

# ELECTRIFYING POWER PLANT SOLUTIONS

Increasing efficiency and operational flexibility



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# ENERGIZING YOUR POTENTIAL

The global energy landscape is transitioning, and the traditional business models of global power producers are being challenged by rising costs, carbon markets, policies and regulations as well as changing consumption behavior. Operational flexibility is now key to cost-efficient power production across the load range.

The implementation of highly efficient and flexible technologies in new power generation plants, as well as the improvement of operational efficiency in existing power plants, is becoming increasingly important to keep pace with the growth in global electricity demand, grid integration requirements and peak load management.

With more than a century of acknowledged industry achievements and technological breakthroughs behind it, GE offers the power industry a wide range of electrical products from motors, generators, drives, transformers and switchgears to protection and control and cabling systems; as well as proven, modular solutions designed for both scalability and flexibility. GE can help you to meet the requirements for base or peak load operations, whether you are planning a new power plant or seeking to enhance existing assets.

# AT WORK ACROSS THE INDUSTRY

GE is active in every segment, power block type, and region of the world, from the most advanced integrated gasification combined cycle, to the largest supercritical coal-fired power plants and the biggest hydro dams. We put our breadth and depth of experience to use every day, devising new solutions to emerging industry challenges, adapting best-in-class technologies to unique segment needs, and creating a power supply that's engineered to perform for you. Our products and solutions are designed to bring you increased efficiency, more operational flexibility, and a seamless integration between your process and the grid.

## GAS-FIRED POWER PLANTS

Gas-fired power plants are playing a major role in both low-emission base load and peak load applications, enhancing plant efficiency when combined with steam turbines using gas turbine exhaust air. Increasingly often, main generators have to be started and ramped up quickly at short notice to cover peaks in demand.

## STEAM POWER PLANTS

Steam power plants contribute to the base power supply in most countries of the world. The requirement to improve the overall efficiency and the environmental compatibility of steam power plants is leading to an increased demand for reliable and efficient drives and power electronics.

## HYDRO POWER PLANTS

Across the broadest rivers and on the largest reservoirs, our power conversion expertise helps improve production and storage flexibility, operating efficiency, and grid compatibility. We are working with our customers to meet the demands and opportunities of the new electric age.

# DISTRIBUTED POWER AND ENERGY & INFRASTRUCTURE

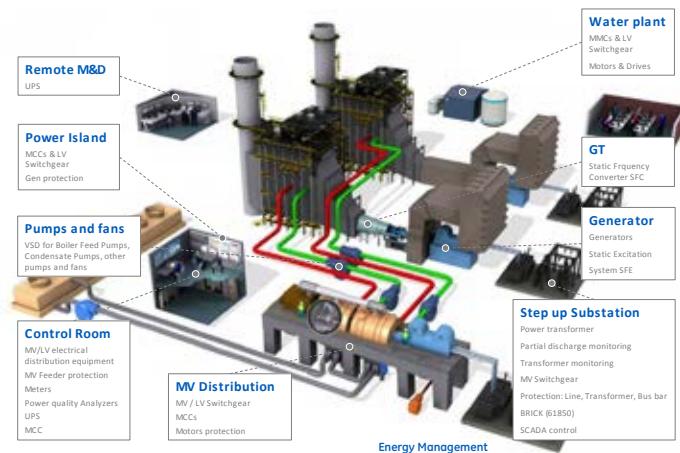
With leading-edge technologies, proven expertise, and continuous innovation in generating and converting electrical energy into productive performance, we are the final link in the power supply chain for industrial clients worldwide in sectors such as metals, aluminum, oil and gas, mining, and ports etc.

# SPECIAL POWER SUPPLIES AND ENERGY & INFRASTRUCTURE

We are applying our experience in power and frequency conversion and deep expertise in power grid adaptation, reversible frequency, power conversion and accurate high current power supplies to support the development of critical infrastructure for ports, hospitals and labs.

# AT WORK ACROSS THE PLANT

We see the whole plant. That's because GE can supply so much of it, from gas turbines and diesel engines to rotating machines; variable speed drives to automation and control systems, and all the electrical equipment in between. But it is when we bring our capabilities together into integrated, engineered solutions that you see the full benefit of the GE synergy.



# AT WORK WITH YOU

We operate as an extension of our customers' teams. Wherever they are across the globe, we are there too, adding people, parts, and perspective to their everyday operations and helping to keep plants running smoothly – for the long term. From hotline, rapid response, and remote diagnostic packages to comprehensive multiyear contracts, our services partnerships are uniquely structured to enhance asset availability and process productivity across every stage of your plant's life cycle.

## COMMISSIONING

Our help is invaluable when it comes to starting up new plants - and operators - with confidence. The services commissioning and training teams help ensure your assets go into active service functioning consistently and efficiently, and your people have the hands-on, real-world skills to operate and maintain them.

## MAINTENANCE

GE is relied on to solve problems, no matter what or where they are. Our Visor Asset Management remote monitoring and support solution, and global network of local service centers - ready with spare parts and field engineers - ensure you'll have the resources to prevent and correct issues on even highly complex systems deployed in inaccessible locations.

## MANAGEMENT

We can keep your plant up-to-date, for the long haul. Our service overhauls, modernization and upgrades, and obsolescence management teams work closely with our customers to ensure proactive lifecycle planning and trouble-free execution, so your assets perform better, longer.

# SYSTEMS & SOLUTIONS



Today's power plants are becoming increasingly complex, especially when it comes to connecting disparate systems together seamlessly. This is creating a number of challenges for the industry in demand management, back-up-power, emergency power, power quality and energy savings.

With one of the largest installed bases of turbine generators in the world, coupled with more than a century of experience delivering innovative, high-voltage solutions in generation, transmission, and distribution networks, GE helps utilities solve these challenges. We offer a versatile and robust suite of solutions for electrical balance of plant (EBoP) applications combining best-in-class manufactured products with engineering and installation services.

Providing a broad range of solutions to suit customers' specific EBoP requirements, GE's solutions are designed with scalability in mind. As a result, they support a large range of projects such as advanced integrated gasification combined cycles, very large supercritical coal-fired power plants, and hydro dams, as well as distributed power for large industrial clients in sectors such as metals, aluminium, oil and gas, mining and ports etc.

GE provides simplified and streamlined commercial offerings for EBoP systems, providing customers with a single, 'one GE' approach. Partnering with customers to define the project scope and vision, along with shared success metrics, is GE's top priority in all electrical balance of plant system implementations. By offering full system lifecycle support, from project conceptualization to post installation, we ensure customers are supported for the long-term.

### Power plant types

- Heavy-duty turbine generation to hydro pump storage
- Renewable wind and solar applications
- Industrial applications

### Solution & Scope

GE's EBoP offering uses a reference design that addresses the electrical aspects of a plant from power evacuation to control. The integrated system is scalable, flexible and designed to respond to customers' requirements, whether as a fully engineered equipment package; a fully engineered, procured and constructed solution; or provided as individual components.

GE's solution can be tailored to meet project-specific needs, compliance to codes and standards, and local requirements. It combines our vast turbine fleet expertise with our EBoP portfolio.

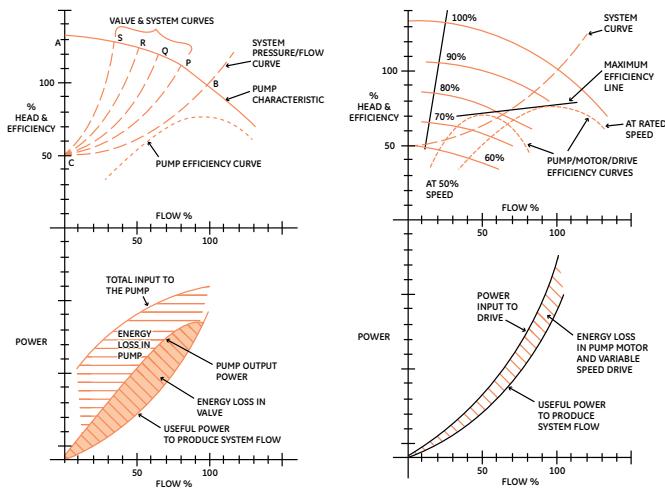
Major components of the solution include:

- High-voltage equipment
- Medium and low-voltage electrical equipment including motors and drives,
- Monitoring and diagnostic systems for starters and excitors, drive systems transformers, and motors
- System protection and control
- Generator step-up transformers
- Auxiliary transformers
- Power metering systems
- Communications systems
- Plant control systems
- Power quality systems
- Comprehensive electrical studies

### Benefits

- Faster return on investment facilitated by on-time COD (Commercial Operation Date)
- High reliability enhanced by proven design, which is compliant with international standards
- Complete monitoring and control of power plant electrical systems enabling better visibility and maintenance
- Seamless installation and commissioning due to the integrated system with optimized interfaces
- Increased visibility and maintenance due to complete monitoring and control of power plant electrical system
- Smoother project execution due to the simple coordinating design and construction entity assuring agreement between all designs and systems

## Energy Savings from Variable Speed Drives (VSD) for Thermal Power Plant Auxiliaries



Thermal power plants typically consume a percentage of the power they produce. This consumption mainly comes from the operation of auxiliary systems such as boiler feed pumps, circulation pumps, cooling water pumps, condensate pumps, exhaust and draught fans, conveyors, and coal mills.

In the past, methods used to control these pumps and fans have often been chosen on the basis that their motors operate at a fixed speed. Variation of the water and/or air flow in these constant speed applications has typically been by the use of control valves and dampers to restrict pipes or air inlet and outlet areas.

We help our customers realize energy and cost benefits by using variable speed drives to achieve the variable flow and optimization of these processes.

### Power plant types

- Gas-fired power plants
- Steam power plants
- Combined cycle power plants

### Solution & Scope

From an energy point of view, there are many similarities between the operation of pumps and fans. Pumps are specifically designed to operate at close to maximum efficiency. Under fixed speed methods, control of flow is achieved by closing control valves. In the case of fixed speed fan control, the inlet or outlet ducts to the fan are restricted by movable dampers to create a pressure drop. This is known as damper control.

In fixed speed control, all systems will show:

- A pump or fan efficiency curve that has a top value near to the design point with lower efficiencies at reduced flows
- A significant additional power loss in the valves or dampers under reduced flow conditions

These methods of control can be compared to driving a car and using the brake to reduce speed while keeping a foot on the accelerator.

### Now contrast them with the variable speed systems...and realize energy savings.

Operation of a pump or fan at variable speed can enable the user to match the pump or fan's characteristic head or flow curve to the needs of the system. In pump and fan applications where the movement of water or air is involved:

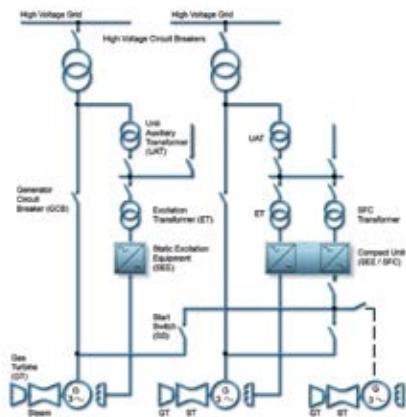
- Flow is proportional to speed of rotation
- Head generated is proportional to speed

As the speed changes, so the efficiency curve changes approximately as shown: i.e., the point of maximum efficiency reduces with the speed and it is possible to operate at the highest pump or fan efficiency over a wide flow range.

### Benefits

- Reduced production costs through energy savings
- Enhanced plant heat rate through increased process efficiency
- Higher power output per energy input, for increased profitability and faster ROI
- Reduced emissions
- Improved operational flexibility during low and peak demands
- Improved accuracy and faster response time of electrical solutions (speed, torque, acceleration, etc.)
- Voltage dip supportability of VSDs to control torque during voltage dip, and restart capability after full voltage interruption
- Reduced short-circuit level in the network (under fault conditions, the VSD will isolate the motor from the network)

## Static Frequency Converters (SFC) and Static Excitation Equipment (SEE)



GE's portfolio incorporates a large range of starting Static Frequency Converters (SFC) and Static Excitation Equipment (SEE) units that are used for gas turbine-driven generators and large synchronous machines. Depending on the start-up process, the SFC power is rated between 1 MW and 40 MW. SEE units are available up to a generator power of 1000 MW.

### Power plant types

- Gas fired power plants
- Steam power plants
- Hydro power plants

### Solution & Scope

GE provides state-of-the-art SFC technology for main generators, which often have to be started and run-up at short notice. In applications with several generators, a cross-over logic is available to start up the generator with one SFC. We offer a standard range of air-cooled converters from 1.9 MW to 15.5 MW and customized water cooled solutions for higher power ratings. These offer a high degree of design flexibility and the advantage of a high-performance control platform at the heart of the system. The control part is based on a modular multiprocessor system with a real-time multitasking operating system.

GE is one of the world's leading manufacturers of SEE units, with an installed base of more than 700 systems in the field. The static excitation system provides the necessary field current for synchronous generators from 20 MW to 1000 MW. Standard units are available up to 8000 A DC. Typical features for SEE units include: redundant control; redundant fans; redundant thyristor bridges (n-1); integrated power system stabilizers; control limiters for the field and stator current under excitation, V/f, etc.; and a user-friendly customer interface for simple operation, monitoring, diagnostics, and maintenance.

For added space and cost savings, we can provide combined SFC and SEE units in one package.

### Benefits

- A broad portfolio of world-leading equipment
- A high degree of design flexibility
- High performance control platform
- Compact combi SFC/SEE units for better use of space

<b>SFC output power</b>	Up to 15.5 MW (air cooled) Up to 40 MW (liquid cooled)
<b>SFC voltage</b>	Up to 3,5 kV (air cooled) and 18 kV (liquid cooled)
<b>SEE current</b>	Up to 8000 A (12000 A peak)
<b>SEE voltage</b>	Up to 780 V (1000 V peak)

## Variable Speed Solution for Pumped Storage Power Plant (PSPP)



GE offers innovative doubly fed and fully fed technology based on a powerful, robust and flexible variable speed drive system for any type and size of pumped storage power plant.

### Power plant types

- Pump storage power plants

### Solution & Scope

GE's leading voltage source inverter (VSI) technology enables pumped storage power plants to significantly expand their capabilities.

The speed power optimization function, in turbine mode, enables the VSI to adapt the turbine speed vs. the water column in order to enhance efficiency and associated power output. In pump mode, the VSI will adapt the speed in order to control the power consumed from grid as the reservoir is replenished.

With the critical grid support function, in turbine mode, the VSI will discharge the rotor inertia equivalent power into the grid to compensate for any frequency drop.

The automatic voltage regulator function enables the VSI to adjust reactive power absorption or delivery to

the grid in order to control the voltage at the point of interconnection.

Finally, the energy recovery braking function enables the VSI to efficiently brake the unit while regenerating power to the grid, using the mechanical brakes only when the speed has fallen below 5%.

### Benefits

- Speed optimization at partial load
- Optimum starting curve for the turbine
- Increased efficiency
- Dynamic active and reactive power control
- Grid stabilization
- Enhanced Capex
- Extended unit operation under varying hydraulic conditions
- No auxiliary equipment needed for start-up or pumping operation
- Controlled consumed power under pump operating mode

## Variable Speed Solution for Small Hydro or Run-off River Plant



GE's Variable Speed Drive System (VSIDS) is perfect for expanding the capabilities of run-off river plants. Compatible with doubly fed induction, squirrel cage or permanent magnet generators, our solution can be implemented for both greenfield and revamping projects.

### Power plant types

- Small hydro or run-off river plants

### Solution & Scope

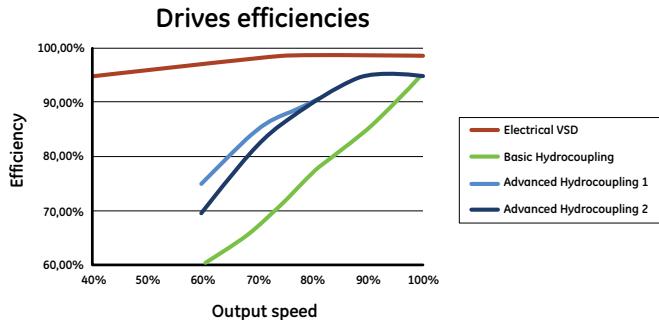
GE's VSIDS can function as an electronic gear box to enable the direct coupling of generator and turbine. This can create advantages in equipment sizing configuration.

GE's systems help optimize the turbine starting curve and can isolate generators from the grid when needed. Our systems control full speed and power variation, and manage extended unit operation at varying hydraulic conditions and partial loads.

### Benefits

- Speed optimization at partial load
- Optimum starting curve for the turbine
- Increased efficiency
- Dynamic active and reactive power control
- Grid stabilization
- Enhanced Capex
- Extended unit operation under varying hydraulic conditions
- No auxiliary equipment needed for start-up

## VSD System vs. Hydrocoupling for Thermal Power Plant Auxiliaries



An electrical Variable Speed Drive System (eVSDS) is a solution that drives thermal power plant auxiliaries like pumps and fans more efficiently than any other means of control (including hydro coupling, throttling valves and dampers) and features many other benefits for customers.

### Power plant types

- Gas-fired power plants
- Steam power plants

### Solution & Scope

Modern thermal power plants are increasingly using eVSDS to drive auxiliary loads like pumps and fans.

Compared with hydrocoupling solutions, eVSDS have clear energy efficiency advantages on the entire speed range: for example, they further expand the plant's operative flexibility by enabling a smooth start-up, meaning no inrush current, no operation restriction and longer lifetime for the shaft train. No inrush current also means no voltage drop onto the grid, which greatly reduces the power supply requirement.

In addition, by offering operational capability on the full speed range, adaptation to process changes are made a lot easier; and with fewer components, no rotating parts and less mechanical stress, maintenance requirements are significantly reduced.

### Benefits

- High operating flexibility and the ability to run at any speed (from 0 to 105% of nominal speed)
- Improved accuracy and faster response time of electrical solutions (speed, torque, acceleration, etc)
- Voltage dip supportability of VSDS to control torque during voltage dip, and restart capability after full voltage interruption

- Reduced noise and vibration
- The ability to share variable speed on several motors or the option to run motor at fixed speed in routine mode for economies of scale and operating flexibility
- Reduced overall power plant size and equipment and no inrush current consequence
- Higher security of supply and reduced network disturbance
- Higher range of power – see the broad track record of electrical VSD applications vs. very few references of Mec/Hyd at high power
- Reduced civil engineering costs and smaller footprint for space savings on the shaft-line
- Reduced short-circuit level in the network (under fault conditions, the VSD will isolate the motor from the network)
- Reduced maintenance, no moving parts

# PRODUCTS

## Synchronous Generators



<b>Output range</b>	Up to 75 MW
<b>Speed range</b>	237–1800 rpm
<b>Frequency</b>	50 Hz/60 Hz
<b>Voltage</b>	Up to 15,000 V
<b>Primary mover</b>	Gas, steam or hydro turbine - gas or diesel engine
<b>Cooling methods</b>	Air or water

GE's generators have a strong reputation for reliability, efficiency and quality across a wide range of applications. They are supplied as either tube-frame or base-frame global vacuum-pressure impregnation (VPI) salient pole machines with protection up to IP56. Rotor construction may be integrally wound poles or separately mounted poles, depending upon speed. Power ratings are from 2,500kW to 75,000kW, covering voltages up to 15,000V and speed ranges from 237 RPM to 1800 RPM.

### Power plant types

- Pump storage power plants

### Solution & Scope

GE provides highly reliable generators designed to be flexible in application, enabling the customer to maintain control over fuel costs, installation costs and technical specifications. An additional benefit is the modular nature of the design, which helps reduce lead times and improve capital cost control.

### Benefits

- Mechanical modularity
- Flexibility with reduced lead-times
- Highly customized electrical design
- Simpler system design
- Well-proven VPI
- Highly reliable
- Pin-vent stator technology
- Increased power density
- Highly efficient machines
- Lower fuel costs
- Outdoor rated
- Excellent in harsh environments
- Enhanced design for variable frequency drive applications

## Horizontal and Vertical Induction Motors



<b>Output range</b>	Up to 40 MW
<b>Speed range</b>	30–7,000 rpm
<b>Frequency</b>	50 Hz/60 Hz and variable frequency
<b>Voltage</b>	200 to 15,000 V
<b>Construction</b>	Horizontal or vertical
<b>Standards</b>	Can include API, IEC, NEMA, GOST, CSA
<b>Cooling methods</b>	Air, water, ODP or TEPV*

\* Open Drip Proof (ODP) Totally-Enclosed Piping Ventilation (TEPV)

The inherent simplicity of induction motors makes them a reliable choice for the power generation sector. Among the leaders in the design and manufacture of low starting current motors and high torque density motors (up to 40 MW), GE offers a comprehensive range of vertical and horizontal induction motors.

### Power plant types

- Gas fired power plants
- Steam power plants

We work within all global standards such as IEC, IEEE, NEMA, API, CSA, and GOST.

### Solution & Scope

GE supplies highly efficient, low-noise motors appropriate for a wide range of applications such as pumps and fans. This well proven work horse is available in a number of different designs from low voltage fractional horse power up to 300 ton machines. Designs are offered with copper or copper alloy, or for smaller machines, both copper and fabricated aluminum.

Each machine is customized to suit our customers' specific needs by modifying the stator and stator winding as well as the rotor cage bar profiles and materials. By adapting designs in this way, GE induction motors can achieve high efficiency levels and an enhanced power factor.

### Benefits

- Compactness thanks to the high torque density of our machines
- Low noise and vibration level for an improved ambient environment
- High efficiency from the (gearless) direct-drive solution arrangement
- Robust construction for high reliability
- The option of low starting current for direct-on-line motors for a smooth start-up
- The ability to customize motor designs for use with variable frequency drives

## Horizontal and Vertical Synchronous Motors



GE offers a full range of horizontal and vertical synchronous motors. Our portfolio includes direct-drive high torque density motors.

### Power plant types

- Gas fired power plants
- Steam power plants

which not only gives reliable starting but also offers high protection for your investment.

### Solution & Scope

Synchronous motors are used because of the high efficiency and controllable power factor of their design. We offer a number of different design options to suit various applications, including laminated and solid pole designs with both cylindrical and salient poles. GE also offers a unique forged integral pole tip design. Field windings are highly optimized to suit individual applications using either wire-wound or strip-wound options. GE has further improved motor reliability by eliminating the need for a rotor-mounted synchronizing module. Fixed speed applications benefit from the use of our ESP1 excitation control,

### Benefits

- Low starting current machines available for a smooth start-up
- Reduced maintenance thanks to the brushless excitation system
- Robustness (in particular brushless components) for enhanced reliability
- High efficiency through customized design
- Improved performance and reduced opex from system improvements (power factor correction capabilities)
- The ability to customize motor designs for use with variable frequency drives

<b>Output range</b>	Up to 100 MW
<b>Speed range</b>	20–7,000 rpm
<b>Frequency</b>	50 Hz/60 Hz or variable frequency
<b>Voltage</b>	690 to 15,000 V
<b>Excitation</b>	Brushless or static with collector rings
<b>Construction</b>	Horizontal or vertical
<b>Standards</b>	Can include API, IEC, NEMA, GOST, CSA
<b>Cooling methods</b>	Air, water, ODP or TEPV*

\* Open Drip Proof (ODP) Totally-Enclosed Piping Ventilation (TEPV)

## Medium Voltage Drives – MV Series



GE's medium voltage drive series is suitable for a wide range of power conversion applications, providing customers with flexible solutions for their needs.

### Power plant types

- Gas fired power plants
- Steam power plants
- Hydro power plants

### Solution & Scope

Advanced technology power electronics and decades of process expertise come together in GE's medium voltage drive series – a portfolio of proven performers. Easy to install and maintain, the series offers high reliability and availability and helps improve the uptime of electrical drive systems. It also can provide the flexibility required to achieve a customized solution across different pump or fan configurations. Building upon our power conversion expertise, GE's PWM medium voltage drive delivers high efficiency at both full and partial loads within a compact design and delivers an accurate and perfect quality torque to pump or fan motors.

### Benefits

- Peak power density – our single drive can deliver up to 15,000kW with just 18 IGBTs, which is equivalent to a power density of 1.5 MVA/m<sup>3</sup>
- Proven reliability and availability with over 10 million hours in operation across an installed base of over 8.5 GW
- Power scalability with à la carte option packaging that can be adapted to a wide range of loads
- A full family of drives – GE's broad portfolio makes us your one-stop provider
- Up to 99% efficiency
- Encoder-less vector control thanks to the high performance control system we developed which guarantees optimum torque quality, power and speed regulation

Output power	Up to 81 MW
Output voltage	Up to 10 kV
Output frequency	15-90 Hz, 0 to 15 Hz on request
Input voltage	3 to 10 kV ±10%
Input frequency	50 or 60 Hz ±5%
VFD system efficiency	Up to 99%
Power factor	>0.96 (DFE) / 1 (AFE)
Input harmonics	IEEE 519 compliant



GE's low voltage drive series is suitable for a wide range of power conversion applications, providing customers with flexible solutions for their needs.

### Power plant types

- Gas fired power plants
- Steam power plants

### Solution & Scope

The LV7000 series is a robust low voltage AC drives solution suitable for a wide range of requirements with a complete power range from 0.25 kW to 2000 kW.

The key design feature is the software and hardware modularity. Two types of control are available – the standard sensor-less vector control and the closed loop flux vector control for more demanding applications.

The LV7000 family comprises compact and high performance drives. LV7000-1 is a space-saving compact drive whereas the LV7000-2 and 3 are high-performance drives combined with

powerful support for various software applications.

The drives are easy to program and use via a keypad. The keypad can easily be removed for hand held use or door mounting. The LV7000-1 has a detachable, seven-segment LCD keypad without memory capabilities which is used to communicate with the drive, set parameters and for monitoring.

The LV7000-2 and 3 have a detachable, alphanumeric keypad with built-in memory. In addition it can be used to copy parameters between different drives and store active parameters for future use.

LV7000 drives are compact and user-friendly, and compared to constant speed solutions they can help you save up to 50% in energy consumption.

### Benefits

- Assured quality and reliability as each drive is tested at maximum temperature and full motor load prior to shipment
- Full modularity – choose from three control units (LV7000-1, LV7000-2, LV7000-3), each with various options
- Easy installation and commissioning using versatile PC tools for loading, setting and comparing parameters
- Quick set-up thanks to smart preset parameters
- Versatile control and integration with single-drive and complex process control applications possible
- Energy savings of up to 50% for improved environmental performance

<b>Output power</b>	Up to 2000 kW
<b>Input voltage</b>	208-240 Vac / 380-500 Vac / 525-690 Vac
<b>Input frequency</b>	50 or 60 Hz $\pm$ 5%
<b>Enclosure</b>	IP21-IP54
<b>Power factor</b>	>0.96 (DFE) / 1 (AFE)
<b>Control</b>	Standard sensor-less vector control or advanced closed loop flux vector



GE's cast coil transformers provide proven technology, application flexibility, reduced maintenance, lower installation cost, operating efficiency and environmental acceptability. Designed for indoor or outdoor use, our transformers meet the demands of the diverse environments that require reliable electrical power supply.

### Power plant types

- Gas-fired power plants
- Steam power plants
- Hydro power plants
- Renewable power generation

### Solution & Scope

Incorporating proven technology, GE's cast coil transformers offer application flexibility and lower installation costs as well as operating efficiency. The advanced design of the winding assembly establishes excellent performance to meet today's requirements, providing indoor and outdoor solutions for demanding and diverse environments, and for all applications that require reliable electrical power.

### Benefits

- Reduced maintenance cost – does not require periodic checking of the oil
- Mechanical strength – ideal for impact loading, mobile machinery and transit systems applications
- Impervious to adverse atmospheric conditions – in harsh environments, the extremely inert epoxy casting renders the windings impervious to moisture, dirt and most corrosive elements
- Suitability for simple indoor installations - no automatic fire extinguishing system or fire vault, oil checking or replacing, or liquid confinement area required
- Can be provided with the highest self-cooled and fan-cooled extended ratings of any transformers in their size class

- High efficiency thanks to excellent mechanical strength which can eliminate conductor movement since both the primary and secondary windings are completely encapsulated in the epoxy resin
- Environmental safety as the epoxy resin makes the transformer impervious to harsh environments, without potential adverse effects on the environment

	IEC	ANSI / IEEE
<b>Phases</b>	3	
<b>Conductors</b>	Copper or Aluminum	
<b>Frequency (Hz)</b>	50	60
<b>Primary Voltage (V)</b>	up to 35,000	
<b>Secondary Voltage (V)</b>	up to 10,000	
<b>Power (kVA)</b>	160 - 20,000	
<b>Off-load topping range</b>	±2 × 2.5%, 5%*	
<b>Insulation class</b>	F (155°C) or H (180°C)	150°C or 180°C
<b>Ambient temperature</b>	Max ≤40	
	Min ≤-5 (indoor), ≤-25 (outdoor) ≤-30	
<b>Altitude (m)</b>	≤1,000	
<b>Connection</b>	Dyn5, Dyn11, YNd511, Yy0 and others	
<b>Cooling</b>	AN, AN/AF, AF AA, AA/FA, AFA	



GE's medium-voltage switchgear (from 630 A–4000 A up to 27 kV) provides ingress protection up to IP43 and built-in safety.

SecoGear™ metal-clad switchgear is designed and manufactured with advanced technology and has been comprehensively and successfully type-tested by KEMA. All SecoGear™ with switching devices are equipped with SecoVac vacuum circuit breakers or fuse contactors.

Note: SecoGear™ switchgear is designed for indoor applications, and is particularly suitable for applications in industry, mining, oil and gas, utilities and infrastructure.

### Power plant types

- Gas-fired power plants
- Steam power plants
- Hydro power plants

production techniques—combined with the protection of the 'E Coat' (cathodic electrocoating) paint process—have resulted in a leading standard of excellence.

### Solution & Scope

SecoGear™ metal-clad switchgear is designed and manufactured with advance technology and has been comprehensively and successfully type-tested.

SecoGear™ switchgear is typically used in power plant substations of public utilities. It is suitable for providing control and protection for transformers, capacitors and motors.

It is designed, assembled and tested to meet or exceed applicable IEC and GB standards. GE's precision-tooled parts, computer-aided design and advanced

All SecoGear™ with switching devices are equipped with SecoVac vacuum circuit breakers or fuse contactors with corresponding specifications.

### Benefits

- High reliability. Since GE introduced the world's first 15 kV vacuum circuit breaker in the 1950s, it has been a world leader in vacuum technology with over 55 years of reliable field operation
- Compact footprint enabling a greater density of circuits in very small space to free more real estate in the plant for core business activity
- Safety and reliability thanks to a metal enclosed partition switchgear which segregates all functional sections for improved safety and reliability due to its full compartmentalization
- Internal arc testing in accordance with IEC standards to 50 kA for 1's in all compartments, which provides plant operators with enhanced safety from events, whether from the front, sides or rear of the switchboard
- A fully insulated bus bar system to reduce the possibility of any internal arc in the bus bar section, enabling increased uptime of the switchboard for safety and availability
- The new SecoVac VB2+G generator circuit breaker is designed to be fitted into SecoGear 17.5kV range of medium-voltage type tested IEC panels)

Description	Unit	Data	
Rated voltage	kV	17.5	27
Rated frequency	Hz	50/60	50/60
Rated power frequency withstand voltage/1 min	kV	38	65
Lightning impulse with stand voltage (peak value)	kV	95	125
Rated current of busbar	A	630/1250/1600/2000 /2500/3150/4000*	630/1250/1600/ 2000/2500
Rated short time withstand current (3s)	kA	20/25/31.5/40/50	20/25/31.5
Rated peak withstand current (peak value)	kA	50/63/80/100/125	50/63/80
Ingress protection		Panel IP4X, Compartment IP2X	Panel IP4X, Compartment IP2X



GE's low-voltage switchgear can provide a safe, efficient and intelligent solution as an integrated low-voltage distribution and motor-control center platform.

### Power plant types

- Gas-fired power plants
- Steam power plants
- Hydro power plants
- Waste-to-energy power plants
- Coal-fired power plants

### Solution & Scope

From the outset, GE's SEN Plus system was developed to meet specific customer requirements. The resulting product offers enhanced flexibility and user safety backed by comprehensive testing and support for a variety of specific configurations.

The system includes the following parts:

- Power center: main distribution panel, modular construction, rated current up to 6300A
- Motor control center: can provide fixed type, plug-in and withdrawable modules for feeder and motor starter application (range of module size varies from 4E to 36E)
- Bus-coupler, transition panel, corner panel: optimized busbar connection between panels and transformer

- Motor protection relay: can be integrated into motor control center to provide comprehensive protection, control, field bus and Ethernet communication function
- Key components: high performance distribution and motor control components, including air circuit breaker EntelliGuard™ L & G, MCCB Record Plus and motor starter Surion

### Benefits

- Enables safety modifications under energized conditions
- Increases functional floor space in building services
- Quick and efficient assembly techniques for fast delivery and customer satisfaction
- Central design and ongoing testing to the latest standards for lower investment costs
- Environmentally aware. Control of waste and packaging reduces manufacturing processes; additional power monitoring features provide energy saving opportunities

- Four-pole KEMA type tested assemblies up to 6400 A for power distribution and control as per IEC 61439-2/EN 60439-1 and IEC/TR 61641 for internal arcing, enabling a boundary-less environment
- Enables installation of equipment in a range of environmental conditions

<b>Standard</b>	Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies	IEC61439-2; GB7251.1-2005; IEC60068-2-57; IEC/TR3 61641
<b>Test Report</b>	KEMA, CCC, IPH, Seismic test, Internal Arcing, Marine approval	
<b>Electrical Data</b>	Rated insulation voltage (Ui)	1000V
	Rated voltage (Ue)	400V/480V/690V
	Rated frequency	50Hz/60Hz
	Rated impulse withstand voltage	8kV/12kV
	Main busbar rated current (Ie)	1000-7600A
	Main busbar short time withstand current (Icw)	Up to 150kA
	Main busbar rated peak withstand current (Ipk)	Up to 330kA
	Vertical busbar rated current (MCC)	850-1900A
	Vertical busbar short time withstand current (Icw)	Up to 100kA
Vertical busbar rated peak withstand current (Ipk)	Up to 220kA	
<b>Structure Feature</b>	Height	2000mm, 2200mm
	Width	400, 500, 600, 800, 1000, 1200mm
	Depth	600, 800, 1200mm
	Unit module	1E=25mm
	Max modules	80E
	Protection degree	IP30-IP54
	Internal separation form	Up to form 4b
	Enclosure	Hot-dip zinc coated steel sheet, epoxy polyester powder

## High-Voltage Gas-insulated Switchgear



GE solutions include gas-insulated switchgear (GIS) for high- to ultra-high-voltage power transmission and distribution networks.

### Power plant types

- Gas-fired power plants
- Steam power plants
- Hydro power plants

### Solution & Scope

We offer a highly reliable, compact GIS that lowers installation space and reduces maintenance requirements. Designed with lightweight, durable aluminum enclosures, total load on the foundation and building floor is significantly reduced. Our GIS requires a low level of maintenance throughout the life of the product. The main components, including circuit breakers, disconnectors, earthing switches, and operating mechanisms, are designed for a normal operation of more than 30 years.

### Benefits

- Designed for reliability and safety. Our design features a minimum number of moving parts and live parts have been enclosed to protect the insulation system against the external environment

- Enhanced durability, thanks to the latest digital machinery technology including the cold flanging and welding of high-strength aluminum enclosures, epoxy resin casting of insulators, and high-strength aluminum alloy casting
- Lower cost of ownership through the use of high-grade materials and components which provide a maximum life cycle of more than 30 years and reduced maintenance over the life of the product (our designs use lightweight aluminum which reduces the costs of civil work and foundation preparation, and provides easy bay access resulting in less scheduled downtime for maintenance and repair)
- Compact and flexible. A design that optimizes the space available for installation and allows for customizable electrical setups that permit new adaptations and upgrades at any time

Feature	Unit	Model Performance*
Rated voltage	kV	up to 800
Rated current	A	up to 6000
Rated frequency	Hz	50/60
Rated power frequency withstand voltage, 1 min (**)	kV	up to 960
Rated lightning impulse withstand voltage (**)	kV	up to 2100
Rated short circuit breaking current	kA	up to 63
Technical Standards supported		ANSI/IEC & IEC

\*performance range varies with model - sales representative to be consulted

\*\*phase to earth



GE offers a suite of reliable transformers that exceed regulation requirements. Our solutions benefit from constant technology development and advanced manufacturing processes to offer a wide range of transformer voltages and capacities that meet a variety of requirements for customers around the world.

### Power plant types

- Gas-fired power plants
- Steam power plants
- Hydro power plants
- Nuclear power plants
- Renewables power plants

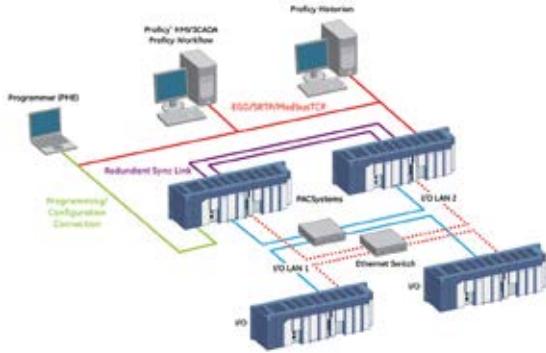
### Solution & Scope

We offer a broad line of power transformers with three phase ratings from 20 to 1500 MVA and voltage ratings from 69 up to 765kV.

Power transformers are a key technology for electric power generation and power transmission. The generator transformer that we provide fully complies with the requirements for power generation islands with excellent performance and exceptional reliability for low loss, low noise, low partial discharge and high short-circuit withstand. A broad range of products aligns with the many types of thermal power sets, including 200MMW, 250MW, 300MW and 600MW configurations.

### Benefits

- Decreased electrical stress in the insulation structures and the prevention of partial discharge initiation
- Improved winding impulse voltage distribution characteristics thanks to in-depth studies and performance analysis
- Reduced leakage flux density control and stray loss
- Control over heating of the high current leads through a redesign of the structure and lead arrangement
- Improved operational reliability through the increased short circuit withstand strength of the windings
- Minimized effects of DC biasing on the transformer core through the analysis of currently used methods
- Decreased noise levels, down to 65dB, with advanced core stacking technology
- Minimized oil flow to reduce the temperature rise of windings
- Improved tank design to meet and/or exceed transportation strength requirements



GE's high availability control solutions are designed for continuous, efficient operations with superior performance and flexibility. If any part of your control system fails, the backup counterpart automatically assumes control to provide continuous operations. Two physically independent controllers—connected to various I/O on our proven industrial network—provide automatic switchover for continuous operations. Our scalable, synchronized, hot-standby redundancy control platform combines domain expertise and advanced technology to meet your needs for enhanced speed and reduced downtime.

### Power plant types

- Gas fired power plants
- Steam power plants,
- Hydro power plants

### Solution & Scope

GE's high availability solutions have two physically independent controllers (connected to various I/O on our proven industrial network) to provide automatic switchover for continuous operations.

Offering true dual redundancy data synchronization with dual modules, they have dedicated redundant links to one another—operating synchronously with virtually no overhead added to the control application to transfer your application's variables, status and I/O data on every scan with speed and transparency.

GE's unique, patented Redundancy Memory Xchange module (based on reflective memory technology) synchronizes the systems at the beginning and end of each logic scan execution to keep all variable data the same—providing rapid and bumpless switchover.

### Benefits

GE's high availability controls operate as a completely integrated system that is user-friendly, customizable and cost-effective for mission-critical auxiliary and mechanical application redundancy. Delivering operational performance, it provides:

- Robust redundancy to reduce downtime
- Fast, full-system, real-time, synchronization

- Synchronized redundant power grids for transparent system switchover
- Concurrent maintainability
- Lower TCO with scalable solution and startup tools

Feature	Controller	I/O Network
<b>Performance</b>	1 GHz processor for each controller; up to 20 auxiliary PLCs can be added	100 MB Ethernet, full duplex; up to 24 ENIUs can be added to system
<b>Technology</b>	Reflective Memory Exchange (RMX) with fiber optic ring configuration	Ethernet (IEEE 802.3) and Ethernet Global Data (EGD), RJ-45 connections
<b>Redundancy</b>	Dual redundancy	Single, dual redundancy
<b>Synchronization</b>	RMX synchronization	RMX optic ring provides realtime data on all installed I/O
<b>Failure Recovery</b>	Bumpless switchover to new master	I/O rack grouping offers independent communication to each controller
<b>Programming Software</b>	Windows-based Proficy machine Edition (PME)	Windows-based Proficy machine Edition (PME)
<b>Diagnostics</b>	Yes	
<b>Distance (Network)</b>	Up to 300 m between primary and secondary (with Reflective Memory Hub (RFM) on fiber up to 10 km)	

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