tool with a touch screen containing important information such as the general status, measurement, alarms and basic local control functional features.
- Remote Diagnosis, Control and Log: The whole INGEDRIVE™ family offers clients powerful tools for commissioning and support based on web technology. This server technology only requires a web browser, allowing remote access via Ethernet to all enabled functional features.
- Customized panels: Ingeteam offers a package of tools for developing and customizing the HMI: both the web application and the operating panel are easily customizable so that they can be adapted to client requirements, permitting customized development according to the client's own requirements.

Hardware Architecture

The control hardware is based on standard shared modules for the whole INGEDRIVE™ family, both in low and medium voltage. The control system consists of the following main modules: PMM [Power Management Module] and CPU [Converter Processing Unit] which permit a multi-drive configuration and can be used for different topologies.

The main characteristics are as follows:

- Reliable hardware based on standard modules.
 - Versatile modular design
 - Validated in different application sectors
- Advanced processing capacity
 - DSP processor for regulation and control functions
 - PLC microprocessor for control logic functions



- Powerful interface for inputs and outputs
 - High-resolution measurements
 - Option for digital/analog input/output expansion
 - Permits communication with multiple field buses
- High electromechanical resistance
 - Robust design with metal casing
 - EMC-certified (IEC 60092 / IEC 61800)

PLC and Control Software

Standard INGEDRIVE devices contain a PLC whose programming is based on the 61131-3 standard, allowing the client to use their own logic and program their own signals and communication according to their needs.

Furthermore, the control system is capable of not only managing single-drive but also multi-drive configurations, adapting itself to the requirements of different applications with the following functional features:

- Multi-drive topology adapted to the application's requirements.
- DC bus voltage regulation using AFE technology.
- Redundant DC bus option using two AFE rectifiers connected to different power networks.
- Frequency converter for hybrid topologies. Static Frequency Converter.
- Battery control for hybrid topologies.

Certifications

INGEGRID™ series complies with the IEC standard, as well as having certifications such as the following:

- CE marked certificates
- Asbestos Free.
- Green Passport.



Applications

- Energy **stabilisation** and programming
- Fast oscillation **compensation** (flicker)
- **Grid** code **compliance**
- **Integration** of **renewable** energies
- **Investment** deferral in infrastructure:
 - Replacement of electrical switchgears
 - Transmission and distribution lines
- **Intermittent** loads (example: railway sector)
- Peak value **limitation**
- Power **quality**
- **Reduction** of harmonics in electrical grids
- **Reduction** of oscillations
- Voltage control and **stabilisation**
- **Voltage** control

In **mines and production plants** with a weak distribution grid and large associated consumptions it is not unusual to find power quality problems, which affects production processes.

Voltage fluctuations and harmonic distortion of the grid may require additional connected generation groups with the consequent increase of consumption and loss of energy efficiency.

This issue, common among this type of facilities, makes INGEGRID™ STATCOM power compensation systems a key feature when it comes to eliminating grid fluctuations and minimising harmonic distortion.



Static Synchronous Compensator

water & air cooled

Plug & Play Solutions

Wherever you want, whenever you want

Thanks to the STATCOM solutions of INGEGRID™ range, which are installed in electrical rooms or in containers (plug&play solutions) and connected to the medium voltage grid, it is possible to stabilise the grid and avoid fluctuations. This allows an increase in productivity together with a reduction in operating costs.



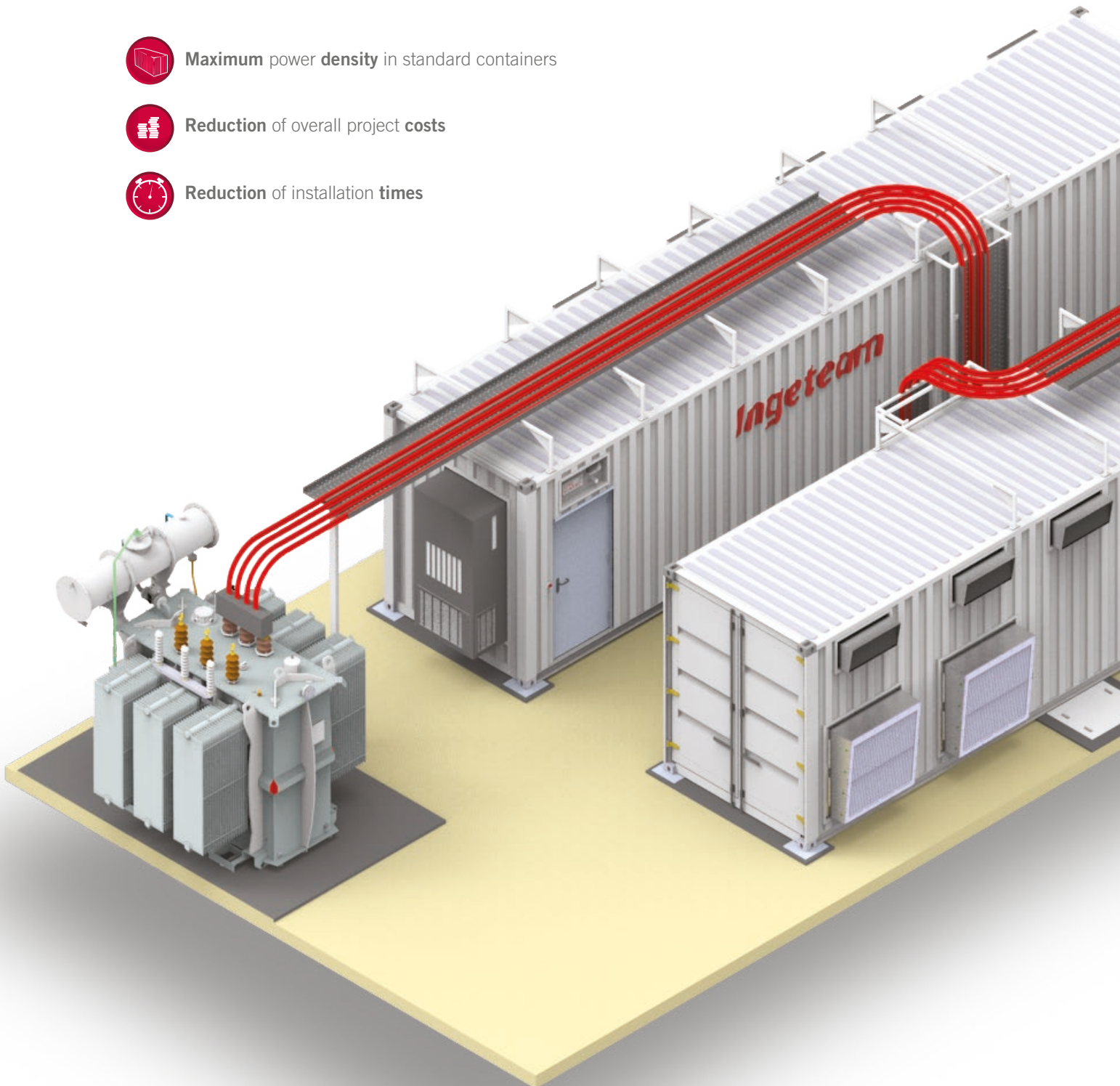
Maximum power density in standard containers

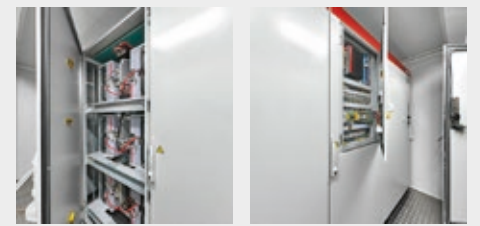
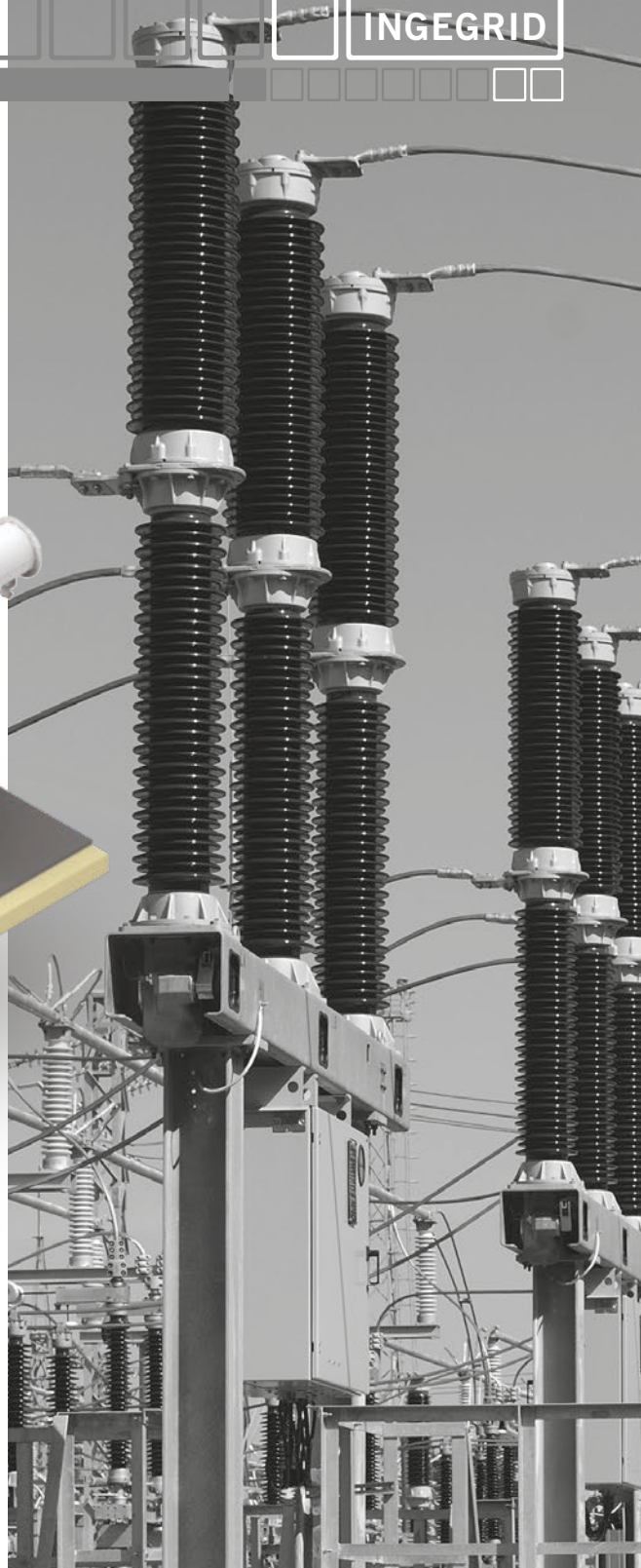
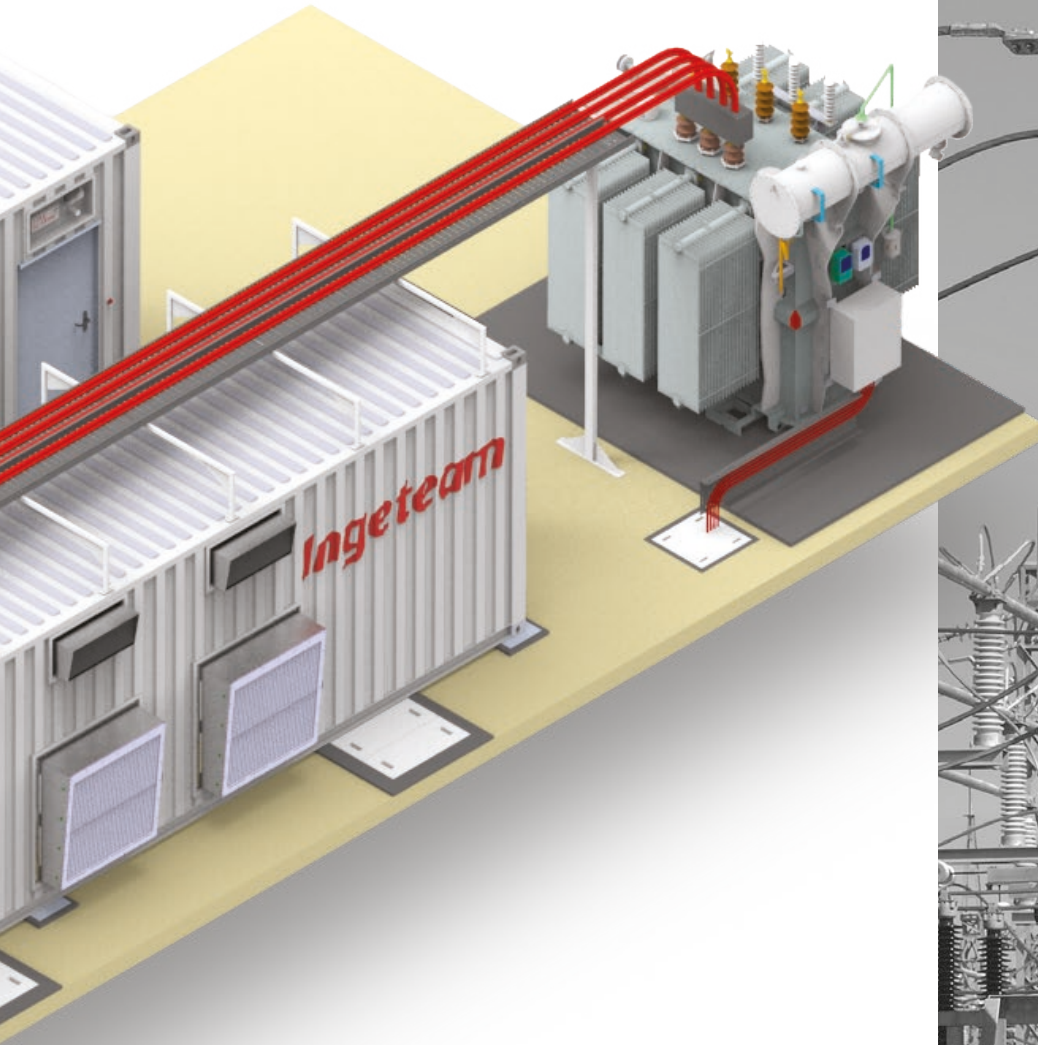


Reduction of overall project **costs**



Reduction of installation **times**





Static Synchronous Compensator

water & air cooled

**CRS
360°**

**CUSTOMER
RELATIONSHIP
SERVICE**

INGEGRID™ Support

In our commitment to offering our clients complete and personalised solutions, Ingeteam offers a 360° CRS (Customer Relationship Service) with all of our product range, providing you with comprehensive consultancy, direct technical support, training and maintenance services throughout the lifetime of our products.

360° CRS is a dynamic, personalised service that covers all of stages and contact points between Ingeteam and our clients. The 360° CRS programme is supported by a professional technical team whose goal is client satisfaction and continuous improvement of products and services, always hand in hand with the latest advances and technologies in each application sector.



The following services are part of the 360° CRS programme



24/7 support included.

Direct access to R&D and design engineers

and direct assistance with key technicians and engineers providing advice and high-quality support to our clients.

Once the warranty period has expired, Ingeteam offers its clients the option to extend out-of-hours customer support services provided by the INGEGRID™ technical support team by means of customized contracts to suit the needs of our clients.



25-year life cycle incl. service + spares

Ingeteam guarantees the repair service of the entire INGEGRID™ family for a period of 25 years after the date of purchase of our equipment.



Remote Access

INGEGRID™ products are ready to be monitored remotely which enables Ingeteam's technical team to offer our clients the option to track and analyse any incident in a device remotely.



Commissioning

The commissioning of INGEGRID™ equipment is carried out by highly-qualified, multidisciplinary staff with experience in a wide range of sectors, to ensure your installation has best adaptation and best performance. This, together with the fact that devices leave the factory having been completely tested and verified, makes the commissioning time considerably shorter.



Repairs [Field Service]

Anytime, anywhere. The aim of INGEGRID™ Support is to minimise the impact of a potential stoppage or incident in our devices.



Technical Support and Engineering

Ingeteam offers its clients pre-sales technical and engineering support in order to provide assistance and advice during the initial stages and from the project definition to the commissioning of our equipment and delivery of our installations.



Training [Training Centre]

Ingeteam's team of course leaders offers comprehensive, customized theory and practical programmes to meet the training requirements of its clients.

Ingeteam has a specific area for providing theory and practical classes where we have specific material and converters with different topologies from the entire INGEGRID™ range. The different options can be summarised in two levels in which the subject content and depth of learning is adapted to the student and to the aim of the course.

- User Level Course:
Explains maintenance and troubleshooting Aimed at users and end users.
- Expert Level Course :
Aimed at equipment commissioning engineers. Suitable for integrators.

Ingeteam

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