



Power Transformers



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Global Top Energy, Machinery & Plant Solution Provider

 **HYOSUNG CORPORATION**
Power & Industrial Systems Performance Group

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About HYOSUNG



Hyosung Power & Industrial Systems PG is a division under Hyosung which consists of seven performance groups (PGs). In addition to establishing itself as a world-class manufacturer of electrical equipments, green technology and industrial machinery, Hyosung is also the largest producer of tire cords and spandex in the global market and the second largest supplier of ATMs in the USA.



01 Our Business

Brief introduction of Hyosung Power & Industrial Systems

Hyosung Power & Industrial Systems Performance Group

Hyosung Power & Industrial Systems Performance Group, a comprehensive energy solution provider, boasts world-leading technology in the global power industry and has secured a competitive capability on par with that of top competitors in transformers, switchgears, motors, decelerators, industrial pumps, and wind energy business.

With globalization as one of our top priorities, we have achieved outstanding increase in sales over the past few years thanks to the enhancement in Hyosung's quality, technology, and brand recognition among overseas clients, which include North America, Europe, the Middle East, and Asia. We expect such robust performance, marked by an increasing number of orders from the overseas market, to continue in the future.

At the heart of our capability to grow as a comprehensive energy solution provider is our global organization structure. Hyosung Power & Industrial Systems Performance Group is divided into four business areas or performance units, depending on the types of flagship products: Power Systems Performance Unit, Industrial Machinery Performance Unit, Hyosung GoodSprings Performance Unit, and the Wind Energy Business Division.

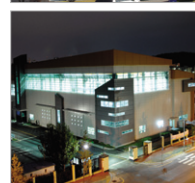
Power Systems Performance Unit

Hyosung's Power Systems Performance Unit provides a full spectrum of power generation, transmission, and distribution services, from design and engineering to the maintenance of equipment and has been building up on cutting-edge information technology resources and developing substation automation systems, such as power monitor and control systems, and early detection and prevention systems.

Such vast product assortment and technical know-how is based on our product development history. In 1992, Hyosung was the first in Korea, and the sixth in the world, to develop a 765kV ultra-high voltage (UHV) transformer, and, in 1999, was the first in the world to manufacture the 800kV gas insulated switchgear (GIS), which has put Hyosung on an equal technological ground as its top global competitors.

Having such world-class technology, we established Baoding Hyosung Tianwei Transformer Co., Ltd., a joint venture with the Baoding Tianwei Organization, to hold the largest share of the market in Baoding City, China. This venture was established in 2003, and by the end of 2004, we established a production plant producing 11,000 transformers per year. In 2006 we acquired one of the top five companies in quality terms as certified by the Chinese government, Nantong Hyosung Transformer Co., Ltd. in Jiangsu.

The Power systems Performance Unit is continuously striving to secure competitiveness in every aspect of quality, technology, sales, services, and management, in order to satisfy customer needs globally and become a top-tire company in the world by providing customers with the best quality products and services in the power systems sector.



Power Transformers

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02 Sustainability

Our sustainability principles are the backbone of the way we design and manufacture products

Quality Assurance

Hyosung strives for excellence. We believe excellence can only be achieved through absolute quality and value for customers. In order to create quality products, we believe that all of the actions of every single employee must be focused in the highest level of quality. In order to achieve such levels, we have implemented a quality assurance policy and programs that make our philosophy into a reality. Our Quality Assurance Policy was founded based on the management policy of the president and meets the demands of ISO 9001. As a globally active company, we are committed to comprehensive and quality management through three quality strategies: quality management system, customer-focused management system, and concentration on core competencies.

The comprehensive quality management system ensures that we completely comply with all compliances and applicable legislation, codes, and standards in addition to implementing efficient operation of our management resources to eliminate unnecessary waste. Our customer-focused management system clarifies and simplifies our first priority which is customer satisfaction. All of our work is aimed to exceed customer needs and provide exceptional value through quality standards, flexibility, and innovation. Finally, we concentrate on our core competencies for strict quality control and continual improvement which provides quality products and cost-saving to our clients via advancement in technical capacity and technological innovation.

We implement our policy via a Quality Management Team manages research laboratories, including the Measurement Standard Laboratory, the Chemical Analysis Laboratory and the Material Analysis Laboratory to maintain a strict control over quality.



Environment Protection Policy

Hyosung understands the impact of Hyosung's activities in the environment and works to protect the environment from pollution, manages the environmental impacts of Hyosung's products and technologies, and prevents future pollution and harmful effects in the environment by investing in environmentally-friendly products and solutions.

Based on this eco-philosophy of shared responsibility, Hyosung has implemented a comprehensive environmental protection program that aims to minimize our impact on the environment and conserve resources. Our environmental policy fulfils all requirements of the ISO 14001.

03 R&D

Inspiring innovation, creation and expertise

Hyosung R&D Center identifies innovation, creation, and expertise as core value, and concentrates on world class R&D activities in the 21st century with a philosophy aspiring after customer satisfaction, quality priority, and performance orientation. Hyosung pursues to be the world's best company in the field of heavy electrical machinery, industrial & electrical electronics engineering, and energy system. Ever since establishment in 1978, R&D Center had led the development of domestic technology. Along with the Anyang and Changwon labs, the group has endeavored to produce core technology and world-class products in the areas of heavy electrical machinery, energy system, electrical electronics engineering, and industrial automation system.

Research Areas

Hyosung R&D Center engages in the activities in the field of energy system, solution & service, applied electrical and electronic technology, basic core technology, technology of improved reliability, core components, and new materials.

Energy System

- Renewable energy (wind system, wind turbine, wind PCS, solar system, PV PCS, fuel cell, co-generation)
- Electric Vehicle (EV charger, EV motor)

Solution & Service

- Power facility diagnosis algorithm and system
- Power facility lifecycle evaluation system
- Service solution for remote diagnosis for prevention

Applied Electrical & Electronic Technology

- Power conversion system
- Flexible AC transmission system and high voltage direct current
- Power quality solution

Basic Core Technology

- Fortified technology in structural dynamics, electromagnetics, heat transfer analysis, etc.
- Skills for system simulation, analysis and evaluation
- Business support technology

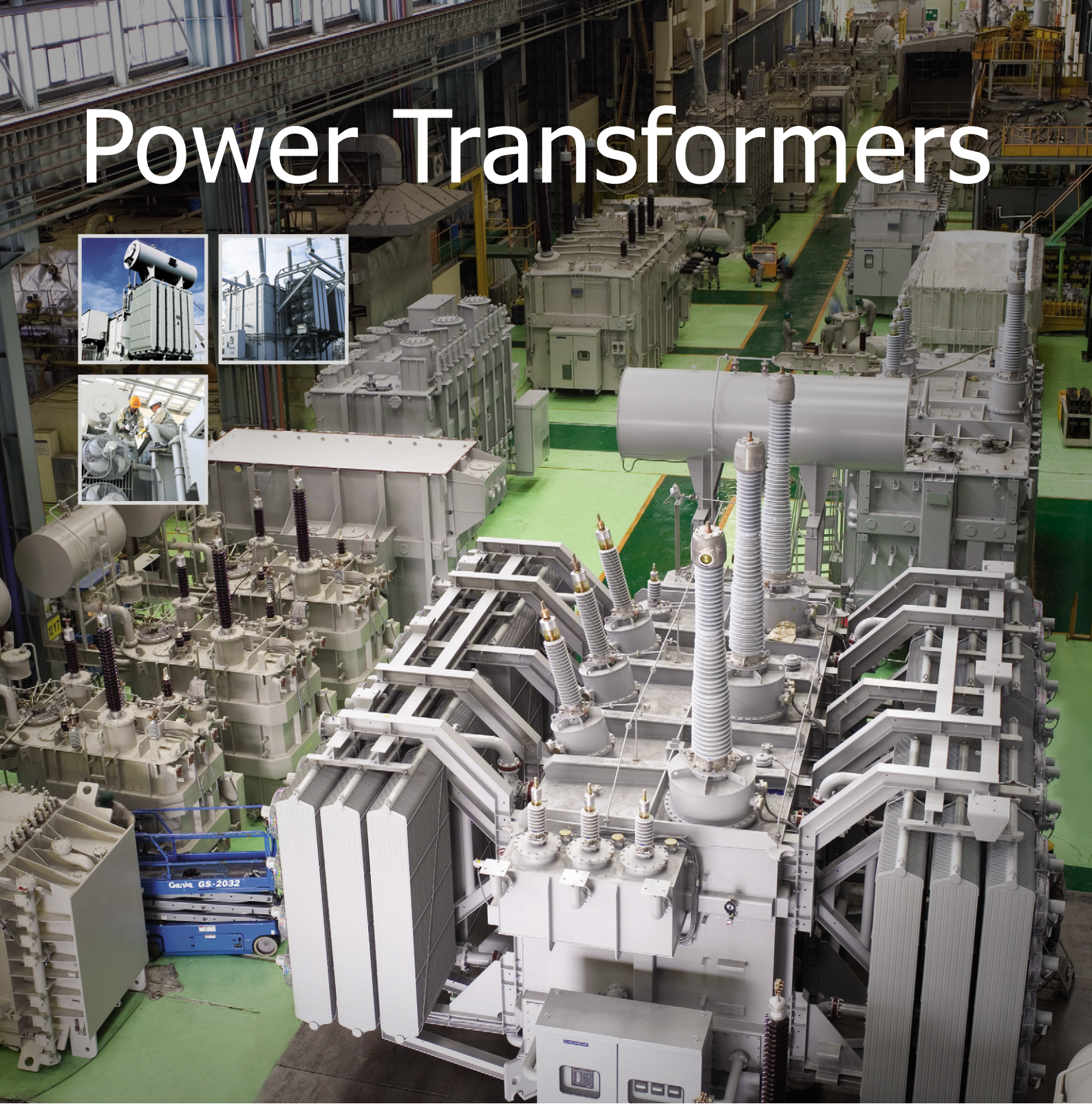
Technology with Improved Reliability

- Test data analysis and testing facility
- Analysis of lifecycle and cause of error
- Reliability assessment (environment-friendliness, durability, long-term degradation, and more)

Core Components and New Materials

- Organic and inorganic insulation materials
- Silicon forming technology
- Intelligent sensor (facility diagnosis, CT, PT, VT, LA, and more)

Power Transformers



Technology

Hyosung is the leading supplier of the power transformer industry. Starting with the development of the 154kV high-voltage transformer in 1969, Hyosung introduced the 345kV and the 765kV transformers subsequently for the first time in the country, and the sixth in the world. Hyosung's power transformers are designed to withstand all environmental hazards.

In the rated power range up to 2000MVA and operating voltage up to 765kV, these transformers have off-load or on-load tap changers to adapt them to various network conditions. Hyosung manufactures transformers under IEC, JEC, ANSI, BS and all required national standards. Hyosung offers individual solutions for satisfying requirements related to types of operation, low noise and low losses, connection technology, type of cooling, transportation, installation and so on.

Various Types

Various types of transformers are available according to the specific requirements including single phase and three phase transformers, auto and multi-winding transformers, reactors and transformers for special applications such as furnace transformer, rectifier transformer and more.

Fit Design

If there are any constraints related to transportation or site conditions, we can offer fit design transformer to ensure smooth shipping and installation. We also possess experience in transportation by airplanes.

Safety

To ensure safe operation of our transformers, potential hazards are identified and eliminated at all stages. Safety during installation is ensured by extending on-site support to customers by our experienced and efficient supervisor.

Flexible Manufacturing System

Our production flow management system is fully computerized and automatically controlled to prioritize and finalize the manufacturing schedules based on delivery dates. This system yields the most optimized use of resources and also enables us to accommodate the unexpected and/or urgent orders by customers with shorter time delivery requirements.

Simple Handling and Maintenance

Compact design of our transformers ensure easy and smooth handling of transformers whereas Efficient design and manufacturing process and use of reliable components and accessories from reputed manufacturers ensure the trouble free operation rendering low maintenance cost of the equipment.

Customized Solutions

Tailor-made customized transformers can also be supplied based on the specific requirements.

Smart Grid Enabled

Design, manufacture, installation, and maintenance & repair of electric power facilities (transformer, GIS, and switchboard) are based on technology and knowhow accumulated over the past 35 years. By linking Hyosung's new preventive diagnostic system, users can diagnose the status of the equipment and schedule inspections through data received in real-time, including partial discharge and insulation oil deterioration, OLTC monitoring, insulation oil temperature, operation status of cooling fans, pumps, motor operation, and oil filter pressure.

General

As the first domestic manufacturer of 765kV power transformers, Hyosung has earned a reputation of having the highest quality for over 40 years. We offer various types of power transformers with ratings up to 765kV. Our transformers have off-load or on-load tap changers to adapt to various network conditions and satisfy both national and international standards. We make sure that the overall quality of design, manufacturing and testing of our power transformers meet the specific specifications of each country and we offer customized services to ensure customer satisfaction.

Production scope

- 110kV~765kV Core Form transformers
- 110kV~765kV Shell Form transformers
- 110kV~765kV Shunt reactors
- Special purpose transformers

- Shunt reactors
- Scott transformers
- Gas-insulated transformers
- Furnace transformers
- Mobile transformers

World Class Technology and Capacity to Meet Global Challenges

- Type / Rating
- Core Form : Up to 3ph 765kV 2000MVA
- Shell Form : Up to 3ph 765kV 1500MVA



Core Form



Shell Form



Transformer Production Hall

Design Concept



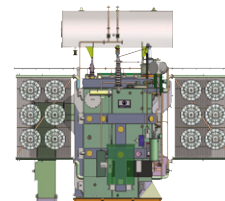
Hyosung's transformers are designed and manufactured through verification from the design stage using design program, electromagnetic field analysis program, and structural analysis program.

Dielectric Strength

Hyosung transformers offer superior dielectric strength to withstand impulse voltage. Our advanced technology design principles ensure low capacitance between winding and the ground for proper coordination of insulating material mitigating any potential creepage issues.

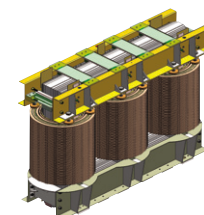
Thermal Capability

The coils that form the electric circuit inside the transformer as well as the core material which creates the magnetic circuit must dissipate heat effectively. This heat must be released through the insulating oil which in turn radiates to the air through the cooler or radiator system. This cooling effect is vital as it is directly linked to insulation life and the total capacity of the transformer. Hyosung's transformers emphasize improving cooling performance as well as regulating the temperature of the hottest spots by using an advanced cooling system.



Mechanical Strength

Hyosung transformers exhibit excellent mechanical strength because the design is able to distribute mechanical force evenly in event of a short circuit condition. Consideration is also given to engineering for overseas and rail transportation requirements required for delivery to the customer's site.

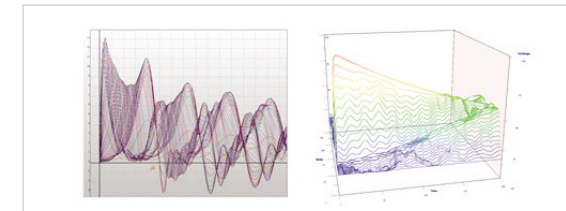


Design and Analysis

Hyosung transformers distinctly stand out from the competition with world-class engineering and unparalleled quality. Our engineering teams use highly efficient, reliable and accurate software programs based on state-of-art techniques for preparing most optimized design to deliver the low cost and high quality products. 2-D electric field analysis for optimization of insulation structure, 3-D magnetic field analysis for determination of partial overheating and tank shield optimization and stress analysis for determination of seismic withstand and short circuit capability are few to name. Our 3-D CAD engineering system allows us to review the final product before assembly preventing errors and minimizing defects at manufacturing stage. Our dedicated R&D cell continue to research and develop innovative, efficient and cost effective designs and working towards standardization of the design parameters to reduce the lead cycle time.

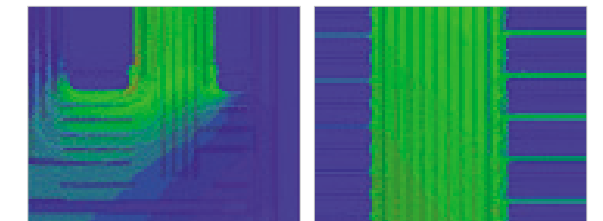
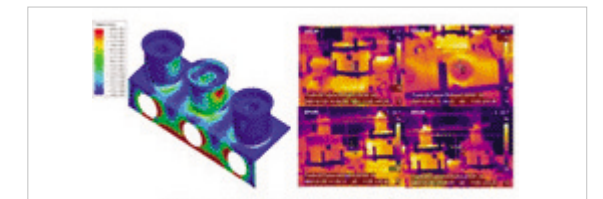
Transient Analysis

The program uses advanced technique for calculation of the various parameters like stresses on each turns, coils and windings. The windings are divided into several segments and the actual test conditions are simulated by proper input. The program gives the values of resistance, inductance and capacitance which are further used to calculate the electrostatic stresses along the winding and determine adequacy of the insulation structure and requirement of intershielding and/or interleaving.



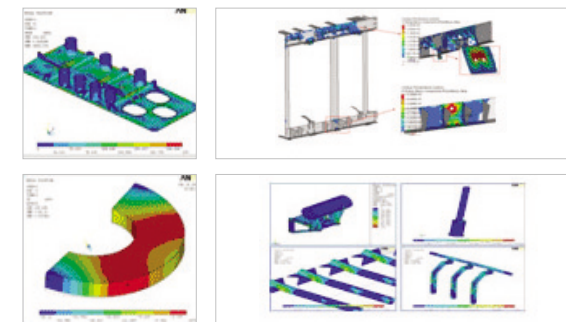
Magnetic Field Analysis

Electromagnetic calculations are performed to describe the stray field in a transformer and to calculate transformer parameters such as impedance, losses and short-circuit forces can be made in the initial design stage.



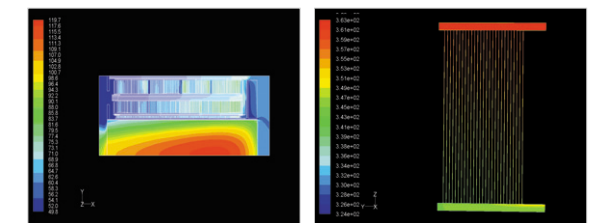
Structural Analysis

Structural analysis is performed to ensure safe operation of the transformer and a robust construction to withstand static and dynamic forces.



Thermal Analysis

Computational Fluid Dynamics (CFD) is used to understand the thermal behavior of the transformer. CFD analysis enables the designer to accurately calculate the fluid velocity, oil and winding temperature in all parts of the transformer.



Data Management

Hyosung maintains database of its engineering schematics. By using our PDM (product data management) system, the design lead cycle time can be reduced by fetching data from existing high quality design units for reference at design stage. Our commitment to provide the transformers with best quality at most competitive price inspires us to strive for innovative research and development which in turn brings perfection to our products making us a reputed name in transformer industry.

Products and Details



Core Form Transformers

Core form transformer refers to the structure of locating low-pressure/high-pressure winding surrounding core to concentric circle.

Characteristic

- Compact structure
- Easy assembly
- Linear potential distribution
- Circular form with short circuit strength
- Easy inspection and repair

Item	Phase	Rated Voltage	Capacity
765kV Transformer	1 ph	765/345/23kV	667MVA
345kV Transformer	3 ph	345/230/13.8kV	700MVA
230kV Transformer	3 ph	245/23kV	875MVA

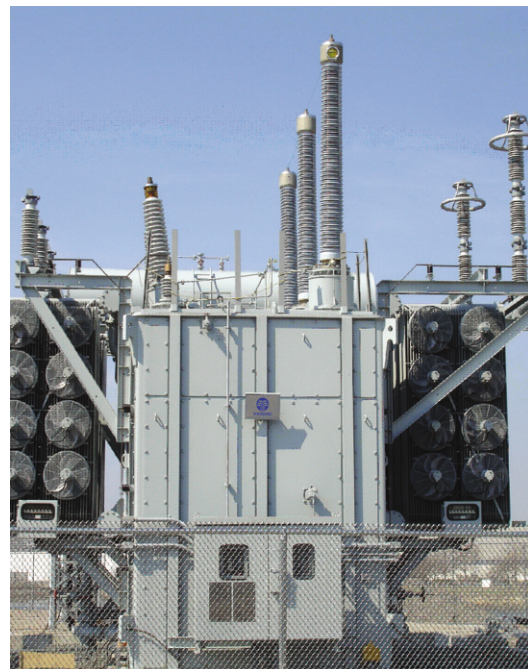
Shell Form Transformers

Shell form transformer refers to the structure of layering core around winding to support winding from the circumference.

Characteristic

- Consistent potential distribution
- Short circuit strength allowing for high dielectric strength
- Outstanding cooling efficiency
- Easy manufacturing of special transformers
- Lay-down shipping

Item	Phase	Rated Voltage	Capacity
765kV Transformer	1 ph	765/345/23kV	667MVA
345kV Transformer	3 ph	345/230/13.8kV	700MVA
230kV Transformer	3 ph	245/23kV	875MVA



345kV Transformer



765kV Transformer



230kV Transformer



500kV Transformer



345kV Transformer



765kV Transformer

Products and Details

Special-Purpose Transformer

Shunt Reactor

The purpose of installing shunt reactor is to compensate no-load/light load capacitance in long-distance EHV (Extra High Voltage) transmission system or control voltage rise caused by sudden change in load.

Scott Transformer

Scott transformer, which is used to transfer power from 3-phase to 2-phase or vice versa, is typically used at railways and electric furnace since it is generally designed to supply 2-phase power from 3-phase power.

SF₆ Gas Transformer

SF₆ gas transformer has no risk of explosion and fire and no damage for lives and environment even if leaks. Hyosung's SF₆ gas transformer has advantages on reducing rate of damp, increasing reliability and optimizing the internal and external structure of transformer.



SF₆ Gas Transformer

Furnace Transformer

Load in the latter part of transformer is electric furnace in which 2nd voltage is substantially smaller than 1st voltage. Heavy amount of electric current flows in 2nd voltage

Mobile Transformer

Mobile transformer is manufactured so that it can be assembled during installation and be delivered quickly.

It is always transported and operated in fixed conditions in a trailer.

Lately, special insulating materials suitable for high temperature are being used in the manufacturing process to satisfy transportation conditions and maximize capacity.



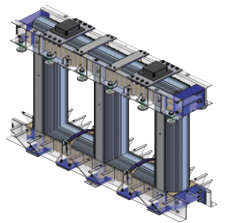
Mobile Transformer



Compartments

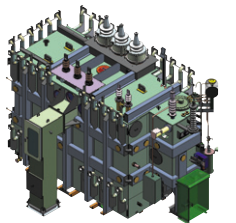
Core

The core is layered step-by-step to maximize space ratio. The same detailed process is utilized whether the transformer being manufactured is core form or shell form design.



Tank

The transformer tank enclosure is robustly manufactured with the necessary strength to protect all internal structures, to contain and preserve insulating oil and to withstand internal pressure during faults. Each tank is manufactured according to customer specification with manholes or hand-holes in locations to allow for simplified installation, maintenance inspection as well as repair.



Winding

The quality of the winding material and how it is processed during manufacturing contribute greatly to the overall quality of our transformers. Hyosung's transformers apply state-of-the-art manufacturing methods for both core form and shell form using advanced materials including rectangular wire or CTC (Continuously Transposed Cable).

In addition, the winding process is completed in a dust-proof clean room with both temperature and humidity controls which meets NAS 100,000 grade.

Core Form



Shell Form



Manufacturing Process



Coil

Core Form

Coil is designed and manufactured to withstand the impulse voltage and prevent it from distortion when a short circuit occurs. Conductors will be transposed at sufficient intervals to minimize currents and equalize the current and temperature distribution along the winding.



Shell Form

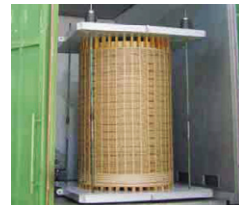
The narrow high-dielectric strength paper is spirally wound in several overlapped layers by winding machine around each strand and layer of subdivided conductors. The outermost paper tape layer has a thermosetting coating. This bonds the coils after clamping and oven-drying to insure mechanical strength and freedom from shifting of turns during assembly.



Insulation

Core Form

The reliability of transformers depends principally on the quality of the insulation system. The insulation system has to meet the following requirements: high dielectric strength, low partial discharge levels, mechanical stability, efficient heat dissipation and long-lasting durability.



Shell Form

Pressboard sheets, having high dielectric strength when oil impregnated, are formed into channels, washers and spacer block assemblies. These are interleaved around and between the coils during stacking to insure adequate electrical clearances and oil flow. The pressboard insulation is only used in compression.



Core Construction

Core Form

The most important part of construction of core is having high permeability and low hysteresis. Structural rigidity is given to the structure material of core form's core by the use of steel plates at the bottom of the core.

Therefore, distortion due to short circuit stresses or transport handling can be prevented.



Shell Form

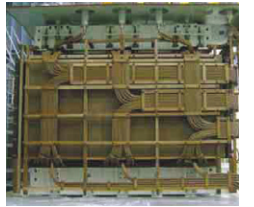
The core material is Hipersil, a cold rolled, grain-oriented, highly permeable, annealed and non-aging silicon steel that will carry one third more flux per unit area than ordinary electrical steel. Each lamination is coated with inorganic insulator.



Core and Coil Assembly

Core Form

Coils are sized and clamped after assembly with the core by being pressed with a special hydraulic fixture, then clamped to the end and lock plates. In the case of core-form transformer, core and coil are supported by vertically connecting leg core to lower yoke and assembling each winding to leg core where the upper tempering iron is assembled on top of the winding.



Shell Form

The coil assemblies are lowered into the form-fit tank bottom and wedged securely in place. Hipersil laminations, stacked on fill blocks around the coils and on a T-beam through the coil openings, are applied with overlapped joints to increase mechanical strength and keep exciting current at a minimum. The core section in the coil openings are wedged at the top to compress the core and to hold the coil assembly rigid. Wedges are driven between phases, top fill blocks are positioned and vertical wood pieces, with pressboard channels that are connected between the top and bottom fill blocks.



Tanking

Core Form

The transformer is provided with a suitable steel tank of substantial construction which is oil-tight and gas-tight. Also, all gaskets are made of materials which do not deteriorate under service conditions. The tank has sufficient strength to withstand an internal pressure of full vacuum and vacuum drying without damage or permanent deformation.

In the case of core-form transformer the joint between the tank and cover is provided with suitable flange and gaskets at top of the tank so that the assembly service is oil-tight and gas-tight.



Shell Form

The form-fit shell form tank designed and built into a unit assembly of high inherent strength withstands the effects of vibration, handling, application of vacuum during the oil filling and prevents oil leakage with suitable gaskets. The form-fit top section, with end frames and side channels welded inside, makes the core into a rigid body when it is lowered over the wood pieces, pulled down and welded to the tank bottom.



Total Quality Assurance

At Hyosung, our goal is not only to meet the needs of our customers today but also to provide them better life in the future.

Hyosung's total quality commitment to our customers is demonstrated by providing the highest quality product at the most competitive prices with on time delivery. Hyosung achieves these high quality levels through our integrated quality assurance program. Hyosung's products are used extensively both at home and abroad. This level of experience allows Hyosung's quality assurance and reliability to exceed those of our competitors. We share our customer's goals with high quality products. From design to assembly, testing and installation, our customer's requirements are our minimum standards. All tests are based on International standards and our customer's requirements. Through additional testing, Hyosung seeks to exceed established testing criteria, thereby producing more reliable products. Our special process operators and technicians are highly trained. Continued professional growth and advanced training are encouraged through internal training groups and outside courses.

All Hyosung's products have ISO 9001, ISO 14001 and OHSAS 18001 certifications. Hyosung endeavors to maintain the highest quality.

Scope

In line with major international standards for quality assurance, the quality assurance program of our plants includes the following elements.

- Contract review
- Inspection/test control
- Design control
- Measuring and test equipment
- Procurement document control
- Storage, handling and shipping
- Material purchasing
- Nonconforming item
- Identification
- Quality assurance records
- Special process



ISO 9001



ISO 14001



OHSAS 18001

Product Development History

Year	Milestones
2010	765kV Auto Transformer (1ph 765kV 500MVA) 875MVA GSU Transformer (3ph 230/23kV 875MVA)
2009	100MVA STATCOM IED for preventive diagnosis of Transformer (IEC61850) 765kV Auto Transformer (1ph 765kV 500MVA & 765kV 333MVA) 990MVA GSU Transformer (3ph 345kV 990MVA)
2008	SF ₆ Gas Insulated Transformer (1ph, 154kV, 60MVA/Bank, 1.3kg/cm ²)
2007	765kV GSU Transformer (1ph, 20.9/765kV 182.2/204MVA)
2004	154kV 80MVA unified power flow controller (FACTS) pilot plant
2003	

Year	Milestones
2002	SF ₆ Gas Insulated Transformer (1ph, 154kV, 60MVA/Bank, 3.8kg/cm ²)
2001	154kV 40MVA Transformer for FACTS
1999	765kV Auto Transformer for commercial use (1ph, 765kV, 2000MVA/Bank)
1997	345kV Shunt Reactor (3ph, 345kV, 100MVAR & 200MVAR)
1992	765kV Transformer (1ph, 23/765kV, 3MVA)
1986	Amorphous Transformer
1984	154kV phase-separated Transformer (3ph, 154kV, 386MVA)
1978	345kV Auto Transformer (1ph, 345/161kV, 500MVA/Bank)
1969	154kV Power Transformer first in Korea (3ph, 154kV, 40MVA)

Global Network

