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HYOSUNG

Cast Resin 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.

Cast Resin 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)

Cast Resin Transformers

General

Hyosung has led the world cast coil industry for 25 years after developing Cast Resin Transformers in 1982. Hyosung has introduced a rectifier transformer, an amorphous transformer and a high-efficiency transformer with its own technology. Hyosung will continue to maintain the superior quality that can satisfy all of its customers around the world, and will endlessly continue its efforts to provide the value its customers truly desire.

Hyosung manufactures Cast Resin Transformers under IEC, JEC, ANSI, CESI, KEMA and every required national standard.
Hyosung Cast Resin Transformers are designed to withstand all environmental hazards, high vibration, fire risk, heavy shocks, etc.

Technology

Features

Self-extinguishing characteristics of epoxy significantly reduces the spread and effect of a fire, and the possibility of explosion is nearly non-existent

Easy transportation and installation with simple structure

No toxic substance (oil or gas) discharged

Extended lifetime
- Adopts a higher class epoxy resin
- Epoxy Resin: uses H class epoxy resin, which is higher than the standard F class, as the main insulation material of the mold transformer to control thermal aging and extend the overall lifetime of the transformer by three-folds. Provides also higher overload capacity.

High stability and durability with strict quality management
- Adopts a higher class epoxy resin
- Vacuum Casting for HV & LV Coils : ·High mechanical (No - Crack) and electrical strength ·High Short-Circuit Strength ·No air-bubble or void inside a coil ·Free of partial discharge
- Insulation System : ·Operates in humid places (environments with humidity higher than 95%) with varying temperature conditions ·Resistance against the Extreme Temp. (-25℃ ~ +50℃)
- High Short-time overload capacity safe under fluctuating loads
- Space Saving : Compact design based on our accumulated experience
- Winding structure : when the radial build (RB) of the Vacuum-Cast winding is large, the temperature gradient between the imbedded conductor and the outer surface of the winding gets higher, then cracks in the epoxy body may cause partial discharges. Therefore, when the RB is large, air ducts are inserted splitting the RB in thinner sections, then the temperature gradient between the imbedded conductor and the outer surface is reduced and cracking is prevented.
- When the air ducts are inserted, the electric field distribution of the Vacuum-Cast winding is improved and the withstanding voltage becomes more resilient against external surge.
- Vacuum-Casting process quality management : By strengthening quality management and a strict control of the Vacuum-casting process which determines the electrical and mechanical quality of the windings, the quality of the Vacuum-casting is performed (*The epoxy casting material is tested regularly and is required for checking the Tg (Glass transition temperature), the temperature at which the epoxy mix transits from the solid glass-like state of the solid polymer to the flexible rubber-like elasticity state as well to control the reactivity and the gel time of the epoxy casting system to maintain process stability.)
- By adopting the latest analysis technique, the transformer can be operated under severe conditions.

Installation Site

Scott connected transformer, Grounding transformer, Auto transformer

Where the installation condition is limited

Where fire prevention is required (Flame Retardancy)

Where customers request reliability

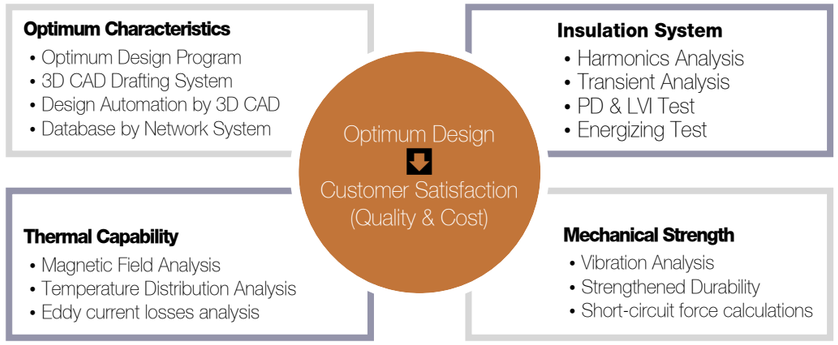
Transformer for special load : Inverter, converter, UPS system, electric arc furnace, variable transmission drive, electric welding device, industrial process control

Where the eco-friendly and environment-resistance is necessary
- Common and public facilities : Condominiums, hotels, studio apartments, shopping malls, hospitals, and other public facilities
- Manufacturing factories : Automobile factories, semiconductor factories, and chemical factories
- Ships and renewable energy facilities : LNG ships, electric propulsion ships, and wind power generation systems
- Special areas : Power plants (nuclear, water, fire, wind, and tidal), airports, subways, container cranes, and tunnel excavation work

Design Concept

Design Concept

Basic Design Concepts



Transformer Tests

For the best quality, all tests are based on international standards, and our customers' requirements.
We guarantee the best quality of our products testing the following :

Routine Test
- Appearance Check
- Measurement of Insulation Resistances
- Measurement of Winding Resistances
- Measurement of Voltage Ratios
- Check of Voltage Vector Relationship
- Measurement of Impedance Voltage & Load Loss
- Measurement of No-Load Loss & Exciting Current
- Power Frequency Withstand Voltage Test
- Induced Over-Voltage Withstand Test
- Core to Frame Insulation Test
- Partial Discharge Test (below 10pico)

Line Test (for perfect quality management)
- Gel Time Test : Measures whether resin is adequately mixed at a right ratio
- Tg Test : Measurement of Tg. (Glass-Transition Temperature) for right mixing of resins
- ASH Content Test : Measures whether filler is evenly distributed

Type Test
- Impulse Test
- Temperature Rise Test
- Sound Level Test

Special Test
- Short Circuit Test
- Fire Behavior Class Test by FILK
- Seismic Test
- Thermographic Imagery Analysis
- Climatic Class Test
- Environmental Class Test

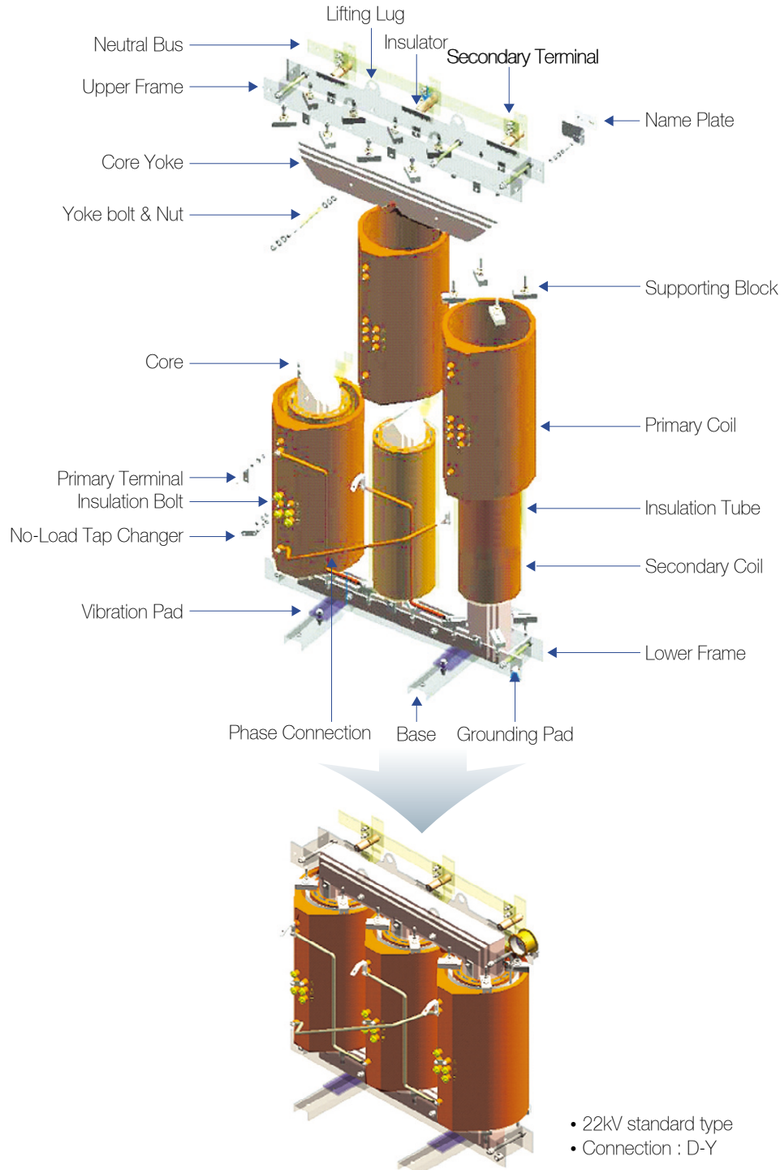
Accessories

Cooling Fan & Controller
Selection is made in consideration of the cooling requirements, enclosure type and location

Temperature Sensor (GW-03)
A sensor, to measure the winding temperature, is installed in the secondary coil. The controller is equipped with a circuit that enables to turn on/off the Fans

Construction

Assembly Diagram



- 22kV standard type
- Connection : D-Y

Products and Details

Product Scope

Hyosung offers three-phase and single-phase Cast Resin Transformers in the following ratings :

- **Rated Frequency** : 50Hz or 60Hz
- **Thermal Insulation Class** : B, F
- **Winding Conductor** : Aluminum or Copper
- **Capacity Available** : From 100kVA up to 40MVA
- **High Voltage** : 36kV, 24kV, 17.5kV, 12kV, 7.2kV, 3.6kV, ≤1.1kV
- **Low Voltage** : 6.6kV or 3.3kV, 600V below
- **Coil Temperature Rise**
  - Primary : 80°C, 100°C
  - Secondary : 80°C, 100°C
- **Applied Standards** : IEC, ANSI, NEMA, DIN, JEC
- **Bisic Lighting Impulse Insulation Level (BIL)** : up to 170kV

Item	Description						
Voltage Class	36kV	24kV	17.5kV	12kV	7.2kV	3.6kV	≤1.1kV
BIL	145/170kV	95/125kV	75/95kV	60/75kV	40/60kV	20/40kV	-

Standard Specification

Classification		Description						
Installation Area		Indoor						
Rated Voltage (kV)	1st Voltage and Tap Voltage	F23.9-R22.9-21.9-20.9-19.9			F6.9-R6.6-6.3-6.0-5.7 F3.45-R3.3-3.15-3.0 -2.85			
	2nd Voltage	6.6 or 3.3	0.38-0.22	0.22-0.11	0.38-0.22			
Phase		3ph	3ph	1ph	3ph			
Standard Connection		△-△	△-Y	1ph, 3-wiring	△-Y			
Rated Capacity(kVA)			75	75	75			
			100	100	100			
			150	150	150			
			200	200	200			
			300	300	300			
			500	500	500			
		750	750		750			
		1,000	1,000		1,000			
		1,500	1,500		1,500			
		2,000	2,000		2,000			
		3,000	3,000		3,000			
		4,000	4,000		4,000			
		5,000	5,000		5,000			
		7,500						
		10,000						
		15,000						
		20,000						
Frequency		50, 60Hz						
Insulation Class		Primary : F, B Secondary : F, B						
Average Winding Temperature Rise		Primary : 100°C, 80°C Secondary : 100°C, 80°C						
Standards		IEC, ANSI, NEMA						
Dielectric Strength / Voltage Class		36kV	24kV	17.5kV	12kV	7.2kV	3.6kV	≤1.1
Power Frequency Withstand Voltage		70kV	50kV	38kV	28kV	20kV	10kV	3kV

Application

1. Location with installation restrictions
2. Location where fire-prevention (non-flammability) is important
3. Location where high-reliability is required
4. Location where environmental friendliness and resistance against hard condition are required

General and public buildings

- Apartments
- Hotels
- Shopping centers
- Hospitals
- Other public buildings

Industrial plants

- Vehicle plants
- Semi-conductor plants
- Chemical plants

Marine and new energy generation facilities

- LNG vessel and electric-driven vessels
- Wind Turbines
- Photovoltaic generation

Special public service projects

◀ *Wolseong atomic power plant 7.5/10MVA (supplied in 1995, currently in preparation of replacement)*

Incheon International Airport (1999~) ▶

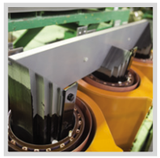
- Power plants (atomic, hydroelectric, thermal, wind, tidal)
- Airports
- Subways
- Container cranes
- Tunnel excavation

Special load applications

- Inverter & Converter
- UPS Systems
- Electric Arc Furnaces
- Adjustable Speed Drives
- Electric Welding Equipment
- Industrial Process Controls

Special Transformers





Customized Transformers for buildings and apartments

Withstands against harmonic waves distortion in general buildings
Hyosung transformers are designed to ensure safe power supply under harmonic distortion.

Low-loss type
Our Cast Resin Transformers are designed to meet today's high efficiency standsrds requirements.

Transformer for IT Centers

Quiet environment for substations
To create a quiet working environment, the noise level of transformers is kept at a minimum level, Using anti-vibration rubber Pads.

Provision for UPS load
We produce transformers which are designed to withstand neutral harmonics, depending upon work place conditions.

Moisture-proof
Both high and low-voltage coil windings are casted to prevent humidity ingress.

Transformer for Inverters and Converters

Withstands against harmonic waves distortion
Hyosung transformers are designed to withstand harmonic waves by lowering the magnetic flux density thus minimizing noise and vibration.

Strengthened durability
Both high and low-voltage coil windings are designed with increased mechanical strength to bear short-time overload.

Measurement of harmonic wave distortion at customers' site
Hyosung can provide on site THD(Total Harmonic Distortion) and harmonics load distribution measurements after installing a transformer, Providing feedback to customers upon request.

Transformers for Semi-Conductor Plants

Provision for DC and inverter loads
Voltage regulation is minimized, and noise and vibration are kept at low level.

Environment-friendly transformer
With easy and minimum maintenance, Hyosung's Transformer keeps clean and safe the environment.

High reliability and safety
Both high and low-voltage coil windings designed with increased mechanical strength to bear short-time overload.

Transformers for Wind Turbines

More stability during the operation
SA (surge absorber) is equipped as default, and the BIL voltage can be increased up to 170BIL upon request to reflect changing climate conditions.

Locating substation within Nacelle
Considering the vibration caused from the blade, Hyosung transformer is equipped with earthquake-proof design as well.

Transformers for Photovoltaic Power Generation

Minimizing no-load loss(high-efficiency transformer)
Considering long stand-by periods and low average load of 15~20% due to climate conditions, the transformer is designed to minimize no-load loss to enable high quality power generation with remarkable efficiency and performance.

Longest durability of 20 years
The transformer is built with the leading edge technology and high quality materials to ensure maximum durability.

Transformers for Vessels

Special installation
Hyosung transformers are designed to operate optimally at temperatures up to 55°C and reinforced to withstand extreme vibration.

Global service network
To ensure timely customer service, the Hyosung network is established world-wide (Pittsburgh, L.A, Rio de Janeiro, Rotterdam, Singapore, Shanghai, etc.)

Transformers for Other Customers

Hyosung can design and produce customized transformers to accommodate various needs of customers.

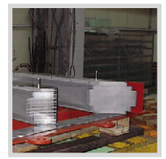
Transformers for hotels
24-hour loads, high stability, environment-friendly, low-noise

Transformers for hospitals
Resistance against harmonic waves distortion, stable power supply

Transformers for sewage treatment plants

Transformers for broadcasting systems, colleges, etc.

High Efficiency Cast Resin Transformers


Uses domain refinement core steel to improve the energy efficiency.

Currently more than 5% of transmitted power is lost due to inefficient power and distribution transformers.Market demand is high for energy-saving(high-efficiency) transformers.
Hyosung successfully developed a 3000kVA high-efficiency transformer, to save costs and improve quality of electricity service.

High Energy Efficiency Equipment

Features

Reduction in no-load loss
The use of magnetic's domain-refined steel laminations for the core (magnetic circuit), which saves stand-by electricity usage by decreasing no-load loss by more than 50% compared to Cast Resin Transformers made of regular grain oriented steel.

Reduction in load loss
Improved coils winding method decreases load loss by more than 20%.

Noise reduction
Environmentally friendly as the noise level is lower than international standards from 5 to 11dB

Withstands against harmonic wave distortion
Can be used under harmonic waves (k-factor 8)

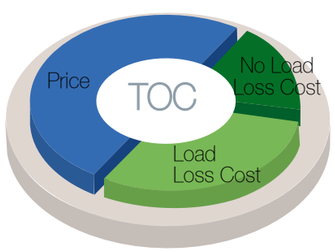
Maximum overload capacity
The thermal time constant of out high efficiency transformers is longer, allowing more margins for winding temperature rise during short-time overload.

Large capacity
Can reach capacity up to 40MVA

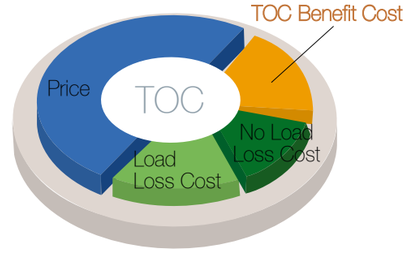
Economic Benefit of Cast Resin Transformers

Usually the 'product purchase' method is used to explain economic benefits of high-efficiency Cast Resin Transformerss.
Costs are evaluated for the Total Owning Cost (TOC) by adding the product price and operating cost (electricity).

TOC (Total Owning Cost) = Initial Purchase Price + Energy Losses (No-load Loss + Load Loss) Capitalization Cost



General Cast Resin Transformers



High-Efficiency Cast Resin Transformers

※The following chart shows that a high-efficiency Cast Resin Transformers uses less electricity and saves cost in the long run, although it requires higher initial investment than general Cast Resin Transformerss.

Core Laminations made of Magnetic Domain Refined Steel

- The product reduced core loss by forcefully distributing the magnetic domain.
- Both mechanical and chemical methods such as laser treatment and geared roll are used.
- In case of laser treatment, core loss deteriorates if the temperature becomes higher than 500 degrees.

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. We achieve these high quality levels through our integrated quality assurance program. Our 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 customers' requirements are our minimum standards.
All tests are based on International standards and our customers' 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 is encouraged through internal training groups and outside courses.
All our products have ISO 9001 and ISO 14001 certifications.
At Hyosung, we endeavor 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
- Purchased materia
- Nonconforming item
- Identification
- Quality assurance records
- Special Process

ISO 9001

ISO 14001

OHSAS 18001

Product Development History

Year	Milestones
2009	ABS Type Test Transformer for Marine Use
2006	AL Foil Type Transformer
2005	Developed Domain Refinement Cast Resin Transformer
2002	Developed Amorphous Transformer
2001	Developed Cast Resin Transformer for Outdoor Use
2000	Developed F1 Class Transformer
1999	Technical Cooperation with HTT
1998	2221kVA Transformer for Rectifiers KEMA Type Test

Year	Milestones
1997	1600kVA Italy CESI Type Test
1995	Successful Type Test of 1000/1333kVA Transformer for Hydro/Coal-fire P/P
1990	Successful Type Test of M&C Type 1000kVA Transformer
1988	Technical Cooperation with M&C
1985	Developed Pre-Preg Cast Resin Transformer
1982	Developed the First Cast Resin Transformer in Korea

Global Network

HYOSUNG