

Beyond

™

**Oil Immersed
Transformer**



LS ELECTRIC

Technological innovation and zero defects. Pride of the world's best beyond Korea top tier.

With states-of-the-art design programs and digital facilities including dust-proof room for absolute quality and high level of management system for manufacturing to inspection.

LS Electric is providing optimized design of oil immersed transformers from distribution to Power transformers and special purpose for HVDC, we are building credibility through flawless control of all process.



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Line-up

From Low voltage to high voltage 380V~550kV

LS ELECTRIC produces zero-defect oil-immersed transformers with the latest clean facilities up to 550kV, 800MVA.

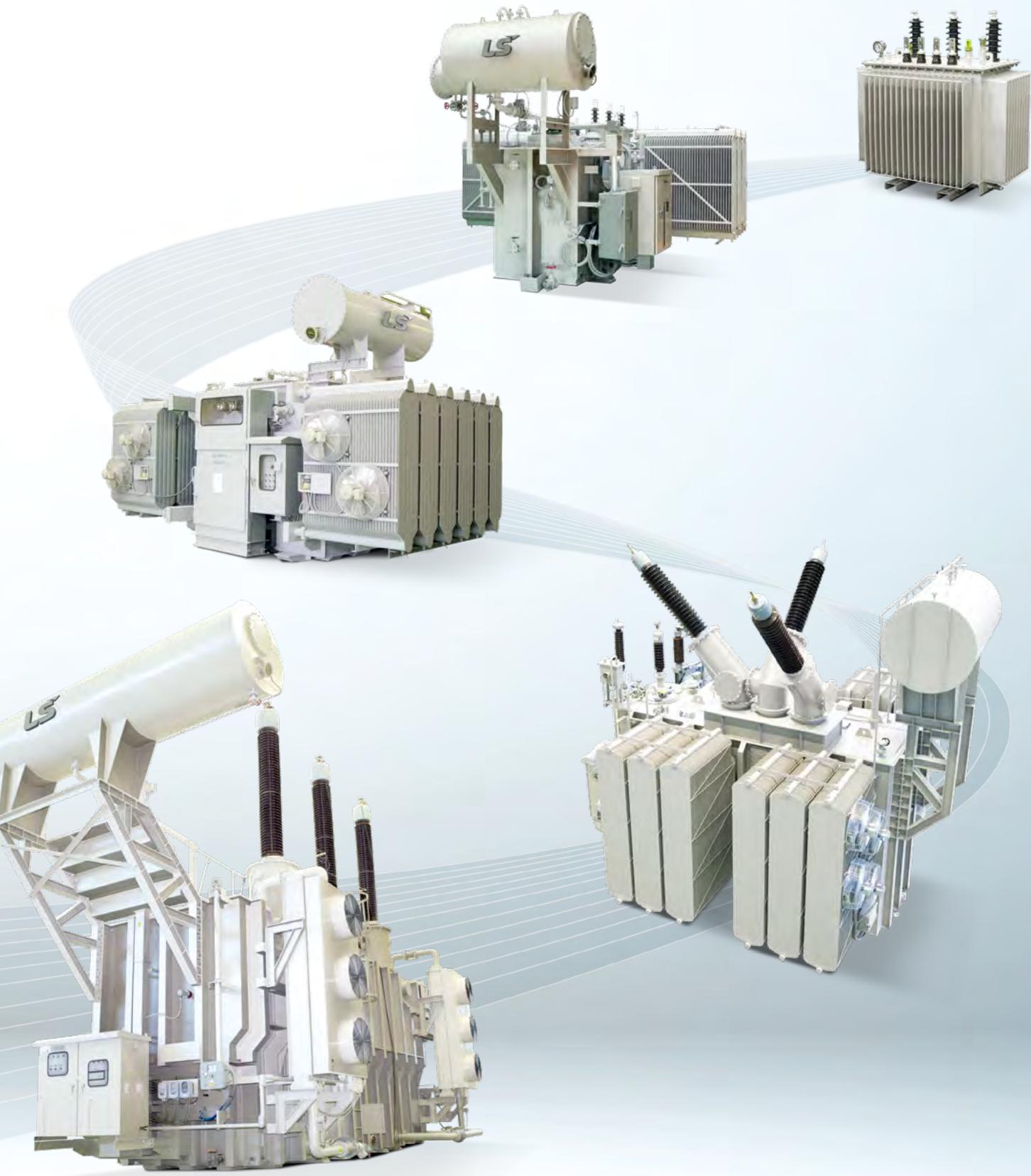
Power Transformer up to 550kV/800MVA

Item	Specification
Applicable Standard	IEC 60076 / ANSI(IEEE) C57
Installation Location	Outdoor / Indoor
Frequency [Hz]	50/60
Insulation	Oil Type
Thermal Class [°C]	105(A)
Winding Temp. Rise [K]	65
Oil Temp. Rise [K]	60
Cooling Method	ONAN, ONAN/ONAF, OFAF, ODAF
Capacity (MVA)	Up to 800 for Three Phase
	Up to 500 for Single Phase

Item	Specification
Oil Preservation System	Conservator Type, N ₂ Sealing Type, Open Breather Type
Base	Skid , Roller
Application	Generation Plant , Substation, Transmission & Distribution
Special Purpose	Scott Connection, Mobile Transformer, Auto Transformer, SVC Transformer, HVDC Converter Transformer

※ LS produces and supplies products conform to customer specification as well as IEC & ANSI standards.





Corrugated Transformer

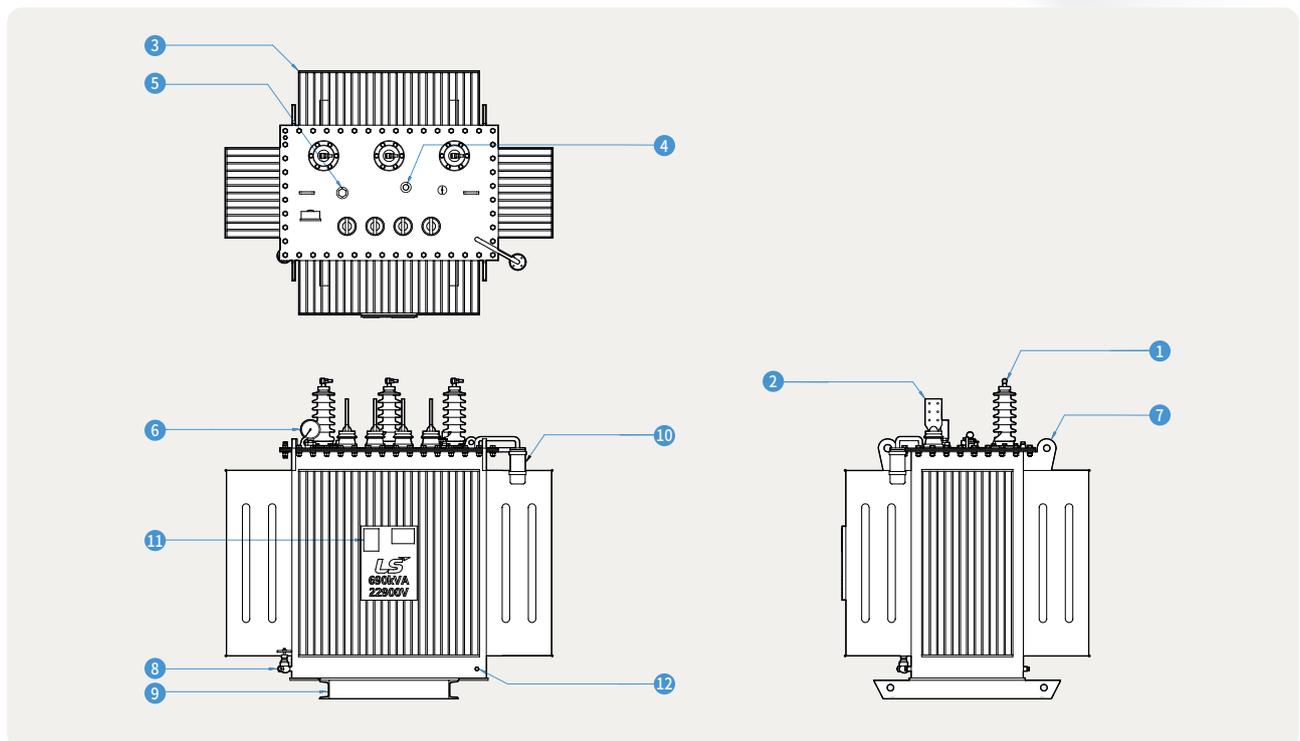
High Efficiency Design

- DOE (US), Toprunner (Japan), etc.

- Capacity : 100~3000kVA
- Voltage : Up to 34.5kV
- Tap Changer : DETC (De Energized Tap Changer)
- Frequency : 50/60Hz
- Cooling type : ONAN



Standard Structure



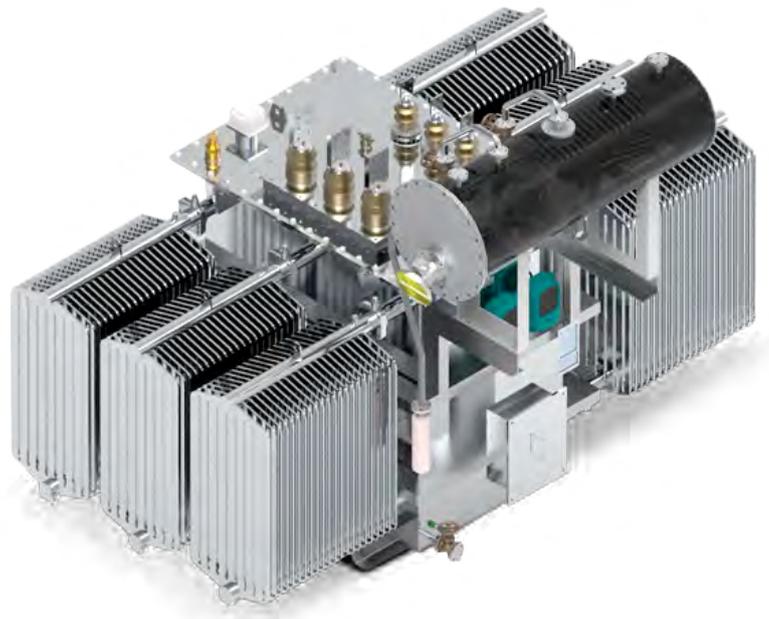
Components

No	Description
1	HV bushing
2	LV bushing
3	Radiator
4	DETC

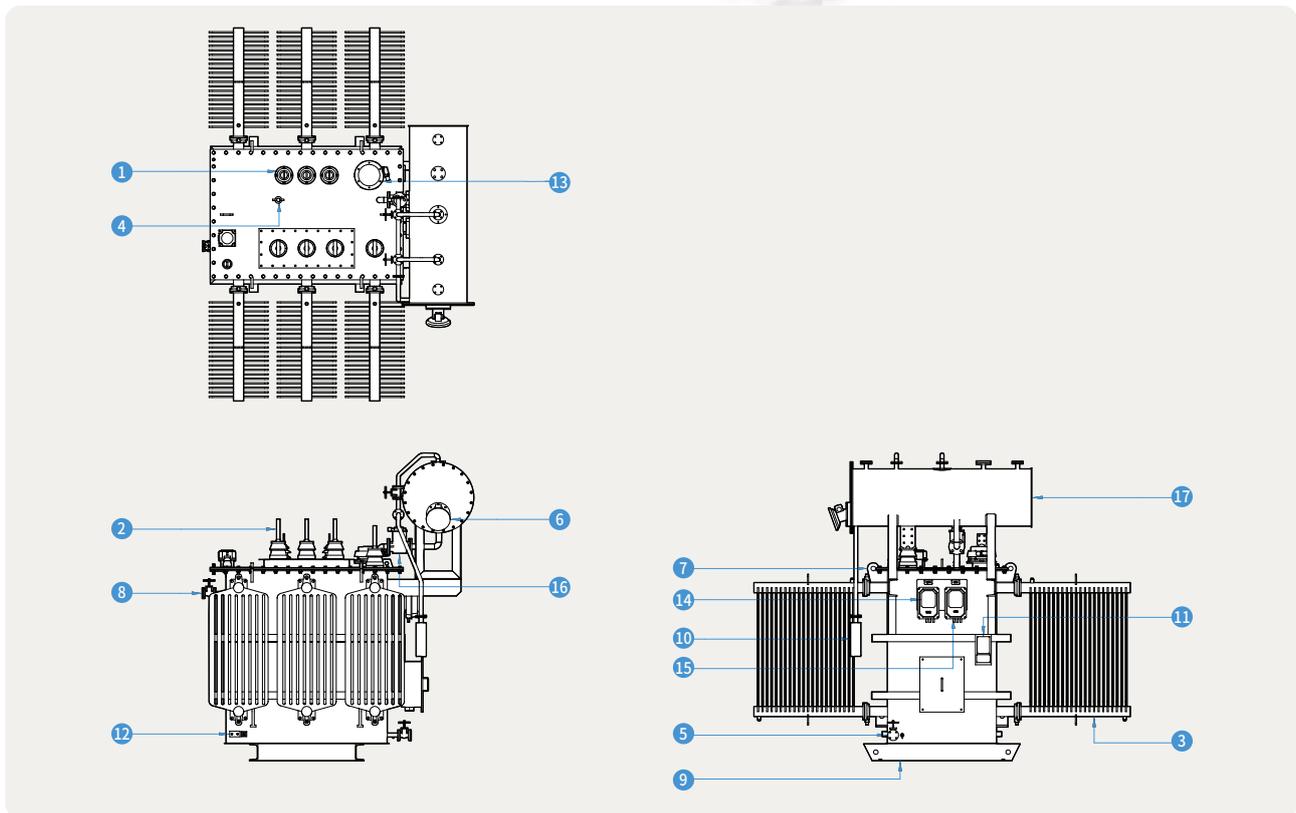
No	Description
5	Oil fill plug
6	Oil level and temp. indicator
7	Lifting lug
8	Drain valve

No	Description
9	Skid base
10	Dehydrating breather
11	Name plate
12	Ground pad

- Capacity : Up to 200MVA
- Voltage : Up to 69kV
- Tap Changer :
DETTC (De Energized Tap Changer)
OLTC (On Load Tap Changer)
- Frequency : 50/60Hz
- Cooling type : ONAN/ONAF



Standard Structure



Components

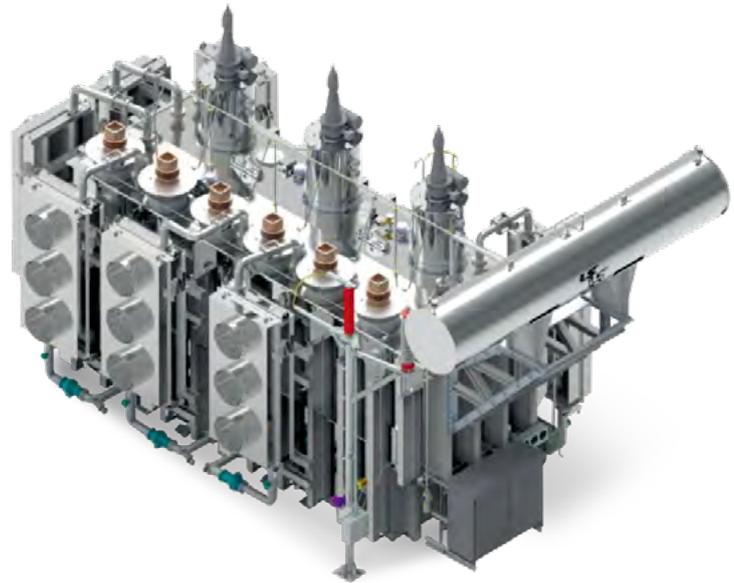
No	Description
1	HV bushing
2	LV bushing
3	Radiator
4	Tap changer
5	Drain valve
6	Oil level indicator

No	Description
7	Lifting lug
8	Filtering valve
9	Skid base
10	Dehydrating breather
11	Name plate
12	Ground pad

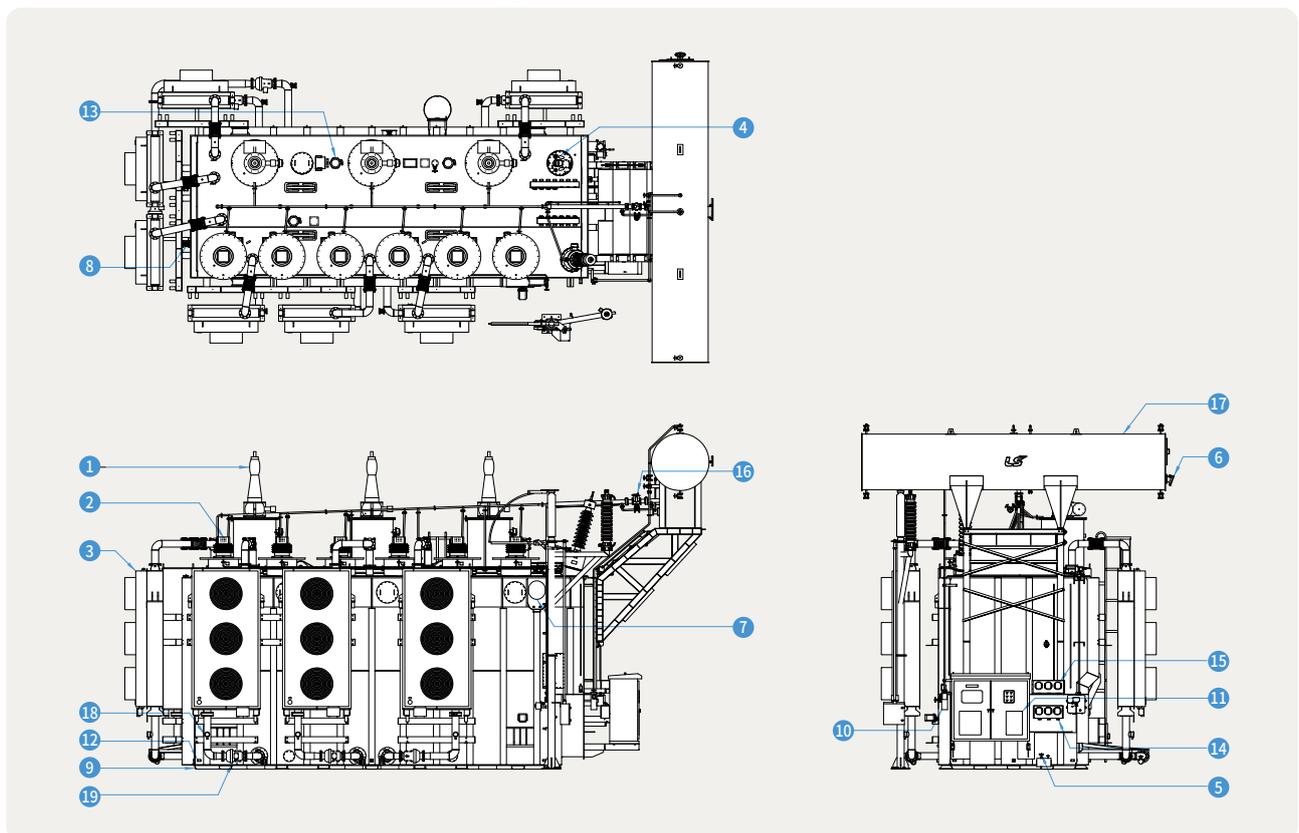
No	Description
13	Pressure relief device
14	Winding temp. Indicator
15	Oil temp. Indicator
16	Buchholz relay
17	Conservator

Power Transformer

- Capacit : Up to 800MVA
- Voltage : Up to 550kV
- Tap Changer :
 DETC (De Energized Tap Changer)
 OLTC (On Load Tap Changer)
- Frequency : 50/60Hz
- Cooling type : ONAN/ONAF/ODAF



Standard Structure (ODAF, Cooler type)



Components

No	Description
1	HV bushing
2	LV bushing
3	Radiator
4	Tap changer
5	Drain valve
6	Oil level indicator
7	Lifting lug

No	Description
8	Filtering valve
9	Skid base
10	Dehydrating breather
11	Name plate
12	Ground pad
13	Pressure relief device
14	Winding temp. Indicator

No	Description
15	Oil temp. Indicator
16	Buchholz relay
17	Conservator
18	Oil flow indicator
19	Pump



Converter Transformer

It is a special transformer used in HVDC system that changes the existing high voltage AC (HVAC) transmission system to high voltage DC (HVDC) transmission system.

The HVDC system is a high value-added power transmission system that can be used for long-distance power transmission, cable power transmission, asynchronous AC grid connection, grid separation, and large-scale renewable energy grid connection. C-TR is an essential component in this system.

HVDC C-TR is designed and manufactured with advanced technology in consideration of electrical and mechanical specificity such as DC Stress, pole reversal stress, harmonic loss, insulation design and structural design of valve bushing, and cooling design as well as existing AC transformer design elements.



Mobile Transformer

Compact type mobile transformer that can be mounted on the trailer is provided.

Mobile Substation has superior mobility and system flexibility compared to conventional substation and is the best solution for emergency power supply (power outage area) or isolated power supply.



Static Var Compensator Transformer

The SVC transformer is the core equipment of the stationary reactive power compensator which improves the electric quality and stability by supplying or absorbing the reactive power inevitably present in the AC transmission system. The SVC transformer connects Thyristor Switched Capacitor (TSC) and Thyristor Controlled Reactor (TCR) to the high voltage transmission system to compensate for reactive power. It is similar to general transformer but it is a special purpose transformer that should be designed to be able to operate continuously for maximum / minimum reactive power compensated operation point.



Scott Transformer

SCOTT transformer is a special transformer that can obtain 2 phase (2 phase, 90° phase difference) output from 3 phase (3 phase, 120° phase difference) power supply.

This transformer is used for special purposes such as when using a large capacity single-phase load as a three-phase power supply. In Korea, it is mainly used for railway supply line, and 3 phase power is converted into 2 phases and divided into upper and lower lines.

In contrast to a conventional SCOTT transformer consisting of two active parts, LS transformer can be configured as one active part, which has advantages such as compact size, weight and competitive price.

Design & Manufacturing Process

Design & Analysis

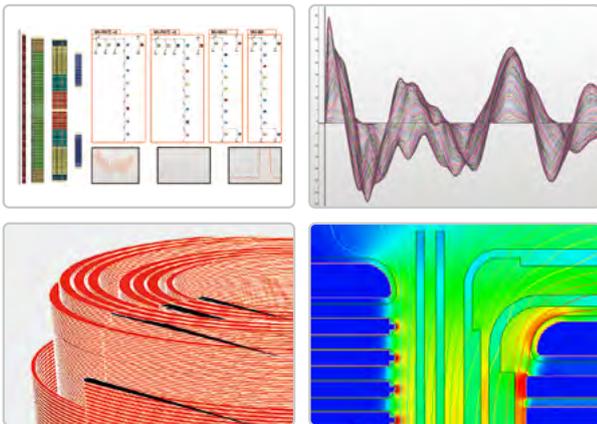
Ensure design reliability/quality by performing 3D electromagnetic field analysis, flow analysis and structural strength analysis based on the latest analysis technology

Electric Field

Electric Field Analysis

- Transient stage voltage oscillation
- Insulation strength against Impulse & AC withstand voltage

Improved reliability with optimal insulation structure



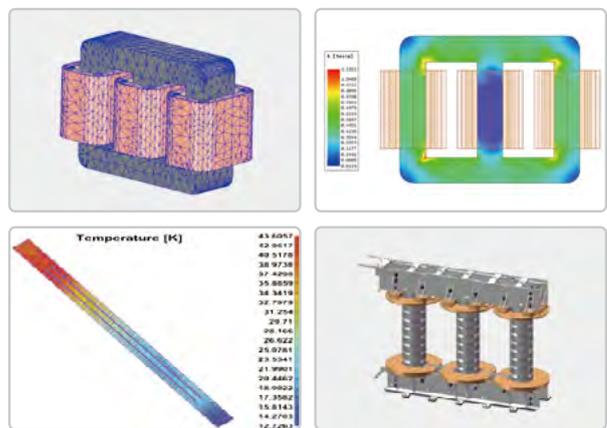
Magnetic Field

3D Magnetic Field Analysis

- Winding overcurrent losses
- Tank losses
- Tie Plate losses
- Frame losses

High-efficiency transformer

design through magnetic field optimization



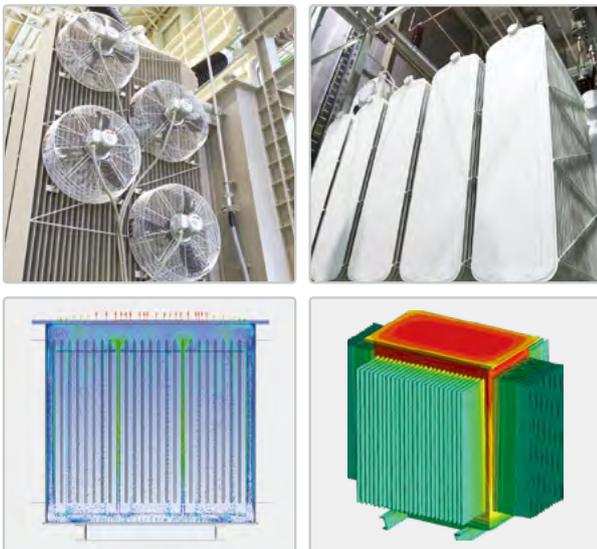
Cooling System

3D Heat Flow Analysis

- Overheating of high current leads
- Oil passage optimization

Cooling system optimization

Reliability of long-term operation

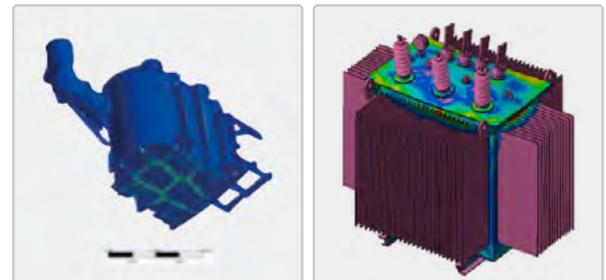


Mechanical Structure

3D Mechanical Structure Analysis & Seismic Analysis

- Frame&Tank structural strength
- Short circuit strength calculation
- Pressure test analysis

Reliability of structure



The seismic strength is verified by analyzing according to the seismic acceleration of the international standard(UBC, IEEE693, Etc) using “Equivalent static analysis” and “Dynamic static analysis”.

Equivalent Static Analysis

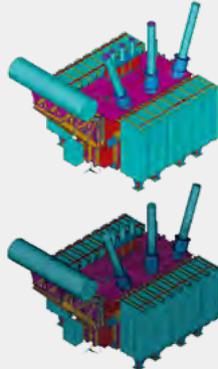
- Perform static analysis by converting the impact of an earthquake into an equivalent static load
- The first vibration mode is suitable for structures with dominant behavior
- Calculation is simple, time and cost are saved

Dynamic Static Analysis

- Response spectrum analysis
 - When there is no actual seismic wave
 - Using the structure's maximum response (displacement, velocity, acceleration)
 - Interpretation based on the principle of superposition to obtain a solution by superimposing each mode
- Time history analysis
 - Artificial earthquakes, past earthquake records are required
 - Accurate analysis, but time consuming, costly and impractical

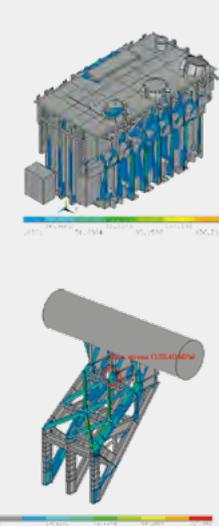
Seismic Analysis Process

Step 1. FE Modeling

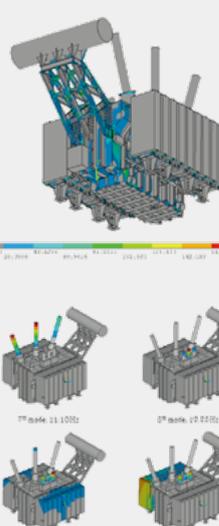


Part	Weight (ton)
HV Bushing	0.83
XV Bushing	0.245
HVN Bushing	0.044
XV Arrester	0.038
Radiator (1EA)	1.575
LCP	0.2

Step 2. Transformer inner pressure and self-weight analysis

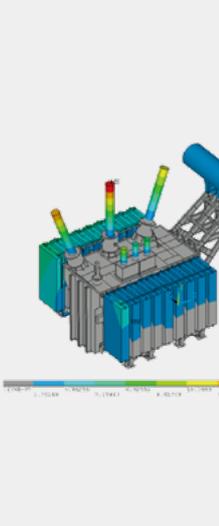
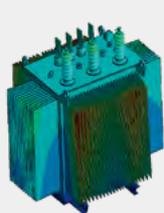
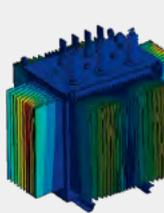
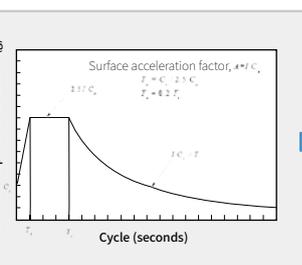
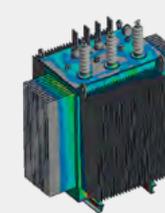


Step 3. Mode analysis



7th mode: 11.1052z
 8th mode: 12.220z
 13th mode: 13.71 Hz
 14th mode: 14.67 Hz

Step 4. Response spectrum analysis

Design & Manufacturing Process

Manufacturing

LS ELECTRIC proposes solutions according to customer requirements analysis, installation purpose and location, and provides a customized total solution from system design, configuration device and system detailed design, manufacturing and testing, commissioning, and maintenance.



Winding

Process for manufacturing winding which flows current by winding the rectangular shaped copper wire(Purity over 99.999%) to the cylinder shaped winding machine.



Core Cutting & Punching

The cores are produced by automatically cutting and punching roll-type silicon steel sheets into designed sizes using the program.



Core Stacking & Assembling

The cut silicon steel sheets are stacked to form magnetic circuits that are capable of generating an electric magnetic flux.



Assembling for Main Body

Core and winding are combined together electro-magnetically.



Final Assembling

Once the main device is inserted into the tank and the vacuum is achieved, the formation for the electrical circuit is completed by filling the insulation fluid and installing the various supplementary equipment types on the outside of the tank.



Final Testing

Upon completion of the final assembly, the transformer's electrical characteristics and electrical insulation performance is checked through final testing to guarantee its utmost quality.

Testing

LS ELECTRIC has world-class reliable test and inspection equipment, and provides the best quality to customers through characteristic tests, dielectric strength tests, and temperature rise tests that satisfy international standards such as IEC, ANSI/IEEE, and NEMA.

Routine Tests

- a) Measurement of winding resistance
- b) Measurement of voltage ratio and check of phase displacement
- c) Measurement of short-circuit impedance and load loss
- d) Measurement of no-load loss and current
- e) Dielectric routine tests

Type Tests

- a) Temperature-rise test
- b) Dielectric type tests
- c) Tests on on-load tap-changers

Special Tests

- a) Dielectric special tests
- b) Determination of capacitances windings-to-earth, and between windings
- c) Determination of transient voltage transfer characteristics
- d) Measurement of zero-sequence impedance(s)
- e) Determination of sound levels
- f) Measurement of the harmonics of the no-load current
- g) Measurement of the power taken by the fan and oil pump motors
- h) Measurement of insulation resistance



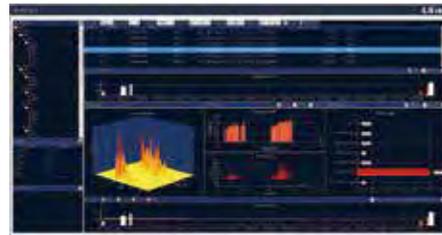
Testing Equipments

Impulse Test	3000kV 300kJ
AC Withstand Voltage Test	600kV 3000kVA
P.D Measurement	ERA/RIV 20kHz-20MHz
M.G set	6.6kV 2400kVA
Loss Measurement	200kV 4000A
Resistance Measurement	100A 1 $\mu\Omega$ ~ 500 Ω
Condenser Bank	130kV 144MVAR

PDPS (Power Equipment Diagnosis & Preventive System)

Through regular monitoring of major power equipment, accidents can be prevented and database management system of events and history of each unit support efficient management of power equipment.

GIS / Tr, Switchgear



PD Diagnosis



Dissolved Gas Analysis

[Work



GIS / Tr / Switchgear

1GBps Fiber Switched Ethernet

↕ (DNP3.0 over TCP/IP)

PD DAU



RT DAU



System Rack



UHF PD



Gas Density



CB Mechanism



Lightning Arrester



DissolveGasAnalysis



Oil-Temperatur



Oil-level Gauge



Others

GIS Diagnosis

- Partial discharge (UHF PD)
- SF₆ Gas density monitoring
- Analysis of circuit breaker operating & condition
- Cumulative breaking current
- Cable PD monitoring
- Lightning arrester leakage current

Transformer Diagnosis

- Oil contained gas concentration
- Insulated oil / Winding temperature
- FAN driving current / time
- PUMP driving current / time
- OLTC operating current / time

Diagnosis HMI

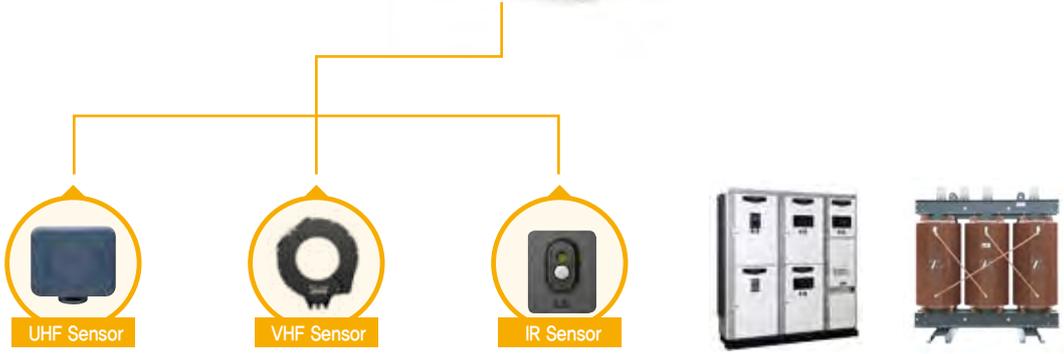


Diagnosis HMI

100MBps Switched Ethernet

Protocol based on TCP

SD DAU

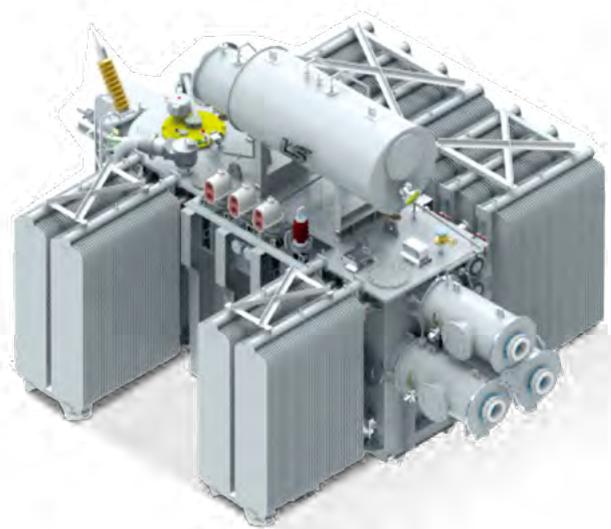


Switchgear Diagnosis

- UHF PD Diagnosis (Inside of the PNL)
- VHF PD Diagnosis (Cable)
- Contactless IR Temp Diagnosis (Phase Temp)
- Contact Temp Diagnosis
- Thermo-graphic Diagnosis

Eco-friendly Ester Oil Transformer

LS ELECTRIC, which considers user safety and the environment as top priority, introduces an eco-friendly ester oil transformer that can reduce the possibility of fire and explosion and prevent environmental pollution in the event of an oil leakage accident.

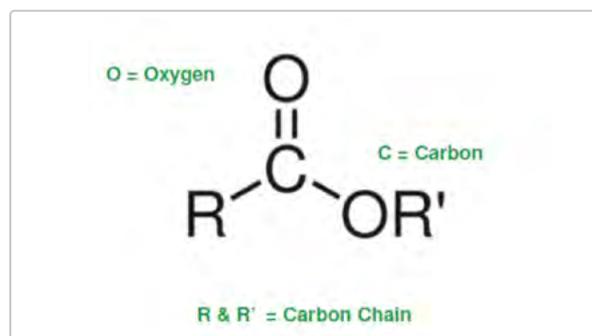


Main Features

- High Biodegradability
→ Minimize environmental pollution
- High Flash point & Fire point
→ Reduce fire risk
- High Water Saturation
→ Transformer life extension

Mineral Oil vs. Natural Ester Oil

Division	Mineral Oil	Natural Ester Oil
Raw material	Petroleum	Vegetal
Flash point	1.0	2.2
Viscosity	1.0	3.6
Pour point	1.0	0.4
Permittivity	1.0	1.5
Water saturation	Poor	Excellent
Oxidation	Good	Poor
Retro-filling	-	Good
Biodegradability	Poor	Excellent
Cost	1.0	2.7



Ester Linkage Chemical Structure

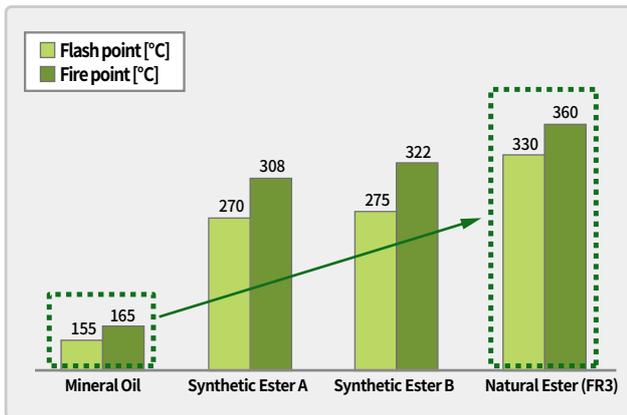
Characteristic of LS's Eco-friendly Ester Oil Transformer

Excellent biodegradability, minimal concern about environmental pollution

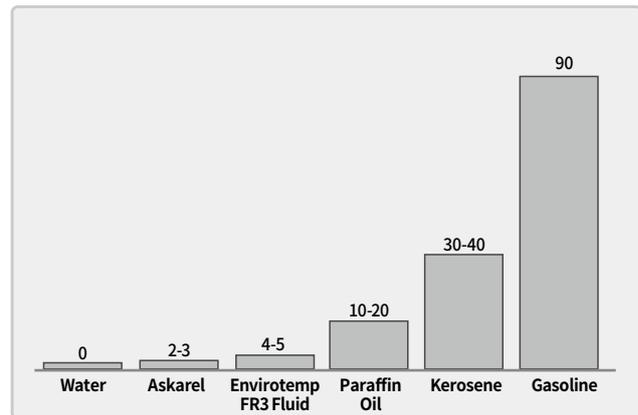
- More than 94% biodegradation of ester oil 28 days after exposure to soil
- Non-toxic and easy to purify

Excellence in fire safety

- K class insulating oil (when the fire point exceeds 300°C)
- At least twice as fire safe as paraffinic insulation oil



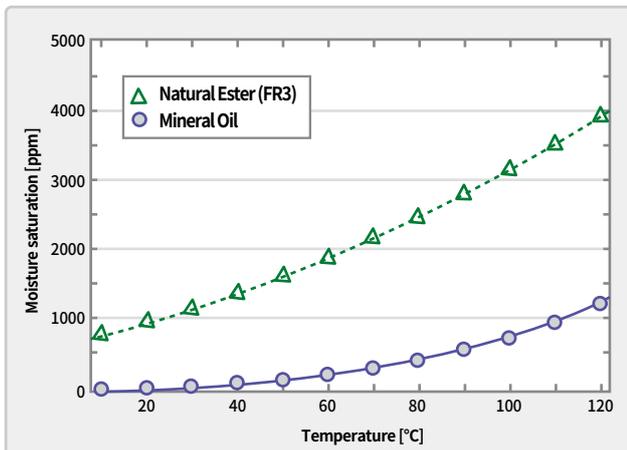
Flash & Fire point by type of insulation oil [°C]



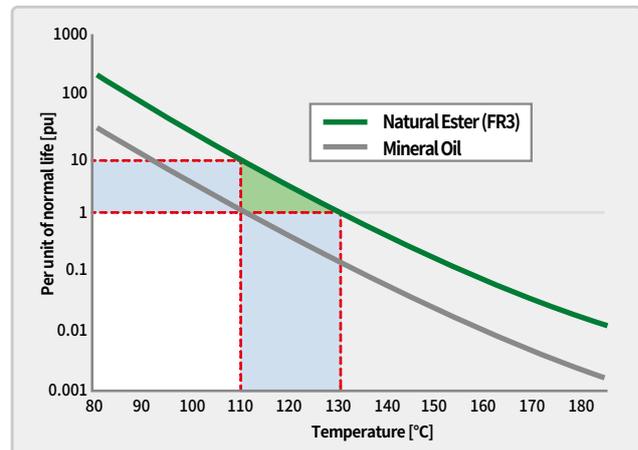
Fire hazard class of various fluids

Operation/maintenance cost reduction effect

- Higher water saturation compared to mineral oil → Reduced insulation moisture content → Reduce the rate of insulation deterioration → Transformer life extension effect



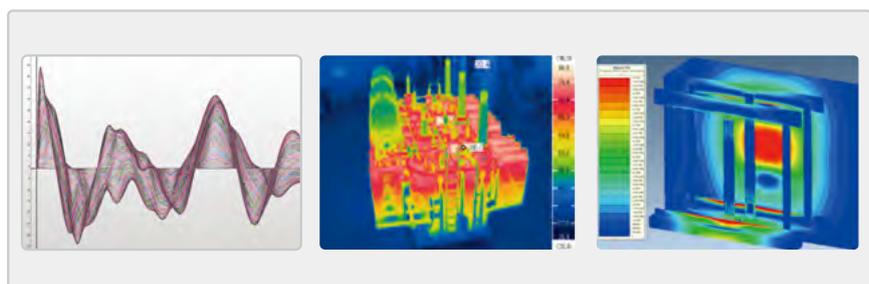
Moisture saturation according to oil type and temperature



Extended life expectancy

Transformer analysis and design considering the characteristics of natural ester oil

- Design technology considering the insulation characteristics
- Cooling design technology considering high viscosity
- High efficiency transformer design technology



Major Reference



Republic of Korea

- SGC Energy, 3ph 154/16.2kV 250/300MVA
- Dangin Unit 4, 3ph 345/18.05kV 616.5/690MVA
- Sinseocheon, 3ph 154kV 403MVA
- Sinjecheon SVC, 1ph 353/34.8kV 225MVA SVC
- BukDangjin - Godeok HVDC,
1ph 345/220kV(±500kV) Y-Y 31.5MVA HVDC CTR



United States

- AMP, 1ph 345kV 42MVA
- WAPA, 3ph 230kV 250MVA
- Hunt Electric, 3ph 138kV 60MVA
- KUB, 3ph 161kV 50MVA
- Samsung Engineering, 3ph 138kV 80MVA



China

- LG Display, 3ph 220kV 100MVA



Brazil

- CSP, 3ph 138kV 50MVA



Iraq

- MOE Mobile, 3ph, 132kV 25MVA
- MOE 1ph, 400kV 83.3MVA
- MOE, 3ph 33kV 31.5MVA, 132kV 63 & 90MVA



Ecuador

- CELEC EP, 3ph, 230kV 167MVA



India

- POSCO, 3ph 220kV 75MVA



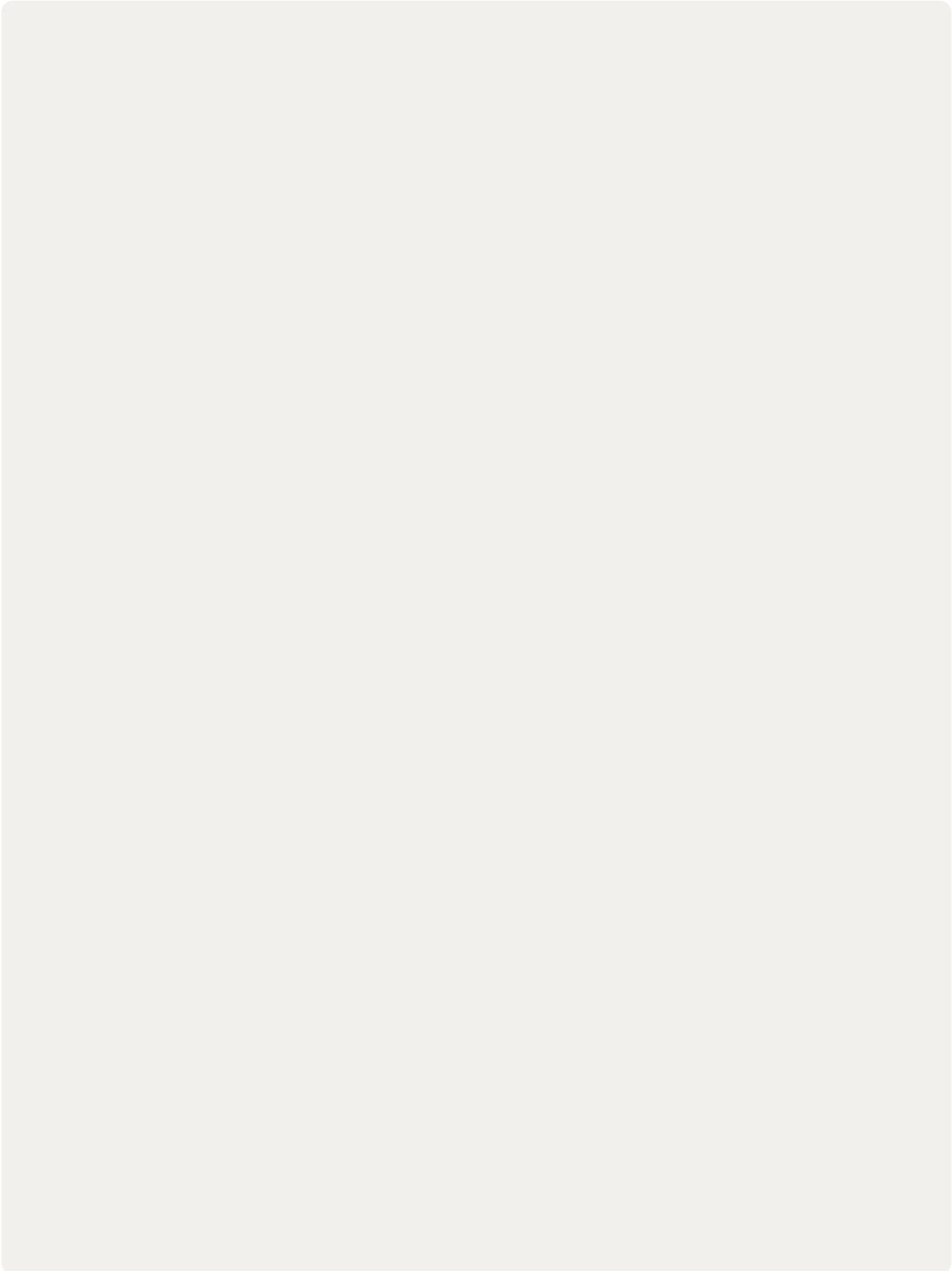
Chile

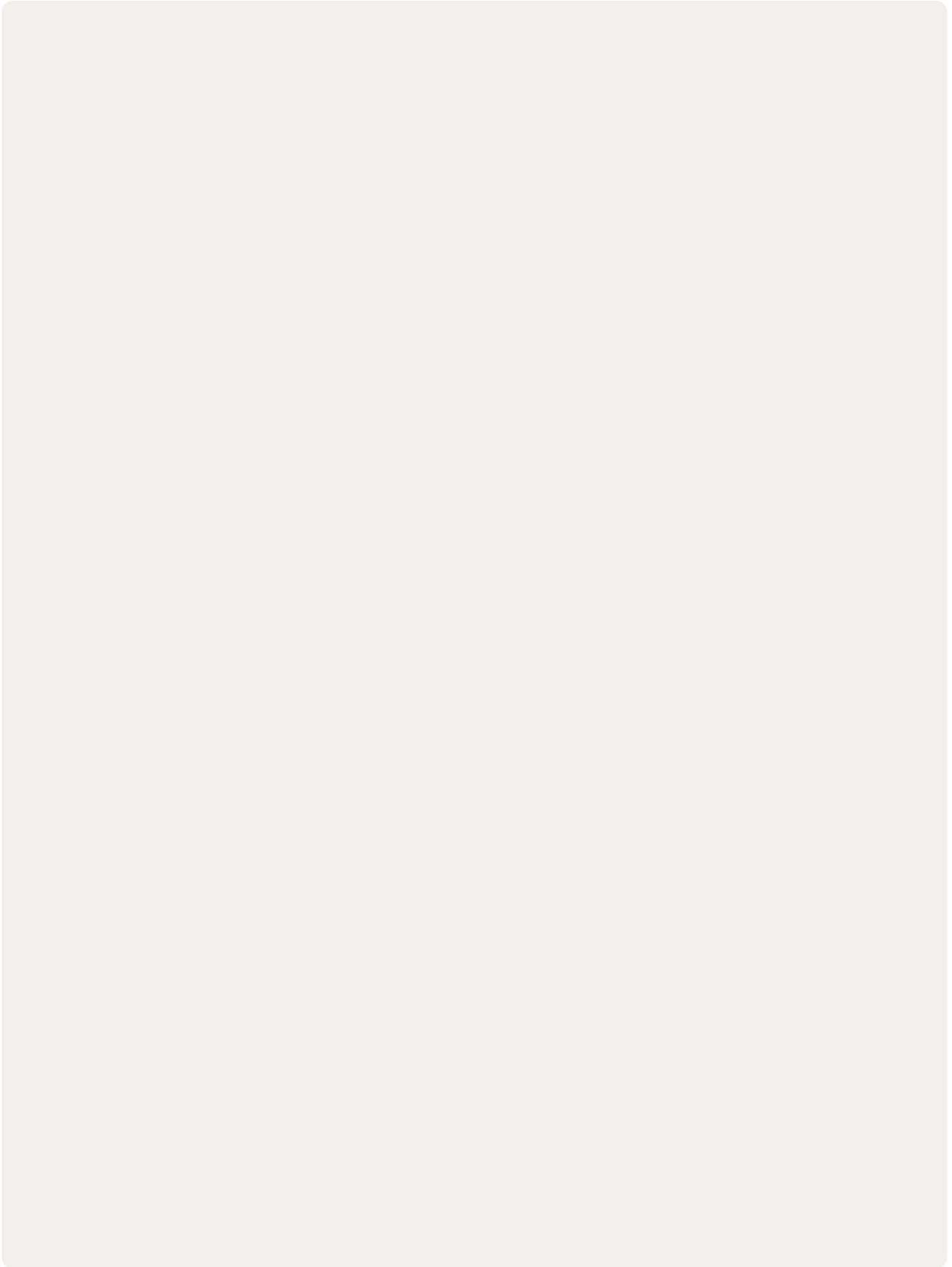
- Abengoa, 3ph 220kV 110MVA

Check List for Order

No	Item	Example
1	Quantity	
2	Applicable Standard	IEC, IEEE, JEC, Etc
3	Loading	Normal, Rectifier, Inverter, Etc
4	Phase (P)	1Phase(1), 3Phase(3), Etc
5	Frequency (Hz)	50, 60
6	Capacity (kVA)	1000/1333, 1500/2000, Etc
7	Cooling type	ONAN, ONAN/ONAF, Etc
8	Rated Voltage (kV)	Primary, Secondary, Tertiary, Etc
9	Tap Range (%)	$\pm 2 \times 2.5\%$, $\pm 8 \times 1.25\%$, Etc
10	Tap Changer	DETC, OLTC
11	Vector Group	YNyn0d1, YNd11, Dyn1, Dd0, Etc
12	Winding Material (Pri./Sec.)	AL/AL, CU/CU, Etc
13	%IZ (%)	5%, 8%, Etc
14	Winding Temperature rise (K)	55K, 65K, Etc
15	Oil Temperature rise (K)	50K, 60K, Etc
16	Location of bushing (Pri.-Sec.)	TOP : T, SIDE : S
17	Oil Preservation type	Breather type, Positive pressure type, Conservator type, Etc
18	Insulation Oil	Mineral Oil, Vegetable Oil, Synthetic Oil
19	Winding Temp. Indicator	Yes/No (Number of contact)
20	Oil Temp. Indicator	Yes/No (Number of contact)
21	Oil Level Gauge	Yes/No (Number of contact)
22	Pressure Relief Device	Yes/No (Number of contact)
23	B-H Relay (With Conservator)	Yes/No (Number of contact)
24	Place of Installation	Indoor, Outdoor

Memo





Global Business



LS ELECTRIC set a mid- to long-term vision for each overseas market to broaden its global business presence. In addition to pursuing the evolution of our existing businesses, we are discovering new business opportunities and strengthening the basis of business operations to take a tailor-made approach to each local market.

<p>1 Europe</p> <p>Accelerating growth mainly in the renewable energy market</p>	<p>2 Middle East & Southwest Asia</p> <p>Strengthening direct sales through localization</p>	<p>3 China</p> <p>Strengthening business capabilities for power equipment and systems</p>
<p>4 Southeast Asia</p> <p>Focusing on the sale of strategic products and project development</p>	<p>5 North America</p> <p>Delivering global products and solutions, tapping into the Central and Latin American markets</p>	

Domestic Subsidiaries

LS Metal
 Manufacturing copper tubes and STS pipes
 Yongsan-gu, Seoul, Korea

- Head Office
- Seoul Office
- Domestic Worksites
- Domestic R&D Centers
- Overseas Holding Company
- Overseas Production Subsidiaries



(as of Dec. 31, 2023)

LS Mecapion	LS -Sauter	LS ITC	A C & T system
Manufacturing industrial electronic equipment Dalseo-gu, Daegu, Korea	Selling BAS/IBS and GBS systems Anyang-si, Gyeonggi-do, Korea	Providing total IT services Yongsan-gu, Seoul, Korea	Manufacturing industrial communication equipment Anyang-si, Gyeonggi-do, Korea
Anyang Yongsan Cheongju, Cheonan, Busan R&D Campus (Anyang), Electric Power R&D Center (Cheongju), Power Testing & Technology Institute (Cheongju), Automation R&D Center (Cheonan), HVDC R&D Center (Busan) Shanghai (China), Chicago (US)	<ul style="list-style-type: none"> ● Overseas Sales Subsidiaries ● Overseas Branches ● Overseas R&D Center 	Hoofddorp (Netherlands), Dubai (UAE), Tokyo (Japan), Chicago (US), Istanbul (Turkey), Jakarta (Indonesia), Madrid (Spain) Shanghai (China), Beijing (China), Guangzhou (China), Qingdao (China), Nanjing (China), Chengdu (China), Shenyang (China), Tokyo (Japan), Hanoi (Vietnam), Ho Chi Minh (Vietnam), Moscow (Russia), Bangkok (Thailand), Santa Fe Springs (US), Singapore (Singapore), Bengaluru (India), Brescia (Italy), Bastrop Campus (US) Wuxi (China)	

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